Package ‘VGAM’

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Title Vector Generalized Linear and Additive Models
Author Thomas Yee [aut, cre] (<https://orcid.org/0000-0002-9970-3907>), Cleve Moler [ctb] (LINPACK routines in src)
Maintainer Thomas Yee <t.yee@auckland.ac.nz>
Depends R (>= 4.0.0), methods, stats, stats4, splines
Suggests VGAMextra, MASS, mgcv
Enhances VGAMdata
Description An implementation of about 6 major classes of statistical regression models. The central algorithm is Fisher scoring and iterative reweighted least squares. At the heart of this package are the vector generalized linear and additive model (VGLM/VGAM) classes. VGLMs can be loosely thought of as multivariate GLMs. VGAMs are data-driven VGLMs that use smoothing. The book "Vector Generalized Linear and Additive Models: With an Implementation in R" (Yee, 2015) <DOI:10.1007/978-1-4939-2818-7> gives details of the statistical framework and the package. Currently only fixed-effects models are implemented. Many (100+) models and distributions are estimated by maximum likelihood estimation (MLE) or penalized MLE. The other classes are RR-VGLMs (reduced-rank VGLMs), quadratic RR-VGLMs, doubly constrained RR-VGLMs, quadratic RR-VGLMs, reduced-rank VGAMs, RCIMs (row-column interaction models)---these classes perform constrained and unconstrained quadratic ordination (CQO/UQO) models in ecology, as well as constrained additive ordination (CAO). Hauck-Donner effect detection is implemented. Note that these functions are subject to change; see the NEWS and ChangeLog files for latest changes.
License GPL-3
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R topics documented:

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- VGAM-package
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VGAM-package

Description

VGAM provides functions for fitting vector generalized linear and additive models (VGLMs and VGAMs), and associated models (Reduced-rank VGLMs or RR-VGLMs, Doubly constrained RR-VGLMs (DRR-VGLMs), Quadratic RR-VGLMs, Reduced-rank VGAMs). This package fits many models and distributions by maximum likelihood estimation (MLE) or penalized MLE, under this statistical framework. Also fits constrained ordination models in ecology such as constrained quadratic ordination (CQO).

Details

This package centers on the iteratively reweighted least squares (IRLS) algorithm. Other key words include Fisher scoring, additive models, reduced-rank regression, penalized likelihood, and constrained ordination. The central modelling functions are \texttt{vglm, vgam, rrvglm, rcim, cco, cao}. Function \texttt{vglm} operates very similarly to \texttt{glm} but is much more general, and many methods functions such as \texttt{coef} and \texttt{predict} are available. The package uses S4 (see \texttt{methods-package}).

Some notable companion packages: (1) \texttt{VGAMdata} mainly contains data sets useful for illustrating VGAM. Some of the big ones were initially from VGAM. Recently, some older VGAM family functions have been shifted into this package. (2) \texttt{VGAMextra} written by Victor Miranda has some additional VGAM family and link functions, with a bent towards time series models. (3) \texttt{svyVGAM} provides design-based inference, e.g., to survey sampling settings. This is because the \texttt{weights} argument of \texttt{vglm} can be assigned any positive values including survey weights.

Compared to other similar packages, such as \texttt{gamlss} and \texttt{mgcv}, VGAM has more models implemented (150+ of them) and they are not restricted to a location-scale-shape framework or (largely) the 1-parameter exponential family. The general statistical framework behind it all, once grasped, makes regression modelling unified. Some features of the package are: (i) many family functions handle multiple responses; (ii) reduced-rank regression is available by operating on latent variables (optimal linear combinations of the explanatory variables); (iii) basic automatic smoothing parameter selection is implemented for VGAMs (\texttt{sm.os} and \texttt{sm.ps} with a call to \texttt{magic}), although it has to be refined; (iv) \texttt{smart} prediction allows correct prediction of nested terms in the formula provided smart functions are used.
The GLM and GAM classes are special cases of VGLMs and VGAMs. The VGLM/VGAM framework is intended to be very general so that it encompasses as many distributions and models as possible. VGLMs are limited only by the assumption that the regression coefficients enter through a set of linear predictors. The VGLM class is very large and encompasses a wide range of multivariate response types and models, e.g., it includes univariate and multivariate distributions, categorical data analysis, extreme values, correlated binary data, quantile and expectile regression, time series problems. Potentially, it can handle generalized estimating equations, survival analysis, bioassay data and nonlinear least-squares problems.

Crudely, VGAMs are to VGLMs what GAMs are to GLMs. Two types of VGAMs are implemented: 1st-generation VGAMs with s use vector backfitting, while 2nd-generation VGAMs with sm.os and sm.ps use O-splines and P-splines so have a direct solution (hence avoids backfitting) and have automatic smoothing parameter selection. The former is older and is based on Yee and Wild (1996). The latter is more modern (Yee, Somchit and Wild, 2024) but it requires a reasonably large number of observations to work well because it is based on optimizing over a predictive criterion rather than using a Bayesian approach.

An important feature of the framework is that of constraint matrices. They apportion the regression coefficients according to each explanatory variable. For example, since each parameter has a link function applied to it to turn it into a linear or additive predictor, does a covariate have an equal effect on each parameter? Or no effect? Arguments such as zero, parallel and exchangeable, are merely easy ways to have them constructed internally. Users may input them explicitly using the constraint argument, and CM.symm0 etc. can make this easier.

Another important feature is implemented by xij. It allows different linear/additive predictors to have a different values of the same explanatory variable, e.g., multinomial for the conditional logit model and the like.

VGLMs with dimension reduction form the class of RR-VGLMs. This is achieved by reduced rank regression. Here, a subset of the constraint matrices are estimated rather than being known and prespecified. Optimal linear combinations of the explanatory variables are taken (creating latent variables) which are used for fitting a VGLM. Thus the regression can be thought of as being in two stages. The class of DRR-VGLMs provides further structure to RR-VGLMs by allowing constraint matrices to be specified for each column of A and row of C. Thus the reduced rank regression can be fitted with greater control.

This package is the first to check for the Hauck-Donner effect (HDE) in regression models; see hdeff. This is an aberration of the Wald statistics when the parameter estimates are too close to the boundary of the parameter space. When present the p-value of a regression coefficient is biased upwards so that a highly significant variable might be deemed nonsignificant. Thus the HDE can create havoc for variable selection!

Somewhat related to the previous paragraph, hypothesis testing using the likelihood ratio test, Rao’s score test (Lagrange multiplier test) and (modified) Wald’s test are all available; see summaryvglm. For all regression coefficients of a model, taken one at a time, all three methods require further IRLS iterations to obtain new values of the other regression coefficients after one of the coefficients has had its value set (usually to 0). Hence the computation load is overall significant.

For a complete list of this package, use library(help = "VGAM"). New VGAM family functions are continually being written and added to the package.
Warning

This package is undergoing continual development and improvement, therefore users should treat many things as subject to change. This includes the family function names, argument names, many of the internals, moving some functions to VGAMdata, the use of link functions, and slot names. For example, many link functions were renamed in 2019 so that they all end in "link", e.g., logl1nk() instead of loge(). Some future pain can be avoided by using good programming techniques, e.g., using extractor functions such as coef(), weights(), vcov(), predict(). Although changes are now less frequent, please expect changes in all aspects of the package. See the NEWS file for a list of changes from version to version.

Author(s)

Thomas W. Yee, <t.yee@auckland.ac.nz>, with contributions from Victor Miranda and several graduate students over the years, especially Xiangjie (Albert) Xue and Chanatda Somchit.

Maintainer: Thomas Yee <t.yee@auckland.ac.nz>.

References


The website for the VGAM package and book is https://www.stat.auckland.ac.nz/~yee/.

There are some resources there, especially as relating to my book and new features added to VGAM. Some useful background reference for the package include:


See Also


Examples

```
# Example 1; proportional odds model
pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo))
depvar(fit1) # Better than using fit1@y; dependent variable (response)
weights(fit1, type = "prior") # Number of observations
coef(fit1, matrix = TRUE) # p.179, in McCullagh and Nelder (1989)
constraints(fit1) # Constraint matrices
summary(fit1) # HDE could affect these results
summary(fit1, lrt0 = TRUE, score0 = TRUE, wald0 = TRUE) # No HDE
hdeff(fit1) # Check for any Hauck-Donner effect

# Example 2; zero-inflated Poisson model
zdata <- data.frame(x2 = runif(nn <- 2000))
zdata <- transform(zdata, pstr0 = logitlink(-0.5 + 1*x2, inverse = TRUE),
                   lambda = loglink( 0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata, y = rzipois(nn, lambda, pstr0 = pstr0))
with(zdata, table(y))
fit2 <- vglm(y ~ x2, zipoisson, data = zdata, trace = TRUE)
coef(fit2, matrix = TRUE) # These should agree with the above values

# Example 3; fit a two species GAM simultaneously
fit3 <- vgam(cbind(agaaua, kniexc) ~ s(altitude, df = c(2, 3)),
             binomialff(multiple.responses = TRUE), data = hunua)
coef(fit3, matrix = TRUE) # Not really interpretable
## Not run: plot(fit3, se = TRUE, overlay = TRUE, lcol = 3:4, scol = 3:4)

## End(Not run)

# Example 4; LMS quantile regression
fit4 <- vgam(BMI ~ s(age, df = c(4, 2)), lms.bcn(zero = 1),
             data = bmi.nz, trace = TRUE)
head(predict(fit4))
```
head(fitted(fit4))
head(bmi.nz) # Person 1 is near the lower quartile among people his age
head(cdf(fit4))

## Not run: par(mfrow = c(1,1), bty = "l", mar = c(5,4,3)+0.1, xpd=TRUE)
qtplot(fit4, percentiles = c(5,50,90,99), main = "Quantiles", las = 1,
xlim = c(15, 90), ylab = "BMI", lwd=2, lcol=4) # Quantile plot

ygrid <- seq(15, 43, len = 100) # BMI ranges
par(mfrow = c(1,1), lwd = 2) # Density plot
aa <- deplot(fit4, x0 = 20, y = ygrid, xlab = "BMI", col = "black",
             main = "Density functions at Age=20 (black), 42 (red) and 55 (blue)")

aa <- deplot(fit4, x0 = 42, y = ygrid, add = TRUE, lty = 2, col = "red")
aa <- deplot(fit4, x0 = 55, y = ygrid, add = TRUE, lty = 4, col = "blue",
             Attach = TRUE)

aa@post$deplot # Contains density function values

## End(Not run)

# Example 5; GEV distribution for extremes
(fit5 <- vglm(maxtemp ~ 1, gevff, data = oxtemp, trace = TRUE))
head(fitted(fit5))
coef(fit5, matrix = TRUE)
Coef(fit5)
vcov(fit5)
vcov(fit5, untransform = TRUE)
sqrt(diag(vcov(fit5))) # Approximate standard errors
## Not run: rlplot(fit5)

A1A2A3

The A1A2A3 Blood Group System

Description

Estimates the three independent parameters of the the A1A2A3 blood group system.

Usage

A1A2A3(link = "logitlink", inbreeding = FALSE, ip1 = NULL, ip2 = NULL, iF = NULL)

Arguments

link Link function applied to p1, p2 and f. See Links for more choices.
inbreeding Logical. Is there inbreeding?
ip1, ip2, iF Optional initial value for p1, p2 and f.
Details

The parameters $p_1$ and $p_2$ are probabilities, so that $p_3=1-p_1-p_2$ is the third probability. The parameter $f$ is the third independent parameter if inbreeding = TRUE. If inbreeding = FALSE then $f = 0$ and Hardy-Weinberg Equilibrium (HWE) is assumed.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The input can be a 6-column matrix of counts, with columns corresponding to $A_1A_1$, $A_1A_2$, $A_1A_3$, $A_2A_2$, $A_2A_3$, $A_3A_3$ (in order). Alternatively, the input can be a 6-column matrix of proportions (so each row adds to 1) and the weights argument is used to specify the total number of counts for each row.

Author(s)

T. W. Yee

References


See Also

AA.Aa.aa, AB.Ab.aB.ab, AB0, MNSs.

Examples

ymat <- cbind(108, 196, 429, 143, 513, 559)
fit <- vglm(ymat ~ 1, A1A2A3(link = probitlink), trace = TRUE, crit = "coef")
fit <- vglm(ymat ~ 1, A1A2A3(link = logitlink, ip1 = 0.3, ip2 = 0.3, iF = 0.02),
trace = TRUE, crit = "coef")
Coef(fit) # Estimated p1 and p2
rbind(ymat, sum(ymat) * fitted(fit))
sqrt(diag(vcov(fit)))
Usage

AA.Aa.aa(linkp = "logitlink", linkf = "logitlink", inbreeding = FALSE,
        ipA = NULL, ifp = NULL, zero = NULL)

Arguments

linkp, linkf       Link functions applied to \( pA \) and \( f \). See Links for more choices.
ipA, ifp           Optional initial values for \( pA \) and \( f \).
inbreeding        Logical. Is there inbreeding?
zero               See CommonVGAMffArguments for information.

Details

This one or two parameter model involves a probability called \( pA \). The probability of getting a count in the first column of the input (an AA) is \( pA \cdot pA \). When \( \text{inbreeding} = \text{TRUE} \), an additional parameter \( f \) is used. If \( \text{inbreeding} = \text{FALSE} \) then \( f = 0 \) and Hardy-Weinberg Equilibrium (HWE) is assumed. The EIM is used if \( \text{inbreeding} = \text{FALSE} \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Setting \( \text{inbreeding} = \text{FALSE} \) makes estimation difficult with non-intercept-only models. Currently, this code seems to work with intercept-only models.

Note

The input can be a 3-column matrix of counts, where the columns are AA, Ab and aa (in order). Alternatively, the input can be a 3-column matrix of proportions (so each row adds to 1) and the weights argument is used to specify the total number of counts for each row.

Author(s)

T. W. Yee

References


See Also

AB.Ab.ab, ABO, A1A2A3, MNSs.
Examples

```r
y <- cbind(53, 95, 38)
fit1 <- vglm(y ~ 1, AA.Aa.aa, trace = TRUE)
fit2 <- vglm(y ~ 1, AA.Aa.aa(inbreeding = TRUE), trace = TRUE)
rbind(y, sum(y) * fitted(fit1))
Coef(fit1) # Estimated pA
Coef(fit2) # Estimated pA and f
summary(fit1)
```

---

### AB.Ab.aB.ab

The AB-Ab-aB-ab Blood Group System

---

**Description**

Estimates the parameter of the AB-Ab-aB-ab blood group system.

**Usage**

```r
AB.Ab.aB.ab(link = "logitlink", init.p = NULL)
```

**Arguments**

- `link` Link function applied to `p`. See `Links` for more choices.
- `init.p` Optional initial value for `p`.

**Details**

This one parameter model involves a probability called `p`.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Note**

The input can be a 4-column matrix of counts, where the columns are AB, Ab, aB and ab (in order). Alternatively, the input can be a 4-column matrix of proportions (so each row adds to 1) and the `weights` argument is used to specify the total number of counts for each row.

**Author(s)**

T. W. Yee

**References**

The ABO Blood Group System

Description

Estimates the two independent parameters of the ABO blood group system.

Usage

```r
ABO(link.pA = "logitlink", link.pB = "logitlink", ipA = NULL, ipB = NULL, ipO = NULL, zero = NULL)
```

Arguments

- `link.pA`, `link.pB` Link functions applied to pA and pB. See `Links` for more choices.
- `ipA`, `ipB`, `ipO` Optional initial value for pA and pB and pO. A NULL value means values are computed internally.
- `zero` Details at `CommonVGAMffArguments`.

Details

The parameters pA and pB are probabilities, so that pO=1−pA−pB is the third probability. The probabilities pA and pB correspond to A and B respectively, so that pO is the probability for O. It is easier to make use of initial values for pO than for pB. In documentation elsewhere I sometimes use pA=p, pB=q, pO=r.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.  

Examples

```r
ymat <- cbind(AB=1997, Ab=906, aB=904, ab=32) # Data from Fisher (1925)
fit <- vglm(ymat ~ 1, AB.Ab.aB.ab(link = "identitylink"), trace = TRUE)
fit <- vglm(ymat ~ 1, AB.Ab.aB.ab, trace = TRUE)
rbind(ymat, sum(ymat)*fitted(fit))
Coef(fit) # Estimated p
p <- sqrt(4*(fitted(fit)[, 4]))
p*p
summary(fit)
```
Note

The input can be a 4-column matrix of counts, where the columns are A, B, AB, O (in order). Alternatively, the input can be a 4-column matrix of proportions (so each row adds to 1) and the weights argument is used to specify the total number of counts for each row.

Author(s)

T. W. Yee

References


See Also

AA.Aa.aa, AB.Ab.aB.ab, A1A2A3, MNSs.

Examples

ymat <- cbind(A = 725, B = 258, AB = 72, O = 1073) # Order matters, not the name
fit <- vglm(ymat ~ 1, ABO(link.pA = "identitylink", link.pB = "identitylink"), trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit) # Estimated pA and pB
rbind(ymat, sum(ymat) * fitted(fit))
sqrt(diag(vcov(fit)))

Description

Fits an adjacent categories regression model to an ordered (preferably) factor response.

Usage

acat(link = "loglink", parallel = FALSE, reverse = FALSE,
    zero = NULL, ynames = FALSE, Thresh = NULL, Trev = reverse,
    Tref = if (Trev) "M" else 1, whitespace = FALSE)
Arguments

link Link function applied to the ratios of the adjacent categories probabilities. See Links for more choices.

parallel A logical, or formula specifying which terms have equal/unequal coefficients.

reverse Logical. By default, the linear/additive predictors used are $\eta_j = \log(P[Y = j + 1]/P[Y = j])$ for $j = 1, \ldots, M$. If reverse is TRUE then $\eta_j = \log(P[Y = j]/P[Y = j + 1])$ will be used.

ynames See multinomial for information.

zero An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \{1,2,\ldots,M\}. See CommonVGAMffArguments for more information.

Thresh, Trev, Tref See cumulative for information. These arguments apply to ordinal categorical regression models.

whitespace See CommonVGAMffArguments for information.

Details

In this help file the response $Y$ is assumed to be a factor with ordered values 1, 2, \ldots, $M + 1$, so that $M$ is the number of linear/additive predictors $\eta_j$. By default, the log link is used because the ratio of two probabilities is positive.

Internally, deriv3 is called to perform symbolic differentiation and consequently this family function will struggle if $M$ becomes too large. If this occurs, try combining levels so that $M$ is effectively reduced. One idea is to aggregate levels with the fewest observations in them first.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

No check is made to verify that the response is ordinal if the response is a matrix; see ordered.

Note

The response should be either a matrix of counts (with row sums that are all positive), or an ordered factor. In both cases, the $y$ slot returned by vglm/vgam/rrvglm is the matrix of counts.

For a nominal (unordered) factor response, the multinomial logit model (multinomial) is more appropriate.

Here is an example of the usage of the parallel argument. If there are covariates $x_1$, $x_2$ and $x_3$, then parallel = TRUE ~ x1 + x2 ~1 and parallel = FALSE ~ x3 are equivalent. This would constrain the regression coefficients for $x_1$ and $x_2$ to be equal; those of the intercepts and $x_3$ would be different.
add1.vglm

Author(s)
Thomas W. Yee

References

See Also
cumulative, cratio, sratio, multinomial, CM.equiv, CommonVGAMffArguments, margeff, pneumo, budworm, deriv3.

Examples
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let, acat, pneumo))
coef(fit, matrix = TRUE)
constraints(fit)
model.matrix(fit)

---

add1.vglm

Add or Drop All Possible Single Terms to/from a Model

Description
Compute all the single terms in the scope argument that can be added to or dropped from the model, fit those models and compute a table of the changes in fit.

Usage
```r
## S3 method for class 'vglm'
add1(object, scope, test = c("none", "LRT"), k = 2, ...)
## S3 method for class 'vglm'
drop1(object, scope, test = c("none", "LRT"), k = 2, ...)
```

Arguments
- `object` a fitted `vglm` model object.
- `scope, k` See `drop1.glm`.
- `test` Same as `drop1.glm` but with fewer choices.
- `...` further arguments passed to or from other methods.
Details

These functions are a direct adaptation of `add1.glm` and `drop1.glm` for `vglm-class` objects. For `drop1` methods, a missing scope is taken to be all terms in the model. The hierarchy is respected when considering terms to be added or dropped: all main effects contained in a second-order interaction must remain, and so on. In a scope formula, means ‘what is already there’.

Compared to `add1.glm` and `drop1.glm` these functions are simpler, e.g., there is no Cp, F and Rao (score) tests, x and scale arguments. Most models do not have a deviance, however twice the log-likelihood differences are used to test the significance of terms.

The default output table gives AIC, defined as minus twice log likelihood plus 2p where p is the rank of the model (the number of effective parameters). This is only defined up to an additive constant (like log-likelihoods).

Value

An object of class "anova" summarizing the differences in fit between the models.

Warning

In general, the same warnings in `add1.glm` and `drop1.glm` apply here. Furthermore, these functions have not been rigorously tested for all models, so treat the results cautiously and please report any bugs.

Care is needed to check that the constraint matrices of added terms are correct. Also, if object is of the form `vglm(..., constraints = list(x1 = cm1, x2 = cm2))` then `add1.vglm` may fail because the constraints argument needs to have the constraint matrices for all terms.

Note

Most VGAM family functions do not compute a deviance, but instead the likelihood function is evaluated at the MLE. Hence a column name "Deviance" only appears for a few models; and almost always there is a column labelled "logLik".

See Also

`step4vglm`, `vglm`, `extractAIC.vglm`, `trim.constraints`, `anova.vglm`, `backPain2`, `update`.

Examples

data("backPain2", package = "VGAM")
summary(backPain2)
fit1 <- vglm(pain ~ x2 + x3 + x4, propodds, data = backPain2)
coef(fit1)
add1(fit1, scope = ~ x2 * x3 * x4, test = "LRT")
drop1(fit1, test = "LRT")
fit2 <- vglm(pain ~ x2 * x3 * x4, propodds, data = backPain2)
drop1(fit2)
AICvlm

Akaike’s Information Criterion

Description
Calculates the Akaike information criterion for a fitted model object for which a log-likelihood value has been obtained.

Usage
\[
\text{AICvlm(object, ..., corrected = FALSE, k = 2)}
\]
\[
\text{AICvgam(object, ..., k = 2)}
\]
\[
\text{AICrrvglm(object, ..., k = 2)}
\]
\[
\text{AICdrrvglm(object, ..., k = 2)}
\]
\[
\text{AICqrrvglm(object, ..., k = 2)}
\]
\[
\text{AICrrvgam(object, ..., k = 2)}
\]

Arguments
- **object**: Some VGAM object, for example, having class vglm-class.
- **...**: Other possible arguments fed into logLik in order to compute the log-likelihood.
- **corrected**: Logical, perform the finite sample correction?
- **k**: Numeric, the penalty per parameter to be used; the default is the classical AIC.

Details
The following formula is used for VGLMs: \(-2\text{log-likelihood} + kn_{\text{par}},\) where \(n_{\text{par}}\) represents the number of parameters in the fitted model, and \(k = 2\) for the usual AIC. One could assign \(k = \log(n)\) (\(n\) the number of observations) for the so-called BIC or SBC (Schwarz’s Bayesian criterion). This is the function AICvlm().

This code relies on the log-likelihood being defined, and computed, for the object. When comparing fitted objects, the smaller the AIC, the better the fit. The log-likelihood and hence the AIC is only defined up to an additive constant.

Any estimated scale parameter (in GLM parlance) is used as one parameter.

For VGAMs and CAO the nonlinear effective degrees of freedom for each smoothed component is used. This formula is heuristic. These are the functions AICvgam() and AICcao().

The finite sample correction is usually recommended when the sample size is small or when the number of parameters is large. When the sample size is large their difference tends to be negligible. The correction is described in Hurvich and Tsai (1989), and is based on a (univariate) linear model with normally distributed errors.

Value
Returns a numeric value with the corresponding AIC (or BIC, or \ldots, depending on \(k\)).
**Warning**

This code has not been double-checked. The general applicability of AIC for the VGLM/VGAM classes has not been developed fully. In particular, AIC should not be run on some VGAM family functions because of violation of certain regularity conditions, etc.

**Note**

AIC has not been defined for QRR-VGLMs, yet.

Using AIC to compare posbinomial models with, e.g., posbernoulli.tb models, requires posbinomial(omit.constant = TRUE). See posbinomial for an example. A warning is given if it suspects a wrong omit.constant value was used.

Where defined, AICc(...) is the same as AIC(..., corrected = TRUE).

**Author(s)**

T. W. Yee.

**References**


**See Also**

VGLMs are described in vglm-class; VGAMs are described in vgam-class; RR-VGLMs are described in rrvglm-class; AIC, BICvlm, TICvlm, drop1.vglm, extractAIC.vglm.

**Examples**

```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let,
             cumulative(parallel = TRUE, reverse = TRUE), data = pneumo))
coef(fit1, matrix = TRUE)
AIC(fit1)
AICc(fit1)  # Quick way
AIC(fit1, corrected = TRUE)  # Slow way
(fit2 <- vglm(cbind(normal, mild, severe) ~ let,
             cumulative(parallel = FALSE, reverse = TRUE), data = pneumo))
coef(fit2, matrix = TRUE)
AIC(fit2)
AICc(fit2)
AIC(fit2, corrected = TRUE)
```
Asymmetric Laplace Distribution Family Functions

Description

Maximum likelihood estimation of the 1, 2 and 3-parameter asymmetric Laplace distributions (ALDs). The 2-parameter ALD may, with trepidation and lots of skill, sometimes be used as an approximation of quantile regression.

Usage

alaplace1(tau = NULL, llocation = "identitylink", ilocation = NULL, kappa = sqrt(tau/(1 - tau)), Scale.arg = 1, ishrinkage = 0.95, parallel.locat = TRUE ~ 0, digit = 4, idf.mu = 3, zero = NULL, imethod = 1)
alaplace2(tau = NULL, llocation = "identitylink", lscale = "loglink", ilocation = NULL, iscale = NULL, kappa = sqrt(tau/(1 - tau)), ishrinkage = 0.95, parallel.locat = TRUE ~ 0, parallel.scale = FALSE ~ 0, digit = 4, idf.mu = 3, imethod = 1, zero = "scale")
alaplace3(llocation = "identitylink", lscale = "loglink", lkappa = "loglink", ilocation = NULL, iscale = NULL, ikappa = 1, imethod = 1, zero = c("scale", "kappa"))

Arguments

tau, kappa Numeric vectors with 0 < \tau < 1 and \kappa > 0. Most users will only specify tau since the estimated location parameter corresponds to the \tau th regression quantile, which is easier to understand. See below for details.

llocation, lscale, lkappa Character. Parameter link functions for location parameter \xi, scale parameter \sigma, asymmetry parameter \kappa. See Links for more choices. For example, the argument llocation can help handle count data by restricting the quantiles to be positive (use llocation = "loglink"). However, llocation is best left alone since the theory only works properly with the identity link.

ilocation, iscale, ikappa Optional initial values. If given, it must be numeric and values are recycled to the appropriate length. The default is to choose the value internally.

parallel.locat, parallel.scale See the parallel argument of CommonVGAMffArguments. These arguments apply to the location and scale parameters. It generally only makes sense for the
scale parameters to be equal, hence set `parallel.scale = TRUE`. Note that assigning `parallel.locat` the value `TRUE` circumvents the seriously embarrassing quantile crossing problem because all constraint matrices except for the intercept correspond to a parallelism assumption.

**imethod**
Initialization method. Either the value 1, 2, 3 or 4.

**idf.mu**
Degrees of freedom for the cubic smoothing spline fit applied to get an initial estimate of the location parameter. See `vsmooth.spline`. Used only when `imethod = 3`.

**ishrinkage**
How much shrinkage is used when initializing $\xi$. The value must be between 0 and 1 inclusive, and a value of 0 means the individual response values are used, and a value of 1 means the median or mean is used. This argument is used only when `imethod = 4`. See `CommonVGAMffArguments` for more information.

**Scale.arg**
The value of the scale parameter $\sigma$. This argument may be used to compute quantiles at different $\tau$ values from an existing fitted `alaplace2()` model (practical only if it has a single value). If the model has `parallel.locat = TRUE` then only the intercept need be estimated; use an offset. See below for an example.

**digt**
Passed into `Round` as the `digits` argument for the $\tau$ values; used cosmetically for labelling.

**zero**
See `CommonVGAMffArguments` for more information. Where possible, the default is to model all the $\sigma$ and $\kappa$ as an intercept-only term. See `CommonVGAMffArguments` for more information.

## Details

These **VGAM** family functions implement one variant of asymmetric Laplace distributions (ALDs) suitable for quantile regression. Kotz et al. (2001) call it the ALD. Its density function is

$$f(y; \xi, \sigma, \kappa) = \frac{\sqrt{2}}{\sigma} \frac{1}{1 + \kappa^2} \exp\left(-\frac{\sqrt{2}}{\sigma \kappa} |y - \xi| \right)$$

for $y \leq \xi$, and

$$f(y; \xi, \sigma, \kappa) = \frac{\sqrt{2}}{\sigma} \frac{1}{1 + \kappa^2} \exp\left(-\frac{\sqrt{2}}{\sigma \kappa} |y - \xi| \right)$$

for $y > \xi$. Here, the ranges are for all real $y$ and $\xi$, positive $\sigma$ and positive $\kappa$. The special case $\kappa = 1$ corresponds to the (symmetric) Laplace distribution of Kotz et al. (2001). The mean is $\xi + \sigma(1/\kappa - \kappa)/\sqrt{2}$ and the variance is $\sigma^2(1 + \kappa^4)/(2\kappa^2)$. The enumeration of the linear/additive predictors used for `alaplace2()` is the first location parameter followed by the first scale parameter, then the second location parameter followed by the second scale parameter, etc. For `alaplace3()`, only a vector response is handled and the last (third) linear/additive predictor is for the asymmetry parameter.

It is known that the maximum likelihood estimate of the location parameter $\xi$ corresponds to the regression quantile estimate of the classical quantile regression approach of Koenker and Bassett (1978). An important property of the ALD is that $P(Y \leq \xi) = \tau$ where $\tau = \kappa^2/(1 + \kappa^2)$ so that $\kappa = \sqrt{\tau/(1 - \tau)}$. Thus `alaplace2()` might be used as an alternative to `rq` in the **quantreg** package, although scoring is really an unsuitable algorithm for estimation here.
Both `alaplace1()` and `alaplace2()` can handle multiple responses, and the number of linear/additive predictors is dictated by the length of `tau` or `kappa`. The functions `alaplace1()` and `alaplace2()` can also handle multiple responses (i.e., a matrix response) but only with a *single-valued* `tau` or `kappa`.

**Value**

An object of class "`vglmff`" (see [vglmff-class](https://example.com)). The object is used by modelling functions such as `vglm` and `vgam`.

In the extra slot of the fitted object are some list components which are useful, e.g., the sample proportion of values which are less than the fitted quantile curves.

**Warning**

These functions are experimental and especially subject to change or withdrawal. The usual MLE regularity conditions do not hold for this distribution so that misleading inferences may result, e.g., in the `summary` and `vcov` of the object. The 1-parameter ALD can be approximated by `extlogF1` which has continuous derivatives and is recommended over `alaplace1`.

Care is needed with `tau` values which are too small, e.g., for count data with `allocation = "loglink"` and if the sample proportion of zeros is greater than `tau`.

**Note**

These VGAM family functions use Fisher scoring. Convergence may be slow and half-stepping is usual (although one can use `trace = TRUE` to see which is the best model and then use `maxit` to choose that model) due to the regularity conditions not holding. Often the iterations slowly crawl towards the solution so monitoring the convergence (set `trace = TRUE`) is highly recommended. Instead, `extlogF1` is recommended.

For large data sets it is a very good idea to keep the length of `tau/kappa` low to avoid large memory requirements. Then for `parallel.locat = FALSE` one can repeatedly fit a model with `alaplace1()` with one `tau` at a time; and for `parallel.locat = TRUE` one can refit a model with `alaplace1()` with one `tau` at a time but using offsets and an intercept-only model.

A second method for solving the noncrossing quantile problem is illustrated below in Example 3. This is called the *accumulative quantile method* (AQM) and details are in Yee (2015). It does not make the strong parallelism assumption.

The functions `alaplace2()` and `laplace` differ slightly in terms of the parameterizations.

**Author(s)**

Thomas W. Yee

**References**


alaplace

See Also
ralap, laplace, extlogF1, CommonVGAMffArguments, lms.bcn, amlnormal, sc.studentt2, simulate.vlm.

Examples

```
## Not run:
# Example 1: quantile regression with smoothing splines
set.seed(123); adata <- data.frame(x2 = sort(runif(n <- 500)))
mymu <- function(x) exp(-2 + 6*sin(2*x-0.2) / (x+0.5)^2)
adata <- transform(adata, y = rpois(n, lambda = mymu(x2)))
mytau <- c(0.25, 0.75); mydof <- 4

fit <- vgam(y ~ s(x2, df = mydof), data=adata, trace=TRUE, maxit = 900, 
            alaplace2(tau = mytau, llocat = "loglink", 
                       parallel.locat = FALSE))
fitp <- vgam(y ~ s(x2, df = mydof), data = adata, trace=TRUE, maxit=900, 
             alaplace2(tau = mytau, llocat = "loglink", parallel.locat = TRUE))

par(las = 1); mylwd <- 1.5
with(adata, plot(x2, jitter(y, factor = 0.5), col = "orange", 
                main = "Example 1; green: parallel.locat = TRUE",
                ylab = "y", pch = "o", cex = 0.75))
with(adata, matlines(x2, fitted(fit ), col = "blue",
                 lty = "solid", lwd = mylwd))
with(adata, matlines(x2, fitted(fitp), col = "green",
                 lty = "solid", lwd = mylwd))

finexgrid <- seq(0, 1, len = 1001)
for (ii in 1:length(mytau))
   lines(finexgrid, qpois(p = mytau[ii], lambda = mymu(finexgrid)),
         col = "blue", lwd = mylwd)
fit@extra # Contains useful information

# Example 2: regression quantile at a new tau value from an existing fit
# Nb. regression splines are used here since it is easier.
fitp2 <- vglm(y ~ sm.bs(x2, df = mydof), data = adata, trace = TRUE, 
               alaplace1(tau = mytau, llocation = "loglink", 
                         parallel.locat = TRUE))

newtau <- 0.5 # Want to refit the model with this tau value
fitp3 <- vglm(y ~ 1 + offset(predict(fitp2)[, 1]),
              alaplace1(tau = newtau, llocation = "loglink"),
              adata)

with(adata, plot(x2, jitter(y, factor = 0.5), col = "orange",
                pch = "o", cex = 0.75, ylab = "y",
                main = "Example 2; parallel.locat = TRUE"))
with(adata, matlines(x2, fitted(fitp2), col = "blue",
                 lty = 1, lwd = mylwd))
with(adata, matlines(x2, fitted(fitp3), col = "black",
                 lty = 1, lwd = mylwd))

# Example 3: noncrossing regression quantiles using a trick: obtain
mytau <- seq(0.2, 0.9, by = 0.1)
answer <- matrix(0, nrow(adata), length(mytau)) # Stores the quantiles
adata <- transform(adata, offsety = y*0)
usetau <- mytau
for (ii in 1:length(mytau)) {
  # cat("\n\nii = ", ii, "\n")
  adata <- transform(adata, usey = y-offsety)
  iloc <- ifelse(ii == 1, with(adata, median(y)), 1.0) # Well-chosen!
  mydf <- ifelse(ii == 1, 5, 3) # Maybe less smoothing will help
  fit3 <- vglm(usey ~ sm.ns(x2, df = mydf), data = adata, trace = TRUE,
               alaplace2(tau = usetau[ii], lloc = "loglink", iloc = iloc))
  answer[, ii] <- (if(ii == 1) 0 else answer[, ii-1]) + fitted(fit3)
  adata <- transform(adata, offsety = answer[, ii])
}

# Plot the results.
with(adata, plot(x2, y, col = "blue",
                 main = paste("Noncrossing and nonparallel; tau = ",
                              paste(mytau, collapse = ", ")),
                 with(adata, matlines(x2, answer, col = "orange", lty = 1))
)

# Zoom in near the origin.
with(adata, plot(x2, y, col = "blue", xlim = c(0, 0.2), ylim = 0:1,
                 main = paste("Noncrossing and nonparallel; tau = ",
                              paste(mytau, collapse = ", ")),
                 with(adata, matlines(x2, answer, col = "orange", lty = 1))
)

## End(Not run)

---

**alaplaceUC**

### The Laplace Distribution

**Description**

Density, distribution function, quantile function and random generation for the 3-parameter asymmetric Laplace distribution with location parameter location, scale parameter scale, and asymmetry parameter kappa.

**Usage**

dalap(x, location = 0, scale = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)),
      log = FALSE)
palap(q, location = 0, scale = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)),
      lower.tail = TRUE, log.p = FALSE)
qalap(p, location = 0, scale = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)),
      lower.tail = TRUE, log.p = FALSE)
ralap(n, location = 0, scale = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)))
Arguments

- **x, q**: vector of quantiles.
- **p**: vector of probabilities.
- **n**: number of observations. If `length(n) > 1` then the length is taken to be the number required.
- **location**: the location parameter \( \xi \).
- **scale**: the scale parameter \( \sigma \). Must consist of positive values.
- **tau**: the quantile parameter \( \tau \). Must consist of values in \((0, 1)\). This argument is used to specify kappa and is ignored if kappa is assigned.
- **kappa**: the asymmetry parameter \( \kappa \). Must consist of positive values.
- **log**: if TRUE, probabilities \( p \) are given as \( \log(p) \).
- **lower.tail, log.p**: Same meaning as in `pnorm` or `qnorm`.

Details

There are many variants of asymmetric Laplace distributions (ALDs) and this one is known as the ALD by Kotz et al. (2001). See `alaplace3`, the VGAM family function for estimating the three parameters by maximum likelihood estimation, for formulae and details. The ALD density may be approximated by `dextlogF`.

Value

dalap gives the density, palap gives the distribution function, qalap gives the quantile function, and ralap generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


See Also

- `alaplace3`, `dextlogF`, `extlogF1`.

Examples

```r
x <- seq(-5, 5, by = 0.01)
loc <- 0; sigma <- 1.5; kappa <- 2
## Not run: plot(x, dalap(x, loc, sigma, kappa = kappa), type = "l",
          main = "Blue is density, orange is the CDF",
          ylim = c(0, 1), sub = "Purple are 5, 10, ..., 95 percentiles",
```

las = 1, ylab = "", cex.main = 0.5, col = "blue")
abline(h = 0, col = "blue", lty = 2)
lines(qalap(seq(0.05, 0.95, by = 0.05), loc, sigma, kappa = kappa),
      dalap(qalap(seq(0.05, 0.95, by = 0.05), loc, sigma, kappa = kappa),
            loc, sigma, kappa = kappa), col = "purple", lty = 3, type = "h")
lines(x, palap(x, loc, sigma, kappa = kappa), col = "orange")
abline(h = 0, lty = 2)
## End(Not run)
pp <- seq(0.05, 0.95, by = 0.05) # Test two functions
max(abs(palap(qalap(pp, loc, sigma, kappa = kappa),
      loc, sigma, kappa = kappa) - pp)) # Should be 0

---

### alogitlink

**Arcsine–Logit Link Mixtures**

**Description**

Computes some arcsine–logit mixture link transformations, including their inverse and the first few derivatives.

**Usage**

```r
alogitlink(theta, bvalue = NULL, taumix.logit = 1,
          tol = 1e-13, nmax = 99, inverse = FALSE, deriv = 0,
          short = TRUE, tag = FALSE, c10 = c(4, -pi))
```

```r
lcalogitlink(theta, bvalue = NULL, pmix.logit = 0.01,
             tol = 1e-13, nmax = 99, inverse = FALSE, deriv = 0,
             short = TRUE, tag = FALSE, c10 = c(4, -pi))
```

**Arguments**

- **theta**: Numeric or character. See below for further details.
- **bvalue**: See [Links](#).
- **taumix.logit**: Numeric, of length 1. Mixing parameter assigned to `logitlink`. Then `1 - exp(-taumix.log * theta)` is used to weight `asinlink`. Thus a 0 value will result in `logitlink` and a very large numeric such as `1e4` should be roughly equivalent to `asinlink` over almost all of the parameter space.
- **pmix.logit**: Numeric, of length 1. Mixing probability assigned to `logitlink`. Then `1 - pmix.logit` is used to weight `asinlink`. Thus a 0 value will result in `asinlink` and 1 is equivalent to `logitlink`.
- **tol, nmax**: Arguments fed into a function implementing a vectorized bisection method.
- **inverse, deriv, short, tag**: Details at [Links](#).
- **c10**: See `asinlink` and `logitlink`. 

---

[Links](#)
Details

`lcalogitlink` is a linear combination (LC) of `asinlink` and `logitlink`.

Value

The following holds for the LC variant. For `deriv >= 0`, `(1 - pmix.logit) * asinlink(p, deriv = deriv) + pmix.logit * logitlink(p, deriv = deriv)` when `inverse = FALSE`, and if `inverse = TRUE` then a nonlinear equation is solved for the probability, given `eta`. For `deriv = 1`, then the function returns `d eta / d theta` as a function of `theta` if `inverse = FALSE`, else if `inverse = TRUE` then it returns the reciprocal.

Warning

The default values for `taumix.logit` and `pmix.logit` may change in the future. The name and order of the arguments may change too.

Author(s)

Thomas W. Yee

References


See Also


Examples

```r
p <- seq(0.01, 0.99, length= 10)
alogitlink(p)
max(abs(alogitlink(alogitlink(p), inv = TRUE) - p)) # 0?
## Not run:
par(mfrow = c(2, 2), lwd = (mylwd <- 2))
y <- seq(-4, 4, length = 100)
p <- seq(0.01, 0.99, by = 0.01)
for (d in 0:1) {
  matplot(p, cbind(logitlink(p, deriv = d), probitlink(p, deriv = d)),
    type = "n", col = "blue", ylab = "transformation",
    las = 1, main = if (d == 0) "Some probability link functions"
    else "First derivative")
  lines(p, logitlink(p, deriv = d), col = "green")
  lines(p, probitlink(p, deriv = d), col = "blue")
  lines(p, clogloglink(p, deriv = d), col = "tan")
  lines(p, alogitlink(p, deriv = d), col = "red3")
  if (d == 0) {
```
altered

Altered, Inflated, Truncated and Deflated Values in GAITD Regression

Description

Return the altered, inflated, truncated and deflated values in a GAITD regression object, else test whether the model is altered, inflated, truncated or deflated.

Usage

altered(object, ...)
inflated(object, ...)
truncated(object, ...)
is.altered(object, ...)
is.deflated(object, ...)
is.inflated(object, ...)
is.truncated(object, ...)
Arguments

object               an object of class "vglm". Currently only a GAITD regression object returns valid results of these functions.

...               any additional arguments, to future-proof this function.

Details

Yee and Ma (2023) propose GAITD regression where values from four (or seven since there are parametric and nonparametric forms) disjoint sets are referred to as special. These extractor functions return one set each; they are the alter, inflate, truncate, deflate (and sometimes max.support) arguments from the family function.

Value

Returns one type of ‘special’ sets associated with GAITD regression. This is a vector, else a list for truncation. All three sets are returned by specials.vglm.

Warning

Some of these functions are subject to change. Only family functions beginning with "gaitd" will work with these functions, hence zipoisson fits will return FALSE or empty values.

References


See Also

vglm, vglm-class, specials.vglm, gaitdpoisson, gaitdlog, gaitdzeta, Gaitdpois.

Examples

```r
abdata <- data.frame(y = 0:7, w = c(182, 41, 12, 2, 2, 0, 0, 1))
fit1 <- vglm(y ~ 1, gaitdpoisson(a.mix = 0),
            data = abdata, weight = w, subset = w > 0)
specials(fit1)    # All three sets
altered(fit1)    # Subject to change
inflated(fit1)   # Subject to change
truncated(fit1)  # Subject to change
is.altered(fit1)
is.inflated(fit1)
is.truncated(fit1)```
amlbinomial

Binomial Logistic Regression by Asymmetric Maximum Likelihood Estimation

Description

Binomial quantile regression estimated by maximizing an asymmetric likelihood function.

Usage

amlbinomial(w.aml = 1, parallel = FALSE, digw = 4, link = "logitlink")

Arguments

- **w.aml**: Numeric, a vector of positive constants controlling the percentiles. The larger the value the larger the fitted percentile value (the proportion of points below the “w-regression plane”). The default value of unity results in the ordinary maximum likelihood (MLE) solution.
- **parallel**: If w.aml has more than one value then this argument allows the quantile curves to differ by the same amount as a function of the covariates. Setting this to be TRUE should force the quantile curves to not cross (although they may not cross anyway). See CommonVGAMffArguments for more information.
- **digw**: Passed into Round as the digits argument for the w.aml values; used cosmetically for labelling.
- **link**: See binomialff.

Details

The general methodology behind this VGAM family function is given in Efron (1992) and full details can be obtained there. This model is essentially a logistic regression model (see binomialff) but the usual deviance is replaced by an asymmetric squared error loss function; it is multiplied by w.aml for positive residuals. The solution is the set of regression coefficients that minimize the sum of these deviance-type values over the data set, weighted by the weights argument (so that it can contain frequencies). Newton-Raphson estimation is used here.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

If w.aml has more than one value then the value returned by deviance is the sum of all the (weighted) deviances taken over all the w.aml values. See Equation (1.6) of Efron (1992).
Note
On fitting, the extra slot has list components "w.aml" and "percentile". The latter is the percent of observations below the “w-regression plane”, which is the fitted values. Also, the individual deviance values corresponding to each element of the argument w.aml is stored in the extra slot.

For amlbinomial objects, methods functions for the generic functions qtplot and cdf have not been written yet.

See amlpoisson about comments on the jargon, e.g., expectiles etc.

In this documentation the word quantile can often be interchangeably replaced by expectile (things are informal here).

Author(s)
Thomas W. Yee

References

See Also
amlpoisson, amlexponential, amlnormal, extlogF1, alaplace1, denorm.

Examples
# Example: binomial data with lots of trials per observation
set.seed(1234)
sizevec <- rep(100, length = (nn <- 200))
mydat <- data.frame(x = sort(runif(nn)))
mydat <- transform(mydat, prob = logitlink(-0 + 2.5*x + x^2, inverse = TRUE))
mydat <- transform(mydat, y = rbinom(nn, size = sizevec, prob = prob))
(fit <- vgam(cbind(y, sizevec - y) ~ s(x, df = 3),
              amlbinomial(w = c(0.01, 0.2, 1, 5, 60)),
              mydat, trace = TRUE))
fit@extra
## Not run:
par(mfrow = c(1,2))
# Quantile plot
with(mydat, plot(x, jitter(y), col = "blue", las = 1, main =
    paste(paste(round(fit@extra$percentile, digits = 1), collapse = ", ",
             "percentile-expectile curves")))))
with(mydat, matlines(x, 100 * fitted(fit), lwd = 2, col = "blue", lty=1))

# Compare the fitted expectiles with the quantiles
with(mydat, plot(x, jitter(y), col = "blue", las = 1, main =
    paste(paste(round(fit@extra$percentile, digits = 1), collapse = ", ",
             "percentile curves are red")))))
with(mydat, matlines(x, 100 * fitted(fit), lwd = 2, col = "blue", lty = 1))
for (ii in fit@extra$percentile)
  with(mydat, matlines(x, 100 * qbinom(p = ii/100, size = sizevec, prob = prob) / sizevec,
    col = "red", lwd = 2, lty = 1))

## End(Not run)

### amlexponential

**Exponential Regression by Asymmetric Maximum Likelihood Estimation**

**Description**

Exponential expectile regression estimated by maximizing an asymmetric likelihood function.

**Usage**

```r
amlexponential(w.aml = 1, parallel = FALSE, imethod = 1, digw = 4,
  link = "loglink")
```

**Arguments**

- `w.aml` Numeric, a vector of positive constants controlling the expectiles. The larger the value the larger the fitted expectile value (the proportion of points below the “w-regression plane”). The default value of unity results in the ordinary maximum likelihood (MLE) solution.
- `parallel` If `w.aml` has more than one value then this argument allows the quantile curves to differ by the same amount as a function of the covariates. Setting this to be TRUE should force the quantile curves to not cross (although they may not cross anyway). See `CommonVGAMffArguments` for more information.
- `imethod` Integer, either 1 or 2 or 3. Initialization method. Choose another value if convergence fails.
- `digw` Passed into `Round` as the digits argument for the `w.aml` values; used cosmetically for labelling.
- `link` See `exponential` and the warning below.

**Details**

The general methodology behind this `VGAM` family function is given in Efron (1992) and full details can be obtained there.

This model is essentially an exponential regression model (see `exponential`) but the usual deviance is replaced by an asymmetric squared error loss function; it is multiplied by `w.aml` for positive residuals. The solution is the set of regression coefficients that minimize the sum of these deviance-type values over the data set, weighted by the `weights` argument (so that it can contain frequencies). Newton-Raphson estimation is used here.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Note that the link argument of exponential and amlexponential are currently different: one is the rate parameter and the other is the mean (expectile) parameter.

If w.aml has more than one value then the value returned by deviance is the sum of all the (weighted) deviances taken over all the w.aml values. See Equation (1.6) of Efron (1992).

Note

On fitting, the extra slot has list components "w.aml" and "percentile". The latter is the percent of observations below the "w-regression plane", which is the fitted values. Also, the individual deviance values corresponding to each element of the argument w.aml is stored in the extra slot.

For amlexponential objects, methods functions for the generic functions qtplot and cdf have not been written yet.

See amlpoisson about comments on the jargon, e.g., expectiles etc.

In this documentation the word quantile can often be interchangeably replaced by expectile (things are informal here).

Author(s)

Thomas W. Yee

References


See Also

exponential, amlbinomial, amlpoisson, amlnormal, extlogF1, alaplace1, lms.bcg, deexp.

Examples

```r
nn <- 2000
mydat <- data.frame(x = seq(0, 1, length = nn))
mydat <- transform(mydat, 
    mu = loglink(-0 + 1.5*x + 0.2*x^2, inverse = TRUE))
mydat <- transform(mydat, mu = loglink(0 - sin(8*x), inverse = TRUE))
mydat <- transform(mydat, y = rexp(nn, rate = 1/mu))
(fit <- vgam(y ~ s(x, df=5), amlexponential(w=c(0.001, 0.1, 0.5, 5, 60)), 
    mydat, trace = TRUE))
fit@extra
## Not run: # These plots are against the sqrt scale (to increase clarity)
par(mfrow = c(1,2))
```
# Quantile plot
with(mydat, plot(x, sqrt(y), col = "blue", las = 1, main =
    paste(paste(round(fit@extra$percentile, digits = 1), collapse="", 
        "percentile-expectile curves"))),
with(mydat, matlines(x, sqrt(fitted(fit)), lwd = 2, col = "blue", lty=1))

# Compare the fitted expectiles with the quantiles
with(mydat, plot(x, sqrt(y), col = "blue", las = 1, main =
    paste(paste(round(fit@extra$percentile, digits = 1), collapse="", 
        "percentile curves are orange"))),
with(mydat, matlines(x, sqrt(fitted(fit)), lwd = 2, col = "blue", lty=1))

for (ii in fit@extra$percentile)
    with(mydat, matlines(x, sqrt(qexp(p = ii/100, rate = 1/mu)),
        col = "orange"))

## End(Not run)

amlnormal  

Asymmetric Least Squares Quantile Regression

Description

Asymmetric least squares, a special case of maximizing an asymmetric likelihood function of a
normal distribution. This allows for expectile/quantile regression using asymmetric least squares
error loss.

Usage

amlnormal(w.aml = 1, parallel = FALSE, lexpectile = "identitylink",
    iexpectile = NULL, imethod = 1, digw = 4)

Arguments

w.aml  Numeric, a vector of positive constants controlling the percentiles. The larger
    the value the larger the fitted percentile value (the proportion of points below
    the “w-regression plane”). The default value of unity results in the ordinary
    least squares (OLS) solution.

parallel  If w.aml has more than one value then this argument allows the quantile curves
to differ by the same amount as a function of the covariates. Setting this to be
TRUE should force the quantile curves to not cross (although they may not cross
anyway). See CommonVGAMffArguments for more information.

lexpectile, iexpectile  See CommonVGAMffArguments for more information.

imethod  Integer, either 1 or 2 or 3. Initialization method. Choose another value if con-
    vergence fails.

digw  Passed into Round as the digits argument for the w.aml values; used cosmeti-
    cally for labelling.
Details

This is an implementation of Efron (1991) and full details can be obtained there. Equation numbers below refer to that article. The model is essentially a linear model (see \texttt{lm}), however, the asymmetric squared error loss function for a residual \( r \) is \( r^2 \) if \( r \leq 0 \) and \( wr^2 \) if \( r > 0 \). The solution is the set of regression coefficients that minimize the sum of these over the data set, weighted by the \texttt{weights} argument (so that it can contain frequencies). Newton-Raphson estimation is used here.

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Note

On fitting, the extra slot has list components "\texttt{w.aml}" and "\texttt{percentile}". The latter is the percent of observations below the "w-regression plane", which is the fitted values.

One difficulty is finding the \texttt{w.aml} value giving a specified percentile. One solution is to fit the model within a root finding function such as \texttt{uniroot}; see the example below.

For \texttt{amlnormal} objects, methods functions for the generic functions \texttt{qtplot} and \texttt{cdf} have not been written yet.

See the note in \texttt{amlpoisson} on the jargon, including \texttt{expectiles} and \texttt{regression quantiles}.

The deviance slot computes the total asymmetric squared error loss (2.5). If \texttt{w.aml} has more than one value then the value returned by the slot is the sum taken over all the \texttt{w.aml} values.

This \texttt{VGAM} family function could well be renamed \texttt{amlnormal()} instead, given the other function names \texttt{amlpoisson}, \texttt{amlbinomial}, etc.

In this documentation the word \texttt{quantile} can often be interchangeably replaced by \texttt{expectile} (things are informal here).

Author(s)

Thomas W. Yee

References


See Also

\texttt{amlpoisson}, \texttt{amlbinomial}, \texttt{amlexponential}, \texttt{bmi.nz}, \texttt{extlogF1}, \texttt{alaplace1}, \texttt{denorm}, \texttt{lms.bcn} and similar variants are alternative methods for quantile regression.

Examples

```r
## Not run:
# Example 1
ooo <- with(bmi.nz, order(age))
bmi.nz <- bmi.nz[ooo, ] # Sort by age
```
(fit <- vglm(BMI ~ sm.bs(age), amlnormal(w.aml = 0.1), bmi.nz))
fit@extra # Gives the w value and the percentile
coef(fit, matrix = TRUE)

# Quantile plot
with(bmi.nz, plot(age, BMI, col = "blue", main =
    paste(round(fit@extra$percentile, digits = 1),
    "expectile-percentile curve"))
with(bmi.nz, lines(age, c(fitted(fit)), col = "black"))

# Example 2
# Find the w values that give the 25, 50 and 75 percentiles
find.w <- function(w, percentile = 50) {
    fit2 <- vglm(BMI ~ sm.bs(age), amlnormal(w = w), data = bmi.nz)
    fit2@extra$percentile - percentile
}

# Quantile plot
with(bmi.nz, plot(age, BMI, col = "blue", las = 1, main =
    "25, 50 and 75 expectile-percentile curves")
for (myp in c(25, 50, 75)) {
    # Note: uniroot() can only find one root at a time
    bestw <- uniroot(f = find.w, interval = c(1/10^4, 10^4),
        percentile = myp)
    fit2 <- vglm(BMI ~ sm.bs(age), amlnormal(w = bestw$root), bmi.nz)
    with(bmi.nz, lines(age, c(fitted(fit2)), col = "orange"))
}

# Example 3; this is Example 1 but with smoothing splines and
# a vector w and a parallelism assumption.
ooo <- with(bmi.nz, order(age))
bmi.nz <- bmi.nz[ooo, ] # Sort by age
fit3 <- vgam(BMI ~ s(age, df = 4), data = bmi.nz, trace = TRUE,
    amlnormal(w = c(0.1, 1, 10), parallel = TRUE))
fit3@extra # The w values, percentiles and weighted deviances

# The linear components of the fit; not for human consumption:
coef(fit3, matrix = TRUE)

# Quantile plot
with(bmi.nz, plot(age, BMI, col="blue", main =
    paste(paste(round(fit3@extra$percentile, digits = 1), collapse = ", ",
    "expectile-percentile curves"))
with(bmi.nz, matlines(age, fitted(fit3), col = 1:fit3@extra$M, lwd = 2))
with(bmi.nz, lines(age, c(fitted(fit ), col = "black")) # For comparison

## End(Not run)
**Description**

Poisson quantile regression estimated by maximizing an asymmetric likelihood function.

**Usage**

```r
amlpoisson(w.aml = 1, parallel = FALSE, imethod = 1, digw = 4, link = "loglink")
```

**Arguments**

- `w.aml` Numeric, a vector of positive constants controlling the percentiles. The larger the value the larger the fitted percentile value (the proportion of points below the “w-regression plane”). The default value of unity results in the ordinary maximum likelihood (MLE) solution.
- `parallel` If `w.aml` has more than one value then this argument allows the quantile curves to differ by the same amount as a function of the covariates. Setting this to be `TRUE` should force the quantile curves to not cross (although they may not cross anyway). See `CommonVGAMffArguments` for more information.
- `imethod` Integer, either 1 or 2 or 3. Initialization method. Choose another value if convergence fails.
- `digw` Passed into `Round` as the `digits` argument for the `w.aml` values; used cosmetically for labelling.
- `link` See `poissonff`.

**Details**

This method was proposed by Efron (1992) and full details can be obtained there.

The model is essentially a Poisson regression model (see `poissonff`) but the usual deviance is replaced by an asymmetric squared error loss function; it is multiplied by `w.aml` for positive residuals. The solution is the set of regression coefficients that minimize the sum of these deviance-type values over the data set, weighted by the `weights` argument (so that it can contain frequencies). Newton-Raphson estimation is used here.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Warning**

If `w.aml` has more than one value then the value returned by `deviance` is the sum of all the (weighted) deviances taken over all the `w.aml` values. See Equation (1.6) of Efron (1992).
Note

On fitting, the extra slot has list components "w.aml" and "percentile". The latter is the percent of observations below the "w-regression plane", which is the fitted values. Also, the individual deviance values corresponding to each element of the argument w.aml is stored in the extra slot.

For amlpoisson objects, methods functions for the generic functions qtpplot and cdf have not been written yet.

About the jargon, Newey and Powell (1987) used the name expectiles for regression surfaces obtained by asymmetric least squares. This was deliberate so as to distinguish them from the original regression quantiles of Koenker and Bassett (1978). Efron (1991) and Efron (1992) use the general name regression percentile to apply to all forms of asymmetric fitting. Although the asymmetric maximum likelihood method very nearly gives regression percentiles in the strictest sense for the normal and Poisson cases, the phrase quantile regression is used loosely in this VGAM documentation.

In this documentation the word quantile can often be interchangeably replaced by expectile (things are informal here).

Author(s)

Thomas W. Yee

References


See Also

amlnormal, amlbinomial, extlogF1, alaplace1.

Examples

```r
set.seed(1234)
mydat <- data.frame(x = sort(runif(nn <- 200)))
mydat <- transform(mydat, y = rpois(nn, exp(0 - sin(8*x))))
(fit <- vgam(y ~ s(x), fam = amlpoisson(w.aml = c(0.02, 0.2, 1, 5, 50)),
            mydat, trace = TRUE))
fit@extra

## Not run:
# Quantile plot
with(mydat, plot(x, jitter(y), col = "blue", las = 1, main =
               paste(paste(round(fit@extra$percentile, digits = 1), collapse = "","),
               "percentile-expectile curves")))
```
anova.vglm

Analysis of Deviance for Vector Generalized Linear Model Fits

Description

Compute an analysis of deviance table for one or more vector generalized linear model fits.

Usage

## S3 method for class 'vglm'
anova(object, ..., type = c("II", "I", "III", 2, 1, 3),
      test = c("LRT", "none"), trydev = TRUE, silent = TRUE)

Arguments

object, ... objects of class vglm, typically the result of a call to vglm, or a list of objects for the "vglmfit" method. Each model must have an intercept term. If "vglmfit" is used then type = 1 or type = "I" must be specified.

type character or numeric; any one of the (effectively three) choices given. Note that anova.glm has 1 or "I" as its default; and that Anova.glm() in car (that is, the car package) has 2 or "II" as its default (and allows for type = "III"), so one can think of this function as a combination of anova.glm and Anova.glm() in car, but with the default of the latter. See Details below for more information.

test a character string, (partially) matching one of "LRT" and "none". In the future it is hoped that "Rao" be also supported, to conduct score tests. The first value is the default.

trydev logical; if TRUE then the deviance is used if possible. Note that only a few VGAM family functions have a deviance that is defined and implemented. Setting it FALSE means the log-likelihood will be used.

silent logical; if TRUE then any warnings will be suppressed. These may arise by IRLS iterations not converging during the fitting of submodels. Setting it FALSE means that any warnings are given.

Details

anova.vglm is intended to be similar to anova.glm so specifying a single object and type = 1 gives a sequential analysis of deviance table for that fit. By analysis of deviance, it is meant loosely that if the deviance of the model is not defined or implemented, then twice the difference between the log-likelihoods of two nested models remains asymptotically chi-squared distributed with degrees of freedom equal to the difference in the number of parameters of the two models. Of course, the usual regularity conditions are assumed to hold. For Type I, the analysis of deviance table has the reductions in the residual deviance as each term of the formula is added in turn are given in as the rows of a table, plus the residual deviances themselves. Type I or sequential tests (as in anova.glm).
are computationally the easiest of the three methods. For this, the order of the terms is important, and the each term is added sequentially from first to last.

The `Anova()` function in `car` allows for testing Type II and Type III (SAS jargon) hypothesis tests, although the definitions used are not precisely that of SAS. As `car` notes, Type I rarely test interesting hypotheses in unbalanced designs. Type III enter each term last, keeping all the other terms in the model.

Type II tests, according to SAS, add the term after all other terms have been added to the model except terms that contain the effect being tested; an effect is contained in another effect if it can be derived by deleting variables from the latter effect. Type II tests are currently the default.

As in `anova.glm`, but not as `Anova.glm()` in `car`, if more than one object is specified, then the table has a row for the residual degrees of freedom and deviance for each model. For all but the first model, the change in degrees of freedom and deviance is also given. (This only makes statistical sense if the models are nested.) It is conventional to list the models from smallest to largest, but this is up to the user. It is necessary to have `type = 1` with more than one objects are specified.

See `anova.glm` for more details and warnings. The `VGAM` package now implements full likelihood models only, therefore no dispersion parameters are estimated.

**Value**

An object of class "anova" inheriting from class "data.frame".

**Warning**

See `anova.glm`. Several `VGAM` family functions implement distributions which do not satisfying the usual regularity conditions needed for the LRT to work. No checking or warning is given for these.

As `car` says, be careful of Type III tests because they violate marginality. Type II tests (the default) do not have this problem.

**Note**

It is possible for this function to stop when `type = 2` or `3`, e.g., `anova(vglm(cans ~ myfactor, poissonff, data = boxcar))` where `myfactor` is a factor.

The code was adapted directly from `anova.glm` and `Anova.glm()` in `car` by T. W. Yee. Hence the Type II and Type III tests do not correspond precisely with the SAS definition.

**See Also**

`anova.glm`, `stat.anova`, `stats:::print.anova`, `Anova.glm()` in `car` if `car` is installed, `vglm`, `lrtest`, `add1.vglm`, `drop1.vglm`, `lrt.stat.vlm`, `score.stat.vlm`, `wald.stat.vlm`, `backPain2`, `update`.

**Examples**

```r
# Example 1: a proportional odds model fitted to pneumo.
set.seed(1)
pneumo <- transform(pneumo, let = log(exposure.time), x3 = runif(8))
fit1 <- vglm(cbind(normal, mild, severe) ~ let , propodds, pneumo)
```

```r
anova.vglm
```
fit2 <- vglm(cbind(normal, mild, severe) ~ let + x3, propodds, pneumo)
fit3 <- vglm(cbind(normal, mild, severe) ~ let + x3, cumulative, pneumo)
anova(fit1, fit2, fit3, type = 1)  # Remember to specify 'type'!!
anova(fit2)
anova(fit2, type = "I")
anova(fit2, type = "III")

# Example 2: a proportional odds model fitted to backPain2.
data("backPain2", package = "VGAM")
summary(backPain2)
fitlogit <- vglm(pain ~ x2 * x3 * x4, propodds, data = backPain2)
coef(fitlogit)
anova(fitlogit)
anova(fitlogit, type = "I")
anova(fitlogit, type = "III")

AR1
Autoregressive Process with Order-1 Family Function

Description
Maximum likelihood estimation of the three-parameter AR-1 model

Usage
AR1(ldrift = "identitylink", lsd = "loglink", lvar = "loglink", lrho = "rhobitlink",
  idrift = NULL, isd = NULL, ivar = NULL, irho = NULL, imethod = 1,
  ishrinkage = 0.95, type.likelihood = c("exact", "conditional"),
  type.EIM = c("exact", "approximate"), var.arg = FALSE, nodrift = FALSE, 
  print.EIM = FALSE, zero = c(if (var.arg) "var" else "sd", "rho"))

Arguments
ldrift, lsd, lvar, lrho
  Link functions applied to the scaled mean, standard deviation or variance, and 
correlation parameters. The parameter drift is known as the drift, and it is a 
scaled mean. See Links for more choices.

idrift, isd, ivar, irho
  Optional initial values for the parameters. If failure to converge occurs then 
try different values and monitor convergence by using trace = TRUE. For a S-
column response, these arguments can be of length S, and they are recycled 
by the columns first. A value NULL means an initial value for each response is 
computed internally.

ishrinkage, imethod, zero
  See CommonVGAMffArguments for more information. The default for zero 
assumes there is a drift parameter to be estimated (the default for that argument), 
so if a drift parameter is suppressed and there are covariates, then zero will need 
to be assigned the value 1 or 2 or NULL.
var.arg

Same meaning as `uninormal`.

nodrift

Logical, for determining whether to estimate the drift parameter. The default is to estimate it. If `TRUE`, the drift parameter is set to 0 and not estimated.

type.EIM

What type of expected information matrix (EIM) is used in Fisher scoring. By default, this family function calls `AR1EIM`, which recursively computes the exact EIM for the AR process with Gaussian white noise. See Porat and Friedlander (1986) for further details on the exact EIM.

If `type.EIM = "approximate"` then approximate expression for the EIM of Autoregressive processes is used; this approach holds when the number of observations is large enough. Succinct details about the approximate EIM are delineated at Porat and Friedlander (1987).

print.EIM

Logical. If `TRUE`, then the first few EIMs are printed. Here, the result shown is the sum of each EIM.

type.likelihood

What type of likelihood function is maximized. The first choice (default) is the sum of the marginal likelihood and the conditional likelihood. Choosing the conditional likelihood means that the first observation is effectively ignored (this is handled internally by setting the value of the first prior weight to be some small positive number, e.g., `1.0e-6`). See the note below.

Details

The AR-1 model implemented here has

\[ Y_1 \sim N(\mu, \sigma^2/(1 - \rho^2)), \]

and

\[ Y_i = \mu^* + \rho Y_{i-1} + e_i, \]

where the \( e_i \) are i.i.d. Normal(0, sd = \( \sigma \)) random variates.

Here are a few notes: (1). A test for weak stationarity might be to verify whether \( 1/\rho \) lies outside the unit circle. (2). The mean of all the \( Y_i \) is \( \mu^*/(1 - \rho) \) and these are returned as the fitted values. (3). The correlation of all the \( Y_i \) with \( Y_{i-1} \) is \( \rho \). (4). The default link function ensures that \(-1 < \rho < 1\).

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Warning

Monitoring convergence is urged, i.e., set `trace = TRUE`.

Moreover, if the exact EIMs are used, set `print.EIM = TRUE` to compare the computed exact to the approximate EIM.

Under the VGLM/VGAM approach, parameters can be modelled in terms of covariates. Particularly, if the standard deviation of the white noise is modelled in this way, then `type.EIM = "exact"` may certainly lead to unstable results. The reason is that white noise is a stationary process, and consequently, its variance must remain as a constant. Consequently, the use of variates to model
this parameter contradicts the assumption of stationary random components to compute the exact EIMs proposed by Porat and Friedlander (1987).

To prevent convergence issues in such cases, this family function internally verifies whether the variance of the white noise remains as a constant at each Fisher scoring iteration. If this assumption is violated and `type.EIM = "exact"` is set, then AR1 automatically shifts to `type.EIM = "approximate"`. Also, a warning is accordingly displayed.

**Note**

Multiple responses are handled. The mean is returned as the fitted values.

**Author(s)**

Victor Miranda (exact method) and Thomas W. Yee (approximate method).

**References**


**See Also**

`AR1EIM`, `vglm.control`, `dAR1`, `arima.sim`.

**Examples**

```r
### Example 1: using arima.sim() to generate a 0-mean stationary time series. 
nn <- 500
tsdata <- data.frame(x2 = runif(nn))
ar.coef.1 <- rhobitlink(-1.55, inverse = TRUE) # Approx -0.65
ar.coef.2 <- rhobitlink(1.0, inverse = TRUE) # Approx 0.50
set.seed(1)
set.seed(1)
tsdata <- transform(tsdata,
            index = 1:nn,
            TS1 = arima.sim(nn, model = list(ar = ar.coef.1),
                            sd = exp(1.5)),
            TS2 = arima.sim(nn, model = list(ar = ar.coef.2),
                            sd = exp(1.0 + 1.5 * x2)))

### An autoregressive intercept-only model. ###
### Using the exact EIM, and "nodrift = TRUE" ###
fit1a <- vglm(TS1 ~ 1, data = tsdata, trace = TRUE,
              AR1(var.arg = FALSE, nodrift = TRUE,
                  type.EIM = "exact",
                  print.EIM = FALSE),
              crit = "coefficients")
Coef(fit1a)
summary(fit1a)

### Not run:
### Two responses. Here, the white noise standard deviation of TS2  ###
```
### is modelled in terms of 'x2'. Also, 'type.EIM = exact'. ###

```r
fit1b <- vglm(cbind(TS1, TS2) ~ x2,
             AR1(zero = NULL, nodrift = TRUE,
                var.arg = FALSE,
                type.EIM = "exact"),
             constraints = list("(Intercept)" = diag(4),
                                "x2" = rbind(0, 0, 1, 0)),
             data = tsdata, trace = TRUE, crit = "coefficients")
coef(fit1b, matrix = TRUE)
summary(fit1b)
```

### Example 2: another stationary time series

```r
nn <- 500
my.rho <- rhobitlink(1.0, inverse = TRUE)
my.mu <- 1.0
my.sd <- exp(1)
tsdata <- data.frame(index = 1:nn, TS3 = runif(nn))
set.seed(2)
for (ii in 2:nn)
  tsdata$TS3[ii] <- my.mu/(1 - my.rho) +
  my.rho * tsdata$TS3[ii-1] + rnorm(1, sd = my.sd)
tsdata <- tsdata[-(1:ceiling(nn/5)), ] # Remove the burn-in data:
```

### Fitting an AR(1). The exact EIMs are used.

```r
fit2a <- vglm(TS3 ~ 1, AR1(type.likelihood = "exact", # "conditional",
                         type.EIM = "exact"),
             data = tsdata, trace = TRUE, crit = "coefficients")
Coef(fit2a)
summary(fit2a) # SEs are useful to know
```

```r
Coef(fit2a)["rho"] # Estimate of rho, for intercept-only models
my.rho # The 'truth' (rho)
Coef(fit2a)["drift"] # Estimate of drift, for intercept-only models
my.mu /(1 - my.rho) # The 'truth' (drift)
```

## End(Not run)

---

### AR1EIM

**Computation of the Exact EIM of an Order-1 Autoregressive Process**

**Description**

Computation of the exact Expected Information Matrix of the Autoregressive process of order-1 (AR(1)) with Gaussian white noise and stationary random components.

**Usage**

```r
AR1EIM(x = NULL, var.arg = NULL, p.drift = NULL,
       WNsdl = NULL, ARcoeff1 = NULL, eps.porat = 1e-2)
```
Arguments

x           A vector of quantiles. The gaussian time series for which the EIMs are computed.
If multiple time series are being analyzed, then x must be a matrix where each
column allocates a response. That is, the number of columns (denoted as NOS)
must match the number of responses.

var.arg   Logical. Same as with AR1.

p.drift   A numeric vector with the scaled mean(s) (commonly referred as drift) of the
AR process(es) in turn. Its length matches the number of responses.

WNsd, ARcoeff1 Matrices. The standard deviation of the white noise, and the correlation (coefficient)
of the AR(1) model, for each observation.
That is, the dimension for each matrix is \(N \times NOS\), where \(N\) is the number of
observations and \(NOS\) is the number of responses. Else, these arguments are
recycled.

eps.porat   A very small positive number to test whether the standard deviation (WNsd) is
close enough to its value estimated in this function.
See below for further details.

Details

This function implements the algorithm of Porat and Friedlander (1986) to recursivel y compute the
exact expected information matrix (EIM) of Gaussian time series with stationary random components.

By default, when the VGLM/VGAM family function AR1 is used to fit an AR(1) model via vglm,
Fisher scoring is executed using the approximate EIM for the AR process. However, this model
can also be fitted using the exact EIMs computed by AR1EIM.

Given \(N\) consecutive data points, \(y_0, y_1, \ldots, y_{N−1}\) with probability density \(f(y)\), the Porat
and Friedlander algorithm calculates the EIMs \(J_{n−1}(\theta)\), for all \(1 \leq n \leq N\). This is done based on
the Levinson-Durbin algorithm for computing the orthogonal polynomials of a Toeplitz matrix. In
particular, for the AR(1) model, the vector of parameters to be estimated under the VGAM/VGLM
approach is

\[
\eta = (\mu^*, \log(\sigma^2), \text{rhobit}(\rho)),
\]

where \(\sigma^2\) is the variance of the white noise and \(\mu^{*}\) is the drift parameter (See AR1 for further
details on this).

Consequently, for each observation \(n = 1, \ldots, N\), the EIM, \(J_n(\theta)\), has dimension \(3 \times 3\), where
the diagonal elements are:

\[
J_{[n,1,1]} = E[-\partial^2 \log f(y)/\partial (\mu^*)^2],
\]

\[
J_{[n,2,2]} = E[-\partial^2 \log f(y)/\partial (\sigma^2)^2],
\]

and
\[ J_{[n,3,3]} = E[-\partial^2 \log f(y)/\partial(\rho)^2]. \]

As for the off-diagonal elements, one has the usual entries, i.e.,

\[ J_{[n,1,2]} = J_{[n,2,1]} = E[-\partial^2 \log f(y)/\partial\sigma^2 \partial\rho], \]

etc.

If \text{var.arg} = \text{FALSE}, then \sigma instead of \sigma^2 is estimated. Therefore, \( J_{[n,2,2]}, J_{[n,1,2]}, \) etc., are correspondingly replaced.

Once these expected values are internally computed, they are returned in an array of dimension \( N \times 1 \times 6 \), of the form

\[ J_{[1,1]} = [J_{[1,1,1]}, J_{[2,2,1]}, J_{[3,3,1]}, J_{[1,1,2]}, J_{[2,2,2]}, J_{[1,1,3]}]. \]

\text{AR1EIM} handles multiple time series, say NOS. If this happens, then it accordingly returns an array of dimension \( N \times NOS \times 6 \). Here, \( J_{[k,\cdot]} \), for \( k = 1, \ldots, NOS \), is a matrix of dimension \( N \times 6 \), which stores the EIMs for the \( k \text{th} \) response, as above, i.e.,

\[ J_{[k,\cdot]} = [J_{[1,1,1]}, J_{[2,2,1]}, J_{[3,3,1]}, \ldots], \]

the \textit{bandwidth} form, as per required by \text{AR1}.

\textbf{Value}

An array of dimension \( N \times NOS \times 6 \), as above.

This array stores the EIMs calculated from the joint density as a function of

\[ \theta = (\mu^*, \sigma^2, \rho). \]

Nevertheless, note that, under the VGAM/VGLM approach, the EIMs must be correspondingly calculated in terms of the linear predictors, \( \eta \).

\textbf{Asymptotic behaviour of the algorithm}

For large enough \( n \), the EIMs, \( J_n(\theta) \), become approximately linear in \( n \). That is, for some \( n_0 \),

\[ J_n(\theta) \equiv J_{n_0}(\theta) + (n - n_0)\bar{J}(\theta), \quad (***) \]

where \( \bar{J}(\theta) \) is a constant matrix.

This relationship is internally considered if a proper value of \( n_0 \) is determined. Different ways can be adopted to find \( n_0 \). In \text{AR1EIM}, this is done by checking the difference between the internally estimated variances and the entered ones at \text{Wnsd}. If this difference is less than eps . \text{porat} at some iteration, say at iteration \( n_0 \), then \text{AR1EIM} takes \( \bar{J}(\theta) \) as the last computed increment of \( J_n(\theta) \), and extrapolates \( J_k(\theta) \), for all \( k \geq n_0 \) using \( (\ast) \). Else, the algorithm will complete the iterations for \( 1 \leq n \leq N \).

Finally, note that the rate of convergence reasonably decreases if the asymptotic relationship \( (\ast) \) is used to compute \( J_k(\theta), k \geq n_0 \). Normally, the number of operations involved on this algorithm is proportional to \( N^2 \).

See Porat and Friedlander (1986) for full details on the asymptotic behaviour of the algorithm.
**Warning**

Arguments `WNsd`, and `ARcoeff1` are matrices of dimension $N \times NOS$. Else, these arguments are accordingly recycled.

**Note**

For simplicity, one can assume that the time series analyzed has a 0-mean. Consequently, where the family function `AR1` calls `AR1EIM` to compute the EIMs, the argument `p.drift` is internally set to zero-vector, whereas $x$ is centered by subtracting its mean value.

**Author(s)**

V. Miranda and T. W. Yee.

**References**


**See Also**

`AR1`.

**Examples**

```r
set.seed(1)
nn <- 500
ARcoeff1 <- c(0.3, 0.25) # Will be recycled.
WNsd <- c(exp(1), exp(1.5)) # Will be recycled.
p.drift <- c(0, 0) # Zero-mean gaussian time series.

### Generate two (zero-mean) AR(1) processes ###
ts1 <- p.drift[1]/(1 - ARcoeff1[1]) +
     arima.sim(model = list(ar = ARcoeff1[1]), n = nn, sd = WNsd[1])
ts2 <- p.drift[2]/(1 - ARcoeff1[2]) +
     arima.sim(model = list(ar = ARcoeff1[2]), n = nn, sd = WNsd[2])

ARdata <- matrix(cbind(ts1, ts2), ncol = 2)

### Compute the exact EIMs: TWO responses. ###
ExactEIM <- AR1EIM(x = ARdata, var.arg = FALSE, p.drift = p.drift,
                   WNsd = WNsd, ARcoeff1 = ARcoeff1)

### For response 1:###
head(ExactEIM[, 1,]) # NOTICE THAT THIS IS A (nn x 6) MATRIX!

### For response 2:
```

asinlink

Asin Link Function

Description

Computes the arcsine link, including its inverse and the first few derivatives.

Usage

asinlink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE, c10 = c(4, -pi))

Arguments

theta Numeric or character. See below for further details.

bvalue See Links.

inverse, deriv, short, tag

Details at Links.

c10 Similar to sqrtlink. The default is intended to match lcalogitlink for binomialff at binomial probabilities (theta) equal to 0.5.

Details

Function alogitlink gives some motivation for this link. However, the problem with this link is that it is bounded by default between (-pi, pi) so that it can be unsuitable for regression. This link is a scaled and centred CDF of the arcsine distribution. The centring is chosen so that asinlink(0.5) is 0, and the scaling is chosen so that asinlink(0.5, deriv = 1) and logitlink(0.5, deriv = 1) are equal (the value 4 actually), hence this link will operate similar to the logitlink when close to 0.5.

Value

Similar to logitlink but using different formulas.

Warning

It is possible that the scaling might change in the future.

Author(s)

Thomas W. Yee

See Also

logitlink, alogitlink, Links, probitlink, clogloglink, cauchitlink, binomialff, sloglink, hdeff.
Examples

p <- seq(0.01, 0.99, length= 10)
asinlink(p)
max(abs(asinlink(asinlink(p), inv = TRUE) - p)) # 0?

## Not run:
par(mfrow = c(2, 2), lwd = (mylwd <- 2))
y <- seq(-4, 4, length = 100)
p <- seq(0.01, 0.99, by = 0.01)

for (d in 0:1) {
  matplot(p, cbind(logitlink(p, deriv = d), probitlink(p, deriv = d)),
  type = "n", col = "blue", ylab = "transformation",
  log = ifelse(d == 1, "y", ""),
  las = 1, main = if (d == 0) "Some probability link functions"
  else "First derivative")
  lines(p, logitlink(p, deriv = d), col = "green")
  lines(p, probitlink(p, deriv = d), col = "blue")
  lines(p, clogloglink(p, deriv = d), col = "tan")
  lines(p, asinlink(p, deriv = d), col = "red3")
  if (d == 0) {
    abline(v = 0.5, h = 0, lty = "dashed")
    legend(0, 4.5, c("logitlink", "probitlink", "clogloglink",
      "asinlink"), lwd = mylwd,
      col = c("green", "blue", "tan", "red3"))
  } else
    abline(v = 0.5, lwd = 0.5, col = "gray")
}

for (d in 0) {
  matplot(y, cbind( logitlink(y, deriv = d, inverse = TRUE),
    probitlink(y, deriv = d, inverse = TRUE)),
  type = "n", col = "blue", xlab = "transformation", ylab = "p",
  main = if (d == 0) "Some inverse probability link functions"
  else "First derivative", las=1)
  lines(y, logitlink(y, deriv = d, inverse = TRUE), col = "green")
  lines(y, probitlink(y, deriv = d, inverse = TRUE), col = "blue")
  lines(y, clogloglink(y, deriv = d, inverse = TRUE), col = "tan")
  lines(y, asinlink(y, deriv = d, inverse = TRUE), col = "red3")
  if (d == 0) {
    abline(h = 0.5, v = 0, lwd = 0.5, col = "gray")
    legend(-4, 1, c("logitlink", "probitlink", "clogloglink",
      "asinlink"), lwd = mylwd,
      col = c("green", "blue", "tan", "red3"))
  }
}
par(lwd = 1)

## End(Not run)
Description

Undergraduate student enrolments at the University of Auckland in 1990.

Usage

data(auuc)

Format

A data frame with 4 observations on the following 5 variables.

- **Commerce**  a numeric vector of counts.
- **Arts**  a numeric vector of counts.
- **SciEng**  a numeric vector of counts.
- **Law**  a numeric vector of counts.
- **Medicine**  a numeric vector of counts.

Details

Each student is cross-classified by their colleges (Science and Engineering have been combined) and the socio-economic status (SES) of their fathers (1 = highest, down to 4 = lowest).

Source

Dr Tony Morrison.

References


Examples

```r
auuc
## Not run:
round(fitted(grc(auuc)))
round(fitted(grc(auuc, Rank = 2)))
## End(Not run)
```
aux.posbernoulli.t

Auxiliary Function for the Positive Bernoulli Family Function with Time Effects

Description

Returns behavioural effects indicator variables from a capture history matrix.

Usage

aux.posbernoulli.t(y, check.y = FALSE, rename = TRUE, name = "bei")

Arguments

y
Capture history matrix. Rows are animals, columns are sampling occasions, and values should be 0s and 1s only.

check.y
Logical, if TRUE then some basic checking is performed.

rename, name
If rename = TRUE then the behavioural effects indicator are named using the value of name as the prefix. If FALSE then use the same column names as y.

Details

This function can help fit certain capture–recapture models (commonly known as $M_{tb}$ or $M_{thb}$ (no prefix h means it is an intercept-only model) in the literature). See posbernoulli.t for details.

Value

A list with the following components.

- **cap.hist1**: A matrix the same dimension as y. In any particular row there are 0s up to the first capture. Then there are 1s thereafter.
- **cap1**: A vector specifying which time occasion the animal was first captured.
- **y0i**: Number of noncaptures before the first capture.
- **yr0i**: Number of noncaptures after the first capture.
- **yr1i**: Number of recaptures after the first capture.

See Also

posbernoulli.t, deermice.
Examples

```r
# Fit a M.tbh model to the deermice data:
(pdata <- aux.posbernoulli.t(with(deermice,
    cbind(y1, y2, y3, y4, y5, y6))))

deermice <- data.frame(deermice,
    bei = 0, # Add this
    pdata$cap.hist1) # Incorporate these
head(deermice) # Augmented with behavioural effect indicator variables
tail(deermice)
```

backPain Data on Back Pain Prognosis, from Anderson (1984)

Description

Data from a study of patients suffering from back pain. Prognostic variables were recorded at presentation and progress was categorised three weeks after treatment.

Usage

data(backPain)

Format

A data frame with 101 observations on the following 4 variables.

- **x2** length of previous attack.
- **x3** pain change.
- **x4** lordosis.
- **pain** an ordered factor describing the progress of each patient with levels worse < same < slight.improvement < moderate.improvement < marked.improvement < complete.relief.

Source

http://ideas.repec.org/c/boc/bocode/s419001.html

The data set and this help file was copied from gnm so that a vignette in VGAM could be run; the analysis is described in Yee (2010).

The data frame backPain2 is a modification of backPain where the variables have been renamed (x1 becomes x2, x2 becomes x3, x3 becomes x4) and converted into factors.

References


Examples

```
summary(backPain)
summary(backPain2)
```

---

**Bacon and Eggs Data**

**Description**

Purchasing of bacon and eggs.

**Usage**

```
data(beggs)
```

**Format**

Data frame of a two way table.

- `b0, b1, b2, b3, b4` The `b` refers to bacon. The number of times bacon was purchased was 0, 1, 2, 3, or 4.
- `e0, e1, e2, e3, e4` The `e` refers to eggs. The number of times eggs was purchased was 0, 1, 2, 3, or 4.

**Details**

The data is from Information Resources, Inc., a consumer panel based in a large US city [see Bell and Lattin (1998) for further details]. Starting in June 1991, the purchases in the bacon and fresh eggs product categories for a sample of 548 households over four consecutive store trips was tracked. Only those grocery shopping trips with a total basket value of at least five dollars was considered. For each household, the total number of bacon purchases in their four eligible shopping trips and the total number of egg purchases (usually a package of eggs) for the same trips, were counted.

**Source**


**References**


**See Also**

`rrvglm`, `rcim`, `grc`.
Examples

beegs
colSums(beegs)
rowSums(beegs)

---

bell 

The Bell Series of Integers

Description

Returns the values of the Bell series.

Usage

bell(n)

Arguments

n 

Vector of non-negative integers. Values greater than 218 return an Inf. Non-integers or negative values return a NaN.

Details

The Bell numbers emerge from a series expansion of $e^{e^x - 1}$ for real $x$. The first few values are $B_0 = 1, B_1 = 1, B_2 = 2, B_3 = 5, B_4 = 15$. The series increases quickly so that overflow occurs when its argument is more than 218.

Value

This function returns $B_n$.

Author(s)

T. W. Yee

References


See Also

bell1ff, rbell.
Benford

Examples

```r
## Not run:
plot(0:10, bell(0:10), log = "y", type = "h", col = "blue")
## End(Not run)
```

Benford

Benford’s Distribution

Description

Density, distribution function, quantile function, and random generation for Benford’s distribution.

Usage

```r
dbenf(x, ndigits = 1, log = FALSE)
pbenf(q, ndigits = 1, lower.tail = TRUE, log.p = FALSE)
qbenf(p, ndigits = 1, lower.tail = TRUE, log.p = FALSE)
rbenf(n, ndigits = 1)
```

Arguments

- `x, q`: vector of quantiles. See `ndigits`.
- `p`: vector of probabilities.
- `n`: number of observations. A single positive integer. Else if `length(n) > 1` then the length is taken to be the number required.
- `ndigits`: Number of leading digits, either 1 or 2. If 1 then the support of the distribution is \{1,\ldots,9\}, else \{10,\ldots,99\}.
- `log, log.p`: Logical. If `log.p = TRUE` then all probabilities `p` are given as `log(p)`.
- `lower.tail`: Same meaning as in `pnorm` or `qnorm`.

Details

Benford’s Law (aka the significant-digit law) is the empirical observation that in many naturally occurring tables of numerical data, the leading significant (nonzero) digit is not uniformly distributed in \{1,2,\ldots,9\}. Instead, the leading significant digit (= $D$, say) obeys the law

$$P(D = d) = \log_{10} \left( 1 + \frac{1}{d} \right)$$

for $d = 1,\ldots,9$. This means the probability the first significant digit is 1 is approximately 0.301, etc.

Benford’s Law was apparently first discovered in 1881 by astronomer/mathematician S. Newcombe. It started by the observation that the pages of a book of logarithms were dirtiest at the beginning and progressively cleaner throughout. In 1938, a General Electric physicist called F. Benford rediscovered the law on this same observation. Over several years he collected data from different
sources as different as atomic weights, baseball statistics, numerical data from *Reader’s Digest*, and drainage areas of rivers.

Applications of Benford’s Law has been as diverse as to the area of fraud detection in accounting and the design computers.

Benford’s distribution has been called “a” logarithmic distribution; see logff.

**Value**

dbenf gives the density, pbenf gives the distribution function, and qbenf gives the quantile function, and rbenf generates random deviates.

**Author(s)**

T. W. Yee and Kai Huang

**References**


**Examples**

dbenf(x <- c(0:10, NA, NaN, -Inf, Inf))
pbenf(x)

```r
## Not run:
xx <- 1:9
barplot(dbenf(xx), col = "lightblue", xlab = "Leading digit",
ylab = "Probability", names.arg = as.character(xx),
main = "Benford's distribution", las = 1)

hist(rbenf(1000), border = "blue", prob = TRUE,
main = "1000 random variates from Benford's distribution",
xlab = "Leading digit", sub="Red is the true probability",
b breaks = 0:9 + 0.5, ylim = c(0, 0.35), xlim = c(0, 10.0))
lines(xx, dbenf(xx), col = "red", type = "h")
points(xx, dbenf(xx), col = "red")

## End(Not run)
```

---

**Benini**

*The Benini Distribution*

**Description**

Density, distribution function, quantile function and random generation for the Benini distribution with parameter shape.
Benini

Usage

\[
\begin{align*}
dbenini(x, y0, \text{shape}, \log = \text{FALSE}) \\
pbenini(q, y0, \text{shape}, \text{lower.tail = TRUE}, \log.p = \text{FALSE}) \\
qbenini(p, y0, \text{shape}, \text{lower.tail = TRUE}, \log.p = \text{FALSE}) \\
rbenini(n, y0, \text{shape})
\end{align*}
\]

Arguments

- \(x, q\) vector of quantiles.
- \(p\) vector of probabilities.
- \(n\) number of observations. Same as \text{runif}.
- \(y0\) the scale parameter \(y_0\).
- \(\text{shape}\) the positive shape parameter \(b\).
- \(\log\) Logical. If \(\log = \text{TRUE}\) then the logarithm of the density is returned.
- \(\text{lower.tail}, \text{log.p}\) Same meaning as in \text{pnorm} or \text{qnorm}.

Details

See \text{benini1}, the \text{VGAM} family function for estimating the parameter \(s\) by maximum likelihood estimation, for the formula of the probability density function and other details.

Value

dbenini gives the density, pbenini gives the distribution function, qbenini gives the quantile function, and rbenini generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


See Also

\text{benini1}.

Examples

```
## Not run:
y0 <- 1; shape <- exp(1)
xx <- seq(0.0, 4, len = 101)
plot(xx, dbenini(xx, y0 = y0, shape = shape), col = "blue",
     main = "Blue is density, orange is the CDF", type = "l",
     sub = "Purple lines are the 10,20,...,90 percentiles",
     ...)
```r
ylim = 0:1, las = 1, ylab = "", xlab = "x")
abline(h = 0, col = "blue", lty = 2)
lines(xx, pbenini(xx, y0 = y0, shape = shape), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qbenini(probs, y0 = y0, shape = shape)
lines(Q, dbenini(Q, y0 = y0, shape = shape),
    col = "purple", lty = 3, type = "h")
pbenini(Q, y0 = y0, shape = shape) - probs  # Should be all zero
```

## End(Not run)

---

**benini1**

**Benini Distribution Family Function**

### Description

Estimating the 1-parameter Benini distribution by maximum likelihood estimation.

### Usage

```r
benini1(y0 = stop("argument 'y0' must be specified"),
    lshape = "loglink", ishape = NULL, imethod = 1,
    zero = NULL, parallel = FALSE,
    type.fitted, percentiles = 50)
```

### Arguments

- **y0**: Positive scale parameter.
- **lshape**: Parameter link function and extra argument of the parameter \( b \), which is the shape parameter. See **Links** for more choices. A log link is the default because \( b \) is positive.
- **ishape**: Optional initial value for the shape parameter. The default is to compute the value internally.
- **imethod**, **zero**, **parallel**
  - Details at **CommonVGAMffArguments**.
- **type.fitted**, **percentiles**
  - See **CommonVGAMffArguments** for information. Using "Qlink" is for quantile-links in **VGAMextra**.

### Details

The Benini distribution has a probability density function that can be written

\[
f(y) = 2s \exp(-s[(\log(y/y_0))^2]) \log(y/y_0)/y
\]

for \( 0 < y_0 < y \), and shape \( s > 0 \). The cumulative distribution function for \( Y \) is

\[
F(y) = 1 - \exp(-s[(\log(y/y_0))^2]).
\]
Here, Newton-Raphson and Fisher scoring coincide. The median of \( Y \) is now returned as the fitted values, by default. This \texttt{VGAM} family function can handle a multiple responses, which is inputted as a matrix.

On fitting, the \texttt{extra} slot has a component called \texttt{y0} which contains the value of the \texttt{y0} argument.

\section*{Value}

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

\section*{Note}

Yet to do: the 2-parameter Benini distribution estimates another shape parameter \( a \) too. Hence, the code may change in the future.

\section*{Author(s)}

T. W. Yee

\section*{References}


\section*{See Also}

\texttt{Benini}.

\section*{Examples}

\begin{verbatim}
y0 <- 1; nn <- 3000 bdata <- data.frame(y = rbenini(nn, y0 = y0, shape = exp(2))) fit <- vglm(y ~ 1, benini1(y0 = y0), data = bdata, trace = TRUE) coef(fit, matrix = TRUE) Coef(fit) fit@extra$y0 c(head(fitted(fit), 1), with(bdata, median(y))) # Should be equal
\end{verbatim}
Usage

`dbetabinom(x, size, prob, rho = 0, log = FALSE)`
`pbetabinom(q, size, prob, rho = 0, log.p = FALSE)`
`rbetabinom(n, size, prob, rho = 0)`
`dbetabinom.ab(x, size, shape1, shape2, log = FALSE, Inf.shape = exp(20), limit.prob = 0.5)`
`pbetabinom.ab(q, size, shape1, shape2, limit.prob = 0.5, log.p = FALSE)`
`rbetabinom.ab(n, size, shape1, shape2, limit.prob = 0.5, .dontuse.prob = NULL)`
`dzoibetabinom(x, size, prob, rho = 0, pstr0 = 0, pstrsize = 0, log = FALSE)`
`pzoibetabinom(q, size, prob, rho, pstr0 = 0, pstrsize = 0, lower.tail = TRUE, log.p = FALSE)`
`rzoibetabinom(n, size, prob, rho = 0, pstr0 = 0, pstrsize = 0)`
`dzoibetabinom.ab(x, size, shape1, shape2, pstr0 = 0, pstrsize = 0, log = FALSE)`
`pzoibetabinom.ab(q, size, shape1, shape2, pstr0 = 0, pstrsize = 0, lower.tail = TRUE, log.p = FALSE)`
`rzoibetabinom.ab(n, size, shape1, shape2, pstr0 = 0, pstrsize = 0)`

Arguments

- **x, q**: vector of quantiles.
- **size**: number of trials.
- **n**: number of observations. Same as `runif`.
- **prob**: the probability of success \( \mu \). Must be in the unit closed interval \([0, 1]\).
- **rho**: the correlation parameter \( \rho \), which should be in the interval \([0, 1]\). The default value of 0 corresponds to the usual binomial distribution with probability \( \text{prob} \). Setting \( \rho = 1 \) would set both shape parameters equal to 0, and the ratio \( 0/0 \) is actually NaN, is interpreted by `Beta` as 0.5. See the warning below.
- **shape1, shape2**: the two (positive) shape parameters of the standard beta distribution. They are called `a` and `b` in `beta` respectively. Note that \( \text{shape1} = \text{prob} \times (1-\text{rho})/\rho \) and \( \text{shape2} = (1-\text{prob}) \times (1-\text{rho})/\rho \) is an important relationship between the parameters, so that the shape parameters are infinite by default because \( \rho = 0 \); hence \text{limit.prob} = \text{prob} is used to obtain the behaviour of the usual binomial distribution.
- **log, log.p, lower.tail**: Same meaning as `runif`.
- **Inf.shape**: Numeric. A large value such that, if shape1 or shape2 exceeds this, then special measures are taken, e.g., calling `dbinom`. Also, if shape1 or shape2 is less than its reciprocal, then special measures are also taken. This feature/approximation is needed to avoid numerical problem with catastrophic cancellation of multiple `lbeta` calls.
- **limit.prob**: Numerical vector; recycled if necessary. If either shape parameters are `Inf` then the binomial limit is taken, with \( \text{shape1} / (\text{shape1} + \text{shape2}) \) as the probability
of success. In the case where both are Inf this probability will be a NaN = Inf/Inf, however, the value limit.prob is used instead. Hence the default for dbetabinom.ab() is to assume that both shape parameters are equal as the limit is taken (indeed, Beta uses 0.5). Note that for [dpr]betabinom(), because rho = 0 by default, then limit.prob = prob so that the beta-binomial distribution behaves like the ordinary binomial distribution with respect to arguments size and prob.

.dontuse.prob  An argument that should be ignored and not used.
pstr0  Probability of a structural zero (i.e., ignoring the beta-binomial distribution). The default value of pstr0 corresponds to the response having a beta-binomial distribution inflated only at size.
pstrsize  Probability of a structural maximum value size. The default value of pstrsize corresponds to the response having a beta-binomial distribution inflated only at 0.

Details

The beta-binomial distribution is a binomial distribution whose probability of success is not a constant but it is generated from a beta distribution with parameters shape1 and shape2. Note that the mean of this beta distribution is mu = shape1/(shape1+shape2), which therefore is the mean or the probability of success.

See betabinomial and betabinomialff, the VGAM family functions for estimating the parameters, for the formula of the probability density function and other details.

For the inflated beta-binomial distribution, the probability mass function is

\[ P(Y = y) = (1 - pstr0 - pstrsize) \times BB(y) + pstr0 \times I[y = 0] + pstrsize \times I[y = size] \]

where BB(y) is the probability mass function of the beta-binomial distribution with the same shape parameters (pbetabinom.ab), pstr0 is the inflated probability at 0 and pstrsize is the inflated probability at 1. The default values of pstr0 and pstrsize mean that these functions behave like the ordinary Betabinom when only the essential arguments are inputted.

Value

dbetabinom and dbetabinom.ab give the density, pbetabinom and pbetabinom.ab give the distribution function, and rbetabinom and rbetabinom.ab generate random deviates.
dzoibetabinom and dzoibetabinom.ab give the inflated density, pzoibetabinom and pzoibetabinom.ab give the inflated distribution function, and rzoibetabinom and rzoibetabinom.ab generate random inflated deviates.

Warning

Setting rho = 1 is not recommended, however the code may be modified in the future to handle this special case.
Note

pzoibetabinom, pzoibetabinom.ab, pbetabinom and pbetabinom.ab can be particularly slow. The functions here ending in .ab are called from those functions which don’t. The simple transformations $\mu = \alpha / (\alpha + \beta)$ and $\rho = 1 / (1 + \alpha + \beta)$ are used, where $\alpha$ and $\beta$ are the two shape parameters.

Author(s)

T. W. Yee and Xiangjie Xue

See Also

Extbetabinom, betabinomial, betabinomialff, Zoabeta, Beta.

Examples

```r
set.seed(1); rbetabinom(10, 100, prob = 0.5)
set.seed(1); rbinom(10, 100, prob = 0.5) # The same as rho = 0

## Not run: N <- 9; xx <- 0:N; s1 <- 2; s2 <- 3
dy <- dbetabinom.ab(xx, size = N, shape1 = s1, shape2 = s2)
barplot(rbind(dy, dbinom(xx, size = N, prob = s1 / (s1+s2))),
beside = TRUE, col = c("blue","green"), las = 1,
main = paste("Beta-binomial (size="N", shape1="s1, ", shape2="s2, ") (blue) vs
", " Binomial(size="N", " prob="s1/(s1+s2), ") (green)",
sep = ""),
names.arg = as.character(xx), cex.main = 0.8)
sum(dy * xx) # Check expected values are equal
sum(dbinom(xx, size = N, prob = s1 / (s1+s2)) * xx)
# Should be all 0:
cumsum(dy) - pbetabinom.ab(xx, N, shape1 = s1, shape2 = s2)

y <- rbetabinom.ab(n = 1e4, size = N, shape1 = s1, shape2 = s2)
ty <- table(y)
barplot(rbind(dy, ty / sum(ty)),
beside = TRUE, col = c("blue", "orange"), las = 1,
main = paste("Beta-binomial (size="N", shape1="s1, ", shape2="s2, ") (blue) vs
", " Random generated beta-binomial(size="N", " prob="s1/(s1+s2), ") (orange)", sep = ""), cex.main = 0.8,
names.arg = as.character(xx))

N <- 1e5; size <- 20; pstr0 <- 0.2; pstrsize <- 0.2
kk <- rzoibetabinom.ab(N, size, s1, s2, pstr0, pstrsize)
hist(kk, probability = TRUE, border = "blue", ylim = c(0, 0.25),
main = "Blue/green = inflated; orange = ordinary beta-binomial",
breaks = -0.5 : (size + 0.5))
sum(kk == 0) / N # Proportion of 0
sum(kk == size) / N # Proportion of size
lines(0 : size, dbetabinom.ab(0 : size, size, s1, s2), col = "orange")
```
betabinomial

Description

Fits a beta-binomial distribution by maximum likelihood estimation. The two parameters here are the mean and correlation coefficient.

Usage

betabinomial(lmu = "logitlink", lrho = "logitlink",
irho = NULL, imethod = 1,
ishrinkage = 0.95, nsimEIM = NULL, zero = "rho")

Arguments

lmu, lrho Link functions applied to the two parameters. See Links for more choices. The defaults ensure the parameters remain in (0, 1), however, see the warning below. For lrho, log1plink (with an offset log(size - 1) for \( \eta_2 \)) and cloglink may be very good choices.

irho Optional initial value for the correlation parameter. If given, it must be in (0, 1), and is recycled to the necessary length. Assign this argument a value if a convergence failure occurs. Having irho = NULL means an initial value is obtained internally, though this can give unsatisfactory results.

imethod An integer with value 1 or 2 or ..., which specifies the initialization method for \( \mu \). If failure to converge occurs try the another value and/or else specify a value for irho.

zero Specifies which linear/additive predictor is to be modelled as an intercept only. If assigned, the single value can be either 1 or 2. The default is to have a single correlation parameter. To model both parameters as functions of the covariates assign zero = NULL. See CommonVGAMffArguments for more information.

ishrinkage, nsimEIM

See CommonVGAMffArguments for more information. The argument ishrinkage is used only if imethod = 2. Using the argument nsimEIM may offer large advantages for large values of \( N \) and/or large data sets.

Details

There are several parameterizations of the beta-binomial distribution. This family function directly models the mean and correlation parameter, i.e., the probability of success. The model can be written \( T|P = p \sim Binomial(N, p) \) where \( P \) has a beta distribution with shape parameters \( \alpha \) and
\( \beta \). Here, \( N \) is the number of trials (e.g., litter size), \( T = NY \) is the number of successes, and \( p \) is the probability of a success (e.g., a malformation). That is, \( Y \) is the \textit{proportion} of successes. Like \texttt{binomialff}, the fitted values are the estimated probability of success (i.e., \( E[Y] \) and not \( E[T] \)) and the prior weights \( N \) are attached separately on the object in a slot.

The probability function is

\[
P(T = t) = \binom{N}{t} \frac{\text{Be}(\alpha + t, \beta + N - t)}{\text{Be}(\alpha, \beta)}
\]

where \( t = 0, 1, \ldots, N \), and \( \text{Be} \) is the \texttt{beta} function with shape parameters \( \alpha \) and \( \beta \). Recall \( Y = T/N \) is the real response being modelled.

The default model is \( \eta_1 = \logit(\mu) \) and \( \eta_2 = \logit(\rho) \) because both parameters lie between 0 and 1. The mean (of \( Y \)) is \( \mu = \alpha/(\alpha + \beta) \) and the variance (of \( Y \)) is \( \mu(1-\mu)(1+(N-1)\rho)/N \). Here, the correlation \( \rho \) is given by \( 1/(1+\alpha+\beta) \) and is the correlation between the \( N \) individuals within a litter. A \textit{litter effect} is typically reflected by a positive value of \( \rho \). It is known as the \textit{over-dispersion parameter}.

This family function uses Fisher scoring. Elements of the second-order expected derivatives with respect to \( \alpha \) and \( \beta \) are computed numerically, which may fail for large \( \alpha, \beta, N \) or else take a long time.

\textbf{Value}

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}.

Suppose \( \text{fit} \) is a fitted beta-binomial model. Then \( \text{depvar(\text{fit})} \) are the sample proportions \( y \), \( \text{fitted(\text{fit})} \) returns estimates of \( E(Y) \), and \( \text{weights(\text{fit}, type = "prior")} \) returns the number of trials \( N \).

\textbf{Warning}

If the estimated rho parameter is close to 0 then a good solution is to use \texttt{extbetabinomial}. Or you could try \texttt{lrho = "rhobitlink"}.

This family function is prone to numerical difficulties due to the expected information matrices not being positive-definite or ill-conditioned over some regions of the parameter space. If problems occur try setting \( \text{irho} \) to some numerical value, \( \text{nsimEIM} = 100 \), say, or else use \texttt{etastart} argument of \texttt{vglm}, etc.

\textbf{Note}

This function processes the input in the same way as \texttt{binomialff}. But it does not handle the case \( N = 1 \) very well because there are two parameters to estimate, not one, for each row of the input. Cases where \( N = 1 \) can be omitted via the \texttt{subset} argument of \texttt{vglm}.

The \textit{extended} beta-binomial distribution of Prentice (1986) implemented by \texttt{extbetabinomial} is the preferred \texttt{VGAM} family function for BBD regression.

\textbf{Author(s)}

T. W. Yee
References


See Also

`extbetabinomial`, `betabinomialff`, `Betabinom`, `binomialff`, `betaff`, `dirmultinomial`, `log1plink`, `cloglink`, `lirat`, `simulate.vlm`.

Examples

# Example 1
bdata <- data.frame(N = 10, mu = 0.5, rho = 0.8)
bdata <- transform(bdata,
    y = rbetabinom(100, size = N, prob = mu, rho = rho))
fit <- vglm(cbind(y, N-y) ~ 1, betabinomial, bdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(cbind(depvar(fit), weights(fit, type = "prior")))

# Example 2
fit <- vglm(cbind(R, N-R) ~ 1, betabinomial, lirat, 
    trace = TRUE, subset = N > 1)
coef(fit, matrix = TRUE)
Coef(fit)
t(fitted(fit))
t(depvar(fit))
t(weights(fit, type = "prior"))

# Example 3, which is more complicated
lirat <- transform(lirat, fgrp = factor(grp))
summary(lirat) # Only 5 litters in group 3
fit2 <- vglm(cbind(R, N-R) ~ fgrp + hb, betabinomial(zero = 2), 
    data = lirat, trace = TRUE, subset = N > 1)
coef(fit2, matrix = TRUE)
## Not run: with(lirat, plot(hb[ N > 1], fit2@misc$rho, 
    xlab = "Hemoglobin", ylab = "Estimated rho", 
    pch = as.character(grp[ N > 1]), col = grp[ N > 1]))
## End(Not run)
## Not run: # cf. Figure 3 of Moore and Tsiatis (1991)
with(lirat, plot(hb, R / N, pch = as.character(grp), col = grp, 
    xlab = "Hemoglobin level", ylab = "Proportion Dead", 
    main = "Fitted values (lines)", las = 1))
smalldf <- with(lirat, lirat[ N > 1, ])
for (gp in 1:4) {
    xx <- with(smalldf, hb[grp == gp])
    yy <- with(smalldf, fitted(fit2)[grp == gp])
    ooo <- order(xx)
    lines(xx[ooo], yy[ooo], col = gp, lwd = 2)
}
betabinomialff

**Beta-binomial Distribution Family Function**

**Description**
Fits a beta-binomial distribution by maximum likelihood estimation. The two parameters here are the shape parameters of the underlying beta distribution.

**Usage**
```r
betabinomialff(lshape1 = "loglink", lshape2 = "loglink", 
ishape1 = 1, ishape2 = NULL, imethod = 1, ishrinkage = 0.95, 
nsimEIM = NULL, zero = NULL)
```

**Arguments**
- `lshape1, lshape2`
  Link functions for the two (positive) shape parameters of the beta distribution. See **Links** for more choices.
- `ishape1, ishape2`
  Initial value for the shape parameters. The first must be positive, and is recycled to the necessary length. The second is optional. If a failure to converge occurs, try assigning a different value to `ishape1` and/or using `ishape2`.
- `zero`
  Can be an integer specifying which linear/additive predictor is to be modelled as an intercept only. If assigned, the single value should be either 1 or 2. The default is to model both shape parameters as functions of the covariates. If a failure to converge occurs, try `zero = 2`. See **CommonVGAMffArguments** for more information.
- `ishrinkage, nsimEIM, imethod`
  See **CommonVGAMffArguments** for more information. The argument `ishrinkage` is used only if `imethod = 2`. Using the argument `nsimEIM` may offer large advantages for large values of `N` and/or large data sets.

**Details**
There are several parameterizations of the beta-binomial distribution. This family function directly models the two shape parameters of the associated beta distribution rather than the probability of success (however, see **Note** below). The model can be written $T|P = p \sim \text{Binomial}(N, p)$ where $P$ has a beta distribution with shape parameters $\alpha$ and $\beta$. Here, $N$ is the number of trials (e.g., litter size), $T = NY$ is the number of successes, and $p$ is the probability of a success (e.g., a malformation). That is, $Y$ is the proportion of successes. Like `binomialff`, the fitted values are the estimated probability of success (i.e., $E[Y]$ and not $E[T]$) and the prior weights $N$ are attached separately on the object in a slot.
The probability function is

\[ P(T = t) = \binom{N}{t} \frac{B(\alpha + t, \beta + N - t)}{B(\alpha, \beta)} \]

where \( t = 0, 1, \ldots, N \), and \( B \) is the beta function with shape parameters \( \alpha \) and \( \beta \). Recall \( Y = T/N \) is the real response being modelled.

The default model is \( \eta_1 = \log(\alpha) \) and \( \eta_2 = \log(\beta) \) because both parameters are positive. The mean (of \( Y \)) is \( \mu = \alpha/(\alpha + \beta) \) and the variance (of \( Y \)) is \( \mu(1 - \mu)(1 + (N - 1)\rho)/N \). Here, the correlation \( \rho \) is given by \( 1/(1 + \alpha + \beta) \) and is the correlation between the \( N \) individuals within a litter. A litter effect is typically reflected by a positive value of \( \rho \). It is known as the over-dispersion parameter.

This family function uses Fisher scoring. The two diagonal elements of the second-order expected derivatives with respect to \( \alpha \) and \( \beta \) are computed numerically, which may fail for large \( \alpha, \beta, N \) or else take a long time.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm.

Suppose \( \text{fit} \) is a fitted beta-binomial model. Then \( \text{fit@y} \) (better: \( \text{depvar(fit)} \)) contains the sample proportions \( y \), \( \text{fitted(fit)} \) returns estimates of \( E(Y) \), and \( \text{weights(fit, type = "prior")} \) returns the number of trials \( N \).

**Warning**

This family function is prone to numerical difficulties due to the expected information matrices not being positive-definite or ill-conditioned over some regions of the parameter space. If problems occur try setting \( \text{ishape1} \) to be some other positive value, using \( \text{ishape2} \) and/or setting \( \text{zero = 2} \).

This family function may be renamed in the future. See the warnings in betabinomial.

**Note**

This function processes the input in the same way as binomialff. But it does not handle the case \( N = 1 \) very well because there are two parameters to estimate, not one, for each row of the input. Cases where \( N = 1 \) can be omitted via the \( \text{subset} \) argument of vglm.

Although the two linear/additive predictors given above are in terms of \( \alpha \) and \( \beta \), basic algebra shows that the default amounts to fitting a logit link to the probability of success; subtracting the second linear/additive predictor from the first gives that logistic regression linear/additive predictor. That is, \( \logit(\mu) = \eta_1 - \eta_2 \). This is illustrated in one of the examples below.

The extended beta-binomial distribution of Prentice (1986) implemented by extbetabinomial is the preferred VGAM family function for BBD regression.

**Author(s)**

T. W. Yee
References


See Also

`extbetabinomial, betabinomial, Betabinom, binomialff, betaff, dirmultinomial, lirat, simulate.vlm`.

Examples

```r
# Example 1
N <- 10; s1 <- exp(1); s2 <- exp(2)
y <- rbetabinom.ab(n = 100, size = N, shape1 = s1, shape2 = s2)
fit <- vglm(cbind(y, N-y) ~ 1, betabinomialff, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(fit@misc$rho) # The correlation parameter
head(cbind(depvar(fit), weights(fit, type = "prior")))
```

```r
# Example 2
fit <- vglm(cbind(R, N-R) ~ 1, betabinomialff, data = lirat, 
trace = TRUE, subset = N > 1)
coef(fit, matrix = TRUE)
Coef(fit)
fit@misc$rho # The correlation parameter
t(fitted(fit))
t(depvar(fit))
t(weights(fit, type = "prior"))
# A "loglink" link for the 2 shape params is a logistic regression:
all.equal(c(fitted(fit)), 
as.vector(logitlink(predict(fit)[, 1] - 
predict(fit)[, 2], inverse = TRUE)))
```

```r
# Example 3, which is more complicated
lirat <- transform(lirat, fgrp = factor(grp))
summary(lirat) # Only 5 litters in group 3
fit2 <- vglm(cbind(R, N-R) ~ fgrp + hb, betabinomialff(zero = 2), 
data = lirat, trace = TRUE, subset = N > 1)
coef(fit2, matrix = TRUE)
coef(fit2, matrix = TRUE)[, 1] - 
coef(fit2, matrix = TRUE)[, 2] # logitlink(p)
## Not run: with(lirat, plot(hb[N > 1], fit2@misc$rho, 
  xlab = "Hemoglobin", ylab = "Estimated rho", 
  pch = as.character(grp[N > 1]), col = grp[N > 1]))
## End(Not run)
```
## Not run:  # cf. Figure 3 of Moore and Tsiatis (1991)
with(lirat, plot(hb, R / N, pch = as.character(grp), col = grp,
    xlab = "Hemoglobin level", ylab = "Proportion Dead", las = 1,
    main = "Fitted values (lines")
)

smalldf <- with(lirat, lirat[N > 1, ])
for (gp in 1:4) {
  xx <- with(smalldf, hb[grp == gp])
  yy <- with(smalldf, fitted(fit2)[grp == gp])
  ooo <- order(xx)
  lines(xx[ooo], yy[ooo], col = gp, lwd = 2)
}
## End(Not run)

betaff The Two-parameter Beta Distribution Family Function

Description

Estimation of the mean and precision parameters of the beta distribution.

Usage

betaff(A = 0, B = 1, lmui = "logitlink", lphi = "loglink",
    imu = NULL, iphi = NULL,
    gprobs.y = ppoints(8), gphi = exp(-3:5)/4, zero = NULL)

Arguments

A, B        Lower and upper limits of the distribution. The defaults correspond to the standard beta distribution where the response lies between 0 and 1.

lmui, lphi  Link function for the mean and precision parameters. The values A and B are extracted from the min and max arguments of extlogitlink. Consequently, only extlogitlink is allowed.

imu, iphi   Optional initial value for the mean and precision parameters respectively. A NULL value means a value is obtained in the initialize slot.

gprobs.y, gphi, zero

See CommonVGAMffArguments for more information.

Details

The two-parameter beta distribution can be written $f(y) =$

$$(y - A)^{\mu_1 \phi - 1} \times (B - y)^{(1 - \mu_1) \phi - 1} / [\beta(\mu_1 \phi, (1 - \mu_1) \phi) \times (B - A)^{\phi - 1}]$$

for $A < y < B$, and $\beta(\cdot, \cdot)$ is the beta function (see beta). The parameter $\mu_1$ satisfies $\mu_1 = (\mu - A) / (B - A)$ where $\mu$ is the mean of $Y$. That is, $\mu_1$ is the mean of of a standard beta distribution:
\[ E(Y) = A + (B - A) \times \mu_1, \] 
and these are the fitted values of the object. Also, \( \phi \) is positive and \( A < \mu < B \). Here, the limits \( A \) and \( B \) are known.

Another parameterization of the beta distribution involving the raw shape parameters is implemented in \texttt{betaR}.

For general \( A \) and \( B \), the variance of \( Y \) is \( (B - A)^2 \times \mu_1 \times (1 - \mu_1)/(1 + \phi) \). Then \( \phi \) can be interpreted as a precision parameter in the sense that, for fixed \( \mu \), the larger the value of \( \phi \), the smaller the variance of \( Y \). Also, \( \mu_1 = \text{shape1}/(\text{shape1} + \text{shape2}) \) and \( \phi = \text{shape1} + \text{shape2} \). Fisher scoring is implemented.

**Value**

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

**Note**

The response must have values in the interval \((A, B)\). The user currently needs to manually choose \( \mu \) to match the input of arguments \( A \) and \( B \), e.g., with \texttt{extlogitlink}; see the example below.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

\texttt{betaR},

\texttt{Beta, dzoabeta, genbetaII, betaII, betabinomialff, betageometric, betaprime, rbetageom, rbetanorm, kumar, extlogitlink, simulate.vlm}.

**Examples**

```r
bdata <- data.frame(y = rbeta(nn <- 1000, shape1 = exp(0), shape2 = exp(1)))
fit1 <- vglm(y ~ 1, betaff, data = bdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1) # Useful for intercept-only models

# General A and B, and with a covariate
bdata <- transform(bdata, x2 = runif(nn))
bdata <- transform(bdata, mu = logitlink(0.5 - x2, inverse = TRUE),
                     prec = exp(3.0 + x2)) # prec == phi
bdata <- transform(bdata, shape2 = prec * (1 - mu),
                     shape1 = mu * prec)
bdata <- transform(bdata,
                   y = rbeta(nn, shape1 = shape1, shape2 = shape2))
```
bdata <- transform(bdata, Y = 5 + 8 * y)  # From 5--13, not 0--1
fit <- vglm(Y ~ x2, data = bdata, trace = TRUE,
  betaff(A = 5, B = 13, lmu = extlogitlink(min = 5, max = 13)))
coef(fit, matrix = TRUE)

Betageom  The Beta-Geometric Distribution

Description

Density, distribution function, and random generation for the beta-geometric distribution.

Usage

  dbetageom(x, shape1, shape2, log = FALSE)
  pbetageom(q, shape1, shape2, log.p = FALSE)
  rbetageom(n, shape1, shape2)

Arguments

  x, q    vector of quantiles.
  n    number of observations. Same as runif.
  shape1, shape2    the two (positive) shape parameters of the standard beta distribution. They are called a and b in beta respectively.
  log, log.p    Logical. If TRUE then all probabilities p are given as log(p).

Details

The beta-geometric distribution is a geometric distribution whose probability of success is not a constant but it is generated from a beta distribution with parameters shape1 and shape2. Note that the mean of this beta distribution is shape1/(shape1+shape2), which therefore is the mean of the probability of success.

Value

  dbetageom gives the density, pbetageom gives the distribution function, and rbetageom generates random deviates.

Note

  pbetageom can be particularly slow.

Author(s)

  T. W. Yee
See Also

geometric, betaff, Beta.

Examples

```r
## Not run:
shape1 <- 1; shape2 <- 2; y <- 0:30
proby <- dbetageom(y, shape1, shape2, log = FALSE)
plot(y, proby, type = "h", col = "blue", ylab = "P[Y=y]", main = paste0(
    "Y ~ Beta-geometric(shape1=" , shape1, ", shape2=" , shape2 , ")")
sum(proby)
## End(Not run)
```

betageometric  

Beta-geometric Distribution Family Function

Description

Maximum likelihood estimation for the beta-geometric distribution.

Usage

```r
betageometric(lprob = "logitlink", lshape = "loglink",
iprob = NULL, ishape = 0.1,
moreSummation = c(2, 100), tolerance = 1.0e-10, zero = NULL)
```

Arguments

- **lprob, lshape**: Parameter link functions applied to the parameters \( p \) and \( \phi \) (called prob and shape below). The former lies in the unit interval and the latter is positive. See Links for more choices.
- **iprob, ishape**: Numeric. Initial values for the two parameters. A NULL means a value is computed internally.
- **moreSummation**: Integer, of length 2. When computing the expected information matrix a series summation from 0 to \( \text{moreSummation}[1] \times \text{max}(y) + \text{moreSummation}[2] \) is made, in which the upper limit is an approximation to infinity. Here, \( y \) is the response.
- **tolerance**: Positive numeric. When all terms are less than this then the series is deemed to have converged.
- **zero**: An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. If used, the value must be from the set \{1, 2\}. See CommonVGAMffArguments for more information.
Details

A random variable $Y$ has a 2-parameter beta-geometric distribution if $P(Y = y) = p(1 - p)^y$ for $y = 0, 1, 2, \ldots$ where $p$ are generated from a standard beta distribution with shape parameters $\text{shape1}$ and $\text{shape2}$. The parameterization here is to focus on the parameters $p$ and $\phi = 1/(\text{shape1} + \text{shape2})$, where $\phi$ is shape. The default link functions for these ensure that the appropriate range of the parameters is maintained. The mean of $Y$ is $E(Y) = \text{shape2}/(\text{shape1} - 1) = (1 - p)/(p - \phi)$ if $\text{shape1} > 1$, and if so, then this is returned as the fitted values.

The geometric distribution is a special case of the beta-geometric distribution with $\phi = 0$ (see geometric). However, fitting data from a geometric distribution may result in numerical problems because the estimate of $\log(\phi)$ will 'converge' to $-\infty$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

The first iteration may be very slow; if practical, it is best for the weights argument of vglm etc. to be used rather than inputting a very long vector as the response, i.e., vglm($y \sim 1, \ldots$, weights = wts) is to be preferred over vglm(rep($y$, wts) ~ 1, \ldots). If convergence problems occur try inputting some values of argument $\text{ishape}$.

If an intercept-only model is fitted then the misc slot of the fitted object has list components $\text{shape1}$ and $\text{shape2}$.

Author(s)

T. W. Yee

References


See Also

general, betaaff, rbetageom.

Examples

bdata <- data.frame(y = 0:11,
        wts = c(227,123,72,42,21,31,11,14,6,4,7,28))
fitb <- vglm(y ~ 1, betageometric, bdata, weight = wts, trace = TRUE)
fitg <- vglm(y ~ 1, geometric, bdata, weight = wts, trace = TRUE)
coef(fitb, matrix = TRUE)
Coef(fitb)
sqrt(diag(vcov(fitb, untransform = TRUE)))
fitb@misc$shape1
fitb@misc$shape2
# Very strong evidence of a beta-geometric:
pchisq(2 * (logLik(fitb) - logLik(fitg)), df = 1, lower.tail = FALSE)

## betaII

### Description

Maximum likelihood estimation of the 3-parameter beta II distribution.

### Usage

```r
betaII(lscale = "loglink", lshape2.p = "loglink",
      lshape3.q = "loglink", iscale = NULL, ishape2.p = NULL,
      ishape3.q = NULL, imethod = 1,
      gscale = exp(-5:5), gshape2.p = exp(-5:5),
      gshape3.q = seq(0.75, 4, by = 0.25),
      probs.y = c(0.25, 0.5, 0.75), zero = "shape")
```

### Arguments

- `lscale`, `lshape2.p`, `lshape3.q`:
  Parameter link functions applied to the (positive) parameters `scale`, `p` and `q`. See `Links` for more choices.
- `iscale`, `ishape2.p`, `ishape3.q`, `imethod`, `zero`:
  See `CommonVGAMffArguments` for information.
- `gscale`, `gshape2.p`, `gshape3.q`:
  See `CommonVGAMffArguments` for information.
- `probs.y`:
  See `CommonVGAMffArguments` for information.

### Details

The 3-parameter beta II is the 4-parameter generalized beta II distribution with shape parameter $a = 1$. It is also known as the Pearson VI distribution. Other distributions which are special cases of the 3-parameter beta II include the Lomax ($p = 1$) and inverse Lomax ($q = 1$). More details can be found in Kleiber and Kotz (2003).

The beta II distribution has density

$$f(y) = y^{p-1}/[b^p B(p,q)\{1 + y/b\}^{p+q}]$$

for $b > 0$, $p > 0$, $q > 0$, $y \geq 0$. Here, $b$ is the scale parameter `scale`, and the others are shape parameters. The mean is

$$E(Y) = b \Gamma(p+1) \Gamma(q-1)/\Gamma(p) \Gamma(q)$$

provided $q > 1$; these are returned as the fitted values. This family function handles multiple responses.
Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note
See the notes in genbetaII.

Author(s)
T. W. Yee

References

See Also
betaff, genbetaII, dagum, sinmad, fisk, inv.lomax, lomax, paralogistic, inv.paralogistic.

Examples
bdata <- data.frame(y = rsinmad(2000, shape1.a = 1, shape3.q = exp(2), scale = exp(1))) # Not genuine data!
# fit <- vglm(y ~ 1, betaII, data = bdata, trace = TRUE)
fit <- vglm(y ~ 1, betaII(ishape2.p = 0.7, ishape3.q = 0.7),
data = bdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. Same as `runif`.
- `shape1, shape2` the two (positive) shape parameters of the standard beta distribution. They are called `a` and `b` respectively in `beta`.
- `mean, sd` the mean and standard deviation of the univariate normal distribution (Normal).
- `log, log.p` Logical. If `TRUE` then all probabilities `p` are given as `log(p)`.
- `lower.tail` Logical. If `TRUE` then the upper tail is returned, i.e., one minus the usual answer.

Details

The function `betauninormal`, the VGAM family function for estimating the parameters, has not yet been written.

Value

dbetanorm gives the density, pbetanorm gives the distribution function, qbetanorm gives the quantile function, and rbetanorm generates random deviates.

Author(s)

T. W. Yee

References


Examples

```r
# Not run:
scale <- 0.1; shape2 <- 4; m <- 1
x <- seq(-10, 2, len = 501)
plot(x, dbetanorm(x, shape1, shape2, m = m), type = "l",
ylim = 0:1, las = 1,
ylab = paste0("betanorm(",shape1,"",",shape2","",m="",m","",sd=1")
main = "Blue is density, orange is the CDF",
sub = "Gray lines are the 10,20,...,90 percentiles", col = "blue")
lines(x, pbetanorm(x, shape1, shape2, m = m), col = "orange")
abline(h = 0, col = "black")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qbetauninormal(probs, shape1, shape2, m = m)
lines(Q, dbetanorm(Q, shape1, shape2, m = m),
col = "gray50", lty = 2, type = "h")
lines(Q, pbetanorm(Q, shape1, shape2, m = m),
col = "gray50", lty = 2, type = "h")
abline(h = probs, col = "gray50", lty = 2)
pbetauninormal(Q, shape1, shape2, m = m) - probs # Should be all 0
```
The Beta-Prime Distribution

Description

Estimation of the two shape parameters of the beta-prime distribution by maximum likelihood estimation.

Usage

betaprime(lshape = "loglink", ishape1 = 2, ishape2 = NULL, zero = NULL)

Arguments

lshape Parameter link function applied to the two (positive) shape parameters. See Links for more choices.

ishape1, ishape2, zero

See CommonVGAMffArguments for more information.

Details

The beta-prime distribution is given by

\[ f(y) = y^{\text{shape}_1-1}(1+y)^{-\text{shape}_1-\text{shape}_2}/B(\text{shape}_1, \text{shape}_2) \]

for \( y > 0 \). The shape parameters are positive, and here, \( B \) is the beta function. The mean of \( Y \) is \( \text{shape}_1/(\text{shape}_2 - 1) \) provided \( \text{shape}_2 > 1 \); these are returned as the fitted values.

If \( Y \) has a Beta\((\text{shape}_1, \text{shape}_2)\) distribution then \( Y/(1-Y) \) and \( (1-Y)/Y \) have a Betaprime\((\text{shape}_1, \text{shape}_2)\) and Betaprime\((\text{shape}_2, \text{shape}_1)\) distribution respectively. Also, if \( Y_1 \) has a gamma\((\text{shape}_1)\) distribution and \( Y_2 \) has a gamma\((\text{shape}_2)\) distribution then \( Y_1/Y_2 \) has a Betaprime\((\text{shape}_1, \text{shape}_2)\) distribution.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Note

The response must have positive values only.

The beta-prime distribution is also known as the beta distribution of the second kind or the inverted beta distribution.
Author(s)

Thomas W. Yee

References


See Also

`betaff`, `Beta`.

Examples

```r
nn <- 1000
bdata <- data.frame(shape1 = exp(1), shape2 = exp(3))
bdata <- transform(bdata, yb = rbeta(nn, shape1, shape2))
bdata <- transform(bdata, y1 = (1-yb) / yb,
                   y2 = yb / (1-yb),
                   y3 = rgamma(nn, exp(3)) / rgamma(nn, exp(2)))

fit1 <- vglm(y1 ~ 1, betaprime, data = bdata, trace = TRUE)
coef(fit1, matrix = TRUE)

fit2 <- vglm(y2 ~ 1, betaprime, data = bdata, trace = TRUE)
coef(fit2, matrix = TRUE)

fit3 <- vglm(y3 ~ 1, betaprime, data = bdata, trace = TRUE)
coef(fit3, matrix = TRUE)

# Compare the fitted values
with(bdata, mean(y3))
head(fitted(fit3))
Coef(fit3) # Useful for intercept-only models
```

betaR

*The Two-parameter Beta Distribution Family Function*

Description

Estimation of the shape parameters of the two-parameter beta distribution.

Usage

```r
betaR(lshape1 = "loglink", lshape2 = "loglink",
     i1 = NULL, i2 = NULL, trim = 0.05,
     A = 0, B = 1, parallel = FALSE, zero = NULL)
```
Arguments

1shape1, 1shape2, i1, i2

Details at CommonVGAMffArguments. See Links for more choices.

trim

An argument which is fed into mean(); it is the fraction (0 to 0.5) of observations to be trimmed from each end of the response y before the mean is computed. This is used when computing initial values, and guards against outliers.

A, B

Lower and upper limits of the distribution. The defaults correspond to the standard beta distribution where the response lies between 0 and 1.

parallel, zero

See CommonVGAMffArguments for more information.

Details

The two-parameter beta distribution is given by

\[ f(y) = (y - A)^{shape1-1} \times (B - y)^{shape2-1} / [Beta(shape1, shape2) \times (B - A)^{shape1+shape2-1}] \]

for \( A < y < B \), and \( Beta(\ldots) \) is the beta function (see beta). The shape parameters are positive, and here, the limits \( A \) and \( B \) are known. The mean of \( Y \) is \( E(Y) = A + (B - A) \times (shape1/(shape1 + shape2)) \), and these are the fitted values of the object.

For the standard beta distribution the variance of \( Y \) is \( shape1 \times shape2 / [(1 + shape1 + shape2) \times (shape1 + shape2)^2] \). If \( \sigma^2 = 1/(1 + shape1 + shape2) \) then the variance of \( Y \) can be written \( \sigma^2 \mu(1 - \mu) \) where \( \mu = shape1/(shape1 + shape2) \) is the mean of \( Y \).

Another parameterization of the beta distribution involving the mean and a precision parameter is implemented in betaff.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Note

The response must have values in the interval \((A, B)\). VGAM 0.7-4 and prior called this function betaff.

Author(s)

Thomas W. Yee

References


See Also

betaaff,
Beta, genbetaII, betaII, betabinomialff, betageometric, betaprime, rbetageom, rbetanorm, kumar, simulate.vlm.

Examples

bdata <- data.frame(y = rbeta(1000, shape1 = exp(0), shape2 = exp(1)))
fit <- vglm(y ~ 1, betaR(1, shape1 = "identitylink",
             lshape2 = "identitylink"), bdata, trace = TRUE, crit = "coef")
fit <- vglm(y ~ 1, betaR, data = bdata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)  # Useful for intercept-only models

bdata <- transform(bdata, Y = 5 + 8 * y)  # From 5 to 13, not 0 to 1
fit <- vglm(Y ~ 1, betaR(5, 13), data = bdata, trace = TRUE)
Coef(fit)
c(meanY = with(bdata, mean(Y)), head(fitted(fit),2))

Biamhcop

Ali-Mikhail-Haq Bivariate Distribution

Description

Density, distribution function, and random generation for the (one parameter) bivariate Ali-Mikhail-Haq distribution.

Usage

dbiamhcop(x1, x2, apar, log = FALSE)
pbiamhcop(q1, q2, apar)
rbiamhcop(n, apar)

Arguments

x1, x2, q1, q2  vector of quantiles.
n  number of observations. Same as runif
apar  the association parameter.
log  Logical. If TRUE then the logarithm is returned.

Details

See biamhcop, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.
Value

dbiamhcop gives the density, pbiamhcop gives the distribution function, and rbiamhcop generates random deviates (a two-column matrix).

Author(s)

T. W. Yee and C. S. Chee

See Also

biamhcop.

Examples

```r
x <- seq(0, 1, len = (N <- 101)); apar <- 0.7
ox <- expand.grid(x, x)
zedd <- dbiamhcop(ox[, 1], ox[, 2], apar = apar)
## Not run:
contour(x, x, matrix(zedd, N, N), col = "blue")
zedd <- pbiamhcop(ox[, 1], ox[, 2], apar = apar)
contour(x, x, matrix(zedd, N, N), col = "blue")
plot(r <- rbiamhcop(n = 1000, apar = apar), col = "blue")
par(mfrow = c(1, 2))
hist(r[, 1]) # Should be uniform
hist(r[, 2]) # Should be uniform
## End(Not run)
```

Ali-Mikhail-Haq Distribution Family Function

Description

Estimate the association parameter of Ali-Mikhail-Haq’s bivariate distribution by maximum likelihood estimation.

Usage

```r
biamhcop(lapar = "rhobitlink", iapar = NULL, imethod = 1, nsimEIM = 250)
```

Arguments

- **lapar**: Link function applied to the association parameter \( \alpha \), which is real and \(-1 < \alpha < 1\). See Links for more choices.
- **iapar**: Numeric. Optional initial value for \( \alpha \). By default, an initial value is chosen internally. If a convergence failure occurs try assigning a different value. Assigning a value will override the argument imethod.
imethod
An integer with value 1 or 2 which specifies the initialization method. If failure to converge occurs try the other value, or else specify a value for iapar.

nsimEIM
See CommonVGAMffArguments for more information.

Details
The cumulative distribution function is
\[ P(Y_1 \leq y_1, Y_2 \leq y_2) = \frac{y_1 y_2}{(1 - \alpha)(1 - y_1)(1 - y_2)} \]
for \(-1 < \alpha < 1\). The support of the function is the unit square. The marginal distributions are the standard uniform distributions. When \(\alpha = 0\) the random variables are independent. This is an Archimedean copula.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note
The response must be a two-column matrix. Currently, the fitted value is a matrix with two columns and values equal to 0.5. This is because each marginal distribution corresponds to a standard uniform distribution.

Author(s)
T. W. Yee and C. S. Chee

References

See Also
rbiamhcop, bifgmccop, bigumbell1exp, rbilogis, simulate.vlm.

Examples
ymat <- rbiamhcop(1000, apar = rhobitlink(2, inverse = TRUE))
fit <- vglm(ymat ~ 1, biamhcop, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
Clayton Copula (Bivariate) Distribution

Description
Density and random generation for the (one parameter) bivariate Clayton copula distribution.

Usage

dbiclaytoncop(x1, x2, apar = 0, log = FALSE)
rbiclaytoncop(n, apar = 0)

Arguments
x1, x2 vector of quantiles. The x1 and x2 should both be in the interval (0, 1).
n number of observations. Same as rnorm.
apar the association parameter. Should be in the interval [0, \infty). The default corresponds to independence.
log Logical. If TRUE then the logarithm is returned.

Details
See biclaytoncop, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

Value
dbiclaytoncop gives the density at point (x1, x2), rbiclaytoncop generates random deviates (a two-column matrix).

Note
dbiclaytoncop() does not yet handle x1 = 0 and/or x2 = 0.

Author(s)
R. Feyter and T. W. Yee

References

See Also
biclaytoncop, binormalcop, binormal.
Examples

```r
## Not run: edge <- 0.01 # A small positive value
N <- 101; x <- seq(edge, 1.0 - edge, len = N); Rho <- 0.7
ox <- expand.grid(x, x)
zedd <- dbiclaytoncop(ox[, 1], ox[, 2], apar = Rho, log = TRUE)
par(mfrow = c(1, 2))
contour(x, x, matrix(zedd, N, N), col = 4, labcex = 1.5, las = 1)
plot(rbiclaytoncop(1000, 2), col = 4, las = 1)
## End(Not run)

biclaytoncop

Clayton Copula (Bivariate) Family Function

Description

Estimate the correlation parameter of the (bivariate) Clayton copula distribution by maximum likelihood estimation.

Usage

biclaytoncop(lapar = "loglink", iapar = NULL, imethod = 1,
parallel = FALSE, zero = NULL)

Arguments

lapar, iapar, imethod
Details at CommonVGAMffArguments. See Links for more link function choices.
parallel, zero
Details at CommonVGAMffArguments. If parallel = TRUE then the constraint is also applied to the intercept.

Details

The cumulative distribution function is

\[ P(u_1, u_2; \alpha) = \left( u_1^{-\alpha} + u_2^{-\alpha} - 1 \right)^{-1/\alpha} \]

for \(0 \leq \alpha\). Here, \(\alpha\) is the association parameter. The support of the function is the interior of the unit square; however, values of 0 and/or 1 are not allowed (currently). The marginal distributions are the standard uniform distributions. When \(\alpha = 0\) the random variables are independent.

This VGAM family function can handle multiple responses, for example, a six-column matrix where the first 2 columns is the first out of three responses, the next 2 columns being the next response, etc.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.
Note

The response matrix must have a multiple of two-columns. Currently, the fitted value is a matrix with the same number of columns and values equal to 0.5. This is because each marginal distribution corresponds to a standard uniform distribution.

This VGAM family function is fragile; each response must be in the interior of the unit square.

Author(s)

R. Feyter and T. W. Yee

References


See Also

rbiclaytoncop, dbiclaytoncop, kendall.tau.

Examples

```r
ymat <- rbiclaytoncop(n = (nn <- 1000), apar = exp(2))
bdata <- data.frame(y1 = ymat[, 1], y2 = ymat[, 2],
                     y3 = ymat[, 1], y4 = ymat[, 2], x2 = runif(nn))
summary(bdata)
## Not run: plot(ymat, col = "blue")
fit1 <- vglm(cbind(y1, y2, y3, y4) ~ 1,  # 2 responses, e.g., (y1,y2) is the 1st
             biclaytoncop, data = bdata,
             trace = TRUE, crit = "coef")  # Sometimes a good idea
coef(fit1, matrix = TRUE)
Coef(fit1)
head(fitted(fit1))
summary(fit1)

# Another example; apar is a function of x2
bdata <- transform(bdata, apar = exp(-0.5 + x2))
ymat <- rbiclaytoncop(n = nn, apar = with(bdata, apar))
bdata <- transform(bdata, y5 = ymat[, 1], y6 = ymat[, 2])
fit2 <- vgam(cbind(y5, y6) ~ s(x2), data = bdata,
             biclaytoncop(lapar = "loglink"), trace = TRUE)
## Not run: plot(fit2, lcol = "blue", scol = "orange", se = TRUE)
```
### Description
Calculates the Bayesian information criterion (BIC) for a fitted model object for which a log-likelihood value has been obtained.

### Usage
```
BICvlm(object, ..., k = log(nobs(object)))
```

### Arguments
- **object, ...** Same as `AICvlm`.
- **k** Numeric, the penalty per parameter to be used; the default is `log(n)` where `n` is the number of observations).

### Details
The so-called BIC or SBC (Schwarz’s Bayesian criterion) can be computed by calling `AICvlm` with a different `k` argument. See `AICvlm` for information and caveats.

### Value
Returns a numeric value with the corresponding BIC, or ..., depending on `k`.

### Warning
Like `AICvlm`, this code has not been double-checked. The general applicability of BIC for the VGLM/VGAM classes has not been developed fully. In particular, BIC should not be run on some VGAM family functions because of violation of certain regularity conditions, etc.

Many VGAM family functions such as `cumulative` can have the number of observations absorbed into the prior weights argument (e.g., `weights` in `vglm`), either before or after fitting. Almost all VGAM family functions can have the number of observations defined by the weights argument, e.g., as an observed frequency. BIC simply uses the number of rows of the model matrix, say, as defining `n`, hence the user must be very careful of this possible error. Use at your own risk!!

### Note
BIC, AIC and other ICs can have have many additive constants added to them. The important thing are the differences since the minimum value corresponds to the best model.

BIC has not been defined for QRR-VGLMs yet.

### Author(s)
T. W. Yee.
Bifgmcop

See Also

AICvlm, VGLMs are described in vglm-class; VGAMs are described in vgam-class; RR-VGLMs are described in rrvglm-class; BIC, AIC.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let,
            cumulative(parallel = TRUE, reverse = TRUE), data = pneumo))
coef(fit1, matrix = TRUE)
BIC(fit1)
(fit2 <- vglm(cbind(normal, mild, severe) ~ let,
            cumulative(parallel = FALSE, reverse = TRUE), data = pneumo))
coef(fit2, matrix = TRUE)
BIC(fit2)

Bifgmcop

Farlie-Gumbel-Morgenstern's Bivariate Distribution

Description

Density, distribution function, and random generation for the (one parameter) bivariate Farlie-Gumbel-Morgenstern’s distribution.

Usage

dbifgmcop(x1, x2, apar, log = FALSE)
pbifgmcop(q1, q2, apar)
rbifgmcop(n, apar)

Arguments

x1, x2, q1, q2 vector of quantiles.
n number of observations. Same as in runif.
apar the association parameter.
log Logical. If TRUE then the logarithm is returned.

Details

See bifgmcop. the VGAM family functions for estimating the parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

Value

dbifgmcop gives the density, pbifgmcop gives the distribution function, and rbifgmcop generates random deviates (a two-column matrix).
bifgmcop

Farlie-Gumbel-Morgenstern’s Bivariate Distribution Family Function

Description

Estimate the association parameter of Farlie-Gumbel-Morgenstern’s bivariate distribution by maximum likelihood estimation.

Usage

bifgmcop(lapar = "rhobitlink", iapar = NULL, imethod = 1)

Arguments

lapar, iapar, imethod

Details

The cumulative distribution function is

\[ P(Y_1 \leq y_1, Y_2 \leq y_2) = y_1 y_2 (1 + \alpha (1 - y_1)(1 - y_2)) \]

for \(-1 < \alpha < 1\). The support of the function is the unit square. The marginal distributions are the standard uniform distributions. When \(\alpha = 0\) the random variables are independent.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The response must be a two-column matrix. Currently, the fitted value is a matrix with two columns and values equal to 0.5. This is because each marginal distribution corresponds to a standard uniform distribution.

Author(s)

T. W. Yee

References


See Also

rbifgmcop, bifrankcop, bifgmexp, simulate.vlm.

Examples

ymat <- rbifgmcop(1000, apar = rhobitlink(3, inverse = TRUE))
## Not run: plot(ymat, col = "blue")
fit <- vglm(ymat ~ 1, fam = bifgmexp, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(fitted(fit))

bifgmexp

Bivariate Farlie-Gumbel-Morgenstern Exponential Distribution Family Function

Description

Estimate the association parameter of FGM bivariate exponential distribution by maximum likelihood estimation.

Usage

bifgmexp(lapar = "rhobitlink", iapar = NULL, tola0 = 0.01, 
imethod = 1)
Arguments

**lapar**
Link function for the association parameter $\alpha$, which lies between $-1$ and $1$. See [Links](#) for more choices and other information.

**iapar**
Numeric. Optional initial value for $\alpha$. By default, an initial value is chosen internally. If a convergence failure occurs try assigning a different value. Assigning a value will override the argument **imethod**.

**tola0**
Positive numeric. If the estimate of $\alpha$ has an absolute value less than this then it is replaced by this value. This is an attempt to fix a numerical problem when the estimate is too close to zero.

**imethod**
An integer with value 1 or 2 which specifies the initialization method. If failure to converge occurs try the other value, or else specify a value for **ia**.

Details

The cumulative distribution function is

$$
P(Y_1 \leq y_1, Y_2 \leq y_2) = e^{-y_1-y_2}(1 + \alpha(1 - e^{-y_1})(1 - e^{-y_2})) + 1 - e^{-y_1} - e^{-y_2}
$$

for $\alpha$ between $-1$ and $1$. The support of the function is for $y_1 > 0$ and $y_2 > 0$. The marginal distributions are an exponential distribution with unit mean. When $\alpha = 0$ then the random variables are independent, and this causes some problems in the estimation process since the distribution no longer depends on the parameter. A variant of Newton-Raphson is used, which only seems to work for an intercept model. It is a very good idea to set trace = TRUE.

Value

An object of class "vglmff" (see [vglmff-class](#)). The object is used by modelling functions such as vglm and vgam.

Note

The response must be a two-column matrix. Currently, the fitted value is a matrix with two columns and values equal to 1. This is because each marginal distribution corresponds to a exponential distribution with unit mean. This VGAM family function should be used with caution.

Author(s)

T. W. Yee

References


See Also

bifgmcop, bigumbelIexp.
Examples

```r
N <- 1000; mdata <- data.frame(y1 = rexp(N), y2 = rexp(N))
## Not run: plot(ymat)
fit <- vglm(cbind(y1, y2) ~ 1, bifgmexp, data = mdata, trace = TRUE)
fit <- vglm(cbind(y1, y2) ~ 1, bifgmexp, data = mdata, # May fail
trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
head(fitted(fit))
```

bifrancop

Frank’s Bivariate Distribution Family Function

Description

Estimate the association parameter of Frank’s bivariate distribution by maximum likelihood estimation.

Usage

```r
bifrancop(lapar = "loglink", iapar = 2, nsimEIM = 250)
```

Arguments

- `lapar`: Link function applied to the (positive) association parameter \( \alpha \). See Links for more choices.
- `iapar`: Numeric. Initial value for \( \alpha \). If a convergence failure occurs try assigning a different value.
- `nsimEIM`: See CommonVGAMffArguments.

Details

The cumulative distribution function is

\[
P(Y_1 \leq y_1, Y_2 \leq y_2) = H_\alpha(y_1, y_2) = \log_\alpha [1 + (\alpha^{y_1} - 1)(\alpha^{y_2} - 1)/(\alpha - 1)]
\]

for \( \alpha \neq 1 \). Note the logarithm here is to base \( \alpha \). The support of the function is the unit square.

When \( 0 < \alpha < 1 \) the probability density function \( h_\alpha(y_1, y_2) \) is symmetric with respect to the lines \( y_2 = y_1 \) and \( y_2 = 1 - y_1 \). When \( \alpha > 1 \) then \( h_\alpha(y_1, y_2) = h_{1/\alpha}(1 - y_1, y_2) \).

\( \alpha = 1 \) then \( H(y_1, y_2) = y_1 y_2 \), i.e., uniform on the unit square. As \( \alpha \) approaches 0 then \( H(y_1, y_2) = \min(y_1, y_2) \). As \( \alpha \) approaches infinity then \( H(y_1, y_2) = \max(0, y_1 + y_2 - 1) \).

The default is to use Fisher scoring implemented using rbifrancop. For intercept-only models an alternative is to set `nsimEIM=NULL` so that a variant of Newton-Raphson is used.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.
### bigumbellexp

**Gumbel's Type I Bivariate Distribution Family Function**

#### Description

Estimate the association parameter of Gumbel's Type I bivariate distribution by maximum likelihood estimation.

#### Usage

```r
bigumbellexp(lapar = "identitylink", iapar = NULL, imethod = 1)
```
Arguments

- `lapar` Link function applied to the association parameter $\alpha$. See Links for more choices.
- `iapar` Numeric. Optional initial value for $\alpha$. By default, an initial value is chosen internally. If a convergence failure occurs try assigning a different value. Assigning a value will override the argument `imethod`.
- `imethod` An integer with value 1 or 2 which specifies the initialization method. If failure to converge occurs try the other value, or else specify a value for `ia`.

Details

The cumulative distribution function is

$$P(Y_1 \leq y_1, Y_2 \leq y_2) = e^{-y_1 - y_2 + \alpha y_1 y_2} + 1 - e^{-y_1} - e^{-y_2}$$

for real $\alpha$. The support of the function is for $y_1 > 0$ and $y_2 > 0$. The marginal distributions are an exponential distribution with unit mean.

A variant of Newton-Raphson is used, which only seems to work for an intercept model. It is a very good idea to set `trace=TRUE`.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vlm` and `vgam`.

Note

The response must be a two-column matrix. Currently, the fitted value is a matrix with two columns and values equal to 1. This is because each marginal distribution corresponds to a exponential distribution with unit mean.

This VGAM family function should be used with caution.

Author(s)

T. W. Yee

References


See Also

`bifgmexp`
Examples

\begin{verbatim}
nn <- 1000
gdata <- data.frame(y1 = rexp(nn), y2 = rexp(nn))
## Not run: with(gdata, plot(cbind(y1, y2)))
fit <- vglm(cbind(y1, y2) ~ 1, bigumbellexp, gdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(fitted(fit))
\end{verbatim}

---

**bilogis**  

**Bivariate Logistic Distribution**

Description

Density, distribution function, quantile function and random generation for the 4-parameter bivariate logistic distribution.

Usage

```r
dbilogis(x1, x2, loc1 = 0, scale1 = 1, loc2 = 0, scale2 = 1,
         log = FALSE)
pbilogis(q1, q2, loc1 = 0, scale1 = 1, loc2 = 0, scale2 = 1)
rbilogis(n, loc1 = 0, scale1 = 1, loc2 = 0, scale2 = 1)
```

Arguments

- `x1, x2, q1, q2` vector of quantiles.
- `n` number of observations. Same as `rlogis`.
- `loc1, loc2` the location parameters \(l_1\) and \(l_2\).
- `scale1, scale2` the scale parameters \(s_1\) and \(s_2\).
- `log` Logical. If `log = TRUE` then the logarithm of the density is returned.

Details

See `bilogis`, the VGAM family function for estimating the four parameters by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

Value

`dbilogis` gives the density, `pbilogis` gives the distribution function, and `rbilogis` generates random deviates (a two-column matrix).

Note

Gumbel (1961) proposed two bivariate logistic distributions with logistic distribution marginals, which he called Type I and Type II. The Type I is this one. The Type II belongs to the Morgenstern type. The `biamhcop` distribution has, as a special case, this distribution, which is when the random variables are independent.
bilogistic

Author(s)

T. W. Yee

References


See Also

bilogistic, biamhcop.

Examples

```r
## Not run: par(mfrow = c(1, 3))
ymat <- rbilogis(n = 2000, loc1 = 5, loc2 = 7, scale2 = exp(1))
myxlim <- c(-2, 15); myylim <- c(-10, 30)
plot(ymat, xlim = myxlim, ylim = myylim)

N <- 100
x1 <- seq(myxlim[1], myxlim[2], len = N)
x2 <- seq(myylim[1], myylim[2], len = N)
ox <- expand.grid(x1, x2)
zz <- dbilogis(oX[,1], oX[,2], loc1 = 5, loc2 = 7, scale2 = exp(1))
contour(x1, x2, matrix(zz, N, N), main = "density")
zz <- pbilogis(oX[,1], oX[,2], loc1 = 5, loc2 = 7, scale2 = exp(1))
contour(x1, x2, matrix(zz, N, N), main = "cdf")
## End(Not run)
```

---

bilogistic

**Bivariate Logistic Distribution Family Function**

Description

Estimates the four parameters of the bivariate logistic distribution by maximum likelihood estimation.

Usage

```r
bilogistic(iLocation = "identitylink", lscale = "loglink",
          iloc1 = NULL, iscale1 = NULL, iloc2 = NULL, iscale2 =
          NULL, imethod = 1, nsimEIM = 250, zero = NULL)
```
Arguments

ilocation  Link function applied to both location parameters \( l_1 \) and \( l_2 \). See Links for more choices.

lscale Parameter link function applied to both (positive) scale parameters \( s_1 \) and \( s_2 \). See Links for more choices.

iloc1, iloc2 Initial values for the location parameters. By default, initial values are chosen internally using imethod. Assigning values here will override the argument imethod.

iscale1, iscale2 Initial values for the scale parameters. By default, initial values are chosen internally using imethod. Assigning values here will override the argument imethod.

imethod An integer with value 1 or 2 which specifies the initialization method. If failure to converge occurs try the other value.

nsimEIM, zero See CommonVGAMffArguments for details.

Details

The four-parameter bivariate logistic distribution has a density that can be written as

\[
f(y_1, y_2; l_1, s_1, l_2, s_2) = 2 \frac{\exp[-(y_1 - l_1)/s_1 - (y_2 - l_2)/s_2]}{s_1 s_2 (1 + \exp[-(y_1 - l_1)/s_1] + \exp[-(y_2 - l_2)/s_2])^3}
\]

where \( s_1 > 0 \) and \( s_2 > 0 \) are the scale parameters, and \( l_1 \) and \( l_2 \) are the location parameters. Each of the two responses are unbounded, i.e., \(-\infty < y_j < \infty\). The mean of \( Y_1 \) is \( l_1 \) etc. The fitted values are returned in a 2-column matrix. The cumulative distribution function is

\[
F(y_1, y_2; l_1, s_1, l_2, s_2) = (1 + \exp[-(y_1 - l_1)/s_1] + \exp[-(y_2 - l_2)/s_2])^{-1}
\]

The marginal distribution of \( Y_1 \) is

\[
P(Y_1 \leq y_1) = F(y_1; l_1, s_1) = (1 + \exp[-(y_1 - l_1)/s_1])^{-1}.
\]

By default, \( \eta_1 = l_1, \eta_2 = \log(s_1), \eta_3 = l_2, \eta_4 = \log(s_2) \) are the linear/additive predictors.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Author(s)

T. W. Yee

References


Binom2.or

See Also

logistic, rbilogis.

Examples

## Not run:
ymat <- rbilogis(n <- 50, loc1 = 5, loc2 = 7, scale2 = exp(1))
plot(ymat)
bfit <- vglm(ymat ~ 1, family = bilogistic, trace = TRUE)
coef(bfit, matrix = TRUE)
Coef(bfit)
head(fitted(bfit))
vcov(bfit)
head(weights(bfit, type = "work"))
summary(bfit)

## End(Not run)

---

Binom2.or  Bivariate Odds Ratio Model

Description

Density and random generation for a bivariate binary regression model using an odds ratio as the measure of dependency.

Usage

rbinom2.or(n, mu1, 
  mu2 = if (exchangeable) mu1 else
  stop("argument 'mu2' not specified"),
  oratio = 1, exchangeable = FALSE, tol = 0.001,
  twoCols = TRUE, colnames = if (twoCols) c("y1","y2") else
  c("00", "01", "10", "11"),
  ErrorCheck = TRUE)
dbinom2.or(mu1, mu2 = if (exchangeable) mu1 else
  stop("'mu2' not specified"),
  oratio = 1, exchangeable = FALSE, tol = 0.001,
  colnames = c("00", "01", "10", "11"), ErrorCheck = TRUE)

Arguments

n  number of observations. Same as in runif. The arguments mu1, mu2, oratio are recycled to this value.

mu1, mu2  The marginal probabilities. Only mu1 is needed if exchangeable = TRUE. Values should be between 0 and 1.
oratio
Odds ratio. Must be numeric and positive. The default value of unity means the
responses are statistically independent.

exchangeable
Logical. If TRUE, the two marginal probabilities are constrained to be equal.

twoCols
Logical. If TRUE, then a $n \times 2$ matrix of 1s and 0s is returned. If FALSE, then a
$n \times 4$ matrix of 1s and 0s is returned.

colnames
The dimnames argument of matrix is assigned list(NULL, colnames).

tol
Tolerance for testing independence. Should be some small positive numerical
value.

ErrorCheck
Logical. Do some error checking of the input parameters?

Details
The function rbinom2.or generates data coming from a bivariate binary response model. The data
might be fitted with the VGAM family function binom2.or.
The function dbinom2.or does not really compute the density (because that does not make sense
here) but rather returns the four joint probabilities.

Value
The function rbinom2.or returns either a 2 or 4 column matrix of 1s and 0s, depending on the
argument twoCols.
The function dbinom2.or returns a 4 column matrix of joint probabilities; each row adds up to
unity.

Author(s)
T. W. Yee

See Also
binom2.or.

Examples

```r
nn <- 1000 # Example 1
ymat <- rbinom2.or(nn, mu1 = logitlink(1, inv = TRUE),
                  oratio = exp(2), exch = TRUE)
  (mytab <- table(ymat[, 1], ymat[, 2], dnn = c("Y1", "Y2")))
  (myor <- mytab["0","0"] * mytab["1","1"] / (mytab["1","0"] *
                  mytab["0","1"]))
fit <- vglm(ymat ~ 1, binom2.or(exch = TRUE))
  coef(fit, matrix = TRUE)

bdata <- data.frame(x2 = sort(runif(nn))) # Example 2
bdata <- transform(bdata,
                   mu1 = logitlink(-2 + 4 * x2, inverse = TRUE),
                   mu2 = logitlink(-1 + 3 * x2, inverse = TRUE))
dmat <- with(bdata, dbinom2.or(mu1 = mu1, mu2 = mu2,
                                oratio = exp(2)))
```
binom2.or

Bivariate Binary Regression with an Odds Ratio (Family Function)

Description

Fits a Palmgren (bivariate odds-ratio model, or bivariate logistic regression) model to two binary responses. Actually, a bivariate logistic/probit/cloglog/cauchit model can be fitted. The odds ratio is used as a measure of dependency.

Usage

binom2.or(lmu = "logitlink", lmu1 = lmu, lmu2 = lmu, loratio = "loglink", imu1 = NULL, imu2 = NULL, ioratio = NULL, zero = "oratio", exchangeable = FALSE, tol = 0.001, more.robust = FALSE)

Arguments

lmu Link function applied to the two marginal probabilities. See Links for more choices. See the note below.

lmu1, lmu2 Link function applied to the first and second of the two marginal probabilities.

loratio Link function applied to the odds ratio. See Links for more choices.

imu1, imu2, ioratio Optional initial values for the marginal probabilities and odds ratio. See CommonVGAMffArguments for more details. In general good initial values are often required so use these arguments if convergence failure occurs.

zero Which linear/additive predictor is modelled as an intercept only? The default is for the odds ratio. A NULL means none. See CommonVGAMffArguments for more details.

exchangeable Logical. If TRUE, the two marginal probabilities are constrained to be equal.

tol Tolerance for testing independence. Should be some small positive numerical value.

more.robust Logical. If TRUE then some measures are taken to compute the derivatives and working weights more robustly, i.e., in an attempt to avoid numerical problems. Currently this feature is not debugged if set TRUE.
Details

Also known informally as the Palmgren model, the bivariate logistic model is a full-likelihood based model defined as two logistic regressions plus $\log(\text{oratio}) = \eta_3$ where $\eta_3$ is the third linear/additive predictor relating the odds ratio to explanatory variables. Explicitly, the default model is

$$\text{logit}[P(Y_j = 1)] = \eta_j, \quad j = 1, 2$$

for the marginals, and

$$\log[P(Y_{00} = 1)P(Y_{11} = 1)/(P(Y_{01} = 1)P(Y_{10} = 1))] = \eta_3,$$

specifies the dependency between the two responses. Here, the responses equal 1 for a success and a 0 for a failure, and the odds ratio is often written $\psi = p_{00}p_{11}/(p_{10}p_{01})$. The model is fitted by maximum likelihood estimation since the full likelihood is specified. The two binary responses are independent if and only if the odds ratio is unity, or equivalently, the log odds ratio is 0. Fisher scoring is implemented.

The default models $\eta_3$ as a single parameter only, i.e., an intercept-only model, but this can be circumvented by setting `zero = NULL` in order to model the odds ratio as a function of all the explanatory variables. The function `binom2.or()` can handle other probability link functions such as `probitlink`, `clogloglink` and `cauchitlink` links as well, so is quite general. In fact, the two marginal probabilities can each have a different link function. A similar model is the bivariate probit model (`binom2.rho`), which is based on a standard bivariate normal distribution, but the bivariate probit model is less interpretable and flexible.

The exchangeable argument should be used when the error structure is exchangeable, e.g., with eyes or ears data.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

When fitted, the `fitted.values` slot of the object contains the four joint probabilities, labelled as $(Y_1, Y_2) = (0,0), (0,1), (1,0), (1,1)$, respectively. These estimated probabilities should be extracted with the `fitted` generic function.

Note

At present we call `binom2.or` families a bivariate odds-ratio model. The response should be either a 4-column matrix of counts (whose columns correspond to $(Y_1, Y_2) = (0,0), (0,1), (1,0), (1,1)$ respectively), or a two-column matrix where each column has two distinct values, or a factor with four levels. The function `rbinom2.or` may be used to generate such data. Successful convergence requires at least one case of each of the four possible outcomes.

By default, a constant odds ratio is fitted because `zero = 3`. Set `zero = NULL` if you want the odds ratio to be modelled as a function of the explanatory variables; however, numerical problems are more likely to occur.

The argument `lmu`, which is actually redundant, is used for convenience and for upward compatibility: specifying `lmu` only means the link function will be applied to `lmu1` and `lmu2`. Users who want a different link function for each of the two marginal probabilities should use the `lmu1` and `lmu2`
arguments, and the argument lmu is then ignored. It doesn’t make sense to specify exchangeable = TRUE and have different link functions for the two marginal probabilities.

Regarding Yee and Dirnbock (2009), the xij (see vglm.control) argument enables environmental variables with different values at the two time points to be entered into an exchangeable binom2.or model. See the author’s webpage for sample code.

Author(s)

Thomas W. Yee

References


See Also

rbinom2.or, binom2.rho, loglinb2, loglinb3, zipebcom, coalminers, binomialff, logitlink, probitlink, clogloglink, cauchitlink.

Examples

# Fit the model in Table 6.7 in McCullagh and Nelder (1989)
coalminers <- transform(coalminers, Age = (age - 42) / 5)
fit <- vglm(cbind(nBnW, nBW, BnW, BW) ~ Age, binom2.or(zero = NULL), data = coalminers)
fitted(fit)
summary(fit)
coef(fit, matrix = TRUE) * fitted(fit) # Table 6.8

## Not run: with(coalminers, matplot(Age, fitted(fit), type = "l", las = 1,
xlab = "(age - 42) / 5", lwd = 2))
with(coalminers, matpoints(Age, depvar(fit), col=1:4))
legend(x = -4, y = 0.5, lty = 1:4, col = 1:4, lwd = 2,
      legend = c("1 = (Breathlessness=0, Wheeze=0)",
                "2 = (Breathlessness=0, Wheeze=1)",
                "3 = (Breathlessness=1, Wheeze=0)",
                "4 = (Breathlessness=1, Wheeze=1)"))

## End(Not run)

# Another model: pet ownership
## Not run: data(xs.nz, package = "VGAMdata")
# More homogeneous:
petdata <- subset(xs.nz, ethnicity == "European" & age < 70 & 
    sex == "M")
petdata <- na.omit(petdata[, c("cat", "dog", "age")])
summary(petdata)
with(petdata, table(cat, dog))  # Can compute the odds ratio

fit <- vgam(cbind((1-cat) * (1-dog), (1-cat) * dog, 
    cat * (1-dog), cat * dog) ~ s(age, df = 5), 
    binom2.or(zero = 3), data = petdata, trace = TRUE)
colSums(depvar(fit))
coef(fit, matrix = TRUE)

## End(Not run)

## Not run:  # Plot the estimated probabilities
ooo <- order(with(petdata, age))
matplot(with(petdata, age)[ooo], fitted(fit)[ooo, ], type = "l", 
    xlab = "Age", ylab = "Probability", main = "Pet ownership", 
    ylim = c(0, max(fitted(fit))), las = 1, lwd = 1.5)
legend("topleft", col=1:4, lty = 1:4, leg = c("no cat or dog ", 
    "dog only", "cat only", "cat and dog"), lwd = 1.5)
## End(Not run)

---

### Description

Density and random generation for a bivariate probit model. The correlation parameter rho is the 
measure of dependency.

### Usage

```r
rbinom2.rho(n, mu1, 
    mu2 = if (exchangeable) mu1 else stop("argument 'mu2' not specified"), 
    rho = 0, exchangeable = FALSE, twoCols = TRUE, 
    colnames = if (twoCols) c("y1","y2") else c("00", "01", "10", "11"), 
    ErrorCheck = TRUE)
dbinom2.rho(mu1, 
    mu2 = if (exchangeable) mu1 else stop("mu2 not specified"), 
    rho = 0, exchangeable = FALSE, 
    colnames = c("00", "01", "10", "11"), ErrorCheck = TRUE)
```

### Arguments

- **n**
  - number of observations. Same as in `runif`. The arguments `mu1`, `mu2`, `rho` are 
    recycled to this value.
mu1, mu2  The marginal probabilities. Only mu1 is needed if exchangeable = TRUE. Values should be between 0 and 1.
rho  The correlation parameter. Must be numeric and lie between −1 and 1. The default value of zero means the responses are uncorrelated.
exchangeable  Logical. If TRUE, the two marginal probabilities are constrained to be equal.
twoCols  Logical. If TRUE, then a n × 2 matrix of 1s and 0s is returned. If FALSE, then a n × 4 matrix of 1s and 0s is returned.
colnames  The dimnames argument of matrix is assigned list(NULL, colnames).
ErrorCheck  Logical. Do some error checking of the input parameters?

Details

The function rbinom2.rho generates data coming from a bivariate probit model. The data might be fitted with the VGAM family function binom2.rho.

The function dbinom2.rho does not really compute the density (because that does not make sense here) but rather returns the four joint probabilities.

Value

The function rbinom2.rho returns either a 2 or 4 column matrix of 1s and 0s, depending on the argument twoCols.

The function dbinom2.rho returns a 4 column matrix of joint probabilities; each row adds up to unity.

Author(s)

T. W. Yee

See Also

binom2.rho.

Examples

(myrho <- rhobitlink(2, inverse = TRUE))  # Example 1
nn <- 2000
ymat <- rbinom2.rho(nn, mu1 = 0.8, rho = myrho, exch = TRUE)
(mytab <- table(ymat[, 1], ymat[, 2], dnn = c("Y1", "Y2")))
fit <- vglm(ymat ~ 1, binom2.rho(exch = TRUE))
coef(fit, matrix = TRUE)

bdata <- data.frame(x2 = sort(runif(nn)))  # Example 2
bdata <- transform(bdata, mu1 = probitlink(-2+4*x2, inv = TRUE),
mu2 = probitlink(-1+3*x2, inv = TRUE))
dmat <- with(bdata, dbinom2.rho(mu1, mu2, myrho))
ymat <- with(bdata, rbinom2.rho(nn, mu1, mu2, myrho))
fit2 <- vglm(ymat ~ x2, binom2.rho, data = bdata)
coef(fit2, matrix = TRUE)
## Not run: matplot(with(bdata, x2), dmat, lty = 1:4, col = 1:4,
binom2.rho

Bivariate Probit Regression

Description

Fits a bivariate probit model to two binary responses. The correlation parameter rho is the measure of dependency.

Usage

binom2.rho(lmu = "probitlink", lrho = "rhobitlink",
imu1 = NULL, imu2 = NULL,
irho = NULL, imethod = 1, zero = "rho",
exchangeable = FALSE, grho = seq(-0.95, 0.95, by = 0.05),
nsimEIM = NULL)

binom2.Rho(rho = 0, imu1 = NULL, imu2 = NULL,
exchangeable = FALSE, nsimEIM = NULL)

Arguments

- `lmu` Link function applied to the marginal probabilities. Should be left alone.
- `lrho` Link function applied to the \( \rho \) association parameter. See Links for more choices.
- `imu1`, `imu2` Optional initial values for the two marginal probabilities. May be a vector.
- `irho` Optional initial value for \( \rho \). If given, this should lie between \(-1\) and \(1\). See below for more comments.
- `zero` Specifies which linear/additive predictors are modelled as intercept-only. A NULL means none. Numerically, the \( \rho \) parameter is easiest modelled as an intercept-only, hence the default. See CommonVGAMffArguments for more information.
- `exchangeable` Logical. If TRUE, the two marginal probabilities are constrained to be equal.
- `imethod`, `nsimEIM`, `grho` See CommonVGAMffArguments for more information. A value of at least 100 for `nsimEIM` is recommended; the larger the value the better.
- `rho` Numeric vector. Values are recycled to the needed length, and ought to be in range, which is \((-1,1)\).
The bivariate probit model was one of the earliest regression models to handle two binary responses jointly. It has a probit link for each of the two marginal probabilities, and models the association between the responses by the $\rho$ parameter of a standard bivariate normal distribution (with zero means and unit variances). One can think of the joint probabilities being $\Phi(\eta_1, \eta_2; \rho)$ where $\Phi$ is the cumulative distribution function of a standard bivariate normal distribution.

Explicitly, the default model is

$$\text{probit}[P(Y_j = 1)] = \eta_j, \quad j = 1, 2$$

for the marginals, and

$$\text{rhobit}[\rho] = \eta_3.$$

The joint probability $P(Y_1 = 1, Y_2 = 1) = \Phi(\eta_1, \eta_2; \rho)$, and from these the other three joint probabilities are easily computed. The model is fitted by maximum likelihood estimation since the full likelihood is specified. Fisher scoring is implemented.

The default models $\eta_3$ as a single parameter only, i.e., an intercept-only model for $\rho$, but this can be circumvented by setting zero = NULL in order to model $\rho$ as a function of all the explanatory variables.

The bivariate probit model should not be confused with a bivariate logit model with a probit link (see binom2.or). The latter uses the odds ratio to quantify the association. Actually, the bivariate logit model is recommended over the bivariate probit model because the odds ratio is a more natural way of measuring the association between two binary responses.

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

When fitted, the fitted.values slot of the object contains the four joint probabilities, labelled as $(Y_1, Y_2) = (0,0), (0,1), (1,0), (1,1)$, respectively.

See binom2.or about the form of input the response should have.

By default, a constant $\rho$ is fitted because zero = "rho". Set zero = NULL if you want the $\rho$ parameter to be modelled as a function of the explanatory variables. The value $\rho$ lies in the interval $(-1, 1)$, therefore a rhobitlink link is default.

Converge problems can occur. If so, assign irho a range of values and monitor convergence (e.g., set trace = TRUE). Else try imethod. Practical experience shows that local solutions can occur, and that irho needs to be quite close to the (global) solution. Also, imu1 and imu2 may be used.

This help file is mainly about binom2.rho(). binom2.Rho() fits a bivariate probit model with known $\rho$. The inputted rho is saved in the misc slot of the fitted object, with rho as the component name.

In some econometrics applications (e.g., Freedman 2010, Freedman and Sekhon 2010) one response is used as an explanatory variable, e.g., a recursive binomial probit model. Such will not work here. Historically, the bivariate probit model was the first VGAM I ever wrote, based on Ashford and Sowden (1970). I don’t think they ever thought of it either! Hence the criticisms raised go beyond the use of what was originally intended.
**Author(s)**

Thomas W. Yee

**References**


**See Also**

`rbinom2.rho, rhobitlink, pbinorm, binom2.or, loglinb2, coalminers, binomialff, rhobitlink, fisherzlink`.

**Examples**

```r
coalminers <- transform(coalminers, Age = (age - 42) / 5)
fit <- vglm(cbind(nBnW, nBW, BnW, BW) ~ Age,
            binom2.rho, data = coalminers, trace = TRUE)
summary(fit)
coef(fit, matrix = TRUE)
```

---

**Description**

Binomial Family Function

**Usage**

```r
binomialff(link = "logitlink", multiple.responses = FALSE,
            parallel = FALSE, zero = NULL, bred = FALSE, earg.link = FALSE)
```

**Arguments**

- `link`: Link function; see `Links` and `CommonVGAMffArguments` for more information.
- `multiple.responses`: Multivariate response? If TRUE, then the response is interpreted as $M$ independent binary responses, where $M$ is the number of columns of the response matrix. In this case, the response matrix should have $Q$ columns consisting of counts (successes), and the weights argument should have $Q$ columns consisting of the number of trials (successes plus failures).
  
  If FALSE and the response is a (2-column) matrix, then the number of successes is given in the first column, and the second column is the number of failures.
parallel

A logical or formula. Used only if `multiple.responses` is `TRUE`. This argument allows for the parallelism assumption whereby the regression coefficients for a variable is constrained to be equal over the \( M \) linear/additive predictors. If \( \text{parallel} = \text{TRUE} \) then the constraint is not applied to the intercepts.

zero

An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \( \{1,2,\ldots,M\} \), where \( M \) is the number of columns of the matrix response. See `CommonVGAMffArguments` for more information.

earg.link

Details at `CommonVGAMffArguments`.

bred

Details at `CommonVGAMffArguments`. Setting \( \text{bred} = \text{TRUE} \) should work for multiple responses (\( \text{multiple.responses} = \text{TRUE} \)) and all `VGAM` link functions; it has been tested for `logitlink` only (and it gives similar results to `brglm` but not identical), and further testing is required. One result from fitting bias reduced binary regression is that finite regression coefficients occur when the data is separable (see example below). Currently `hdeff.vglm` does not work when \( \text{bred} = \text{TRUE} \).

Details

This function is largely to mimic `binomial`, however there are some differences.

When used with `cqo` and `cao`, it may be preferable to use the `clogloglink` link.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `vgam`, `rrvglm`, `cqo`, and `cao`.

Warning

See the above note regarding \( \text{bred} \).

The maximum likelihood estimate will not exist if the data is `completely separable` or `quasi-completely separable`. See Chapter 10 of Altman et al. (2004) for more details, and `safeBinaryRegression` and `hdeff.vglm`. Yet to do: add a `sepcheck = TRUE`, say, argument to further detect this problem and give an appropriate warning.

Note

If `multiple.responses` is `FALSE` (default) then the response can be of one of two formats: a factor (first level taken as failure), or a 2-column matrix (first column = successes) of counts. The argument weights in the modelling function can also be specified as any vector of positive values. In general, 1 means success and 0 means failure (to check, see the \( y \) slot of the fitted object). Note that a general vector of proportions of success is no longer accepted.

The notation \( M \) is used to denote the number of linear/additive predictors.

If `multiple.responses` is `TRUE`, then the matrix response can only be of one format: a matrix of 1’s and 0’s (1 = success).

Fisher scoring is used. This can sometimes fail to converge by oscillating between successive iterations (Ridout, 1990). See the example below.
Author(s)

Thomas W. Yee

References


See Also

hdeff.vglm, Links, alogitlink, asinlink, N1binomial, rrvglm, cqn, cao, betabinomial, posbinomial, zibinomial, double.expbinomial, seq2binomial, amlbinomial, simplex, binomial, simulate.vlm, safeBinaryRegression, residuals.vglm.

Examples

shunua <- hunua[sort.list(with(hunua, altitude)),] # Sort by altitude
fit <- vglm(agaaus ~ poly(altitude, 2), binomialff(link = clogloglink),
            data = shunua)
## Not run:
plot(agaaus ~ jitter(altitude), shunua, ylab = "Pr(Agaaus = 1)",
     main = "Presence/absence of Agathis australis", col = 4, las = 1)
with(shunua, lines(altitude, fitted(fit), col = "orange", lwd = 2))
## End(Not run)

# Fit two species simultaneously
fit2 <- vgam(cbind(agaaus, kniexc) ~ s(altitude),
             binomialff(multiple.responses = TRUE), data = shunua)
## Not run:
with(shunua, matplot(altitude, fitted(fit2), type = "l",
                      main = "Two species response curves", las = 1))
## End(Not run)

# Shows that Fisher scoring can sometime fail. See Ridout (1990).
ridout <- data.frame(v = c(1000, 100, 10), r = c(4, 3, 3), n = rep(5, 3))
(ridout <- transform(ridout, logv = log(v)))
# The iterations oscillates between two local solutions:
glm.fail <- glm(r/n ~ offset(logv) + 1, weight = n,
                binomial(link = 'cloglog'), ridout, trace = TRUE)
coef(glm.fail)
# vglm()’s half-stepping ensures the MLE of -5.4007 is obtained:
vglm.ok <- vglm(cbind(r, n-r) ~ offset(logv) + 1,
                binomialff(link = clogloglink), ridout, trace = TRUE)
coef(vglm.ok)

# Separable data
set.seed(123)
threshold <- 0
bdata <- data.frame(x2 = sort(rnorm(nn <- 100)))
bdata <- transform(bdata, y1 = ifelse(x2 < threshold, 0, 1))
fit <- vglm(y1 ~ x2, binomialff(bred = TRUE),
           data = bdata, criter = "coef", trace = TRUE)
coef(fit, matrix = TRUE) # Finite!!
summary(fit)
## Not run: plot(depvar(fit) ~ x2, data = bdata, col = "blue", las = 1)
lines(fitted(fit) ~ x2, data = bdata, col = "orange")
abline(v = threshold, col = "gray", lty = "dashed")
## End(Not run)

---

Binorm

Bivariate Normal Distribution Cumulative Distribution Function

Description

Density, cumulative distribution function and random generation for the bivariate normal distribution.

Usage

dbinorm(x1, x2, mean1 = 0, mean2 = 0, var1 = 1, var2 = 1, cov12 = 0,
log = FALSE)
pbinorm(q1, q2, mean1 = 0, mean2 = 0, var1 = 1, var2 = 1, cov12 = 0)
rbinorm(n, mean1 = 0, mean2 = 0, var1 = 1, var2 = 1, cov12 = 0)

Arguments

x1, x2, q1, q2    vector of quantiles.
mean1, mean2, var1, var2, cov12    vector of means, variances and the covariance.
n    number of observations. Same as rnorm.
log    Logical. If log = TRUE then the logarithm of the density is returned.

Details

The default arguments correspond to the standard bivariate normal distribution with correlation parameter $\rho = 0$. That is, two independent standard normal distributions. Let $sd1$ (say) be $\sqrt{\text{var1}}$ and written $\sigma_1$, etc. Then the general formula for the correlation coefficient is $\rho = \frac{\text{cov}}{\sigma_1 \sigma_2}$ where $\text{cov}$ is argument cov12. Thus if arguments var1 and var2 are left alone then cov12 can be inputted with $\rho$.

One can think of this function as an extension of `pnorm` to two dimensions, however note that the argument names have been changed for VGAM 0.9-1 onwards.
Value
dbinorm gives the density, pbinorm gives the cumulative distribution function, rbinorm generates random deviates ($n$ by 2 matrix).

Warning
Being based on an approximation, the results of pbinorm() may be negative! Also, pnorm2() should be withdrawn soon; use pbinorm() instead because it is identical.

Note
For rbinorm(), if the $i$th variance-covariance matrix is not positive-definite then the $i$th row is all NAs.

References
pbinorm() is based on Donnelly (1973), the code was translated from FORTRAN to ratfor using struct, and then from ratfor to C manually. The function was originally called bivnor, and TWY only wrote a wrapper function.

See Also
pnorm, binormal, uninormal.

Examples
```r
yvec <- c(-5, -1.96, 0, 1.96, 5)
ymat <- expand.grid(yvec, yvec)
bind(ymat, pbinorm(ymat[, 1], ymat[, 2]))

## Not run: rhovec <- seq(-0.95, 0.95, by = 0.01)
plot(rhovec, pbinorm(0, 0, cov12 = rhovec),
xlab = expression(rho), lwd = 2,
type = "l", col = "blue", las = 1)
abline(v = 0, h = 0.25, col = "gray", lty = "dashed")
## End(Not run)
```

Description
Maximum likelihood estimation of the five parameters of a bivariate normal distribution.
binormal

Usage

```r
binormal(lmean1 = "identitylink", lmean2 = "identitylink",
  lsd1  = "loglink",   lsd2  = "loglink",
  lrho  = "rhobitlink",
  imean1 = NULL,      imean2 = NULL,
  isd1  = NULL,       isd2  = NULL,
  irho  = NULL,       imethod = 1,
  eq.mean = FALSE,    eq.sd = FALSE,
  zero = c("sd", "rho"), rho.arg = NA)
```

Arguments

- `lmean1, lmean2, lsd1, lsd2, lrho`
  Link functions applied to the means, standard deviations and rho parameters. See `Links` for more choices. Being positive quantities, a log link is the default for the standard deviations.
- `imean1, imean2, isd1, isd2, irho, imethod, zero`
  See `CommonVGAMffArguments` for more information.
- `eq.mean, eq.sd`
  Logical or formula. Constrains the means or the standard deviations to be equal.
- `rho.arg`
  If $\rho$ is known then this argument may be assigned the (scalar) value lying in $(-1, 1)$. The default is to estimate that parameter so that $M = 5$. If known, then other arguments such as `lrho` and `irho` are ignored, and "rho" is removed from `zero`.

Details

For the bivariate normal distribution, this fits a linear model (LM) to the means, and by default, the other parameters are intercept-only. The response should be a two-column matrix. The correlation parameter is $\rho$, which lies between $-1$ and $1$ (thus the `rhobitlink` link is a reasonable choice). The fitted means are returned as the fitted values, which is in the form of a two-column matrix. Fisher scoring is implemented.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Warning

This function may be renamed to `normal2()` or something like that at a later date.

Note

If both equal means and equal standard deviations are desired then use something like constraints = `list("(Intercept)" = matrix(c(1,1,0,0,0,0,0,1,1,0,0,0,0,0,1), 5, 3))` and maybe `zero = NULL` etc.
Author(s)
T. W. Yee

See Also
uninormal, trinormal, pbinorm, bistudentt, rhobitlink.

Examples

```r
set.seed(123); nn <- 1000
data <- data.frame(x2 = runif(nn), x3 = runif(nn))
data <- transform(data, y1 = rnorm(nn, 1 + 2 * x2),
                   y2 = rnorm(nn, 3 + 4 * x2))
fit1 <- vglm(cbind(y1, y2) ~ x2,
            binormal(eq.sd = TRUE), data, trace = TRUE)
coef(fit1, matrix = TRUE)
constraints(fit1)
summary(fit1)

# Estimated P(Y1 <= y1, Y2 <= y2) under the fitted model
var1 <- loglink(2 * predict(fit1)[, "loglink(sd1)"], inv = TRUE)
var2 <- loglink(2 * predict(fit1)[, "loglink(sd2)"], inv = TRUE)
cov12 <- rhobitlink(predict(fit1)[, "rhobitlink(rho)"], inv = TRUE)
head(with(data, pbinorm(y1, y2,
                        mean1 = predict(fit1)[, "mean1"],
                        mean2 = predict(fit1)[, "mean2"],
                        var1 = var1, var2 = var2, cov12 = cov12)))
```

---

`binormalcop`  
**Gaussian Copula (Bivariate) Family Function**

**Description**
Estimate the correlation parameter of the (bivariate) Gaussian copula distribution by maximum likelihood estimation.

**Usage**

```r
binormalcop(lrho = "rhobitlink", irho = NULL,
imethod = 1, parallel = FALSE, zero = NULL)
```

**Arguments**
- `lrho, irho, imethod`
  Details at `CommonVGAMffArguments`. See `Links` for more link function choices.
- `parallel, zero`
  Details at `CommonVGAMffArguments`. If `parallel = TRUE` then the constraint is applied to the intercept too.
Details

The cumulative distribution function is

$$P(Y_1 \leq y_1, Y_2 \leq y_2) = \Phi_2(\Phi^{-1}(y_1), \Phi^{-1}(y_2); \rho)$$

for $-1 < \rho < 1$, $\Phi_2$ is the cumulative distribution function of a standard bivariate normal (see `pbinorm`), and $\Phi$ is the cumulative distribution function of a standard univariate normal (see `pnorm`).

The support of the function is the interior of the unit square; however, values of 0 and/or 1 are not allowed. The marginal distributions are the standard uniform distributions. When $\rho = 0$ the random variables are independent.

This VGAM family function can handle multiple responses, for example, a six-column matrix where the first 2 columns is the first out of three responses, the next 2 columns being the next response, etc.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

Note

The response matrix must have a multiple of two-columns. Currently, the fitted value is a matrix with the same number of columns and values equal to 0.5. This is because each marginal distribution corresponds to a standard uniform distribution.

This VGAM family function is fragile; each response must be in the interior of the unit square. Setting `crit = "coef"` is sometimes a good idea because inaccuracies in `pbinorm` might mean unnecessary half-stepping will occur near the solution.

Author(s)

T. W. Yee

References


See Also

`rbinormcop`, `rhobitlink`, `pnorm`, `kendall.tau`.

Examples

```r
nn <- 1000
ymat <- rbinormcop(nn, rho = rhobitlink(-0.9, inverse = TRUE))
bdata <- data.frame(y1 = ymat[, 1], y2 = ymat[, 2],
                    y3 = ymat[, 1], y4 = ymat[, 2],
                    x2 = runif(nn))
summary(bdata)
```
```R
## Not run: plot(ymat, col = "blue")
fit1 <- # 2 responses, e.g., (y1,y2) is the 1st
  vglm(cbind(y1, y2, y3, y4) ~ 1, fam = binormalcop,
       crit = "coef", # Sometimes a good idea
data = bdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
head(fitted(fit1))
summary(fit1)

# Another example; rho is a linear function of x2
bdata <- transform(bdata, rho = -0.5 + x2)
ys <- rbinormcop(n = nn, rho = with(bdata, rho))
bdata <- transform(bdata, y5 = yмат[,1], y6 = yмат[,2])
fit2 <- vgam(cbind(y5, y6) ~ s(x2), data = bdata,
               binormalcop(lrho = "identitylink"), trace = TRUE)
## Not run: plot(fit2, lcol = "blue", scol = "orange", se = TRUE)
```

# Binormalcop

## Gaussian Copula (Bivariate) Distribution

### Description

Density, distribution function, and random generation for the (one parameter) bivariate Gaussian copula distribution.

### Usage

- `dbinormcop(x1, x2, rho = 0, log = FALSE)`
- `pbinormcop(q1, q2, rho = 0)`
- `rbinormcop(n, rho = 0)`

### Arguments

- **x1, x2, q1, q2**
  - vector of quantiles. The `x1` and `x2` should be in the interval (0, 1). Ditto for `q1` and `q2`.
- **n**
  - number of observations. Same as `rnorm`.
- **rho**
  - the correlation parameter. Should be in the interval (−1, 1).
- **log**
  - Logical. If TRUE then the logarithm is returned.

### Details

See `binormalcop`, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

### Value

`dbinormcop` gives the density, `pbinormcop` gives the distribution function, and `rbinormcop` generates random deviates (a two-column matrix).
Note

Yettodo: allow x1 and/or x2 to have values 1, and to allow any values for x1 and/or x2 to be outside the unit square.

Author(s)

T. W. Yee

See Also

binormalcop, binormal.

Examples

```r
## Not run: edge <- 0.01 # A small positive value
N <- 101; x <- seq(edge, 1.0 - edge, len = N); Rho <- 0.7
ox <- expand.grid(x, x)
zedd <- dbinormcop(ox[, 1], ox[, 2], rho = Rho, log = TRUE)
contour(x, x, matrix(zedd, N, N), col = "blue", labcex = 1.5)
zedd <- pbinormcop(ox[, 1], ox[, 2], rho = Rho)
contour(x, x, matrix(zedd, N, N), col = "blue", labcex = 1.5)
## End(Not run)
```

Biplackett

Plackett’s Bivariate Copula

Description

Density, distribution function, and random generation for the (one parameter) bivariate Plackett copula.

Usage

```r
dbiplackcop(x1, x2, oratio, log = FALSE)
pbiplackcop(q1, q2, oratio)
rbiplackcop(n, oratio)
```

Arguments

```r
x1, x2, q1, q2    vector of quantiles.
n            number of observations. Same as in runif.
oratio         the positive odds ratio $\psi$.
log            Logical. If TRUE then the logarithm is returned.
```

Biplackett

Plackett’s Bivariate Copula

Description

Density, distribution function, and random generation for the (one parameter) bivariate Plackett copula.

Usage

```r
dbiplackcop(x1, x2, oratio, log = FALSE)
pbiplackcop(q1, q2, oratio)
rbiplackcop(n, oratio)
```

Arguments

```r
x1, x2, q1, q2    vector of quantiles.
n            number of observations. Same as in runif.
oratio         the positive odds ratio $\psi$.
log            Logical. If TRUE then the logarithm is returned.
```
Details

See `biplackettcop`, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

Value

dbiplackcop gives the density, pbiplackcop gives the distribution function, and rbiplackcop generates random deviates (a two-column matrix).

Author(s)

T. W. Yee

References


See Also

`biplackettcop`, `bifrankcop`.

Examples

```r
## Not run: N <- 101; oratio <- exp(1)
x <- seq(0, 1, len = N)
ox <- expand.grid(x, x)
zedd <- dbiplackcop(ox[, 1], ox[, 2], oratio = oratio)
contour(x, x, matrix(zedd, N, N), col = "blue")
zedd <- pbiplackcop(ox[, 1], ox[, 2], oratio = oratio)
contour(x, x, matrix(zedd, N, N), col = "blue")

plot(rr <- rbiplackcop(n = 3000, oratio = oratio))
par(mfrow = c(1, 2))
hist(rr[, 1]) # Should be uniform
hist(rr[, 2]) # Should be uniform

## End(Not run)
```
Usage

biplackettcpop(link = "loglink", ioratio = NULL, imethod = 1, nsimEIM = 200)

Arguments

link Link function applied to the (positive) odds ratio $\psi$. See Links for more choices and information.

ioratio Numeric. Optional initial value for $\psi$. If a convergence failure occurs try assigning a value or a different value.

imethod, nsimEIM See CommonVGAMffArguments.

Details

The defining equation is

$$\psi = H \times (1 - y_1 - y_2 + H) / ((y_1 - H) \times (y_2 - H))$$

where $P(Y_1 \leq y_1, Y_2 \leq y_2) = H_\psi(y_1, y_2)$ is the cumulative distribution function. The density function is

$$h_\psi(y_1, y_2) = \psi[1 + (\psi - 1)(y_1 + y_2 - 2y_1y_2)] / ([1 + (\psi - 1)(y_1 + y_2)]^2 - 4\psi(\psi - 1)y_1y_2)^{3/2}$$

for $\psi > 0$. Some writers call $\psi$ the cross product ratio but it is called the odds ratio here. The support of the function is the unit square. The marginal distributions here are the standard uniform although it is commonly generalized to other distributions.

If $\psi = 1$ then $h_\psi(y_1, y_2) = y_1y_2$, i.e., independence. As the odds ratio tends to infinity one has $y_1 = y_2$. As the odds ratio tends to 0 one has $y_2 = 1 - y_1$.

Fisher scoring is implemented using rbiplackcop. Convergence is often quite slow.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The response must be a two-column matrix. Currently, the fitted value is a 2-column matrix with 0.5 values because the marginal distributions correspond to a standard uniform distribution.

Author(s)

T. W. Yee

References

See Also

rbiplackcop, bifrankcop.

Examples

## Not run:
ymat <- rbiplackcop(n = 2000, oratio = exp(2))
plot(ymat, col = "blue")
fit <- vglm(ymat ~ 1, fam = biplacketcop, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
vcov(fit)
head(fitted(fit))
summary(fit)

## End(Not run)

---

**Bisa**

### The Birnbaum-Saunders Distribution

**Description**

Density, distribution function, and random generation for the Birnbaum-Saunders distribution.

**Usage**

dbisa(x, scale = 1, shape, log = FALSE)
pbisa(q, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
qbisa(p, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
rbisa(n, scale = 1, shape)
Arguments

- x, q: vector of quantiles.
- p: vector of probabilities.
- n: Same as in `runif`.
- scale, shape: the (positive) scale and shape parameters.
- log: Logical. If TRUE then the logarithm of the density is returned.
- lower.tail, log.p: Same meaning as in `pnorm` or `qnorm`.

Details

The Birnbaum-Saunders distribution is a distribution which is used in survival analysis. See `bisa`, the VGAM family function for estimating the parameters, for more details.

Value

dbisa gives the density, pbisa gives the distribution function, and qbisa gives the quantile function, and rbisa generates random deviates.

Author(s)

T. W. Yee and Kai Huang

See Also

`bisa`.

Examples

```r
## Not run:
x <- seq(0, 6, len = 400)
plot(x, dbisa(x, shape = 1), type = "l", col = "blue",
     ylab = "Density", lwd = 2, ylim = c(0,1.3), lty = 3,
     main = "X ~ Birnbaum-Saunders(shape, scale = 1)")
lines(x, dbisa(x, shape = 2), col = "orange", lty = 2, lwd = 2)
lines(x, dbisa(x, shape = 0.5), col = "green", lty = 1, lwd = 2)
legend(x = 3, y = 0.9, legend = paste("shape = ",c(0.5, 1,2)),
       col = c("green","blue","orange"), lty = 1:3, lwd = 2)

shape <- 1; x <- seq(0, 4, len = 401)
plot(x, dbisa(x, shape = shape), type = "l", col = "blue",
     main = "Blue is density, orange is the CDF", las = 1,
     sub = "Red lines are the 10,20,...,90 percentiles",
     ylab = "", ylim = 0:1)
abline(h = 0, col = "blue", lty = 2)
lines(x, pbisa(x, shape = shape), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qbisa(probs, shape = shape)
lines(Q, dbisa(Q, shape = shape), col = "red", lty = 3, type = "h")
```
pbisa(Q, shape = shape) - probs # Should be all zero
abline(h = probs, col = "red", lty = 3)
lines(Q, pbisa(Q, shape = shape), col = "red", lty = 3, type = "h")

## End(Not run)

**bisa**

_Birnbaum-Saunders Regression Family Function_

**Description**

Estimates the shape and scale parameters of the Birnbaum-Saunders distribution by maximum likelihood estimation.

**Usage**

```r
bisa(lscale = "loglink", lshape = "loglink", iscale = 1,
     ishape = NULL, imethod = 1, zero = "shape", nowarning = FALSE)
```

**Arguments**

- `nowarning` Logical. Suppress a warning? Ignored for VGAM 0.9-7 and higher.
- `lscale`, `lshape` Parameter link functions applied to the shape and scale parameters (\(a\) and \(b\) below). See Links for more choices. A log link is the default for both because they are positive.
- `iscale`, `ishape` Initial values for \(a\) and \(b\). A NULL means an initial value is chosen internally using `imethod`.
- `imethod` An integer with value 1 or 2 or 3 which specifies the initialization method. If failure to converge occurs try the other value, or else specify a value for `ishape` and/or `iscale`.
- `zero` Specifies which linear/additive predictor is modelled as intercept-only. If used, choose one value from the set \{1,2\}. See CommonVGAMffArguments for more details.

**Details**

The (two-parameter) Birnbaum-Saunders distribution has a cumulative distribution function that can be written as

\[
F(y; a, b) = \Phi[\xi(y/b)/a]
\]

where \(\Phi(\cdot)\) is the cumulative distribution function of a standard normal (see \texttt{pnorm}), \(\xi(t) = \sqrt{t} - 1/\sqrt{t}, y > 0, a > 0\) is the shape parameter, \(b > 0\) is the scale parameter. The mean of \(Y\) (which is the fitted value) is \(b(1 + a^2/2)\). and the variance is \(a^2b^2(1 + 5/4a^2)\). By default, \(\eta_1 = \log(a)\) and \(\eta_2 = \log(b)\) for this family function.

Note that \(a\) and \(b\) are orthogonal, i.e., the Fisher information matrix is diagonal. This family function implements Fisher scoring, and it is unnecessary to compute any integrals numerically.
Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Author(s)

T. W. Yee

References


See Also

\texttt{pbisa}, \texttt{inv.gaussianff}, \texttt{CommonVGAMffArguments}.

Examples

\begin{verbatim}
bdatal <- data.frame(x2 = runif(nn <- 1000))
bdatal <- transform(bdatal, shape = exp(-0.5 + x2),
                    scale = exp(1.5))
bdatal <- transform(bdatal, y = rbisa(nn, scale, shape))
fit1 <- vglm(y ~ x2, bisa(zero = 1), data = bdatal, trace = TRUE)
coef(fit1, matrix = TRUE)

# Not run:
bdatal2 <- data.frame(shape = exp(-0.5), scale = exp(0.5))
bdatal2 <- transform(bdatal2, y = rbisa(nn, scale, shape))
fit <- vglm(y ~ 1, bisa, data = bdatal2, trace = TRUE)
with(bdatal2, hist(y, prob = TRUE, ylim = c(0, 0.5),
                  col = "lightblue"))
coef(fit, matrix = TRUE)
with(bdatal2, mean(y))
head(fitted(fit))
x <- with(bdatal2, seq(0, max(y), len = 200))
lines(dbisa(x, Coef(fit)[1], Coef(fit)[2]) ~ x, data = bdatal2,
     col = "orange", lwd = 2)
# End(Not run)
\end{verbatim}
Bistudentt

Bivariate Student-t Distribution Density Function

Description

Density for the bivariate Student-t distribution.

Usage

dbistudentt(x1, x2, df, rho = 0, log = FALSE)

Arguments

x1, x2 vector of quantiles.
df, rho vector of degrees of freedom and correlation parameter. For df, a value Inf is currently not working.
log Logical. If log = TRUE then the logarithm of the density is returned.

Details

One can think of this function as an extension of dt to two dimensions. See bistudentt for more information.

Value

dbistudentt gives the density.

See Also

bistudentt, dt.

Examples

## Not run: N <- 101; x <- seq(-4, 4, len = N); Rho <- 0.7
mydf <- 10; ox <- expand.grid(x, x)
zedd <- dbistudentt(ox[, 1], ox[, 2], df = mydf,
rho = Rho, log = TRUE)
contour(x, x, matrix(zedd, N, N), col = "blue", labcex = 1.5)
## End(Not run)
bistudentt

Bivariate Student-t Family Function

Description

Estimate the degrees of freedom and correlation parameters of the (bivariate) Student-t distribution by maximum likelihood estimation.

Usage

bistudentt(ldf = "logloglink", lrho = "rhobitlink",
idf = NULL, irho = NULL, imethod = 1,
parallel = FALSE, zero = "rho")

Arguments

ldf, lrho, idf, irho, imethod

Details at CommonVGAMffArguments. See Links for more link function choices.

parallel, zero

Details at CommonVGAMffArguments.

Details

The density function is

\[ f(y_1, y_2; \nu, \rho) = \frac{1}{2\pi \sqrt{1 - \rho^2}} \left(1 + \frac{y_1^2 + y_2^2 - 2\rho y_1 y_2}{\nu(1 - \rho^2)}\right)^{-\frac{(\nu+2)}{2}} \]

for \(-1 < \rho < 1\), and real \(y_1\) and \(y_2\).

This VGAM family function can handle multiple responses, for example, a six-column matrix where the first 2 columns is the first out of three responses, the next 2 columns being the next response, etc.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

The working weight matrices have not been fully checked.

Note

The response matrix must have a multiple of two-columns. Currently, the fitted value is a matrix with the same number of columns and values equal to 0.0.

Author(s)

T. W. Yee, with help from Thibault Vatter.
References


See Also

dbistudentt, binormal, pt.

Examples

```r
nn <- 1000
mydof <- logloglink(1, inverse = TRUE)
ymat <- cbind(rt(nn, df = mydof), rt(nn, df = mydof))
bdata <- data.frame(y1 = ymat[, 1], y2 = ymat[, 2],
                    y3 = ymat[, 1], y4 = ymat[, 2],
                    x2 = runif(nn))
summary(bdata)
## Not run: plot(ymat, col = "blue")
fit1 <- # 2 responses, e.g., (y1,y2) is the 1st
glm(cbind(y1, y2, y3, y4) ~ 1,
     bistudentt, # crit = "coef", # Sometimes a good idea
data = bdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
head(fitted(fit1))
summary(fit1)
```

---

**bmi.nz**

*Body Mass Index of New Zealand Adults Data*

Description

The body mass indexes and ages from an approximate random sample of 700 New Zealand adults.

Usage

data(bmi.nz)

Format

A data frame with 700 observations on the following 2 variables.

- **age** a numeric vector; their age (years).
- **BMI** a numeric vector; their body mass indexes, which is their weight divided by the square of their height (kg / m²).
Details

They are a random sample from the Fletcher Challenge/Auckland Heart and Health survey conducted in the early 1990s.

There are some outliers in the data set.

A variable gender would be useful, and may be added later.

Source

Formerly the Clinical Trials Research Unit, University of Auckland, New Zealand.

References


Examples

```r
## Not run: with(bmi.nz, plot(age, BMI, col = "blue"))
fit <- vgam(BMI ~ s(age, df = c(2, 4, 2)), lms.yjn,
            data = bmi.nz, trace = TRUE)
qtplot(fit, pcol = "blue", tcol = "brown", lcol = "brown")
## End(Not run)
```

---

**borel.tanner**  
*Borel-Tanner Distribution Family Function*

**Description**

Estimates the parameter of a Borel-Tanner distribution by maximum likelihood estimation.

**Usage**

```r
borel.tanner(Qsize = 1, link = "logitlink", imethod = 1)
```

**Arguments**

- **Qsize**  
  A positive integer. It is called $Q$ below and is the initial queue size. The default value $Q = 1$ corresponds to the Borel distribution.

- **link**  
  Link function for the parameter; see Links for more choices and for general information.

- **imethod**  
  See CommonVGAMffArguments. Valid values are 1, 2, 3 or 4.
Details

The Borel-Tanner distribution (Tanner, 1953) describes the distribution of the total number of customers served before a queue vanishes given a single queue with random arrival times of customers (at a constant rate \( r \) per unit time, and each customer taking a constant time \( b \) to be served). Initially the queue has \( Q \) people and the first one starts to be served. The two parameters appear in the density only in the form of the product \( rb \), therefore we use \( a = rb \), say, to denote the single parameter to be estimated. The density function is

\[
f(y; a) = \frac{Q}{(y-Q)!} y^{y-Q} a^{Q-1} a^y \exp(-ay)
\]

where \( y = Q, Q + 1, Q + 2, \ldots \). The case \( Q = 1 \) corresponds to the Borel distribution (Borel, 1942). For the \( Q = 1 \) case it is necessary for \( 0 < a < 1 \) for the distribution to be proper. The Borel distribution is a basic Lagrangian distribution of the first kind. The Borel-Tanner distribution is an \( Q \)-fold convolution of the Borel distribution.

The mean is \( Q/(1 - a) \) (returned as the fitted values) and the variance is \( Qa/(1 - a)^3 \). The distribution has a very long tail unless \( a \) is small. Fisher scoring is implemented.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Author(s)

T. W. Yee

References


See Also

rbort, poissonff, felix.

Examples

```r
bdata <- data.frame(y = rbort(n = 200))
fit <- vglm(y ~ 1, borel.tanner, bdata, trace = TRUE, crit = "c")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```
The Borel-Tanner Distribution

Description
Density and random generation for the Borel-Tanner distribution.

Usage
\[
\text{dbort}(x, \text{Qsize} = 1, a = 0.5, \text{log} = \text{FALSE})
\]
\[
\text{rbort}(n, \text{Qsize} = 1, a = 0.5)
\]

Arguments
- \text{x}: vector of quantiles.
- \text{n}: number of observations. Must be a positive integer of length 1.
- \text{Qsize, a}: See \text{borel.tanner}.
- \text{log}: Logical. If \text{log} = \text{TRUE} then the logarithm of the density is returned.

Details
See \text{borel.tanner}, the \text{VGAM} family function for estimating the parameter, for the formula of the probability density function and other details.

Value
\text{dbort} gives the density, \text{rbort} generates random deviates.

Warning
Looping is used for \text{rbort}, therefore values of \text{a} close to 1 will result in long (or infinite!) computational times. The default value of \text{a} is subjective.

Author(s)
T. W. Yee

See Also
\text{borel.tanner}.

Examples
```
## Not run: qsize <- 1; a <- 0.5; x <- qsize:(qsize+10)
plot(x, dbort(x, qsize, a), type = "h", las = 1, col = "blue",
     ylab = paste("fbort(qsize=", qsize, ", a=", a, ", "")),
     log = "y", main = "Borel-Tanner density function")
## End(Not run)
```
Inputting Data to fit a Bradley Terry Model

**Description**

Takes in a square matrix of counts and outputs them in a form that is accessible to the `brat` and `bratt` family functions.

**Usage**

```r
Brat(mat, ties = 0 * mat, string = c(">", "="), whitespace = FALSE)
```

**Arguments**

- `mat` Matrix of counts, which is considered \( M \) by \( M \) in dimension when there are ties, and \( M + 1 \) by \( M + 1 \) when there are no ties. The rows are winners and the columns are losers, e.g., the 2-1 element is now many times Competitor 2 has beaten Competitor 1. The matrices are best labelled with the competitors’ names.
- `ties` Matrix of counts. This should be the same dimension as `mat`. By default, there are no ties. The matrix must be symmetric, and the diagonal should contain `NA`s.
- `string` Character. The matrices are labelled with the first value of the descriptor, e.g., "NZ > Oz" ‘means’ NZ beats Australia in rugby. Suggested alternatives include "beats " or " wins against ". The second value is used to handle ties.
- `whitespace` Logical. If TRUE then a white space is added before and after `string`; it generally enhances readability. See `CommonVGAMffArguments` for some similar-type information.

**Details**

In the `VGAM` package it is necessary for each matrix to be represented as a single row of data by `brat` and `bratt`. Hence the non-diagonal elements of the \( M + 1 \) by \( M + 1 \) matrix are concatenated into \( M(M + 1) \) values (no ties), while if there are ties, the non-diagonal elements of the \( M \) by \( M \) matrix are concatenated into \( M(M - 1) \) values.

**Value**

A matrix with 1 row and either \( M(M + 1) \) or \( M(M - 1) \) columns.

**Note**

This is a data preprocessing function for `brat` and `bratt`.

Yet to do: merge `InverseBrat` into `brat`.

**Author(s)**

T. W. Yee
References

See Also

*brat, bratt, InverseBrat.*

Examples

```r
journal <- c("Biometrika", "Comm Statist", "JASA", "JRSS-B")
mat <- matrix(c(NA, 33, 320, 284, 730, NA, 813, 276,
                498, 68, NA, 325, 221, 17, 142, NA), 4, 4)
dimnames(mat) <- list(winner = journal, loser = journal)
Brat(mat) # Less readable
Brat(mat, whitespace = TRUE) # More readable
vglm(Brat(mat, whitespace = TRUE) ~ 1, brat, trace = TRUE)
```

brat

---

**Bradley Terry Model**

Description

Fits a Bradley Terry model (intercept-only model) by maximum likelihood estimation.

Usage

```r
brat(refgp = "last", refvalue = 1, ialpha = 1)
```

Arguments

- `refgp` Integer whose value must be from the set \{1, \ldots, \(M + 1\}\}, where there are \(M + 1\) competitors. The default value indicates the last competitor is used—but don’t input a character string, in general.
- `refvalue` Numeric. A positive value for the reference group.
- `ialpha` Initial values for the \(\alpha\)s. These are recycled to the appropriate length.

Details

The Bradley Terry model involves \(M + 1\) competitors who either win or lose against each other (no draws/ties allowed in this implementation—see *bratt* if there are ties). The probability that Competitor \(i\) beats Competitor \(j\) is \(\alpha_i/ (\alpha_i + \alpha_j)\), where all the \(\alpha\)s are positive. Loosely, the \(\alpha\)s can be thought of as the competitors’ ‘abilities’. For identifiability, one of the \(\alpha_i\) is set to a known value `refvalue`, e.g., 1. By default, this function chooses the last competitor to have this reference value.

The data can be represented in the form of a \(M + 1\) by \(M + 1\) matrix of counts, where winners are the rows and losers are the columns. However, this is not the way the data should be inputted (see below).
Excluding the reference value/group, this function chooses $\log(\alpha_j)$ as the $M$ linear predictors. The log link ensures that the $\alpha$s are positive.

The Bradley Terry model can be fitted by logistic regression, but this approach is not taken here. The Bradley Terry model can be fitted with covariates, e.g., a home advantage variable, but unfortunately, this lies outside the VGLM theoretical framework and therefore cannot be handled with this code.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm.

**Warning**

Presently, the residuals are wrong, and the prior weights are not handled correctly. Ideally, the total number of counts should be the prior weights, after the response has been converted to proportions. This would make it similar to family functions such as multinomial and binomialff.

**Note**

The function Brat is useful for coercing a $M + 1$ by $M + 1$ matrix of counts into a one-row matrix suitable for brat. Diagonal elements are skipped, and the usual S order of c(a.matrix) of elements is used. There should be no missing values apart from the diagonal elements of the square matrix. The matrix should have winners as the rows, and losers as the columns. In general, the response should be a 1-row matrix with $M(M + 1)$ columns.

Only an intercept model is recommended with brat. It doesn’t make sense really to include covariates because of the limited VGLM framework.

Notationally, note that the VGAM family function brat has $M + 1$ contestants, while bratt has $M$ contestants.

**Author(s)**

T. W. Yee

**References**


The BradleyTerry2 package has more comprehensive capabilities than this function.

**See Also**

bratt, Brat, multinomial, binomialff.
Examples

# Citation statistics: being cited is a 'win'; citing is a 'loss'
journal <- c("Biometrika", "Comm.Statist", "JASA", "JRSS-B")
mat <- matrix(c( NA, 33, 320, 284,
                730, NA, 813, 276,
                498, 68, NA, 325,
                221, 17, 142, NA), 4, 4)
dimnames(mat) <- list(winner = journal, loser = journal)
fit <- vglm(Brat(mat) ~ 1, brat(refgp = 1), trace = TRUE)
fit <- vglm(Brat(mat) ~ 1, brat(refgp = 1), trace = TRUE, crit = "coef")
summary(fit)
c(0, coef(fit)) # Log-abilities (in order of "journal")
c(1, Coef(fit)) # Abilities (in order of "journal")
fitted(fit) # Probabilities of winning in awkward form
(check <- InverseBrat(fitted(fit))) # Probabilities of winning
check + t(check) # Should be 1's in the off-diagonals

bratt

Bradley Terry Model With Ties

Description

Fits a Bradley Terry model with ties (intercept-only model) by maximum likelihood estimation.

Usage

bratt(refgp = "last", refvalue = 1, ialpha = 1, i0 = 0.01)

Arguments

refgp
  Integer whose value must be from the set \{1, \ldots, M\}, where there are \(M\) competitors. The default value indicates the last competitor is used—but don’t input a character string, in general.

refvalue
  Numeric. A positive value for the reference group.

ialpha
  Initial values for the \(\alpha\)s. These are recycled to the appropriate length.

i0
  Initial value for \(\alpha_0\). If convergence fails, try another positive value.

Details

There are several models that extend the ordinary Bradley Terry model to handle ties. This family function implements one of these models. It involves \(M\) competitors who either win or lose or tie against each other. (If there are no draws/ties then use \texttt{brat}). The probability that Competitor \(i\) beats Competitor \(j\) is \(\alpha_i/\left(\alpha_i + \alpha_j + \alpha_0\right)\), where all the \(\alpha\)s are positive. The probability that Competitor \(i\) ties with Competitor \(j\) is \(\alpha_0/\left(\alpha_i + \alpha_j + \alpha_0\right)\). Loosely, the \(\alpha\)s can be thought of as the competitors’ ‘abilities’, and \(\alpha_0\) is an added parameter to model ties. For identifiability, one of the \(\alpha_i\) is set to a known value \texttt{refvalue}, e.g., 1. By default, this function chooses the last competitor to have this reference value. The data can be represented in the form of a \(M\) by \(M\) matrix of counts,
where winners are the rows and losers are the columns. However, this is not the way the data should
be inputted (see below).

Excluding the reference value/group, this function chooses \( \log(\alpha_j) \) as the first \( M-1 \) linear predic-
tors. The log link ensures that the \( \alpha \)s are positive. The last linear predictor is \( \log(\alpha_0) \).

The Bradley Terry model can be fitted with covariates, e.g., a home advantage variable, but unfor-
tunately, this lies outside the VGLM theoretical framework and therefore cannot be handled with
this code.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm.

Note

The function \texttt{Brat} is useful for coercing a \( M \) by \( M \) matrix of counts into a one-row matrix suitable
for \texttt{bratt}. Diagonal elements are skipped, and the usual S order of \( \text{c(a.matrix)} \) of elements is
used. There should be no missing values apart from the diagonal elements of the square matrix.
The matrix should have winners as the rows, and losers as the columns. In general, the response
should be a matrix with \( M(M-1) \) columns.
Also, a symmetric matrix of ties should be passed into \texttt{Brat}. The diagonal of this matrix should be
all NAs.
Only an intercept model is recommended with \texttt{bratt}. It doesn’t make sense really to include
covariates because of the limited VGLM framework.
Notationally, note that the \texttt{VGAM} family function \texttt{brat} has \( M+1 \) contestants, while \texttt{bratt} has
\( M \) contestants.

Author(s)

T. W. Yee

References

Pages 513–526.

See Also

\texttt{brat, Brat, binomialff}.

Examples

# citation statistics: being cited is a 'win'; citing is a 'loss'
journal <- c("Biometrika", "Comm.Statist", "JASA", "JRSS-B")
mat <- matrix(c(NA, 33, 320, 284,
                 730, NA, 813, 276,
                 498, 68, NA, 325,
                 221, 17, 142, NA), 4, 4)
dimnames(mat) <- list(winner = journal, loser = journal)

# Add some ties. This is fictitional data.
ties <- 5 + 0 * mat
ties[2, 1] <- ties[1, 2] <- 9

# Now fit the model
fit <- vglm(Brat(mat, ties) ~ 1, bratt(refgp = 1), trace = TRUE, 
crit = "coef")

summary(fit)
c(0, coef(fit)) # Log-abilities (last is log(alpha0))
c(1, Coef(fit))  # Abilities (last is alpha0)

fit@misc$alpha  # alpha_1,...,alpha_M
fit@misc$alpha0  # alpha_0

fitted(fit)  # Probabilities of winning and tying, in awkward form
predict(fit)
(check <- InverseBrat(fitted(fit)))  # Probabilities of winning
qprob <- attr(fitted(fit), "probtie")  # Probabilities of a tie
qprobmat <- InverseBrat(c(qprob), NCo = nrow(ties))  # Pr(tie)
check + t(check) + qprobmat  # Should be 1s in the off-diagonals

__budworm__  

**Western Spuce Budworm**

**Description**

Counts of western spuce budworm (Choristoneura freemani) across seven developmental stages (five larval instars, pupae, and adults) on 12 sampling occasions.

**Usage**

data(budworm)

**Format**

A data frame with the following variables.

- **ddeg** Degree days.
- **total** Sum of stages 1–7.
- **stage1, stage2, stage3, stage4** Successive stages.
- **stage5, stage6, stage7** Successive stages.
Details

This data concerns the development of a defoliating moth widespread in western North America (i.e., north of Mexico). According to Boersch-Supan (2021), the insect passes through successive stages \( j = 1, \ldots, r \), delimited by \( r - 1 \) moults. The data was originally used in a 1986 publication but has been corrected for two sampling occasions; the data appears in Candy (1990) and was analyzed in Boersch-Supan (2021). See the latter for more references.

Source


References


Examples

budworm
summary(budworm)

calibrate          Model Calibrations

Description

calibrate is a generic function used to produce calibrations from various model fitting functions. The function invokes particular ‘methods’ which depend on the ‘class’ of the first argument.

Usage

calibrate(object, ...)

Arguments

object          An object for which a calibration is desired.
...          Additional arguments affecting the calibration produced. Usually the most important argument in ... is newdata which, for calibrate, contains new response data, \( Y \), say.

Details

Given a regression model with explanatory variables \( X \) and response \( Y \), calibration involves estimating \( X \) from \( Y \) using the regression model. It can be loosely thought of as the opposite of predict (which takes an \( X \) and returns a \( Y \) of some sort.) In general, the central algorithm is maximum likelihood calibration.
calibrate

Value

In general, given a new response \( Y \), some function of the explanatory variables \( X \) are returned. For example, for constrained ordination models such as CQO and CAO models, it is usually not possible to return \( X \), so the latent variables are returned instead (they are linear combinations of the \( X \)). See the specific calibrate methods functions to see what they return.

Note

This function was not called predictx because of the inability of constrained ordination models to return \( X \); they can only return the latent variable values (also known as site scores) instead.

Author(s)

T. W. Yee

References


See Also

predict, calibrate.rrvglm, calibrate.qrrvglm.

Examples

```r
## Not run:
hspillar[, 1:6] <- scale(hspider[, 1:6]) # Stdzed environmental vars
set.seed(123)
pcao1 <- cao(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull, Zoraspin) ~
             WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
             family = poissonff, data = hspider, Rank = 1, Bestof = 3,
             df1.nl = c(Zoraspin = 2, 1.9), Crow1positive = TRUE)

siteNos <- 1:2 # Calibrate these sites
cpcao1 <- calibrate(pcao1, trace = TRUE,
                     newdata = data.frame(depvar(pcao1)[siteNos, ],
                                          model.matrix(pcao1)[siteNos, ]))

# Graphically compare the actual site scores with their calibrated values
persp(pcao1, main = "Site scores: solid=actual, dashed=calibrated",
      label = TRUE, col = "blue", las = 1)
abline(v = latvar(pcao1)[siteNos], col = seq(siteNos)) # Actual scores
abline(v = cpcao1, lty = 2, col = seq(siteNos)) # Calibrated values

## End(Not run)
```
Description

calibrate is a generic function applied to RR-VGLMs, QRR-VGLMs and RR-VGAMs, etc.

Methods

object The object from which the calibration is performed.

describe.qrrvglm Calibration for Constrained Regression Models

Description

Performs maximum likelihood calibration for constrained quadratic and additive ordination models (CQO and CAO models are better known as QRR-VGLMs and RR-VGAMs respectively).

Usage

```
calibrate.qrrvglm(object, newdata = NULL, 
                 type = c("latvar", "predictors", "response", "vcov", "everything"),
                 lr.confint = FALSE, cf.confint = FALSE,
                 level = 0.95, initial.vals = NULL, ...)
```

Arguments

object The fitted CQO/CAO model.

newdata A data frame with new response data, such as new species data. The default is to use the original data used to fit the model; however, the calibration may take a long time to compute because the computations are expensive. Note that the creation of the model frame associated with newdata is fragile. Factors may not be created properly. If a variable is binary then its best for it to be straightforward and have only 0 and 1 as values.

type What type of result to be returned. The first are the calibrated latent variables or site scores. This is always computed. The "predictors" are the linear/quadratic or additive predictors evaluated at the calibrated latent variables or site scores. The "response" are the fitted values (usually means) evaluated at the calibrated latent variables or site scores. The "vcov" are the Wald-type estimated variance-covariance matrices of the calibrated latent variables or site scores. The "everything" is for all of them, i.e., all types. Note that for CAO models, the "vcov" type is unavailable.
lr.confint, level

Compute approximate likelihood ratio based confidence intervals? If TRUE then level is the confidence level required and one should have type = "latvar" or type = "everything"; and currently only rank-1 models are supported. This option works for CLO and CQO models and not for CAO models. The function uniroot is called to solve for the root of a nonlinear equation to obtain each confidence limit, and this is not entirely reliable. It is assumed that the likelihood function is unimodal about its MLE because only one root is returned if there is more than one. One root is found on each side of the MLE. Technically, the default is to find the value of the latent variable whose difference in deviance (or twice the difference in log-likelihoods) from the optimal model is equal to qchisq(level, df = 1). The intervals are not true profile likelihood intervals because it is not possible to estimate the regression coefficients of the QRR-VGLM/RR-VGLM based on one response vector. See confint to get the flavour of these two arguments in general.

cf.confint

Compute approximate characteristic function based confidence intervals? If TRUE then level is the confidence level required and one should have type = "latvar" or type = "everything"; and currently only rank-1 models are supported. This option works for binomialff and poissonff CLO and CQO models and not for CAO models. The function uniroot is called to solve for the root of a nonlinear equation to obtain each confidence limit, and this is not entirely reliable. It is assumed that the likelihood function is unimodal because only one root is returned if there is more than one. Technically, the CDF of a normalized score statistic is obtained by Gauss–Hermite numerical integration of a complex-valued integrand, and this is based on the inversion formula described in Abate and Witt (1992).

initial.vals

Initial values for the search. For rank-1 models, this should be a vector having length equal to nrow(newdata), and for rank-2 models this should be a two-column matrix with the number of rows equaling the number of rows in newdata. The default is a grid defined by arguments in calibrate.qrrvglm.control.

... Arguments that are fed into calibrate.qrrvglm.control.

Details

Given a fitted regression CQO/CAO model, maximum likelihood calibration is theoretically easy and elegant. However, the method assumes that all the responses are independent, which is often not true in practice. More details and references are given in Yee (2018) and ch.6 of Yee (2015).

The function optim is used to search for the maximum likelihood solution. Good initial values are needed, and arguments in calibrate.qrrvglm.control allows the user some control over the choice of these.

Value

Several methods are implemented to obtain confidence intervals/regions for the calibration estimates. One method is when lr.confint = TRUE, then a 4-column matrix is returned with the confidence limits being the final 2 columns (if type = "everything" then the matrix is returned in the lr.confint list component). Another similar method is when cf.confint = TRUE. There may be
some redundancy in whatever is returned. Other methods are returned by using type and they are described as follows.

The argument type determines what is returned. If type = "everything" then all the type values are returned in a list, with the following components. Each component has length nrow(newdata).

- **latvar**: Calibrated latent variables or site scores (the default). This may have the attribute "objectiveFunction" which is usually the log-likelihood or the deviance.

- **predictors**: linear/quadratic or additive predictors. For example, for Poisson families, this will be on a log scale, and for binomial families, this will be on a logit scale.

- **response**: Fitted values of the response, evaluated at the calibrated latent variables.

- **vcov**: Wald-type estimated variance-covariance matrices of the calibrated latent variables or site scores. Actually, these are stored in a 3-D array whose dimension is c(Rank(object), Rank(object), nrow(newdata)). This type has only been implemented for \texttt{binomialff} and \texttt{poissonff} models with canonical links and no\texttt{RRR} = \~1 and, for CQOs, I.tolerances = TRUE or eq.tolerances = TRUE.

**Warning**

This function is computationally expensive. Setting trace = TRUE to get a running log can be a good idea. This function has been tested but not extensively.

**Note**

Despite the name of this function, CAO models are handled as well to a certain extent. Some combinations of parameters are not handled, e.g., \texttt{lr.confint} = TRUE only works for rank-1, type = "vcov" only works for \texttt{binomialff} and \texttt{poissonff} models with canonical links and no\texttt{RRR} = \~1, and higher-order rank models need eq.tolerances = TRUE or I.tolerances = TRUE as well. For rank-1 objects, \texttt{lr.confint} = TRUE is recommended above type = "vcov" in terms of accuracy and overall generality. For class "\texttt{qrrvglm}" objects it is necessary that all response' tolerance matrices are positive-definite which correspond to bell-shaped response curves/surfaces.

For \texttt{binomialff} and \texttt{poissonff} models the deviance slot is used for the optimization rather than the loglikelihood slot, therefore one can calibrate using real-valued responses. (If the loglikelihood slot were used then functions such as \texttt{dpois} would be used with log = TRUE and then would be restricted to feed in integer-valued response values.)

Maximum likelihood calibration for Gaussian logit regression models may be performed by \texttt{rioja} but this applies to a single environmental variable such as pH in \texttt{data("SWAP", package = "rioja")}. In \texttt{VGAM} \texttt{calibrate()} estimates values of the latent variable rather than individual explanatory variables, hence the setting is more on ordination.

**Author(s)**

T. W. Yee. Recent work on the standard errors by David Zucker and Sam Oman at HUJI is gratefully acknowledged—these are returned in the vcov component and provided inspiration for \texttt{lr.confint} and \texttt{cf.confint}. A joint publication is being prepared on this subject.
References


See Also

calibrate.qrrvglm.control, calibrate.rrvglm, calibrate, cqo, cao, optim, uniroot.

Examples

```r
## Not run:
hspsode[, 1:6] <- scale(hspider[, 1:6])  # Stdze environmental variables
set.seed(123)
siteNos <- c(1, 5)  # Calibrate these sites
pet1 <- cqo(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull, Zoraspin) ~
             WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + Reflux,
             trace = FALSE,
             data = hspider[-siteNos, ],  # Sites not in fitted model
             family = poissonff, I.toler = TRUE, Crowlpositive = TRUE)
y0 <- hspider[siteNos, colnames(depvar(pet1))])  # Species counts
(cpet1 <- calibrate(pet1, trace = TRUE, newdata = data.frame(y0)))
(clrpet1 <- calibrate(pet1, lr.confint = TRUE, newdata = data.frame(y0)))
(ccfpet1 <- calibrate(pet1, cf.confint = TRUE, newdata = data.frame(y0)))
(cp1wald <- calibrate(pet1, newdata = y0, type = "everything"))
## End(Not run)

## Not run:
# Graphically compare the actual site scores with their calibrated
# values. 95 percent likelihood-based confidence intervals in green.
persp(pet1, main = "Site scores: solid=actual, dashed=calibrated",
      label = TRUE, col = "gray50", las = 1)

# Actual site scores:
xvars <- rownames(concoef(pet1))  # Variables comprising the latvar
est.latvar <- as.matrix(hspider[siteNos, xvars]) %*% concoef(pet1)
abline(v = est.latvar, col = seq(siteNos))  # Calibrated values
arrows(clrpet1[, 3], c(60, 60), clrpet1[, 4], c(60, 60), # Add CIs
       length = 0.08, col = "orange", angle = 90, code = 3, lwd = 2)
arrows(ccfpet1[, 3], c(70, 70), ccfpet1[, 4], c(70, 70), # Add CIs
       length = 0.08, col = "limegreen", angle = 90, code = 3, lwd = 2)
arrows(cp1wald$latvar - 1.96 * sqrt(cp1wald$vcov), c(65, 65),
       cp1wald$latvar + 1.96 * sqrt(cp1wald$vcov), c(65, 65), # Wald CIs
       length = 0.08, col = "blue", angle = 90, code = 3, lwd = 2)
legend("topright", lwd = 2,
       leg = c("CF interval", "Wald interval", "LR interval"),
       col = c("limegreen", "blue", "orange"), lty = 1)
```

calibrate.qrrvglm.control

Control Function for CQO/CAO Calibration

Description
Algorithmic constants and parameters for running `calibrate.qrrvglm` are set using this function.

Usage

```r
calibrate.qrrvglm.control(object, trace = FALSE, method.optim = "BFGS",
gridSize = ifelse(Rank == 1, 21, 9), varI.latvar = FALSE, ...)
```

Arguments

- **object**: The fitted CQO/CAO model. The user should ignore this argument.
- **trace**: Logical indicating if output should be produced for each iteration. It is a good idea to set this argument to be `TRUE` since the computations are expensive.
- **method.optim**: Character. Fed into the `method` argument of `optim`.
- **gridSize**: Numeric, recycled to length `Rank`. Controls the resolution of the grid used for initial values. For each latent variable, an equally spaced grid of length `gridSize` is cast from the smallest site score to the largest site score. Then the likelihood function is evaluated on the grid, and the best fit is chosen as the initial value. Thus increasing the value of `gridSize` increases the chance of obtaining the global solution, however, the computing time increases proportionately.
- **varI.latvar**: Logical. For CQO objects only, this argument is fed into `Coef.qrrvglm`.
- **...**: Avoids an error message for extraneous arguments.

Details

Most CQO/CAO users will only need to make use of `trace` and `gridSize`. These arguments should be used inside their call to `calibrate.qrrvglm`, not this function directly.

Value

A list which with the following components.

- **trace**: Numeric (even though the input can be logical).
- **gridSize**: Positive integer.
- **varI.latvar**: Logical.

Note

Despite the name of this function, CAO models are handled as well.
References


See Also

`calibrate.qrrvglm`, `Coef.qrrvglm`.

Examples

```r
## Not run: hspider[, 1:6] <- scale(hspider[, 1:6]) # Needed for I.tol=TRUE
set.seed(123)
p1 <- cqo(cbind(Alopacce, Alopucne, Pardlugu, Pardnigr,
    Pardpull, Trocterr, Zoraspin) ~
    WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
    family = poissonff, data = hspider, I.tol = TRUE)
sort(deviance(p1, history = TRUE)) # A history of all the iterations
siteNos <- 3:4 # Calibrate these sites
cp1 <- calibrate(p1, trace = TRUE,
    new = data.frame(depvar(p1)[siteNos, ]))
## End(Not run)
## Not run:
# Graphically compare the actual site scores with their calibrated values
persp(p1, main = "Site scores: solid=actual, dashed=calibrated",
    label = TRUE, col = "blue", las = 1)
abline(v = latvar(p1)[siteNos], col = seq(siteNos)) # Actual site scores
abline(v = cp1, lty = 2, col = seq(siteNos)) # Calibrated values
## End(Not run)
```

---

calibrate.rrvglm  
*Calibration for CLO models (RR-VGLMs)*

**Description**

Performs maximum likelihood calibration for constrained linear ordination models (CLO models are better known as RR-VGLMs).

**Usage**

```r
calibrate.rrvglm(object, newdata = NULL,
    type = c("latvar", "predictors", "response", "vcov", "everything"),
    lr.confint = FALSE, cf.confint = FALSE,
    level = 0.95, initial.vals = NULL, ...)
```
Arguments

object  The fitted \texttt{rrvglm} model. Note that object should be fitted with corner constraints.

newdata  See \texttt{calibrate.qrrvglm}.

type  See \texttt{calibrate.qrrvglm}. If type = "vcov" then object should have been fitted using \texttt{binomialff} or \texttt{poissonff} with canonical links, and have noRRR = ~ 1.

lr.confint, cf.confint, level  Same as \texttt{calibrate.qrrvglm}.

initial.vals  Same as \texttt{calibrate.qrrvglm}. The default is a grid defined by arguments in \texttt{calibrate.rrvglm.control}.

...  Arguments that are fed into \texttt{calibrate.rrvglm.control}.

Details

Given a fitted regression CLO model, maximum likelihood calibration is theoretically easy and elegant. However, the method assumes that all responses are independent. More details and references are given in Yee (2015).

Calibration requires \textit{grouped} or \textit{non-sparse} data as the response. For example, if the family function is \texttt{multinomial} then one cannot usually calibrate y0 if it is a vector of 0s except for one 1. Instead, the response vector should be from grouped data so that there are few 0s. Indeed, it is found empirically that the stereotype model (also known as a reduced-rank \texttt{multinomial} logit model) calibrates well only with grouped data, and if the response vector is all 0s except for one 1 then the MLE will probably be at -Inf or +Inf. As another example, if the family function is \texttt{poissonff} then y0 must not be a vector of all 0s; instead, the response vector should have few 0s ideally. In general, you can use simulation to see what type of data calibrates acceptably.

Internally, this function is a simplification of \texttt{calibrate.qrrvglm} and users should look at that function for details. Good initial values are needed, and a grid is constructed to obtain these. The function \texttt{calibrate.rrvglm.control} allows the user some control over the choice of these.

Value

See \texttt{calibrate.qrrvglm}. Of course, the quadratic term in the latent variables vanishes for RR-VGLMs, so the model is simpler.

Warning

See \texttt{calibrate.qrrvglm}.

Note

See \texttt{calibrate.qrrvglm} about, e.g., calibration using real-valued responses.

Author(s)

T. W. Yee
See Also

calibrate.qrrvglm, calibrate.rrvglm, weightsvglm, optim, uniroot.

Examples

## Not run:  # Example 1
nona.xs.nz <- na.omit(xs.nz)  # Overkill!! (Data in VGAMdata package)
nona.xs.nz$dmd <- with(nona.xs.nz, round(drinkmaxday))
nona.xs.nz$feethr <- with(nona.xs.nz, round(feethour))
nona.xs.nz$sleephr <- with(nona.xs.nz, round(sleep))
nona.xs.nz$beats <- with(nona.xs.nz, round(pulse))

p2 <- rrvglm(cbind(dmd, feethr, sleephr, beats) ~ age + smokenow +
    depressed + embarrassed + fedup + hurt + miserable +  # 11 psychological
    nofriend + moody + nervous + tense + worry + worrier, # variables
    noRRR = ~ age + smokenow, trace = FALSE, poissonff, data = nona.xs.nz,
    Rank = 2)
cp2 <- calibrate(p2, newdata = head(nona.xs.nz, 9), trace = TRUE)
cp2

two.cases <- nona.xs.nz[1:2, ]  # Another calibration example
two.cases$dmd <- c(4, 10)
two.cases$feethr <- c(4, 7)
two.cases$sleephr <- c(7, 8)
two.cases$beats <- c(62, 71)
(cp2b <- calibrate(p2, newdata = two.cases))

## End(Not run)

calibrate.rrvglm.control

*Control Function for CLO (RR-VGLM) Calibration*

**Description**

Algorithmic constants and parameters for running `calibrate.rrvglm` are set using this function.

**Usage**

```r
calibrate.rrvglm.control(object, trace = FALSE, method.optim = "BFGS",
    gridSize = ifelse(Rank == 1, 17, 9), ...)
```
Arguments

- **object**: The fitted `rrvglm` model. The user should ignore this argument.
- **trace, method.optim**: Same as `calibrate.qrrvglm.control`.
- **gridSize**: Same as `calibrate.qrrvglm.control`.
- **...**: Avoids an error message for extraneous arguments.

Details

Most CLO users will only need to make use of `trace` and `gridSize`. These arguments should be used inside their call to `calibrate.rrvglm`, not this function directly.

Value

Similar to `calibrate.qrrvglm.control`.

See Also

`calibrate.rrvglm`, `Coef.rrvglm`.

---

**cao**

Fitting Constrained Additive Ordination (CAO)

Description

A constrained additive ordination (CAO) model is fitted using the reduced-rank vector generalized additive model (RR-VGAM) framework.

Usage

```r
cao(formula, family = stop("argument 'family' needs to be assigned"),
    data = list(),
    weights = NULL, subset = NULL, na.action = na.fail,
    etastart = NULL, mustart = NULL, coefstart = NULL,
    control = cao.control(...), offset = NULL,
    method = "cao.fit", model = FALSE, x.arg = TRUE, y.arg = TRUE,
    contrasts = NULL, constraints = NULL,
    extra = NULL, qr.arg = FALSE, smart = TRUE, ...)
```

Arguments

- **formula**: a symbolic description of the model to be fit. The RHS of the formula is used to construct the latent variables, upon which the smooths are applied. All the variables in the formula are used for the construction of latent variables except for those specified by the argument `noRRR`, which is itself a formula. The LHS of the formula contains the response variables, which should be a matrix with each column being a response (species).
family

a function of class "vglmff" (see vglmff-class) describing what statistical model is to be fitted. This is called a "VGAM family function". See CommonVGAMffArguments for general information about many types of arguments found in this type of function. See cqo for a list of those presently implemented.

data

an optional data frame containing the variables in the model. By default the variables are taken from environment(formula), typically the environment from which cao is called.

weights

an optional vector or matrix of (prior) weights to be used in the fitting process. For cao, this argument currently should not be used.

subset

an optional logical vector specifying a subset of observations to be used in the fitting process.

na.action

a function which indicates what should happen when the data contain NAs. The default is set by the na.action setting of options, and is na.fail if that is unset. The “factory-fresh” default is na.omit.

etastart

starting values for the linear predictors. It is a $M$-column matrix. If $M = 1$ then it may be a vector. For cao, this argument currently should not be used.

mustart

starting values for the fitted values. It can be a vector or a matrix. Some family functions do not make use of this argument. For cao, this argument currently should not be used.

coefstart

starting values for the coefficient vector. For cao, this argument currently should not be used.

control

a list of parameters for controlling the fitting process. See cao.control for details.

offset

a vector or $M$-column matrix of offset values. These are a priori known and are added to the linear predictors during fitting. For cao, this argument currently should not be used.

method

the method to be used in fitting the model. The default (and presently only) method cao.fit uses iteratively reweighted least squares (IRLS) within FORTRAN code called from optim.

model

a logical value indicating whether the model frame should be assigned in the model slot.

x.arg, y.arg

logical values indicating whether the model matrix and response vector/matrix used in the fitting process should be assigned in the x and y slots. Note the model matrix is the linear model (LM) matrix.

contrasts

an optional list. See the contrasts.arg of model.matrix.default.

constraints

an optional list of constraint matrices. For cao, this argument currently should not be used. The components of the list must be named with the term it corresponds to (and it must match in character format). Each constraint matrix must have $M$ rows, and be of full-column rank. By default, constraint matrices are the $M$ by $M$ identity matrix unless arguments in the family function itself override these values. If constraints is used it must contain all the terms; an incomplete list is not accepted.

extra

an optional list with any extra information that might be needed by the family function. For cao, this argument currently should not be used.
For `cao`, this argument currently should not be used.

logical value indicating whether smart prediction (`smartpred`) will be used.

further arguments passed into `cao.control`.

Details

The arguments of `cao` are a mixture of those from `vgam` and `cqo`, but with some extras in `cao.control`. Currently, not all of the arguments work properly.

CAO can be loosely thought of as the result of fitting generalized additive models (GAMs) to several responses (e.g., species) against a very small number of latent variables. Each latent variable is a linear combination of the explanatory variables; the coefficients C (called $C$ below) are called constrained coefficients or canonical coefficients, and are interpreted as weights or loadings. The C are estimated by maximum likelihood estimation. It is often a good idea to apply `scale` to each explanatory variable first.

For each response (e.g., species), each latent variable is smoothed by a cubic smoothing spline, thus CAO is data-driven. If each smooth were a quadratic then CAO would simplify to constrained quadratic ordination (CQO; formerly called canonical Gaussian ordination or CGO). If each smooth were linear then CAO would simplify to constrained linear ordination (CLO). CLO can theoretically be fitted with `cao` by specifying `df1.nl=0`, however it is more efficient to use `rrvglm`.

Currently, only `Rank=1` is implemented, and only `noRRR =~1` models are handled.

With binomial data, the default formula is

$$\text{logit}(P[Y_s = 1]) = \eta_s = f_s(\nu), \quad s = 1, 2, \ldots, S$$

where $x_2$ is a vector of environmental variables, and $\nu = C^T x_2$ is a $R$-vector of latent variables. The $\eta_s$ is an additive predictor for species $s$, and it models the probabilities of presence as an additive model on the logit scale. The matrix $C$ is estimated from the data, as well as the smooth functions $f_s$. The argument `noRRR =~1` specifies that the vector $x_1$, defined for RR-VGLMs and QRR-VGLMs, is simply a 1 for an intercept. Here, the intercept in the model is absorbed into the functions. A `clogloglink` link may be preferable over a `logitlink` link.

With Poisson count data, the formula is

$$\log(E[Y_s]) = \eta_s = f_s(\nu)$$

which models the mean response as an additive models on the log scale.

The fitted latent variables (site scores) are scaled to have unit variance. The concept of a tolerance is undefined for CAO models, but the optimums and maximums are defined. The generic functions `Max` and `Opt` should work for CAO objects, but note that if the maximum occurs at the boundary then `Max` will return a `NA`. Inference for CAO models is currently undeveloped.

Value

An object of class "cao" (this may change to "rrvgam" in the future). Several generic functions can be applied to the object, e.g., `Coef`, `concoef`, `lvplot`, `summary`. 
Warning

CAO is very costly to compute. With version 0.7-8 it took 28 minutes on a fast machine. I hope to look at ways of speeding things up in the future.

Use \texttt{set.seed} just prior to calling \texttt{cao()} to make your results reproducible. The reason for this is finding the optimal CAO model presents a difficult optimization problem, partly because the log-likelihood function contains many local solutions. To obtain the (global) solution the user is advised to try \textit{many} initial values. This can be done by setting \texttt{Bestof} some appropriate value (see \texttt{cao.control}). Trying many initial values becomes progressively more important as the nonlinear degrees of freedom of the smooths increase.

Note

CAO models are computationally expensive, therefore setting \texttt{trace = TRUE} is a good idea, as well as running it on a simple random sample of the data set instead.

Sometimes the IRLS algorithm does not converge within the FORTRAN code. This results in warnings being issued. In particular, if an error code of 3 is issued, then this indicates the IRLS algorithm has not converged. One possible remedy is to increase or decrease the nonlinear degrees of freedom so that the curves become more or less flexible, respectively.

Author(s)

T. W. Yee

References


See Also

\texttt{cao.control}, \texttt{Coef.cao}, \texttt{cqo}, \texttt{latvar}, \texttt{Opt.Max}, \texttt{calibrate.qrrvglm}, \texttt{persp.cao}, \texttt{poissonff}, \texttt{binomialff}, \texttt{negbinomial}, \texttt{gamma2}, \texttt{set.seed}, \texttt{gam()} in \texttt{gam}, \texttt{trap0}.

Examples

```r
## Not run:
hspider[, 1:6] <- scale(hspider[, 1:6]) # Stdzd environmental vars
set.seed(149) # For reproducible results
ap1 <- cao(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull) ~ WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux, 
family = poissonff, data = hspider, Rank = 1, 
df1.nl = c(Pardpull= 2.7, 2.5),
Bestof = 7, Crow1positive = FALSE)

sort(deviance(ap1, history = TRUE)) # A history of all the iterations
Coef(ap1)
concoef(ap1)

par(mfrow = c(2, 2))
plot(ap1) # All the curves are unimodal; some quite symmetric
```
cao.control

Control Function for RR-VGAMs (CAO)

Description

Algorithmic constants and parameters for a constrained additive ordination (CAO), by fitting a reduced-rank vector generalized additive model (RR-VGAM), are set using this function. This is the control function for cao.

Usage

cao.control(Rank = 1, all.knots = FALSE, criterion = "deviance", Cinit = NULL, Crowlpositive = TRUE, epsilon = 1.0e-05, Etamat.colmax = 10, GradientFunction = FALSE, iKvector = 0.1, iShape = 0.1, noRRR = ~ 1, Norrr = NA, SmallNo = 5.0e-13, Use.Init.Poisson.QO = TRUE, Bestof = if (length(Cinit)) 1 else 10, maxitl = 10, imethod = 1, bf.epsilon = 1.0e-7, bf.maxit = 10, Maxit.optim = 250, optim.maxit = 20, sd.sitescores = 1.0, sd.Cinit = 0.02, suppress.warnings = TRUE, trace = TRUE, df1.nl = 2.5, df2.nl = 2.5, spar1 = 0, spar2 = 0, ...)

Arguments

Rank

The numerical rank $R$ of the model, i.e., the number of latent variables. Currently only Rank = 1 is implemented.

all.knots

Logical indicating if all distinct points of the smoothing variables are to be used as knots. Assigning the value FALSE means fewer knots are chosen when the number of distinct points is large, meaning less computational expense. See vgam.control for details.
criterion Convergence criterion. Currently, only one is supported: the deviance is minimized.

Cinit Optional initial C matrix which may speed up convergence.

Crow1positive Logical vector of length Rank (recycled if necessary): are the elements of the first row of C positive? For example, if Rank is 4, then specifying Crow1positive = c(FALSE, TRUE) will force C[1,1] and C[1,3] to be negative, and C[1,2] and C[1,4] to be positive.

epsilon Positive numeric. Used to test for convergence for GLMs fitted in FORTRAN. Larger values mean a loosening of the convergence criterion.

Eamat.colmax Positive integer, no smaller than Rank. Controls the amount of memory used by .Init.Poisson.QO(). It is the maximum number of columns allowed for the pseudo-response and its weights. In general, the larger the value, the better the initial value. Used only if Use.Init.Poisson.QO = TRUE.

GradientFunction Logical. Whether optim’s argument gr is used or not, i.e., to compute gradient values. Used only if FastAlgorithm is TRUE. Currently, this argument must be set to FALSE.

iKvector, iShape See qrrvglm.control.

noRRR Formula giving terms that are not to be included in the reduced-rank regression (or formation of the latent variables). The default is to omit the intercept term from the latent variables. Currently, only noRRR = ~ 1 is implemented.

Norrr Defunct. Please use noRRR. Use of Norrr will become an error soon.

SmallNo Positive numeric between .Machine$double.eps and 0.0001. Used to avoid under- or over-flow in the IRLS algorithm.

Use.Init.Poisson.QO Logical. If TRUE then the function .Init.Poisson.QO is used to obtain initial values for the canonical coefficients C. If FALSE then random numbers are used instead.

Bestof Integer. The best of Bestof models fitted is returned. This argument helps guard against local solutions by (hopefully) finding the global solution from many fits. The argument works only when the function generates its own initial value for C, i.e., when C are not passed in as initial values. The default is only a convenient minimal number and users are urged to increase this value.

maxitl Positive integer. Maximum number of Newton-Raphson/Fisher-scoring/local-scoring iterations allowed.

imethod See qrrvglm.control.

bf.epsilon Positive numeric. Tolerance used by the modified vector backfitting algorithm for testing convergence.

bf.maxit Positive integer. Number of backfitting iterations allowed in the compiled code.

Maxit.optim Positive integer. Number of iterations given to the function optim at each of the optim.maxit iterations.

optim.maxit Positive integer. Number of times optim is invoked.
sd.sitescores  Numeric. Standard deviation of the initial values of the site scores, which are
generated from a normal distribution. Used when `Use.Init.Poisson.QO` is
FALSE.

sd.Cinit  Standard deviation of the initial values for the elements of `C`. These are normally
distributed with mean zero. This argument is used only if `Use.Init.Poisson.QO`
= FALSE.

suppress.warnings  Logical. Suppress warnings?

trace  Logical indicating if output should be produced for each iteration. Having the
value TRUE is a good idea for large data sets.

df1.nl, df2.nl  Numeric and non-negative, recycled to length `S`. Nonlinear degrees of freedom
for smooths of the first and second latent variables. A value of 0 means the
smooth is linear. Roughly, a value between 1.0 and 2.0 often has the approximate
flexibility of a quadratic. The user should not assign too large a value to this
argument, e.g., the value 4.0 is probably too high. The argument `df1.nl`
is ignored if `spar1` is assigned a positive value or values. Ditto for `df2.nl`.

spar1, spar2  Numeric and non-negative, recycled to length `S`. Smoothing parameters of the
smooths of the first and second latent variables. The larger the value, the more
smooth (less wiggly) the fitted curves. These arguments are an alternative to
specifying `df1.nl` and `df2.nl`. A value 0 (the default) for `spar1` means that
`df1.nl` is used. Ditto for `spar2`. The values are on a scaled version of the latent
variables. See Green and Silverman (1994) for more information.

...  Ignored at present.

details

Many of these arguments are identical to `qrrvglm.control`. Here, `R` is the Rank, `M` is the number
of additive predictors, and `S` is the number of responses (species). Thus `M = S` for binomial and
Poisson responses, and `M = 2S` for the negative binomial and 2-parameter gamma distributions.

Allowing the smooths too much flexibility means the CAO optimization problem becomes more
difficult to solve. This is because the number of local solutions increases as the nonlinearity of the
smooths increases. In situations of high nonlinearity, many initial values should be used, so that
`Bestof` should be assigned a larger value. In general, there should be a reasonable value of `df1.nl`
somewhere between 0 and about 3 for most data sets.

Value

A list with the components corresponding to its arguments, after some basic error checking.

Note

The argument `df1.nl` can be inputted in the format `c(spp1 = 2, spp2 = 3, 2.5)`, say, meaning the
default value is 2.5, but two species have alternative values.

If `spar1 = 0` and `df1.nl = 0` then this represents fitting linear functions (CLO). Currently, this is
handled in the awkward manner of setting `df1.nl` to be a small positive value, so that the smooth
is almost linear but not quite. A proper fix to this special case should done in the short future.
Author(s)

T. W. Yee

References


See Also
cao.

Examples

```r
## Not run:
hsider[,1:6] <- scale(hspider[,1:6]) # Standardized environmental vars
set.seed(123)
ap1 <- cao(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull, Zoraspin) ~
    WaterCon + BareSand + FallTwig +
    CoveMoss + CoveHerb + RefiLux,
    family = poissonff, data = hspider,
    df1.nl = c(Zoraspin = 2.3, 2.1),
    Bestof = 10, Crowtpositive = FALSE)

sort(deviance(ap1, history = TRUE)) # A history of all the iterations
Coef(ap1)

Coef(ap1)

par(mfrow = c(2, 3)) # All or most of the curves are unimodal; some are
plot(ap1, lcol = "blue") # quite symmetric. Hence a CQO model should be ok

par(mfrow = c(1, 1), las = 1)

index <- 1:ncol(depvar(ap1)) # lvplot is jagged because only 28 sites

lvplot(ap1, lcol = index, pcol = index, y = TRUE)

trplot(ap1, label = TRUE, col = index)
abline(a = 0, b = 1, lty = 2)

persp(ap1, label = TRUE, col = 1:4)

## End(Not run)
```

Cardioid Distribution

Description

Density, distribution function, quantile function and random generation for the cardioid distribution.
Usage

dcard(x, mu, rho, log = FALSE)
pocard(q, mu, rho, lower.tail = TRUE, log.p = FALSE)
qcard(p, mu, rho, tolerance = 1e-07, maxits = 500,
        lower.tail = TRUE, log.p = FALSE)
rcard(n, mu, rho, ...)

Arguments

x, q
vector of quantiles.

p
vector of probabilities.

n
number of observations. Same as in runif.

mu, rho
See cardioid for more information.

tolerance, maxits, ...
   The first two are control parameters for the algorithm used to solve for the roots
   of a nonlinear system of equations; tolerance controls for the accuracy and
   maxits is the maximum number of iterations. rcard calls qcard so the ... can
   be used to vary the two arguments.

log
Logical. If log = TRUE then the logarithm of the density is returned.

lower.tail, log.p
   Same meaning as in pnorm or qnorm.

Details

   See cardioid, the VGAM family function for estimating the two parameters by maximum likeli-
   hood estimation, for the formula of the probability density function and other details.

Value

   dcard gives the density, pcard gives the distribution function, qcard gives the quantile function,
   and rcard generates random deviates.

Note

   Convergence problems might occur with rcard.

Author(s)

   Thomas W. Yee and Kai Huang

See Also

   cardioid.
Examples

```r
## Not run:
mu <- 4; rho <- 0.4; x <- seq(0, 2*pi, len = 501)
plot(x, dcard(x, mu, rho), type = "l", las = 1, ylim = c(0, 1),
ylab = paste("[dp]card(mu=", mu, ", rho=", rho, ")"),
main = "Blue is density, orange is the CDF", col = "blue",
sub = "Purple lines are the 10,20,...,90 percentiles")
lines(x, pcard(x, mu, rho), col = "orange")

probs <- seq(0.1, 0.9, by = 0.1)
Q <- qcard(probs, mu, rho)
lines(Q, dcard(Q, mu, rho), col = "purple", lty = 3, type = "h")
lines(Q, pcard(Q, mu, rho), col = "purple", lty = 3, type = "h")
abline(h = c(0,probs, 1), v = c(0, 2*pi), col = "purple", lty = 3)
max(abs(pcard(Q, mu, rho) - probs)) # Should be 0

## End(Not run)
```

cardioid | Cardioid Distribution Family Function

Description

Estimates the two parameters of the cardioid distribution by maximum likelihood estimation.

Usage

```r
cardioid(lmu = extlogitlink(min = 0, max = 2*pi),
        lrho = extlogitlink(min = -0.5, max = 0.5),
        imu = NULL, irho = 0.3, nsimEIM = 100, zero = NULL)
```

Arguments

- `lmu, lrho`: Parameter link functions applied to the \( \mu \) and \( \rho \) parameters, respectively. See `Links` for more choices.
- `imu, irho`: Initial values. A `NULL` means an initial value is chosen internally. See `CommonVGAMffArguments` for more information.
- `nsimEIM, zero`: See `CommonVGAMffArguments` for more information.

Details

The two-parameter cardioid distribution has a density that can be written as

\[
f(y; \mu, \rho) = \frac{1}{2\pi} \left( 1 + 2 \rho \cos(y - \mu) \right)
\]

where \( 0 < y < 2\pi, 0 < \mu < 2\pi, \) and \( -0.5 < \rho < 0.5 \) is the concentration parameter. The default link functions enforce the range constraints of the parameters.

For positive \( \rho \) the distribution is unimodal and symmetric about \( \mu \). The mean of \( Y \) (which make up the fitted values) is

\[
\pi + \left( \frac{\rho}{\pi} \right) \left( (2\pi - \mu) \sin(2\pi - \mu) + \cos(2\pi - \mu) - \mu \sin(\mu) - \cos(\mu) \right).
\]
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

Numerically, this distribution can be difficult to fit because of a log-likelihood having multiple maximums. The user is therefore encouraged to try different starting values, i.e., make use of ímu and irho.

Note

Fisher scoring using simulation is used.

Author(s)

T. W. Yee

References


See Also

rcard, extlogitlink, vonmises.

CircStats and circular currently have a lot more R functions for circular data than the VGAM package.

Examples

```r
## Not run:
cdata <- data.frame(y = rcard(n = 1000, mu = 4, rho = 0.45))
fit <- vglm(y ~ 1, cardioid, data = cdata, trace = TRUE)
coef(fit, matrix=TRUE)
Coef(fit)
c(with(cdata, mean(y)), head(fitted(fit), 1))
summary(fit)
## End(Not run)
```
Cauchit Link Function

Description

Computes the cauchit (tangent) link transformation, including its inverse and the first two derivatives.

Usage

cauchitlink(theta, bvalue = .Machine$double.eps,
          inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)

Arguments

theta Numeric or character. See below for further details.
bvalue See Links.
inverse, deriv, short, tag
          Details at Links.

Details

This link function is an alternative link function for parameters that lie in the unit interval. This type of link bears the same relation to the Cauchy distribution as the probit link bears to the Gaussian. One characteristic of this link function is that the tail is heavier relative to the other links (see examples below).

Numerical values of theta close to 0 or 1 or out of range result in Inf, -Inf, NA or NaN.

Value

For deriv = 0, the tangent of theta, i.e., tan(pi * (theta-0.5)) when inverse = FALSE, and if inverse = TRUE then 0.5 + atan(theta)/pi.

For deriv = 1, then the function returns d eta / d theta as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

Numerical instability may occur when theta is close to 1 or 0. One way of overcoming this is to use bvalue.

As mentioned above, in terms of the threshold approach with cumulative probabilities for an ordinal response this link function corresponds to the Cauchy distribution (see cauchy1).

Author(s)

Thomas W. Yee
References

See Also
logitlink, probitlink, clogloglink, loglink, cauchy, cauchy1, Cauchy.

Examples

```r
p <- seq(0.01, 0.99, by = 0.01)
cau<ref>chitlink(p)
max(abs(cauchitlink(cauchitlink(p), inverse = TRUE) - p)) # Should be 0

p <- c(seq(-0.02, 0.02, by=0.01), seq(0.97, 1.02, by = 0.01))
cauchitlink(p) # Has no NAs

## Not run:
par(mfrow = c(2, 2), lwd = (mylwd <- 2))
y <- seq(-4, 4, length = 100)
p <- seq(0.01, 0.99, by = 0.01)
for (d in 0:1) {
  matplot(p, cbind(logitlink(p, deriv = d), probitlink(p, deriv = d)),
  type = "n", col = "purple", ylab = "transformation",
  las = 1, main = if (d == 0) "Some probability link functions"
  else "First derivative")
  lines(p, logitlink(p, deriv = d), col = "limegreen")
  lines(p, probitlink(p, deriv = d), col = "purple")
  lines(p, clogloglink(p, deriv = d), col = "chocolate")
  lines(p, cauchitlink(p, deriv = d), col = "tan")
  if (d == 0) {
    abline(v = 0.5, h = 0, lty = "dashed")
    legend(0, 4.5, c("logitlink", "probitlink", "clogloglink",
      "cauchitlink"), lwd = mylwd,
      col = c("limegreen", "purple", "chocolate", "tan"))
  } else
    abline(v = 0.5, lty = "dashed")
}

for (d in 0) {
  matplot(y, cbind( logitlink(y, deriv = d, inverse = TRUE),
     probitlink(y, deriv = d, inverse = TRUE)),
  type = "n", col = "purple", xlab = "transformation", ylab = "p",
  main = if (d == 0) "Some inverse probability link functions"
  else "First derivative", las=1)
  lines(y, logitlink(y, deriv = d, inverse = TRUE), col = "limegreen")
  lines(y, probitlink(y, deriv = d, inverse = TRUE), col = "purple")
  lines(y, clogloglink(y, deriv = d, inverse = TRUE), col = "chocolate")
  lines(y, cauchitlink(y, deriv = d, inverse = TRUE), col = "tan")
  if (d == 0) {
    abline(h = 0.5, v = 0, lty = "dashed")
  }
}
```
cauchy

Cauchy Distribution Family Function

Description
Estimates either the location parameter or both the location and scale parameters of the Cauchy distribution by maximum likelihood estimation.

Usage

cauchy(llocation = "identitylink", lscale = "loglink", imethod = 1, ilocation = NULL, iscale = NULL, gprobs.y = ppoints(19), gscale.mux = exp(-3:3), zero = "scale")
cauchy1(scale.arg = 1, llocation = "identitylink", ilocation = NULL, imethod = 1, gprobs.y = ppoints(19), zero = NULL)

Arguments
llocation, lscale
Parameter link functions for the location parameter $a$ and the scale parameter $b$. See Links for more choices.

ilocation, iscale
Optional initial value for $a$ and $b$. By default, an initial value is chosen internally for each.

imethod
Integer, either 1 or 2 or 3. Initial method, three algorithms are implemented. The user should try all possible values to help avoid converging to a local solution. Also, choose the another value if convergence fails, or use ilocation and/or iscale.

gprobs.y, gscale.mux, zero
See CommonVGAMffArguments for information.

scale.arg
Known (positive) scale parameter, called $b$ below.

Details
The Cauchy distribution has density function

$$f(y; a, b) = \{\pi b[1 + ((y - a)/b)^2]\}^{-1}$$
where \( y \) and \( a \) are real and finite, and \( b > 0 \). The distribution is symmetric about \( a \) and has a heavy tail. Its median and mode are \( a \), but the mean does not exist. The fitted values are the estimates of \( a \). Fisher scoring is used.

If the scale parameter is known (cauchy1) then there may be multiple local maximum likelihood solutions for the location parameter. However, if both location and scale parameters are to be estimated (cauchy) then there is a unique maximum likelihood solution provided \( n > 2 \) and less than half the data are located at any one point.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

**Warning**

It is well-known that the Cauchy distribution may have local maximums in its likelihood function; make full use of imethod, ilocation, iscale etc.

**Note**

Good initial values are needed. By default cauchy searches for a starting value for \( a \) and \( b \) on a 2-D grid. Likewise, by default, cauchy1 searches for a starting value for \( a \) on a 1-D grid. If convergence to the global maximum is not achieved then it also pays to select a wide range of initial values via the ilocation and/or iscale and/or imethod arguments.

**Author(s)**

T. W. Yee

**References**


**See Also**

Cauchy, cauchit, studentt, simulate.vlm.
Examples

# Both location and scale parameters unknown
set.seed(123)
cdata <- data.frame(x2 = runif(nn <- 1000))
cdata <- transform(cdata, loc = exp(1 + 0.5 * x2), scale = exp(1))
cdata <- transform(cdata, y2 = rcauchy(nn, loc, scale))
fit2 <- vglm(y2 ~ x2, cauchy(lloc = "loglink"), data = cdata)
coef(fit2, matrix = TRUE)
head(fitted(fit2))  # Location estimates
summary(fit2)

# Location parameter unknown

cdata <- transform(cdata, scale1 = 0.4)
cdata <- transform(cdata, y1 = rcauchy(nn, loc, scale1))
fit1 <- vglm(y1 ~ x2, cauchy1(scale = 0.4), data = cdata, trace = TRUE)
coef(fit1, matrix = TRUE)

---

cdf.lmscreg Cumulative Distribution Function for LMS Quantile Regression

Description

Computes the cumulative distribution function (CDF) for observations, based on a LMS quantile regression.

Usage

cdf.lmscreg(object, newdata = NULL, ...)

Arguments

object A VGAM quantile regression model, i.e., an object produced by modelling functions such as vglm and vgam with a family function beginning with "lms."
newdata Data frame where the predictions are to be made. If missing, the original data is used.
... Parameters which are passed into functions such as cdf.lms.yjn.

Details

The CDFs returned here are values lying in [0,1] giving the relative probabilities associated with the quantiles newdata. For example, a value near 0.75 means it is close to the upper quartile of the distribution.

Value

A vector of CDF values lying in [0,1].
Note

The data are treated like quantiles, and the percentiles are returned. The opposite is performed by `qtplot.lmscreg`.

The CDF values of the model have been placed in `@post$cdf` when the model was fitted.

Author(s)

Thomas W. Yee

References


See Also

depplot.lmscreg, qtplot.lmscreg, lms.bcn, lms.bcg, lms.yjn, CommonVGAMffArguments.

Examples

```r
fit <- vgam(BMI ~ s(age, df=c(4, 2)), lms.bcn(zero = 1), data = bmi.nz)
head(fit@post$cdf)
head(cdf(fit)) # Same
head(depvar(fit))
head(fitted(fit))

cdf(fit, data.frame(age = c(31.5, 39), BMI = c(28.4, 24)))
```

---

cens.gumbel Censored Gumbel Distribution

Description

Maximum likelihood estimation of the 2-parameter Gumbel distribution when there are censored observations. A matrix response is not allowed.

Usage

```r
cens.gumbel(llocation = "identitylink", lscale = "loglink",
            iscale = NULL, mean = TRUE, percentiles = NULL,
            zero = "scale")
```
cens.gumbel

Arguments

- **location, lscale**
  Character. Parameter link functions for the location and (positive) scale parameters. See Links for more choices.

- **iscale**
  Numeric and positive. Initial value for scale. Recycled to the appropriate length. In general, a larger value is better than a smaller value. The default is to choose the value internally.

- **mean**
  Logical. Return the mean? If TRUE then the mean is returned, otherwise percentiles given by the percentiles argument.

- **percentiles**
  Numeric with values between 0 and 100. If mean=FALSE then the fitted values are percentiles which must be specified by this argument.

- **zero**
  An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The value (possibly values) must be from the set {1,2} corresponding respectively to location and scale. If zero=NULL then all linear/additive predictors are modelled as a linear combination of the explanatory variables. The default is to fit the shape parameter as an intercept only. See CommonVGAMffArguments for more information.

Details

This VGAM family function is like gumbel but handles observations that are left-censored (so that the true value would be less than the observed value) else right-censored (so that the true value would be greater than the observed value). To indicate which type of censoring, input extra = list(leftcensored = vec1, rightcensored = vec2) where vec1 and vec2 are logical vectors the same length as the response. If the two components of this list are missing then the logical values are taken to be FALSE. The fitted object has these two components stored in the extra slot.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Numerical problems may occur if the amount of censoring is excessive.

Note

See gumbel for details about the Gumbel distribution. The initial values are based on assuming all uncensored observations, therefore could be improved upon.

Author(s)

T. W. Yee

References

See Also
gumbel, gumbelff, rgumbel, guplot, gev, venice.

Examples

```r
# Example 1
ystar <- venice[["r1"]]
# Use the first order statistic as the response
nn <- length(ystar)
L <- runif(nn, 100, 104)
# Lower censoring points
U <- runif(nn, 130, 135)
# Upper censoring points
y <- pmax(L, ystar)
# Left censored
y <- pmin(U, y)
# Right censored
extra <- list(leftcensored = ystar < L, rightcensored = ystar > U)
fit <- vglm(y ~ scale(year), data = venice, trace = TRUE, extra = extra,
            fam = cens.gumbel(mean = FALSE, perc = c(5, 25, 50, 75, 95)))
coef(fit, matrix = TRUE)
head(fitted(fit))
fit@extra

# Example 2: simulated data
nn <- 1000
ystar <- rgumbel(nn, loc = 1, scale = exp(0.5))
# The uncensored data
L <- runif(nn, -1, 1)
# Lower censoring points
U <- runif(nn, 2, 5)
# Upper censoring points
y <- pmax(L, ystar)
# Left censored
y <- pmin(U, y)
# Right censored
## Not run: par(mfrow = c(1, 2)); hist(ystar); hist(y);
extra <- list(leftcensored = ystar < L, rightcensored = ystar > U)
fit <- vglm(y ~ 1, trace = TRUE, extra = extra, fam = cens.gumbel)
coef(fit, matrix = TRUE)
```

---

cens.normal  
Censored Normal Distribution

Description

Maximum likelihood estimation for the normal distribution with left and right censoring.

Usage

cens.normal(lmu = "identitylink", lsd = "loglink", imethod = 1,
             zero = "sd")

Arguments

- **lmu, lsd**: Parameter link functions applied to the mean and standard deviation parameters. See Links for more choices. The standard deviation is a positive quantity, therefore a log link is the default.
Initialization method. Either 1 or 2, this specifies two methods for obtaining initial values for the parameters.

zero

A vector, e.g., containing the value 1 or 2; if so, the mean or standard deviation respectively are modelled as an intercept only. Setting zero = NULL means both linear/additive predictors are modelled as functions of the explanatory variables. See CommonVGAMffArguments for more information.

Details

This function is like uninormal but handles observations that are left-censored (so that the true value would be less than the observed value) else right-censored (so that the true value would be greater than the observed value). To indicate which type of censoring, input extra = list(leftcensored = vec1, rightcensored = vec2) where vec1 and vec2 are logical vectors the same length as the response. If the two components of this list are missing then the logical values are taken to be FALSE. The fitted object has these two components stored in the extra slot.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

This function, which is an alternative to tobit, cannot handle a matrix response and uses different working weights. If there are no censored observations then uninormal is recommended instead.

Author(s)

T. W. Yee

See Also

tobit, uninormal, double.cens.normal.

Examples

## Not run:
cdata <- data.frame(x2 = runif(nn <- 1000)) # ystar are true values
cdata <- transform(cdata, ystar = rnorm(nn, m = 100 + 15 * x2, sd = exp(3)))
with(cdata, hist(ystar))
cdata <- transform(cdata, L = runif(nn, 80, 90), # Lower censoring points
                   U = runif(nn, 130, 140)) # Upper censoring points
cdata <- transform(cdata, y = pmax(L, ystar)) # Left censored
with(cdata, hist(y))
cdata <- transform(cdata, y = pmin(U, y)) # Right censored
with(cdata, hist(y))
Extra <- list(leftcensored = with(cdata, ystar < L),
              rightcensored = with(cdata, ystar > U))
fit1 <- vglm(y ~ x2, cens.normal, data = cdata, crit = "c", extra = Extra)
fit2 <- vglm(y ~ x2, tobit(Lower = with(cdata, L), Upper = with(cdata, U)),
            data = cdata, crit = "c", trace = TRUE)
coef(fit1, matrix = TRUE)
max(abs(coef(fit1, matrix = TRUE) -
      coef(fit2, matrix = TRUE))) # Should be 0
names(fit1@extra)

## End(Not run)

cens.poisson Censored Poisson Family Function

Description
Family function for a censored Poisson response.

Usage
cens.poisson(link = "loglink", imu = NULL,
         biglambda = 10, smallno = 1e-10)

Arguments
- **link**: Link function applied to the mean; see Links for more choices.
- **imu**: Optional initial value; see CommonVGAMffArguments for more information.
- **biglambda, smallno**: Used to help robustify the code when lambda is very large and the ppois value is so close to 0 that the first derivative is computed to be a NA or NaN. When this occurs mills.ratio is called.

Details
Often a table of Poisson counts has an entry \( J^+ \) meaning \( J \geq J \). This family function is similar to poissonff but handles such censored data. The input requires SurvS4. Only a univariate response is allowed. The Newton-Raphson algorithm is used.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning
As the response is discrete, care is required with Surv, especially with "interval" censored data because of the (start, end] format. See the examples below. The examples have \( y < L \) as left censored and \( y \geq U \) (formatted as \( U^+ \)) as right censored observations, therefore \( L \leq y < U \) is for uncensored and/or interval censored observations. Consequently the input must be tweaked to conform to the (start, end] format.

A bit of attention has been directed to try robustify the code when lambda is very large, however this currently works for left and right censored data only, not interval censored data. Sometimes the fix involves an approximation, hence it is a good idea to set trace = TRUE.
Note

The function `poissonff` should be used when there are no censored observations. Also, NAs are not permitted with `SurvS4`, nor is `type = "counting"`.

Author(s)

Thomas W. Yee

References

See `survival` for background.

See Also

`SurvS4, poissonff, Links, mills.ratio`.

Examples

```r
# Example 1: right censored data
set.seed(123); U <- 20
cdata <- data.frame(y = rpois(N <- 100, exp(3)))
cdata <- transform(cdata, cy = pmin(U, y),
                    rcensored = (y >= U))
cdata <- transform(cdata, status = ifelse(rcensored, 0, 1))
with(cdata, table(cy))
with(cdata, table(rcensored))
with(cdata, table(print(SurvS4(cy, status)))) # Check; U+ means >= U
fit <- vglm(SurvS4(cy, status) ~ 1, cens.poisson, data = cdata,
            trace = TRUE)
coef(fit, matrix = TRUE)
with(cdata, table(print(depvar(fit)))) # Another check; U+ means >= U

# Example 2: left censored data
L <- 15
cdata <- transform(cdata,
                    cY = pmax(L, y),
                    lcensored = y < L) # Note y < L, not cY == L or y <= L
cdata <- transform(cdata, status = ifelse(lcensored, 0, 1))
with(cdata, table(cY))
with(cdata, table(lcensored))
with(cdata, table(print(SurvS4(cY, status, type = "left")))) # Check
fit <- vglm(SurvS4(cY, status, type = "left") ~ 1, cens.poisson,
            data = cdata, trace = TRUE)
coef(fit, matrix = TRUE)

# Example 3: interval censored data
cdata <- transform(cdata, Lvec = rep(L, len = N),
                    Uvec = rep(U, len = N))
cdata <- transform(cdata,
                    icensored = Lvec <= y & y < Uvec) # Not lensored or rcensored
with(cdata, table(icensored))
```
cdata <- transform(cdata, status = rep(3, N)) # 3 == interval censored
cdata <- transform(cdata,
  status = ifelse(rcensored, 0, status)) # 0 means right censored
cdata <- transform(cdata,
  status = ifelse(lcensored, 2, status)) # 2 means left censored
# Have to adjust Lvec and Uvec because of the (start, end] format:
cdata$Lvec[with(cdata, incensored)] <- cdata$Lvec[with(cdata, incensored)]-1
cdata$Uvec[with(cdata, incensored)] <- cdata$Uvec[with(cdata, incensored)]-1
# Unchanged:
cdata$Lvec[with(cdata, lcensored)] <- cdata$Lvec[with(cdata, lcensored)]
cdata$Lvec[with(cdata, rcensored)] <- cdata$Lvec[with(cdata, rcensored)]
cdata$Uvec[with(cdata, lcensored)] <- cdata$Uvec[with(cdata, rcensored)]
with(cdata, # Check
table(ii <- print(SurvS4(Lvec, Uvec, status, type = "interval"))))
fit <- glm(SurvS4(Lvec, Uvec, status, type = "interval") ~ 1,
cens.poisson, data = cdata, trace = TRUE)
coef(fit, matrix = TRUE) # Another check
table(print(depvar(fit))) # Another check

# Example 4: Add in some uncensored observations
index <- (1:N)[with(cdata, incensored)]
index <- head(index, 4)
cdata$status[index] <- 1 # actual or uncensored value
cdata$Lvec[index] <- cdata$y[index]
with(cdata, table(ii <- print(SurvS4(Lvec, Uvec, status,
  type = "interval")))) # Check
fit <- glm(SurvS4(Lvec, Uvec, status, type = "interval") ~ 1,
cens.poisson, data = cdata, trace = TRUE, crit = "c")
coef(fit, matrix = TRUE)
table(print(depvar(fit))) # Another check

---

**cfibrosis**  
*Cystic Fibrosis Data*

**Description**

This data frame concerns families data and cystic fibrosis.

**Usage**

```r
data(cfibrosis)
```

**Format**

A data frame with 24 rows on the following 4 variables.

**siblings, affected, ascertained, families** Over ascertainment families, the \( k \)th ascertainment family has \( s_k \) siblings of whom \( r_k \) are affected and \( a_k \) are ascertained.
Details

The data set allows a classical segregation analysis to be performed. In particular, to test Mendelian segregation ratios in nuclear family data. The likelihood has similarities with seq2binomial.

Source

The data is originally from Crow (1965) and appears as Table 2.3 of Lange (2002).


Examples

cfibrosis
summary(cfibrosis)

cgo

Redirects the user to cqo

Description

Redirects the user to the function cqo.

Usage

cgo(...)

Arguments

...  Ignored.

Details

The former function cgo has been renamed cqo because CGO (for canonical Gaussian ordination) is a confusing and inaccurate name. CQO (for constrained quadratic ordination) is better. This new nomenclature described in Yee (2006).

Value

Nothing is returned; an error message is issued.

Warning

The code, therefore, in Yee (2004) will not run without changing the "g" to a "q".
**Author(s)**

Thomas W. Yee

**References**


**See Also**

cqo.

**Examples**

```r
## Not run:
cgo()
## End(Not run)
```

---

**chest.nz**  
*Chest Pain in NZ Adults Data*

**Description**

Presence/absence of chest pain in 10186 New Zealand adults.

**Usage**

data(chest.nz)

**Format**

A data frame with 73 rows and the following 5 variables.

- **age** a numeric vector; age (years).
- **nolnor** a numeric vector of counts; no pain on LHS or RHS.
- **nolr** a numeric vector of counts; no pain on LHS but pain on RHS.
- **lnor** a numeric vector of counts; no pain on RHS but pain on LHS.
- **lr** a numeric vector of counts; pain on LHS and RHS of chest.

**Details**

Each adult was asked their age and whether they experienced any pain or discomfort in their chest over the last six months. If yes, they indicated whether it was on their LHS and/or RHS of their chest.
chinese.nz

Source

Examples
```r
## Not run:
fit <- vgam(cbind(nolnor, nolr, lnor, lr) ~ s(age, c(4, 3)),
            binom2.or(exchan = TRUE, zero = NULL), data = chest.nz)
coef(fit, matrix = TRUE)
## End(Not run)
## Not run: plot(fit, which.cf = 2, se = TRUE)
```

chinese.nz

Chinese Population in New Zealand 1867–2001 Data

Description
The Chinese population in New Zealand from 1867 to 2001, along with the whole of the New Zealand population.

Usage
data(chinese.nz)

Format
A data frame with 27 observations on the following 4 variables.

- **year**  Year.
- **male**  Number of Chinese males.
- **female**  Number of Chinese females.
- **nz**  Total number in the New Zealand population.

Details
Historically, there was a large exodus of Chinese from the Guangdong region starting in the mid-1800s to the gold fields of South Island of New Zealand, California (a region near Mexico), and southern Australia, etc. Discrimination then meant that only men were allowed entry, to hinder permanent settlement. In the case of New Zealand, the government relaxed its immigration laws after WWII to allow wives of Chinese already in NZ to join them because China had been among the Allied powers. Gradual relaxation in the immigration and an influx during the 1980s meant the Chinese population became increasingly demographically normal over time.

The NZ total for the years 1867 and 1871 exclude the Maori population. Three modifications have been made to the female column to make the data internally consistent with the original table.
Examples

```r
## Not run: par(mfrow = c(1, 2))
plot(female / (male + female) ~ year, chinese.nz, type = "b",
     ylab = "Proportion", col = "blue", las = 1,
     cex = 0.015 * sqrt(male + female),
#   cex = 0.10 * sqrt((male + female)^1.5 / sqrt(female) / sqrt(male)),
     main = "Proportion of NZ Chinese that are female")
abline(h = 0.5, lty = "dashed", col = "gray")

fit1.cnz <- vglm(cbind(female, male) ~ year, binomialff,
                 data = chinese.nz)
fit2.cnz <- vglm(cbind(female, male) ~ sm.poly(year, 2), binomialff,
                 data = chinese.nz)
fit4.cnz <- vglm(cbind(female, male) ~ sm.bs(year, 5), binomialff,
                 data = chinese.nz)

lines(fitted(fit1.cnz) ~ year, chinese.nz, col = "purple", lty = 1)
lines(fitted(fit2.cnz) ~ year, chinese.nz, col = "green", lty = 2)
lines(fitted(fit4.cnz) ~ year, chinese.nz, col = "orange", lwd = 2, lty = 1)
legend("bottomright", col = c("purple", "green", "orange"),
       lty = c(1, 2, 1), legend = c("linear", "quadratic", "B-spline"))

plot(100*(male+female)/nz ~ year, chinese.nz, type = "b", ylab = "Percent",
     ylim = c(0, max(100*(male+female)/nz)), col = "blue", las = 1,
     main = "Percent of NZers that are Chinese")
abline(h = 0, lty = "dashed", col = "gray")
## End(Not run)
```

chisq

Chi-squared and Chi Distributions

Description

Maximum likelihood estimation of the degrees of freedom for a chi-squared distribution. Also fits the chi distribution.

Usage

```r
chisq(link = "loglink", zero = NULL, squared = TRUE)
```

Arguments

- `link` See `CommonVGAMffArguments` for information.
- `zero` Logical. Set `FALSE` for the chi distribution.
Details

The degrees of freedom is treated as a real parameter to be estimated and not as an integer. Being positive, a log link is used by default. Fisher scoring is used.

If a random variable has a chi-squared distribution then the square root of the random variable has a chi distribution. For both distributions, the fitted value is the mean.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

Multiple responses are permitted. There may be convergence problems if the degrees of freedom is very large or close to zero.

Author(s)

T. W. Yee

References


See Also

Chisquare, uninormal.

Examples

cdata <- data.frame(x2 = runif(nn <- 1000))
cdata <- transform(cdata, y1 = rchisq(nn, df = exp(1 - 1 * x2)),
                 y2 = rchisq(nn, df = exp(2 - 2 * x2)))
fit <- vglm(cbind(y1, y2) ~ x2, chisq, data = cdata, trace = TRUE)
coef(fit, matrix = TRUE)

clo Redirects the User to rrvglm()
Arguments

... Ignored.

Details

CLO stands for *constrained linear ordination*, and is fitted with a statistical class of models called *reduced-rank vector generalized linear models* (RR-VGLMs). It allows for generalized reduced-rank regression in that response types such as Poisson counts and presence/absence data can be handled.

Currently in the *VGAM* package, *rrvglm* is used to fit RR-VGLMs. However, the Author’s opinion is that linear responses to a latent variable (composite environmental gradient) is not as common as unimodal responses, therefore *cqo* is often more appropriate.

The new CLO/CQO/CAO nomenclature described in Yee (2006).

Value

Nothing is returned; an error message is issued.

Author(s)

Thomas W. Yee

References


See Also

*rrvglm*, *cqo*.

Examples

```r
## Not run:
clo()
## End(Not run)
```
**clogloglink**

*Complementary Log-log Link Function*

## Description

Computes the complementary log-log transformation, including its inverse and the first two derivatives. The complementary log transformation is also computed.

## Usage

```r
clogloglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
cloglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
```

## Arguments

- `theta`: Numeric or character. See below for further details.
- `bvalue`: See Links for general information about links.
- `inverse`, `deriv`, `short`, `tag`
  - Details at Links.

## Details

The complementary log-log link function is commonly used for parameters that lie in the unit interval. But unlike logitlink, probitlink and cauchitlink, this link is not symmetric. It is the inverse CDF of the extreme value (or Gumbel or log-Weibull) distribution. Numerical values of theta close to 0 or 1 or out of range result in Inf, -Inf, NA or NaN.

The complementary log link function is the same as the complementary log-log but the outer log is omitted. This link is suitable for lrho in betabinomial because it handles probability-like parameters but also allows slight negative values in theory. In particular, cloglink safeguards against parameters exceeding unity.

## Value

For `deriv = 0`, the complimentary log-log of theta, i.e., \( \log(-\log(1 - \theta)) \) when `inverse = FALSE`, and if `inverse = TRUE` then \( 1 - \exp(-\exp(\theta)) \).

For `deriv = 1`, then the function returns \( \frac{d}{d\theta} \theta \) as a function of theta if `inverse = FALSE`, else if `inverse = TRUE` then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base \( e \).
Note

Numerical instability may occur when theta is close to 1 or 0. One way of overcoming this is to use bvalue.

Changing 1s to 0s and 0s to 1s in the response means that effectively a loglog link is fitted. That is, transform y by \( 1 - y \). That’s why only one of \texttt{clogloglink} and \texttt{logloglink} is written.

With constrained ordination (e.g., \texttt{cquo} and \texttt{cao}) used with \texttt{binomialff}, a complementary log-log link function is preferred over the default \texttt{logitlink}, for a good reason. See the example below.

In terms of the threshold approach with cumulative probabilities for an ordinal response this link function corresponds to the extreme value distribution.

Author(s)

Thomas W. Yee

References


See Also

\texttt{Links, logitoffsetlink}, \texttt{logitlink}, \texttt{probitlink}, \texttt{cauchitlink}, \texttt{pgumbel}.

Examples

```r
p <- seq(0.01, 0.99, by = 0.01)
clogloglink(p)
max(abs(clogloglink(clogloglink(p), inverse = TRUE) - p)) # Should be 0

p <- c(seq(-0.02, 0.02, by = 0.01), seq(0.97, 1.02, by = 0.01))
clogloglink(p) # Has NAs
clogloglink(p, bvalue = .Machine$double.eps) # Has no NAs
```
family = "binomial", hi.abundance = 5, seed = 123,
Rank = Rank)
fitc <- cqo(attr(mydata, "formula"), I.tol = TRUE, data = mydata,
fam = binomialff(multiple.responses = TRUE, link = "cloglog"),
Rank = Rank)
fitl <- cqo(attr(mydata, "formula"), I.tol = TRUE, data = mydata,
fam = binomialff(multiple.responses = TRUE, link = "logitlink"),
Rank = Rank)

# Compare the fitted models (cols 1 and 3) with the truth (col 2)
cbind(concoef(fitc), attr(mydata, "concoefficients"), concoef(fitl))
## End(Not run)

---

**CM.equid**

*Constraint Matrices for Symmetry, Order, Parallelism, etc.*

**Description**

Given $M$ linear/additive predictors, construct the constraint matrices to allow symmetry, (linear and normal) ordering, etc. in terms such as the intercept.

**Usage**

- `CM.equid(M, Trev = FALSE, Tref = 1)`
- `CM.free(M, Trev = FALSE, Tref = 1)`
- `CM.ones(M, Trev = FALSE, Tref = 1)`
- `CM.symm0(M, Trev = FALSE, Tref = 1)`
- `CM.symm1(M, Trev = FALSE, Tref = 1)`
- `CM.qnorm(M, Trev = FALSE, Tref = 1)`

**Arguments**

- **M** Number of linear/additive predictors, usually $> 1$.
- **Tref** Reference level for the threshold, this should be a single value from $1:M$. This argument is ignored by some of the above functions.
- **Trev** Logical. Apply reverse direction for the thresholds direction? This argument is ignored by some of the above functions.

**Details**

A constraint matrix is $M \times R$ where $R$ is its rank and usually the elements are 0, 1 or $-1$. There is a constraint matrix for each column of the LM matrix used to fit the `vglm`. They are used to apportion the regression coefficients to the linear predictors, e.g., parallelism, exchangeability, etc. The functions described here are intended to construct constraint matrices easily for symmetry constraints and linear ordering etc. They are potentially useful for categorical data analysis (e.g., `cumulative`, `multinomial`), especially for the intercept term. When applied to `cumulative`, they are sometimes called *structured thresholds*, e.g., `ordinal`. 
One example is the stereotype model proposed by Anderson (1984) (see `multinomial` and `rrvglm`) where the elements of the \( A \) matrix are ordered. This is not fully possible in \texttt{VGAM} but some special cases can be fitted, e.g., use \texttt{CM.equid} to create a linear ordering. And \texttt{CM.symm1} might result in fully ordered estimates too, etc.

\texttt{CM.free} creates free or unconstrained estimates. It is almost always the case for VGLMs, and is simply \texttt{diag(M)}.

\texttt{CM.ones} creates equal estimates, which is also known as the \textit{parallelism} assumption in models such as \texttt{cumulative}. It gets its name because the constraint matrix is simply \texttt{matrix(1, M, 1)}.

\texttt{CM.equid} creates equidistant estimates. This is a linear scaling, and the direction and origin are controlled by \texttt{Treverse} and \texttt{Tref} respectively.

\texttt{CM.qnorm} and \texttt{CM.qlogis} are based on \texttt{qnorm} and \texttt{qlogis}. For example, \texttt{CM.qnorm(M)} is essentially \texttt{cbind(qnorm(seq(M) / (M + 1)))}. This might be useful with a model with \texttt{probitlink} applied to multiple intercepts.

Further details can be found at \texttt{cumulative} and \texttt{CommonVGAMffArguments},

\textbf{Value}

A constraint matrix.

\textbf{See Also}

\texttt{CommonVGAMffArguments, cumulative, acat, cratio, sratio, multinomial}.

\textbf{Examples}

\begin{verbatim}
CM.equid(4)
CM.equid(4, Trev = TRUE, Tref = 3)
CM.symm1(5)
CM.symm0(5)
CM.qnorm(5)
\end{verbatim}

\textbf{coalminers} 

\textit{Breathlessness and Wheeze Amongst Coalminers Data}

\textbf{Description}

Coalminers who are smokers without radiological pneumoconiosis, classified by age, breathlessness and wheeze.

\textbf{Usage}

\begin{verbatim}
data(coalminers)
\end{verbatim}
Format

A data frame with 9 age groups with the following 5 columns.

- **BW**: Counts with breathlessness and wheeze.
- **BnW**: Counts with breathlessness but no wheeze.
- **nBW**: Counts with no breathlessness but wheeze.
- **nBnW**: Counts with neither breathlessness or wheeze.
- **age**: Age of the coal miners (actually, the midpoints of the 5-year category ranges).

Details

The data were published in Ashford and Sowden (1970). A more recent analysis is McCullagh and Nelder (1989, Section 6.6).

Source


References


Examples

```r
str(coalminers)
```

---

**Description**

*Coef* is a generic function which computes model coefficients from objects returned by modelling functions. It is an auxiliary function to `coef` that enables extra capabilities for some specific models.

**Usage**

```r
Coef(object, ...)
```

**Arguments**

- `object`: An object for which the computation of other types of model coefficients or quantities is meaningful.
- `...`: Other arguments fed into the specific methods function of the model.
Details

This function can often be useful for \texttt{vglm} objects with just an intercept term in the RHS of the formula, e.g., \texttt{y \sim 1}. Then often this function will apply the inverse link functions to the parameters. See the example below.

For reduced-rank VGLMs, this function can return the \texttt{A}, \texttt{C} matrices, etc.

For quadratic and additive ordination models, this function can return ecological meaningful quantities such as tolerances, optimums, maximums.

Value

The value returned depends specifically on the methods function invoked.

Warning

This function may not work for all \texttt{VGAM} family functions. You should check your results on some artificial data before applying it to models fitted to real data.

Author(s)

Thomas W. Yee

References


See Also

\texttt{coef}, \texttt{Coef.vlm}, \texttt{Coef.rrvglm}, \texttt{Coef.qrrvglm}, \texttt{depvar}.

Examples

```r
nn <- 1000
bdata <- data.frame(y = rbeta(nn, shape1 = 1, shape2 = 3))  # Original scale
fit <- vglm(y \sim 1, betaR, data = bdata, trace = TRUE)  # Intercept-only model
coef(fit, matrix = TRUE)  # Both on a log scale
Coef(fit)  # On the original scale
```

Description

This methods function returns important matrices etc. of a QO object.

Usage

```r
Coef.qrrvglm(object, varI.latvar = FALSE, refResponse = NULL, ...)
```
Arguments

- **object**: A CQO object. The former has class "qrrvglm".
- **varI.latvar**: Logical indicating whether to scale the site scores (latent variables) to have variance-covariance matrix equal to the rank-\(R\) identity matrix. All models have uncorrelated site scores (latent variables), and this option stretches or shrinks the ordination axes if TRUE. See below for further details.
- **refResponse**: Integer or character. Specifies the *reference response or reference species*. By default, the reference species is found by searching sequentially starting from the first species until a positive-definite tolerance matrix is found. Then this tolerance matrix is transformed to the identity matrix. Then the sites scores (latent variables) are made uncorrelated. See below for further details.

... Currently unused.

Details

If `I.tolerances=TRUE` or `eq.tolerances=TRUE` (and its estimated tolerance matrix is positive-definite) then all species’ tolerances are unity by transformation or by definition, and the spread of the site scores can be compared to them. Vice versa, if one wishes to compare the tolerances with the sites score variability then setting `varI.latvar=TRUE` is more appropriate.

For rank-2 QRR-VGLMs, one of the species can be chosen so that the angle of its major axis and minor axis is zero, i.e., parallel to the ordination axes. This means the effect on the latent vars is independent on that species, and that its tolerance matrix is diagonal. The argument `refResponse` allows one to choose which is the reference species, which must have a positive-definite tolerance matrix, i.e., is bell-shaped. If `refResponse` is not specified, then the code will try to choose some reference species starting from the first species. Although the `refResponse` argument could possibly be offered as an option when fitting the model, it is currently available after fitting the model, e.g., in the functions `Coef.qrrvglm` and `lvplot.qrrvglm`.

Value

The \(A, B_1, C, T, D\) matrices/arrays are returned, along with other slots. The returned object has class "Coef.qrrvglm" (see `Coef.qrrvglm-class`).

Note

Consider an equal-tolerances Poisson/binomial CQO model with \(noRRR = \sim 1\). For \(R = 1\) it has about \(2S + p_2\) parameters. For \(R = 2\) it has about \(3S + 2p_2\) parameters. Here, \(S\) is the number of species, and \(p_2 = p - 1\) is the number of environmental variables making up the latent variable. For an unequal-tolerances Poisson/binomial CQO model with \(noRRR = \sim 1\), it has about \(3S - 1 + p_2\) parameters for \(R = 1\), and about \(6S - 3 + 2p_2\) parameters for \(R = 2\). Since the total number of data points is \(nS\), where \(n\) is the number of sites, it pays to divide the number of data points by the number of parameters to get some idea about how much information the parameters contain.

Author(s)

Thomas W. Yee
References


See Also

cqo, Coef.qrrvglm-class, print.Coef.qrrvglm, lvplot.qrrvglm.

Examples

```r
set.seed(123)
x2 <- rnorm(n <- 100)
x3 <- rnorm(n)
x4 <- rnorm(n)
latvar1 <- 0 + x3 - 2*x4
lambda1 <- exp(3 - 0.5 * (latvar1-0)^2)
lambda2 <- exp(2 - 0.5 * (latvar1-1)^2)
lambda3 <- exp(2 - 0.5 * ((latvar1+4)/2)^2)  # Unequal tolerances
y1 <- rpois(n, lambda1)
y2 <- rpois(n, lambda2)
y3 <- rpois(n, lambda3)
set.seed(111)
## Not run: lvplot(p1, y = TRUE, lcol = 1:3, pch = 1:3, pcol = 1:3)
# vvv Coef(p1)
# vvv print(Coef(p1), digits=3)
```

---

**Coef.qrrvglm-class**

**Class “Coef.qrrvglm”**

**Description**

The most pertinent matrices and other quantities pertaining to a QRR-VGLM (CQO model).

**Objects from the Class**

Objects can be created by calls of the form `Coef(object,...)` where `object` is an object of class "qrrvglm" (created by `cqo`).

In this document, \( R \) is the rank, \( M \) is the number of linear predictors and \( n \) is the number of observations.
Slots

A: Of class "matrix", A, which are the linear ‘coefficients’ of the matrix of latent variables. It is $M$ by $R$.

B1: Of class "matrix", B1. These correspond to terms of the argument noRRR.

C: Of class "matrix", C, the canonical coefficients. It has $R$ columns.

Constrained: Logical. Whether the model is a constrained ordination model.

D: Of class "array", $D[,,j]$ is an order-Rank matrix, for $j = 1, \ldots, M$. Ideally, these are negative-definite in order to make the response curves/surfaces bell-shaped.

Rank: The rank (dimension, number of latent variables) of the RR-VGLM. Called $R$.

latvar: $n$ by $R$ matrix of latent variable values.

latvar.order: Of class "matrix", the permutation returned when the function order is applied to each column of latvar. This enables each column of latvar to be easily sorted.

Maximum: Of class "numeric", the $M$ maximum fitted values. That is, the fitted values at the optimums for noRRR = ~1 models. If noRRR is not ~1 then these will be NAs.

NOS: Number of species.

Optimum: Of class "matrix", the values of the latent variables where the optimums are. If the curves are not bell-shaped, then the value will be NA or NaN.

Optimum.order: Of class "matrix", the permutation returned when the function order is applied to each column of Optimum. This enables each row of Optimum to be easily sorted.

bellshaped: Vector of logicals: is each response curve/surface bell-shaped?

dispersion: Dispersion parameter(s).

Dzero: Vector of logicals, is each of the response curves linear in the latent variable(s)? It will be if and only if $D[,,j]$ equals $O$, for $j = 1, \ldots, M$.

Tolerance: Object of class "array", $Tolerance[,,j]$ is an order-Rank matrix, for $j = 1, \ldots, M$, being the matrix of tolerances (squared if on the diagonal). These are denoted by $T$ in Yee (2004). Ideally, these are positive-definite in order to make the response curves/surfaces bell-shaped. The tolerance matrices satisfy $T_s = -\frac{1}{2}D_s^{-1}$.

Author(s)

Thomas W. Yee

References


See Also

Coef.qrrvglm, cqo, print.Coef.qrrvglm.
Examples

```r
x2 <- rnorm(n <- 100)
x3 <- rnorm(n)
x4 <- rnorm(n)
latvar1 <- 0 + x3 - 2*x4
lambda1 <- exp(3 - 0.5 * ( latvar1-0)^2)
lambda2 <- exp(2 - 0.5 * ( latvar1-1)^2)
lambda3 <- exp(2 - 0.5 * ((latvar1+4)/2)^2)
y1 <- rpois(n, lambda1)
y2 <- rpois(n, lambda2)
y3 <- rpois(n, lambda3)
yy <- cbind(y1, y2, y3)
## Not run:
lvplot(p1, y = TRUE, lcol = 1:3, pch = 1:3, pcol = 1:3)
## End(Not run)
```

Description

This methods function returns important matrices etc. of a RR-VGLM object.

Usage

```r
Coef.rrvglm(object, ...)
```

Arguments

- `object` An object of class "rrvglm".
- `...` Currently unused.

Details

The A, B1, C matrices are returned, along with other slots. See `rrvglm` for details about RR-VGLMs.

Value

An object of class "Coef.rrvglm" (see `Coef.rrvglm-class`).

Note

This function is an alternative to `coef.rrvglm`. 

Coef.rrvglm Returns Important Matrices etc. of a RR-VGLM Object
Author(s)
Thomas W. Yee

References

See Also
`Coef.rrvglm-class`, `print.Coef.rrvglm`, `rrvglm`.

Examples
```r
# Rank-1 stereotype model of Anderson (1984)
pneumo <- transform(pneumo, let = log(exposure.time), x3 = runif(nrow(pneumo)))
fit <- rrvglm(cbind(normal, mild, severe) ~ let + x3, multinomial, data = pneumo)
coef(fit, matrix = TRUE)
Coef(fit)
```

Description
The most pertinent matrices and other quantities pertaining to a RR-VGLM.

Objects from the Class
Objects can be created by calls of the form `Coef(object, ...)` where `object` is an object of class `rrvglm` (see `rrvglm-class`).

In this document, $M$ is the number of linear predictors and $n$ is the number of observations.

Slots
- `A`: Of class "matrix", $A$.
- `C`: Of class "matrix", $C$.
- `rank`: The rank of the RR-VGLM.
- `colx1.index`: Index of the columns of the "vlm"-type model matrix corresponding to the variables in $x1$. These correspond to $B1$.
- `colx2.index`: Index of the columns of the "vlm"-type model matrix corresponding to the variables in $x2$. These correspond to the reduced-rank regression.
- `Atilde`: Object of class "matrix", the $A$ matrix with the corner rows removed. Thus each of the elements have been estimated. This matrix is returned only if corner constraints were used.
Author(s)
Thomas W. Yee

References

See Also
Coef.rrvglm, rrvglm, rrvglm-class, print.Coef.rrvglm.

Examples
```r
# Rank-1 stereotype model of Anderson (1984)
pneumo <- transform(pneumo, let = log(exposure.time), x3 = runif(nrow(pneumo)))
fit <- rrvglm(cbind(normal, mild, severe) ~ let + x3, multinomial, data = pneumo)
coef(fit, matrix = TRUE)
Coef(fit)
# print(Coef(fit), digits = 3)
```

---

**Coef.vlm**

*Extract Model Coefficients for VLM Objects*

**Description**
Amongst other things, this function applies inverse link functions to the parameters of intercept-only VGLMs.

**Usage**

```r
Coef.vlm(object, ...)
```

**Arguments**

- `object` A fitted model.
- `...` Arguments which may be passed into `coef`.

**Details**
Most VGAM family functions apply a link function to the parameters, e.g., positive parameter are often have a log link, parameters between 0 and 1 have a logit link. This function can back-transform the parameter estimate to the original scale.

**Value**
For intercept-only models (e.g., formula is `y ~ 1`) the back-transformed parameter estimates can be returned.
Warning
This function may not work for all VGAM family functions. You should check your results on some artificial data before applying it to models fitted to real data.

Author(s)
Thomas W. Yee

References

See Also
Coef, coef.

Examples
```
set.seed(123); nn <- 1000
bdata <- data.frame(y = rbeta(nn, shape1 = 1, shape2 = 3))
fit <- vglm(y ~ 1, betaff, data = bdata, trace = TRUE) # intercept-only model
coef(fit, matrix = TRUE) # log scale
Coef(fit) # On the original scale
```

---

**cofvgam**

*Extract Model Coefficients of a vgam() Object*

**Description**

Extracts the estimated coefficients from vgam() objects.

**Usage**

```
cofvgam(object, type = c("linear", "nonlinear"), ...)
```

**Arguments**

- **object**
  A vgam object.
- **type**
  Character. The default is the first choice.
- **...**
  Optional arguments fed into coefvlm.

**Details**

For VGAMs, because modified backfitting is performed, each fitted function is decomposed into a linear and nonlinear (smooth) part. The argument type is used to return which one is wanted.
Value

A vector if type = "linear". A list if type = "nonlinear", and each component of this list corresponds to an s term; the component contains an S4 object with slot names such as "Bcoefficients", "knots", "xmin", "xmax".

Author(s)

Thomas W. Yee

See Also

vgam, coefvlm, coef.

Examples

fit <- vgam(agaauas ~ s(altitude, df = 2), binomialff, data = hunua)
coef(fit)  # Same as coef(fit, type = "linear")
(ii <- coef(fit, type = "nonlinear"))
is.list(ii)
names(ii)
slotNames(ii[[1]])

coefvlm

Extract Model Coefficients

Description

Extracts the estimated coefficients from VLM objects such as VGLMs.

Usage

coefvlm(object, matrix.out = FALSE, label = TRUE, colon = FALSE, ...)

Arguments

object An object for which the extraction of coefficients is meaningful. This will usually be a vglm object.
matrix.out Logical. If TRUE then a matrix is returned. The explanatory variables are the rows. The linear/additive predictors are the columns. The constraint matrices are used to compute this matrix.
label Logical. If FALSE then the names of the vector of coefficients are set to NULL.
colon Logical. Explanatory variables which appear in more than one linear/additive predictor are labelled with a colon, e.g., age:1, age:2. However, if it only appears in one linear/additive predictor then the :1 is omitted by default. Then setting colon = TRUE will add the :1.
... Currently unused.
Details

This function works in a similar way to applying coef() to a \texttt{lm} or \texttt{glm} object. However, for VGLMs, there are more options available.

Value

A vector usually. A matrix if \texttt{matrix.out} = \texttt{TRUE}.

Author(s)

Thomas W. Yee

References


See Also

\texttt{vglm}, \texttt{coefvgam}, \texttt{coef}.

Examples

```r
zdata <- data.frame(x2 = runif(nn <- 200))
zdata <- transform(zdata, pstr0 = logitlink(-0.5 + 1*x2, inverse = TRUE),
                    lambda = loglink( 0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata, y2 = rzipois(nn, lambda, pstr0 = pstr0))
fit2 <- vglm(y2 ~ x2, zipoisson(zero = 1), data = zdata, trace = TRUE)
coef(fit2, matrix = TRUE) # Always a good idea
coef(fit2)
coef(fit2, colon = TRUE)
```

Description

Here is a description of some common and typical arguments found in many \texttt{VGAM} family functions, e.g., \texttt{zero}, \texttt{lsigma}, \texttt{isigma}, \texttt{gsigma}, \texttt{eq.mean}, \texttt{nsimEI} and \texttt{parallel}.

Usage

```r
TypicalVGAMfamilyFunction(ls\texttt{sigma} = "loglink",
                           is\texttt{igma} = \texttt{NULL},
                           zero = \texttt{NULL}, gs\texttt{igma} = exp(-5:5),
                           eq\texttt{mean} = \texttt{FALSE},
                           parallel = \texttt{TRUE},
                           ...
```

(End of Document)
Arguments

lsigma Character. Link function applied to a parameter and not necessarily a mean. See Links for a selection of choices. If there is only one parameter then this argument is often called link.

isigma Optional initial values can often be inputted using an argument beginning with "i". For example, "isigma" and "ilocation", or just "init" if there is one parameter. A value of NULL means a value is computed internally, i.e., a self-starting VGAM family function. If a failure to converge occurs make use of these types of arguments.

type.fitted = c("mean", "quantiles", "Qlink", "pobs0", "pstr0", "onempstr0"),
percentiles = c(25, 50, 75),
probs.x = c(0.15, 0.85),
probs.y = c(0.25, 0.50, 0.75),
multiple.responses = FALSE, earg.link = FALSE,
isshrinkage = 0.95, nointercept = NULL,
whitespace = FALSE, bred = FALSE, lss = TRUE,
oim = FALSE, nsimEIM = 100, byrow.arg = FALSE,
link.list = list("(Default)" = "identitylink",
x2 = "loglink",
x3 = "logitlink",
x4 = "multilogitlink",
x5 = "multilogitlink"),
earg.list = list("(Default)" = list(),
x2 = list(),
x3 = list(offset = -1),
x4 = list(),
x5 = list()),
Thresh = NULL, nrfs = 1)

Some VGAM family functions allow the zero argument to accept negative values; if so then its absolute value is recycled over each (usual) response. For example, zero = -2 for the two-parameter negative binomial distribution would mean, for each response, the second linear/additive predictor is modelled as intercepts-only. That is, for all the $k$ parameters in negbinomial (this VGAM family function can handle a matrix of responses).
Suppose \( \text{zero} = \text{zerovec} \) where \( \text{zerovec} \) is a vector of negative values. If \( G \) is the usual \( M \) value for a univariate response then the actual values for argument \( \text{zero} \) are all values in \( c(\text{abs}(\text{zerovec}), G + \text{abs}(\text{zerovec}), 2G + \text{abs}(\text{zerovec}), \ldots) \) lying in the integer range 1 to \( M \). For example, setting \( \text{zero} = -c(2, 3) \) for a matrix response of 4 columns with \text{zinegbinomial} (which usually has \( G = M = 3 \) for a univariate response) would be equivalent to \( \text{zero} = c(2, 3, 5, 6, 8, 9, 11, 12) \). This example has \( M = 12 \). Note that if \( \text{zerovec} \) contains negative values then their absolute values should be elements from the set 1:G.

Note: \( \text{zero} \) may have positive and negative values, for example, setting \( \text{zero} = c(-2, 3) \) in the above example would be equivalent to \( \text{zero} = c(2, 3, 5, 8, 11) \).

The argument \( \text{zero} \) also accepts a character vector (for \text{VGAM} 1.0-1 onwards). Each value is fed into \text{grep} with \text{fixed} = \text{TRUE}, meaning that wildcards "*" are not useful. See the example below—all the variants work; those with \text{LOCAT} issue a warning that that value is unmatched. Importantly, the parameter names are \( c("\text{location1}","\text{scale1}","\text{location2}","\text{scale2})\) because there are 2 responses. Yee (2015) described \( \text{zero} \) for only numerical input. Allowing character input is particularly important when the number of parameters cannot be determined without having the actual data first. For example, with time series data, an ARMA\((p,q)\) process might have parameters \( \theta_1, \ldots, \theta_p \) which should be intercept-only by default. Then specifying a numerical default value for \( \text{zero} \) would be too difficult (there are the drift and scale parameters too). However, it is possible with the character representation: \( \text{zero} = "\text{theta}" \) would achieve this. In the future, most \text{VGAM} family functions might be converted to the character representation—the advantage being that it is more readable. When programming a \text{VGAM} family function that allows character input, the variable \text{predictors.names} must be assigned correctly.

If the constraints argument is used then the family function’s \( \text{zero} \) argument (if it exists) needs to be set to \text{NULL}. This avoids what could be a probable contradiction. Sometimes setting other arguments related to constraint matrices to \text{FALSE} is also a good idea, e.g., \text{parallel} = \text{FALSE}, \text{exchangeable} = \text{FALSE}.

### gsigma

Grid-search initial values can be inputted using an argument beginning with "g", e.g., "gsigma", "gshape" and "gscale". If argument \text{isigma} is inputted then that has precedence over \text{gsigma}, etc. If the grid search is 2-dimensional then it is advisable not to make the vectors too long as a nested for loop may be used. Ditto for 3-dimensions etc. Sometimes a ".mux" is added as a suffix, e.g., gshape.mux; this means that the grid is created relatively and not absolutely, e.g., its values are multiplied by some single initial estimate of the parameter in order to create the grid on an absolute scale.

Some family functions have an argument called \text{gprobs}.y. This is fed into the \text{probs} argument of \text{quantile} in order to obtain some values of central tendency of the response, i.e., some spread of values in the middle. When \text{imethod} = 1 to obtain an initial value for the mean Some family functions have an argument called \text{iprobs}.y, and if so, then these values can overwrite \text{gprobs}.y.

### eq.mean

Logical. Constrain all the means to be equal? This type of argument is simpler than \text{parallel} because only a single \text{TRUE} or \text{FALSE} can be assigned and not a formula. Thus if \text{TRUE} then it will be enforced over all variables.
parallel

A logical, or a simple formula specifying which terms have equal/unequal coefficients. The formula must be simple, i.e., additive with simple main effects terms. Interactions and nesting etc. are not handled. To handle complex formulas use the constraints argument (of vglm etc.); however, there is a lot more setting up involved and things will not be as convenient.

Here are some examples. 1. parallel = TRUE ~ x2 + x5 means the parallelism assumption is only applied to $X_2$, $X_5$ and the intercept. 2. parallel = TRUE ~ -1 and parallel = TRUE ~ 0 mean the parallelism assumption is applied to no variables at all. Similarly, parallel = FALSE ~ -1 and parallel = FALSE ~ 0 mean the parallelism assumption is applied to all the variables including the intercept. 3. parallel = FALSE ~ x2 - 1 and parallel = FALSE ~ x2 + 0 applies the parallelism constraint to all terms (including the intercept) except for $X_2$. 4. parallel = FALSE ~ x2 * x3 probably will not work. Instead, expand it out manually to get parallel = FALSE ~ x2 + x3 + x2:x3, and that should work. That’s because the main formula processes or expands the "*" operator but parallel does not. 5. To check whether parallel has done what was expected, type coef(fit, matrix = TRUE) or constraints(fit) for confirmation.

This argument is common in VGAM family functions for categorical responses, e.g., cumulative, acat, cratio, sratio. For the proportional odds model (cumulative) having parallel constraints applied to each explanatory variable (except for the intercepts) means the fitted probabilities do not become negative or greater than 1. However this parallelism or proportional-odds assumption ought to be checked.

nsimEIM

Some VGAM family functions use simulation to obtain an approximate expected information matrix (EIM). For those that do, the nsimEIM argument specifies the number of random variates used per observation; the mean of nsimEIM random variates is taken. Thus nsimEIM controls the accuracy and a larger value may be necessary if the EIMs are not positive-definite. For intercept-only models (y ~ 1) the value of nsimEIM can be smaller (since the common value used is also then taken as the mean over the observations), especially if the number of observations is large.

Some VGAM family functions provide two algorithms for estimating the EIM. If applicable, set nsimEIM = NULL to choose the other algorithm.

imethod

An integer with value 1 or 2 or 3 or ... which specifies the initialization method for some parameters or a specific parameter. If failure to converge occurs try the next higher value, and continue until success. For example, imethod = 1 might be the method of moments, and imethod = 2 might be another method. If no value of imethod works then it will be necessary to use arguments such as isigma. For many VGAM family functions it is advisable to try this argument with all possible values to safeguard against problems such as converging to a local solution. VGAM family functions with this argument usually correspond to a model or distribution that is relatively hard to fit successfully, therefore care is needed to ensure the global solution is obtained. So using all possible values that this argument supplies is a good idea.

VGAM family functions such genpoisson2 recycle imethod to be of length 2 corresponding to the 2 parameters. In the future, this feature will be extended to other family functions to confer more flexibility.
**Form2**

Formula. Using applied to models with \( M = 2 \). Specifies the terms for \( \eta_2 \) and the other terms belong to \( \eta_1 \). It is a way to partition the \( X \) matrix into two sets of covariates, where they are assigned to each \( \eta_j \) separately. This argument sets up constraint matrices \( rbind(0, 1) \) for terms in Form2 and \( rbind(1, 0) \) for \( \text{setdiff(formula, Form2)} \) so to speak. Note that sometimes this argument is only accessed if \( vfl = \text{TRUE} \). Arguments such as \( \text{Form1} \) and \( \text{Form3} \) are also possible in \text{VGAM} family functions because the \( \eta_j \) which is likely to be modelled more simply is chosen for convenience.

**vfl**

A single logical. This stands for variance–variance factored loglinear (VFL) model. If \( \text{TRUE} \) then usually some other argument such as \( \text{Form2} \) or \( \text{parallel} \) is used to partition the main \text{vglm} formula into two sets of covariates. For some families such as \text{negbinomial} this enables overdispersion to be modelled conveniently via a loglinear model, given the mean. It is necessary to read the online help regarding each \text{VGAM} family function because each one may different from others. To fit some VFL models it is necessary to make a copy of existing covariates by creating new variable names and then adding it to the main formula.

A good question is: why is \( vfl \) necessary? Wouldn’t \( \text{Form2} \) be sufficient? Setting \( vfl = \text{TRUE} \) enables some internal checking such as avoiding conflicts. For example, it is often necessary to set \( \text{zero} = \text{NULL} \) and \( \text{parallel} = \text{FALSE} \), otherwise there would be contradictions.

**type.fitted**

Character. Type of fitted value returned by the \text{fitted()} methods function. The first choice is always the default. The available choices depends on what kind of family function it is. Using the first few letters of the chosen choice is okay. See \text{fittedvlm} for more details.

The choice "Qlink" refers to quantile-links, which was introduced in December 2018 in \text{VGAMextra} 0.0-2 for several 1-parameter distributions. Here, either the \text{loglink} or \text{logitlink} or \text{identitylink} of the quantile is the link function (and the choice is dependent on the support of the distribution), and link functions end in "Qlink". A limited amount of support is provided for such links, e.g., \text{fitted(fit)} are the fitted quantiles, which is the same as \text{predict(fit, type = "response")}. However, \text{fitted(fit, percentiles = 77)} will not work.

**percentiles**

Numeric vector, with values between 0 and 100 (although it is not recommended that exactly 0 or 100 be inputted). Used only if \( \text{type.fitted} = \text{"quantiles"} \) or \( \text{type.fitted} = \text{"percentiles"} \), then this argument specifies the values of these quantiles. The argument name tries to reinforce that the values lie between 0 and 100. See \text{fittedvlm} for more details.

**probs.x, probs.y**

Numeric, with values in (0, 1). The probabilities that define quantiles with respect to some vector, usually an \( x \) or \( y \) of some sort. This is used to create two subsets of data corresponding to ‘low’ and ‘high’ values of \( x \) or \( y \). Each value is separately fed into the \text{probs} argument of \text{quantile}. If the data set size is small then it may be necessary to increase/decrease slightly the first/second values respectively.

**lss**

Logical. This stands for the ordering: location, scale and shape. Should the ordering of the parameters be in this order? Almost all \text{VGAM} family functions
have this order by default, but in order to match the arguments of existing R functions, one might need to set lss = FALSE. For example, the arguments of \texttt{weibullR} are scale and shape, whereas \texttt{rweibull} are shape and scale. As a temporary measure (from \texttt{VGAM 0.9-7} onwards but prior to version 1.0-0), some family functions such as \texttt{sinmad} have an lss argument without a default. For these, setting lss = FALSE will work. Later, lss = TRUE will be the default. Be careful for the dpqr-type functions, e.g., \texttt{rsinmad}.

\textbf{Thresh}  
\textit{Thresholds} is another name for the intercepts, e.g., for categorical models. They may be constrained by functions such as \texttt{CM.equid} and \texttt{CM.qnorm}. The string "CM." and the Thresh argument is pasted and then that function is called to obtain the constraint matrix for the intercept term. So Thresh = "free", Thresh = "equid", Thresh = "qnorm", Thresh = "symm0", Thresh = "symm1" etc. are possibilities. Families that use this include \texttt{multinomial}, \texttt{cratio}, \texttt{sratio}, \texttt{cumulative}, \texttt{acat}.

\textbf{whitespace}  
Logical. Should white spaces (" ") be used in the labelling of the linear/additive predictors? Setting TRUE usually results in more readability but it occupies more columns of the output.

\textbf{oim}  
Logical. Should the observed information matrices (OIMs) be used for the working weights? In general, setting oim = TRUE means the Newton-Raphson algorithm, and oim = FALSE means Fisher-scoring. The latter uses the EIM, and is usually recommended. If oim = TRUE then nSIMEIM is ignored.

\textbf{nrfs}  
Numeric, a value in \([0,1]\). Experimental argument for allowing a mixture of Newton-Raphson and Fisher scoring. The working weights are taken as a linear combination of the two. If \texttt{nrfs} = 0 then Newton-Raphson is used, i.e., the OIM is wholly used. If \texttt{nrfs} = 1 then Fisher scoring is used, i.e., the EIM is wholly used. If convergence is successful then one might expect Newton-Raphson to be faster than Fisher scoring because the former has an order-2 convergence rate while the latter has a linear rate.

\textbf{multiple.responses}  
Logical. Some \texttt{VGAM} family functions allow a multivariate or vector response. If so, then usually the response is a matrix with columns corresponding to the individual response variables. They are all fitted simultaneously. Arguments such as \texttt{parallel} may then be useful to allow for relationships between the regressions of each response variable. If \texttt{multiple.responses} = TRUE then sometimes the response is interpreted differently, e.g., \texttt{posbinomial} chooses the first column of a matrix response as success and combines the other columns as failure, but when \texttt{multiple.responses} = TRUE then each column of the response matrix is the number of successes and the weights argument is of the same dimension as the response and contains the number of trials.

\textbf{earg.link}  
This argument should be generally ignored.

\textbf{byrow.arg}  
Logical. Some \texttt{VGAM} family functions that handle multiple responses have arguments that allow input to be fed in which affect all the responses, e.g., \texttt{imu} for initializing a mu parameter. In such cases it is sometime more convenient to input one value per response by setting \texttt{byrow.arg} = TRUE; then values are recycled in order to form a matrix of the appropriate dimension. This argument
matches byrow in `matrix`; in fact it is fed into such using `matrix(..., byrow = byrow.arg)`. This argument has no effect when there is one response.

**ishrinkage**  
Shrinkage factor $s$ used for obtaining initial values. Numeric, between 0 and 1. In general, the formula used is something like $s\mu + (1 - s)y$ where $\mu$ is a measure of central tendency such as a weighted mean or median, and $y$ is the response vector. For example, the initial values are slight perturbations of the mean towards the actual data. For many types of models this method seems to work well and is often reasonably robust to outliers in the response. Often this argument is only used if the argument `imethod` is assigned a certain value.

**nointercept**  
An integer-valued vector specifying which linear/additive predictors have no intercepts. Any values must be from the set \{1,2,...,M\}. A value of `NULL` means no such constraints.

**bred**  
Logical. Some VGAM family functions will allow bias-reduction based on the work by Kosmidis and Firth. Sometimes half-stepping is a good idea; set stepsize = 0.5 and monitor convergence by setting `trace = TRUE`.

**link.list, earg.list**  
Some VGAM family functions (such as `normal.vcm`) implement models with potentially lots of parameter link functions. These two arguments allow many such links and extra arguments to be inputted more easily. One has something like `link.list = list("(Default)" = "identitylink", x2 = "loglink", x3 = "logofflink")` and `earg.list = list("(Default)" = list(), x2 = list(), x3 = "list(offset = -1)")`. Then any unnamed terms will have the default link with its corresponding extra argument. Note: the `multilogitlink` link is also possible, and if so, at least two instances of it are necessary. Then the last term is the baseline/reference group.

**Details**

Full details will be given in documentation yet to be written, at a later date! A general recommendation is to set `trace = TRUE` whenever any model fitting is done, since monitoring convergence is usually very informative.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Warning**

The `zero` argument is supplied for convenience but conflicts can arise with other arguments, e.g., the constraints argument of `vglm` and `vgam`. See Example 5 below for an example. If not sure, use, e.g., `constraints(fit)` and `coef(fit, matrix = TRUE)` to check the result of a fit `fit`.

The arguments `zero` and `nointercept` can be inputted with values that fail. For example, `multinomial(zero = 2, nointercept = 1:3)` means the second linear/additive predictor is identically zero, which will cause a failure.

Be careful about the use of other potentially contradictory constraints, e.g., `multinomial(zero = 2, parallel = TRUE ~ x3)`. If in doubt, apply `constraints()` to the fitted object to check.
VGAM family functions with the nsimEIM may have inaccurate working weight matrices. If so, then the standard errors of the regression coefficients may be inaccurate. Thus output from summary(fit), vcov(fit), etc. may be misleading.

Changes relating to the lss argument have very important consequences and users must beware. Good programming style is to rely on the argument names and not on the order.

Author(s)

T. W. Yee

References


See Also

Links, vglm, vgam, vglmff-class, UtilitiesVGAM, multilogitlink, multinomial, VGAMextra.

Examples

# Example 1
cumulative()
cumulative(link = "probitlink", reverse = TRUE, parallel = TRUE)

# Example 2
wdata <- data.frame(x2 = runif(nn <- 1000))
wdata <- transform(wdata,
    y = rweibull(nn, shape = 2 + exp(1 + x2), scale = exp(-0.5)))
fit <- vglm(y ~ x2, weibullR(lshape = logofflink(offset = -2), zero = 2),
            data = wdata)
coef(fit, mat = TRUE)

# Example 3; multivariate (multiple) response
## Not run:
ndata <- data.frame(x = runif(nn <- 500))
ndata <- transform(ndata,
    y1 = rnbinom(nn, exp(1), mu = exp(3+x)), # k is size
    y2 = rnbinom(nn, exp(0), mu = exp(2-x)))
fit <- vglm(cbind(y1, y2) ~ x, negbinomial(zero = -2), ndata)
coef(fit, matrix = TRUE)
## End(Not run)

# Example 4
## Not run:
# fit1 and fit2 are equivalent
fit1 <- vglm(ymatrix ~ x2 + x3 + x4 + x5,
            cumulative(parallel = FALSE ~ 1 + x3 + x5), cdata)
fit2 <- vglm(ymatrix ~ x2 + x3 + x4 + x5,
            cumulative(parallel = TRUE ~ x2 + x4), cdata)
## End(Not run)

# Example 5
udata <- data.frame(x2 = rnorm(nn <- 200))
udata <- transform(udata,
                   x1copy = 1, # Copy of the intercept
                   x3 = runif(nn),
                   y1 = rnorm(nn, 1 - 3*x2, sd = exp(1 + 0.2*x2)),
                   y2 = rnorm(nn, 1 - 3*x2, sd = exp(1)))
args(uninormal)
fit1 <- vglm(y1 ~ x2, uninormal, udata) # This is okay
fit2 <- vglm(y2 ~ x2, uninormal(zero = 2), udata) # This is okay
fit4 <- vglm(y2 ~ x2 + x1copy + x3,
             uninormal(zero = NULL, vfl = TRUE,
                        Form2 = ~ x1copy + x3 - 1), udata)
coef(fit4, matrix = TRUE) # VFL model

# This creates potential conflict
clist <- list("(Intercept)" = diag(2), "x2" = diag(2))
fit3 <- vglm(y2 ~ x2, uninormal(zero = 2), data = udata,
             constraints = clist) # Conflict!
coef(fit3, matrix = TRUE) # Shows that clist["x2"] was overwritten,
constraints(fit3) # i.e., 'zero' seems to override the 'constraints' arg

# Example 6 ('whitespace' argument)
pneumo <- transform(pneumo, let = log(exposure.time))
fit1 <- vglm(cbind(normal, mild, severe) ~ let,
             sratio(whitespace = FALSE, parallel = TRUE), pneumo)
fit2 <- vglm(cbind(normal, mild, severe) ~ let,
             sratio(whitespace = TRUE, parallel = TRUE), pneumo)
head(predict(fit1), 2) # No white spaces
head(predict(fit2), 2) # Uses white spaces

# Example 7 ('zero' argument with character input)
set.seed(123); n <- 1000
ldata <- data.frame(x2 = runif(n))
ldata <- transform(ldata, y1 = rlogis(n, loc = 5*x2, scale = exp(2)))
ldata <- transform(ldata, y2 = rlogis(n, loc = 5*x2, scale = exp(1*x2)))
ldata <- transform(ldata, w1 = runif(n))
ldata <- transform(ldata, w2 = runif(n))
fit7 <- vglm(cbind(y1, y2) ~ x2,
             logistic(zero = "location1"), # location1 is intercept-only
             logistic(zero = "location2"),
             logistic(zero = "location*"), # Not okay... all is unmatched
             logistic(zero = "scale1"),
             logistic(zero = "scale2"),
concoef

## Description
concoef is a generic function which extracts the constrained (canonical) coefficients from objects returned by certain modelling functions.

## Usage
concoef(object, ...)

## Arguments
- **object**: An object for which the extraction of canonical coefficients is meaningful.
- **...**: Other arguments fed into the specific methods function of the model.

## Details
For constrained quadratic and ordination models, *canonical coefficients* are the elements of the $C$ matrix used to form the latent variables. They are highly interpretable in ecology, and are looked at as weights or loadings. They are also applicable for reduced-rank VGLMs.

## Value
The value returned depends specifically on the methods function invoked.

## Warning
concoef replaces ccoef; the latter is deprecated.

For QO models, there is a direct inverse relationship between the scaling of the latent variables (site scores) and the tolerances. One normalization is for the latent variables to have unit variance. Another normalization is for all the species’ tolerances to be unit (provided `eq.tolerances` is `TRUE`). These two normalizations cannot simultaneously hold in general. For rank $R$ models with $R > 1$ it becomes more complicated because the latent variables are also uncorrelated. An important argument when fitting quadratic ordination models is whether `eq.tolerances` is `TRUE` or `FALSE`. See Yee (2004) for details.
Author(s)

Thomas W. Yee

References


See Also

concoef-method, concoef.qrrvglm, concoef.cao, coef.

Examples

```r
## Not run: set.seed(111) # This leads to the global solution
hspider[,1:6] <- scale(hspider[,1:6]) # Standardized environmental vars
p1 <- cqo(cbind(Alopacce, Alopune, Alopfabr, Arctlute, Arctperi,  
         Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,  
         Trocterr, Zoraspin) ~  
         WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,  
         family = poissonff, data = hspider, Crow1positive = FALSE)
concoef(p1)

## End(Not run)
```
Confidence Intervals for Parameters of VGLMs

Description

Computes confidence intervals (CIs) for one or more parameters in a fitted model. Currently the object must be a "vglm" object.

Usage

confintvglm(object, parm, level = 0.95, method = c("wald", "profile"),
trace = NULL, ...)

Arguments

object A fitted model object.
parm, level, ... Same as confint.
method Character. The default is the first method. Abbreviations are allowed. Currently "profile" is basically working; and it is likely to be more accurate especially for small samples, as it is based on a profile log likelihood, however it is computationally intensive.
trace Logical. If TRUE then one can monitor the computation as it progresses (because it is expensive). The default is the original model’s trace value (see vglm.control). Setting FALSE suppresses all intermediate output.

Details

The default for this methods function is based on confint.default and assumes asymptotic normality. In particular, the coef and vcov methods functions are used for vglm-class objects.

When method = "profile" the function profilevglm is called to do the profiling. The code is very heavily based on profile.glm which was originally written by D. M. Bates and W. N. Venables (For S in 1996) and subsequently corrected by B. D. Ripley. Sometimes the profiling method can give problems, for example, cumulative requires the M linear predictors not to intersect in the data cloud. Such numerical problems are less common when method = "wald", however, it is well-known that inference based on profile likelihoods is generally more accurate than Wald, especially when the sample size is small. The deviance (deviance(object)) is used if possible, else the difference 2 * (logLik(object) - ell) is computed, where ell are the values of the loglikelihood on a grid.

For Wald CIs and rrvglm-class objects, currently an error message is produced because I haven’t gotten around to write the methods function; it’s not too hard, but am too busy! An interim measure is to coerce the object into a "vglm" object, but then the confidence intervals will tend to be too narrow because the estimated constraint matrices are treated as known.

For Wald CIs and vgam-class objects, currently an error message is produced because the theory is undeveloped.
Value

Same as `confint`.

Note

The order of the values of argument `method` may change in the future without notice. The functions `plot.profile.glm` and `pairs.profile.glm` from `MASS` appear to work with output from this function.

Author(s)

Thomas Yee adapted `confint.lm` to handle "glm" objects, for Wald-type confidence intervals. Also, `profile.glm` was originally written by D. M. Bates and W. N. Venables (For S in 1996) and subsequently corrected by B. D. Ripley. This function effectively calls `confint.profile.glm()` in `MASS`.

See Also

`vcovvlm`, `summaryvglm`, `confint.profile.glm`, `lrt.stat.vlm`, `wald.stat`, `plot.profile.glm`, `pairs.profile.glm`.

Examples

```r
# Example 1: this is based on a glm example
counts <- c(18,17,15,20,10,20,25,13,12)
outcome <- gl(3, 1, 9); treatment <- gl(3, 3)
glm.D93 <- glm(counts ~ outcome + treatment, family = poisson())
vglm.D93 <- vglm(counts ~ outcome + treatment, family = poissonff)
confint(glm.D93)  # needs MASS to be present on the system
confint.default(glm.D93)  # based on asymptotic normality
confint(vglm.D93)
confint(vglm.D93) - confint(glm.D93)  # Should be all 0s
confint(vglm.D93) - confint.default(glm.D93)  # based on asympt. normality

# Example 2: simulated negative binomial data with multiple responses
ndata <- data.frame(x2 = runif(nn <- 100))
ndata <- transform(ndata, y1 = rnbinom(nn, mu = exp(3+x2), size = exp(1)),
y2 = rnbinom(nn, mu = exp(2-x2), size = exp(0)))
fit1 <- vglm(cbind(y1, y2) ~ x2, negbinomial, data = ndata, trace = TRUE)
coef(fit1)
coef(fit1, matrix = TRUE)
confint(fit1)
confint(fit1, "x2:1")  # This might be improved to "x2" some day...
## Not run:
confint(fit1, method = "profile")  # Computationally expensive
confint(fit1, "x2:1", method = "profile", trace = FALSE)
## End(Not run)

fit2 <- rrvglm(y1 ~ x2, negbinomial(zero = NULL), data = ndata)
confint(as(fit2, "vglm"))  # Too narrow (SEs are biased downwards)
```
**Description**

Extractor function for the *constraint matrices* of objects in the VGAM package.

**Usage**

```r
constraints(object, ...)  
constraints.vlm(object, type = c("lm", "term"), all = TRUE, which,  
matrix.out = FALSE, colnames.arg = TRUE,  
rownames.arg = TRUE, ...)  
```

**Arguments**

- `object` Some VGAM object, for example, having class `vglmff-class`.
- `type` Character. Whether LM- or term-type constraints are to be returned. The number of such matrices returned is equal to `nvar(object, type = "lm")` and the number of terms, respectively.
- `all`, `which` If `all = FALSE` then `which` gives the integer index or a vector of logicals specifying the selection.
- `matrix.out` Logical. If `TRUE` then the constraint matrices are `cbind()`ed together. The result is usually more compact because the default is a list of constraint matrices.
- `colnames.arg`, `rownames.arg` Logical. If `TRUE` then column and row names are assigned corresponding to the variables.
- `...` Other possible arguments such as `type`.

**Details**

Constraint matrices describe the relationship of coefficients/component functions of a particular explanatory variable between the linear/additive predictors in VGLM/VGAM models. For example, they may be all different (constraint matrix is the identity matrix) or all the same (constraint matrix has one column and has unit values).

VGLMs and VGAMs have constraint matrices which are *known*. The class of RR-VGLMs have constraint matrices which are *unknown* and are to be estimated.

**Value**

The extractor function `constraints()` returns a list comprising of constraint matrices—usually one for each column of the VLM model matrix, and in that order. The list is labelled with the variable names. Each constraint matrix has $M$ rows, where $M$ is the number of linear/additive predictors, and whose rank is equal to the number of columns. A model with no constraints at all has an order $M$ identity matrix as each variable’s constraint matrix.
For `vglm` and `vgam` objects, feeding in `type = "term"` constraint matrices back into the same model should work and give an identical model. The default are the "lm"-type constraint matrices; this is a list with one constraint matrix per column of the LM matrix. See the constraints argument of `vglm`, and the example below.

**Note**

In all `VGAM` family functions `zero = NULL` means none of the linear/additive predictors are modelled as intercepts-only. Other arguments found in certain `VGAM` family functions which affect constraint matrices include `parallel` and `exchangeable`.

The constraints argument in `vglm` and `vgam` allows constraint matrices to be inputted. If so, then `constraints(fit, type = "lm")` can be fed into the constraints argument of the same object to get the same model. The $x_{ij}$ argument does not affect constraint matrices; rather, it allows each row of the constraint matrix to be multiplied by a specified vector.

**Author(s)**

T. W. Yee

**References**


**See Also**

`is.parallel`, `is.zero`, `trim.constraints`. VGLMs are described in `vglm-class`; RR-VGLMs are described in `rrvglm-class`.

Arguments such as `zero` and `parallel` found in many `VGAM` family functions are a way of creating/modifying constraint matrices conveniently, e.g., see `zero`. See `CommonVGAMffArguments` for more information.

**Examples**

```r
# Fit the proportional odds model:
# pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ sm.bs(let, 3),
  cumulative(parallel = TRUE, reverse = TRUE), data = pneumo))
coef(fit1, matrix = TRUE)
constraints(fit1) # Parallel assumption results in this
constraints(fit1, type = "term") # Same as the default ("vlm"-type)
is.parallel(fit1)
# An equivalent model to fit1 (needs the type "term" constraints):
clist.term <- constraints(fit1, type = "term") # "term"-type constraints
# cumulative() has no 'zero' argument to set to NULL (a good idea
```
# when using the 'constraints' argument):
(fit2 <- vglm(cbind(normal, mild, severe) ~ sm.bs(let, 3), data = pneumo,
    cumulative(reverse = TRUE), constraints = clist.term))
abs(max(coef(fit1, matrix = TRUE) -
    coef(fit2, matrix = TRUE))) # Should be zero

# Fit a rank-1 stereotype (RR-multinomial logit) model:
fit <- rrvglm(Country ~ Width + Height + HP, multinomial, data = car.all)
constraints(fit) # All except the first are the estimated A matrix

---

### cops

**Centre of the Parameter Space**

#### Description

Returns a vector similar to coefs() comprising the centre of the parameter space (COPS) values, given a fitted VGLM regression.

#### Usage

```r
cops(object, ...)
copsvglm(object, beta.range = c(-5, 6),
    tol = .Machine$double.eps^0.25,
    dointercepts = TRUE, trace. = FALSE,
    slowtrain = FALSE, ...)
```

#### Arguments

- `object` A `vglm` object. However, this function will not work for all such objects.
- `beta.range` Numeric. Interval for the numerical search. After a little scaling, it is effectively fed into `interval` in `optimize`. Convergence failure may occur if this argument is too wide so it is a good idea to vary this argument. In fact, it is strongly recommended that several values be fed into this argument to help ensure the proper solution is obtained.
- `tol` Numeric. Fed into `tol` in `optimize`.
- `dointercepts` Logical. Compute the COPS for the intercepts? This should be set to `FALSE` for models such as `propodds` and `cumulative`.
- `trace.` Logical. Print a running log? This may or may not work properly.
- `slowtrain` Logical. If `TRUE` then all columns of a matrix is computed. If `FALSE` then only one column of a matrix is computed, and this is the only column needed.
- `...` currently unused but may be used in the future for further arguments passed into the other methods functions.
Details

For many models, some COPS values will be Inf or -Inf so that manual checking is needed, for example, poissonff. Each value returned may be effectively that of beta.range or NA. The answers returned by this function only make sense if the COPSs are in the interior of the parameter space. This function was written specifically for logistic regression but has much wider applicability. Currently the result returned depends critically on beta.range so that the answer should be checked after several values are fed into that argument.

Value

A named vector, similar to coefvlm. If trace, then a list is returned, having a component comprising a matrix of function evaluations used by optimize.

Note

This function is experimental and can be made to run more efficiently in the future.

Author(s)

Thomas W. Yee.

References


See Also

hdeff, coefvlm, coef.

Examples

```r
## Not run: data("xs.nz", package = "VGAMdata")
data1 <- na.omit(xs.nz[, c("age", "cancer", "sex")])
fit1 <- vglm(cancer ~ age + sex, binomialff, data1)
cops(fit1)  # 'beta.range' is okay here

## End(Not run)
```

corbet  

Corbet's Butterfly Data

Description

About 3300 individual butterflies were caught in Malaya by naturalist Corbet trapping butterflies. They were classified to about 500 species.

Usage

data(corbet)
Format

A data frame with 24 observations on the following 2 variables.

species Number of species.
ofreq Observed frequency of individual butterflies of that species.

Details

In the early 1940s Corbet spent two years trapping butterflies in Malaya. Of interest was the total number of species. Some species were so rare (e.g., 118 species had only one specimen) that it was thought likely that there were many unknown species.

Actually, 119 species had over 24 observed frequencies, so this could/should be appended to the data set. Hence there are 620 species in total in a sample size of \( n = 9031 \) individuals.

References


Examples

```
summary(corbet)
```

---

**cquo**

*Fitting Constrained Quadratic Ordination (CQO)*

Description

A constrained quadratic ordination (CQO; formerly called canonical Gaussian ordination or CGO) model is fitted using the quadratic reduced-rank vector generalized linear model (QRR-VGLM) framework.

Usage

```
cqo(formula, family = stop("argument 'family' needs to be assigned"),
    data = list(), weights = NULL, subset = NULL,
    na.action = na.fail, etastart = NULL, mustart = NULL,
    coefstart = NULL, control = qrrvglm.control(...), offset = NULL,
    method = "cqo.fit", model = FALSE, x.arg = TRUE, y.arg = TRUE,
    contrasts = NULL, contraints = NULL, extra = NULL,
    smart = TRUE, ...)```

Arguments

- **formula**: A symbolic description of the model to be fit. The RHS of the formula is applied to each linear predictor. Different variables in each linear predictor can be chosen by specifying constraint matrices.

- **family**: A function of class "glmff" (see vglmff-class) describing what statistical model is to be fitted. This is called a "VGAM family function". See CommonVGAMffArguments for general information about many types of arguments found in this type of function. Currently the following families are supported: poissonff, binomialff (logitlink and clogloglink links available), negbinomial, gamma2. Sometimes special arguments are required for cqo(), e.g., binomialff(multiple.responses = TRUE).

- **data**: An optional data frame containing the variables in the model. By default the variables are taken from environment(formula), typically the environment from which cqo is called.

- **weights**: An optional vector or matrix of (prior) weights to be used in the fitting process. Currently, this argument should not be used.

- **subset**: An optional logical vector specifying a subset of observations to be used in the fitting process.

- **na.action**: A function which indicates what should happen when the data contain NAs. The default is set by the na.action setting of options, and is na.fail if that is unset. The “factory-fresh” default is na.omit.

- **etastart**: Starting values for the linear predictors. It is a \( M \)-column matrix. If \( M = 1 \) then it may be a vector. Currently, this argument probably should not be used.

- **mustart**: Starting values for the fitted values. It can be a vector or a matrix. Some family functions do not make use of this argument. Currently, this argument probably should not be used.

- **coefstart**: Starting values for the coefficient vector. Currently, this argument probably should not be used.

- **control**: A list of parameters for controlling the fitting process. See qrrvglm.control for details.

- **method**: The method to be used in fitting the model. The default (and presently only) method cqo.fit uses iteratively reweighted least squares (IRLS).

- **model**: A logical value indicating whether the model frame should be assigned in the model slot.

- **x.arg, y.arg**: Logical values indicating whether the model matrix and response matrix used in the fitting process should be assigned in the x and y slots. Note the model matrix is the LM model matrix.

- **contrasts**: An optional list. See the contrasts.arg of model.matrix.default.

- **constraints**: An optional list of constraint matrices. The components of the list must be named with the term it corresponds to (and it must match in character format). Each constraint matrix must have \( M \) rows, and be of full-column rank. By default, constraint matrices are the \( M \) by \( M \) identity matrix unless arguments in the
family function itself override these values. If constraints is used it must contain all the terms; an incomplete list is not accepted. Constraint matrices for \( x_2 \) variables are taken as the identity matrix.

extra

an optional list with any extra information that might be needed by the family function.

smart

logical value indicating whether smart prediction (smartpred) will be used.

... further arguments passed into `qrrvglm.control`.

Details

QRR-VGLMs or constrained quadratic ordination (CQO) models are estimated here by maximum likelihood estimation. Optimal linear combinations of the environmental variables are computed, called latent variables (these appear as `latvar` for \( R = 1 \) else `latvar1`, `latvar2`, etc. in the output). Here, \( R \) is the rank or the number of ordination axes. Each species’ response is then a regression of these latent variables using quadratic polynomials on a transformed scale (e.g., log for Poisson counts, logit for presence/absence responses). The solution is obtained iteratively in order to maximize the log-likelihood function, or equivalently, minimize the deviance.

The central formula (for Poisson and binomial species data) is given by

\[
\eta = B_1^T x_1 + A \nu + \sum_{m=1}^{M} (\nu D_m \nu) e_m
\]

where \( x_1 \) is a vector (usually just a 1 for an intercept), \( x_2 \) is a vector of environmental variables, \( \nu = C^T x_2 \) is a \( R \)-vector of latent variables, \( e_m \) is a vector of 0s but with a 1 in the \( m \)th position. The \( \eta \) are a vector of linear/additive predictors, e.g., the \( m \)th element is \( \eta_m = \log(E[Y_m]) \) for the \( m \)th species. The matrices \( B_1, A, C \) and \( D_m \) are estimated from the data, i.e., contain the regression coefficients. The tolerance matrices satisfy \( T_s = -\frac{1}{2} D_s^{-1} \). Many important CQO details are directly related to arguments in `qrrvglm.control`, e.g., the argument `noRRR` specifies which variables comprise \( x_1 \).

Theoretically, the four most popular VGAM family functions to be used with `cqo` correspond to the Poisson, binomial, normal, and negative binomial distributions. The latter is a 2-parameter model. All of these are implemented, as well as the 2-parameter gamma.

For initial values, the function `.Init.Poisson.QO` should work reasonably well if the data is Poisson with species having equal tolerances. It can be quite good on binary data too. Otherwise the `Cinit` argument in `qrrvglm.control`, e.g., the argument `noRRR` specifies which variables comprise \( x_1 \).

Incidentally, Unconstrained quadratic ordination (UQO) may be performed by, e.g., fitting a Goodman’s RC association model; see `uqo` and the Yee and Hadi (2014) referenced there. For UQO, the response is the usual site-by-species matrix and there are no environmental variables; the site scores are free parameters. UQO can be performed under the assumption that all species have the same tolerance matrices.
Value
An object of class "qrrvglm".

Warning
Local solutions are not uncommon when fitting CQO models. To increase the chances of obtaining the global solution, increase the value of the argument Bestof in qrrvglm.control. For reproducibility of the results, it pays to set a different random number seed before calling cqo (the function set.seed does this). The function cqo chooses initial values for C using .Init.Poisson.QO() if Use.Init.Poisson.QO = TRUE, else random numbers.

Unless I.tolerances = TRUE or eq.tolerances = FALSE, CQO is computationally expensive with memory and time. It pays to keep the rank down to 1 or 2. If eq.tolerances = TRUE and I.tolerances = FALSE then the cost grows quickly with the number of species and sites (in terms of memory requirements and time). The data needs to conform quite closely to the statistical model, and the environmental range of the data should be wide in order for the quadratics to fit the data well (bell-shaped response surfaces). If not, RR-VGLMs will be more appropriate because the response is linear on the transformed scale (e.g., log or logit) and the ordination is called constrained linear ordination or CLO.

Like many regression models, CQO is sensitive to outliers (in the environmental and species data), sparse data, high leverage points, multicollinearity etc. For these reasons, it is necessary to examine the data carefully for these features and take corrective action (e.g., omitting certain species, sites, environmental variables from the analysis, transforming certain environmental variables, etc.). Any optimum lying outside the convex hull of the site scores should not be trusted. Fitting a CAO is recommended first, then upon transformations etc., possibly a CQO can be fitted.

For binary data, it is necessary to have ‘enough’ data. In general, the number of sites $n$ ought to be much larger than the number of species $S$, e.g., at least 100 sites for two species. Compared to count (Poisson) data, numerical problems occur more frequently with presence/absence (binary) data. For example, if Rank = 1 and if the response data for each species is a string of all absences, then all presences, then all absences (when enumerated along the latent variable) then infinite parameter estimates will occur. In general, setting I.tolerances = TRUE may help.

This function was formerly called cgo. It has been renamed to reinforce a new nomenclature described in Yee (2006).

Note
The input requires care, preparation and thought—a lot more than other ordination methods. Here is a partial checklist.

1. The number of species should be kept reasonably low, e.g., 12 max. Feeding in 100+ species wholesale is a recipe for failure. Choose a few species carefully. Using 10 well-chosen species is better than 100+ species thrown in willy-nilly.

2. Each species should be screened individually first, e.g., for presence/absence is the species totally absent or totally present at all sites? For presence/absence data sort(colMeans(data)) can help avoid such species.

3. The number of explanatory variables should be kept low, e.g., 7 max.
(4) Each explanatory variable should be screened individually first, e.g., is it heavily skewed or are there outliers? They should be plotted and then transformed where needed. They should not be too highly correlated with each other.

(5) Each explanatory variable should be scaled, e.g., to mean 0 and unit variance. This is especially needed for I.tolerance = TRUE.

(6) Keep the rank low. Only if the data is very good should a rank-2 model be attempted. Usually a rank-1 model is all that is practically possible even after a lot of work. The rank-1 model should always be attempted first. Then might be clever and try use this for initial values for a rank-2 model.

(7) If the number of sites is large then choose a random sample of them. For example, choose a maximum of 500 sites. This will reduce the memory and time expense of the computations.

(8) Try I.tolerance = TRUE or eq.tolerance = FALSE if the inputted data set is large, so as to reduce the computational expense. That's because the default, I.tolerance = FALSE and eq.tolerance = TRUE, is very memory hungry.

By default, a rank-1 equal-tolerances QRR-VGLM model is fitted (see qrrvglm.control for the default control parameters). If Rank > 1 then the latent variables are always transformed so that they are uncorrelated. By default, the argument trace is TRUE meaning a running log is printed out while the computations are taking place. This is because the algorithm is computationally expensive, therefore users might think that their computers have frozen if trace = FALSE!

The argument Bestof in qrrvglm.control controls the number of models fitted (each uses different starting values) to the data. This argument is important because convergence may be to a local solution rather than the global solution. Using more starting values increases the chances of finding the global solution. Always plot an ordination diagram (use the generic function lvplot) and see if it looks sensible. Local solutions arise because the optimization problem is highly nonlinear, and this is particularly true for CAO.

Many of the arguments applicable to cqo are common to vglm and rrvglm.control. The most important arguments are Rank, noRRR, Bestof, I.tolerances, eq.tolerances, isd.latvar, and MUXfactor.

When fitting a 2-parameter model such as the negative binomial or gamma, it pays to have eq.tolerances = TRUE and I.tolerances = FALSE. This is because numerical problems can occur when fitting the model far away from the global solution when I.tolerances = TRUE. Setting the two arguments as described will slow down the computation considerably, however it is numerically more stable.

In Example 1 below, an unequal-tolerances rank-1 QRR-VGLM is fitted to the hunting spiders dataset, and Example 2 is the equal-tolerances version. The latter is less likely to have convergence problems compared to the unequal-tolerances model. In Example 3 below, an equal-tolerances rank-2 QRR-VGLM is fitted to the hunting spiders dataset. The numerical difficulties encountered in fitting the rank-2 model suggests a rank-1 model is probably preferable. In Example 4 below, constrained binary quadratic ordination (in old nomenclature, constrained Gaussian logit ordination) is fitted to some simulated data coming from a species packing model. With multivariate binary responses, one must use multiple.responses = TRUE to indicate that the response (matrix) is multivariate. Otherwise, it is interpreted as a single binary response variable. In Example 5 below, the deviance residuals are plotted for each species. This is useful as a diagnostic plot. This is done by (re)regressing each species separately against the latent variable.

Sometime in the future, this function might handle input of the form cqo(x, y), where x and y are matrices containing the environmental and species data respectively.
Author(s)

Thomas W. Yee. Thanks to Alvin Sou for converting a lot of the original FORTRAN code into C.

References


logical Monographs, 74*, 685–701.


Research, 18*, 271–317.


See Also

qrrvglm.control, Coef.qrrvglm, predictqrrvglm, calibrate.qrrvglm, model.matrixqrrvglm, 
vcovqrrvglm, rcqo, cao, uqo, rrvglm, poissonff, binomialff, negbinomial, gamma2, lvplot.qrrvglm, 
perspqrrvglm, trplot.qrrvglm, vglm, set.seed, hspider, trapO.

Examples

```r
## Not run:
# Example 1; Fit an unequal tolerances model to the hunting spiders data
hspider[,1:6] <- scale(hspider[,1:6]) # Standardized environmental variables
set.seed(1234) # For reproducibility of the results
plut <- cqo(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi, 
Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull, 
Trocterr, Zoraspin) ~ 
WaterCon + BareSand + FallTwig + CoveMos + CoveHerb + ReflLux, 
fam = poissonff, data = hspider, Crow1positive = FALSE, 
eq.tol = FALSE)

sort(deviance(plut, history = TRUE)) # A history of all the iterations
if (deviance(plut) > 1177) warning("suboptimal fit obtained")

S <- ncol(depvar(plut)) # Number of species
c1r <- (1:(S+1))[-7] # Omits yellow
lvplot(plut, y = TRUE, lcol = clr, pch = 1:S, pcol = clr, 
las = 1) # Ordination diagram
legend("topright", leg = colnames(depvar(plut)), col = clr, 
pch = 1:S, merge = TRUE, bty = "n", lty = 1:S, lwd = 2)
(cp <- Coef(plut))

(a <- latvar(cp)[cp$latvar.order]) # Ordered site scores along the gradient
# Names of the ordered sites along the gradient:
rownames(latvar(cp))[cp$latvar.order]
(aa <- Opdiscp[C, cp$Optimum.order]) # Ordered optimums along the gradient
aa <- aa[!is.na(aa)] # Delete the species that is not unimodal
names(aa) # Names of the ordered optimums along the gradient

trplot(plut, which.species = 1:3, log = "xy", type = "b", lty = 1, lwd = 2, 
col = c("blue", "red", "green"), label = TRUE) -> ii # Trajectory plot
legend(0.00005, 0.3, paste(ii$species[1], ii$species[2], sep = " and "), 
lwd = 2, lty = 1, col = c("blue", "red", "green"))
```

abline(a = 0, b = 1, lty = "dashed")

S <- ncol(depvar(plut))  # Number of species
clr <- (1:(S+1))[-7]  # Omits yellow
persp(plut, col = clr, label = TRUE, las = 1)  # Perspective plot

# Example 2; Fit an equal tolerances model. Less numerically fraught.
set.seed(1234)
p1et <- cqo(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
    Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
    Trocterr, Zoraspin) ~ WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
    poissonff, data = hspider, Crow1positive = FALSE)

sort(deviance(p1et, history = TRUE))  # A history of all the iterations
if (deviance(p1et) > 1586) warning("suboptimal fit obtained")
S <- ncol(depvar(p1et))  # Number of species
clr <- (1:(S+1))[-7]  # Omits yellow
persp(p1et, col = clr, label = TRUE, las = 1)

# Example 3: A rank-2 equal tolerances CQO model with Poisson data
# This example is numerically fraught... need I.toler = TRUE too.
set.seed(555)
p2 <- cqo(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
    Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
    Trocterr, Zoraspin) ~ WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
    poissonff, data = hspider, Crow1positive = FALSE,
    I.toler = TRUE, Rank = 2, Bestof = 3, isd.latvar = c(2.1, 0.9))

sort(deviance(p2, history = TRUE))  # A history of all the iterations
if (deviance(p2) > 1127) warning("suboptimal fit obtained")
lvplot(p2, ellips = FALSE, label = TRUE, xlim = c(-3,4),
    C = TRUE, Ccol = "brown", sites = TRUE, scol = "grey",
    pcol = "blue", pch = "+", chull = TRUE, ccol = "grey")

# Example 4: species packing model with presence/absence data
set.seed(2345)
n <- 200; p <- 5; S <- 5
mydata <- rcqo(n, p, S, fam = "binomial", hi.abundance = 4,
    eq.tol = TRUE, es.opt = TRUE, eq.max = TRUE)
myform <- attr(mydata, "formula")
set.seed(1234)
b1et <- cqo(myform, binomialff(multiple.responses = TRUE, link = "clogloglink"),
    data = mydata)

sort(deviance(b1et, history = TRUE))  # A history of all the iterations
lvplot(b1et, y = TRUE, lcol = 1:S, pch = 1:S, pcol = 1:S, las = 1)
Coef(b1et)

# Compare the fitted model with the 'truth'
cbind(truth = attr(mydata, "concoefficients"), fitted = concoef(b1et))
# Example 5: Plot the deviance residuals for diagnostic purposes

```r
set.seed(1234)
plet <- cco(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
                Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
                Trocterr, Zoraspin) ~
                WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
                poissonff, data = hspider, eq.tol = TRUE, trace = FALSE)

# A history of all the iterations

if (deviance(plet) > 1586) warning("suboptimal fit obtained")
S <- ncol(depvar(plet))
par(mfrow = c(3, 4))
for (ii in 1:S) {
  tempdata <- data.frame(latvar1 = c(latvar(plet)),
                          sppCounts = depvar(plet)[, ii])
  tempdata <- transform(tempdata, myOffset = -0.5 * latvar1^2)
  fit1 <- vglm(sppCounts ~ offset(myOffset) + latvar1, poissonff,
               data = tempdata, trace = FALSE)
  devresid <- resid(fit1, type = "deviance")
  predvalues <- predict(fit1) + fit1@offset
  ooo <- with(tempdata, order(latvar1))
  plot(predvalues + devresid ~ latvar1, data = tempdata, col = "red",
       xlab = "latvar1", ylab = "", main = colnames(depvar(plet))[ii])
  with(tempdata, lines(latvar1[ooo], predvalues[ooo], col = "blue"))
}
```

## End(Not run)

---

**crashes**

*Crashes on New Zealand Roads in 2009*

**Description**

A variety of reported crash data cross-classified by time (hour of the day) and day of the week, accumulated over 2009. These include fatalities and injuries (by car), trucks, motor cycles, bicycles and pedestrians. There are some alcohol-related data too.

**Usage**

```r
data(crashi)
data(crashf)
data(crashtr)
```
data(crashmc)
data(crashbc)
data(crashp)
data(alcoff)
data(alclevels)

**Format**

Data frames with hourly times as rows and days of the week as columns. The alclevels dataset has hourly times and alcohol levels.

**Mon, Tue, Wed, Thu, Fri, Sat, Sun** Day of the week.

**0-30, 31-50, 51-80, 81-100, 121-150, 151-200, 201-250, 251-300, 301-350, 350+** Blood alcohol level (milligrams alcohol per 100 millilitres of blood).

**Details**

Each cell is the aggregate number of crashes reported at each hour-day combination, over the 2009 calendar year. The rownames of each data frame is the start time (hourly from midnight onwards) on a 24 hour clock, e.g., 21 means 9.00pm to 9.59pm.

For crashes, chrashi are the number of injuries by car, crashf are the number of fatalities by car (not included in chrashi), crashtr are the number of crashes involving trucks, crashmc are the number of crashes involving motorcyclists, crashbc are the number of crashes involving bicycles, and crashp are the number of crashes involving pedestrians. For alcohol-related offences, alcoff are the number of alcohol offenders from breath screening drivers, and alclevels are the blood alcohol levels of fatally injured drivers.

**Source**


**References**


**See Also**

rrvglm, rcim, grc.

**Examples**

```r
## Not run: plot(unlist(alcoff), type = "l", frame.plot = TRUE,
axes = FALSE, col = "blue", bty = "o",
main = "Alcoholic offenders on NZ roads, aggregated over 2009",
sub = "Vertical lines at midnight (purple) and noon (orange)",
xlab = "Day/hour", ylab = "Number of offenders")
axis(1, at = 1 + (0:6) * 24 + 12, labels = colnames(alcoff))
axis(2, las = 1)
```
## Goodmans RC models

## Not run:
```
fitgrc1 <- grc(alcoff)  # Rank-1 model
fitgrc2 <- grc(alcoff, Rank = 2, Corner = FALSE, Uncor = TRUE)
Coef(fitgrc2)
```

## Not run: 
```
biplot(fitgrc2, scaleA = 2.3, Ccol = "blue", Acol = "orange",
      Clabels = as.character(1:23), xlim = c(-1.3, 2.3),
      ylim = c(-1.2, 1))
```

---

**cratio**  

**Ordinal Regression with Continuation Ratios**

### Description

Fits a continuation ratio logit/probit/cloglog/cauchit/... regression model to an ordered (preferably) factor response.

### Usage

```r
cratio(link = "logitlink", parallel = FALSE, reverse = FALSE,
       zero = NULL, ynames = FALSE, Thresh = NULL, Trev = reverse,
       Tref = if (Trev) "M" else 1, whitespace = FALSE)
```

### Arguments

- **link**: Link function applied to the \( M \) continuation ratio probabilities. See **Links** for more choices.
- **parallel**: A logical, or formula specifying which terms have equal/unequal coefficients.
- **reverse**: Logical. By default, the continuation ratios used are \( \eta_j = \logit(P[Y > j | Y \geq j]) \) for \( j = 1, \ldots, M \). If reverse is TRUE, then \( \eta_j = \logit(P[Y < j + 1 | Y \leq j + 1]) \) will be used.
- **ynames**: See **multinomial** for information.
- **zero**: An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \{1,2,\ldots,M\}. The default value means none are modelled as intercept-only terms. See **CommonVGAMffArguments** for more information.
- **Thresh, Trev, Tref**: See **cumulative** for information. These arguments apply to ordinal categorical regression models.
- **whitespace**: See **CommonVGAMffArguments** for information.
Details

In this help file the response $Y$ is assumed to be a factor with ordered values $1, 2, \ldots, M + 1$, so that $M$ is the number of linear/additive predictors $\eta_j$.

There are a number of definitions for the continuation ratio in the literature. To make life easier, in the VGAM package, we use continuation ratios and stopping ratios (see `sratio`). Stopping ratios deal with quantities such as $\logitlink(P[Y=j|Y\geq j])$.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `rrvglm` and `vgam`.

Warning

No check is made to verify that the response is ordinal if the response is a matrix; see `ordered`.

Boersch-Supan (2021) looks at sparse data and the numerical problems that result; see `sratio`.

Note

The response should be either a matrix of counts (with row sums that are all positive), or a factor. In both cases, the $y$ slot returned by `vglm/vgam/rrvglm` is the matrix of counts.

For a nominal (unordered) factor response, the multinomial logit model (`multinomial`) is more appropriate.

Here is an example of the usage of the parallel argument. If there are covariates $x_1$, $x_2$ and $x_3$, then `parallel = TRUE ~ x1 + x2 -1` and `parallel = FALSE ~ x3` are equivalent. This would constrain the regression coefficients for $x_1$ and $x_2$ to be equal; those of the intercepts and $x_3$ would be different.

Author(s)

Thomas W. Yee

References

See `sratio`.

See Also

`sratio, acat, cumulative, multinomial, CM.equid, CommonVGAMffArguments, margeff, pneumo, budworm, logitlink, probitlink, clogloglink, cauchitlink`.

Examples

```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let,
            cratio(parallel = TRUE), data = pneumo))
coef(fit, matrix = TRUE)
constraints(fit)
predict(fit)
```
cumulative

predict(fit, untransform = TRUE)
margeff(fit)

cumulative

Ordinal Regression with Cumulative Probabilities

Description

Fits a cumulative link regression model to a (preferably ordered) factor response.

Usage

cumulative(link = "logitlink", parallel = FALSE,
reverse = FALSE, multiple.responses = FALSE,
ynames = FALSE, Thresh = NULL, Trev = reverse,
Tref = if (Trev) "M" else 1, whitespace = FALSE)

Arguments

link Link function applied to the $J$ cumulative probabilities. See Links for more choices, e.g., for the cumulative probitlink/clogloglink/...models.

parallel A logical or formula specifying which terms have equal/unequal coefficients. See below for more information about the parallelism assumption. The default results in what some people call the generalized ordered logit model to be fitted. If parallel = TRUE then it does not apply to the intercept. The partial proportional odds model can be fitted by assigning this argument something like parallel = TRUE ~ -1 + x3 + x5 so that there is one regression coefficient for x3 and x5. Equivalently, setting parallel = FALSE ~ 1 + x2 + x4 means $M$ regression coefficients for the intercept and x2 and x4. It is important that the intercept is never parallel. See CommonVGAMffArguments for more information.

reverse Logical. By default, the cumulative probabilities used are $P(Y \leq 1), P(Y \leq 2), ..., P(Y \leq J)$. If reverse is TRUE then $P(Y \geq 2), P(Y \geq 3), ..., P(Y \geq J + 1)$ are used.

ynames See multinomial for information.

multiple.responses Logical. Multiple responses? If TRUE then the input should be a matrix with values 1, 2, ..., $L$, where $L = J + 1$ is the number of levels. Each column of the matrix is a response, i.e., multiple responses. A suitable matrix can be obtained from Cut.

Thresh Character. The choices concern constraint matrices applied to the intercepts. They can be constrained to be equally-spaced (equidistant) etc. See CommonVGAMffArguments and constraints for general information. Basically, the choice is pasted to the end of "CM." and that function is called. This means users can easily write their own CM.-type function.
If equally-spaced then the direction and the reference level are controlled by \(T_{rev}\) and \(T_{ref}\), and the constraint matrix will be \(M\) by 2, with the second column corresponding to the distance between the thresholds.

If "symm1" then the fitted intercepts are symmetric about the median (\(M\) odd) intercept. If \(M\) is even then the median is the mean of the two most inner and adjacent intercepts. For this, \(CM_{.symm1}\) is used to construct the appropriate constraint matrix.

If "symm0" then the median intercept is 0 by definition and the symmetry occurs about the origin. Thus the intercepts comprise pairs that differ by sign only. The appropriate constraint matrix is as with "symm1" but with the first column deleted. The choices "symm1" and "symm0" are effectively equivalent to "symmetric" and "symmetric2" respectively in \texttt{ordinal}.

For "qnorm" then \(CM_{.qnorm}\) uses the \(qnorm((1:M)/(M+1))\) quantiles of the standard normal.

\(T_{rev}, T_{ref}\) \hspace{1cm} Support arguments for \texttt{Thresh} for equally-spaced intercepts. The logical argument \(T_{rev}\) is applied first to give the direction (i.e., ascending or descending) before row \(T_{ref}\) (ultimately numeric) of the first (intercept) constraint matrix is set to the reference level. See \texttt{constraints} for information.

whitespace \hspace{1cm} See \texttt{CommonVGAMffArguments} for information.

\textbf{Details}

In this help file the response \(Y\) is assumed to be a factor with ordered values \(1, 2, \ldots, J+1\). Hence \(M\) is the number of linear/additive predictors \(\eta_j\); for \texttt{cumulative()} one has \(M = J\).

This \texttt{VGAM} family function fits the class of \textit{cumulative link models} to (hopefully) an ordinal response. By default, the \textit{non-parallel} cumulative logit model is fitted, i.e.,

\[
\eta_j = \logit(P[Y \leq j])
\]

where \(j = 1, 2, \ldots, M\) and the \(\eta_j\) are not constrained to be parallel. This is also known as the \textit{non-proportional odds model}. If the logit link is replaced by a complementary log-log link (\texttt{clogloglink}) then this is known as the \textit{proportional-hazards model}.

In almost all the literature, the constraint matrices associated with this family of models are known. For example, setting \texttt{parallel = TRUE} will make all constraint matrices (except for the intercept) equal to a vector of \(M\) 1’s. If the constraint matrices are equal, unknown and to be estimated, then this can be achieved by fitting the model as a reduced-rank vector generalized linear model (RR-VGLM; see \texttt{rrvglm}). Currently, reduced-rank vector generalized additive models (RR-VGAMs) have not been implemented here.

\textbf{Value}

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

\textbf{Warning}

No check is made to verify that the response is ordinal if the response is a matrix; see \texttt{ordered}.

Boersch-Supan (2021) looks at sparse data and the numerical problems that result; see \texttt{sratio}.
Note

The response should be either a matrix of counts (with row sums that are all positive), or a factor. In both cases, the y slot returned by \texttt{vglm/vgam/rrvglm} is the matrix of counts. The formula must contain an intercept term. Other \texttt{VGAM} family functions for an ordinal response include \texttt{acat, cratio, sratio}. For a nominal (unordered) factor response, the multinomial logit model (\texttt{multinomial}) is more appropriate.

With the logit link, setting \texttt{parallel = TRUE} will fit a proportional odds model. Note that the \texttt{TRUE} here does not apply to the intercept term. In practice, the validity of the \textit{proportional odds assumption} needs to be checked, e.g., by a likelihood ratio test (LRT). If acceptable on the data, then numerical problems are less likely to occur during the fitting, and there are less parameters. Numerical problems occur when the linear/additive predictors cross, which results in probabilities outside of (0, 1); setting \texttt{parallel = TRUE} will help avoid this problem.

Here is an example of the usage of the parallel argument. If there are covariates \texttt{x2, x3} and \texttt{x4}, then \texttt{parallel = TRUE ~ x2 + x3 -1} and \texttt{parallel = FALSE ~ x4} are equivalent. This would constrain the regression coefficients for \texttt{x2} and \texttt{x3} to be equal; those of the intercepts and \texttt{x4} would be different.

If the data is inputted in \textit{long} format (not \textit{wide} format, as in \texttt{pneumo} below) and the self-starting initial values are not good enough then try using \texttt{mustart, coefstart} and/or \texttt{etatstart}. See the example below.

To fit the proportional odds model one can use the \texttt{VGAM} family function \texttt{propodds}. Note that \texttt{propodds(reverse)} is equivalent to \texttt{cumulative(parallel = TRUE, reverse = reverse)} (which is equivalent to \texttt{cumulative(parallel = TRUE, reverse = reverse, link = "logitlink")}). It is for convenience only. A call to \texttt{cumulative()} is preferred since it reminds the user that a parallelism assumption is made, as well as being a lot more flexible.

Category specific effects may be modelled using the \texttt{xij}-facility; see \texttt{vglm.control} and \texttt{fill11}.

With most Threshold choices, the first few fitted regression coefficients need care in their interpretation. For example, some values could be the distance away from the median intercept. Typing something like \texttt{constraints(fit)[[1]]} gives the constraint matrix of the intercept term.

Author(s)

Thomas W. Yee

References


**See Also**

`propodds`, `constraints`, `CM.ones`, `CM.equiv`, `R2latvar`, `ordsup`, `prplot`, `margeff`, `acat`, `cratio`, `sratio`, `multinomial`, `CommonVGAMffArguments`, `pneumo`, `budworm`, `Links`, `hdeff.vglm`, `logitlink`, `probitlink`, `clogloglink`, `cauchitlink`, `logistic1`.

**Examples**

```r
# Proportional odds model (p.179) of McCullagh and Nelder (1989)
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let,
            cumulative(parallel = TRUE, reverse = TRUE), pneumo))
depvar(fit)  # Sample proportions (good technique)
fit@y        # Sample proportions (bad technique)
weights(fit, type = "prior")  # Number of observations
coef(fit, matrix = TRUE)
constraints(fit)  # Constraint matrices
apply(fitted(fit), 1, which.max)  # Classification
apply(predict(fit, newdata = pneumo, type = "response"),
       1, which.max)  # Classification
R2latvar(fit)
```

```r
# Check that the model is linear in let ----------------------
fit2 <- vgam(cbind(normal, mild, severe) ~ s(let, df = 2),
             cumulative(reverse = TRUE), data = pneumo)
```

```r
## Not run:
plot(fit2, se = TRUE, overlay = TRUE, lcol = 1:2, scol = 1:2)
## End(Not run)
```

```r
# Check the proportional odds assumption with a LRT ----------
(fit3 <- vglm(cbind(normal, mild, severe) ~ let,
              cumulative(parallel = FALSE, reverse = TRUE), pneumo))
pchisq(2 * (logLik(fit3) - logLik(fit)), df =
       length(coef(fit3)) - length(coef(fit)), lower.tail = FALSE)
lrtest(fit3, fit)  # More elegant
```

```r
# A factor() version of fit -------------------------------
# This is in long format (cf. wide format above)
Nobs <- round(depvar(fit) * c(weights(fit, type = "prior")))
sumNobs <- colSums(Nobs)  # apply(Nobs, 2, sum)
pneumo.long <-
  data.frame(symptoms = ordered(rep(rep(colnames(Nobs), nrow(Nobs)),
                                    times = c(t(Nobs))),
                          levels = colnames(Nobs)),
              let = rep(rep(with(pneumo, let), each = ncol(Nobs)),
                        times = c(t(Nobs))))
with(pneumo.long, table(let, symptoms))  # Should be same as pneumo
```
Dagum

The Dagum Distribution

Description
Density, distribution function, quantile function and random generation for the Dagum distribution
with shape parameters a and p, and scale parameter scale.

Usage

```r
ddagum(x, scale = 1, shape1.a, shape2.p, log = FALSE)
pdagum(q, scale = 1, shape1.a, shape2.p, lower.tail = TRUE, log.p = FALSE)
qdagum(p, scale = 1, shape1.a, shape2.p, lower.tail = TRUE, log.p = FALSE)
rdagum(n, scale = 1, shape1.a, shape2.p)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1`, the length is taken to be the number
  required.
- `shape1.a, shape2.p` shape parameters.
- `scale` scale parameter.
- `log` Logical. If `log = TRUE` then the logarithm of the density is returned.
- `lower.tail, log.p` Same meaning as in `pnorm` or `qnorm`.

Details

See `dagum`, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.
Value

ddagum gives the density, pdagum gives the distribution function, qdagum gives the quantile function, and rdagum generates random deviates.

Note

The Dagum distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)

T. W. Yee and Kai Huang

References


See Also

dagum, genbetaII.

Examples

```r
probs <- seq(0.1, 0.9, by = 0.1)
shape1.a <- 1; shape2.p <- 2
# Should be 0:
max(abs(pdagum(qdagum(probs, shape1.a = shape1.a, shape2.p = 
shape2.p), shape1.a = shape1.a, shape2.p = shape2.p) - probs))
```

```r
## Not run: par(mfrow = c(1, 2))
x <- seq(-0.01, 5, len = 401)
plot(x, dexp(x), type = "l", col = "black",
ylab = "", las = 1, ylim = c(0, 1),
main = "Black is std exponential, others are ddagum(x,...)")
lines(x, ddagum(x, shape1.a = shape1.a, shape2.p = 1), col = "orange")
lines(x, ddagum(x, shape1.a = shape1.a, shape2.p = 2), col = "blue")
lines(x, ddagum(x, shape1.a = shape1.a, shape2.p = 5), col = "green")
legend("topright", col = c("orange","blue","green"),
1ty = rep(1, len = 3), legend = paste("shape1.a = ", shape1.a,
", shape2.p =", c(1, 2, 5)))
```

```r
plot(x, pexp(x), type = "l", col = "black", ylab = "", las = 1,
main = "Black is std exponential, others are pdagum(x,...)"
lines(x, pdagum(x, shape1.a = shape1.a, shape2.p = 1), col = "orange")
lines(x, pdagum(x, shape1.a = shape1.a, shape2.p = 2), col = "blue")
lines(x, pdagum(x, shape1.a = shape1.a, shape2.p = 5), col = "green")
legend("bottomright", col = c("orange", "blue", "green"),
1ty = rep(1, len = 3), legend = paste("shape1.a = ", shape1.a,
", shape2.p =", c(1, 2, 5)))
```

## End(Not run)
Description

Maximum likelihood estimation of the 3-parameter Dagum distribution.

Usage

```r
dagum(lscale = "loglink", lshape1.a = "loglink", lshape2.p =
  "loglink", iscale = NULL, ishape1.a = NULL, ishape2.p =
  NULL, imethod = 1, lss = TRUE, gscale = exp(-5:5), gshape1.a
  = seq(0.75, 4, by = 0.25), gshape2.p = exp(-5:5), probs.y =
  c(0.25, 0.5, 0.75), zero = "shape")
```

Arguments

- `lss`: See `CommonVGAMffArguments` for important information.
- `lshape1.a, lscale, lshape2.p`: Parameter link functions applied to the (positive) parameters a, scale, and p. See `Links` for more choices.
- `iscale, ishape1.a, ishape2.p, imethod, zero`: See `CommonVGAMffArguments` for information. For `imethod = 2` a good initial value for `ishape2.p` is needed to obtain a good estimate for the other parameter.
- `gscale, gshape1.a, gshape2.p`: See `CommonVGAMffArguments` for information.
- `probs.y`: See `CommonVGAMffArguments` for information.

Details

The 3-parameter Dagum distribution is the 4-parameter generalized beta II distribution with shape parameter \( q = 1 \). It is known under various other names, such as the Burr III, inverse Burr, beta-K, and 3-parameter kappa distribution. It can be considered a generalized log-logistic distribution. Some distributions which are special cases of the 3-parameter Dagum are the inverse Lomax \((a = 1)\), Fisk \((p = 1)\), and the inverse paralogistic \((a = p)\). More details can be found in Kleiber and Kotz (2003).

The Dagum distribution has a cumulative distribution function

\[
F(y) = [1 + (y/b)^{-a}]^{-p}
\]

which leads to a probability density function

\[
f(y) = apy^{p-1}/[b^p\{1 + (y/b)^a\}^{p+1}]
\]

for \( a > 0, b > 0, p > 0, y \geq 0 \). Here, \( b \) is the scale parameter scale, and the others are shape parameters. The mean is

\[
E(Y) = b\Gamma(p + 1/a)\Gamma(1 - 1/a)/\Gamma(p)
\]

provided \(-ap < 1 < a\); these are returned as the fitted values. This family function handles multiple responses.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

See the notes in genbetaII.

From Kleiber and Kotz (2003), the MLE is rather sensitive to isolated observations located sufficiently far from the majority of the data. Reliable estimation of the scale parameter require $n > 7000$, while estimates for $a$ and $p$ can be considered unbiased for $n > 2000$ or 3000.

Author(s)

T. W. Yee

References


See Also

Dagum, genbetaII, betaII, sinmad, fisk, inv.lomax, lomax, paralogistic, inv.paralogistic, simulate.vlm.

Examples

```r
## Not run:
ddata <- data.frame(y = rdagum(n = 3000, scale = exp(2),
                      shape1 = exp(1), shape2 = exp(1)))
fit <- vglm(y ~ 1, dagum(lss = FALSE), data = ddata, trace = TRUE)
fit <- vglm(y ~ 1, dagum(lss = FALSE, ishape1.a = exp(1)),
           data = ddata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
## End(Not run)
```

---

**dAR1**

*The AR-1 Autoregressive Process*

Description

Density for the AR-1 model.
Usage

dAR1(x, drift = 0, var.error = 1, ARcoef1 = 0.0,
    type.likelihood = c("exact", "conditional"), log = FALSE)

Arguments

x, vector of quantiles.
drift the scaled mean (also known as the drift parameter), $\mu^\ast$. Note that the mean is
$\mu^\ast/(1 - \rho)$. The default corresponds to observations that have mean 0.
log Logical. If TRUE then the logarithm of the density is returned.
type.likelihood, var.error, ARcoef1
See AR1. The argument ARcoef1 is $\rho$. The argument var.error is the variance
of the i.i.d. random noise, i.e., $\sigma^2$. If type.likelihood = "conditional" then
the first element or row of the result is currently assigned NA—this is because
the density of the first observation is effectively ignored.

Details

Most of the background to this function is given in AR1. All the arguments are converted into
matrices, and then all their dimensions are obtained. They are then coerced into the same size: the
number of rows is the maximum of all the single rows, and ditto for the number of columns.

Value

dAR1 gives the density.

Author(s)

T. W. Yee and Victor Miranda

See Also

AR1.

Examples

nn <- 100; set.seed(1)
tdata <- data.frame(index = 1:nn,
    TS1 = arima.sim(nn, model = list(ar = -0.50),
        sd = exp(1)))

fit1 <- vglm(TS1 ~ 1, AR1, data = tdata, trace = TRUE)
rhobitlink(-0.5)
coef(fit1, matrix = TRUE)
(Cfit1 <- Coef(fit1))
summary(fit1)  # SEs are useful to know
logLik(fit1)
sum(dAR1(depvar(fit1), drift = Cfit1[1], var.error = (Cfit1[2])^2,
    ARcoef1 = Cfit1[3], log = TRUE))

fit2 <- vglm(TS1 ~ 1, AR1(type.likelihood = "cond"), data = tdata, trace = TRUE)
Captures of *Peromyscus maniculatus* (Also Known as Deer Mice).

**Description**

Captures of *Peromyscus maniculatus* collected at East Stuart Gulch, Colorado, USA.

**Usage**

```r
data(deermice)
```

**Format**

The format is a data frame.

**Details**

*Peromyscus maniculatus* is a rodent native to North America. The deer mouse is small in size, only about 8 to 10 cm long, not counting the length of the tail.

Originally, the columns of this data frame represent the sex (m or f), the ages (y: young, sa: semi-adult, a: adult), the weights in grams, and the capture histories of 38 individuals over 6 trapping occasions (1: captured, 0: not captured).

The data set was collected by V. Reid and distributed with the CAPTURE program of Otis et al. (1978).

deermice has 38 deermice whereas Perom had 36 deermice (Perom has been withdrawn.) In deermice the two semi-adults have been classified as adults. The sex variable has 1 for female, and 0 for male.

**References**


**See Also**

`posbernoulli.b`, `posbernoulli.t.fill1`. 
**Examples**

```r
head(deermice)
## Not run:
f1 <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + age,
            posbernoulli.t(parallel.t = TRUE), deermice, trace = TRUE)
coef(f1)
coef(f1, matrix = TRUE)
## End(Not run)
```

---

**deplot.lmscreg**

*Density Plot for LMS Quantile Regression*

**Description**

Plots a probability density function associated with a LMS quantile regression.

**Usage**

```r
deplot.lmscreg(object, newdata = NULL, x0, y.arg, show.plot = TRUE, ...)
```

**Arguments**

- **object**: A VGAM quantile regression model, i.e., an object produced by modelling functions such as `vglm` and `vgam` with a family function beginning with "lms.", e.g., `lms.yjn`.
- **newdata**: Optional data frame containing secondary variables such as sex. It should have a maximum of one row. The default is to use the original data.
- **x0**: Numeric. The value of the primary variable at which to make the ‘slice’.
- **y.arg**: Numerical vector. The values of the response variable at which to evaluate the density. This should be a grid that is fine enough to ensure the plotted curves are smooth.
- **show.plot**: Logical. Plot it? If FALSE no plot will be done.
- **...**: Graphical parameter that are passed into `plotdeplot.lmscreg`.

**Details**

This function calls, e.g., `deplot.lms.yjn` in order to compute the density function.
**Value**

The original object but with a list placed in the slot `post`, called `@post$deplot`. The list has components

- **newdata**: The argument `newdata` above, or a one-row data frame constructed out of the `x0` argument.

- **y**: The argument `y.arg` above.

- **density**: Vector of the density function values evaluated at `y.arg`.

**Note**

`plotdeplot.lmscreg` actually does the plotting.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

`plotdeplot.lmscreg, qtplot.lmscreg, lms.bcn, lms.bcg, lms.yjn`.

**Examples**

```r
## Not run:
fit <- vgam(BMI ~ s(age, df = c(4, 2)), lms.bcn(zero = 1), bmi.nz)
ygrid <- seq(15, 43, by = 0.25)
deplot(fit, x0 = 20, y = ygrid, xlab = "BMI", col = "green", l1wd = 2,
       main = "BMI distribution at ages 20 (green), 40 (blue), 60 (red)"
)
deplot(fit, x0 = 40, y = ygrid, add = TRUE, col = "blue", l1wd = 2)
deplot(fit, x0 = 60, y = ygrid, add = TRUE, col = "red", l1wd = 2) -> a

names(a@post$deplot)
a@post$deplot$newdata
head(a@post$deplot$y)
head(a@post$deplot$density)

## End(Not run)
```
depvar

---

**Response Variable Extracted**

**Description**

A generic function that extracts the response/dependent variable from objects.

**Usage**

`depvar(object, ...)`

**Arguments**

- `object`  
  An object that has some response/dependent variable.

- `...`  
  Other arguments fed into the specific methods function of the model. In particular, sometimes `type = c("lm", "lm2")` is available, in which case the first one is chosen if the user does not input a value. The latter value corresponds to argument `form2`, and sometimes a response for that is optional.

**Details**

By default this function is preferred to calling `fit@y`, say.

**Value**

The response/dependent variable, usually as a matrix or vector.

**Author(s)**

Thomas W. Yee

**See Also**

`model.matrix`, `vglm`.

**Examples**

```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo))
fit@y  # Sample proportions (not recommended)
depvar(fit) # Better than using fit@y
weights(fit, type = "prior")  # Number of observations
```
**dextlogF**

*Extended log-F Distribution*

**Description**

Density for the extended log-F distribution.

**Usage**

\[ \text{dextlogF}(x, \lambda, \tau, \text{location} = 0, \text{scale} = 1, \log = \text{FALSE}) \]

**Arguments**

- `x`: Vector of quantiles.
- `lambda`, `tau`: See `extlogF1`.
- `location`, `scale`: See `extlogF1`.
- `log`: If `TRUE` then the log density is returned, else the density.

**Details**

The details are given in `extlogF1`.

**Value**

`dextlogF` gives the density.

**Author(s)**

T. W. Yee

**See Also**

`extlogF1`, `dalap`.

**Examples**

```r
## Not run: x <- seq(-2, 8, by = 0.1); mytau <- 0.25; mylambda <- 0.2
plot(x, dextlogF(x, mylambda, tau = mytau), type = "l",
     las = 1, col = "blue", ylab = "PDF (log-scale)", log = "y",
     main = "Extended log-F density function is blue",
     sub = "Asymmetric Laplace is orange dashed")
lines(x, dalap(x, tau = mytau, scale = 3.5), col = "orange", lty = 2)
abline(v = 0, col = "gray", lty = 2)
## End(Not run)
```
Description

Returns the residual degrees-of-freedom extracted from a fitted VGLM object.

Usage

df.residual_vlm(object, type = c("vlm", "lm"), ...)

Arguments

object an object for which the degrees-of-freedom are desired, e.g., a vglm object.

 type the type of residual degrees-of-freedom wanted. In some applications the ‘usual’ LM-type value may be more appropriate. The default is the first choice.

... additional optional arguments.

Details

When a VGLM is fitted, a large (VLM) generalized least squares (GLS) fit is done at each IRLS iteration. To do this, an ordinary least squares (OLS) fit is performed by transforming the GLS using Cholesky factors. The number of rows is \( M \) times the ‘ordinary’ number of rows of the LM-type model: \( nM \). Here, \( M \) is the number of linear/additive predictors. So the formula for the VLM-type residual degrees-of-freedom is \( nM - p^* \) where \( p^* \) is the number of columns of the ‘big’ VLM matrix. The formula for the LM-type residual degrees-of-freedom is \( n - p_j \) where \( p_j \) is the number of columns of the ‘ordinary’ LM matrix corresponding to the \( j \)th linear/additive predictor.

Value

The value of the residual degrees-of-freedom extracted from the object. When \( \text{type} = "vlm" \) this is a single integer, and when \( \text{type} = "lm" \) this is a \( M \)-vector of integers.

See Also

vglm, deviance, lm, anova.vglm,

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo))
head(model.matrix(fit, type = "vlm"))
head(model.matrix(fit, type = "lm"))

df.residual(fit, type = "vlm") # \( n \times M - p_{VLMM} \)
nobs(fit, type = "vlm") # \( n \times M \)
nvar(fit, type = "vlm") # \( p_{VLMM} \)
df.residual(fit, type = "lm") # n - p_LM(j)
nobs(fit, type = "lm") # n
nvar(fit, type = "lm") # p_LM
nvar_vlm(fit, type = "lm") # p_LM(j) (<= p_LM elementwise)

---

**dgaitdplot**

*Plotting the GAITD Combo Density*

**Description**

Plots a 1- or 2-parameter GAITD combo probability mass function.

**Usage**

```r
dgaitdplot(theta.p, fam = "pois", a.mix = NULL, i.mix = NULL,
d.mix = NULL, a.mlm = NULL, i.mlm = NULL,
d.mlm = NULL, truncate = NULL, max.support = Inf,
pobs.mix = 0, pobs.mlm = 0,
pstr.mix = 0, pstr.mlm = 0,
pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
theta.a = theta.p, theta.i = theta.p, theta.d = theta.p,
deflation = FALSE, plot.it = TRUE, new.plot = TRUE,
offset.x = ifelse(new.plot, 0, 0.25), type.plot = "h",
xlim = c(0, min(100, max.support + 2)),
ylim = NULL, xlab = "", ylab = "Probability", main = "",
cex.main = 1.2, posn.main = NULL,
all.col = NULL, all.lty = NULL, all.lwd = NULL,
lty.p = "solid", lty.a.mix = "longdash", lty.a.mlm = "longdash",
lty.i.mix = "dashed", lty.i.mlm = "dashed",
lty.d.mix = "solid", lty.d.mlm = "solid", lty.d.dip = "dashed",
col.p = "pink2",
col.a.mix = artichoke.col, col.a.mlm = asparagus.col,
col.i.mix = indigo.col, col.i.mlm = iris.col,
col.d.mix = deer.col, col.d.mlm = dirt.col, col.d.dip = desire.col,
col.t = turquoise.col, cex.p = 1, lwd.p = NULL, lwd.a = NULL,
lwd.i = NULL, lwd.d = NULL, iontop = TRUE, dontop = TRUE,
las = 0, lend = "round", axes.x = TRUE, axes.y = TRUE,
Plot.trunc = TRUE, cex.t = 1, pch.t = 1,
baseparams.argnames = NULL, npars = 1, flip.args = FALSE, ...
```

**Arguments**

- **theta.p** Numeric, usually scalar but may have length 2. This matches with, e.g., `lambda.p` for `Gaitdpois`. A length 2 example is `c(size.p, munb.p)` for `Gaitdnbinom`, in which case `fam = "nbinom"`. Another length 2 example is `c(mean.p, dispind.p)` for `Gaitgenpois1`, in which case `fam = "genpois1"`.

- **fam** Character. paste0("dgait", fam) should be a d-type function returning the PMF. The default is for the GAITD Poisson combo.
a.mix, i.mix, a.mlm, i.mlm
See Gaitdpois and gaitdpoisson.
d.mix, d.mlm
See Gaitdpois and gaitdpoisson.
truncate, max.support
See Gaitdpois and gaitdpoisson.
pobs.mix, pobs.mlm, byrow.aid
See Gaitdpois and gaitdpoisson.
pstr.mix, pstr.mlm, pdip.mix, pdip.mlm
See Gaitdpois and gaitdpoisson.
theta.a, theta.i, theta.d
Similar to theta.p, and they should have the same length too.
deflation
Logical. Plot the deflation (dip) probabilities?
plot.it
Logical. Plot the PMF?
new.plot, offset.x
If new.plot then plot is called. If multiple plots are desired then use offset.x
to shift the lines.
xlim, ylim, xlab, ylab
See par and plot.default. Argument xlim should be integer-valued.
main, cex.main, posn.main
Character, size and position of main for the title. See title, par and plot.default.
The position is used if it is a 2-vector.
all.col, all.lty, all.lwd
These arguments allow all the colours, line types and line widths arguments to
be assigned to these values, i.e., so that they are the same for all values of the
support. For example, if all.lwd = 2 then this sets lwd.p, lwd.a, lwd.i and
lwd.d all equal to 2.
lty.p, lty.a.mix, lty.a.mlm, lty.i.mix, lty.i.mlm
Line type for parent, altered and inflated. See par and plot.default.
col.p, col.a.mix, col.a.mlm, col.i.mix, col.i.mlm
Line colour for parent (nonspecial), altered, inflated, truncated and deflated val-
ues. See par and plot.default. Roughly, by default and currently, the parent is
pink-like, the altered are greenish, the inflated are purplish/violet, the truncated
are light blue, and the deflated are brownish with the dip probabilities being
reddish. The proper colour names are similar to being acrostic. For each opera-
tor, the colours of "mix" vs "mlm" are similar but different—this is intentional.
Warning: the default colours might change, depending on style!
lty.d.mix, lty.d.mlm, lty.d.dip
Similar to above. Used when deflation = TRUE.
col.d.mix, col.d.mlm, col.d.dip
Similar to above. Used when deflation = TRUE. The website https://www.
spycolor.com was used to choose some of the default colours; the first two are
also called "dirt" and "deer" respectively, which are both brownish.
col.t
Point colour for truncated values, the default is "tan".
type.plot, cex.p
The former matches 'type' argument in plot.default. The latter is the size of
the point if type.plot = "p" or type.plot = "b", etc.
lwd.p, lwd.a, lwd.i, lwd.d
   Line width for parent, altered and inflated. See par and plot.default. By
default par()$lwd is used for all of them.

las, lend
   See par.

iontop, dontop
   Logicals. Draw the inflated and deflated bars on top? The default is to draw
the spikes on top, but if FALSE then the spikes are drawn from the bottom—this
makes it easier to see their distribution. Likewise, if deflation = TRUE then
donstop is used to position the deflation (dip) probabilities.

axes.x, axes.y
   Logical. Plot axes? See par and plot.default.

Plot.trunc, cex.t, pch.t
   Logical. Plot the truncated values? If so, then specify the size and plotting
character. See par and plot.default.

baseparams.argnames
   Character string specifying the argument name for the generic parameter theta,
e.g., "lambda" for gaitdpoisson. By appending .p, there is an argument called
lambda.p in dgaitdpois. Another example is for gaitdlog: "shape" ap-
pended with .p means that dgaitdlog should have an argument called shape.p.
This argument is optional and increases the reliability of the do.call call internally.

nparams, flip.args
   Not for use by the user. It is used internally to handle the NBD.

... 
   Currently unused but there is provision for passing graphical arguments in in the
future; see par.

Details

This is meant to be a crude function to plot the PMF of the GAITD combo model. Some flexibility
is offered via many graphical arguments, but there are still many improvements that could be done.

Value

A list is returned invisibly. The components are:

x
   The integer values between the values of xlim.

pmf.z
   The value of the PMF, by calling the d-type function with all the arguments fed
   in.

sc.parent
   The same level as the scaled parent distribution. Thus for inflated values, the
   value where the spikes begin. And for deflated values, the value at the top of
   the dips. This is a convenient way to obtain them as it is quite cumbersome
to compute them manually. For any nonspecial value, such as non-inflated and
non-deflated values, they are equal to pmf.z.

unsc.parent
   Unscaled parent distribution. If there is no alteration, inflation, deflation and
   truncation then this is the basic PMF stipulated by the parent distribution only.
   Usually this is FYI only.
Note

This utility function may change a lot in the future. Because this function is called by a shiny app, if any parameter values lie outside the parameter space then stop will be called. For example, too much deflation results in NaN values returned by dgaitdnbinom.

Author(s)

T. W. Yee.

See Also

plotdgaitd, spikeplot, meangaitd, Gaitdpois, gaitdpoisson, Gaitdnbinom, multilogitlink.

Examples

```r
## Not run: i.mix <- seq(0, 25, by = 5)
mean.p <- 10; size.p <- 8
dgaitplot(c(size.p, mean.p), fam = "nbinom", xlim = c(0, 25),
a.mix = i.mix + 1, i.mix = i.mix, pobs.mix = 0.1,
pstr.mix = 0.1, lwd.i = 2,lwd.p = 2, lwd.a = 2)
## End(Not run)
```

---

### dhuber

**Huber’s Least Favourable Distribution**

**Description**

Density, distribution function, quantile function and random generation for Huber’s least favourable distribution, see Huber and Ronchetti (2009).

**Usage**

```r
dhuber(x, k = 0.862, mu = 0, sigma = 1, log = FALSE)
edhuber(x, k = 0.862, mu = 0, sigma = 1, log = FALSE)
rhuber(n, k = 0.862, mu = 0, sigma = 1)
qhuber(p, k = 0.862, mu = 0, sigma = 1, lower.tail = TRUE,
      log.p = FALSE)
phuber(q, k = 0.862, mu = 0, sigma = 1, lower.tail = TRUE,
      log.p = FALSE)
```

**Arguments**

- `x, q` numeric vector, vector of quantiles.
- `p` vector of probabilities.
- `n` number of random values to be generated. If length(n) > 1 then the length is taken to be the number required.
k numeric. Borderline value of central Gaussian part of the distribution. This is known as the tuning constant, and should be positive. For example, \( k = 0.862 \) refers to a 20\% contamination neighborhood of the Gaussian distribution. If \( k = 1.40 \) then this is 5\% contamination.

\( \mu \) numeric. Distribution mean.

\( \sigma \) numeric. Distribution scale (\( \sigma = 1 \) defines the distribution in standard form, with standard Gaussian centre).

log Logical. If log = TRUE then the logarithm of the result is returned.

lower.tail, log.p

Same meaning as in pnorm or qnorm.

Details

Details are given in huber2, the VGAM family function for estimating the parameters \( \mu \) and \( \sigma \).

Value
dhuber gives out a vector of density values.
edhuber gives out a list with components val (density values) and eps (contamination proportion).
rhuber gives out a vector of random numbers generated by Huber's least favourable distribution.
phuber gives the distribution function, qhuber gives the quantile function.

Author(s)

Christian Hennig wrote \( [d, ed, r] \)huber() (from smoothmest) and slight modifications were made by T. W. Yee to replace looping by vectorization and addition of the log argument. Arash Ardalan wrote \( [p q] \)huber(), and two arguments for these were implemented by Kai Huang. This help file was adapted from smoothmest.

See Also

huber2.

Examples

set.seed(123456)
edhuber(1:5, k = 1.5)
rhuber(5)

## Not run: \( \mu \) <- 3; xx <- seq(-2, 7, len = 100) # Plot CDF and PDF
plot(xx, dhuber(xx, \( \mu \) = \( \mu \)), type = "l", col = "blue", las = 1,
    main = "blue is density, orange is the CDF", ylab = "",
    sub = "Purple lines are the 10,20,...,90 percentiles",
    ylim = 0:1)
abline(h = 0, col = "blue", lty = 2)
lines(xx, phuber(xx, \( \mu \) = \( \mu \)), type = "l", col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qhuber(probs, \( \mu \) = \( \mu \))
Diffzeta

Differenced Zeta Distribution

Description

Density, distribution function, quantile function, and random generation for the differenced zeta distribution.

Usage

diffzeta(x, shape, start = 1, log = FALSE)
pdiffzeta(q, shape, start = 1, lower.tail = TRUE)
qdiffzeta(p, shape, start = 1)
rdiffzeta(n, shape, start = 1)

Arguments

x, q, p, n  Same as in runif.
shape, start  Details at diffzeta.
log, lower.tail  Same as in runif.

Details

This distribution appears to work well on the distribution of English words in such texts. Some more details are given in diffzeta.

Value

diffzeta gives the density, pdiffzeta gives the distribution function, qdiffzeta gives the quantile function, and rdiffzeta generates random deviates.

Note

Given some response data, the VGAM family function diffzeta estimates the parameter shape. Function pdiffzeta() suffers from the problems that plog sometimes has, i.e., when p is very close to 1.

Author(s)

T. W. Yee
See Also
diffzeta, zetaff, zipf, Oizeta.

Examples
diffzeta(1:20, 0.5, start = 2)
rdiffzeta(20, 0.5)

## Not run: shape <- 0.8; x <- 1:10
plot(x, ddiffzeta(x, sh = shape), type = "h", ylim = 0:1, las = 1,
     sub = "shape=0.8", col = "blue", ylab = "Probability",
     main = "Differenced zeta distribution: blue=PMF; orange=CDF")
lines(x + 0.1, pdiffzeta(x, shape = shape), col = "orange",
      lty = 3, type = "h")
## End(Not run)

diffzeta

Description
Estimates the parameter of the differenced zeta distribution.

Usage
diffzeta(start = 1, lshape = "loglink", ishape = NULL)

Arguments
lshape, ishape  Same as zetaff.
start  Smallest value of the support of the distribution. Must be a positive integer.

Details
The PMF is
\[ P(Y = y) = \frac{a^s}{y^s} - \frac{a^s}{(1 + y)^s}, \quad s > 0, \quad y = a, a + 1, \ldots, \]

where \( s \) is the positive shape parameter, and \( a \) is \( \text{start} \). According to Moreno-Sanchez et al. (2016), this model fits quite well to about 40 percent of all the English books in the Project Gutenberg database (about 30,000 texts). Multiple responses are handled.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.
**dirichlet**

**Author(s)**

T. W. Yee

**References**


**See Also**

`Diffzeta, zetaff, zeta, zipf, zipf`.

**Examples**

```r
odata <- data.frame(x2 = runif(nn <- 1000)) # Artificial data
odata <- transform(odata, shape = loglink(-0.25 + x2, inv = TRUE))
oda <- transform(odata, y1 = rdiffzeta(nn, shape))
with(odata, table(y1))
ofit <- vglm(y1 ~ x2, diffzeta, odata, trace = TRUE)
coef(ofit, matrix = TRUE)
```

---

**dirichlet**  

*Fitting a Dirichlet Distribution*

**Description**

Fits a Dirichlet distribution to a matrix of compositions.

**Usage**

```r
dirichlet(link = "loglink", parallel = FALSE, zero = NULL, imethod = 1)
```

**Arguments**

- `link`  
  Link function applied to each of the $M$ (positive) shape parameters $\alpha_j$. See `Links` for more choices. The default gives $\eta_j = \log(\alpha_j)$.

- `parallel`, `zero`, `imethod`  
  See `CommonVGAMffArguments` for more information.
Details

In this help file the response is assumed to be a $M$-column matrix with positive values and whose rows each sum to unity. Such data can be thought of as compositional data. There are $M$ linear/additive predictors $\eta_j$.

The Dirichlet distribution is commonly used to model compositional data, including applications in genetics. Suppose $(Y_1, \ldots, Y_M)^T$ is the response. Then it has a Dirichlet distribution if $(Y_1, \ldots, Y_{M-1})^T$ has density

$$
\frac{\Gamma(\alpha_+)}{\prod_{j=1}^{M} \Gamma(\alpha_j)} \prod_{j=1}^{M} y_j^{\alpha_j - 1}
$$

where $\alpha_+ = \alpha_1 + \cdots + \alpha_M$, $\alpha_j > 0$, and the density is defined on the unit simplex

$$
\Delta_M = \left\{ (y_1, \ldots, y_M)^T : y_1 > 0, \ldots, y_M > 0, \sum_{j=1}^{M} y_j = 1 \right\}.
$$

One has $E(Y_j) = \alpha_j/\alpha_+$, which are returned as the fitted values. For this distribution Fisher scoring corresponds to Newton-Raphson.

The Dirichlet distribution can be motivated by considering the random variables $(G_1, \ldots, G_M)^T$ which are each independent and identically distributed as a gamma distribution with density $f(g_j) = g_j^{\alpha_j - 1} e^{-g_j/\Gamma(\alpha_j)}$. Then the Dirichlet distribution arises when $Y_j = G_j / (G_1 + \cdots + G_M)$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

When fitted, the fitted.values slot of the object contains the $M$-column matrix of means.

Note

The response should be a matrix of positive values whose rows each sum to unity. Similar to this is count data, where probably a multinomial logit model (multinomial) may be appropriate. Another similar distribution to the Dirichlet is the Dirichlet-multinomial (see dirmultinomial).

Author(s)

Thomas W. Yee

References


See Also

rdiric, dirmultinomial, multinomial, simplex.
Examples

ddata <- data.frame(rdiric(1000,
    shape = exp(c(y1 = -1, y2 = 1, y3 = 0))))
fit <- vglm(cbind(y1, y2, y3) ~ 1, dirichlet,
    data = ddata, trace = TRUE, crit = "coef")
Coef(fit)
coef(fit, matrix = TRUE)
head(fitted(fit))

dirmul.old  Fitting a Dirichlet-Multinomial Distribution

Description

Fits a Dirichlet-multinomial distribution to a matrix of non-negative integers.

Usage

dirmul.old(link = "loglink", ialpha = 0.01, parallel = FALSE,
    zero = NULL)

Arguments

link  Link function applied to each of the $M$ (positive) shape parameters $\alpha_j$ for $j = 1,\ldots,M$. See Links for more choices. Here, $M$ is the number of columns of the response matrix.

ialpha  Numeric vector. Initial values for the alpha vector. Must be positive. Recycled to length $M$.

parallel  A logical, or formula specifying which terms have equal/unequal coefficients.

zero  An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set $\{1,2,\ldots,M\}$. See CommonVGAMffArguments for more information.

Details

The Dirichlet-multinomial distribution, which is somewhat similar to a Dirichlet distribution, has probability function

$$
P(Y_1 = y_1, \ldots, Y_M = y_M) = \binom{2y_*}{y_1,\ldots,y_M} \frac{\Gamma(\alpha_+)}{\Gamma(2y_* + \alpha_+)} \prod_{j=1}^{M} \frac{\Gamma(y_j + \alpha_j)}{\Gamma(\alpha_j)}$$

for $\alpha_j > 0$, $\alpha_+ = \alpha_1 + \cdots + \alpha_M$, and $2y_* = y_1 + \cdots + y_M$. Here, $\binom{a}{b}$ means “$a$ choose $b$” and refers to combinations (see choose). The (posterior) mean is

$$
E(Y_j) = (y_j + \alpha_j)/(2y_* + \alpha_+)
$$

for $j = 1,\ldots,M$, and these are returned as the fitted values as a $M$-column matrix.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Note

The response should be a matrix of non-negative values. Convergence seems to slow down if there are zero values. Currently, initial values can be improved upon.

This function is almost defunct and may be withdrawn soon. Use dirmultinomial instead.

Author(s)

Thomas W. Yee

References


See Also
dirmultinomial, dirichlet, betabinomialff, multinomial.

Examples

# Data from p.50 of Lange (2002)
alleleCounts <- c(2, 84, 59, 41, 53, 131, 2, 0,
                 0, 50, 137, 78, 54, 51, 0, 0,
                 0, 80, 128, 26, 55, 95, 0, 0,
                 0, 16, 40, 8, 68, 14, 7, 1)
dim(alleleCounts) <- c(8, 4)
alleleCounts <- data.frame(t(alleleCounts))
dimnames(alleleCounts) <- list(c("White", "Black", "Chicano", "Asian"),
paste("Allele", 5:12, sep = ""))

set.seed(123) # @initialize uses random numbers
fit <- vglm(cbind(Allele5,Allele6,Allele7,Allele8,Allele9,
                 Allele10,Allele11,Allele12) ~ 1, dirmul.old,
             trace = TRUE, crit = "c", data = alleleCounts)

(sfit <- summary(fit))
vcov(sfit)
round(eta2theta(coef(fit),

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dirmul.old
dirmultinomial

Fitting a Dirichlet-Multinomial Distribution

Description

Fits a Dirichlet-multinomial distribution to a matrix response.

Usage

dirmultinomial(lphi = "logitlink", iphi = 0.10, parallel = FALSE, zero = "M")

Arguments

lphi Link function applied to the $\phi$ parameter, which lies in the open unit interval $(0, 1)$. See Links for more choices.

iphi Numeric. Initial value for $\phi$. Must be in the open unit interval $(0, 1)$. If a failure to converge occurs then try assigning this argument a different value.

parallel A logical (formula not allowed here) indicating whether the probabilities $\pi_1, \ldots, \pi_{M-1}$ are to be equal via equal coefficients. Note $\pi_M$ will generally be different from the other probabilities. Setting parallel = TRUE will only work if you also set zero = NULL because of interference between these arguments (with respect to the intercept term).

zero An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set $\{1, 2, \ldots, M\}$. If the character "M" then this means the numerical value $M$, which corresponds to linear/additive predictor associated with $\phi$. Setting zero = NULL means none of the values from the set $\{1, 2, \ldots, M\}$. See CommonVGAMffArguments for more information.
Details

The Dirichlet-multinomial distribution arises from a multinomial distribution where the probability parameters are not constant but are generated from a multivariate distribution called the Dirichlet distribution. The Dirichlet-multinomial distribution has probability function

\[
P(Y_1 = y_1, \ldots, Y_M = y_M) = \binom{N^*}{y_1, \ldots, y_M} \prod_{j=1}^M \frac{\pi_j (1 - \phi) + (r - 1)\phi}{\prod_{r=1}^{N^*} (1 - \phi + (r - 1)\phi)}
\]

where \(\phi\) is the over-dispersion parameter and \(N^* = y_1 + \cdots + y_M\). Here, \(\binom{a}{b}\) means "a choose b" and refers to combinations (see choose). The above formula applies to each row of the matrix response. In this VGAM family function the first \(M - 1\) linear/additive predictors correspond to the first \(M - 1\) probabilities via

\[
\eta_j = \log(P[Y = j]/P[Y = M]) = \log(\pi_j/\pi_M)
\]

where \(\eta_j\) is the \(j\)th linear/additive predictor \((\eta_M = 0\) by definition for \(P[Y = M]\) but not for \(\phi\)) and \(j = 1, \ldots, M - 1\). The \(M\)th linear/additive predictor corresponds to \(\text{lp1}()\) applied to \(\phi\).

Note that \(E(Y_j) = N_\pi j\) but the probabilities (returned as the fitted values) \(\pi_j\) are bundled together as a \(M\)-column matrix. The quantities \(N_\pi\) are returned as the prior weights.

The beta-binomial distribution is a special case of the Dirichlet-multinomial distribution when \(M = 2\); see betabinomial. It is easy to show that the first shape parameter of the beta distribution is \(\text{shape}_1 = \pi(1/\phi - 1)\) and the second shape parameter is \(\text{shape}_2 = (1 - \pi)(1/\phi - 1)\). Also, \(\phi = 1/(1 + \text{shape}_1 + \text{shape}_2)\), which is known as the intra-cluster correlation coefficient.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

If the model is an intercept-only model then \(\text{misc}\) (which is a list) has a component called \(\text{shape}\) which is a vector with the \(M\) values \(\pi_j(1/\phi - 1)\).

Warning

This VGAM family function is prone to numerical problems, especially when there are covariates.

Note

The response can be a matrix of non-negative integers, or else a matrix of sample proportions and the total number of counts in each row specified using the \text{weights} argument. This dual input option is similar to multinomial.

To fit a ‘parallel’ model with the \(\phi\) parameter being an intercept-only you will need to use the \text{constraints} argument.

Currently, Fisher scoring is implemented. To compute the expected information matrix a for loop is used; this may be very slow when the counts are large. Additionally, convergence may be slower than usual due to round-off error when computing the expected information matrices.

Author(s)

Thomas W. Yee
References


See Also

dirmul.old, betabinomial, betabinomialff, dirichlet, multinomial.

Examples

```r
nn <- 5; M <- 4; set.seed(1)
ydata <- data.frame(round(matrix(runif(nn * M, max = 100), nn, M)))
colnames(ydata) <- paste("y", 1:M, sep = "")  # Integer counts

fit <- vglm(cbind(y1, y2, y3, y4) ~ 1, dirmultinomial,
            data = ydata, trace = TRUE)
head(fitted(fit))
depvar(fit)  # Sample proportions
weights(fit, type = "prior", matrix = FALSE)  # Total counts per row

## Not run:
ydata <- transform(ydata, x2 = runif(nn))
fit <- vglm(cbind(y1, y2, y3, y4) ~ x2, dirmultinomial,
            data = ydata, trace = TRUE)
Coef(fit)
coef(fit, matrix = TRUE)
(sfit <- summary(fit))
vcov(sfit)
## End(Not run)
```

### dlogF

**log F Distribution**

**Description**

Density for the log F distribution.

**Usage**

```r
dlogF(x, shape1, shape2, log = FALSE)
```
Arguments

- **x**: Vector of quantiles.
- **shape1, shape2**: Positive shape parameters.
- **log**: If TRUE then the log density is returned, else the density.

Details

The details are given in `logF`.

Value

dlogF gives the density.

Author(s)

T. W. Yee

See Also

hypersecant, dextlogF.

Examples

```r
## Not run: shape1 <- 1.5; shape2 <- 0.5; x <- seq(-5, 8, length = 1001)
plot(x, dlogF(x, shape1, shape2), type = "l",
     las = 1, col = "blue", ylab = "pdf",
     main = "log F density function")
## End(Not run)
```

---

**double.cens.normal**

Univariate Normal Distribution with Double Censoring

Description

Maximum likelihood estimation of the two parameters of a univariate normal distribution when there is double censoring.

Usage

double.cens.normal(r1 = 0, r2 = 0, lmu = "identitylink", lsd =
                   "loglink", imu = NULL, isd = NULL, zero = "sd")

Arguments

- **r1, r2**: Integers. Number of smallest and largest values censored, respectively.
- **lmu, lsd**: Parameter link functions applied to the mean and standard deviation. See `Links` for more choices.
- **imu, isd, zero**: See `CommonVGAMffArguments` for more information.
Details

This family function uses the Fisher information matrix given in Harter and Moore (1966). The matrix is not diagonal if either \( r_1 \) or \( r_2 \) are positive.

By default, the mean is the first linear/additive predictor and the log of the standard deviation is the second linear/additive predictor.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Note

This family function only handles a vector or one-column matrix response. The `weights` argument, if used, are interpreted as frequencies, therefore it must be a vector with positive integer values.

With no censoring at all (the default), it is better (and equivalent) to use `uninormal`.

Author(s)

T. W. Yee

References


See Also

`uninormal`, `cens.normal`, `tobit`.

Examples

```r
## Not run: # Repeat the simulations of Harter & Moore (1966)
SIMS <- 100 # Number of simulations (change this to 1000)
mu.save <- sd.save <- rep(NA, len = SIMS)
r1 <- 0; r2 <- 4; nn <- 20
for (sim in 1:SIMS) {
  y <- sort(rnorm(nn)) # Delete r1 smallest and r2 largest
  y <- y[(1+r1):(nn-r2)]
  fit <- vglm(y ~ 1, double.cens.normal(r1 = r1, r2 = r2))
  mu.save[sim] <- predict(fit)[1, 1]
  sd.save[sim] <- exp(predict(fit)[1, 2]) # Assumes a log link & ~ 1
}
c(mean(mu.save), mean(sd.save)) # Should be c(0,1)
c(sd(mu.save), sd(sd.save))
## End(Not run)

# Data from Sarhan & Greenberg (1962); MLEs are mu=9.2606, sd=1.3754
strontium90 <- data.frame(y = c(8.2, 8.4, 9.1, 9.8, 9.9))
```

```
```r
fit <- vglm(y ~ 1, double.cens.normal(r1 = 2, r2 = 3, isd = 6),
           data = strontium90, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
```

double.expbinomial

**Double Exponential Binomial Distribution Family Function**

**Description**
Fits a double exponential binomial distribution by maximum likelihood estimation. The two parameters here are the mean and dispersion parameter.

**Usage**
```r
double.expbinomial(lmean = "logitlink", ldispersion = "logitlink",
                   idispersion = 0.25, zero = "dispersion")
```

**Arguments**
- **lmean, ldispersion** Link functions applied to the two parameters, called \(\mu\) and \(\theta\) respectively below. See **Links** for more choices. The defaults cause the parameters to be restricted to \((0,1)\).
- **idispersion** Initial value for the dispersion parameter. If given, it must be in range, and is recycled to the necessary length. Use this argument if convergence failure occurs.
- **zero** A vector specifying which linear/additive predictor is to be modelled as intercept-only. If assigned, the single value can be either 1 or 2. The default is to have a single dispersion parameter value. To model both parameters as functions of the covariates assign `zero = NULL`. See **CommonVGAMffArguments** for more details.

**Details**
This distribution provides a way for handling overdispersion in a binary response. The double exponential binomial distribution belongs the family of double exponential distributions proposed by Efron (1986). Below, equation numbers refer to that original article. Briefly, the idea is that an ordinary one-parameter exponential family allows the addition of a second parameter \(\theta\) which varies the dispersion of the family without changing the mean. The extended family behaves like the original family with sample size changed from \(n\) to \(n\theta\). The extended family is an exponential family in \(\mu\) when \(n\) and \(\theta\) are fixed, and an exponential family in \(\theta\) when \(n\) and \(\mu\) are fixed. Having \(0 < \theta < 1\) corresponds to overdispersion with respect to the binomial distribution. See Efron (1986) for full details.

This **VGAM** family function implements an approximation (2.10) to the exact density (2.4). It replaces the normalizing constant by unity since the true value nearly equals 1. The default model fitted is \(\eta_1 = \text{logit}(\mu)\) and \(\eta_2 = \text{logit}(\theta)\). This restricts both parameters to lie between 0 and 1, although the dispersion parameter can be modelled over a larger parameter space by assigning the arguments `ldispersion` and `edispersion`. 
Approximately, the mean (of $Y$) is $\mu$. The effective sample size is the dispersion parameter multiplied by the original sample size, i.e., $n\theta$. This family function uses Fisher scoring, and the two estimates are asymptotically independent because the expected information matrix is diagonal.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm.

**Warning**

Numerical difficulties can occur; if so, try using idispersion.

**Note**

This function processes the input in the same way as binomialff, however multiple responses are not allowed (binomialff(multiple.responses = FALSE)).

**Author(s)**

T. W. Yee

**References**


**See Also**

binomialff, toxop, CommonVGAMffArguments.

**Examples**

# This example mimics the example in Efron (1986).
# The results here differ slightly.

# Scale the variables
toxop <- transform(toxop,
    phat = positive / ssize,
    srainfall = scale(rainfall), # (6.1)
    sN = scale(ssize)) # (6.2)

# A fit similar (should be identical) to Sec.6 of Efron (1986).
# But does not use poly(), and M = 1.25 here, as in (5.3)
cmlist <- list("(Intercept)" = diag(2),
    "I(srainfall)" = rbind(1, 0),
    "I(srainfall^2)" = rbind(1, 0),
    "I(srainfall^3)" = rbind(1, 0),
    "I(sN)" = rbind(0, 1),
    "I(sN^2)" = rbind(0, 1))

fit <- vglm(cbind(phat, 1 - phat) * ssize ~

### double.expbinomial

255
I(srainfall) + I(srainfall^2) + I(srainfall^3) +
I(sN) + I(sN^2),

\texttt{double.expbinomial}(ldisp = \texttt{extlogitlink}(min = 0, max = 1.25),
iddisp = 0.2, zero = \texttt{NULL}),
toxop, trace = \texttt{TRUE}, constraints = \texttt{cmlist})

# Now look at the results
c\texttt{coef(fit, matrix = TRUE)}
\texttt{head(fitted(fit))}
\texttt{summary(fit)}
\texttt{vcov(fit)}
\texttt{sqrt(diag(vcov(fit)))} # Standard errors

# Effective sample size (not quite the last column of Table 1)
\texttt{head(predict(fit))}
\texttt{Dispersion <- extlogitlink(predict(fit)[,2], min = 0, max = 1.25,}
\texttt{inverse = \texttt{TRUE})}
\texttt{c(round(weights(fit, type = "prior") * Dispersion, digits = 1))}

# Ordinary logistic regression (gives same results as (6.5))
ofit <- \texttt{vglm(cbind(phat, 1 - phat) * ssize ~}
\texttt{I(srainfall) + I(srainfall^2) + I(srainfall^3),}
\texttt{binomialff, toxop, trace = \texttt{TRUE})}

# Same as fit but it uses \texttt{poly()}, and can be plotted (cf. Fig.1)
c\texttt{mlist2 <- list("(Intercept)" = diag(2),}
\texttt{"poly(srainfall, degree = 3)" = rbind(1, 0),}
\texttt{"poly(sN, degree = 2)" = rbind(0, 1))}
\texttt{fit2 <-}
\texttt{vglm(cbind(phat, 1 - phat) * ssize ~}
\texttt{poly(srainfall, degree = 3) + poly(sN, degree = 2),}
\texttt{double.expbinomial}(ldisp = extlogitlink(min = 0, max = 1.25),
iddisp = 0.2, zero = \texttt{NULL}),
toxop, trace = \texttt{TRUE}, constraints = \texttt{cmlist2})

## Not run: \texttt{par(mfrow = c(1, 2))} # Cf. Fig.1
\texttt{plot(as(fit2, "vgam"), se = \texttt{TRUE}, lcol = "blue", scol = "orange")}

# Cf. Figure 1(a)
\texttt{par(mfrow = c(1,2))}
\texttt{ooo <- with(toxop, sort.list(rainfall))}
\texttt{with(toxop, plot(rainfall[ooo], fitted(fit2)[ooo], type = "l",}
\texttt{col = "blue", las = 1, ylim = c(0.3, 0.65))}
\texttt{with(toxop, points(rainfall[ooo], fitted(ofit)[ooo],}
\texttt{col = "orange", type = "b", pch = 19))}

# Cf. Figure 1(b)
\texttt{ooo <- with(toxop, sort.list(ssize))}
\texttt{with(toxop, plot(ssize[ooo], Dispersion[ooo], type = "l",}
\texttt{col = "blue", las = 1, xlim = c(0, 100))}

## End(Not run)
Relative Frequencies of Serum Proteins in White Pekin Ducklings

Description

Relative frequencies of serum proteins in white Pekin ducklings as determined by electrophoresis.

Usage

data(ducklings)

Format

The format is: chr "ducklings"

Details

Columns p1, p2, p3 stand for pre-albumin, albumin, globulins respectively. These were collected from 3-week old white Pekin ducklings. Let $Y_1$ be proportional to the total milligrams of pre-albumin in the blood serum of a duckling. Similarly, let $Y_2$ and $Y_3$ be directly proportional to the same factor as $Y_1$ to the total milligrams respectively of albumin and globulins in its blood serum. The proportion of pre-albumin is given by $Y_1/(Y_1 + Y_2 + Y_3)$, and similarly for the others.

Source

Mosimann, J. E. (1962) On the compound multinomial distribution, the multivariate $\beta$-distribution, and correlations among proportions, Biometrika, 49, 65–82.

See Also

dirichlet.

Examples

print(ducklings)

eCDF

Empirical Cumulative Distribution Function

Description

Returns the desired quantiles of quantile regression object such as an extlogF1() or lms.bcn() VGLM object

Usage

eCDF.vglm(object, all = FALSE, ...)

Arguments

- object: an object such as a `vglm` object with family function `extlogF1` or `lms.bcn`.
- all: Logical. Return all other information? If true, the empirical CDF is returned.
- ...: additional optional arguments. Currently unused.

Details

This function was specifically written for a `vglm` object with family function `extlogF1` or `lms.bcn`. It returns the proportion of data lying below each of the fitted quantiles, and optionally the desired quantiles (arguments `tau` or `percentiles / 100` in the family function). The output is coerced to be comparable between family functions by calling the columns by the same names.

Value

A vector with each value lying in (0, 1). If `all = TRUE` then a 2-column matrix with the second column being the `tau` values or equivalent.

See Also

`extlogF1`, `lms.bcn`, `vglm`.

Examples

```r
fit1 <- vglm(BMI ~ ns(age, 4), extlogF1, data = bmi.nz) # trace = TRUE
eCDF(fit1)
eCDF(fit1, all = TRUE)
```

Description

Enzyme velocity and substrate concentration.

Usage

data(enzyme)

Format

A data frame with 12 observations on the following 2 variables.

- `conc` a numeric explanatory vector; substrate concentration
- `velocity` a numeric response vector; enzyme velocity

Details

Sorry, more details need to be included later.
**erf**

Error Function, and variants

**Description**

Computes the error function, or its inverse, based on the normal distribution. Also computes the complement of the error function, or its inverse.

**Usage**

```r
erf(x, inverse = FALSE)
erfc(x, inverse = FALSE)
```

**Arguments**

- `x` Numeric.
- `inverse` Logical. Of length 1.

**Details**

\( \text{Erf}(x) \) is defined as

\[
\operatorname{Erf}(x) = \frac{2}{\sqrt{\pi}} \int_0^x \exp(-t^2) dt
\]

so that it is closely related to \( \text{pnorm} \). The inverse function is defined for \( x \) in \((-1, 1)\).
Value

Returns the value of the function evaluated at x.

Note

Some authors omit the term $2/\sqrt{\pi}$ from the definition of $Erf(x)$. Although defined for complex arguments, this function only works for real arguments.

The complementary error function $erfc(x)$ is defined as $1 - erf(x)$, and is implemented by erfc. Its inverse function is defined for $x$ in $(0, 2)$.

Author(s)

T. W. Yee

References


See Also

pnorm.

Examples

```r
## Not run:
curve(erf, -3, 3, col = "orange", ylab = "", las = 1)
curve(pnorm, -3, 3, add = TRUE, col = "blue", lty = "dotted", lwd = 2)
abline(v = 0, h = 0, lty = "dashed")
legend("topleft", c("erf(x)", "pnorm(x)"), col = c("orange", "blue"),
    lty = c("solid", "dotted"), lwd = 1:2)
## End(Not run)
```

erlang

**Erlang Distribution**

Description

Estimates the scale parameter of the Erlang distribution by maximum likelihood estimation.

Usage

erlang(shape.arg, lscale = "loglink", imethod = 1, zero = NULL)
erlang

Arguments

- **shape.arg**: The shape parameters. The user must specify a positive integer, or integers for multiple responses. They are recycled by `row = TRUE` according to `matrix`.
- **lscale**: Link function applied to the (positive) `scale` parameter. See `Links` for more choices.
- **imethod, zero**: See `CommonVGAMffArguments` for more details.

Details

The Erlang distribution is a special case of the gamma distribution with `shape` that is a positive integer. If `shape.arg = 1` then it simplifies to the exponential distribution. As illustrated in the example below, the Erlang distribution is the distribution of the sum of `shape.arg` independent and identically distributed exponential random variates.

The probability density function of the Erlang distribution is given by

\[ f(y) = \exp(-y/scale)y^{shape-1}scale^{-shape}/\Gamma(shape) \]

for known positive integer `shape`, unknown `scale > 0` and `y > 0`. Here, \( \Gamma(shape) \) is the gamma function, as in `gamma`. The mean of \( Y \) is \( \mu = shape \times scale \) and its variance is \( shape \times scale^2 \).

The linear/additive predictor, by default, is \( \eta = \log(scale) \).

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

Note

Multiple responses are permitted. The rate parameter found in `gammaR` is `1/scale` here—see also `rgamma`.

Author(s)

T. W. Yee

References

Most standard texts on statistical distributions describe this distribution, e.g.,

See Also

- `gammaR`, `exponential`, `simulate.vlm`. 
**Examples**

```r
rate <- exp(2); myshape <- 3
data <- data.frame(y = rep(0, nn <- 1000))
for (ii in 1:myshape)
  data <- transform(data, y = y + rexp(nn, rate = rate))
fit <- vglm(y ~ 1, erlang(shape = myshape), data, trace = TRUE)
coef(fit, matrix = TRUE)
1/rate
summary(fit)
```

**Expectiles-Exponential**

*Expectiles of the Exponential Distribution*

**Description**

Density function, distribution function, and expectile function and random generation for the distribution associated with the expectiles of an exponential distribution.

**Usage**

```r
dexp(x, rate = 1, log = FALSE)
pexp(q, rate = 1, lower.tail = TRUE, log.p = FALSE)
qexp(p, rate = 1, Maxit.nr = 10, Tol.nr = 1.0e-6,
    lower.tail = TRUE, log.p = FALSE)
rexp(n, rate = 1)
```

**Arguments**

- `x, p, q` See `dexp`.
- `n, rate, log` See `rexp`.
- `lower.tail, log.p` Same meaning as in `pexp` or `qexp`.
- `Maxit.nr, Tol.nr` See `deunif`.

**Details**

General details are given in `deunif` including a note regarding the terminology used. Here, `exp` corresponds to the distribution of interest, $F$, and `eexp` corresponds to $G$. The addition of “e” is for the ‘other’ distribution associated with the parent distribution. Thus `dexp` is for $g$, `pexp` is for $G$, `qexp` is for the inverse of $G$, `rexp` generates random variates from $g$.

For `qexp` the Newton-Raphson algorithm is used to solve for $y$ satisfying $p = G(y)$. Numerical problems may occur when values of `p` are very close to 0 or 1.
deexp(x) gives the density function \( g(x) \). peexp(q) gives the distribution function \( G(q) \). qeexp(p) gives the expectile function: the value \( y \) such that \( G(y) = p \). reexp(n) gives \( n \) random variates from \( G \).

Author(s)
T. W. Yee and Kai Huang

See Also
deunif, denorm, dexp.

Examples

```r
my.p <- 0.25; y <- rexp(nn <- 1000)
(myexp <- qeexp(my.p))
sum(myexp - y[y <= myexp]) / sum(abs(myexp - y))  # Should be my.p

## Not run: par(mfrow = c(2,1))
yy <- seq(-0, 4, len = nn)
plot(yy, deexp(yy), col = "blue", ylim = 0:1, xlab = "y",ylab = "g(y)",
     type = "l", main = "g(y) for Exp(1); dotted green is f(y) = dexp(y)"
lines(yy, dexp(yy), col = "green", lty = "dotted", lwd = 2)  # 'original'

plot(yy, peexp(yy), type = "l", col = "blue", ylim = 0:1,
     xlab = "y", ylab = "G(y)",
     type = "l", main = "G(y) for Exp(1)"
lines(yy, pexp(yy), col = "green", lty = "dotted", lwd = 2)
## End(Not run)
```

Description

Density function, distribution function, and expectile function and random generation for the distribution associated with the expectiles of a normal distribution.

Usage

```r
denorm(x, mean = 0, sd = 1, log = FALSE)
penorm(q, mean = 0, sd = 1, lower.tail = TRUE, log.p = FALSE)
qenorm(p, mean = 0, sd = 1, Maxit.nr = 10, Tol.nr = 1.0e-6,
     lower.tail = TRUE, log.p = FALSE)
renorm(n, mean = 0, sd = 1)
```
Expectiles-Normal

Arguments

- `x, p, q` See `deunif`
- `n, mean, sd, log` See `rnorm`
- `lower.tail, log.p` Same meaning as in `pnorm` or `qnorm`.
- `Maxit.nr, Tol.nr` See `deunif`.

Details

General details are given in `deunif` including a note regarding the terminology used. Here, `norm` corresponds to the distribution of interest, \( F \), and `enorm` corresponds to \( G \). The addition of “e” is for the ‘other’ distribution associated with the parent distribution. Thus `denorm` is for \( g \), `penorm` is for \( G \), `qenorm` is for the inverse of \( G \), `renorm` generates random variates from \( g \).

For `qenorm` the Newton-Raphson algorithm is used to solve for \( y \) satisfying \( p = G(y) \). Numerical problems may occur when values of \( p \) are very close to 0 or 1.

Value

- `denorm(x)` gives the density function \( g(x) \).
- `penorm(q)` gives the distribution function \( G(q) \).
- `qenorm(p)` gives the expectile function: the value \( y \) such that \( G(y) = p \).
- `renorm(n)` gives \( n \) random variates from \( G \).

Author(s)

T. W. Yee and Kai Huang

See Also

- `deunif`, `deexp`, `dnorm`, `amlnormal`, `lms.bcn`

Examples

```r
my.p <- 0.25; y <- rnorm(nn <- 1000)
(myexp <- qenorm(my.p))
sum(myexp - y[y <= myexp]) / sum(abs(myexp - y)) # Should be my.p

# Non-standard normal
mymean <- 1; mysd <- 2
yy <- rnorm(nn, mymean, mysd)
(myexp <- qenorm(my.p, mymean, mysd))
sum(myexp - yy[yy <= myexp]) / sum(abs(myexp - yy)) # Should be my.p
penorm(-Inf, mymean, mysd) # Should be 0
penorm( Inf, mymean, mysd) # Should be 1
penorm(mean(yy), mymean, mysd) # Should be 0.5
abs(qenorm(0.5, mymean, mysd) - mean(yy)) # Should be 0
abs(penorm(myexp, mymean, mysd) - my.p) # Should be 0
integrate(f = denorm, lower = -Inf, upper = Inf, mymean, mysd) # Should be 1
```
## Not run:
par(mfrow = c(2, 1))

yy <- seq(-3, 3, len = nn)
plot(yy, denorm(yy), type = "l", col="blue", xlab = "y", ylab = "g(y)",
    main = "g(y) for N(0,1); dotted green is f(y) = dnorm(y)"
lines(yy, dnorm(yy), col = "green", lty = "dotted", lwd = 2)  # 'original'

plot(yy, penorm(yy), type = "l", col = "blue", ylim = 0:1,
xlab = "y", ylab = "G(y)",
    main = "G(y) for N(0,1)"
abline(v = 0, h = 0.5, col = "red", lty = "dashed"
lines(yy, pnorm(yy), col = "green", lty = "dotted", lwd = 2)
## End(Not run)

---

**Expectiles-sc.t2**

**Expectiles/Quantiles of the Scaled Student t Distribution with 2 Df**

### Description

Density function, distribution function, and quantile/expectile function and random generation for the scaled Student t distribution with 2 degrees of freedom.

### Usage

- `dsc.t2(x, location = 0, scale = 1, log = FALSE)`
- `psc.t2(q, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)`
- `qsc.t2(p, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)`
- `rsc.t2(n, location = 0, scale = 1)`

### Arguments

- `x, q` Vector of expectiles/quantiles. See the terminology note below.
- `p` Vector of probabilities. These should lie in $(0, 1)$.
- `n, log` See `runif`.
- `location, scale` Location and scale parameters. The latter should have positive values. Values of these vectors are recycled.
- `lower.tail, log.p` Same meaning as in `pt` or `qt`.

### Details

A Student-t distribution with 2 degrees of freedom and a scale parameter of $\sqrt{2}$ is equivalent to the standard form of this distribution (called Koenker’s distribution below). Further details about this distribution are given in `sc.studentt2`.
Value

dsc.t2(x) gives the density function. psc.t2(q) gives the distribution function. qsc.t2(p) gives the expectile and quantile function. rsc.t2(n) gives \( n \) random variates.

Author(s)

T. W. Yee and Kai Huang

See Also

dt, sc.studentt2.

Examples

```r
my.p <- 0.25; y <- rsc.t2(nn <- 5000)
(myexp <- qsc.t2(my.p))
sum(myexp - y[y <= myexp]) / sum(abs(myexp - y)) \# Should be my.p

# Equivalently:
I1 <- mean(y <= myexp) * mean(myexp - y[y <= myexp])
I2 <- mean(y > myexp) * mean(-myexp + y[y > myexp])
I1 / (I1 + I2) \# Should be my.p

# Or:
I1 <- sum(myexp - y[y <= myexp])
I2 <- sum(-myexp + y[y > myexp])

# Non-standard Koenker distribution
myloc <- 1; myscale <- 2
yy <- rsc.t2(nn, myloc, myscale)
(myexp <- qsc.t2(my.p, myloc, myscale))
sum(myexp - yy[yy <= myexp]) / sum(abs(myexp - yy)) \# Should be my.p

psc.t2(mean(yy), myloc, myscale) \# Should be 0.5
abs(qsc.t2(0.5, myloc, myscale) - mean(yy)) \# Should be 0
abs(psc.t2(myexp, myloc, myscale) - my.p) \# Should be 0
integrate(f = dsc.t2, lower = -Inf, upper = Inf,
locat = myloc, scale = myscale) \# Should be 1

y <- seq(-7, 7, len = 201)
max(abs(dsc.t2(y) - dt(y / sqrt(2), df = 2) / sqrt(2))) \# Should be 0

## Not run:
plot(y, dsc.t2(y), type = "l", col = "blue", las = 1,
ylim = c(0, 0.4), main = "Blue = Koenker; orange = N(0, 1)"
lines(y, dnorm(y), type = "l", col = "orange")
abline(h = 0, v = 0, lty = 2)
## End(Not run)
```
Description

Density function, distribution function, and expectile function and random generation for the distribution associated with the expectiles of a uniform distribution.

Usage

deunif(x, min = 0, max = 1, log = FALSE)
peunif(q, min = 0, max = 1, lower.tail = TRUE, log.p = FALSE)
qeunif(p, min = 0, max = 1, Maxit.nr = 10, Tol.nr = 1.0e-6, lower.tail = TRUE, log.p = FALSE)
reunif(n, min = 0, max = 1)

Arguments

x, q
Vector of expectiles. See the terminology note below.
p
Vector of probabilities. These should lie in (0, 1).
n, min, max, log
See runif.
lower.tail, log.p
Same meaning as in punif or qunif.
Maxit.nr
Numeric. Maximum number of Newton-Raphson iterations allowed. A warning is issued if convergence is not obtained for all p values.
Tol.nr
Numeric. Small positive value specifying the tolerance or precision to which the expectiles are computed.

Details

Jones (1994) elucidated on the property that the expectiles of a random variable X with distribution function $F(x)$ correspond to the quantiles of a distribution $G(x)$ where $G$ is related by an explicit formula to $F$. In particular, let $y$ be the $p$-expectile of $F$. Then $y$ is the $p$-quantile of $G$ where

$$p = G(y) = (P(y) - yF(y))/(2[P(y) - yF(y)] + y - \mu),$$

and $\mu$ is the mean of $X$. The derivative of $G$ is

$$g(y) = (\mu F(y) - P(y))/(2[P(y) - yF(y)] + y - \mu)^2.$$ 

Here, $P(y)$ is the partial moment $\int_{-\infty}^{y} xf(x) \, dx$ and $0 < p < 1$. The 0.5-expectile is the mean $\mu$ and the 0.5-quantile is the median.

A note about the terminology used here. Recall in the S language there are the dpqr-type functions associated with a distribution, e.g., dunif, punif, qunif, runif, for the uniform distribution. Here, unif corresponds to $F$ and eunif corresponds to $G$. The addition of “e” (for expectile) is for the ‘other’ distribution associated with the parent distribution. Thus deunif is for $g$, peunif is for $G$, qeunif is for the inverse of $G$, reunif generates random variates from $g$.

For qeunif the Newton-Raphson algorithm is used to solve for $y$ satisfying $p = G(y)$. Numerical problems may occur when values of $p$ are very close to 0 or 1.
**Value**

deunif(x) gives the density function \( g(x) \). peunif(q) gives the distribution function \( G(q) \). qeunif(p) gives the expectile function: the expectile \( y \) such that \( G(y) = p \). reunif(n) gives \( n \) random variates from \( G \).

**Author(s)**

T. W. Yee and Kai Huang

**References**


**See Also**

dexp, denorm, dunif, dsc.t2.

**Examples**

```r
my.p <- 0.25; y <- runif(nn <- 1000)
(myexp <- qeunif(my.p))
sum(myexp - y[ y <= myexp]) / sum(abs(myexp - y))  # Should be my.p
# Equivalently:
I1 <- mean(y <= myexp) * mean( myexp - y[ y <= myexp])
I2 <- mean(y >  myexp) * mean(-myexp + y[ y >  myexp])
I1 / (I1 + I2)  # Should be my.p
# Or:
I1 <- sum( myexp - y[ y <= myexp])
I2 <- sum(-myexp + y[ y >  myexp])

# Non-standard uniform
mymin <- 1; mymax <- 8
yy <- runif(nn, mymin, mymax)
(myexp <- qeunif(my.p, mymin, mymax))
sum(yy - y[yy <= myexp]) / sum(abs(myexp - y))  # Should be my.p
peunif(mymin, mymin, mymax)  # Should be 0
peunif(mymin, mymin, mymax)  # Should be 1
peunif(mean(yy), mymin, mymax)  # Should be 0.5
abs(qeunif(0.5, mymin, mymax) - mean(yy))  # Should be 0
abs(qeunif(0.5, mymin, mymax) - (mymin+mymax)/2)  # Should be 0
abs(peunif(myexp, mymin, mymax) - my.p)  # Should be 0
integrate(f = deunif, lower = mymin - 3, upper = mymax + 3,
min = mymin, max = mymax)  # Should be 1

## Not run:
par(mfrow = c(2,1))
yy <- seq(0.0, 1.0, len = nn)
plot(yy, peunif(yy), type = "l", col = "blue", ylim = c(0, 2),
xlab = "y", ylab = "g(y)", main = "g(y) for Uniform(0,1)"
lines(yy, dunif(yy), col = "green", lty = "dotted", lwd = 2)  # 'original'
```


plot(yy, peunif(yy), type = "l", col = "blue", ylim = 0:1,
    xlab = "y", ylab = "G(y)", main = "G(y) for Uniform(0,1)"
abline(a = 0.0, b = 1.0, col = "green", lty = "dotted", lwd = 2)
abline(v = 0.5, h = 0.5, col = "red", lty = "dashed")
## End(Not run)

expexpff

Exponentiated Exponential Distribution

Description

Estimates the two parameters of the exponentiated exponential distribution by maximum likelihood estimation.

Usage

expexpff(lrate = "loglink", lshape = "loglink",
           irate = NULL, ishape = 1.1, tolerance = 1.0e-6, zero = NULL)

Arguments

lshape, lrate Parameter link functions for the \( \lambda \) and \( \alpha \) parameters. See \texttt{Links} for more choices. The defaults ensure both parameters are positive.

ishape Initial value for the \( \alpha \) parameter. If convergence fails try setting a different value for this argument.

irate Initial value for the \( \lambda \) parameter. By default, an initial value is chosen internally using \texttt{ishape}.

tolerance Numeric. Small positive value for testing whether values are close enough to 1 and 2.

zero An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The default is none of them. If used, choose one value from the set \{1,2\}. See \texttt{CommonVGAMffArguments} for more information.

Details

The exponentiated exponential distribution is an alternative to the Weibull and the gamma distributions. The formula for the density is

\[
f(y; \lambda, \alpha) = \alpha \lambda (1 - \exp(-\lambda y))^{\alpha - 1} \exp(-\lambda y)
\]

where \( y > 0, \lambda > 0 \) and \( \alpha > 0 \). The mean of \( Y \) is \( (\psi(\alpha + 1) - \psi(1))/\lambda \) (returned as the fitted values) where \( \psi \) is the digamma function. The variance of \( Y \) is \( (\psi'(1) - \psi'(\alpha + 1))/\lambda^2 \) where \( \psi' \) is the trigamma function.

This distribution has been called the two-parameter generalized exponential distribution by Gupta and Kundu (2006). A special case of the exponentiated exponential distribution: \( \alpha = 1 \) is the exponential distribution.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Practical experience shows that reasonably good initial values really helps. In particular, try setting different values for the ishape argument if numerical problems are encountered or failure to convergence occurs. Even if convergence occurs try perturbing the initial value to make sure the global solution is obtained and not a local solution. The algorithm may fail if the estimate of the shape parameter is too close to unity.

Note

Fisher scoring is used, however, convergence is usually very slow. This is a good sign that there is a bug, but I have yet to check that the expected information is correct. Also, I have yet to implement Type-I right censored data using the results of Gupta and Kundu (2006).

Another algorithm for fitting this model is implemented in expexpff1.

Author(s)

T. W. Yee

References


See Also

dexpexpff1, gammaR, weibullR, CommonVGAMArguments.

Examples

# A special case: exponential data
edata <- data.frame(y = rexp(n <- 1000))
fit <- vglm(y ~ 1, fam = expexpff, data = edata, trace = TRUE, maxit = 99)
coef(fit, matrix = TRUE)
Coef(fit)

# Ball bearings data (number of million revolutions before failure)
edata <- data.frame(bbearings = c(17.88, 28.92, 33.00, 41.52, 42.12, 45.60, 48.80, 51.84, 54.12, 55.56, 67.80, 68.64, 68.64, 68.88, 84.12, 93.12, 98.64, 105.12, 105.84, 127.92, 128.04, 173.40))
fit <- vglm(bbearings ~ 1, fam = expexpff(irate = 0.05, ish = 5),
trace = TRUE, maxit = 300, data = edata)
expexpff1

Exponentiated Exponential Distribution

Description

Estimates the two parameters of the exponentiated exponential distribution by maximizing a profile (concentrated) likelihood.

Usage

expexpff1(lrate = "loglink", irate = NULL, ishape = 1)

Arguments

lrate Parameter link function for the (positive) $\lambda$ parameter. See Links for more choices.
irate Initial value for the $\lambda$ parameter. By default, an initial value is chosen internally using ishape.
isehpe Initial value for the $\alpha$ parameter. If convergence fails try setting a different value for this argument.

Details

See expexpff for details about the exponentiated exponential distribution. This family function uses a different algorithm for fitting the model. Given $\lambda$, the MLE of $\alpha$ can easily be solved in terms of $\lambda$. This family function maximizes a profile (concentrated) likelihood with respect to $\lambda$. Newton-Raphson is used, which compares with Fisher scoring with expexpff.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.
Warning

The standard errors produced by a summary of the model may be wrong.

Note

This family function works only for intercept-only models, i.e., \( y \sim 1 \) where \( y \) is the response.
The estimate of \( \alpha \) is attached to the \texttt{misc} slot of the object, which is a list and contains the component shape.
As Newton-Raphson is used, the working weights are sometimes negative, and some adjustment is made to these to make them positive.
Like \texttt{expexpff}, good initial values are needed. Convergence may be slow.

Author(s)

T. W. Yee

References


See Also

\texttt{expexpff}, \texttt{CommonVGAMffArguments}.

Examples

# Ball bearings data (number of million revolutions before failure)
edata <- data.frame(bbearings = c(17.88, 28.92, 33.00, 41.52, 42.12, 45.60, 48.80, 51.84, 51.96, 54.12, 55.56, 67.80, 68.64, 68.64, 68.88, 84.12, 93.12, 98.64, 105.12, 105.84, 127.92, 128.04, 173.40))
fit <- \texttt{vglm(bbearings \sim 1, expexpff1(ishape = 4), trace = TRUE, maxit = 250, checkwz = FALSE, data = edata)}
\texttt{coef(fit, matrix = TRUE)} # Authors get c(0.0314, 5.2589) with log-lik -112.9763
\texttt{logLik(fit)}
fit@misc$shape # Estimate of shape

# Failure times of the airconditioning system of an airplane
eedata <- data.frame(acplane = c(23, 261, 87, 7, 120, 14, 62, 47, 225, 71, 246, 21, 42, 20, 5, 12, 120, 11, 3, 14, 71, 11, 14, 11, 16, 90, 1, 16, 52, 95))
fit <- \texttt{vglm(acplane \sim 1, expexpff1(ishape = 0.8), trace = TRUE, maxit = 50, checkwz = FALSE, data = edata)}
\texttt{coef(fit, matrix = TRUE)}
\texttt{Coeff(fit)} # Authors get c(0.0145, 0.8130) with log-lik -152.264
\texttt{logLik(fit)}
fit@misc$shape # Estimate of shape
Description

Density, distribution function, quantile function and random generation for the exponential geometric distribution.

Usage

dexpgeom(x, scale = 1, shape, log = FALSE)
pexpgeom(q, scale = 1, shape)
qexpgeom(p, scale = 1, shape)
rexpgeom(n, scale = 1, shape)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. If length(n) > 1 then the length is taken to be the number required.
scale, shape positive scale and shape parameters.
log Logical. If log = TRUE then the logarithm of the density is returned.

Details

See expgeometric, the VGAM family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dexpgeom gives the density, pexpgeom gives the distribution function, qexpgeom gives the quantile function, and rexpgeom generates random deviates.

Note

We define scale as the reciprocal of the scale parameter used by Adamidis and Loukas (1998).

Author(s)

J. G. Lauder and T. W. Yee

See Also

expgeometric, exponential, geometric.
Examples

```r
## Not run:
shape <- 0.5; scale <- 1; nn <- 501
x <- seq(-0.10, 3.0, len = nn)
plot(x, dexpgeom(x, scale, shape), type = "l", las = 1, ylim = c(0, 2),
ylab = paste("[dp]expgeom(shape = ", shape, ", scale = ", scale, ")"),
col = "blue", cex.main = 0.8,
main = "Blue is density, red is cumulative distribution function",
sub = "Purple lines are the 10,20,...,90 percentiles")
lines(x, pexpgeom(x, scale, shape), col = "red")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qexpgeom(probs, scale, shape)
lines(Q, dexpgeom(Q, scale, shape), col = "purple", lty = 3, type = "h")
lines(Q, pexpgeom(Q, scale, shape), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pexpgeom(Q, scale, shape) - probs)) # Should be 0
## End(Not run)
```

expgeometric  
Exponential Geometric Distribution Family Function

Description

Estimates the two parameters of the exponential geometric distribution by maximum likelihood estimation.

Usage

```r
expgeometric(lscale = "loglink", lshape = "logitlink",
iscale = NULL, ishape = NULL,
tol12 = 1e-05, zero = 1, nsimEIM = 400)
```

Arguments

- `lscale, lshape` Link function for the two parameters. See Links for more choices.
- `iscale, ishape` Numeric. Optional initial values for the scale and shape parameters.
- `tol12` Numeric. Tolerance for testing whether a parameter has value 1 or 2.
- `zero, nsimEIM` See CommonVGAMffArguments.

Details

The exponential geometric distribution has density function

\[ f(y; c = scale, s = shape) = \frac{1}{c}(1 - s)e^{-y/c}(1 - se^{-y/c})^{-2} \]

where \( y > 0, \) \( c > 0 \) and \( s \in (0,1) \). The mean, \((c(s - 1)/s) \log(1 - s)\) is returned as the fitted values. Note the median is \( c \log(2 - s) \). Simulated Fisher scoring is implemented.
expint

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

We define scale as the reciprocal of the scale parameter used by Adamidis and Loukas (1998).

Author(s)

J. G. Lauder and T. W. Yee

References


See Also
dexpgeom, exponential, geometric.

Examples

## Not run:
Scale <- exp(2); shape = logitlink(-1, inverse = TRUE);
edata <- data.frame(y = rexpgeom(n = 2000, scale = Scale, shape = shape))
fit <- vglm(y ~ 1, expgeometric, edata, trace = TRUE)
c(with(edata, mean(y)), head(fitted(fit), 1))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

## End(Not run)

expint

The Exponential Integral and Variants

Description

Computes the exponential integral $Ei(x)$ for real values, as well as $\exp(-x) \times Ei(x)$ and $E_1(x)$ and their derivatives (up to the 3rd derivative).

Usage

expint(x, deriv = 0)
expexpint(x, deriv = 0)
expint.E1(x, deriv = 0)
Arguments

- **x**: Numeric. Ideally a vector of positive reals.
- **deriv**: Integer. Either 0, 1, 2 or 3.

Details

The exponential integral $E_i(x)$ function is the integral of $\exp(t)/t$ from 0 to $x$, for positive real $x$. The function $E_1(x)$ is the integral of $\exp(-t)/t$ from $x$ to infinity, for positive real $x$.

Value

Function `expint(x, deriv = n)` returns the $n$th derivative of $E_i(x)$ (up to the 3rd), function `expexpint(x, deriv = n)` returns the $n$th derivative of $\exp(-x) \times E_i(x)$ (up to the 3rd), function `expint.E1(x, deriv = n)` returns the $n$th derivative of $E_1(x)$ (up to the 3rd).

Warning

These functions have not been tested thoroughly.

Author(s)

T. W. Yee has simply written a small wrapper function to call the NETLIB FORTRAN code. Xiangjie Xue modified the functions to calculate derivatives. Higher derivatives can actually be calculated—please let me know if you need it.

References

https://netlib.org/specfun/ei.

See Also

- `log`, `exp`. There is also a package called `expint`.

Examples

```r
## Not run:
par(mfrow = c(2, 2))
curve(expint, 0.01, 2, xlim = c(0, 2), ylim = c(-3, 5),
     las = 1, col = "orange")
abline(v = (-3):5, h = (-4):5, lwd = 2, lty = "dotted", col = "gray")
abline(h = 0, v = 0, lty = "dashed", col = "blue")

curve(expexpint, 0.01, 2, xlim = c(0, 2), ylim = c(-3, 2),
      las = 1, col = "orange")
abline(v = (-3):2, h = (-4):5, lwd = 2, lty = "dotted", col = "gray")
abline(h = 0, v = 0, lty = "dashed", col = "blue")

curve(expint.E1, 0.01, 2, xlim = c(0, 2), ylim = c(0, 5),
      las = 1, col = "orange")
abline(v = (-3):2, h = (-4):5, lwd = 2, lty = "dotted", col = "gray")
```
explink

```
abline(h = 0, v = 0, lty = "dashed", col = "blue")

## End(Not run)
```

---

**explink**

*Exponential Link Function*

---

**Description**

Computes the exponential transformation, including its inverse and the first two derivatives.

**Usage**

```
explink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
short = TRUE, tag = FALSE)
```

**Arguments**

- `theta` Numeric or character. See below for further details.
- `bvalue` See `clogloglink`.
- `inverse, deriv, short, tag`
  Details at `Links`.

**Details**

The exponential link function is potentially suitable for parameters that are positive. Numerical values of `theta` close to negative or positive infinity may result in `0`, `Inf`, `-Inf`, `NA`, or `NaN`.

**Value**

For `explink` with `deriv = 0`, the exponential of `theta`, i.e., `exp(theta)` when `inverse = FALSE`. And if `inverse = TRUE` then `log(theta)`, if `theta` is not positive then it will return `NaN`.

For `deriv = 1`, then the function returns `d eta / d theta` as a function of `theta` if `inverse = FALSE`, else if `inverse = TRUE` then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base `e`.

**Note**

This function has particular use for computing quasi-variances when used with `rcim` and `uninormal`.

Numerical instability may occur when `theta` is close to negative or positive infinity. One way of overcoming this (one day) is to use `bvalue`.

**Author(s)**

Thomas W. Yee
explog

See Also

Links, loglink, rcim, Qvar, uninormal.

Examples

theta <- rnorm(30)
explink(theta)
max(abs(explink(explink(theta), inverse = TRUE) - theta))  # 0?

explog

The Exponential Logarithmic Distribution

Description

Density, distribution function, quantile function and random generation for the exponential logarithmic distribution.

Usage

dexplog(x, scale = 1, shape, log = FALSE)
pexplog(q, scale = 1, shape)
qexplog(p, scale = 1, shape)
rexplog(n, scale = 1, shape)

Arguments

x, q
vector of quantiles.
p
vector of probabilities.
n
number of observations. If length(n) > 1 then the length is taken to be the number required.
scale, shape
positive scale and shape parameters.
log
Logical. If log = TRUE then the logarithm of the density is returned.

Details

See explogf, the VGAM family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dexplog gives the density, pexplog gives the distribution function, qexplog gives the quantile function, and rexplog generates random deviates.

Note

We define scale as the reciprocal of the scale parameter used by Tahmasabi and Rezaei (2008).
explogff

Author(s)
J. G. Lauder and T. W. Yee

See Also
explogff, exponential.

Examples

```r
## Not run:
shape <- 0.5; scale <- 2; nn <- 501
x <- seq(-0.50, 6.0, len = nn)
plot(x, dexplog(x, scale, shape), type = "l", las = 1, ylim = c(0, 1.1),
     ylab = paste("[dp]explog(shape = ", shape, ", scale = ", scale, ")"),
     col = "blue", cex.main = 0.8,
     main = "Blue is density, orange is cumulative distribution function",
     sub = "Purple lines are the 10, 20, ..., 90 percentiles")
lines(x, pexplog(x, scale, shape), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qexplog(probs, scale, shape = shape)
lines(Q, dexplog(Q, scale, shape = shape), col = "purple", lty = 3, type = "h")
lines(Q, pexplog(Q, scale, shape = shape), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pexplog(Q, scale, shape = shape) - probs)) # Should be 0
## End(Not run)
```

explogff

Exponential Logarithmic Distribution Family Function

Description

Estimates the two parameters of the exponential logarithmic distribution by maximum likelihood estimation.

Usage

```r
explogff(lscale = "loglink", lshape = "logitlink",
         iscale = NULL, ishape = NULL,
         tol12 = 1e-05, zero = 1, nsimEIM = 400)
```

Arguments

- `lscale`, `lshape` See CommonVGAMffArguments for information.
- `tol12` Numeric. Tolerance for testing whether a parameter has value 1 or 2.
- `iscale`, `ishape`, `zero`, `nsimEIM`
  See CommonVGAMffArguments.
explogff

Details

The exponential logarithmic distribution has density function

\[ f(y; c, s) = \frac{1}{(1 - \log p)} \frac{((1/c)(1 - s)e^{-y/c} - (1 - (1 - s)e^{-y/c})}{(1 - (1 - s)e^{-y/c})} \]

where \( y > 0 \), scale parameter \( c > 0 \), and shape parameter \( s \in (0, 1) \). The mean, \((-\text{polylog}(2, 1 - p)c)/\log(s)\) is not returned as the fitted values. Note the median is \( c \log(1 + \sqrt{s}) \) and it is currently returned as the fitted values. Simulated Fisher scoring is implemented.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Note

We define scale as the reciprocal of the rate parameter used by Tahmasabi and Sadegh (2008).

Yet to do: find a \texttt{polylog()} function.

Author(s)

J. G. Lauder and T. W. Yee

References


See Also

dexplog, exponential.

Examples

```r
## Not run: Scale <- exp(2); shape <- logitlink(-1, inverse = TRUE)
edata <- data.frame(y = rexplog(n = 2000, scale = Scale, shape = shape))
fit <- vglm(y ~ 1, explogff, data = edata, trace = TRUE)
c(with(edata, median(y)), head(fitted(fit), 1))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
## End(Not run)
```
Description

Maximum likelihood estimation for the exponential distribution.

Usage

```r
exponential(link = "loglink", location = 0, expected = TRUE,
    type.fitted = c("mean", "percentiles", "Qlink"),
    percentiles = 50,
    ishrinkage = 0.95, parallel = FALSE, zero = NULL)
```

Arguments

- `link`: Parameter link function applied to the positive parameter `rate`. See Links for more choices.
- `location`: Numeric of length 1, the known location parameter, `A`, say.
- `expected`: Logical. If TRUE Fisher scoring is used, otherwise Newton-Raphson. The latter is usually faster.
- `ishrinkage`, `parallel`, `zero`: See CommonVGAMffArguments for information.
- `type.fitted`, `percentiles`: See CommonVGAMffArguments for information.

Details

The family function assumes the response `Y` has density

\[
f(y) = \lambda \exp(-\lambda(y - A))
\]

for `y > A`, where `A` is the known location parameter. By default, `A = 0`. Then \(E(Y) = A + 1/\lambda\) and \(Var(Y) = 1/\lambda^2\).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as `vglm`, and `vgam`.

Note

Suppose `A = 0`. For a fixed time interval, the number of events is Poisson with mean `\lambda` if the time between events has a geometric distribution with mean `\lambda^{-1}`. The argument `rate` in exponential is the same as `rexp` etc. The argument `lambda` in `rpois` is somewhat the same as `rate` here.
The Exponential Poisson Distribution

Description

Density, distribution function, quantile function and random generation for the exponential poisson distribution.

Author(s)

T. W. Yee

References


See Also

amlexponential, gpd, laplace, expgeometric, explogff, poissonff, mix2exp, freund61, simulate.vlm, Exponential.

Examples

```r
edata <- data.frame(x2 = runif(nn <- 100) - 0.5)
edata <- transform(edata, x3 = runif(nn) - 0.5)
edata <- transform(edata, eta = 0.2 - 0.7 * x2 + 1.9 * x3)
edata <- transform(edata, rate = exp(eta))
edata <- transform(edata, y = rexp(nn, rate = rate))
with(edata, stem(y))

fit.slow <- vglm(y ~ x2 + x3, exponential, data = edata, trace = TRUE)
fit.fast <- vglm(y ~ x2 + x3, exponential(exp = FALSE), data = edata,
               trace = TRUE, crit = "coef")
coef(fit.slow, mat = TRUE)
summary(fit.slow)

# Compare results with a GPD. Has a threshold.
threshold <- 0.5
gdata <- data.frame(y1 = threshold + rexp(n = 3000, rate = exp(1.5)))

fit.exp <- vglm(y1 ~ 1, exponential(location = threshold), data = gdata)
coef(fit.exp, matrix = TRUE)
Coef(fit.exp)
logLik(fit.exp)

fit.gpd <- vglm(y1 ~ 1, gpd(threshold = threshold), data = gdata)
coef(fit.gpd, matrix = TRUE)
Coef(fit.gpd)
logLik(fit.gpd)
```
Usage

dexppois(x, rate = 1, shape, log = FALSE)
pexppois(q, rate = 1, shape, lower.tail = TRUE, log.p = FALSE)
qexppois(p, rate = 1, shape, lower.tail = TRUE, log.p = FALSE)
rexppois(n, rate = 1, shape)

Arguments

x, q  vector of quantiles.
p  vector of probabilities.
n  number of observations. If length(n) > 1 then the length is taken to be the
number required.
shape, rate  positive parameters.
log  Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p  Same meaning as in pnorm or qnorm.

Details

See expoisson, the VGAM family function for estimating the parameters, for the formula of the
probability density function and other details.

Value

dexppois gives the density, pexppois gives the distribution function, qexppois gives the quantile
function, and rexppois generates random deviates.

Author(s)

Kai Huang and J. G. Lauder

See Also

exppoisson.

Examples

## Not run: rate <- 2; shape <- 0.5; nn <- 201
x <- seq(-0.05, 1.05, len = nn)
plot(x, dexppois(x, rate = rate, shape), type = "l", las = 1, ylim = c(0, 3),
ylab = paste("fexpoisson(rate = ", rate, ", shape = ", shape, ")"),
col = "blue", cex.main = 0.8,
main = "Blue is the density, orange the cumulative distribution function",
sub = "Purple lines are the 10,20,...,90 percentiles")
lines(x, pexppois(x, rate = rate, shape), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qexppois(probs, rate = rate, shape)
lines(Q, dexppois(Q, rate = rate, shape), col = "purple", lty = 3, type = "h")
lines(Q, pexppois(Q, rate = rate, shape), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3); abline(h = 0, col = "gray50")
max(abs(pexppois(Q, rate = rate, shape) - probs)) # Should be 0

## End(Not run)

des  

Exponential Poisson Distribution Family Function

Description
Estimates the two parameters of the exponential Poisson distribution by maximum likelihood estimation.

Usage
```r
exppoisson(lrate = "loglink", lshape = "loglink",  
            irate = 2, ishape = 1.1, zero = NULL)
```

Arguments
- `lshape, lrate`: Link function for the two positive parameters. See links for more choices.
- `ishape, irate`: Numeric. Initial values for the shape and rate parameters. Currently this function is not intelligent enough to obtain better initial values.
- `zero`: See CommonVGAMffArguments.

Details
The exponential Poisson distribution has density function

\[
f(y; \beta = \text{rate}, \lambda = \text{shape}) = \frac{\lambda \beta}{1 - e^{-\lambda}} e^{-\lambda y + \lambda \exp(-\beta y)}
\]

where \(y > 0\), and the parameters shape, \(\lambda\), and rate, \(\beta\), are positive. The distribution implies a population facing discrete hazard rates which are multiples of a base hazard. This VGAM family function requires the hypergeo package (to use their genhypergeo function). The median is returned as the fitted value.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning
This VGAM family function does not work properly!

Author(s)
J. G. Lauder, jamesglauder@gmail.com
References


See Also

dexp, dpois, exponential, poisson.

Examples

```r
## Not run:
shape <- exp(1); rate <- exp(2)
rdata <- data.frame(y = rexp(n = 1000, rate = rate, shape = shape))
library("hypergeo") # Required!
fit <- vglm(y ~ 1, expoisson, data = rdata, trace = FALSE, maxit = 1200)
c(with(rdata, median(y)), head(fitted(fit), 1))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
## End(Not run)
```

Extbetabinom

The Beta-Binomial Distribution

Description

Density, distribution function, quantile function and random generation for the extended beta-binomial distribution.

Usage

```r
dextbetabinom(x, size, prob, rho = 0, 
log = FALSE, forbycol = TRUE)
pextbetabinom(q, size, prob, rho = 0, 
lower.tail = TRUE, forbycol = TRUE)
qextbetabinom(p, size, prob, rho = 0, 
forbycol = TRUE)
rextbetabinom(n, size, prob, rho = 0)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `size` number of trials.
- `n` number of observations. Same as `runif`.
- `prob` the probability of success \(\mu\). Must be in the unit closed interval \([0, 1]\).
rho the correlation parameter \( \rho \), which may be negative for underdispersion or else be in the interval \([0, 1)\) for overdispersion. The default value of 0 corresponds to the usual binomial distribution with probability \( \text{prob} \).

log, lower.tail

Same meaning as \texttt{runif}.

forbycol Logical. A for loop cycles over either the rows or columns and this argument determines which. The rows are \( 1:length(x) \) and the columns are \( 0:max(size) \). The best choice is data set dependent.

Details

The \textit{extended} beta-binomial distribution allows for a slightly negative correlation parameter between binary responses within a cluster (e.g., a litter). An exchangeable error structure with correlation \( \rho \) is assumed.

Value
dextbetabinom gives the density, pextbetabinom gives the distribution function, qextbetabinom gives the quantile function and rextbetabinom generates random deviates.

Warning

Setting \( \rho = 1 \) is not recommended as NaN is returned, however the code may be modified in the future to handle this special case.

Note

Currently most of the code is quite slow. Speed improvements are a future project. Use forbycol optimally.

See Also
dextbetabinomial, Betabinom, Binomial.

Examples

```r
dset.seed(1); rextbetabinom(10, 100, 0.5)
dset.seed(1); rbinom(10, 100, 0.5) # Same

## Not run: N <- 9; xx <- 0:N; prob <- 0.5; rho <- -0.02
dy <- dextbetabinom(xx, N, prob, rho)
dbin <- dbinom(xx, size = N, prob),
deach = TRUE, col = c("blue", "green"), las = 1,
dmain = paste0("Beta-binom(size="), N,
", prob="", prob = prob, ", rho="), rho, ") (blue) vs\n", " Binom(size="), N", prob = prob, ") (green")
dnmes.arg = as.character(xx), cex.main = 0.8)
dsum(dy * xx) # Check expected values are equal
dsum(dbinom(xx, size = N, prob = prob) * xx)
cumsum(dy) - pextbetabinom(xx, N, prob, rho) # 0?
```
extbetabinomial

## End(Not run)

---

### extbetabinomial

**Extended Beta-binomial Distribution Family Function**

#### Description

Fits an extended beta-binomial distribution by maximum likelihood estimation. The two parameters here are the mean and correlation coefficient.

#### Usage

```r
extbetabinomial(lmu = "logitlink", lrho = "cloglink",
    zero = "rho", irho = 0, grho = c(0, 0.05, 0.1, 0.2),
    vfl = FALSE, Form2 = NULL,
    imethod = 1, ishrinkage = 0.95)
```

#### Arguments

- `lmu`, `lrho` Link functions applied to the two parameters. See [Links](#) for more choices. The first default ensure the mean remain in $(0, 1)$, while the second allows for a slightly negative correlation parameter: you could say it lies in $(\max(-\mu/(N - \mu - 1), - (1 - \mu)/(N - (1 - \mu) - 1)), 1)$ where $\mu$ is the mean (probability) and $N$ is size. See below for details. For `lrho`, `cloglink` is a good choice because it handles parameter values from 1 downwards. Other good choices include `logofflink(offset = 1)` and `rhobitlink`.

- `irho`, `grho` The first is similar to `betabinomial` and it is a good idea to use this argument because to conduct a grid search based on `grho` is expensive. The default is effectively a binomial distribution. Set `irho = NULL` to perform a grid search which is more reliable but slow.

- `imethod` Similar to `betabinomial`.

- `zero` Similar to `betabinomial`. Also, see `CommonVGAMffArguments` for more information. Modelling rho with covariates requires large samples.

- `ishrinkage` See `betabinomial` and `CommonVGAMffArguments` for information.

- `vfl`, `Form2` See `CommonVGAMffArguments`. If `vfl = TRUE` then `Form2` should be a formula specifying the terms for $\eta_2$ and all others are used for $\mu$. It is similar to `uninormal`. If these arguments are used then `cbind(0, log(size1 / (size1 - 1)))` should be used as an offset, and set `zero = NULL` too.

#### Details

The *extended* beta-binomial distribution (EBBD) proposed by Prentice (1986) allows for a slightly negative correlation parameter whereas the ordinary BBD `betabinomial` only allows values in $(0, 1)$ so it handles overdispersion only. When negative, the data is underdispersed relative to an ordinary binomial distribution.
Argument \( \rho \) is used here for the \( \delta \) used in Prentice (1986) because it is the correlation between the (almost) Bernoulli trials. (They are actually simple binary variates.) We use here \( N \) for the number of trials (e.g., litter size), \( T = NY \) is the number of successes, and \( p \) (or \( \mu \)) is the probability of a success (e.g., a malformation). That is, \( Y \) is the proportion of successes. Like binomialff, the fitted values are the estimated probability of success (i.e., \( E[Y] \) and not \( E[T] \)) and the prior weights \( N \) are attached separately on the object in a slot.

The probability function is difficult to write but it involves three series of products. Recall \( Y = T/N \) is the real response being modelled, where \( T \) is the (total) sum of \( N \) correlated (almost) Bernoulli trials.

The default model is \( \eta_1 = \logit(\mu) \) and \( \eta_2 = \text{clog}(\rho) \) because the first parameter lies between 0 and 1. The second link is \text{cloglink}. The mean of \( Y \) is \( p = \mu \) and the variance of \( Y \) is \( \mu(1 - \mu)/(1+(N-1)\rho)/N \). Here, the correlation \( \rho \) may be slightly negative and is the correlation between the \( N \) individuals within a litter. A litter effect is typically reflected by a positive value of \( \rho \) and corresponds to overdispersion with respect to the binomial distribution. Thus an exchangeable error structure is assumed between units within a litter for the EBBD.

This family function uses Fisher scoring. Elements of the second-order expected derivatives are computed numerically, which may fail for models very near the boundary of the parameter space. Usually, the computations are expensive for large \( N \) because of a for loop, so it may take a long time.

Value

An object of class "vglmff" (see \text{vglmff-class}). The object is used by modelling functions such as \text{vglm}.

Suppose \( \text{fit} \) is a fitted EBB model. Then \( \text{depvar(\text{fit})} \) are the sample proportions \( y \), \( \text{fitted(\text{fit})} \) returns estimates of \( E(Y) \), and \( \text{weights(\text{fit}, \text{type = "prior"})} \) returns the number of trials \( N \).

Warning

Modelling \( \rho \) using covariates well requires much data so it is usually best to leave zero alone. It is good to set \text{trace} = \text{TRUE} and play around with \text{irho} if there are problems achieving convergence. Convergence problems will occur when the estimated \( \rho \) is close to the lower bound, i.e., the underdispersion is almost too severe for the EBB to cope.

Note

This function is recommended over \text{betabinomial} and \text{betabinomialff}. It processes the input in the same way as \text{binomialff}. But it does not handle the case \( N \leq 2 \) very well because there are two parameters to estimate, not one, for each row of the input. Cases where \( N > 2 \) can be selected via the \text{subset} argument of \text{vglm}.

Author(s)

T. W. Yee
References


See Also

`Extbetabinom, betabinomial, betabinomialff, binomialff, dirmultinomial, cloglink, lirat`.

Examples

```
# Example 1
edata <- data.frame(N = 10, mu = 0.5, rho = 0.1)
edata <- transform(edata,
  y = rextbetabinom(100, N, mu, rho = rho))
fit1 <- vglm(cbind(y, N-y) ~ 1, extbetabinomial, edata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
head(cbind(depvar(fit1), weights(fit1, type = "prior")))

# Example 2: VFL model
## Not run: N <- size1 <- 10; nn <- 2000; set.seed(1)
edata <- # Generate the data set. Expensive.
  data.frame(x2 = runif(nn),
    ooo = log(size1 / (size1 - 1)))
edata <- transform(edata, x1copy = 1, x2copy = x2,
  y2 = rextbetabinom(nn, size1, # Expensive
    logitlink(1 + x2, inverse = TRUE),
    cloglink(ooo + 1 - 0.5 * x2, inv = TRUE)))
fit2 <- vglm(data = edata,
  cbind(y2, N - y2) ~ x2 + x1copy + x2copy,
  extbetabinomial(zero = NULL, vfl = TRUE,
    Form2 = ~ x1copy + x2copy - 1),
  offset = cbind(0, ooo), trace = TRUE)
coef(fit2, matrix = TRUE)
wald.stat(fit2, values0 = c(1, 1, -0.5))
## End(Not run)
```

Description

Maximum likelihood estimation of the 1-parameter extended log-F distribution.
Usage

```
extlogF1(tau = c(0.25, 0.5, 0.75), parallel = TRUE ~ 0, 
seppar = 0, tol0 = -0.001, 
location = "identitylink", ilocation = NULL, 
lambda.arg = NULL, scale.arg = 1, ishrinkage = 0.95, 
digt = 4, idf.mu = 3, imethod = 1)
```

Arguments

tau Numeric, the desired quantiles. A strictly increasing sequence, each value must 
be in (0, 1). The default values are the three quartiles, matching `lms.bcn`.

parallel Similar to `alaplace1`, applying to the location parameters. One can try fix up 
the quantile-crossing problem after fitting the model by calling `fix.crossing`. 
Use `is.crossing` to see if there is a problem. The default for `parallel` is 
totally `FALSE`, i.e., `FALSE` for every variable including the intercept. Quantile-
crossing can occur when values of `tau` are too close, given the data. How the 
quantiles are modelled with respect to the covariates also has a big effect, e.g., 
if they are too flexible or too inflexible then the problem is likely to occur. For 
example, using `bs` with `df = 10` is likely to create problems. 
Setting `parallel = TRUE` results in a totally parallel model; all 
quantiles are parallel and this assumption can be too strong for some data sets. Instead, 
`fix.crossing` only repairs the quantiles that cross. So one must carefully 
choose values of `tau` for fitting the original fit.

seppar, tol0 Numeric, both of unit length and nonnegative, the separation and shift parameters. 
If `seppar` is positive then any crossing quantile is penalized by the difference 
cubed multiplied by `seppar`. The log-likelihood subtracts the penalty. The 
shift parameter ensures that the result is strictly noncrossing when `seppar` is 
large enough; otherwise if `tol0 = 0` and `seppar` is large then the crossing quantiles 
remain crossed even though the offending amount becomes small but never exactly 0. 
Informally, `tol0` pushes the adjustment enough so that `is.crossing` 
should return `FALSE`. 
If `tol0` is positive then that is the shift in absolute terms. But `tol0` may be 
assigned a negative value, in which case it is interpreted multiplicatively `relative` 
to the midspread of the response; `tol0 <- abs(tol0) * midspread`. Regardless, `fit@extra$tol0` is the amount in absolute terms. 
If avoiding the quantile crossing problem is of concern to you, try increasing 
`seppar` to decrease the amount of crossing. Probably it is best to choose the 
smallest value of `seppar` so that `is.crossing` returns `FALSE`. Increasing `tol0` relatively or absolutely means the fitted quantiles are allowed to move apart 
more. However, `tau` must be considered when choosing `tol0`.

location, ilocation See `Links` for more choices and `CommonVGAMffArguments` for more information. 
Choosing `loglink` should usually be good for counts. And choosing 
`logitlink` should be a reasonable for proportions. However, avoid choosing 
`tau` values close to the boundary, for example, if `p_0` is the proportion of 0s then 
choose `p_0 \ll \tau`. For proportions grouped data is much better than ungrouped
data, and the bigger the groups the more the granularity so that the empirical proportion can approximate \( \tau \) more closely.

\textbf{lambda.arg} Positive tuning parameter which controls the sharpness of the cusp. The limit as it approaches 0 is probably very similar to \texttt{dalap}. The default is to choose the value internally. If \texttt{scale.arg} increases, then probably \texttt{lambda.arg} needs to increase accordingly. If \texttt{lambda.arg} is too large then the empirical quantiles may not be very close to \( \tau \). If \texttt{lambda.arg} is too close to 0 then the convergence behaviour will not be good and local solutions found, as well as numerical problems in general. Monitoring convergence is recommended when varying \texttt{lambda.arg}.

\textbf{scale.arg} Positive scale parameter and sometimes called \texttt{scale}. The transformation used is \((y - \text{location}) / \text{scale}\). This function should be okay for response variables having a moderate range (0–100, say), but if very different from this then experimenting with this argument will be a good idea.

\texttt{ishrinkage, idf.mu, digit} Similar to \texttt{alaplace1}.

\textbf{imethod} Initialization method. Either the value 1, 2, or … See \texttt{CommonVGAMffArguments} for more information.

**Details**

This is an experimental family function for quantile regression. Fasiolo et al. (2020) propose an extended log-F distribution (ELF) however this family function only estimates the location parameter. The distribution has a scale parameter which can be inputted (default value is unity). One location parameter is estimated for each \( \tau \) value and these are the estimated quantiles. For quantile regression it is not necessary to estimate the scale parameter since the log-likelihood function is triangle shaped.

The ELF is used as an approximation of the asymmetric Laplace distribution (ALD). The latter cannot be estimated properly using Fisher scoring/IRLS but the ELF holds promise because it has continuous derivatives and therefore fewer problems with the regularity conditions. Because the ELF is fitted to data to obtain an empirical result the convergence behaviour may not be gentle and smooth. Hence there is a function-specific control function called \texttt{extlogF1.control} which has something like \texttt{stepsize = 0.5} and \texttt{maxits = 100}. It has been found that slowing down the rate of convergence produces greater stability during the estimation process. Regardless, convergence should be monitored carefully always.

This function accepts a vector response but not a matrix response.

**Value**

An object of class \"vglmff\" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

**Note**

Changes will occur in the future to fine-tune things. In general setting \texttt{trace = TRUE} is strongly encouraged because it is needful to check that convergence occurs properly.

If \texttt{seppar > 0} then \texttt{logLik(fit)} will return the penalized log-likelihood.
Author(s)

Thomas W. Yee

References


See Also

dextlogF, is.crossing, fix.crossing, eCDF, vglm.control, logF, alaplace1, dalap, lms.bcn.

Examples

```r
nn <- 1000; mytau <- c(0.25, 0.75)
edata <- data.frame(x2 = sort(rnorm(nn)))
edata <- transform(edata, y1 = 1 + x2 + rnorm(nn, sd = exp(-1)),
  y2 = cos(x2) / (1 + abs(x2)) + rnorm(nn, sd = exp(-1)))
fit1 <- vglm(y1 ~ x2, extlogF1(tau = mytau), data = edata) # trace = TRUE
fit2 <- vglm(y2 ~ bs(x2, 6), extlogF1(tau = mytau), data = edata)
coef(fit1, matrix = TRUE)
fit2@extra$percentile # Empirical percentiles here
summary(fit2)
c(is.crossing(fit1), is.crossing(fit2))
head(fitted(fit1))
## Not run: plot(y2 ~ x2, edata, col = "blue")
matlines(with(edata, x2), fitted(fit2), col="orange", lty = 1, lwd = 2)
## End(Not run)
```

<table>
<thead>
<tr>
<th>familyname</th>
<th>Family Function Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Description

Extractor function for the name of the family function of an object in the **VGAM** package.

Usage

```r
familyname(object, ...)
familyname.vlm(object, all = FALSE, ...)
```

Arguments

- `object` Some **VGAM** object, for example, having class `vglmff-class`.
- `all` If `all = TRUE` then all of the `family` slot is returned; this contains subclasses the object might have. The default is return the first value only.
- `...` Other possible arguments for the future.
Details

Currently VGAM implements over 150 family functions. This function returns the name of the function assigned to the family argument, for modelling functions such as vglm and vgam. Sometimes a slightly different answer is returned, e.g., propodds really calls cumulative with some arguments set, hence the output returned by this function is "cumulative" (note that one day this might change, however).

Value

A character string or vector.

Note

Arguments used in the invocation are not included. Possibly this is something to be done in the future.

See Also

vglmff-class, vglm-class.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit1 <- vglm(cbind(normal, mild, severe) ~ let,
            cumulative(parallel = TRUE, reverse = TRUE), data = pneumo)
familyname(fit1)
familyname(fit1, all = TRUE)
familyname(propodds()) # "cumulative"

Felix

The Felix Distribution

Description

Density for the Felix distribution.

Usage

dfelix(x, rate = 0.25, log = FALSE)

Arguments

x vector of quantiles.
rate See felix.
log Logical. If log = TRUE then the logarithm of the density is returned.
Details

See felix, the VGAM family function for estimating the parameter, for the formula of the probability density function and other details.

Value

dfelix gives the density.

Warning

The default value of rate is subjective.

Author(s)

T. W. Yee

See Also

felix.

Examples

```r
## Not run:
rate <- 0.25; x <- 1:15
plot(x, dfelix(x, rate), type = "h", las = 1, col = "blue",
     ylab = paste("dfelix(rate=", rate, ")"),
     main = "Felix density function")
## End(Not run)
```

felix

Felix Distribution Family Function

Description

Estimates the parameter of a Felix distribution by maximum likelihood estimation.

Usage

felix(lrate = extlogitlink(min = 0, max = 0.5), imethod = 1)

Arguments

lrate

Link function for the parameter, called a below; see Links for more choices and for general information.

imethod

See CommonVGAMffArguments. Valid values are 1, 2, 3 or 4.
Details

The Felix distribution is an important basic Lagrangian distribution. The density function is

\[ f(y; a) = \frac{1}{((y - 1)/2)!} y^{y-3/2} a^{(y-1)/2} \exp(-ay) \]

where \( y = 1, 3, 5, \ldots \) and \( 0 < a < 0.5 \). The mean is \( 1/(1 - 2a) \) (returned as the fitted values). Fisher scoring is implemented.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Author(s)

T. W. Yee

References


See Also

dfelix, borel.tanner.

Examples

```r
fdata <- data.frame(y = 2 * rpois(n = 200, 1) + 1) # Not real data!
fit <- vglm(y ~ 1, felix, data = fdata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```

---

**fff**  

*F Distribution Family Function*

Description

Maximum likelihood estimation of the (2-parameter) F distribution.

Usage

```r
fff(link = "loglink", idf1 = NULL, idf2 = NULL, nsimEIM = 100, 
imethod = 1, zero = NULL)
```
Arguments

- **link**: Parameter link function for both parameters. See Links for more choices. The default keeps the parameters positive.
- **idf1, idf2**: Numeric and positive. Initial value for the parameters. The default is to choose each value internally.
- **nsimEIM, zero**: See CommonVGAMffArguments for more information.
- **imethod**: Initialization method. Either the value 1 or 2. If both fail try setting values for idf1 and idf2.

Details

The F distribution is named after Fisher and has a density function that has two parameters, called df1 and df2 here. This function treats these degrees of freedom as positive reals rather than integers. The mean of the distribution is \( \frac{\text{df1}}{\text{df1} - 2} \) provided \( \text{df1} > 2 \), and its variance is \( \frac{2\text{df1}^2}{(\text{df1} + \text{df2} - 2)\text{df1}(\text{df2} - 4)} \) provided \( \text{df2} > 4 \). The estimated mean is returned as the fitted values. Although the F distribution can be defined to accommodate a non-centrality parameter ncp, it is assumed zero here. Actually it shouldn’t be too difficult to handle any known ncp; something to do in the short future.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Numerical problems will occur when the estimates of the parameters are too low or too high.

Author(s)

T. W. Yee

References


See Also

FDist.

Examples

```r
## Not run:
fdata <- data.frame(x2 = runif(nn <- 2000))
fdata <- transform(fdata, df1 = exp(2+0.5*x2),
                   df2 = exp(2-0.5*x2))
fdata <- transform(fdata, y = rf(nn, df1, df2))
fit <- vglm(y ~ x2, fff, data = fdata, trace = TRUE)
```
fill1

Creates a Matrix of Appropriate Dimension

Description

A support function for the argument \texttt{xij}, it generates a matrix of an appropriate dimension.

Usage

\texttt{fill1(x, values = 0, ncolx = ncol(x))}

Arguments

\begin{itemize}
\item \texttt{x} \hspace{1cm} A vector or matrix which is used to determine the dimension of the answer, in particular, the number of rows. After converting \texttt{x} to a matrix if necessary, the answer is a matrix of values \texttt{values}, of dimension \texttt{nrow(x)} by \texttt{ncolx}.
\item \texttt{values} \hspace{1cm} Numeric. The answer contains these values, which are recycled \textit{columnwise} if necessary, i.e., as \texttt{matrix(values, ..., byrow=TRUE)}.
\item \texttt{ncolx} \hspace{1cm} The number of columns of the returned matrix. The default is the number of columns of \texttt{x}.
\end{itemize}

Details

The \texttt{xij} argument for \texttt{vglm} allows the user to input variables specific to each linear/additive predictor. For example, consider the bivariate logit model where the first/second linear/additive predictor is the logistic regression of the first/second binary response respectively. The third linear/additive predictor is \( \log(OR) = \eta_3 \), where \( OR \) is the odds ratio. If one has ocular pressure as a covariate in this model then \texttt{xij} is required to handle the ocular pressure for each eye, since these will be different in general. [This contrasts with a variable such as age, the age of the person, which has a common value for both eyes.] In order to input these data into \texttt{vglm} one often finds that functions \texttt{fill1}, \texttt{fill2}, etc. are useful.

All terms in the \texttt{xij} and formula arguments in \texttt{vglm} must appear in the \texttt{form2} argument too.

Value

\texttt{matrix(values, nrow=nrow(x), ncol=ncolx)}, i.e., a matrix consisting of values values, with the number of rows matching \texttt{x}, and the default number of columns is the number of columns of \texttt{x}.  

Note

The effect of the xij argument is after other arguments such as exchangeable and zero. Hence xij does not affect constraint matrices.

Additionally, there are currently 3 other identical fill1 functions, called fill2, fill3 and fill4; if you need more then assign fill5 = fill6 = fill1 etc. The reason for this is that if more than one fill1 function is needed then they must be unique. For example, if $M = 4$ then $xij = \text{list}(\text{op} \sim \text{lop} + \text{rop} + \text{fill1}(\text{mop}) + \text{fill1}(\text{mop}))$ would reduce to $xij = \text{list}(\text{op} \sim \text{lop} + \text{rop} + \text{fill1}(\text{mop}))$, whereas $xij = \text{list}(\text{op} \sim \text{lop} + \text{rop} + \text{fill1}(\text{mop}) + \text{fill2}(\text{mop}))$ would retain all $M$ terms, which is needed.

In Examples 1 to 3 below, the xij argument illustrates covariates that are specific to a linear predictor. Here, lop/rop are the ocular pressures of the left/right eye in an artificial dataset, and mop is their mean. Variables leye and reye might be the presence/absence of a particular disease on the LHS/RHS eye respectively.

In Example 3, the xij argument illustrates fitting the (exchangeable) model where there is a common smooth function of the ocular pressure. One should use regression splines since s in vgam does not handle the xij argument. However, regression splines such as bs and ns in vgam do not handle the xij argument. However, regression splines such as bs and ns need to have the same basis functions here for both functions, and Example 3 illustrates a trick involving a function BS to obtain this, e.g., same knots. Although regression splines create more than a single column per term in the model matrix, fill1(BS(lop,rop)) creates the required (same) number of columns.

Author(s)

T. W. Yee

See Also

vglm.control, vglm, multinomial, Select.

Examples

```r
fill1(runif(5))
fill1(runif(5), ncol = 3)
fill1(runif(5), val = 1, ncol = 3)

# Generate (independent) eyes data for the examples below; OR=1.
nn <- 10000  # Number of people
eyesdata <- data.frame(lop = round(runif(nn, 2),
                      rop = round(runif(nn, 2),
                      age = round(rnorm(nn, 40, 10)))
eyesdata <- transform(eyesdata,
                      mop = (lop + rop) / 2,  # Mean ocular pressure
                      op = (lop + rop) / 2,   # Value unimportant unless plotting
                      # op = lop,
                      # Choose this if plotting
                      etal = 0 - 2*lop + 0.04*age, # Linear predictor for left eye
                      etar = 0 - 2*rop + 0.04*age) # Linear predictor for right eye
eyesdata <- transform(eyesdata,
                      leye = rbinom(nn, size=1, prob = logitlink(etal, inverse = TRUE)),
                      reye = rbinom(nn, size=1, prob = logitlink(etar, inverse = TRUE)))
```
# Example 1. All effects are linear.
fit1 <- vglm(cbind(leye, reye) ~ op + age,
  family = binom2.or(exchangeable = TRUE, zero = 3),
  data = eyesdata, trace = TRUE,
  xij = list(op ~ lop + rop + fill1(lop)),
  form2 = ~ op + lop + rop + fill1(lop) + age)

head(model.matrix(fit1, type = "lm")) # LM model matrix
head(model.matrix(fit1, type = "vlm")) # Big VLM model matrix
coef(fit1)
coef(fit1, matrix = TRUE) # Unchanged with 'xij'
constraints(fit1)
max(abs(predict(fit1)-predict(fit1, new = eyesdata))) # Okay
summary(fit1)
## Not run:
plotvgam(fit1, se = TRUE) # Wrong, e.g., coz it plots against op, not lop.
# So set op = lop in the above for a correct plot.
## End(Not run)

# Example 2. This uses regression splines on ocular pressure.
# It uses a trick to ensure common basis functions.
BS <- function(x, ...) sm.bs(c(x,...), df = 3)[1:length(x), , drop = FALSE] # trick

fit2 <-
vglm(cbind(leye, reye) ~ BS(lop, rop) + age,
  family = binom2.or(exchangeable = TRUE, zero = 3),
  data = eyesdata, trace = TRUE,
  xij = list(BS(lop, rop) ~ BS(lop, rop) +
  BS(rop, lop) +
  fill1(BS(lop, rop))),
  form2 = ~ BS(lop, rop) + BS(rop, lop) + fill1(BS(lop, rop)) +
  lop + rop + age)

head(model.matrix(fit2, type = "lm")) # LM model matrix
head(model.matrix(fit2, type = "vlm")) # Big VLM model matrix
coef(fit2)
coef(fit2, matrix = TRUE)
summary(fit2)
fit2@smart.prediction
max(abs(predict(fit2) - predict(fit2, new = eyesdata))) # Okay
predict(fit2, new = head(eyesdata)) # OR is 'scalar' as zero=3
max(abs(head(predict(fit2)) - predict(fit2, new = head(eyesdata)))) # Should be 0
## Not run:
plotvgam(fit2, se = TRUE, xlab = "lop") # Correct
## End(Not run)

# Example 3. Capture-recapture model with ephemeral and enduring
# memory effects. Similar to Yang and Chao (2005), Biometrics.
deermice <- transform(deermice, Lag1 = y1)
M.tbh.lag1 <-
### Description

A data frame of a toxicity trial.

### Usage

```r
data(finney44)
```

### Format

A data frame with 6 observations on the following 3 variables.

- `pconc`: a numeric vector, percent concentration of pyrethrins.
- `hatched`: number of eggs that hatched.
- `unhatched`: number of eggs that did not hatch.

### Details

Finney (1944) describes a toxicity trial of five different concentrations of pyrethrins (percent) plus a control that were administered to eggs of *Ephestia kuhniella*. The natural mortality rate is large, and a common adjustment is to use Abbott’s formula.

### References


### Examples

```r
data(finney44)
transform(finney44, mortality = unhatched / (hatched + unhatched))
```
Description
Computes the Fisher Z transformation, including its inverse and the first two derivatives.

Usage
fisherzlink(theta, bminvalue = NULL, bmaxvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)

Arguments
theta Numeric or character. See below for further details.

bminvalue, bmaxvalue
Optional boundary values. Values of theta which are less than or equal to −1 can be replaced by bminvalue before computing the link function value. Values of theta which are greater than or equal to 1 can be replaced by bmaxvalue before computing the link function value. See Links.

inverse, deriv, short, tag
Details at Links.

Details
The fisherz link function is commonly used for parameters that lie between −1 and 1. Numerical values of theta close to −1 or 1 or out of range result in Inf, -Inf, NA or NaN.

Value
For deriv = 0, 0.5 * log((1+theta)/(1-theta)) (same as atanh(theta)) when inverse = FALSE, and if inverse = TRUE then (exp(2*theta)−1)/(exp(2*theta)+1) (same as tanh(theta)).

For deriv = 1, then the function returns d eta / d theta as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base e.

Note
Numerical instability may occur when theta is close to −1 or 1. One way of overcoming this is to use, e.g., bminvalue.

The link function rhobitlink is very similar to fisherzlink, e.g., just twice the value of fisherzlink. This link function may be renamed to atanhlink in the near future.

Author(s)
Thomas W. Yee
The Fisk Distribution

Density, distribution function, quantile function and random generation for the Fisk distribution with shape parameter \( a \) and scale parameter \( \text{scale} \).

Usage

\[
dfisk(x, \text{scale} = 1, \text{shape1.a}, \text{log} = \text{FALSE})
\]

\[
\text{pfisk}(q, \text{scale} = 1, \text{shape1.a}, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE})
\]

\[
\text{qfisk}(p, \text{scale} = 1, \text{shape1.a}, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE})
\]

\[
\text{rfisk}(n, \text{scale} = 1, \text{shape1.a})
\]

Arguments

- \( x, q \) vector of quantiles.
- \( p \) vector of probabilities.
- \( n \) number of observations. If \( \text{length}(n) > 1 \) then the length is taken to be the number required.
- \( \text{shape1.a} \) shape parameter.
- \( \text{scale} \) scale parameter.
- \( \text{log} \) Logical. If \( \text{log} = \text{TRUE} \) then the logarithm of the density is returned.
- \( \text{lower.tail}, \text{log.p} \) Same meaning as in \( \text{pnorm} \) or \( \text{qnorm} \).
**Details**

See `fisk`, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.

**Value**

dfisk gives the density, pfisk gives the distribution function, qfisk gives the quantile function, and rfisk generates random deviates.

**Note**

The Fisk distribution is a special case of the 4-parameter generalized beta II distribution.

**Author(s)**

T. W. Yee and Kai Huang

**References**


**See Also**

`fisk`, `genbetaII`.

**Examples**

```r
fdata <- data.frame(y = rfisk(1000, shape = exp(1), scale = exp(2)))
fit <- vglm(y ~ 1, fisk(lss = FALSE), data = fdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
```

---

**fisk**

*Fisk Distribution family function*

**Description**

Maximum likelihood estimation of the 2-parameter Fisk distribution.

**Usage**

```r
fisk(lscale = "loglink", lshape1.a = "loglink", iscale = NULL,
    ishape1.a = NULL, imethod = 1, lss = TRUE,
    gscale = exp(-5:5), gshape1.a = seq(0.75, 4, by = 0.25),
    probs.y = c(0.25, 0.5, 0.75), zero = "shape")
```
Arguments

lss
See CommonVGAMffArguments for important information.

lshape1.a, lscale
Parameter link functions applied to the (positive) parameters \(a\) and scale. See Links for more choices.

iscale, ishape1.a, imethod, zero
See CommonVGAMffArguments for information. For \(imethod = 2\) a good initial value for iscale is needed to obtain a good estimate for the other parameter.

gscale, gshape1.a
See CommonVGAMffArguments for information.

probs.y
See CommonVGAMffArguments for information.

Details

The 2-parameter Fisk (aka log-logistic) distribution is the 4-parameter generalized beta II distribution with shape parameter \(q = p = 1\). It is also the 3-parameter Singh-Maddala distribution with shape parameter \(q = 1\), as well as the Dagum distribution with \(p = 1\). More details can be found in Kleiber and Kotz (2003).

The Fisk distribution has density

\[
f(y) = ay^{a-1}/[b^a\{1 + (y/b)^a\}^2]
\]

for \(a > 0, b > 0, y \geq 0\). Here, \(b\) is the scale parameter scale, and \(a\) is a shape parameter. The cumulative distribution function is

\[
F(y) = 1 - [1 + (y/b)^a]^{-1} = [1 + (y/b)^{-a}]^{-1}.
\]

The mean is

\[
E(Y) = b \Gamma(1 + 1/a) \Gamma(1 - 1/a)
\]

provided \(a > 1\); these are returned as the fitted values. This family function handles multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

See the notes in genbetaII.

Author(s)

T. W. Yee

References

See Also

Fisk, genbetaII, betaII, dagum, sinmad, inv.lomax, lomax, paralogistic, inv.paralogistic, simulate.vlm.

Examples

fdata <- data.frame(y = rfisk(200, shape = exp(1), exp(2)))
fit <- vglm(y ~ 1, fisk(lss = FALSE), data = fdata, trace = TRUE)
fit <- vglm(y ~ 1, fisk(ishape1.a = exp(2)), fdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

fittedvlm

Fitted Values of a VLM object

Description

Extractor function for the fitted values of a model object that inherits from a vector linear model (VLM), e.g., a model of class "vglm".

Usage

fittedvlm(object, drop = FALSE, type.fitted = NULL, percentiles = NULL, ...)

Arguments

object a model object that inherits from a VLM.
drop Logical. If FALSE then the answer is a matrix. If TRUE then the answer is a vector.
type.fitted Character. Some VGAM family functions have a type.fitted argument. If so then a different type of fitted value can be returned. It is recomputed from the model after convergence. Note: this is an experimental feature and not all VGAM family functions have this implemented yet. See CommonVGAMffArguments for more details.
percentiles See CommonVGAMffArguments for details.
... Currently unused.

Details

The "fitted values" usually corresponds to the mean response, however, because the VGAM package fits so many models, this sometimes refers to quantities such as quantiles. The mean may even not exist, e.g., for a Cauchy distribution.

Note that the fitted value is output from the @linkinv slot of the VGAM family function, where the eta argument is the $n \times M$ matrix of linear predictors.
Value

The fitted values evaluated at the final IRLS iteration.

Note

This function is one of several extractor functions for the VGAM package. Others include \texttt{coef}, \texttt{deviance}, \texttt{weights} and \texttt{constraints} etc. This function is equivalent to the methods function for the generic function \texttt{fitted}.values.

If \texttt{fit} is a VLM or VGLM then \texttt{fitted(fit)} and \texttt{predict(fit, type = "response")} should be equivalent (see \texttt{predictvglm}). The latter has the advantage in that it handles a newdata argument so that the fitted values can be computed for a different data set.

Author(s)

Thomas W. Yee

References


See Also

\texttt{fitted}, \texttt{predictvglm}, \texttt{vglmff-class}.

Examples

# Categorical regression example 1
pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo))
fitted(fit1)

# LMS quantile regression example 2
fit2 <- vgam(BMI ~ s(age, df = c(4, 2)),
            lms.bcn(zero = 1), data = bmi.nz, trace = TRUE)
head(predict(fit2, type = "response")) # Equals to both these:
head(fitted(fit2))
predict(fit2, type = "response", newdata = head(bmi.nz))

# Zero-inflated example 3
zdata <- data.frame(x2 = runif(nn <- 1000))
zdata <- transform(zdata,
  pstr0.3 = logitlink(-0.5, inverse = TRUE),
  lambda.3 = loglink(-0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata,
  y1 = rzipois(nn, lambda = lambda.3, pstr0 = pstr0.3))
fit3 <- vglm(y1 ~ x2, zipoisson(zero = NULL), zdata, trace = TRUE)
head(fitted(fit3, type.fitted = "mean")) # E(Y) (the default)
head(fitted(fit3, type.fitted = "pobs0")) # Pr(Y = 0)
head(fitted(fit3, type.fitted = "pstr0")) # Prob of a structural 0
head(fitted(fit3, type.fitted = "onempstr0")) # 1 - Pr(structural 0)
Description

Returns a similar object fitted with columns of the constraint matrices amalgamated so it is a partially parallel VGLM object. The columns combined correspond to certain crossing quantiles. This applies especially to an extlogF1() VGLM object.

Usage

fix.crossing.vglm(object, maxit = 100, trace = FALSE, ...)

Arguments

object an object such as a vglm object with family function extlogF1.
maxit, trace values for overwriting components in vglm.control. Setting these to NULL will mean the values in vglm.control on object will be retained.
... additional optional arguments. Currently unused.

Details

The quantile crossing problem has been described as disturbing and embarrassing. This function was specifically written for a vglm with family function extlogF1. It examines the fitted quantiles of object to see if any cross. If so, then a pair of columns is combined to make those two quantiles parallel. After fitting the submodel it then repeats testing for crossing quantiles and repairing them, until there is no more quantile crossing detected. Note that it is possible that the quantiles cross in some subset of the covariate space not covered by the data—see is.crossing.

This function is fragile and likely to change in the future. For extlogF1 models, it is assumed that argument data has been assigned a data frame, and that the default values of the argument parallel has been used; this means that the second constraint matrix is diag(M). The constraint matrix of the intercept term remains unchanged as diag(M).

Value

An object very similar to the original object, but with possibly different constraint matrices (partially parallel) so as to remove any quantile crossing.

See Also

extlogF1, is.crossing, lms.bcn, vglm.
Examples

```r
## Not run: ooo <- with(bmi.nz, order(age))
bmi.nz <- bmi.nz[ooo, ] # Sort by age
with(bmi.nz, plot(age, BMI, col = "blue"))
mytau <- c(50, 93, 95, 97) / 100 # Some quantiles are quite close
fit1 <- vglm(BMI ~ ns(age, 7), extlogF1(mytau), bmi.nz, trace = TRUE)
plot(BMI ~ age, bmi.nz, col = "blue", las = 1,
     main = "Partially parallel (darkgreen) & nonparallel quantiles",
     sub = "Crossing quantiles are orange")
fix.crossing(fit1)
matlines(with(bmi.nz, age), fitted(fit1), lty = 1, col = "orange")
fit2 <- fix.crossing(fit1) # Some quantiles have been fixed
constraints(fit2)
matlines(with(bmi.nz, age), fitted(fit2), lty = "dashed",
        col = "darkgreen", lwd = 2)
## End(Not run)
```

flourbeetle

### Mortality of Flour Beetles from Carbon Disulphide

**Description**

The `flourbeetle` data frame has 8 rows and 4 columns. Two columns are explanatory, the other two are responses.

**Usage**

```r
data(flourbeetle)
```

**Format**

This data frame contains the following columns:

- **logdose** `log10` applied to CS2mgL.
- **CS2mgL** a numeric vector, the concentration of gaseous carbon disulphide in mg per litre.
- **exposed** a numeric vector, counts; the number of beetles exposed to the poison.
- **killed** a numeric vector, counts; the numbers killed.

**Details**

These data were originally given in Table IV of Bliss (1935) and are the combination of two series of toxicological experiments involving *Tribolium confusum*, also known as the flour beetle. Groups of such adult beetles were exposed for 5 hours of gaseous carbon disulphide at different concentrations, and their mortality measured.

**Source**

Foldnorm

The Folded-Normal Distribution

Description

Density, distribution function, quantile function and random generation for the (generalized) folded-normal distribution.

Usage

dfoldnorm(x, mean = 0, sd = 1, a1 = 1, a2 = 1, log = FALSE)
pfoldnorm(q, mean = 0, sd = 1, a1 = 1, a2 = 1, lower.tail = TRUE, log.p = FALSE)
qfoldnorm(p, mean = 0, sd = 1, a1 = 1, a2 = 1, lower.tail = TRUE, log.p = FALSE, ...)
rfoldnorm(n, mean = 0, sd = 1, a1 = 1, a2 = 1)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. Same as rnorm.
mean, sd see rnorm.
a1, a2 see foldnormal.
log Logical. If TRUE then the log density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.
... Arguments that can be passed into uniroot.

Details

See foldnormal, the VGAM family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dfoldnorm gives the density, pfoldnorm gives the distribution function, qfoldnorm gives the quantile function, and rfoldnorm generates random deviates.

See Also

binomialff, probitlink.

Examples

fit1 <- vglm(cbind(killed, exposed - killed) ~ logdose,
            binomialff(link = probitlink), flourbeetle, trace = TRUE)
summary(fit1)
foldnormal

Folded Normal Distribution Family Function

Description

Fits a (generalized) folded (univariate) normal distribution.

Usage

```r
foldnormal(lmean = "identitylink", lsd = "loglink", imean = NULL,
           isd = NULL, a1 = 1, a2 = 1, nsimEIM = 500, imethod = 1,
           zero = NULL)
```

Arguments

- `lmean, lsd` Link functions for the mean and standard deviation parameters of the usual univariate normal distribution. They are \( \mu \) and \( \sigma \) respectively. See `Links` for more choices.
- `imean, isd` Optional initial values for \( \mu \) and \( \sigma \). A `NULL` means a value is computed internally. See `CommonVGAMffArguments`.

Examples

```r
## Not run:
m <- 1.5; SD <- exp(0)
x <- seq(-1, 4, len = 501)
plot(x, dfoldnorm(x, m = m, sd = SD), type = "l", ylim = 0:1,
ylab = paste("foldnorm(m = ", m, ", sd = ",
               round(SD, digits = 3), ")"), las = 1,
main = "Blue is density, orange is CDF", col = "blue",
sub = "Purple lines are the 10,20,...,90 percentiles")
abline(h = 0, col = "gray50")
lines(x, pfoldnorm(x, m = m, sd = SD), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qfoldnorm(probs, m = m, sd = SD)
lines(Q, dfoldnorm(Q, m = m, SD), col = "purple", lty = 3, type = "h")
lines(Q, pfoldnorm(Q, m, SD), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pfoldnorm(Q, m = m, sd = SD) - probs)) # Should be 0
## End(Not run)
```
foldnormal

\(a_1, a_2\) Positive weights, called \(a_1\) and \(a_2\) below. Each must be of length 1.

\texttt{nsimEIM, imethod, zero}

See \texttt{CommonVGAMffArguments}.

**Details**

If a random variable has an ordinary univariate normal distribution then the absolute value of that random variable has an ordinary \textit{folded normal distribution}. That is, the sign has not been recorded; only the magnitude has been measured.

More generally, suppose \(X\) is normal with mean \(\mu\) and standard deviation \(\sigma\). Let \(Y = \max(a_1 X, -a_2 X)\) where \(a_1\) and \(a_2\) are positive weights. This means that \(Y = a_1 X\) for \(X > 0\), and \(Y = a_2 X\) for \(X < 0\). Then \(Y\) is said to have a \textit{generalized folded normal distribution}. The ordinary folded normal distribution corresponds to the special case \(a_1 = a_2 = 1\).

The probability density function of the ordinary folded normal distribution can be written
\[
dnorm(y, \text{mean}, \text{sd}) + dnorm(y, -\text{mean}, \text{sd})
\]
for \(y \geq 0\). By default, \texttt{mean} and \texttt{log(sd)} are the linear/additive predictors. Having \texttt{mean=0} and \texttt{sd=1} results in the \textit{half-normal} distribution. The mean of an ordinary folded normal distribution is
\[
E(Y) = \sigma \sqrt{\frac{2}{\pi}} \exp\left(-\frac{\mu^2}{2\sigma^2}\right) + \mu [1 - 2\Phi(-\mu/\sigma)]
\]
and these are returned as the fitted values. Here, \(\Phi()\) is the cumulative distribution function of a standard normal (\texttt{pnorm}).

**Value**

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

**Warning**

Under- or over-flow may occur if the data is ill-conditioned. It is recommended that several different initial values be used to help avoid local solutions.

**Note**

The response variable for this family function is the same as \texttt{uninormal} except positive values are required. Reasonably good initial values are needed. Fisher scoring using simulation is implemented.

See \texttt{CommonVGAMffArguments} for general information about many of these arguments.

Yet to do: implement the results of Johnson (1962) which gives expressions for the EIM, albeit, under a different parameterization. Also, one element of the EIM appears to require numerical integration.

**Author(s)**

Thomas W. Yee
References


See Also

rfoldnorm, uninormal, dnorm, skewnormal.

Examples

```r
## Not run: m <- 2; SD <- exp(1)
fdata <- data.frame(y = rfoldnorm(n <- 1000, m = m, sd = SD))
hist(with(fdata, y), prob = TRUE, main = paste(“foldnormal(m = “,
     m”, sd = “, round(SD, 2), “)”))
fit <- vglm(y ~ 1, foldnormal, data = fdata, trace = TRUE)
coef(fit, matrix = TRUE)
(Cfit <- Coef(fit))
# Add the fit to the histogram:
mygrid <- with(fdata, seq(min(y), max(y), len = 200))
lines(mygrid, dfoldnorm(mygrid, Cfit[1], Cfit[2]), col = “orange”)
## End(Not run)
```

formulavlm

`Model Formulae and Term Names for VGLMs`

Description

The methods function for `formula` to extract the formula from a fitted object, as well as a methods function to return the names of the terms in the formula.

Usage

```r
## S3 method for class 'vlm'
formula(x, ...) 
formulavlm(x, form.number = 1, ...) 
term.names(model, ...) 
term.namesvlm(model, form.number = 1, ...)
```

Arguments

- `x, model` A fitted model object.
- `form.number` Formula number, is 1 or 2, which correspond to the arguments `form1` and `form2` respectively.
- `...` Same as `formula`.
Details

The formula methods function is based on formula.

Value

The formula methods function should return something similar to formula. The term.names methods function should return a character string with the terms in the formula; this includes any intercept (which is denoted by "(Intercept)" as the first element.)

Author(s)

Thomas W. Yee

See Also

has.intercept.vlm.

Examples

# Example: this is based on a glm example
counts <- c(18,17,15,20,10,20,25,13,12)
outcome <- gl(3, 1, 9); treatment <- gl(3, 3)
vglm.D93 <- vglm(counts ~ outcome + treatment, family = poissonff)
formula(vglm.D93)
pdata <- data.frame(counts, outcome, treatment) # Better style
vglm.D93 <- vglm(counts ~ outcome + treatment, poissonff, data = pdata)
formula(vglm.D93)
term.names(vglm.D93)
responseName(vglm.D93)
has.intercept(vglm.D93)

Frank

Frank’s Bivariate Distribution

Description

Density, distribution function, and random generation for the (one parameter) bivariate Frank distribution.

Usage

dbifrankcop(x1, x2, apar, log = FALSE)
pbifrankcop(q1, q2, apar)
rbifrankcop(n, apar)
Frank

Arguments

- \(x_1, x_2, q_1, q_2\) vector of quantiles.
- \(n\) number of observations. Same as in \texttt{runif}.
- \(\text{apar}\) the positive association parameter.
- \(\text{log}\) Logical. If \(\text{log} = \text{TRUE}\) then the logarithm of the density is returned.

Details

See \texttt{bifrankcop}, the \texttt{VGAM} family functions for estimating the association parameter by maximum likelihood estimation, for the formula of the cumulative distribution function and other details.

Value

d\texttt{bifrankcop} gives the density, \texttt{pbifrankcop} gives the distribution function, and \texttt{rbifrankcop} generates random deviates (a two-column matrix).

Author(s)

T. W. Yee

References


See Also

\texttt{bifrankcop}.

Examples

```r
## Not run: N <- 100; apar <- exp(2)
xx <- seq(-0.30, 1.30, len = N)
ox <- expand.grid(xx, xx)
zedd <- dbifrankcop(xx[, 1], xx[, 2], apar = apar)
contour(xx, xx, matrix(zedd, N, N))
zedd <- pbifrankcop(xx[, 1], xx[, 2], apar = apar)
contour(xx, xx, matrix(zedd, N, N))
plot(rr <- rbifrankcop(n = 3000, apar = exp(4)))
par(mfrow = c(1, 2))
hist(rr[, 1]); hist(rr[, 2]) # Should be uniform

## End(Not run)
```
Description

Density, distribution function, quantile function and random generation for the three parameter Frechet distribution.

Usage

dfrechet(x, location = 0, scale = 1, shape, log = FALSE)
pfrechet(q, location = 0, scale = 1, shape,
  lower.tail = TRUE, log.p = FALSE)
qfrechet(p, location = 0, scale = 1, shape,
  lower.tail = TRUE, log.p = FALSE)
rfrechet(n, location = 0, scale = 1, shape)

Arguments

x, q
vector of quantiles.
p
vector of probabilities.
n
number of observations. Passed into runif.
location, scale, shape
the location parameter \( a \), scale parameter \( b \), and shape parameter \( s \).
log
Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p
Same meaning as in punif or qunif.

Details

See frechet, the VGAM family function for estimating the 2 parameters (without location parameter) by maximum likelihood estimation, for the formula of the probability density function and range restrictions on the parameters.

Value

dfrechet gives the density, pfrechet gives the distribution function, qfrechet gives the quantile function, and rfrechet generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References

See Also

frechet.

Examples

```r
## Not run: shape <- 5
x <- seq(-0.1, 3.5, length = 401)
plot(x, dfrechet(x, shape = shape), type = "l", ylab = "",
     main = "Frechet density divided into 10 equal areas",
     sub = "Orange = CDF", las = 1)
abline(h = 0, col = "blue", lty = 2)
qq <- qfrechet(seq(0.1, 0.9, by = 0.1), shape = shape)
lines(qq, dfrechet(qq, shape = shape), col = 2, lty = 2, type = "h")
lines(x, pfrechet(q = x, shape = shape), col = "orange")
## End(Not run)
```

frechet

Frechet Distribution Family Function

Description

Maximum likelihood estimation of the 2-parameter Frechet distribution.

Usage

```r
frechet(location = 0, lscale = "loglink",
     lshape = logofflink(offset = -2),
     iscale = NULL, ishape = NULL, nsimEIM = 250, zero = NULL)
```

Arguments

- `location`: Numeric. Location parameter. It is called \(a\) below.
- `lscale`, `lshape`: Link functions for the parameters; see `Links` for more choices.
- `iscale`, `ishape`, `zero`, `nsimEIM`

See `CommonVGAMffArguments` for information.

Details

The (3-parameter) Frechet distribution has a density function that can be written

\[
f(y) = \frac{sb}{(y-a)^2} \left[ \frac{b}{y-a} \right]^{s-1} \exp\left[ -\left( \frac{b}{y-a} \right)^s \right]
\]

for \(y > a\) and scale parameter \(b > 0\). The positive shape parameter is \(s\). The cumulative distribution function is

\[
F(y) = \exp\left[ -\left( \frac{b}{y-a} \right)^s \right].
\]
The mean of $Y$ is $a + b\Gamma(1 - 1/s)$ for $s > 1$ (these are returned as the fitted values). The variance of $Y$ is $b^2[\Gamma(1 - 2/s) - \Gamma^2(1 - 1/s)]$ for $s > 2$.

Family frechet has $a$ known, and $\log(b)$ and $\log(s - 2)$ are the default linear/additive predictors. The working weights are estimated by simulated Fisher scoring.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

Family function frechet may fail for low values of the shape parameter, e.g., near 2 or lower.

Author(s)

T. W. Yee

References


See Also

rfrechet, gev.

Examples

```r
## Not run:
set.seed(123)
fdata <- data.frame(y1 = rfrechet(1000, shape = 2 + exp(1)))
with(fdata, hist(y1))
fit2 <- vglm(y1 ~ 1, frechet, data = fdata, trace = TRUE)
coef(fit2, matrix = TRUE)
Coef(fit2)
head(fitted(fit2))
with(fdata, mean(y1))
head(weights(fit2, type = "working"))
vcov(fit2)
## End(Not run)
```
Freund's (1961) Bivariate Extension of the Exponential Distribution

Description

Estimate the four parameters of the Freund (1961) bivariate extension of the exponential distribution by maximum likelihood estimation.

Usage

freund61(la = "loglink", lap = "loglink", lb = "loglink", lbp = "loglink", ia = NULL, iap = NULL, ib = NULL, ibp = NULL, independent = FALSE, zero = NULL)

Arguments

la, lap, lb, lbp

Link functions applied to the (positive) parameters $\alpha$, $\alpha'$, $\beta$ and $\beta'$, respectively (the "p" stands for "prime"). See Links for more choices.

ia, iap, ib, ibp

Initial value for the four parameters respectively. The default is to estimate them all internally.

independent

Logical. If TRUE then the parameters are constrained to satisfy $\alpha = \alpha'$ and $\beta = \beta'$, which implies that $y_1$ and $y_2$ are independent and each have an ordinary exponential distribution.

zero

A vector specifying which linear/additive predictors are modelled as intercepts only. The values can be from the set {1,2,3,4}. The default is none of them. See CommonVGAMffArguments for more information.

Details

This model represents one type of bivariate extension of the exponential distribution that is applicable to certain problems, in particular, to two-component systems which can function if one of the components has failed. For example, engine failures in two-engine planes, paired organs such as peoples’ eyes, ears and kidneys. Suppose $y_1$ and $y_2$ are random variables representing the lifetimes of two components $A$ and $B$ in a two component system. The dependence between $y_1$ and $y_2$ is essentially such that the failure of the $B$ component changes the parameter of the exponential life distribution of the $A$ component from $\alpha$ to $\alpha'$, while the failure of the $A$ component changes the parameter of the exponential life distribution of the $B$ component from $\beta$ to $\beta'$.

The joint probability density function is given by

$$f(y_1, y_2) = \alpha \beta' \exp(-\beta' y_2 - (\alpha + \beta - \beta') y_1)$$

for $0 < y_1 < y_2$, and

$$f(y_1, y_2) = \beta \alpha' \exp(-\alpha' y_1 - (\alpha + \beta - \alpha') y_2)$$
for $0 < y_2 < y_1$. Here, all four parameters are positive, as well as the responses $y_1$ and $y_2$. Under this model, the probability that component $A$ is the first to fail is $\alpha/(\alpha + \beta)$. The time to the first failure is distributed as an exponential distribution with rate $\alpha + \beta$. Furthermore, the distribution of the time from first failure to failure of the other component is a mixture of Exponential($\alpha'$) and Exponential($\beta'$) with proportions $\beta/(\alpha + \beta)$ and $\alpha/(\alpha + \beta)$ respectively.

The marginal distributions are, in general, not exponential. By default, the linear/additive predictors are $\eta_1 = \log(\alpha), \eta_2 = \log(\alpha'), \eta_3 = \log(\beta), \eta_4 = \log(\beta')$.

A special case is when $\alpha = \alpha'$ and $\beta = \beta'$, which means that $y_1$ and $y_2$ are independent, and both have an ordinary exponential distribution with means $1/\alpha$ and $1/\beta$ respectively.

Fisher scoring is used, and the initial values correspond to the MLEs of an intercept model. Consequently, convergence may take only one iteration.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

To estimate all four parameters, it is necessary to have some data where $y_1 < y_2$ and $y_2 < y_1$.

The response must be a two-column matrix, with columns $y_1$ and $y_2$. Currently, the fitted value is a matrix with two columns; the first column has values $(\alpha' + \beta)/(\alpha'(\alpha + \beta))$ for the mean of $y_1$, while the second column has values $(\beta' + \alpha)/(\beta'(\alpha + \beta))$ for the mean of $y_2$. The variance of $y_1$ is

$$\frac{(\alpha')^2 + 2\alpha\beta + \beta^2}{(\alpha')^2(\alpha + \beta)^2},$$

the variance of $y_2$ is

$$\frac{(\beta')^2 + 2\alpha\beta + \alpha^2}{(\beta')^2(\alpha + \beta)^2},$$

the covariance of $y_1$ and $y_2$ is

$$\frac{\alpha'\beta' - \alpha\beta}{\alpha'\beta'(\alpha + \beta)^2}.$$

Author(s)

T. W. Yee

References


See Also

exponential.
Examples

```r
fdata <- data.frame(y1 = rexp(nn <- 1000, rate = exp(1)))
fdata <- transform(fdata, y2 = rexp(nn, rate = exp(2)))
fit1 <- vglm(cbind(y1, y2) ~ 1, freund61, fdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
vcov(fit1)
head(fitted(fit1))
summary(fit1)
```

# y1 and y2 are independent, so fit an independence model
```r
fit2 <- vglm(cbind(y1, y2) ~ 1, freund61(indep = TRUE),
             data = fdata, trace = TRUE)
coef(fit2, matrix = TRUE)
constraints(fit2)
pchisq(2 * (logLik(fit1) - logLik(fit2)), # p-value
df = df.residual(fit2) - df.residual(fit1),
       lower.tail = FALSE)
lrtest(fit1, fit2) # Better alternative
```

---

Gaitdbinom

### Generally Altered, Inflated, Truncated and Deflated Binomial Distribution

**Description**

Density, distribution function, quantile function and random generation for the generally altered, inflated, truncated and deflated binomial distribution. Both parametric and nonparametric variants are supported; these are based on finite mixtures of the parent with itself and the multinomial logit model (MLM) respectively.

**Usage**

```r
dgaitdbinom(x, size.p, prob.p,
            a.mix = NULL, a.mlm = NULL,
            i.mix = NULL, i.mlm = NULL,
            d.mix = NULL, d.mlm = NULL, truncate = NULL,
            pobs.mix = 0, pobs.mlm = 0,
            pstr.mix = 0, pstr.mlm = 0,
            pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
            size.a = size.p, size.i = size.p, size.d = size.p,
            prob.a = prob.p, prob.i = prob.p, prob.d = prob.p,
            log = FALSE, ...)
pgaitdbinom(q, size.p, prob.p,
            a.mix = NULL, a.mlm = NULL,
            i.mix = NULL, i.mlm = NULL,
            d.mix = NULL, d.mlm = NULL, truncate = NULL,
            pobs.mix = 0, pobs.mlm = 0,
            size.a = size.p, size.i = size.p, size.d = size.p,
            prob.a = prob.p, prob.i = prob.p, prob.d = prob.p,
            log = FALSE, ...)
```
pstr.mix = 0, pstr.mlm = 0,
pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
size.a = size.p, size.i = size.p, size.d = size.p,
prob.a = prob.p, prob.i = prob.p, prob.d = prob.p,
lower.tail = TRUE, ...
qgaitdbinom(p, size.p, prob.p,
a.mix = NULL, a.mlm = NULL,
i.mix = NULL, i.mlm = NULL,
d.mix = NULL, d.mlm = NULL, truncate = NULL,
pobs.mix = 0, pobs.mlm = 0,
pstr.mix = 0, pstr.mlm = 0,
pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
size.a = size.p, size.i = size.p, size.d = size.p,
prob.a = prob.p, prob.i = prob.p, prob.d = prob.p, ...
rgaitdbinom(n, size.p, prob.p,
a.mix = NULL, a.mlm = NULL,
i.mix = NULL, i.mlm = NULL,
d.mix = NULL, d.mlm = NULL, truncate = NULL,
pobs.mix = 0, pobs.mlm = 0,
pstr.mix = 0, pstr.mlm = 0,
pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
size.a = size.p, size.i = size.p, size.d = size.p,
prob.a = prob.p, prob.i = prob.p, prob.d = prob.p, ...

Arguments

x, q, p, n, log, lower.tail
   Same meaning as in Binomial.
size.p, prob.p   Same meaning as in Binomial. See Gaitdpois for generic information.
size.a, prob.a   See Gaitdpois for generic information.
size.i, prob.i   See Gaitdpois for generic information.
size.d, prob.d   See Gaitdpois for generic information.
truncate   See Gaitdpois for generic information.
a.mix, i.mix, d.mix
   See Gaitdpois for generic information.
a.mlm, i.mlm, d.mlm
   See Gaitdpois for generic information.
pstr.mix, pstr.mlm, byrow.aid
   See Gaitdpois for generic information.
pobs.mix, pobs.mlm
   See Gaitdpois for generic information.
pdip.mix, pdip.mlm
   See Gaitdpois for generic information.
...
   Arguments such as max.support that are ignored. This will occur internally within dgaitdplot.
Details

These functions for the GAITD binomial distribution are analogous to the GAITD Poisson, hence most details have been put in Gaitdpois.

Value

dgaitdbinom gives the density, pgaitdbinom gives the distribution function, qgaitdbinom gives the quantile function, and rgaitdbinom generates random deviates. The default values of the arguments correspond to ordinary dbinom, pbinom, qbinom, rbinom respectively.

Warning

See Gaitdpois about the dangers of too much inflation and/or deflation on GAITD PMFs, and the difficulties detecting such.

Note

Functions Posbinom have been moved to VGAMdata. It is better to use dgaitdbinom(x, size, prob, truncate = 0) instead of dposbinom(x, size, prob), etc.

Author(s)

T. W. Yee.

See Also

Gaitdpois, Gaitdnbinom, multinomial, Gaitdlog, Gaitdzeta.

Examples

```r
size <- 20
tvec <- 14; pobs.a <- 0.05; pstr.i <- 0.15
tvec <- 14; pobs.a <- 0.05; pstr.i <- 0.15
dvec <- 5; pdip.mlm <- 0.05

(ddd <- dgaitdbinom(xgrid, size, prob.p = prob,
                     prob.a = prob + 0.05, truncate = tvec, pobs.mix = pobs.a,
                     pdip.mlm = pdip.mlm, d.mlm = dvec,
                     pobs.mlm = pobs.a, a.mlm = avec,
                     pstr.mix = pstr.i, i.mix = ivec))
```

```r
## Not run: dgaitdplot(c(size, prob), ylab = "Probability",
xlab = "x", pobs.mix = pobs.mix,
pobs.mlm = pobs.a, a.mlm = avec, all.lwd = 3,
pdip.mlm = pdip.mlm, d.mlm = dvec, fam = "binom",
pstr.mix = pstr.i, i.mix = ivec, deflation = TRUE,
main = "GAITD Combo PMF---Binomial Parent")
```
## End(Not run)
**Description**

Density, distribution function, quantile function and random generation for the generally altered, inflated, truncated and deflated logarithmic distribution. Both parametric and nonparametric variants are supported; these are based on finite mixtures of the parent with itself and the multinominal logit model (MLM) respectively.

**Usage**

```r
dgaitdlog(x, shape.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, shape.a = shape.p, shape.i = shape.p, shape.d = shape.p, log = FALSE)

pgaitdlog(q, shape.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, shape.a = shape.p, shape.i = shape.p, shape.d = shape.p, lower.tail = TRUE)

qgaitdlog(p, shape.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, shape.a = shape.p, shape.i = shape.p, shape.d = shape.p)

rgaitdlog(n, shape.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, shape.a = shape.p, shape.i = shape.p, shape.d = shape.p)
```

**Arguments**

- `x, q, p, n, log, lower.tail`
  
  Same meaning as in `dlog`.
### Gaitdlog

**shape.p, shape.a, shape.i, shape.d**

Same meaning as shape for dlog, i.e., for an ordinary logarithmic distribution. See Gaitdpois for generic information.

**truncate, max.support**

See Gaitdpois for generic information.

**a.mix, i.mix, d.mix**

See Gaitdpois for generic information.

**a.mlm, i.mlm, d.mlm**

See Gaitdpois for generic information.

**pobs.mlm, pstr.mlm, pdip.mlm, byrow.aid**

See Gaitdpois for generic information.

**pobs.mix, pstr.mix, pdip.mix**

See Gaitdpois for generic information.

### Details

These functions for the logarithmic distribution are analogous to the Poisson, hence most details have been put in Gaitdpois. These functions do what Oalog, Oilog, Otlog collectively did plus much more.

### Value

dgaitdlog gives the density, pgaitdlog gives the distribution function, qgaitdlog gives the quantile function, and rgaitdlog generates random deviates. The default values of the arguments correspond to ordinary dlog, plog, qlog, rlog respectively.

### Warning

See Gaitdpois about the dangers of too much inflation and/or deflation on GAITD PMFs, and the difficulties detecting such.

### Note

See Gaitdpois for general information also relevant to this parent distribution.

### Author(s)

T. W. Yee.

### See Also

gaitdlog, Gaitdpois, dgaitdplot, Gaitdzeta, multinomial, Oalog, Oilog, Otlog.

### Examples

```r
ivec <- c(2, 10); avec <- ivec + 1; shape <- 0.995; xgrid <- 0:15
max.support <- 15; pobs.a <- 0.10; pstr.i <- 0.15
dvec <- 1; pdip.mlm <- 0.05
ddd <- dgaitdlog(xgrid, shape,
    max.support = max.support, pobs.mix = pobs.a,
```
gaitdlog

Generally Altered, Inflated, Truncated and Deflated Logarithmic Regression

Description

Fits a generally altered, inflated, truncated and deflated logarithmic regression by MLE. The GAITD combo model having 7 types of special values is implemented. This allows logarithmic mixtures on nested and/or partitioned support as well as a multinomial logit model for altered, inflated and deflated values. Truncation may include the upper tail.

Usage

```r
gaitdlog(a.mix = NULL, i.mix = NULL, d.mix = NULL,
a.mlm = NULL, i.mlm = NULL, d.mlm = NULL,
truncate = NULL, max.support = Inf,
zero = c("pobs", "pstr", "pdip"), eq.ap = TRUE, eq.ip = TRUE,
eq.dp = TRUE, parallel.a = FALSE,
parallel.i = FALSE, parallel.d = FALSE,
lshape.p = "logitlink", lshape.a = lshape.p,
lshape.i = lshape.p, lshape.d = lshape.p,
type.fitted = c("mean", "shapes", "pobs.mlm", "pstr.mlm",
"pdip.mlm", "pobs.mix", "pstr.mix", "pdip.mix", "Pobs.mix",
"Pstr.mix", "Pdip.mix", "nonspecial",
"Numer", "Denom.p", "sum.mlm.i", "sum.mix.i", "sum.mix.d",
"sum.mix.d", "ptrunc.p", "cdf.max.s"),
gshape.p = -expm1(-7 * ppoints(12)), gpstr.mix = ppoints(7) / 3,
gpstr.mlm = ppoints(7) / (3 + length(i.mlm)),
imethod = 1, mux.init = c(0.75, 0.5, 0.75),
ishape.p = NULL, ishape.a = ishape.p,
ishape.i = ishape.p, ishape.d = ishape.p,
ipobs.mix = NULL, ipstr.mix = NULL, ipdip.mix = NULL,
ipobs.mlm = NULL, ipstr.mlm = NULL, ipdip.mlm = NULL,
byrow.aid = FALSE, ishrinkage = 0.95, probs.y = 0.35)
```
Arguments

truncate, max.support
  See gaitdpoisson.
a.mix, i.mix, d.mix
  See gaitdpoisson.
a.mlm, i.mlm, d.mlm
  See gaitdpoisson.
lshape.p, lshape.a, lshape.i, lshape.d
  Link functions. See gaitdpoisson and Links for more choices and information. Actually, it is usually a good idea to set these arguments equal to logffMlink because the log-mean is the first linear/additive predictor so it is like a Poisson regression.
eq.ap, eq.ip, eq.dp
  Single logical each. See gaitdpoisson.
parallel.a, parallel.i, parallel.d
  Single logical each. See gaitdpoisson.
type.fitted, mux.init
  See gaitdpoisson.
imethod, ipobs.mix, ipstr.mix, ipdip.mix
  See CommonVGAMffArguments and gaitdpoisson for information.
ipobs.mlm, ipstr.mlm, ipdip.mlm, byrow.aid
  See CommonVGAMffArguments and gaitdpoisson for information.
gpstr.mlx, gpstr.mlm
  See CommonVGAMffArguments and gaitdpoisson for information.
gshape.p, ishape.p
  See CommonVGAMffArguments and gaitdpoisson for information. The former argument is used only if the latter is not given. Practical experience has shown that good initial values are needed, so if convergence is not obtained then try a finer grid.
ishape.a, ishape.i, ishape.d
  See CommonVGAMffArguments and gaitdpoisson for information.
probs.y, ishrinkage
  See CommonVGAMffArguments and gaitdpoisson for information.
zero
  See gaitdpoisson and CommonVGAMffArguments for information.

Details

Many details to this family function can be found in gaitdpoisson because it is also a 1-parameter discrete distribution. This function currently does not handle multiple responses. Further details are at Gaitdlog.

As alluded to above, when there are covariates it is much more interpretable to model the mean rather than the shape parameter. Hence logffMlink is recommended. (This might become the default in the future.) So installing VGAMextra is a good idea.

Apart from the order of the linear/additive predictors, the following are (or should be) equivalent: gaitdlog() and logff(), gaitdlog(a.mix = 1) and oalog(zero = "pobs1"), gaitdlog(i.mix = 1) and oilog(zero = "pstr1"), gaitdlog(truncate = 1) and otlog(). The functions oalog, oilog and otlog have been placed in VGAMdata.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

See gaitdpoisson.

Note

See gaitdpoisson.

Author(s)

T. W. Yee

See Also

Gaitdlog, logff, logffMlink, Gaitdpois, gaitdpoisson, gaitdzena, spikeplot, goffset, Trunc, oalog, oilog, otllog, CommonVGAMffArguments, rootogram4, simulate.vlm.

Examples

```r
avec <- c(5, 10)  # Alter these values parametrically
ivec <- c(3, 15)  # Inflate these values
tvec <- c(6, 7)   # Truncate these values
max.support <- 20; set.seed(1)
pobs.a <- pstr.i <- 0.1
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, shape.p = logitlink(2+0.5*x2, inverse = TRUE))
gdata <- transform(gdata,
  y1 = rgaitdlog(nn, shape.p, a.mix = avec, pobs.mix = pobs.a,
  i.mix = ivec, pstr.mix = pstr.i, truncate = tvec,
  max.support = max.support))
gaitdlog(a.mix = avec, i.mix = ivec, max.support = max.support)
with(gdata, table(y1))
## Not run: spikeplot(with(gdata, y1), las = 1)
fit7 <- vglm(y1 ~ x2, trace = TRUE, data = gdata,
  gaitdlog(i.mix = ivec, truncate = tvec,
  max.support = max.support, a.mix = avec,
  eq.ap = TRUE, eq.ip = TRUE))
head(fitted(fit7, type.fitted = "Pstr.mix"))
head(predict(fit7))
t(coef(fit7, matrix = TRUE))  # Easier to see with t()
summary(fit7)
## Not run: spikeplot(with(gdata, y1), lwd = 2, ylim = c(0, 0.4))
plotgaitd(fit7, new.plot = FALSE, offset.x = 0.2, all.lwd = 2)
## End(Not run)
```
Gaitdnbinom

Generally Altered, Inflated, Truncated and Deflated Negative Binomial Distribution

Description

Density, distribution function, quantile function and random generation for the generally altered, inflated, truncated and deflated negative binomial (GAITD-NB) distribution. Both parametric and nonparametric variants are supported; these are based on finite mixtures of the parent with itself and the multinomial logit model (MLM) respectively.

Usage

dgaitdnbinom(x, size.p, munb.p,
           a.mix = NULL, a.mlm = NULL,
           i.mix = NULL, i.mlm = NULL,
           d.mix = NULL, d.mlm = NULL, truncate = NULL,
           max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
           pstr.mix = 0, pstr.mlm = 0,
           pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
           size.a = size.p, size.i = size.p, size.d = size.p,
           munb.a = munb.p, munb.i = munb.p, munb.d = munb.p,
           log = FALSE)

pgaitdnbinom(q, size.p, munb.p,
              a.mix = NULL, a.mlm = NULL,
              i.mix = NULL, i.mlm = NULL,
              d.mix = NULL, d.mlm = NULL, truncate = NULL,
              max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
              pstr.mix = 0, pstr.mlm = 0,
              pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
              size.a = size.p, size.i = size.p, size.d = size.p,
              munb.a = munb.p, munb.i = munb.p, munb.d = munb.p,
              lower.tail = TRUE)

qgaitdnbinom(p, size.p, munb.p,
             a.mix = NULL, a.mlm = NULL,
             i.mix = NULL, i.mlm = NULL,
             d.mix = NULL, d.mlm = NULL, truncate = NULL,
             max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
             pstr.mix = 0, pstr.mlm = 0,
             pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
             size.a = size.p, size.i = size.p, size.d = size.p,
             munb.a = munb.p, munb.i = munb.p, munb.d = munb.p)

rgaitdnbinom(n, size.p, munb.p,
              a.mix = NULL, a.mlm = NULL,
              i.mix = NULL, i.mlm = NULL,
              d.mix = NULL, d.mlm = NULL, truncate = NULL,
              max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
Gaitdnbinom

\[
pstr.mix = 0, \ pstr.mlm = 0, \\
pdip.mix = 0, \ pdip.mlm = 0, \ byrow.aid = FALSE, \\
size.a = size.p, \ size.i = size.p, \ size.d = size.p, \\
umb.a = numb.p, \ numb.i = numb.p, \ numb.d = numb.p)
\]

Arguments

- **x, q, p, n, log, lower.tail**
  - Same meaning as in \texttt{rnbinom}.
- **size.p, numb.p**
  - Same meaning as in \texttt{rnbinom}. See \texttt{Gaitdpois} for generic information.
- **size.a, numb.a**
  - See \texttt{Gaitdpois} for generic information.
- **size.i, numb.i**
  - See \texttt{Gaitdpois} for generic information.
- **size.d, numb.d**
  - See \texttt{Gaitdpois} for generic information.
- **truncate, max.support**
  - See \texttt{Gaitdpois} for generic information.
- **a.mix, i.mix, d.mix**
  - See \texttt{Gaitdpois} for generic information.
- **a.mlm, i.mlm, d.mlm**
  - See \texttt{Gaitdpois} for generic information.
- **pobs.mlm, pstr.mlm, byrow.aid**
  - See \texttt{Gaitdpois} for generic information.
- **pobs.mix, pstr.mix**
  - See \texttt{Gaitdpois} for generic information.
- **pdip.mix, pdip.mlm**
  - See \texttt{Gaitdpois} for generic information.

Details

These functions for the NBD are analogous to the Poisson, hence most details have been put in \texttt{Gaitdpois}. The NBD has two possible parameterizations: one involving a probability (argument begins with \texttt{prob}) and the other the mean (beginning with \texttt{mu}). Only the latter is supported here.

For now, arguments such as \texttt{prob.p} and \texttt{prob.a} are no longer supported. That’s because \texttt{mu} is more likely to be used by most statisticians than \texttt{prob}; see \texttt{dnbinom}.

Value

d\texttt{gaitdnbinom} gives the density, p\texttt{gaitdnbinom} gives the distribution function, q\texttt{gaitdnbinom} gives the quantile function, and r\texttt{gaitdnbinom} generates random deviates. The default values of the arguments correspond to ordinary \texttt{dnbinom}, \texttt{pnbinom}, \texttt{qnbinom}, \texttt{rnbinom} respectively.

Warning

See \texttt{Gaitdpois} about the dangers of too much inflation and/or deflation on GAITD PMFs, and the difficulties detecting such.
Note

Four functions were moved from VGAM to VGAMdata; they can be seen at Posnegbin. It is preferable to use dgaitdnbinom(x, size, munb.p = munb, truncate = 0) instead of dposnbinom(x, size, munb = munb), etc.

Author(s)

T. W. Yee.

See Also

gaitdnbinomial, Gaitdpois, multinomial, Gaitdbinom, Gaitdlog, Gaitdzeta.

Examples

```r
size <- 10; xgrid <- 0:25
ivec <- c(5, 6, 10, 14); avec <- c(8, 11); munb <- 10
tvec <- 15; pobs.a <- 0.05; pstr.i <- 0.25
dvec <- 13; pdip.mlm <- 0.03; pobs.mlm <- 0.05
(ddd <- dgaitdnbinom(xgrid, size, munb.p = munb, munb.a = munb + 5,
                      truncate = tvec, pobs.mix = pobs.a,
                      pdip.mlm = pdip.mlm, d.mlm = dvec,
                      pobs.mlm = pobs.a, a.mlm = avec,
                      pstr.mix = pstr.i, i.mix = ivec))
```

```
## Not run: dgaitdplot(c(size, munb), fam = "nbinom",
                   ylab = "Probability", xlab = "x", xlim = c(0, 25),
                   truncate = tvec, pobs.mix = pobs.mix,
                   pobs.mlm = pobs.mlm, a.mlm = avec, all.lwd = 3,
                   pdip.mlm = pdip.mlm, d.mlm = dvec,
                   pstr.mix = pstr.i, i.mix = ivec, deflation = TRUE,
                   main = "GAITD Combo PMF---NB Parent")
## End(Not run)
```

---

**gaitdnbinomial**

**Generally Altered, Inflated, Truncated and Deflated Negative Binomial Regression**

**Description**

Fits a generally altered, inflated truncated and deflated negative binomial regression by MLE. The GAITD combo model having 7 types of special values is implemented. This allows mixtures of negative binomial distributions on nested and/or partitioned support as well as a multinomial logit model for (nonparametric) altered, inflated and deflated values.
Usage

gaitdnbinomial(a.mix = NULL, i.mix = NULL, d.mix = NULL,
a.mlm = NULL, i.mlm = NULL, d.mlm = NULL,
truncate = NULL, zero = c("size", "pobs", "pstr", "pdip"),
eq.ap = TRUE, eq.ip = TRUE, eq.dp = TRUE,
parallel.a = FALSE, parallel.i = FALSE, parallel.d = FALSE,
llmunb.p = "loglink",
llmunb.a = llmunb.p, llmunb.i = llmunb.p, llmunb.d = llmunb.p,
llsize.p = "loglink",\nllsize.a = llsize.p, llsize.i = llsize.p, llsize.d = llsize.p,
type.fitted = c("mean", "munbs", "sizes", "pobs.mlm",
"pstr.mlm", "pdip.mlm", "pobs.mix", "pstr.mix", "pdip.mix",
"Denom.p", "sum.mlm.i", "sum.mix.i",
"sum.mlm.d", "sum.mix.d", "ptrunc.p", "cdf.max.s"),
gpstr.mix = ppoints(7) / 3,
gpstr.mlm = ppoints(7) / (3 + length(i.mlm)),
imethod = 1, mux.init = c(0.75, 0.5, 0.75, 0.5),
llmunb.p = NULL, llmunb.a = llmunb.p,
llmunb.i = llmunb.p, llmunb.d = llmunb.p,
llsize.p = NULL, llsize.a = llsize.p,
llsize.i = llsize.p, llsize.d = llsize.p,
llpobs.mix = NULL, llpstr.mix = NULL,
llpdip.mix = NULL, llpobs.mlm = NULL,
llpstr.mlm = NULL, llpdip.mlm = NULL,
byrow.aid = FALSE, ishrinkage = 0.95, probs.y = 0.35,
nsimEIM = 500, cutoff.prob = 0.999, eps.trig = 1e-7,
nbd.max.support = 4000, max.chunk.MB = 30)

Arguments

truncate See gaitdpoisson.
a.mix, i.mix, d.mix
See gaitdpoisson.
a.mlm, i.mlm, d.mlm
See gaitdpoisson.
llmunb.p, llmunb.a, llmunb.i, llmunb.d
Link functions pertaining to the mean parameters. See gaitdpoisson where
lllambda.p etc. are the equivalent.
llsize.p, llsize.a, llsize.i, llsize.d
Link functions pertaining to the size parameters. See NegBinomial.
eq.ap, eq.ip, eq.dp
See gaitdpoisson. These apply to both munb and size parameters simultaneously. See NegBinomial also.
parallel.a, parallel.i, parallel.d
See gaitdpoisson.
type.fitted
See gaitdpoisson.
Details

The GAITD–NB combo model is the pinnacle of GAITD regression for counts because it potentially handles underdispersion, equidispersion and overdispersion relative to the Poisson, as well as alteration, inflation, deflation and truncation at arbitrary support points. In contrast, gaitdpoisson cannot handle overdispersion so well. The GAITD–NB is so flexible that it can accommodate up to seven modes.

The full GAITD–NB–MLM–NB–MLM–NB–MLM combo model may be fitted with this family function. There are seven types of special values and all arguments for these may be used in a single model. Here, the MLM represents the nonparametric while the NB refers to the negative binomial mixtures. The defaults for this function correspond to an ordinary negative binomial regression so that negbinomial is called instead.

While much of the documentation here draws upon gaitdpoisson, there are additional details here because the NBD is a two parameter distribution that handles overdispersion relative to the Poisson. Consequently, this family function is exceeding flexible and there are many more pitfalls to avoid.

The order of the linear/additive predictors is best explained by an example. Suppose a combo model has length(a.mix) > 3 and length(i.mix) > 3, length(d.mix) > 3, a.mlm = 3:5, i.mlm = 6:9 and d.mlm = 10:12, say. Then loglink(munb.p) and loglink(size.p) are the first two. The third is multilogitlink(pobs.mix) followed by loglink(munb.a) and loglink(size.a) because a.mix is long enough. The sixth is multilogitlink(pstr.mix) followed by loglink(munb.i) and loglink(size.i) because i.mix is long enough. The ninth is multilogitlink(pdip.mix) followed by loglink(munb.d) and loglink(size.d) because d.mix is long enough. Next are the probabilities for the a.mlm values. Then are the probabilities for the i.mlm values. Lastly are the probabilities for the d.mlm values. All the probabilities are estimated by one big MLM.
and effectively the "(Others)" column of left over probabilities is associated with the nonspecial values. These might be called the nonspecial baseline probabilities (NBP) or reserve probabilities. The dimension of the vector of linear/additive predictors here is \( M = 21 \).

Apart from the order of the linear/additive predictors, the following are (or should be) equivalent:
- \texttt{gaitdnbinomial()} and \texttt{negbinomial()}.
- \texttt{gaitdnbinomial(a.mix = 0)} and \texttt{zanegbinomial(zero = "pobs0")}, \texttt{gaitdnbinomial(i.mix = 0)} and \texttt{zinegbinomial(zero = "pstr0")}, \texttt{gaitdnbinomial(truncate = 0)} and \texttt{posnegbinomial()}.

Likewise, if \( a \texttt{.mix} \) and \( i \texttt{.mix} \) are assigned a scalar then it effectively moves that scalar to \( a \texttt{.mlm} \) and \( i \texttt{.mlm} \) because there is no parameters such as \( \texttt{munb.i} \) being estimated. Thus \texttt{gaitdnbinomial(a.mix = 0)} and \texttt{gaitdnbinomial(a.mlm = 0)} are the effectively same, and ditto for \texttt{gaitdnbinomial(i.mix = 0)} and \texttt{gaitdnbinomial(i.mlm = 0)}.

**Value**

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, \texttt{rrvglm} and \texttt{vgam}.

The fitted.values slot of the fitted object, which should be extracted by the generic function \texttt{fitted}, returns the mean \( \mu \) by default. See the information above on type.fitted.

**Warning**

See \texttt{gaitdpoisson}. Also, having eq.ap = \texttt{TRUE}, eq.ip = \texttt{TRUE} and eq.dp = \texttt{TRUE} is often needed to obtain initial values that are good enough because they borrow strength across the different operators. It is usually easy to relax these assumptions later.

This family function is under constant development and future changes will occur.

**Note**

If \texttt{length(a.mix)} is 1 then effectively this becomes a value of \texttt{a.mlm}. If \texttt{length(a.mix)} is 2 then an error message will be issued (overfitting really). If \texttt{length(a.mix)} is 3 then this is almost overfitting too. Hence \texttt{length(a.mix)} should be 4 or more. Ditto for \texttt{length(i.mix)} and \texttt{length(d.mix)}.

See \texttt{gaitdpoisson} for notes about numerical problems that can easily arise. With the NBD there is even more potential trouble that can occur. In particular, good initial values are more necessary so it pays to experiment with arguments such as \texttt{imunb.p} and \texttt{isize.p}, as well as fitting an intercept-only model first before adding covariates and using \texttt{etastart}.

Currently \texttt{max.support} is missing because only \texttt{Inf} is handled. This might change later.

**Author(s)**

T. W. Yee

**References**

Gaitdpois

See Also

Gaitdnbinom, dgaitdplot, multinomial, rootogram4, specials, plotdgaitd, spikeplot, meangaitd, KLD, gaitdpoisson, gaitlog, gaitdzeeta, multilogitlink, multinomial, goffset, Trunc, negbinomial, CommonVGAMffArguments, simulate.vlm.

Examples

```r
## Not run:
i.mix <- c(5, 10, 12, 16)  # Inflate these values parametrically
i.mlm <- c(14, 15)  # Inflate these values
a.mix <- c(1, 6, 13, 20)  # Alter these values
tvec <- c(3, 11)  # Truncate these values
pstr.mlm <- 0.1  # So parallel.i = TRUE
pobs.mix <- pstr.mix <- 0.1; set.seed(1)
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, munb.p = exp(2 + 0.0 * x2),
                   size.p = exp(1))
gdata <- transform(gdata,
                   y1 = rgaitdnbinom(nn, size.p, munb.p, a.mix = a.mix,
                                     i.mix = i.mix,
                                     pobs.mix = pobs.mix, pstr.mix = pstr.mix,
                                     i.mlm = i.mlm, pstr.mlm = pstr.mlm,
                                     truncate = tvec))
gaitdnbinomial(a.mix = a.mix, i.mix = i.mix, i.mlm = i.mlm)
with(gdata, table(y1))
fit1 <- vglm(y1 ~ 1, crit = "coef", trace = TRUE, data = gdata,
              gaitdnbinomial(a.mix = a.mix, i.mix = i.mix,
                             i.mlm = i.mlm,
                             parallel.i = TRUE, eq.ap = TRUE,
                             eq.ip = TRUE, truncate = tvec))
head(fitted(fit1, type.fitted = "Pstr.mix"))
head(predict(fit1))
t(coef(fit1, matrix = TRUE))  # Easier to see with t()
summary(fit1)
spikeplot(with(gdata, y1), lwd = 2)
plotdgaitd(fit1, new.plot = FALSE, offset.x = 0.2, all.lwd = 2)
## End(Not run)
```

Gaitdpois

Generally Altered, Inflated, Truncated and Deflated Poisson Distribution

Description

Density, distribution function, quantile function and random generation for the generally altered, inflated, truncated and deflated Poisson distribution. Both parametric and nonparametric variants are supported; these are based on finite mixtures of the parent with itself and the multinomial logit model (MLM) respectively.
Usage

dgaitdpois(x, lambda.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, lambda.a = lambda.p, lambda.i = lambda.p, lambda.d = lambda.p, log = FALSE)

pgaitdpois(q, lambda.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, lambda.a = lambda.p, lambda.i = lambda.p, lambda.d = lambda.p, lower.tail = TRUE, checkd = FALSE)

qgaitdpois(p, lambda.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, lambda.a = lambda.p, lambda.i = lambda.p, lambda.d = lambda.p)

rgaitdpois(n, lambda.p, a.mix = NULL, a.mlm = NULL, i.mix = NULL, i.mlm = NULL, d.mix = NULL, d.mlm = NULL, truncate = NULL, max.support = Inf, pobs.mix = 0, pobs.mlm = 0, pstr.mix = 0, pstr.mlm = 0, pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE, lambda.a = lambda.p, lambda.i = lambda.p, lambda.d = lambda.p)

Arguments

x, q, p, n

Same meaning as in Poisson.

log, lower.tail

Same meaning as in Poisson.

lambda.p, lambda.a, lambda.i, lambda.d

Same meaning as in Poisson, i.e., for an ordinary Poisson distribution. The first is for the main parent (or base) distribution. The next two concern the parametric variant and these distributions (usually spikes) may be altered and/or inflated. The last one concerns the deflated variant. Short vectors are recycled.

truncate, max.support

numeric; these specify the set of truncated values. The default value of NULL means an empty set for the former. The latter is the maximum support value so that any value larger has been truncated (necessary because truncate = (max. support + 1):Inf is not allowed), hence is needed for truncating the upper tail of the distribution. Note that max(truncate) < max. support must be satisfied otherwise an error message will be issued.

a.mix, i.mix, d.mix

Vectors of nonnegative integers; the altered, inflated and deflated values for the parametric variant. Each argument must have unique values only. Assigning argument a.mix means that pobs.mix will be used. Assigning i.mix means that pstr.mix will be used. Assigning d.mix means that pdip.mix will be used. If a.mix is of unit length then the default probability mass function (PMF)
evaluated at a.mix will be pobs.mix. So having a.mix = 0 corresponds to the zero-inflated Poisson distribution (see zipois).

a.mlm, i.mlm, d.mlm

Similar to the above, but for the nonparametric (MLM) variant. For example, assigning a.mlm means that pobs.mlm will be used. Collectively, the above 7 arguments represent 7 disjoint sets of special values and they are a proper subset of the support of the distribution.

pobs.mlm, pstr.mlm, pdip.mlm, byrow.aid

The first three arguments are coerced into a matrix of probabilities using byrow.aid to determine the order of the elements (similar to byrow in matrix, and the .aid reinforces the behaviour that it applies to both altered, inflated and deflated cases). The first argument is recycled if necessary to become n x length(a.mlm). The second argument becomes n x length(i.mlm). The third argument becomes n x length(d.mlm). Thus these arguments are not used unless a.mlm, i.mlm and d.mlm are assigned. For deflated models, pdip.mix and pdip.mlm are positive-valued and VGAM will subtract these quantities; the argument deflation has been deprecated.

pobs.mix, pstr.mix, pdip.mix

Vectors of probabilities that are recycled if necessary to length n. The first argument is used when a.mix is not NULL. The second argument is used when i.mix is not NULL. The third argument is used when d.mix is not NULL.

checkd

Logical. If TRUE then the density is computed at floor(q) with the same parameters. This can help detect whether the PMF is invalid. If so, then NaNs are returned. See Example 2 below.

Details

These functions allow any combination of 4 operator types: truncation, alteration, inflation and deflation. The precedence is truncation, then alteration and lastly inflation and deflation. Informally, deflation can be thought of as the opposite of inflation. This order minimizes the potential interference among the operators. Loosely, a set of probabilities is set to 0 by truncation and the remaining probabilities are scaled up. Then a different set of probabilities are set to some values pobs.mix and/or pobs.mlm and the remaining probabilities are rescaled up. Then another different set of probabilities is inflated by an amount pstr.mlm and/or proportional to pstr.mix so that individual elements in this set have two sources. Then another different set of probabilities is deflated by an amount pdip.mlm and/or proportional to pdip.mix. Then all the probabilities are rescaled so that they sum to unity.

Both parametric and nonparametric variants are implemented. They usually have arguments with suffix .mix and .mlm respectively. The MLM is a loose coupling that effectively separates the parent (or base) distribution from the altered values. Values inflated nonparametrically effectively have their spikes shaved off. The .mix variant has associated with it lambda.a and lambda.i and lambda.d because it is mixture of 4 Poisson distributions with partitioned or nested support.

Any value of the support of the distribution that is altered, inflated, truncated or deflated is called a special value. A special value that is altered may mean that its probability increases or decreases relative to the parent distribution. An inflated special value means that its probability has increased, provided alteration elsewhere has not made it decrease in the first case. There are seven types of special values and they are represented by a.mix, a.mlm, i.mix, i.mlm, d.mix, d.mlm, truncate.
Gaitdpois

Terminology-wise, special values are altered or inflated or truncated or deflated, and the remaining support points that correspond directly to the parent distribution are nonspecial or ordinary. These functions do what Zapois, Zipois, Pospois collectively did plus much more.

In the notation of Yee and Ma (2023) these functions allow for the special cases: (i) GAIT–Pois(lambda.p)–Pois(lambda.a,a.mix,pobs.mix)–Pois(lambda.i,i.mix,pstr.mix); (ii) GAIT–Pois(lambda.p)–MLM(a.mlm,pobs.mlm)–MLM(i.mlm,pstr.mlm). Model (i) is totally parametric while model (ii) is the most nonparametric possible.

Value
dgaitdpois gives the density, pgaitdpois gives the distribution function, qgaitdpois gives the quantile function, and rgaitdpois generates random deviates. The default values of the arguments correspond to ordinary dpois, ppois, qpois, rpois respectively.

Warning
It is possible that the GAITD PMF is invalid because of too much inflation and/or deflation. This would result in some probabilities exceeding unity or being negative. Hence x should ideally contain these types of special values so that this can be detected. If so then a NaN is returned and a warning is issued, e.g., same as dnorm(0, 0, sd = -1). To help checking, pgaitdpois(q, ...) calls dgaitdpois(floor(q), ...) if checkd is TRUE.

That is, given the parameters, it is impractical to determine whether the PMF is valid. To do this, one would have to compute the PMF at all values of its support and check that they are nonnegative and sum to unity. Hence one must be careful to input values from the parameter space, especially for inflation and deflation. See Example 2 below.

Note
Functions Pospois and those similar have been moved to VGAMdata. It is better to use dgaitdpois(x, lambda, truncate = 0) instead of dposbinom(x, lambda), etc.

Author(s)
T. W. Yee.

References

See Also
gaitdpoisson, multinomial, specials, spikeplot, dgaitdplot, Zapois, Zipois, Pospois Poisson; Gaitdbinom, Gaitdnbinom, Gaitdlog, Gaitdzeta.
Examples

# Example 1
ivec <- c(6, 14); avec <- c(8, 11); lambda <- 10; xgrid <- 0:25
tvec <- 15; max.support <- 20; pobs.mix <- 0.05; pstr.i <- 0.25
dvec <- 13; pdip.mlm <- 0.05; pobs.mlm <- 0.05
(ddd <- dgaitdpois(xgrid, lambda, lambda.a = lambda + 5,
                   truncate = tvec, max.support = max.support, pobs.mix = pobs.mix,
                   pobs.mlm = pobs.mlm, a.mlm = avec,
                   pdip.mlm = pdip.mlm, d.mlm = dvec,
                   pstr.mix = pstr.i, i.mix = ivec))
## Not run: dgaitdplot(lambda, ylab = "Probability", xlab = "x",
                   truncate = tvec, max.support = max.support, pobs.mix = pobs.mix,
                   pobs.mlm = pobs.mlm, a.mlm = avec, all.lwd = 3,
                   pdip.mlm = pdip.mlm, d.mlm = dvec,
                   pstr.mix = pstr.i, i.mix = ivec, deflation = TRUE,
                   main = "GAITD Combo PMF---Poisson Parent")
## End(Not run)

# Example 2: detection of an invalid PMF
xgrid <- 1:3 # Does not cover the special values purposely
(ddd <- dgaitdpois(xgrid, 1, pdip.mlm = 0.1, d.mlm = 5,
                   pstr.mix = 0.95, i.mix = 0)) # Undetected
xgrid <- 0:13 # Wider range so this detects the problem
(ddd <- dgaitdpois(xgrid, 1, pdip.mlm = 0.1, d.mlm = 5,
                   pstr.mix = 0.95, i.mix = 0)) # Detected
sum(ddd, na.rm = TRUE) # Something gone awry

---

gaitdpoisson

Generally Altered, Inflated, Truncated and Deflated Poisson Regression

Description

Fits a generally altered, inflated, truncated and deflated Poisson regression by MLE. The GAITD combo model having 7 types of special values is implemented. This allows mixtures of Poissons on nested and/or partitioned support as well as a multinomial logit model for (nonparametric) altered, inflated and deflated values. Truncation may include the upper tail.

Usage

gaitdpoisson(a.mix = NULL, i.mix = NULL, d.mix = NULL,
a.mlm = NULL, i.mlm = NULL, d.mlm = NULL,
truncate = NULL, max.support = Inf,
zero = c("pobs", "pstr", "pdip"),
eq.ap = TRUE, eq.ip = TRUE, eq.dp = TRUE,
parallel.a = FALSE, parallel.i = FALSE, parallel.d = FALSE,
llambda.p = "loglink", llambda.a = llambda.p,
llambda.i = llambda.p, llambda.d = llambda.p,
type.fitted = c("mean", "lambdas", "pobs.mlm", "pstr.mlm",
"pdip.mlm"),
"truncs", "maxs", "probs"})
"pdip.mlm", "pobs.mix", "pstr.mix", "pdip.mix”,
"Pobs.mix”, "Pstr.mix”, "Pdip.mix”, "nonspecial”,
"Numer”, "Denom.p”, "sum.mlm.i”, “sum.mix.i”,
“sum.mlm.d”, “sum.mix.d”, “ptrunc.p”,
"cdf.max.s"), gpstr.mix = ppoints(7) / 3,
gpstr.mlm = ppoints(7) / (3 + length(i.mlm)),
imethod = 1, mux.init = c(0.75, 0.5, 0.75),
ilambda.p = NULL, ilambda.a = ilambda.p,
ilambda.i = ilambda.p, ilambda.d = ilambda.p,
ipobs.mix = NULL, ipstr.mix = NULL, ipdip.mix = NULL,
ipobs.mlm = NULL, ipstr.mlm = NULL, ipdip.mlm = NULL,
byrow.aid = FALSE, ishrinkage = 0.95, probs.y = 0.35)

Arguments

truncate, max.support

Vector of truncated values, i.e., nonnegative integers. For the first seven arguments (for the special values) a NULL stands for an empty set, and the seven sets must be mutually disjoint. Argument max.support enables RHS-truncation, i.e., something equivalent to truncate = (U+1):Inf for some upper support point U specified by max.support.

a.mix, i.mix, d.mix

Vector of altered and inflated values corresponding to finite mixture models. These are described as parametric or structured.

The parameter lambda.p is always estimated. If length(a.mix) is 1 or more then the parameter pobs.mix is estimated. If length(i.mix) is 1 or more then the parameter pstr.mix is estimated. If length(d.mix) is 1 or more then the parameter pdip.mix is estimated.

If length(a.mix) is 2 or more then the parameter lambda.a is estimated. If length(i.mix) is 2 or more then the parameter lambda.i is estimated. If length(d.mix) is 2 or more then the parameter lambda.d is estimated.

If length(a.mix) == 1, length(i.mix) == 1 or length(d.mix) == 1 then lambda.a, lambda.i and lambda.d are unidentifiable and therefore ignored. In such cases it would be equivalent to moving a.mix into a.mlm, etc.

Due to its great flexibility, it is easy to misuse this function and ideally the values of the above arguments should be well justified by the application on hand. Adding inappropriate or unnecessary values to these arguments willy-nilly is a recipe for disaster, especially for i.mix and d.mix. Using a.mlm effectively removes a subset of the data from the main analysis, therefore may result in a substantial loss of efficiency. For seeped values, a.mlm, a.mlm, d.mlm and d.mlm can be used only. Heaped values can be handled by i.mlm and i.mix, as well as a.mlm and a.mlm. Because of the NBP reason below, it sometimes may be necessary to specify deflated values to altered values.

a.mlm, i.mlm, d.mlm

Vector of altered, inflated and deflated values corresponding to the multinomial logit model (MLM) probabilities of observing those values—see multinomial. These are described as nonparametric or unstructured.
llambda.p, lllambda.a, lllambda.i, lllambda.d

Link functions for the parent, altered, inflated and deflated distributions respectively. See Links for more choices and information.

eq.ap, eq.ip, eq.dp

Single logical each. Constrain the rate parameters to be equal? See CommonVGAMffArguments for information. Having all three arguments TRUE gives greater stability in the estimation because of fewer parameters and therefore fewer initial values needed, however if so then one should try relax some of the arguments later.

For the GIT–Pois submodel, after plotting the responses, if the distribution of the spikes above the nominal probabilities has roughly the same shape as the ordinary values then setting eq.ip = TRUE would be a good idea so that \( \lambda_i = \lambda_p \). And if i.mix is of length 2 or a bit more, then TRUE should definitely be entertained. Likewise, for heaped or seeped data, setting eq.ap = TRUE (so that \( \lambda_p = \lambda_p \)) would be a good idea for the GAT–Pois if the shape of the altered probabilities is roughly the same as the parent distribution.

parallel.a, parallel.i, parallel.d

Single logical each. Constrain the MLM probabilities to be equal? If so then this applies to all length(a.mlm) pobs.mlm probabilities or all length(i.mlm) pstr.mlm probabilities or all length(d.mlm) pdip.mlm probabilities. See CommonVGAMffArguments for information. The default means that the probabilities are generally un constrained and unstructured and will follow the shape of the data. See constraints.

type.fitted

See CommonVGAMffArguments and below for information. The first value is the default, and this is usually the unconditional mean. Choosing an irrelevant value may result in an NA being returned and a warning, e.g., "pstr.mlm" for a nonparametric GAT model.

The choice "lambdas" returns a matrix with at least one column and up to three others, corresponding to all those estimated. In order, their colnames are "\( \lambda_p \)", "\( \lambda_a \)", "\( \lambda_i \)" and "\( \lambda_d \)". For other distributions such as gaitdlog type.fitted = "shapes" is permitted and the colnames are "shape.p", "shape.a", "shape.i" and "shape.d", etc.

Option "Pobs.mix" provides more detail about "pobs.mix" by returning a matrix whose columns correspond to each altered value; the row sums (rowSums) of this matrix is "pobs.mix". Likewise "Pstr.mix" about "pstr.mix" and "Pdip.mix" about "pdip.mix".

The choice "cdf.max.s" is the CDF evaluated at max.support using the parent distribution, e.g., ppois(max.support, \( \lambda_p \)) for gaitdpoisson. The value should be 1 if max.support = Inf (the default). The choice "nonspecial" is the probability of a nonspecial value. The choices "Denom.p" and "Numer" are quantities found in the GAITD combo PMF and are for convenience only.

The choice type.fitted = "pobs.mlm" returns a matrix whose columns are the altered probabilities (Greek symbol \( \omega_\alpha \)). The choice "pstr.mlm" returns a matrix whose columns are the inflated probabilities (Greek symbol \( \phi_\alpha \)). The choice "pdip.mlm" returns a matrix whose columns are the deflated probabilities (Greek symbol \( \psi_\alpha \)).

The choice "ptrunc.p" returns the probability of having a truncated value with respect to the parent distribution. It includes any truncated values in the upper tail beyond max.support. The probability of a value less than or equal to max.support with respect to the parent distribution is "cdf.max.s".
The choice "sum.mlm.i" adds two terms. This gives the probability of an inflated value, and the formula can be loosely written down as something like "pstr.mlm" + "Numer" * dpois(i.mlm, lambda.p) / "Denom.p". The other three "sum.m*" arguments are similar.

**gpstr.mix, gpstr.mlm**

See [CommonVGAMffArguments](#) for information. Gridsearch values for the two parameters. If failure occurs try a finer grid, especially closer to 0, and/or experiment with mux.init.

**imethod, ipobs.mix, ipstr.mix, ipdip.mix**

See [CommonVGAMffArguments](#) for information. Good initial values are difficult to compute because of the great flexibility of GAITD regression, therefore it is often necessary to use these arguments. A careful examination of a spikeplot of the data should lead to good choices.

**ipobs.mlm, ipstr.mlm, ipdip.mlm**

See [CommonVGAMffArguments](#) for information.

**mux.init**

Numeric, of length 3. General downward multiplier for initial values for the sample proportions (MLEs actually). This is under development and more details are forthcoming. In general, 1 means unchanged and values should lie in (0, 1], and values about 0.5 are recommended. The elements apply in order to altered, inflated and deflated (no distinction between mix and MLM).

**ilambda.p, ilambda.a, ilambda.i, ilambda.d**

Initial values for the rate parameters; see [CommonVGAMffArguments](#) for information.

**probs.y, ishrinkage**

See [CommonVGAMffArguments](#) for information.

**byrow.aid**

Details are at [Gaitdpois](#).

**zero**

See [CommonVGAMffArguments](#) for information. By default, all the MLM probabilities are modelled as simple as possible (intercept-only) to help avoid numerical problems, especially when there are many covariates. The Poisson means are modelled by the covariates, and the default zero vector is pruned of any irrelevant values. To model all the MLM probabilities with covariates set zero = NULL, however, the number of regression coefficients could be excessive.

For the MLM probabilities, to model pobs.mix only with covariates set zero = c('pstr', 'pobs.mlm', 'pdip'). Likewise, to model pstr.mix only with covariates set zero = c('pobs', 'pstr.mlm', 'pdip').

It is noted that, amongst other things, zipoisson and zipoissonff differ with respect to zero, and ditto for zapoisson and zapoissonff.

**Details**

The full GAITD–Pois combo model may be fitted with this family function. There are seven types of special values and all arguments for these may be used in a single model. Here, the MLM represents the nonparametric while the Pois refers to the Poisson mixtures. The defaults for this function correspond to an ordinary Poisson regression so that poissonff is called instead. A MLM with only one probability to model is equivalent to logistic regression (binomialff and logitlink).

The order of the linear/additive predictors is best explained by an example. Suppose a combo model has length(a.mix) > 2 and length(i.mix) > 2, length(d.mix) > 2, a.mlm = 3:5, i.mlm = 6:9
and \(d.mlm = 10:12\), say. Then \(\log\text{link}(\lambda.p)\) is the first. The second is \(\text{multilogitlink}(pobs.mix)\) followed by \(\log\text{link}(\lambda.a)\) because \(a.mix\) is long enough. The fourth is \(\text{multilogitlink}(pstr.mix)\) followed by \(\log\text{link}(\lambda.d)\) because \(d.mix\) is long enough. Next are the probabilities for the \(a.mlm\) values. Then are the probabilities for the \(i.mlm\) values. Lastly are the probabilities for the \(d.mlm\) values. All the probabilities are estimated by one big MLM and effectively the "(Others)" column of left over probabilities is associated with the nonspecial values. These might be called the \textit{nonspecial baseline probabilities (NBP)}. The dimension of the vector of linear/additive predictors here is \(M = 17\).

Two mixture submodels that may be fitted can be abbreviated GAT–Pois or GIT–Pois. For the GAT model the distribution being fitted is a (spliced) mixture of two Poissons with differing (partitioned) support. Likewise, for the GIT model the distribution being fitted is a mixture of two Poissons with nested support. The two rate parameters may be constrained to be equal using eq.ap and eq.ip.

A good first step is to apply \texttt{spikeplot} for selecting candidate values for altering, inflating and deflecting. Deciding between parametrically or nonparametrically can also be determined from examining the spike plot. Misspecified \(a.mix/a.mlm/i.mlm/d.mlm/d.mlm\) will result in convergence problems (setting \(\text{trace} = \text{TRUE}\) is a very good idea.) This function currently does not handle multiple responses. Further details are at \texttt{Gaitdpois}.

A well-conditioned data–model combination should pose no difficulties for the automatic starting value selection being successful. Failure to obtain initial values from this self-starting family function indicates the degree of inflation/deflation may be marginal and/or a misspecified model. If this problem is worth surmounting the arguments to focus on especially are \texttt{mux.init}, \texttt{gpstr.mlm}, \texttt{gpstr.mlm}, \texttt{ipdip.mlm} and \texttt{ipdip.mlm}. See below for the stepping-stone trick.

Apart from the order of the linear/additive predictors, the following are (or should be) equivalent: \texttt{gaitdpoisson()} and \texttt{poissonff()}, \texttt{gaitdpoisson(a.mix = 0)} and \texttt{zapoison(zer0 = "pobs0")}, \texttt{gaitdpoisson(i.mix = 0) and zipoison(zer0 = "pstr0")}, \texttt{gaitdpoisson(truncate = 0) and pospoisson().} Likewise, if \(a.mix\) and \(i.mix\) are assigned a scalar then it effectively moves that scalar to \(a.mlm\) and \(i.mlm\) because there is no \(\lambda.a\) or \(\lambda.i\) being estimated. Thus \texttt{gaitdpoisson(a.mix = 0)} and \texttt{gaitdpoisson(a.mlm = 0)} are the effectively same, and ditto for \texttt{gaitdpoisson(i.mix = 0)} and \texttt{gaitdpoisson(i.mlm = 0)}.

**Value**

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, \texttt{rrvglm} and \texttt{vgam}.

The \texttt{fitted.values} slot of the fitted object, which should be extracted by the generic function \texttt{fitted}, returns the mean \(\mu\) by default. See the information above on \texttt{type.fitted}.

**Warning**

Amateurs tend to be overzealous fitting zero-inflated models when the fitted mean is low—the warning of \texttt{ziP} should be heeded. For GAITD regression the warning applies more strongly and generally; here to all \(i.mix\), \(i.mlm\), \(d.mix\) and \(d.mlm\) values, not just 0. Even one misspecified special value usually will cause convergence problems.

Default values for this and similar family functions may change in the future, e.g., eq.ap and eq.ip. Important internal changes might occur too, such as the ordering of the linear/additive predictors and the quantities returned as the fitted values.
Using \texttt{i.mlm} requires more caution than \texttt{a.mlm} because gross inflation is ideally needed for it to work safely. Ditto for \texttt{i.mix} versus \texttt{a.mix}. Data exhibiting deflation or little to no inflation will produce numerical problems, hence set \texttt{trace = TRUE} to monitor convergence. More than c.10 IRLS iterations should raise suspicion.

Ranking the four operators by difficulty, the easiest is truncation followed by alteration, then inflation and the most difficult is deflation. The latter needs good initial values and the current default will probably not work on some data sets. Studying the spikeplot is time very well spent. In general it is very easy to specify an \textit{overfitting} model so it is a good idea to split the data into training and test sets.

This function is quite memory-hungry with respect to \texttt{length(c(a.mix, i.mix, d.mix, a.mlm, i.mlm, d.mlm))}. On consuming something different, because all values of the NBP vector need to be positive it pays to be economical with respect to \texttt{d.mlm} especially so that one does not consume up probabilities unnecessarily so to speak.

It is often a good idea to set \texttt{eq.ip = TRUE}, especially when \texttt{length(i.mix)} is not much more than 2 or the values of \texttt{i.mix} are not spread over the range of the response. This way the estimation can borrow strength from both the inflated and non-inflated values. If the \texttt{i.mix} values form a single small cluster then this can easily create estimation difficulties—the idea is somewhat similar to multicollinearity. The same holds for \texttt{d.mix}.

\section*{Note}

Numerical problems can easily arise because of the exceeding flexibility of this distribution and/or the lack of sizeable inflation/deflation; it is a good idea to gain experience with simulated data first before applying it to real data. Numerical problems may arise if any of the special values are in remote places of the support, e.g., a value \(y\) such that \(\text{dpois}(y, \lambda.p)\) is very close to 0. This is because the ratio of two tiny values can be unstable.

Good initial values may be difficult to obtain using self-starting procedures, especially when there are covariates. If so, then it is advisable to use a trick: fit an intercept-only model first and then use \texttt{etastart = predict(int.only.model)} to fit the model with covariates. This uses the simpler model as a stepping-stone.

The labelling of the linear/additive predictors has been abbreviated to reduce space. For example, \texttt{multilogitlink(pobs.mix)} and \texttt{multilogitlink(pstr.mix)} would be more accurately \texttt{multilogitlink(cbind(pobs.mix, pstr.mix))} because one grand MLM is fitted. This shortening may result in modifications needed in other parts of \texttt{VGAM} to compensate.

Because estimation involves a MLM, the restricted parameter space means that if the dip probabilities are large then the NBP may become too close to 0. If this is so then there are tricks to avoid a negative NBP. One of them is to model as many values of \texttt{d.mlm} as \texttt{d.mix}, hence the dip probabilities become modelled via the deflation distribution instead. Another trick to alter those special values rather than deflating them if the dip probabilities are large.

Due to its complexity, the HDE test \texttt{hdeff} is currently unavailable for GAITD regressions.

Randomized quantile residuals (RQRs) are available; see \texttt{residualsvglm}.

\section*{Author(s)}

T. W. Yee
References


See Also

Gaitdpois, multinomial, rootogram4, specials, plotgaitd, spikeplot, meangaitd, KLD, goffset.Trunc, gaitdnbinomial, gaitdlog, gaitdzeta, multilogitlink, multinomial, residualsvglm, poissonff, zapoisson, zipoisson, pospoisson, CommonVGAMffArguments, simulate.vlm.

Examples

```r
i.mix <- c(5, 10)  # Inflate these values parametrically
i.mlm <- c(14, 15) # Inflate these values
a.mix <- c(1, 13)  # Alter these values
tvec <- c(3, 11)   # Truncate these values
pstr.mlm <- 0.1    # So parallel.i = TRUE
pobs.mix <- pstr.mix <- 0.1
max.support <- 20; set.seed(1)
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, lambda.p = exp(2 + 0.0 * x2))
gdata <- transform(gdata, y1 = rgaitdpois(nn, lambda.p, a.mix = a.mix, i.mix = i.mix,
                                        a.mlm = a.mlm, i.mlm = i.mlm, parallel.i = TRUE,
                                        truncate = tvec, max.support = max.support))
gaitdpoisson(a.mix = a.mix, i.mix = i.mix, i.mlm = i.mlm)
with(gdata, table(y1))
fit1 <- vglm(y1 ~ 1, crit = "coef", trace = TRUE, data = gdata,
             gaitdpoisson(a.mix = a.mix, i.mix = i.mix,
                          i.mlm = i.mlm, parallel.i = TRUE,
                          eq.ap = TRUE, eq.ip = TRUE, truncate =
                          tvec, max.support = max.support))
head(fitted(fit1, type.fitted = "Pstr.mix"))
head(predict(fit1))
t(coef(fit1, matrix = TRUE))  # Easier to see with t()
summary(fit1)  # No HDE test by default but HDEtest = TRUE is ideal
## Not run: spikeplot(with(gdata, y1), lwd = 2)
plotgaitd(fit1, new.plot = FALSE, offset.x = 0.2, all.lwd = 2)
## End(Not run)
```

---

**Gaitdzeta**

**Generally Altered, Inflated and Truncated and Deflated Zeta Distribution**

**Description**

Density, distribution function, quantile function and random generation for the generally altered, inflated, truncated and deflated zeta distribution. Both parametric and nonparametric variants are
supported; these are based on finite mixtures of the parent with itself and the multinomial logit model (MLM) respectively.

Usage

dgaitdzeta(x, shape.p, a.mix = NULL, a.mlm = NULL,
                   i.mix = NULL, i.mlm = NULL,
                   d.mix = NULL, d.mlm = NULL, truncate = NULL,
                   max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
                   pstr.mix = 0, pstr.mlm = 0,
                   pdip.mix = 0, pdip.mlm = 0,
                   byrow.aid = FALSE,
                   shape.a = shape.p, shape.i = shape.p, shape.d = shape.p,
                   log = FALSE)
pgaitdzeta(q, shape.p, a.mix = NULL, a.mlm = NULL,
                   i.mix = NULL, i.mlm = NULL,
                   d.mix = NULL, d.mlm = NULL, truncate = NULL,
                   max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
                   pstr.mix = 0, pstr.mlm = 0,
                   pdip.mix = 0, pdip.mlm = 0,
                   byrow.aid = FALSE,
                   shape.a = shape.p, shape.i = shape.p, shape.d = shape.p,
                   lower.tail = TRUE)
qgaitdzeta(p, shape.p, a.mix = NULL, a.mlm = NULL,
                   i.mix = NULL, i.mlm = NULL,
                   d.mix = NULL, d.mlm = NULL, truncate = NULL,
                   max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
                   pstr.mix = 0, pstr.mlm = 0,
                   pdip.mix = 0, pdip.mlm = 0,
                   byrow.aid = FALSE,
                   shape.a = shape.p, shape.i = shape.p, shape.d = shape.p)
rgaitdzeta(n, shape.p, a.mix = NULL, a.mlm = NULL,
                   i.mix = NULL, i.mlm = NULL,
                   d.mix = NULL, d.mlm = NULL, truncate = NULL,
                   max.support = Inf, pobs.mix = 0, pobs.mlm = 0,
                   pstr.mix = 0, pstr.mlm = 0,
                   pdip.mix = 0, pdip.mlm = 0,
                   byrow.aid = FALSE,
                   shape.a = shape.p, shape.i = shape.p, shape.d = shape.p)

Arguments

x, q, p, n, log, lower.tail
  Same meaning as in dzeta.
shape.p, shape.a, shape.i, shape.d
  Same meaning as shape for dzeta, i.e., for an ordinary zeta distribution. See Gaitdpois for generic information.
truncate, max.support
  See Gaitdpois for generic information.
a.mix, i.mix, d.mix
   See Gaitdpois for generic information.

a.mlm, i.mlm, d.mlm
   See Gaitdpois for generic information.

pobs.mlm, pstr.mlm, pdip.mlm, byrow.aid
   See Gaitdpois for generic information.

pobs.mix, pstr.mix, pdip.mix
   See Gaitdpois for generic information.

Details

These functions for the zeta distribution are analogous to the Poisson, hence most details have been
put in Gaitdpois. These functions do what Oazeta, Oizeta, Otzeta collectively did plus much
more.

Value

dgaitdzeta gives the density, pgaitdzeta gives the distribution function, qgaitdzeta gives the
quantile function, and rgaitdzeta generates random deviates. The default values of the arguments
 correspond to ordinary dzeta, pzeta, qzeta, rzeta respectively.

Warning

See Gaitdpois about the dangers of too much inflation and/or deflation on GAITD PMFs, and the
difficulties detecting such.

Note

See Gaitdpois for general information also relevant to this parent distribution.

Author(s)

T. W. Yee.

See Also

gaitdzeta, Gaitdpois, dgaiddplot, multinomial, Oazeta, Oizeta, Otzeta.

Examples

ivec <- c(2, 10); avec <- ivec + 4; shape <- 0.95; xgrid <- 0:29
tvec <- 15; max.support <- 25; pobs.a <- 0.10; pstr.i <- 0.15
(ddd <- dgaitdzeta(xgrid, shape, truncate = tvec,
   max.support = max.support, pobs.mix = pobs.a,
   a.mix = avec, pstr.mix = pstr.i, i.mix = ivec))
## Not run: plot(xgrid, ddd, type = "n", ylab = "Probability",
    xlab = "x", main = "GAIT PMF---Zeta Parent")
mylwd <- 0.5
abline(v = avec, col = 'blue', lwd = mylwd)
abline(v = ivec, col = 'purple', lwd = mylwd)
abline(v = tvec, col = 'tan', lwd = mylwd)
abline(v = max.support, col = 'magenta', lwd = mylwd)
abline(h = c(pobs.a, pstr.i, 0:1), col = 'gray', lty = "dashed")
lines(xgrid, dzeta(xgrid, shape), col='gray', lty="dashed")  # f_{\pi}
lines(xgrid, ddd, type = "h", col = "pink", lwd = 3)  # GAIT PMF
points(xgrid[ddd == 0], ddd[ddd == 0], pch = 16, col = 'tan', cex = 2)

## End(Not run)

gaitdzeta

Generally Altered, Inflated, Truncated and Deflated Zeta Regression

Description

Fits a generally altered, inflated, truncated and deflated zeta regression by MLE. The GAITD combo model having 7 types of special values is implemented. This allows mixtures of zetas on nested and/or partitioned support as well as a multinomial logit model for altered, inflated and deflated values.

Usage

gaitdzeta(a.mix = NULL, i.mix = NULL, d.mix = NULL,
a.mlm = NULL, i.mlm = NULL, d.mlm = NULL,
truncate = NULL, max.support = Inf,
zero = c("pobs", "pstr", "pdip"), eq.ap = TRUE, eq.ip = TRUE,
eq.dp = TRUE, parallel.a = FALSE,
parallel.i = FALSE, parallel.d = FALSE,
lshape.p = "loglink", lshape.a = lshape.p,
lshape.i = lshape.p, lshape.d = lshape.p,
type.fitted = c("mean", "shapes", "pobs.mlm", "pstr.mlm",
"pdip.mlm", "pobs.mix", "pstr.mix", "pdip.mix", "Pobs.mix",
"Psstr.mix", "Pdpip.mix", "nonspecial",
"Numer", "Denom.p", "sum.mlm.i", "sum.mix.i", "sum.mld.d",
"sum.mix.d", "ptrunc.p", "cdf.max.s"),
gshape.p = -expm1(-ppoints(7)), gpstr.mix = ppoints(7) / 3,
gpstr.mlm = ppoints(7) / (3 + length(i.mlm)),
imethod = 1, mux.init = c(0.75, 0.5, 0.75),
ishape.p = NULL, ishape.a = ishape.p,
ishape.i = ishape.p, ishape.d = ishape.p,
ipobs.mix = NULL, ipstr.mix = NULL, ipdip.mix = NULL,
ipobs.mlm = NULL, ipstr.mlm = NULL, ipdip.mlm = NULL,
byrow.aid = FALSE, ishrinkage = 0.95, probs.y = 0.35)

Arguments

truncate, max.support

See gaitdpoisson. Only max.support = Inf is allowed because some equations are intractable.
gaitdzeta

a.mix, i.mix, d.mix
See gaitdpoisson.

a.mlm, i.mlm, d.mlm
See gaitdpoisson.

lshape.p, lshape.a, lshape.i, lshape.d
Link functions. See gaitdpoisson and Links for more choices and information. Actually, it is usually a good idea to set these arguments equal to zetaffMlink because the log-mean is the first linear/additive predictor so it is like a Poisson regression.

eq.ap, eq.ip, eq.dp
Single logical each. See gaitdpoisson

parallel.a, parallel.i, parallel.d
Single logical each. See gaitdpoisson.

type.fitted, mux.init
See gaitdpoisson.

imethod, ipobs.mix, ipstr.mix, idip.mix
See CommonVGAMffArguments and gaitdpoisson for information.

ipobs.mlm, ipstr.mlm, idip.mlm, byrow.aid
See CommonVGAMffArguments and gaitdpoisson for information.

gpstr.mix, gpstr.mlm
See CommonVGAMffArguments and gaitdpoisson for information.

gshape.p, ishape.p
See CommonVGAMffArguments and gaitdpoisson for information. The former is used only if the latter is not given. Practical experience has shown that good initial values are needed, so if convergence is not obtained then try a finer grid.

ishape.a, ishape.i, ishape.d
See CommonVGAMffArguments and gaitdpoisson for information.

probs.y, ishrinkage
See CommonVGAMffArguments and gaitdpoisson for information.

zero
See gaitdpoisson and CommonVGAMffArguments for information.

Details

Many details to this family function can be found in gaitdpoisson because it is also a 1-parameter discrete distribution. This function currently does not handle multiple responses. Further details are at Gaitdzeta.

As alluded to above, when there are covariates it is much more interpretable to model the mean rather than the shape parameter. Hence zetaffMlink is recommended. (This might become the default in the future.) So installing VGAMextra is a good idea.

Apart from the order of the linear/additive predictors, the following are (or should be) equivalent: gaitdzeta() and zetaff(), gaitdzeta(a.mix = 1) and oazeta(zero = "pobs1"), gaitdzeta(i.mix = 1) and oizeta(zero = "pstr1"), gaitdzeta(truncate = 1) and otzeta(). The functions oazeta, oizeta and otzeta have been placed in VGAMdata.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.
Warning
See `gaitdpoisson`.

Note
See `gaitdpoisson`.

Author(s)
T. W. Yee

See Also
`Gaitdzeta, zetaff, zetaffMlink, Gaitdpois, gaitdpoisson, gaitdlog, spikeplot, goffset, Trunc, oazeta, oizeta, otzeta, CommonVGAMffArguments, rootogram4, simulate.vlm`.

Examples
```r
# Not run:
avec <- c(5, 10)  # Alter these values parametrically
ivec <- c(3, 15)  # Inflate these values
tvec <- c(6, 7)   # Truncate these values
set.seed(1); pobs.a <- pstr.i <- 0.1
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, shape.p = logitlink(2, inverse = TRUE))
gdata <- transform(gdata,
  y1 = rgaitdzeta(nn, shape.p, a.mix = avec, pobs.mix = pobs.a,
      i.mix = ivec, pstr.mix = pstr.i, truncate = tvec))
gaitdzeta(a.mix = avec, i.mix = ivec)
with(gdata, table(y1))
spikeplot(with(gdata, y1), las = 1)
fit7 <- vglm(y1 ~ 1, trace = TRUE, data = gdata, crit = "coef",
   gaitdzeta(i.mix = ivec, truncate = tvec,
      a.mix = avec, eq.ap = TRUE, eq.ip = TRUE))
head(fitted(fit7, type.fitted = "Pstr.mix"))
head(predict(fit7))
t(coef(fit7, matrix = TRUE))  # Easier to see with t()
summary(fit7)
spikeplot(with(gdata, y1), lwd = 2, ylim = c(0, 0.6), xlim = c(0, 20))
plotgaitd(fit7, new.plot = FALSE, offset.x = 0.2, all.lwd = 2)
```

## End(Not run)

---

gamma1  1-parameter Gamma Regression Family Function

Description
Estimates the 1-parameter gamma distribution by maximum likelihood estimation.
Usage

\texttt{gamma1(link = "loglink", zero = NULL, parallel = FALSE,}
\texttt{ type.fitted = c("mean", "percentiles", "Qlink"),}
\texttt{ percentiles = 50)}

Arguments

- **link**: Link function applied to the (positive) \textit{shape} parameter. See \texttt{Links} for more choices and general information.
- **zero**, **parallel**: Details at \texttt{CommonVGAMffArguments}.
- **type.fitted**, **percentiles**: See \texttt{CommonVGAMffArguments} for information. Using "Qlink" is for quantile-links in \texttt{VGAMextra}.

Details

The density function is given by

\[ f(y) = \exp(-y) \times y^{\text{shape }- 1} / \Gamma(\text{shape}) \]

for \textit{shape} \(>\) 0 and \(y \geq 0\). Here, \(\Gamma(\text{shape})\) is the gamma function, as in \texttt{gamma}. The mean of \(Y\) (returned as the default fitted values) is \(\mu = \text{shape}\), and the variance is \(\sigma^2 = \text{shape}\).

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Note

This \texttt{VGAM} family function can handle a multiple responses, which is inputted as a matrix.

The parameter \textit{shape} matches with \textit{shape} in \texttt{rgamma}. The argument \textit{rate} in \texttt{rgamma} is assumed 1 for this family function, so that \texttt{scale = 1} is used for calls to \texttt{dgamma}, \texttt{qgamma}, etc.

If \textit{rate} is unknown use the family function \texttt{gammaR} to estimate it too.

Author(s)

T. W. Yee

References


See Also

\texttt{gammaR} for the 2-parameter gamma distribution, \texttt{lgamma1}, \texttt{lindley}, \texttt{simulate.vlm}, \texttt{gammaff.mm}. 
gamma2

Examples

gdata <- data.frame(y = rgamma(n = 100, shape = exp(3)))
fit <- vglm(y ~ 1, gamma1, data = gdata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

Description

Estimates the 2-parameter gamma distribution by maximum likelihood estimation.

Usage

gamma2(lmu = "loglink", lshape = "loglink", imethod = 1, ishape = NULL,
parallel = FALSE, deviance.arg = FALSE, zero = "shape")

Arguments

- lmu, lshape: Link functions applied to the (positive) mu and shape parameters (called μ and a respectively). See Links for more choices.
- ishape: Optional initial value for shape. A NULL means a value is computed internally. If a failure to converge occurs, try using this argument. This argument is ignored if used within cqo; see the iShape argument of qrrglm.control instead.
- imethod: An integer with value 1 or 2 which specifies the initialization method for the μ parameter. If failure to converge occurs try another value (and/or specify a value for ishape).
- deviance.arg: Logical. If TRUE, the deviance function is attached to the object. Under ordinary circumstances, it should be left alone because it really assumes the shape parameter is at the maximum likelihood estimate. Consequently, one cannot use that criterion to minimize within the IRLS algorithm. It should be set TRUE only when used with cqo under the fast algorithm.
- zero: See CommonVGAMffArguments for information.
- parallel: Details at CommonVGAMffArguments. If parallel = TRUE then the constraint is not applied to the intercept.

Details

This distribution can model continuous skewed responses. The density function is given by

\[ f(y; \mu, a) = \frac{\exp(-ay/\mu) \times (ay/\mu)^{a-1} \times a}{\mu \times \Gamma(a)} \]

for \( \mu > 0, a > 0 \) and \( y > 0 \). Here, \( \Gamma(\cdot) \) is the gamma function, as in gamma. The mean of \( Y \) is \( \mu = \mu \) (returned as the fitted values) with variance \( \sigma^2 = \mu^2/a \). If \( 0 < a < 1 \) then the density has a
pole at the origin and decreases monotonically as \( y \) increases. If \( a = 1 \) then this corresponds to the exponential distribution. If \( a > 1 \) then the density is zero at the origin and is unimodal with mode at \( y = \mu - \mu/a \); this can be achieved with lshape="logloglink".

By default, the two linear/additive predictors are \( \eta_1 = \log(\mu) \) and \( \eta_2 = \log(a) \). This family function implements Fisher scoring and the working weight matrices are diagonal.

This \texttt{VGAM} family function handles \textit{multivariate} responses, so that a matrix can be used as the response. The number of columns is the number of species, say, and \texttt{zero=-2} means that all species have a shape parameter equalling a (different) intercept only.

\textbf{Value}

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

\textbf{Note}

The response must be strictly positive. A moment estimator for the shape parameter may be implemented in the future.

If \( \mu \) and \( \text{shape} \) are vectors, then \texttt{rgamma}(\( n = n \), \( \text{shape} = \text{shape} \), \( \text{scale} = \mu/\text{shape} \)) will generate random gamma variates of this parameterization, etc.; see \texttt{GammaDist}.

\textbf{Author(s)}

T. W. Yee

\textbf{References}

The parameterization of this \texttt{VGAM} family function is the 2-parameter gamma distribution described in the monograph


\textbf{See Also}

\texttt{gamma1} for the 1-parameter gamma distribution, \texttt{gammaR} for another parameterization of the 2-parameter gamma distribution that is directly matched with \texttt{rgamma, bigamma.mckay} for a bivariate gamma distribution, \texttt{gammaff.mm} for another, \texttt{expexpff, GammaDist, CommonVGAMffArguments, simulate.vlm, negloglink}.

\textbf{Examples}

```r
# Essentially a 1-parameter gamma
gdata <- data.frame(y = rgamma(n = 100, shape = exp(1)))
fit1 <- vglm(y ~ 1, gamma1, data = gdata)
fit2 <- vglm(y ~ 1, gamma2, data = gdata, trace = TRUE, crit = "coef")
coef(fit2, matrix = TRUE)
c(Coef(fit2), colMeans(gdata))
```

# Essentially a 2-parameter gamma
gdata <- data.frame(y = rgamma(n = 500, rate = exp(-1), shape = exp(2)))
fit2 <- vglm(y ~ 1, gamma2, data = gdata, trace = TRUE, crit = "coef")
coef(fit2, matrix = TRUE)
c(Coef(fit2), colMeans(gdata))
summary(fit2)

---

**gammaff.mm**

**Multivariate Gamma Family Function: Mathai and Moschopoulos (1992)**

**Description**

Estimate the scale parameter and shape parameters of the Mathai and Moschopoulos (1992) multivariate gamma distribution by maximum likelihood estimation.

**Usage**

```r
gammaff.mm(lscale = "loglink", lshape = "loglink",
           iscale = NULL, ishape = NULL, imethod = 1,
           eq.shapes = FALSE, sh.byrow = TRUE, zero = "shape")
```

**Arguments**

- `lscale`, `lshape`: Link functions applied to the (positive) parameters $b$, and $s_1, \ldots, s_Q$ respectively. See Links for more choices. In the future, `lshapes` might be used instead; of course, this link applies to all the shape parameters.
- `iscale`, `ishape`, `sh.byrow`: Optional initial values. The default is to compute them internally. Argument `sh.byrow` is fed into `byrow` in `matrix` and concerns the ordering of the initial shape parameters; a matrix of dimension $n$ by $Q$ is ultimately constructed. See also CommonVGAMffArguments.
- `eq.shapes`: Logical. Constrain the shape parameters to be equal? See also CommonVGAMffArguments.
- `imethod`, `zero`: See CommonVGAMffArguments.

**Details**

This distribution has the bivariate gamma distribution `bigamma.mckay` as a special case. Let $Q > 1$ be the number of columns of the response matrix $y$. Then the joint probability density function is given by

$$f(y_1, \ldots, y_Q; b, s_1, \ldots, s_Q) = y_1^{s_1}(y_2-y_1)^{s_2} \cdots (y_Q-y_{Q-1})^{s_Q} \exp(-y_Q/b)/(b^{s_\ast} \Gamma(s_1) \cdots \Gamma(s_Q))$$

for $b > 0$, $s_1 > 0, \ldots, s_Q > 0$ and $0 < y_1 < y_2 < \cdots < y_Q < \infty$. Also, $s_{\ast Q} = s_1 + \cdots + s_Q$. Here, $\Gamma$ is the gamma function, By default, the linear/additive predictors are $\eta_1 = \log(b), \eta_2 = \log(s_1), \ldots, \eta_M = \log(s_Q)$. Hence $Q = M - 1$. The marginal distributions are gamma, with shape parameters $s_1$ up to $s_Q$, but they have a common scale parameter $b$. 
The fitted value returned is a matrix with columns equalling their respective means; for column \( j \) it is \( \text{sum}(\text{shape}[1:j]) \times \text{scale} \).

The correlations are always positive; for columns \( j \) and \( k \) with \( j < k \), the correlation is \( \sqrt{\text{sum}(\text{shape}[1:j]) / \text{sum}(\text{shape}[1:k])} \). Hence the variance of column \( j \) is \( \text{sum}(\text{shape}[1:j]) \times \text{scale}^2 \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The response must be a matrix with at least two columns. Apart from the first column, the differences between a column and its LHS adjacent column must all be positive. That is, each row must be strictly increasing.

Author(s)

T. W. Yee

References


See Also

bigamma.mckay, gammaff.

Examples

```r
## Not run:
data("mbflood", package = "VGAMdata")
mbflood <- transform(mbflood, VdivD = V / D)
fit <- vglm(cbind(Q, y2 = Q + VdivD) ~ 1,
            gammaff.mm, trace = TRUE, data = mbflood)
coef(fit, matrix = TRUE)
Coef(fit)
vcov(fit)
colMeans(depvar(fit))  # Check moments
head(fitted(fit), 1)
## End(Not run)
```
Description

Estimate the parameter of a gamma hyperbola bivariate distribution by maximum likelihood estimation.

Usage

gammahyperbola(ltheta = "loglink", itheta = NULL, expected = FALSE)

Arguments

- ltheta: Link function applied to the (positive) parameter θ. See Links for more choices.
- itheta: Initial value for the parameter. The default is to estimate it internally.
- expected: Logical. FALSE means the Newton-Raphson (using the observed information matrix) algorithm, otherwise the expected information matrix is used (Fisher scoring algorithm).

Details

The joint probability density function is given by

\[ f(y_1, y_2) = \exp(-e^{-\theta} y_1/\theta - \theta y_2) \]

for \( \theta > 0, y_1 > 0, y_2 > 1 \). The random variables \( Y_1 \) and \( Y_2 \) are independent. The marginal distribution of \( Y_1 \) is an exponential distribution with rate parameter \( \exp(-\theta)/\theta \). The marginal distribution of \( Y_2 \) is an exponential distribution that has been shifted to the right by 1 and with rate parameter \( \theta \). The fitted values are stored in a two-column matrix with the marginal means, which are \( \theta \exp(\theta) \) and \( 1 + 1/\theta \).

The default algorithm is Newton-Raphson because Fisher scoring tends to be much slower for this distribution.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The response must be a two-column matrix.

Author(s)

T. W. Yee
References

See Also
exponential.

Examples
```r
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, theta = exp(-2 + x2))
gdata <- transform(gdata, y1 = rexp(nn, rate = exp(-theta)/theta),
                   y2 = rexp(nn, rate = theta) + 1)
fit <- vglm(cbind(y1, y2) ~ x2, gammahyperbola(expected = TRUE), data = gdata)
coef(fit, matrix = TRUE)
Coef(fit)
head(fitted(fit))
summary(fit)
```

gammaR 2-parameter Gamma Regression Family Function

Description
Estimates the 2-parameter gamma distribution by maximum likelihood estimation.

Usage
gammaR(lrate = "loglink", lshape = "loglink", irate = NULL,
       ishape = NULL, lss = TRUE, zero = "shape")

Arguments
- lrate, lshape: Link functions applied to the (positive) rate and shape parameters. See Links for more choices.
- irate, ishape: Optional initial values for rate and shape. A NULL means a value is computed internally. If a failure to converge occurs, try using these arguments.
- zero, lss: Details at CommonVGAMffArguments.

Details
The density function is given by
\[
f(y; \text{rate}, \text{shape}) = \exp(-\text{rate} \times y) \times y^{\text{shape}-1} \times \text{rate}^{\text{shape}} / \Gamma(\text{shape})
\]
for shape > 0, rate > 0 and y > 0. Here, \(\Gamma(\text{shape})\) is the gamma function, as in gamma. The mean of \(Y\) is \(\mu = \text{shape}/\text{rate}\) (returned as the fitted values) with variance \(\sigma^2 = \mu^2/\text{shape} = \text{shape}/\text{rate}^2\). By default, the two linear/additive predictors are \(\eta_1 = \log(\text{rate})\) and \(\eta_2 = \log(\text{shape})\).
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

The parameters rate and shape match with the arguments rate and shape of rgamma. The order of the arguments agree too. Here, scale = 1/rate is used, so one can use negloglink. Multiple responses are handled.

If rate = 1 use the family function gamma1 to estimate shape.

The reciprocal of a 2-parameter gamma random variate has an inverse gamma distribution. One might write a VGAM family function called invgammaR() to estimate this, but for now, just feed in the reciprocal of the response.

Author(s)

T. W. Yee

References


See Also

gamma1 for the 1-parameter gamma distribution, gamma2 for another parameterization of the 2-parameter gamma distribution, bigamma.mckay for a bivariate gamma distribution, gammaff.mm for another, expexpff, simulate.vlm, rgamma, negloglink.

Examples

# Essentially a 1-parameter gamma
gdata <- data.frame(y1 = rgamma(n <- 100, shape = exp(1)))
fit1 <- vglm(y1 ~ 1, gamma1, data = gdata, trace = TRUE)
fit2 <- vglm(y1 ~ 1, gammaR, data = gdata, trace = TRUE, crit = "coef")
coef(fit2, matrix = TRUE)
Coef(fit2)

# Essentially a 2-parameter gamma
gdata <- data.frame(y2 = rgamma(n = 500, rate = exp(1), shape = exp(2)))
fit2 <- vglm(y2 ~ 1, gammaR, data = gdata, trace = TRUE, crit = "coef")
coef(fit2, matrix = TRUE)
Coef(fit2)
summary(fit2)
GARMA (Generalized Autoregressive Moving-Average) Models

Description

Fits GARMA models to time series data.

Usage

garma(link = "identitylink", p.ar.lag = 1, q.ma.lag = 0,
      coefstart = NULL, step = 1)

Arguments

- link: Link function applied to the mean response. The default is suitable for continuous responses. The link loglink should be chosen if the data are counts. The link reciprocal can be chosen if the data are counts and the variance assumed for this is $\mu^2$. The links logitlink, probitlink, clogloglink, and cauchitlink are supported and suitable for binary responses. Note that when the log or logit link is chosen: for log and logit, zero values can be replaced by bvalue. See loglink and logitlink etc. for specific information about each link function.
- p.ar.lag: A positive integer, the lag for the autoregressive component. Called $p$ below.
- q.ma.lag: A non-negative integer, the lag for the moving-average component. Called $q$ below.
- coefstart: Starting values for the coefficients. Assigning this argument is highly recommended. For technical reasons, the argument coefstart in vglm cannot be used.
- step: Numeric. Step length, e.g., 0.5 means half-step sizing.

Details

This function draws heavily on Benjamin et al. (1998). See also Benjamin et al. (2003). GARMA models extend the ARMA time series model to generalized responses in the exponential family, e.g., Poisson counts, binary responses. Currently, this function is rudimentary and can handle only certain continuous, count and binary responses only. The user must choose an appropriate link for the link argument.

The GARMA($p$, $q$) model is defined by firstly having a response belonging to the exponential family

$$ f(y_t|D_t) = \exp \left\{\frac{y_t \theta_t - b(\theta_t)}{\phi/A_t} + c(y_t, \phi/A_t) \right\} $$

where $\theta_t$ and $\phi$ are the canonical and scale parameters respectively, and $A_t$ are known prior weights. The mean $\mu_t = E(Y_t|D_t) = b'(\theta_t)$ is related to the linear predictor $\eta_t$ by the link function $g$.
Here, $D_t = \{x_t, \ldots, x_1, y_{t-1}, \ldots, y_1, \mu_{t-1}, \ldots, \mu_1\}$ is the previous information set. Secondly, the GARMA($p, q$) model is defined by

$$g(\mu_t) = \eta_t = x_t^T \beta + \sum_{k=1}^{p} \phi_k(g(y_{t-k}) - x_{t-k}^T \beta) + \sum_{k=1}^{q} \theta_k(g(y_{t-k}) - \eta_{t-k}).$$

Parameter vectors $\beta$, $\phi$ and $\theta$ are estimated by maximum likelihood.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm.

Warning

This VGAM family function is 'non-standard' in that the model does need some coercing to get it into the VGLM framework. Special code is required to get it running. A consequence is that some methods functions may give wrong results when applied to the fitted object.

Note

This function is unpolished and is requires lots of improvements. In particular, initialization is very poor. Results appear very sensitive to quality of initial values. A limited amount of experience has shown that half-stepsizing is often needed for convergence, therefore choosing crit = "coef" is not recommended.

Overdispersion is not handled. For binomial responses it is currently best to input a vector of 1s and 0s rather than the cbind(successes, failures) because the initialize slot is rudimentary.

Author(s)

T. W. Yee

References


Examples

gdata <- data.frame(interspike = c(68, 41, 82, 66, 101, 66, 57, 41, 27, 78, 59, 73, 6, 44, 72, 66, 59, 60, 39, 52, 50, 29, 38, 56, 76, 55, 73, 104, 104, 52, 25, 33, 28, 60, 47, 6, 47, 22, 35, 30, 29, 58, 24, 34, 36, 34, 6, 19, 28, 16,
36, 33, 12, 26, 36, 39, 24, 14, 28, 13,
2, 30, 18, 17, 28, 9, 28, 20, 17, 12,
19, 18, 14, 23, 18, 22, 18, 19, 26, 27,
23, 24, 35, 22, 29, 28, 17, 30, 34, 17,
20, 49, 29, 35, 49, 25, 55, 42, 29, 16)) # See Zeger and Qaqish (1988)
gdata <- transform(gdata, spikenum = seq(interspike))
bvalue <- 0.1 # .Machine$double.xmin # Boundary value
fit <- vglm(interspike ~ 1, trace = TRUE, data = gdata,
               garma(loglink(bvalue = bvalue),
               p = 2, coefstart = c(4, 0.3, 0.4)))
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit) # A bug here
## Not run: with(gdata, plot(interspike, ylim = c(0, 120), las = 1,
                              xlab = "Spike Number", ylab = "Inter-Spike Time (ms)", col = "blue")
with(gdata, lines(spikenum[-(1:fit@misc$plag)], fitted(fit), col = "orange"))
abline(h = mean(with(gdata, interspike)), lty = "dashed", col = "gray")
## End(Not run)

GenbetaII

The Generalized Beta II Distribution

Description

Density for the generalized beta II distribution with shape parameters a and p and q, and scale parameter scale.

Usage

dgenbetaII(x, scale = 1, shape1.a, shape2.p, shape3.q, log = FALSE)

Arguments

x vector of quantiles.
shape1.a, shape2.p, shape3.q positive shape parameters.
scale positive scale parameter.
log Logical. If log = TRUE then the logarithm of the density is returned.

Details

See genbetaII, which is the VGAM family function for estimating the parameters by maximum likelihood estimation. Several distributions, such as the Singh-Maddala, are special case of this flexible 4-parameter distribution. The product of shape1.a and shape2.p determines the behaviour of the density at the origin.

Value

dgenbetaII gives the density.
**Author(s)**

T. W. Yee

**References**


**See Also**

`genbetaII`.

**Examples**

dgenbetaII(0, shape1.a = 1/4, shape2.p = 4, shape3.q = 3)
dgenbetaII(0, shape1.a = 1/4, shape2.p = 2, shape3.q = 3)
dgenbetaII(0, shape1.a = 1/4, shape2.p = 8, shape3.q = 3)

---

**Description**

Maximum likelihood estimation of the 4-parameter generalized beta II distribution.

**Usage**

```r
genbetaII(lscale = "loglink", lshape1.a = "loglink", lshape2.p = "loglink", lshape3.q = "loglink", iscale = NULL, ishape1.a = NULL, ishape2.p = NULL, ishape3.q = NULL, lss = TRUE, gscale = exp(-5:5), gshape1.a = exp(-5:5), gshape2.p = exp(-5:5), gshape3.q = exp(-5:5), zero = "shape")
```

**Arguments**

- `lss` See `CommonVGAMffArguments` for important information.
- `lshape1.a`, `lscale`, `lshape2.p`, `lshape3.q` Parameter link functions applied to the shape parameter a, scale parameter scale, shape parameter p, and shape parameter q. All four parameters are positive. See `Links` for more choices.
- `iscale`, `ishape1.a`, `ishape2.p`, `ishape3.q` Optional initial values for the parameters. A NULL means a value is computed internally using the arguments `gscale`, `gshape1.a`, etc.
- `gscale`, `gshape1.a`, `gshape2.p`, `gshape3.q` See `CommonVGAMffArguments` for information. Replaced by `iscale`, `ishape1.a` etc. if given.
- `zero` The default is to set all the shape parameters to be intercept-only. See `CommonVGAMffArguments` for information.
Details

This distribution is most useful for unifying a substantial number of size distributions. For example, the Singh-Maddala, Dagum, Fisk (log-logistic), Lomax (Pareto type II), inverse Lomax, beta distribution of the second kind distributions are all special cases. Full details can be found in Kleiber and Kotz (2003), and Brazauskas (2002). The argument names given here are used by other families that are special cases of this family. Fisher scoring is used here and for the special cases too.

The 4-parameter generalized beta II distribution has density

\[ f(y) = ay^{ap-1}/[b^{ap} B(p, q)\{1 + (y/b)^a\}]^{p+q} \]

for \( a > 0 \), \( b > 0 \), \( p > 0 \), \( q > 0 \), \( y \geq 0 \). Here \( B \) is the beta function, and \( b \) is the scale parameter scale, while the others are shape parameters. The mean is

\[ E(Y) = b \Gamma(p + 1/a) \Gamma(q - 1/a)/\Gamma(p) \Gamma(q) \]

provided \(-ap < 1 < aq\); these are returned as the fitted values.

This family function handles multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

This distribution is very flexible and it is not generally recommended to use this family function when the sample size is small—numerical problems easily occur with small samples. Probably several hundred observations at least are needed in order to estimate the parameters with any level of confidence. Neither is the inclusion of covariates recommended at all—not unless there are several thousand observations. The mean is finite only when \(-ap < 1 < aq\), and this can be easily violated by the parameter estimates for small sample sizes. Try fitting some of the special cases of this distribution (e.g., sinmad, fisk, etc.) first, and then possibly use those models for initial values for this distribution.

Note

The default is to use a grid search with respect to all four parameters; this is quite costly and is time consuming. If the self-starting initial values fail, try experimenting with the initial value arguments. Also, the constraint \(-ap < 1 < aq\) may be violated as the iterations progress so it pays to monitor convergence, e.g., set trace = TRUE. Successful convergence depends on having very good initial values. This is rather difficult for this distribution so that a grid search is conducted by default. One suggestion for increasing the estimation reliability is to set stepsize = 0.5 and maxit = 100; see vglm.control.

Author(s)

T. W. Yee, with help from Victor Miranda.
References


See Also
dgenbetaII, betaII, dagum, sinmad, fisk, lomax, inv.lomax, paralogistic, inv.paralogistic, lino, CommonVGAMffArguments, vglm.control.

Examples

```r
## Not run:
gdata <- data.frame(y = rsinmad(3000, shape1 = exp(1), scale = exp(2),
                     shape3 = exp(1))) # A special case!
fit <- vglm(y ~ 1, genbetaII(lss = FALSE), data = gdata, trace = TRUE)
fit <- vglm(y ~ 1, data = gdata, trace = TRUE,
            genbetaII(ishape1.a = 3, iscale = 7, ishape3.q = 2.3))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
## End(Not run)
```

gengamma.stacy

*Generalized Gamma distribution family function*

Description

Estimation of the 3-parameter generalized gamma distribution proposed by Stacy (1962).

Usage

```r
gengamma.stacy(lscale = "loglink", ld = "loglink", lk = "loglink",
              iscale = NULL, id = NULL, ik = NULL, imethod = 1,
              gscale.mux = exp((-4:4)/2), gshape1.d = exp((-5:5)/2),
              gshape2.k = exp((-5:5)/2), probs.y = 0.3, zero = c("d", "k"))
```

Arguments

- `lscale`, `ld`, `lk` Parameter link function applied to each of the positive parameters `b`, `d` and `k`, respectively. See *Links* for more choices.
- `iscale`, `id`, `ik` Initial value for `b`, `d` and `k`, respectively. The defaults mean an initial value is determined internally for each.
- `gscale.mux`, `gshape1.d`, `gshape2.k` See *CommonVGAMffArguments* for information. Replaced by iscale, id etc. if given.
Details

The probability density function can be written
\[ f(y; b, d, k) = \frac{db^{-dk}y^{dk-1} \exp[-(y/b)^d]}{\Gamma(k)} \]
for scale parameter \( b > 0 \), and Weibull-type shape parameter \( d > 0 \), gamma-type shape parameter \( k > 0 \), and \( y > 0 \). The mean of \( Y \) is \( b \times \Gamma(k + 1/d)/\Gamma(k) \) (returned as the fitted values), which equals \( bk \) if \( d = 1 \).

There are many special cases, as given in Table 1 of Stacey and Mihran (1965). In the following, the parameters are in the order \( b, d, k \). The special cases are: Exponential \( f(y; b, 1, 1) \), Gamma \( f(y; b, 1, k) \), Weibull \( f(y; b, d, 1) \), Chi Squared \( f(y; 2, 1, a/2) \) with \( a \) degrees of freedom, Chi \( f(y; \sqrt{2}, 2, a/2) \) with \( a \) degrees of freedom, Half-normal \( f(y; \sqrt{2}, 2, 1) \), Spherical normal \( f(y; \sqrt{2}, 2, 3/2) \), Rayleigh \( f(y; c\sqrt{2}, 2, 1) \) where \( c > 0 \). Also the log-normal distribution corresponds to when \( k = \text{Inf} \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

Several authors have considered maximum likelihood estimation for the generalized gamma distribution and have found that the Newton-Raphson algorithm does not work very well and that the existence of solutions to the log-likelihood equations is sometimes in doubt. Although Fisher scoring is used here, it is likely that the same problems will be encountered. It appears that large samples are required, for example, the estimator of \( k \) became asymptotically normal only with 400 or more observations. It is not uncommon for maximum likelihood estimates to fail to converge even with two or three hundred observations. With covariates, even more observations are needed to increase the chances of convergence. Using covariates is not advised unless the sample size is at least a few thousand, and even if so, modelling 1 or 2 parameters as intercept-only is a very good idea (e.g., zero = 2:3). Monitoring convergence is also a very good idea (e.g., set trace = TRUE). Half-stepping is not uncommon, and if this occurs, then the results should be viewed with more suspicion.

Note

The notation used here differs from Stacy (1962) and Prentice (1974). Poor initial values may result in failure to converge so if there are covariates and there are convergence problems, try using or checking the zero argument (e.g., zero = 2:3) or the ik argument or the imethod argument, etc.

Author(s)

T. W. Yee
References


See Also

`rgengamma.stacy`, `gamma1`, `gamma2`, `prentice74`, `simulate.vlm`, `chisq`, `lognormal`, `rayleigh`, `weibullR`.

Examples

```r
k <- exp(-1); Scale <- exp(1); dd <- exp(0.5); set.seed(1)
gdata <- data.frame(y = rgamma(2000, shape = k, scale = Scale))
gfit <- vglm(y ~ 1, gengamma.stacy, data = gdata, trace = TRUE)
coef(gfit, matrix = TRUE)
```

---

**gengammaUC**

*Generalized Gamma Distribution*

**Description**

Density, distribution function, quantile function and random generation for the generalized gamma distribution with scale parameter `scale`, and parameters `d` and `k`.

**Usage**

```r
dgengamma.stacy(x, scale = 1, d, k, log = FALSE)
pgengamma.stacy(q, scale = 1, d, k,
    lower.tail = TRUE, log.p = FALSE)
qgengamma.stacy(p, scale = 1, d, k,
    lower.tail = TRUE, log.p = FALSE)
rgengamma.stacy(n, scale = 1, d, k)
```

**Arguments**

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. Same as in `runif`.
- `scale` the (positive) scale parameter $b$.
- `d, k` the (positive) parameters $d$ and $k$. Both can be thought of as shape parameters, where $d$ is of the Weibull-type and $k$ is of the gamma-type.
log
Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p
Same meaning as in pnorm or qnorm.

Details
See gengamma.stacy, the VGAM family function for estimating the generalized gamma distribution by maximum likelihood estimation, for formulae and other details. Apart from n, all the above arguments may be vectors and are recycled to the appropriate length if necessary.

Value
dgengamma.stacy gives the density, pgengamma.stacy gives the distribution function, qgengamma.stacy gives the quantile function, and rgengamma.stacy generates random deviates.

Author(s)
T. W. Yee and Kai Huang

References

See Also
gengamma.stacy.

Examples
## Not run: x <- seq(0, 14, by = 0.01); d <- 1.5; Scale <- 2; k <- 6
plot(x, dgengamma.stacy(x, Scale, d = d, k = k), type = "l",
    col = "blue", ylim = 0:1,
    main = "Blue is density, orange is the CDF",
    sub = "Purple are 5,10,...95 percentiles", las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(qgengamma.stacy(seq(0.05, 0.95, by = 0.05), Scale, d = d, k = k),
    dgengamma.stacy(qgengamma.stacy(seq(0.05, 0.95, by = 0.05),
    Scale, d = d, k = k),
    Scale, d = d, k = k), col = "purple", lty = 3, type = "h")
lines(x, pgengamma.stacy(x, Scale, d = d, k = k), col = "orange")
abline(h = 0, lty = 2)
## End(Not run)
Description

Density, distribution function, quantile function and random generation for the original parameterization of the generalized Poisson distribution.

Usage

dgenpois0(x, theta, lambda = 0, log = FALSE)
pgegenpois0(q, theta, lambda = 0, lower.tail = TRUE)
qgenpois0(p, theta, lambda = 0)
rgenpois0(n, theta, lambda = 0, algorithm = c("qgenpois0", "inv", "bup", "chdn", "napp", "bran"))

Arguments

x, q
Vector of quantiles.
p
Vector of probabilities.
n
Similar to runif.
theta, lambda
See genpoisson0. The default value of lambda corresponds to an ordinary Poisson distribution. Nonnegative values of lambda are currently required.
lower.tail, log
Similar to Poisson.
algorithm
Character. Six choices are available, standing for the qgenpois0, inversion, build-up, chop-down, normal approximation and branching methods. The first one is the default and calls qgenpois0 with runif as its first argument. The value inputted may be abbreviated, e.g., alg = "n". The last 5 algorithms are a direct implementation of Demirtas (2017) and the relative performance of the algorithms are described there—however, the vectorization here may render the comments on relative speed as no longer holding.

Details

Most of the background to these functions are given in genpoisson0. Some warnings relevant to this distribution are given there. The complicated range of the parameter lambda when negative is no longer supported because the distribution is not normalized. For other GPD variants see Genpois1.

Value

dgenpois0 gives the density, pgenpois0 gives the distribution function, qgenpois0 gives the quantile function, and rgenpois generates random deviates. For some of these functions such as dgenpois0 and pgenpois0 the value NaN is returned for elements not satisfying the parameter restrictions, e.g., if \( \lambda > 1 \). For some of these functions such as rgenpois0 the input must not contain NAs or NaNs, etc. since the implemented algorithms are fragile.
Warning

These have not been tested thoroughly.

For pgentpois0() `mapply` is called with `0:q` as input, hence will be very slow and memory-hungry for large values of `q`. Likewise qgentpois0() and rgentpois0() may suffer from the same limitations.

Note

For rgentpois0(): (1). "inv", "bup" and "chdn" appear similar and seem to work okay. (2). "napp" works only when theta is large, away from 0. It suffers from 0-inflation. (3). "bran" has a relatively heavy RHS tail and requires positive lambda. More details can be found in Famoye (1997) and Demirtas (2017).

The function dgenpois0 uses `lfactorial`, which equals `Inf` when `x` is approximately `1e306` on many machines. So the density is returned as `0` in very extreme cases; see `.Machine`.

Author(s)

T. W. Yee. For rgenpois0() the last 5 algorithms are based on code written in H. Demirtas (2017) and vectorized by T. W. Yee; but the "bran" algorithm was rewritten from Famoye (1997).

References


See Also

genpoisson0, Genpois1, dpois.

Examples

```r
sum(dgenpois0(0:1000, theta = 2, lambda = 0.5))
## Not run: theta <- 2; lambda <- 0.2; y <- 0:10
proby <- dgenpois0(y, theta = theta, lambda = lambda, log = FALSE)
plot(y, proby, type = "h", col = "blue", lwd = 2, ylab = "Pr(Y=y)",
     main = paste0("Y ~ GP-0(theta="", theta, ", lambda=",
                      lambda, ")"), las = 1, ylim = c(0, 0.3),
     sub = "Orange is the Poisson probability function")
lines(y + 0.1, dpois(y, theta), type = "h", lwd = 2, col = "orange")
## End(Not run)
```
**Generalized Poisson Distribution (GP-1 and GP-2 Parameterizations of the Mean)**

**Description**
Density, distribution function, quantile function and random generation for two parameterizations (GP-1 and GP-2) of the generalized Poisson distribution of the mean.

**Usage**
- `dgenpois1(x, meanpar, dispind = 1, log = FALSE)`
- `pgenpois1(q, meanpar, dispind = 1, lower.tail = TRUE)`
- `qgenpois1(p, meanpar, dispind = 1)`
- `rgenpois1(n, meanpar, dispind = 1)`
- `dgenpois2(x, meanpar, disppar = 0, log = FALSE)`
- `pgenpois2(q, meanpar, disppar = 0, lower.tail = TRUE)`
- `qgenpois2(p, meanpar, disppar = 0)`
- `rgenpois2(n, meanpar, disppar = 0)`

**Arguments**
- `x, q` Vector of quantiles.
- `p` Vector of probabilities.
- `n` Similar to `runif`.
- `meanpar, dispind` The mean and dispersion index (index of dispersion), which are the two parameters for the GP-1. The mean is positive while the `dispind` is $\geq 1$. The default value of `dispind` corresponds to an ordinary Poisson distribution.
- `disppar` The dispersion parameter for the GP-2: $\text{disppar} \geq 0$. The default value of `disppar` corresponds to an ordinary Poisson distribution.
- `lower.tail, log` See `Genpois0`.

**Details**
These are wrapper functions for those in `Genpois0`. The first parameter is the mean, therefore both the GP-1 and GP-2 are recommended for regression and can be compared somewhat to `poissonff` and `negbinomial`. The variance of a GP-1 is $\mu \varphi$ where $\varphi = 1/(1 - \lambda)^2$ is `dispind`. The variance of a GP-2 is $\mu(1 + \alpha \mu)^2$ where $\theta = \mu/(1 + \alpha \mu)$, $\lambda = \alpha \mu/(1 + \alpha \mu)$, and is $\alpha$ the dispersion parameter `disppar`. Thus the variance is linear with respect to the mean for GP-1 while the variance is cubic with respect to the mean for GP-2.

Recall that the *index of dispersion* (also known as the *dispersion index*) is the ratio of the variance and the mean. Also, $\mu = \theta/(1 - \lambda)$ in the original formulation with variance $\theta/(1 - \lambda)^3$. The GP-1 is due to Consul and Famoye (1992). The GP-2 is due to Wang and Famoye (1997).
Value
dgenpois1 and dgenpois2 give the density, pgenpois1 and dgenpois2 give the distribution function, agenpois1 and agenpois2 give the quantile function, and rgenpois1 and rgenpois2 generate random deviates. See Genpois0 for more information.

Warning
Genpois0 has warnings that should be heeded.

Author(s)
T. W. Yee.

References

See Also
Genpois0.

Examples
sum(dgenpois1(0:1000, meanpar = 5, dispind = 2))
## Not run: dispind <- 5; meanpar <- 5; y <- 0:15
proby <- dgenpois1(y, meanpar = meanpar, dispind)
plot(y, proby, type = "h", col = "blue", lwd = 2, ylab = "P[Y=y]",
     main = paste0("Y ~ GP-1(meanpar=", meanpar, ", dispind=", dispind, ")", las = 1, ylim = c(0, 0.3),
     sub = "Orange is the Poisson probability function")
lines(y + 0.1, dpois(y, meanpar), type = "h", lwd = 2, col = "orange")
## End(Not run)

Description
Estimation of the two-parameter generalized Poisson distribution (original parameterization).

Usage
genpoisson0(ltheta = "loglink", llambda = "logitlink",
          itheta = NULL, ilambda = NULL, imethod = c(1, 1),
          ishrinkage = 0.95, glambda = ppoints(5),
          parallel = FALSE, zero = "lambda")
Arguments

ltheta, llambda

Parameter link functions for $\theta$ and $\lambda$. See Links for more choices. In theory the
$\lambda$ parameter is allowed to be negative to handle underdispersion, however this is
no longer supported, hence $0 < \lambda < 1$. The $\theta$ parameter is positive, therefore
the default is the log link.

itheta, ilambda

Optional initial values for $\lambda$ and $\theta$. The default is to choose values internally.

imethod

See CommonVGAMffArguments for information. Each value is an integer
1 or 2 or 3 which specifies the initialization method for each of the parameters. If failure
to converge occurs try another value and/or else specify a value for ilambda and/or itheta. The argument is recycled to length 2, and the first value corre-
sponds to theta, etc.

ishrinkage, zero

See CommonVGAMffArguments for information.

glambda, parallel

See CommonVGAMffArguments for information. Argument glambda is similar to
gsigma there and is currently used only if imethod[2] = 1.

Details

The generalized Poisson distribution (GPD) was proposed by Consul and Jain (1973), and it has
PMF

$$f(y) = \theta (\theta + \lambda y)^{y-1} \exp(-\theta - \lambda y)/y!$$

for $0 < \theta$ and $y = 0, 1, 2, \ldots$. Theoretically, $\max(-1, -\theta/m) \leq \lambda \leq 1$ where $m \geq 4$ is the
greatest positive integer satisfying $\theta + m\lambda > 0$ when $\lambda < 0$ and then $Pr(Y = y) = 0$ for
$y > m$. However, there are problems with a negative $\lambda$ such as it not being normalized, so this
family function restricts $\lambda$ to $(0, 1)$.

This original parameterization is called the GP-0 by VGAM, partly because there are two other
common parameterizations called the GP-1 and GP-2 (see Yang et al. (2009), genpoisson1 and
genpoisson2) that are more suitable for regression. However, genpoisson() has been simplified
to genpoisson0 by only handling positive parameters, hence only overdispersion relative to the
Poisson is accommodated. Some of the reasons for this are described in Scollnik (1998), e.g., the
probabilities do not sum to unity when lambda is negative. To simply things, VGAM 1.1-4 and
later will only handle positive lambda.

An ordinary Poisson distribution corresponds to $\lambda = 0$. The mean (returned as the fitted values) is
$E(Y) = \theta/(1 - \lambda)$ and the variance is $\theta/(1 - \lambda)^3$ so that the variance is proportional to the mean,
just like the NB-1 and quasi-Poisson.

For more information see Consul and Famoye (2006) for a summary and Consul (1989) for more
details.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as
vglm, and vgam.
Warning

Although this family function is far less fragile compared to what used to be called genpoisson() it is still a good idea to monitor convergence because equidispersion may result in numerical problems; try poissonff instead. And underdispersed data will definitely result in numerical problems and warnings; try quasipoisson instead.

Note

This family function replaces genpoisson(), and some of the major changes are: (i) the swapping of the linear predictors; (ii) the change from rhobitlink to logitlink in llambda to reflect the no longer handling of underdispersion; (iii) proper Fisher scoring is implemented to give improved convergence.

Notationally, and in the literature too, don’t get confused because theta (and not lambda) here really matches more closely with lambda of dpois.

This family function handles multiple responses. This distribution is potentially useful for dispersion modelling. Convergence and numerical problems may occur when lambda becomes very close to 0 or 1.

Author(s)

T. W. Yee. Easton Huch derived the EIM and it has been implemented in the weights slot.

References


See Also

Genpois0, genpoisson1, genpoisson2, poissonff, negbinomial, Poisson, quasipoisson.

Examples

```r
gdata <- data.frame(x2 = runif(nn <- 500))
gdata <- transform(gdata, y1 = rgenpois0(nn, theta = exp(2 + x2), logitlink(1, inverse = TRUE)))
gfit0 <- vglm(y1 ~ x2, genpoisson0, data = gdata, trace = TRUE)
coef(gfit0, matrix = TRUE)
summary(gfit0)
```
Description

Estimation of the two-parameter generalized Poisson distribution (GP-1 parameterization) which has the variance as a linear function of the mean.

Usage

genpoisson1(lmeanpar = "loglink", ldispind = "logloglink",
parallel = FALSE, zero = "dispind",
vfl = FALSE, Form2 = NULL,
imeanpar = NULL, idispind = NULL, imethod = c(1, 1),
ishrinkage = 0.95, gdispind = exp(1:5))

Arguments

lmeanpar, ldispind
Parameter link functions for \( \mu \) and \( \phi \). They are called the mean parameter and dispersion index respectively. See Links for more choices. In theory the \( \phi \) parameter might be allowed to be less than unity to handle underdispersion but this is not supported. The mean is positive so its default is the log link. The dispersion index is \( > 1 \) so its default is the log-log link.

vfl, Form2
If \( vfl = \text{TRUE} \) then Form2 should be assigned a formula having terms comprising \( \eta_2 = \log \log \phi \). This is similar to uninormal. See CommonVGAMffArguments for information.

imeanpar, idispind
Optional initial values for \( \mu \) and \( \phi \). The default is to choose values internally.

imethod
See CommonVGAMffArguments for information. The argument is recycled to length 2, and the first value corresponds to \( \mu \), etc.

ishrinkage, zero
See CommonVGAMffArguments for information.

gdispind, parallel
See CommonVGAMffArguments for information. Argument gdispind is similar to gsigma there and is currently used only if imethod[2] = 2.

Details

This is a variant of the generalized Poisson distribution (GPD) and is similar to the GP-1 referred to by some writers such as Yang, et al. (2009). Compared to the original GP-0 (see genpoisson0) the GP-1 has \( \theta = \mu / \sqrt{\phi} \) and \( \lambda = 1 - 1 / \sqrt{\phi} \) so that the variance is \( \mu \phi \). The first linear predictor by default is \( \eta_1 = \log \mu \) so that the GP-1 is more suitable for regression than the GP-1.

This family function can handle only overdispersion relative to the Poisson. An ordinary Poisson distribution corresponds to \( \phi = 1 \). The mean (returned as the fitted values) is \( E(Y) = \mu \). For overdispersed data, this GP parameterization is a direct competitor of the NB-1 and quasi-Poisson.
Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning

See \texttt{genpoisson0} for warnings relevant here, e.g., it is a good idea to monitor convergence because of equidispersion and underdispersion.

Author(s)

T. W. Yee.

See Also

\texttt{Genpois1, genpoisson0, genpoisson2, poissonff, negbinomial, Poisson, quasipoisson}.

Examples

```r
gdata <- data.frame(x2 = runif(nn <- 500))
gdata <- transform(gdata, y1 = rgenpois1(nn, exp(2 + x2),
logloglink(-1, inverse = TRUE)))
gfit1 <- vglm(y1 ~ x2, genpoisson1, gdata, trace = TRUE)
coef(gfit1, matrix = TRUE)
summary(gfit1)
```

---

\textbf{Description}

Estimation of the two-parameter generalized Poisson distribution (GP-2 parameterization) which has the variance as a cubic function of the mean.

\textbf{Usage}

```r
genpoisson2(lmeanpar = "loglink", ldisppar = "loglink",
parallel = FALSE, zero = "disppar",
vl = FALSE, oparallel = FALSE,
imeanpar = NULL, idisppar = NULL, imethod = c(1, 1),
ishrinkage = 0.95, gdisppar = exp(1:5))
```
genpoisson2

Arguments

lmeanpar, ldisppar
Parameter link functions for \( \mu \) and \( \alpha \). They are called the mean and dispersion parameters respectively. See Links for more choices. In theory the \( \alpha \) parameter might be allowed to be negative to handle underdispersion but this is not supported. All parameters are positive, therefore the defaults are the log link.

imeanpar, idisppar
Optional initial values for \( \mu \) and \( \alpha \). The default is to choose values internally.

tfl, oparallel
Argument oparallel is similar to parallel but uses rbind(1, -1) instead. If \( tfl = \text{TRUE} \) then oparallel should be assigned a formula having terms comprising \( \eta_1 = \log \mu \), and then the other terms in the main formula are for \( \eta_2 = \log \alpha \). See CommonVGAMffArguments for information.

imethod
See CommonVGAMffArguments for information. The argument is recycled to length 2, and the first value corresponds to \( \mu \), etc.

ishrinkage, zero
See CommonVGAMffArguments for information.

gdisppar, parallel
See CommonVGAMffArguments for information. Argument gdisppar is similar to gsigma there and is currently used only if imethod[2] = 2.

Details

This is a variant of the generalized Poisson distribution (GPD) and called GP-2 by some writers such as Yang, et al. (2009). Compared to the original GP-0 (see genpoisson0) the GP-2 has \( \theta = \mu/(1 + \alpha \mu) \) and \( \lambda = \alpha \mu/(1 + \alpha \mu) \) so that the variance is \( \mu(1 + \alpha \mu)^2 \). The first linear predictor by default is \( \eta_1 = \log \mu \) so that the GP-2 is more suitable for regression than the GP-0.

This family function can handle only overdispersion relative to the Poisson. An ordinary Poisson distribution corresponds to \( \alpha = 0 \). The mean (returned as the fitted values) is \( E(Y) = \mu \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

See genpoisson0 for warnings relevant here, e.g., it is a good idea to monitor convergence because of equidispersion and underdispersion.

Author(s)

T. W. Yee.

References

See Also

Genpois2, genpoisson0, genpoisson1, poissonff, negbinomial, Poisson, quasipoisson.

Examples

gdata <- data.frame(x2 = runif(nn <- 500))
gdata <- transform(gdata, y1 = rgenpois2(nn, exp(2 + x2),
loglink(-1, inverse = TRUE)))
gfit2 <- vglm(y1 ~ x2, genpoisson2, gdata, trace = TRUE)
coef(gfit2, matrix = TRUE)
summary(gfit2)

dgenray
The Generalized Rayleigh Distribution

Description

Density, distribution function, quantile function and random generation for the generalized Rayleigh distribution.

Usage

dgenray(x, scale = 1, shape, log = FALSE)
pgenray(q, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
qgenray(p, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
rgenray(n, scale = 1, shape)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. If length(n) > 1 then the length is taken to be the number required.
scale, shape positive scale and shape parameters.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.

Details

See genrayleigh, the VGAM family function for estimating the parameters, for the formula of the probability density function and other details.

Value
dgenray gives the density, pgenray gives the distribution function, qgenray gives the quantile function, and rgenray generates random deviates.
genrayleigh

Note

We define \texttt{scale} as the reciprocal of the scale parameter used by Kundu and Raqab (2005).

Author(s)

Kai Huang and J. G. Lauder and T. W. Yee

See Also

genrayleigh, rayleigh.

Examples

```r
## Not run:
shape <- 0.5; Scale <- 1; nn <- 501
x <- seq(-0.10, 3.0, len = nn)
plot(x, dgenray(x, shape, scale = Scale), type = "l", las = 1, ylim = c(0, 1.2),
ylab = paste("[dp]genray(shape = ", shape, ", scale = ", Scale, ")"),
col = "blue", cex.main = 0.8,
main = "Blue is density, orange is cumulative distribution function",
sub = "Purple lines are the 10,20,...,90 percentiles")
lines(x, pgenray(x, shape, scale = Scale), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qgenray(probs, shape, scale = Scale)
lines(Q, pgenray(Q, shape, scale = Scale), col = "purple", lty = 3, type = "h")
lines(Q, qgenray(Q, shape, scale = Scale), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pgenray(Q, shape, scale = Scale) - probs)) # Should be 0

## End(Not run)
```

genrayleigh

Generalized Rayleigh Distribution Family Function

Description

Estimates the two parameters of the generalized Rayleigh distribution by maximum likelihood estimation.

Usage

```r
genrayleigh(lscale = "loglink", lshape = "loglink",
iscale = NULL, ishape = NULL,
tol12 = 1e-05, nsimEIM = 300, zero = 2)
```
Arguments

- `lscale, lshape`: Link function for the two positive parameters, scale and shape. See `Links` for more choices.
- `iscale, ishape`: Numeric. Optional initial values for the scale and shape parameters.
- `nsimEIM, zero`: See `CommonVGAMffArguments`.
- `tol12`: Numeric and positive. Tolerance for testing whether the second shape parameter is either 1 or 2. If so then the working weights need to handle these singularities.

Details

The generalized Rayleigh distribution has density function

\[ f(y; b = \text{scale}, s = \text{shape}) = (2sy/b^2)e^{-(y/b)^2}(1 - e^{-(y/b)^2})^{s-1} \]

where \( y > 0 \) and the two parameters, \( b \) and \( s \), are positive. The mean cannot be expressed nicely so the median is returned as the fitted values. Applications of the generalized Rayleigh distribution include modeling strength data and general lifetime data. Simulated Fisher scoring is implemented.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

Note

We define `scale` as the reciprocal of the scale parameter used by Kundu and Raqab (2005).

Author(s)

J. G. Lauder and T. W. Yee

References


See Also

dgenray, rayleigh.

Examples

```r
Scale <- exp(1); shape <- exp(1)
rdata <- data.frame(y = rgenray(n = 1000, scale = Scale, shape = shape))
fit <- vglm(y ~ 1, genrayleigh, data = rdata, trace = TRUE)
c(with(rdata, mean(y)), head(fitted(fit), 1))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```
Generalized Secant Hyperbolic Distribution

Description
Density, distribution function, quantile function and random generation for the generalized secant hyperbolic distribution.

Usage
- `dgensh(x, shape, location = 0, scale = 1, tol0 = 1e-4, log = FALSE)`
- `pgensh(q, shape, location = 0, scale = 1, tol0 = 1e-4, lower.tail = TRUE)`
- `qgensh(p, shape, location = 0, scale = 1, tol0 = 1e-4)`
- `rgensh(n, shape, location = 0, scale = 1, tol0 = 1e-4)`

Arguments
- `x, q, p, n, log, lower.tail`
  Similar meaning as in `Normal`.
- `shape` Numeric. Shape parameter, called `t` in Vaughan (2002). Valid values are $-\pi/2 < t$.
- `location, scale` Numeric. The location and (positive) scale parameters.
- `tol0` Numeric. Used to test whether the shape parameter is close enough to be treated as 0.

Details
This is an implementation of the family of symmetric densities described by Vaughan (2002). By default, the mean and variance are 0 and 1, for all $t$. Some special (default) cases are: $t = 0$: logistic (which is similar to `stats:dt` with 9 degrees of freedom); $t = -\pi/2$: the standard secant hyperbolic (whence the name); $t = \infty$: uniform(-sqrt(3), sqrt(3)).

Value
- `dgensh` gives the density, `pgensh` gives the distribution function, `qgensh` gives the quantile function, and `rgensh` generates random deviates.

Warning
Numerical problems may occur when some argument values are extreme.

Author(s)
T. W. Yee.
See Also

gensh, logistic, hypersecant, Logistic.

Examples

```r
x <- seq(-2, 4, by = 0.01)
loc <- 1; shape <- -pi / 2
# Not run: plot(x, dgensh(x, shape, loc), type = "l",
   main = "Blue is density, orange is the CDF",
   ylim = 0:1, las = 1, ylab = "",
   sub = "Purple are 5, 10, ..., 95 percentiles",
   col = "blue")
abline(h = 0, col = "blue", lty = 2)
lines(qgensh((1:19) / 20, shape, loc), type = "h",
   dgensh(qgensh((1:19) / 20, shape, loc),
   shape, loc), col = "purple", lty = 3)
lines(x, pgensh(x, shape, loc), col = "orange")
abline(h = 0, lty = 2)
# End(Not run)

pp <- (1:19) / 20  # Test two functions
max(abs(pgensh(qgensh(pp, shape, loc),
   shape, loc) - pp))  # Should be 0
```

gensh

*Generalized Secant Hyperbolic Regression Family Function*

Description

Estimation of the parameters of the generalized secant hyperbolic distribution.

Usage

```r
gensh(shape, llocation = "identitylink",
   lscale = "loglink", zero = "scale",
   ilocation = NULL, iscale = NULL, imethod = 1,
   glocation.mux = exp((-4:4)/2),
   gscale.mux = exp((-4:4)/2),
   probs.y = 0.3, tol0 = 1e-4)
```

Arguments

- **shape**: Numeric of length 1. Shape parameter, called $t$ in Vaughan (2002). Valid values are $-\pi/2 < t$.
- **llocation, lscale**: Parameter link functions applied to the two parameters. See [Links](#) for more choices. See [CommonVGAMffArguments](#) for more information.
- **zero, imethod**: See [CommonVGAMffArguments](#) for information.
Details

The probability density function of the hyperbolic secant distribution is given by

\[ f(y; a, b, s) = \left( \frac{c_1/b}{\exp(c_2 z) + 2C_3 \exp(c_2 z) + 1} \right) \]

for shape parameter \(-\pi < s\) and all real \(y\). The scalars \(c_1, c_2, C_3\) are functions of \(s\). The mean of \(Y\) is the location parameter \(a\) (returned as the fitted values). All moments of the distribution are finite.

Further details about the parameterization can be found in Vaughan (2002). Fisher scoring is implemented and it has a diagonal EIM. More details are at \texttt{Gensh}.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Author(s)

T. W. Yee

References


See Also

\texttt{hypersecant}, \texttt{logistic}.

Examples

```r
sh <- -pi / 2; loc <- 2
hdata <- data.frame(x2 = rnorm(nn <- 200))
hdata <- transform(hdata, y = rgensh(nn, sh, loc))
fit <- vglm(y ~ x2, gensh(sh), hdata, trace = TRUE)
coef(fit, matrix = TRUE)
```
geometric

Geometric (Truncated and Untruncated) Distributions

Description

Maximum likelihood estimation for the geometric and truncated geometric distributions.

Usage

geometric(link = "logitlink", expected = TRUE, imethod = 1, iprob = NULL, zero = NULL)

truncgeometric(upper.limit = Inf, link = "logitlink", expected = TRUE, imethod = 1, iprob = NULL, zero = NULL)

Arguments

link

Parameter link function applied to the probability parameter $p$, which lies in the unit interval. See Links for more choices.

expected

Logical. Fisher scoring is used if expected = TRUE, else Newton-Raphson.

iprob, imethod, zero

See CommonVGAMffArguments for details.

upper.limit

Numeric. Upper values. As a vector, it is recycled across responses first. The default value means both family functions should give the same result.

Details

A random variable $Y$ has a 1-parameter geometric distribution if $P(Y = y) = p(1 - p)^y$ for $y = 0, 1, 2, \ldots$. Here, $p$ is the probability of success, and $Y$ is the number of (independent) trials that are fails until a success occurs. Thus the response $Y$ should be a non-negative integer. The mean of $Y$ is $E(Y) = (1 - p)/p$ and its variance is $Var(Y) = (1 - p)/p^2$. The geometric distribution is a special case of the negative binomial distribution (see negbinomial). The geometric distribution is also a special case of the Borel distribution, which is a Lagrangian distribution. If $Y$ has a geometric distribution with parameter $p$ then $Y + 1$ has a positive-geometric distribution with the same parameter. Multiple responses are permitted.

For truncgeometric(), the (upper) truncated geometric distribution can have response integer values from 0 to upper.limit. It has density $prob \times (1 - prob)^y / [1 - 1 - (1 - prob)^{(1 + upper.limit)}]$.

For a generalized truncated geometric distribution with integer values $L$ to $U$, say, subtract $L$ from the response and feed in $U - L$ as the upper limit.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.
Author(s)

T. W. Yee. Help from Viet Hoang Quoc is gratefully acknowledged.

References


See Also

negbinomial, Geometric, betageometric, expgeometric, zageometric, zigeometric, rbetageom, simulate.vlm.

Examples

gdata <- data.frame(x2 = runif(nn <- 1000) - 0.5)
gdata <- transform(gdata, x3 = runif(nn) - 0.5, x4 = runif(nn) - 0.5)
gdata <- transform(gdata, eta = -1.0 - 1.0 * x2 + 2.0 * x3)
gdata <- transform(gdata, prob = logitlink(eta, inverse = TRUE))
gdata <- transform(gdata, y1 = rgeom(nn, prob))
with(gdata, table(y1))
fit1 <- vglm(y1 ~ x2 + x3 + x4, geometric, data = gdata, trace = TRUE)
coef(fit1, matrix = TRUE)
summary(fit1)

# Truncated geometric (between 0 and upper.limit)
upper.limit <- 5
tdata <- subset(gdata, y1 <= upper.limit)
nrow(tdata)  # Less than nn
fit2 <- vglm(y1 ~ x2 + x3 + x4, truncgeometric(upper.limit),
            data = tdata, trace = TRUE)
coef(fit2, matrix = TRUE)

# Generalized truncated geometric (between lower.limit and upper.limit)
lower.limit <- 1
upper.limit <- 8
gtdata <- subset(gdata, lower.limit <= y1 & y1 <= upper.limit)
with(gtdata, table(y1))
nrow(gtdata)  # Less than nn
fit3 <- vglm(y1 - lower.limit ~ x2 + x3 + x4,
            truncgeometric(upper.limit - lower.limit),
            data = gtdata, trace = TRUE)
coef(fit3, matrix = TRUE)
get.smart.prediction

Description

Retrieve one component of the list .smart.prediction from smartpredenv.

Usage

get.smart()

Details

get.smart is used in "read" mode within a smart function: it retrieves parameters saved at the time of fitting, and is used for prediction. get.smart is only used in smart functions such as sm.poly; get.smart.prediction is only used in modelling functions such as lm and glm. The function get.smart gets only a part of .smart.prediction whereas get.smart.prediction gets the entire .smart.prediction.

Value

Returns with one list component of .smart.prediction from smartpredenv, in fact, .smart.prediction[[.smart.prediction.counter]]. The whole procedure mimics a first-in first-out stack (better known as a queue).

Side Effects

The variable .smart.prediction.counter in smartpredenv is incremented beforehand, and then written back to smartpredenv.

See Also

get.smart.prediction.

Examples

print(sm.min1)

get.smart.prediction  Retrieves “.smart.prediction”

Description

Retrieves .smart.prediction from smartpredenv.

Usage

get.smart.prediction()

Details

A smart modelling function such as lm allows smart functions such as sm.bs to write to a data structure called .smart.prediction in smartpredenv. At the end of fitting, get.smart.prediction retrieves this data structure. It is then attached to the object, and used for prediction later.
Description

Maximum likelihood estimation of the 3-parameter generalized extreme value (GEV) distribution.

Usage

```r
gev(llocation = "identitylink", lscale = "loglink",
    lshape = logofflink(offset = 0.5), percentiles = c(95, 99),
    ilocation = NULL, iscale = NULL, ishape = NULL, imethod = 1,
    gprobs.y = (1:9)/10, gscale.mux = exp((-5:5)/6),
    gshape = (-5:5) / 11 + 0.01,
    iprobs.y = NULL, tolshape0 = 0.001,
    type.fitted = c("percentiles", "mean"),
    zero = c("scale", "shape"))
```

```r
genvf(llocation = "identitylink", lscale = "loglink",
      lshape = logofflink(offset = 0.5), percentiles = c(95, 99),
      ilocation = NULL, iscale = NULL, ishape = NULL, imethod = 1,
      gprobs.y = (1:9)/10, gscale.mux = exp((-5:5)/6),
      gshape = (-5:5) / 11 + 0.01,
      iprobs.y = NULL, tolshape0 = 0.001,
      type.fitted = c("percentiles", "mean"),
      zero = c("scale", "shape"))
```

Arguments

- `llocation, lscale, lshape`
  Parameter link functions for $\mu$, $\sigma$ and $\xi$ respectively. See Links for more choices. For the shape parameter, the default logofflink link has an offset called $A$ below; and then the linear/additive predictor is $\log(\xi + A)$ which means that $\xi > -A$. For technical reasons (see Details) it is a good idea for $A = 0.5$.  

Examples

```r
## Not run:
fit$smart <- get.smart.prediction()  # Put at the end of lm()
## End(Not run)
```

See Also

- get.smart, lm.
percentiles

Numeric vector of percentiles used for the fitted values. Values should be between 0 and 100. This argument is ignored if `type.fitted = "mean"`.

type.fitted

See `CommonVGAMffArguments` for information. The default is to use the percentiles argument. If "mean" is chosen, then the mean \( \mu + \sigma \Gamma(1 - \xi - 1)/\xi \) is returned as the fitted values, and these are only defined for \( \xi < 1 \).

ilocation, iscale, ishape

Numeric. Initial value for the location parameter, \( \sigma \) and \( \xi \). A NULL means a value is computed internally. The argument ishape is more important than the other two. If a failure to converge occurs, or even to obtain initial values occurs, try assigning ishape some value (positive or negative; the sign can be very important). Also, in general, a larger value of iscale tends to be better than a smaller value.

imethod

Initialization method. Either the value 1 or 2. If both methods fail then try using ishape. See `CommonVGAMffArguments` for information.

gshape

Numeric vector. The values are used for a grid search for an initial value for \( \xi \). See `CommonVGAMffArguments` for information.

gprobs.y, gscale.mux, iprobs.y

Numeric vectors, used for the initial values. See `CommonVGAMffArguments` for information.

tolshape0

Passed into `dgev` when computing the log-likelihood.

zero

A specifying which linear/additive predictors are modelled as intercepts only. The values can be from the set \{1,2,3\} corresponding respectively to \( \mu, \sigma, \xi \). If `zero = NULL` then all linear/additive predictors are modelled as a linear combination of the explanatory variables. For many data sets having `zero = 3` is a good idea. See `CommonVGAMffArguments` for information.

Details

The GEV distribution function can be written

\[
G(y) = \exp\left(-\left|\frac{(y - \mu)}{\sigma}\right|^{-\frac{1}{\xi}}\right)
\]

where \( \sigma > 0, -\infty < \mu < \infty \), and \( 1 + \xi (y - \mu)/\sigma > 0 \). Here, \( x_+ = \max(x, 0) \). The \( \mu, \sigma, \xi \) are known as the location, scale and shape parameters respectively. The cases \( \xi > 0, \xi < 0, \xi = 0 \) correspond to the Frechet, reverse Weibull, and Gumbel types respectively. It can be noted that the Gumbel (or Type I) distribution accommodates many commonly-used distributions such as the normal, lognormal, logistic, gamma, exponential and Weibull.

For the GEV distribution, the \( k \)th moment about the mean exists if \( \xi < 1/k \). Provided they exist, the mean and variance are given by \( \mu + \sigma \Gamma(1 - \xi - 1)/\xi \) and \( \sigma^2 \{\Gamma(1 - 2\xi) - \Gamma^2(1 - \xi)\}/\xi^2 \) respectively, where \( \Gamma \) is the gamma function.

Smith (1985) established that when \( \xi > -0.5 \), the maximum likelihood estimators are completely regular. To have some control over the estimated \( \xi \) try using lshape = `logofflink(offset = 0.5)`, say, or lshape = `extlogitlink(min = -0.5, max = 0.5)`, say.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`. 
Warning

Currently, if an estimate of $\xi$ is too close to 0 then an error may occur for `gev()` with multivariate responses. In general, `gevff()` is more reliable than `gev()`.

Fitting the GEV by maximum likelihood estimation can be numerically fraught. If $1 + \xi (y - \mu) / \sigma \leq 0$ then some crude evasive action is taken but the estimation process can still fail. This is particularly the case if `vgam` with `s` is used; then smoothing is best done with `vglm` with regression splines (`bs` or `ns`) because `vglm` implements half-stepsizing whereas `vgam` doesn’t (half-stepsizing helps handle the problem of straying outside the parameter space.)

Note

The `VGAM` family function `gev` can handle a multivariate (matrix) response, cf. multiple responses. If so, each row of the matrix is sorted into descending order and NAs are put last. With a vector or one-column matrix response using `gevff` will give the same result but be faster and it handles the $\xi = 0$ case. The function `gev` implements Tawn (1988) while `gevff` implements Prescott and Walden (1980).

Function `egev()` has been replaced by the new family function `gevff()`. It now conforms to the usual `VGAM` philosophy of having $M_1$ linear predictors per (independent) response. This is the usual way multiple responses are handled. Hence `vglm(cbind(y1, y2), ..., gevff, ...)` will have 6 linear predictors and it is possible to constrain the linear predictors so that the answer is similar to `gev()`. Missing values in the response of `gevff()` will be deleted; this behaviour is the same as with almost every other `VGAM` family function.

The shape parameter $\xi$ is difficult to estimate accurately unless there is a lot of data. Convergence is slow when $\xi$ is near $-0.5$. Given many explanatory variables, it is often a good idea to make sure `zero = 3`. The range restrictions of the parameter $\xi$ are not enforced; thus it is possible for a violation to occur.

Successful convergence often depends on having a reasonably good initial value for $\xi$. If failure occurs try various values for the argument `ishape`, and if there are covariates, having `zero = 3` is advised.

Author(s)

T. W. Yee

References


The Generalized Extreme Value Distribution

Description
Density, distribution function, quantile function and random generation for the generalized extreme value distribution (GEV) with location parameter location, scale parameter scale and shape parameter shape.

Usage

dgev(x, location = 0, scale = 1, shape = 0, log = FALSE, tolshape0 = sqrt(.Machine$double.eps))
pgev(q, location = 0, scale = 1, shape = 0, lower.tail = TRUE, log.p = FALSE)
qgev(p, location = 0, scale = 1, shape = 0, lower.tail = TRUE, log.p = FALSE)
rgev(n, location = 0, scale = 1, shape = 0)
Arguments

\( x, q \)  
vector of quantiles.

\( p \)  
vector of probabilities.

\( n \)  
number of observations. If \( \text{length}(n) > 1 \) then the length is taken to be the number required.

location  
the location parameter \( \mu \).

scale  
the (positive) scale parameter \( \sigma \). Must consist of positive values.

shape  
the shape parameter \( \xi \).

log  
Logical. If \( \text{log} = \text{TRUE} \) then the logarithm of the density is returned.

lower.tail, log.p  
Same meaning as in \text{punif} or \text{qunif}.

tolshape0  
Positive numeric. Threshold/tolerance value for resting whether \( \xi \) is zero. If the absolute value of the estimate of \( \xi \) is less than this value then it will be assumed zero and a Gumbel distribution will be used.

Details

See \text{gev}, the \text{VGAM} family function for estimating the 3 parameters by maximum likelihood estimation, for formulae and other details. Apart from \( n \), all the above arguments may be vectors and are recycled to the appropriate length if necessary.

Value

d\text{gev} gives the density, p\text{gev} gives the distribution function, q\text{gev} gives the quantile function, and r\text{gev} generates random deviates.

Note

The default value of \( \xi = 0 \) means the default distribution is the Gumbel.

Currently, these functions have different argument names compared with those in the \text{evd} package.

Author(s)

T. W. Yee

References


See Also

\text{gev}, \text{gevff}, \text{vglm.control}.
Examples

```r
loc <- 2; sigma <- 1; xi <- -0.4
pgev(qgev(seq(0.05, 0.95, by = 0.05), loc, sigma, xi), loc, sigma, xi)
## Not run: x <- seq(loc - 3, loc + 3, by = 0.01)
plot(x, dgev(x, loc, sigma, xi), type = "l", col = "blue", ylim = c(0, 1),
     main = "Blue is density, orange is the CDF",
     sub = "Purple are 10,...,90 percentiles", ylab = "", las = 1)
abline(h = 0, col = "blue", lty = 2)
lines(qgev(seq(0.1, 0.9, by = 0.1), loc, sigma, xi),
      dgev(qgev(seq(0.1, 0.9, by = 0.1), loc, sigma, xi), loc, sigma, xi),
      col = "purple", lty = 3, type = "h")
lines(x, pgev(x, loc, sigma, xi), type = "l", col = "orange")
abline(h = (0:10)/10, lty = 2, col = "gray50")
## End(Not run)
```

gew General Electric and Westinghouse Data

Description

General Electric and Westinghouse capital data.

Usage

data(gew)

Format

A data frame with 20 observations on the following 7 variables. All variables are numeric vectors. Variables ending in .g correspond to General Electric and those ending in .w are Westinghouse.

- **year** The observations are the years from 1934 to 1953
- **invest.g, invest.w** investment figures. These are \( I = \text{Gross investment} = \text{additions to plant and equipment plus maintenance and repairs in millions of dollars deflated by } P_1. \)
- **capital.g, capital.w** capital stocks. These are \( C = \text{The stock of plant and equipment} = \text{accumulated sum of net additions to plant and equipment deflated by } P_1 \) minus depreciation allowance deflated by \( P_3. \)
- **value.g, value.w** market values. These are \( F = \text{Value of the firm} = \text{price of common and preferred shares at December 31 (or average price of December 31 and January 31 of the following year) times number of common and preferred shares outstanding plus total book value of debt at December 31 in millions of dollars deflated by } P_2. \)
Details

These data are a subset of a table in Boot and de Wit (1960), also known as the Grunfeld data. It is
used a lot in econometrics, e.g., for seemingly unrelated regressions (see SURff).

Here, $P_1 =$ Implicit price deflator of producers durable equipment (base 1947), $P_2 =$ Implicit price
deflator of G.N.P. (base 1947), $P_3 =$ Depreciation expense deflator = ten years moving average of
wholesale price index of metals and metal products (base 1947).

Source

Table 10 of: Boot, J. C. G. and de Wit, G. M. (1960) Investment Demand: An Empirical Contri-


References


See Also

SURff, http://statmath.wu.ac.at/~zeileis/grunfeld (the link might now be stale).

Examples

str(gew)

---

goffset  GAITD Offset for the GTE Method

Description

Utility function to create a matrix of log-offset values, to help facilitate the Generally-Truncated-
Expansion method

Usage

goffset(mux, n,
    a.mix = NULL, i.mix = NULL, d.mix = NULL,
    a.mlm = NULL, i.mlm = NULL, d.mlm = NULL, par1or2 = 1)
Arguments

- **mux**: Multiplier. Usually a small positive integer. Must be positive. The value 1 means no change.
- **n**: Number of rows. A positive integer, it should be the number of rows of the data frame containing the data.
- **a.mix, i.mix, d.mix**: See, e.g., `gaitdpoisson`.
- **a.mlm, i.mlm, d.mlm**: See, e.g., `gaitdpoisson`.
- **par1or2**: Number of parameters of the parent distribution. Set `par1or2 = 2` for `gaitdnbinomial`, else the default value should be used.

Details

This function is intended to make the Generally-Truncated-Expansion (GTE) method easier for the user. It only makes sense if the linear predictors(s) are log of the mean of the parent distribution, which is the usual case for `gaitdpoisson` and `gaitdnbinomial`. However, for `gaitdlog` and `gaitdzeta` one should be using `logffMlink` and `zetaffMlink`.

Without this function, the user must do quite a lot of book-keeping to know which columns of the offset matrix is to be assigned `log(mux)`. This can be rather laborious.

In the fictitional example below the response is underdispersed with respect to a Poisson distribution and doubling the response achieves approximate equidispersion.

Value

A matrix with `n` rows and the same number of columns that a GAITD regression would produce for its matrix of linear predictors. The matrix can be inputted into `vglm` by assigning the offset argument.

Note

This function is still in a developmental stage. The order of the arguments might change, hence it’s safest to invoke it with full specification.

See Also

`gaitdpoisson`, `gaitdlog`, `gaitdzeta`, `gaitdnbinomial`, `Trunc`, `offset`.

Examples

```r
i.mix <- c(5, 10, 15, 20); a.mlm <- 13; mymux <- 2
i.offset(mymux, 10, i.mix = i.mix, a.mlm = a.mlm)
## Not run: org1 <- with(gdata, range(y)) # Original range of the data
glm(mymux * y ~ 1, offset = offset(mymux, nrow(gdata), i.mix = i.mix, a.mlm = a.mlm),
gaitdpoisson(a.mlm = mymux * a.mlm, i.mix = mymux * i.mix,
            truncate = Trunc(org1, mymux)),
data = gdata)
```
Gompertz

Description

Density, cumulative distribution function, quantile function and random generation for the Gompertz distribution.

Usage

dgompertz(x, scale = 1, shape, log = FALSE)
pgompertz(q, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
qgompertz(p, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
rgompertz(n, scale = 1, shape)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. Same as in runif.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.
scale, shape positive scale and shape parameters.

Details

See gompertz for details.

Value

dgompertz gives the density, pgompertz gives the cumulative distribution function, qgompertz gives the quantile function, and rgompertz generates random deviates.

Author(s)

T. W. Yee and Kai Huang

See Also

gompertz, dgumbel, dmakeham.
Examples

```r
probs <- seq(0.01, 0.99, by = 0.01)
Shape <- exp(1); Scale <- exp(1)
max(abs(pgompertz(qgompertz(p = probs, Scale, shape = Shape),
Scale, shape = Shape) - probs)) # Should be 0

## Not run: x <- seq(-0.1, 1.0, by = 0.001)
plot(x, dgompertz(x, Scale,shape = Shape), type = "l", las = 1,
main = "Blue is density, orange is the CDF", col = "blue",
sub = "Purple lines are the 10,20,...,90 percentiles",
ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(x, pgompertz(x, Scale, shape = Shape), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qgompertz(probs, Scale, shape = Shape)
lines(Q, dgompertz(Q, Scale, shape = Shape), col = "purple",
lty = 3, type = "h")
pgompertz(Q, Scale, shape = Shape) - probs # Should be all zero
abline(h = probs, col = "purple", lty = 3)
## End(Not run)
```

gompertz  

**Gompertz Regression Family Function**

Description

Maximum likelihood estimation of the 2-parameter Gompertz distribution.

Usage

```r
gompertz(lscalescale = "loglink", lshape = "loglink",
iscale = NULL, ishape = NULL,
nsimEIM = 500, zero = NULL, nowarning = FALSE)
```

Arguments

- `nowarning` Logical. Suppress a warning? Ignored for **VGAM** 0.9-7 and higher.
- `lscale, lshape` Parameter link functions applied to the shape parameter \(a\), scale parameter \(\beta\).
  - All parameters are positive. See **Links** for more choices.
- `ishape, iscale` Optional initial values. A **NULL** means a value is computed internally.
- `nsimEIM, zero` See **CommonVGAMffArguments**.

Details

The Gompertz distribution has a cumulative distribution function

\[
F(x; \alpha, \beta) = 1 - \exp\left[-(\alpha/\beta) \times (\exp(\beta x) - 1)\right]
\]
which leads to a probability density function

\[ f(x; \alpha, \beta) = \alpha \exp(\beta x) \exp[-(\alpha/\beta) \times (\exp(\beta x) - 1)] \]

for \( \alpha > 0, \beta > 0, x > 0 \). Here, \( \beta \) is called the scale parameter scale, and \( \alpha \) is called the shape parameter (one could refer to \( \alpha \) as a location parameter and \( \beta \) as a shape parameter—see Lenart (2014)). The mean is involves an exponential integral function. Simulated Fisher scoring is used and multiple responses are handled.

The Makeham distribution has an additional parameter compared to the Gompertz distribution. If \( X \) is defined to be the result of sampling from a Gumbel distribution until a negative value \( Z \) is produced, then \( X = -Z \) has a Gompertz distribution.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

The same warnings in makeham apply here too.

Author(s)

T. W. Yee

References


See Also
dgompertz, makeham, simulate.vlm.

Examples

```r
## Not run:
gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, eta1 = -1,
                   eta2 = -1 + 0.2 * x2,
                   ceta1 = 1,
                   ceta2 = -1 + 0.2 * x2)
gdata <- transform(gdata, shape1 = exp(eta1),
                   shape2 = exp(eta2),
                   scale1 = exp(ceta1),
                   scale2 = exp(ceta2))
gdata <- transform(gdata, y1 = rgompertz(nn, scale = scale1, shape = shape1),
                   y2 = rgompertz(nn, scale = scale2, shape = shape2))
fit1 <- vglm(y1 ~ 1, gompertz, data = gdata, trace = TRUE)
fit2 <- vglm(y2 ~ x2, gompertz, data = gdata, trace = TRUE)
```
gpd

Generalized Pareto Distribution Regression Family Function

Description

Maximum likelihood estimation of the 2-parameter generalized Pareto distribution (GPD).

Usage

gpd(threshold = 0, lscale = "loglink", lshape = logofflink(offset = 0.5), percentiles = c(90, 95), iscale = NULL, ishape = NULL, toshape0 = 0.001, type.fitted = c("percentiles", "mean"), imethod = 1, zero = "shape")

Arguments

threshold Numeric, values are recycled if necessary. The threshold value(s), called \( \mu \) below.
lscale Parameter link function for the scale parameter \( \sigma \). See Links for more choices.
lshape Parameter link function for the shape parameter \( \xi \). See Links for more choices. The default constrains the parameter to be greater than \(-0.5\) because if \( \xi \leq -0.5 \) then Fisher scoring does not work. See the Details section below for more information. For the shape parameter, the default logofflink link has an offset called \( A \) below; and then the second linear/additive predictor is \( \log(\xi + A) \) which means that \( \xi > -A \). The working weight matrices are positive definite if \( A = 0.5 \).
percentiles Numeric vector of percentiles used for the fitted values. Values should be between 0 and 100. See the example below for illustration. This argument is ignored if type.fitted = "mean".
type.fitted See CommonVGAMffArguments for information. The default is to use the percentiles argument. If "mean" is chosen, then the mean \( \mu + \sigma/(1 - \xi) \) is returned as the fitted values, and these are only defined for \( \xi < 1 \).
iscale, ishape Numeric. Optional initial values for \( \sigma \) and \( \xi \). The default is to use imethod and compute a value internally for each parameter. Values of ishape should be between \(-0.5\) and 1. Values of iscale should be positive.
toshape0 Passed into dgpd when computing the log-likelihood.
Method of initialization, either 1 or 2. The first is the method of moments, and the second is a variant of this. If neither work, try assigning values to arguments `ishape` and/or `iscale`.

`zero` can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. For one response, the value should be from the set \{1,2\} corresponding respectively to \(\sigma\) and \(\xi\). It is often a good idea for the \(\sigma\) parameter only to be modelled through a linear combination of the explanatory variables because the shape parameter is probably best left as an intercept only: `zero = 2`. Setting `zero = NULL` means both parameters are modelled with explanatory variables. See `CommonVGAMffArguments` for more details.

**Details**

The distribution function of the GPD can be written

\[
G(y) = 1 - \left[1 + \frac{\xi(y - \mu)}{\sigma}\right]^{-1/\xi}
\]

where \(\mu\) is the location parameter (known, with value `threshold`), \(\sigma > 0\) is the scale parameter, \(\xi\) is the shape parameter, and \(h_+ = \max(h, 0)\). The function \(1 - G\) is known as the *survivor function*. The limit \(\xi \to 0\) gives the *shifted exponential* as a special case:

\[
G(y) = 1 - \exp\left[-\frac{(y - \mu)}{\sigma}\right].
\]

The support is \(y > \mu\) for \(\xi > 0\), and \(\mu < y < \mu - \sigma/\xi\) for \(\xi < 0\).

Smith (1985) showed that if \(\xi \leq -0.5\) then this is known as the nonregular case and problems/difficulties can arise both theoretically and numerically. For the (regular) case \(\xi > -0.5\) the classical asymptotic theory of maximum likelihood estimators is applicable; this is the default.

Although for \(\xi < -0.5\) the usual asymptotic properties do not apply, the maximum likelihood estimator generally exists and is superefficient for \(-1 < \xi < -0.5\), so it is “better” than normal. When \(\xi < -1\) the maximum likelihood estimator generally does not exist as it effectively becomes a two parameter problem.

The mean of \(Y\) does not exist unless \(\xi < 1\), and the variance does not exist unless \(\xi < 0.5\). So if you want to fit a model with finite variance use `lshape = "extlogitlink"`.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`. However, for this VGAM family function, `vglm` is probably preferred over `vgam` when there is smoothing.

**Warning**

Fitting the GPD by maximum likelihood estimation can be numerically fraught. If \(1 + \frac{\xi(y - \mu)}{\sigma} \leq 0\) then some crude evasive action is taken but the estimation process can still fail. This is particularly the case if `vgam` with `s` is used. Then smoothing is best done with `vglm` with regression splines (bs or ns) because `vglm` implements half-stepsizing whereas `vgam` doesn’t. Half-stepsizing helps handle the problem of straying outside the parameter space.
Note

The response in the formula of \texttt{vglm} and \texttt{vgam} is $y$. Internally, $y - \mu$ is computed. This \texttt{VGAM} family function can handle a multiple responses, which is inputted as a matrix. The response stored on the object is the original uncentred data.

With functions \texttt{rgpd}, \texttt{dgpd}, etc., the argument location matches with the argument threshold here.

Author(s)

T. W. Yee

References


See Also

\texttt{rgpd}, \texttt{meplot}, \texttt{gev}, \texttt{paretoff}, \texttt{vglm}, \texttt{vgam}, \texttt{s}.

Examples

```r
# Simulated data from an exponential distribution (xi = 0)
Threshold <- 0.5
gdata <- data.frame(y1 = Threshold + rexp(n = 3000, rate = 2))
fit <- vglm(y1 ~ 1, gpd(threshold = Threshold), data = gdata, trace = TRUE)
head(fitted(fit))
summary(depvar(fit)) # The original uncentred data
coef(fit, matrix = TRUE) # xi should be close to 0
Coef(fit)
summary(fit)

head(fit@extra$threshold) # Note the threshold is stored here

# Check the 90 percentile
ii <- depvar(fit) < fitted(fit)[1, "90%"]
100 * table(ii) / sum(table(ii)) # Should be 90%

# Check the 95 percentile
ii <- depvar(fit) < fitted(fit)[1, "95%"]
100 * table(ii) / sum(table(ii)) # Should be 95%

## Not run: plot(depvar(fit), col = "blue", las = 1,
main = "Fitted 90% and 95% quantiles")
matlines(1:length(depvar(fit)), fitted(fit), lty = 2:3, lwd = 2)
## End(Not run)
```
# Another example

gdata <- data.frame(x2 = runif(nn <- 2000))
Threshold <- 0; xi <- exp(-0.8) - 0.5
gdata <- transform(gdata, y2 = rgpd(nn, scale = exp(1 + 0.1*x2), shape = xi))
fit <- vglm(y2 ~ x2, gpd(Threshold), data = gdata, trace = TRUE)
coef(fit, matrix = TRUE)

## Not run: # Nonparametric fits
# Not so recommended:
fit1 <- vgam(y2 ~ s(x2), gpd(Threshold), data = gdata, trace = TRUE)
par(mfrow = c(2, 1))
plot(fit1, se = TRUE, scol = "blue")
# More recommended:
fit2 <- vglm(y2 ~ sm.bs(x2), gpd(Threshold), data = gdata, trace = TRUE)
plot(as(fit2, "vgam"), se = TRUE, scol = "blue")
## End(Not run)

---

**The Generalized Pareto Distribution**

**Description**

Density, distribution function, quantile function and random generation for the generalized Pareto distribution (GPD) with location parameter location, scale parameter scale and shape parameter shape.

**Usage**

```r
dgpd(x, location = 0, scale = 1, shape = 0, log = FALSE, tolshape0 = sqrt(.Machine$double.eps))
pgpd(q, location = 0, scale = 1, shape = 0, lower.tail = TRUE, log.p = FALSE)
qgpd(p, location = 0, scale = 1, shape = 0, lower.tail = TRUE, log.p = FALSE)
rgpd(n, location = 0, scale = 1, shape = 0)
```

**Arguments**

- **x, q** vector of quantiles.
- **p** vector of probabilities.
- **n** number of observations. If `length(n) > 1` then the length is taken to be the number required.
- **location** the location parameter \( \mu \).
- **scale** the (positive) scale parameter \( \sigma \).
shape  
the shape parameter $\xi$.

log  
Logical. If log = TRUE then the logarithm of the density is returned.

lower.tail, log.p  
Same meaning as in punif or qunif.

tol.shape0  
Positive numeric. Threshold/tolerance value for resting whether $\xi$ is zero. If the absolute value of the estimate of $\xi$ is less than this value then it will be assumed zero and an exponential distribution will be used.

Details

See gpd, the VGAM family function for estimating the two parameters by maximum likelihood estimation, for formulae and other details. Apart from n, all the above arguments may be vectors and are recyled to the appropriate length if necessary.

Value

dgpd gives the density, pgpd gives the distribution function, qgpd gives the quantile function, and rgpd generates random deviates.

Note

The default values of all three parameters, especially $\xi = 0$, means the default distribution is the exponential.

Currently, these functions have different argument names compared with those in the evd package.

Author(s)

T. W. Yee and Kai Huang

References


See Also

gpd, Exponential.

Examples

```r
## Not run:
loc <- 2; sigma <- 1; xi <- -0.4
x <- seq(loc - 0.2, loc + 3, by = 0.01)
plot(x, dgpd(x, loc, sigma, xi), type = "l", col = "blue",
     main = "Blue is density, red is the CDF", ylim = c(0, 1),
     sub = "Purple are 5,10,...,95 percentiles", ylab = "", las = 1)
abline(h = 0, col = "blue", lty = 2)
lines(qgpd(seq(0.05, 0.95, by = 0.05), loc, sigma, xi),
      dgpd(qgpd(seq(0.05, 0.95, by = 0.05), loc, sigma, xi), loc, sigma, xi),
      col = "purple", lty = 3, type = "h")
lines(x, pgpd(x, loc, sigma, xi), type = "l", col = "red")
```
## Description

A 4-column matrix.

## Usage

data(grain.us)

## Format

The columns are:

- `wheat.flour` numeric
- `corn` numeric
- `wheat` numeric
- `rye` numeric

## Details

Monthly averages of grain prices in the United States for wheat flour, corn, wheat, and rye for the period January 1961 through October 1972. The units are US dollars per 100 pound sack for wheat flour, and per bushel for corn, wheat and rye.

## Source


## References


## Examples

```r
## Not run:
cgrain <- scale(grain.us, scale = FALSE)  # Center the time series only
fit <- vglm(cgrain ~ 1, rrar(Rank = c(4, 1)),
            epsilon = 1e-3, stepsize = 0.5, trace = TRUE, maxit = 50)
summary(fit)
## End(Not run)
```
Row-Column Interaction Models including Goodman’s RC Association Model and Unconstrained Quadratic Ordination

Description

Fits a Goodman’s RC association model (GRC) to a matrix of counts, and more generally, row-column interaction models (RCIMs). RCIMs allow for unconstrained quadratic ordination (UQO).

Usage

```r
grc(y, Rank = 1, Index.corner = 2:(1 + Rank),
    str0 = 1, summary.arg = FALSE, h.step = 1e-04, ...)
rcim(y, family = poissonff, Rank = 0, M1 = NULL,
    weights = NULL, which.linpred = 1,
    Index.corner = ifelse(is.null(str0), 0, max(str0)) + 1:Rank,
    rprefix = "Row.", cprefix = "Col.", iprefix = "X2.",
    offset = 0, str0 = if (Rank) 1 else NULL,
    summary.arg = FALSE, h.step = 0.0001,
    rbaseline = 1, cbaseline = 1,
    has.intercept = TRUE, M = NULL, rindex = 2:nrow(y),
    cindex = 2:ncol(y), iindex = 2:nrow(y), ...)
```

Arguments

- **y**  
  For `grc()`: a matrix of counts. For `rcim()`: a general matrix response depending on `family`. Output from `table()` is acceptable; it is converted into a matrix. Note that `y` should be at least 3 by 3 in dimension.

- **family**  
  A VGAM family function. By default, the first linear/additive predictor is fitted using main effects plus an optional rank-Rank interaction term. Not all family functions are suitable or make sense. All other linear/additive predictors are fitted using an intercept-only, so it has a common value over all rows and columns. For example, `zipoissonff` may be suitable for counts but not `zipoisson` because of the ordering of the linear/additive predictors. If the VGAM family function does not have an `infos` slot then `M1` needs to be inputted (the number of linear predictors for an ordinary (usually univariate) response, aka `M`). The VGAM family function also needs to be able to handle multiple responses (currently not all of them can do this).

- **Rank**  
  An integer from the set \{0,...,\min(nrow(y), ncol(y))\}. This is the dimension of the fit in terms of the interaction. For `grc()` this argument must be positive. A value of 0 means no interactions (i.e., main effects only); each row and column is represented by an indicator variable.

- **weights**  
  Prior weights. Fed into `rrvglm` or `vglm`.

- **which.linpred**  
  Single integer. Specifies which linear predictor is modelled as the sum of an intercept, row effect, column effect plus an optional interaction term. It should be one value from the set 1:M1.
Index.corner A vector of Rank integers. These are used to store the Rank by Rank identity matrix in the A matrix; corner constraints are used.

rprefix, cprefix, iprefix Character, for rows and columns and interactions respectively. For labelling the indicator variables.

offset Numeric. Either a matrix of the right dimension, else a single numeric expanded into such a matrix.

str0 Ignored if Rank = 0, else an integer from the set \{1,...,min(nrow(y), ncol(y))\}, specifying the row that is used as the structural zero. Passed into rrvglm.control if Rank > 0. Set str0 = NULL for none.

summary.arg Logical. If TRUE then a summary is returned. If TRUE then y may be the output (fitted object) of grc().

h.step A small positive value that is passed into summary.rrvglm(). Only used when summary.arg = TRUE.

... Arguments that are passed into rrvglm.control().

M1 The number of linear predictors of the VGAM family function for an ordinary (univariate) response. Then the number of linear predictors of the rcim() fit is usually the number of columns of y multiplied by M1. The default is to evaluate the infos slot of the VGAM family function to try to evaluate it; see vglmff-class. If this information is not yet supplied by the family function then the value needs to be inputted manually using this argument.

rbaseline, cbaseline Baseline reference levels for the rows and columns. Currently stored on the object but not used.

has.intercept Logical. Include an intercept?

M, cindex M is the usual VGAM M, viz. the number of linear/additive predictors in total. Also, cindex means column index, and these point to the columns of y which are part of the vector of linear/additive predictor main effects. For family = multinomial it is necessary to input these arguments as M = ncol(y)-1 and cindex = 2:(ncol(y)-1).

rindex, iindex rindex means row index, and these are similar to cindex. iindex means interaction index, and these are similar to cindex.

Details

Goodman’s RC association model fits a reduced-rank approximation to a table of counts. A Poisson model is assumed. The log of each cell mean is decomposed as an intercept plus a row effect plus a column effect plus a reduced-rank component. The latter can be collectively written $A \times C$, the product of two ‘thin’ matrices. Indeed, A and C have Rank columns. By default, the first column and row of the interaction matrix $A \times C$ is chosen to be structural zeros, because str0 = 1. This means the first row of A are all zeros.

This function uses options()$contrasts to set up the row and column indicator variables. In particular, Equation (4.5) of Yee and Hastie (2003) is used. These are called Row. and Col. (by default) followed by the row or column number.
The function `rcim()` is more general than `grc()`. Its default is a no-interaction model of `grc()`, i.e., rank-0 and a Poisson distribution. This means that each row and column has a dummy variable associated with it. The first row and first column are baseline. The power of `rcim()` is that many **VGAM** family functions can be assigned to its `family` argument. For example, `uninormal` fits something in between a 2-way ANOVA with and without interactions, `alaplace2` with Rank = 0 is something like `medpolish`. Others include `zipoissonff` and `negbinomial`. Hopefully one day all **VGAM** family functions will work when assigned to the `family` argument, although the result may not have meaning.

**Unconstrained quadratic ordination** (UQO) can be performed using `rcim()` and `grc()`. This has been called **unconstrained Gaussian ordination** in the literature, however the word **Gaussian** has two meanings which is confusing; it is better to use **quadratic** because the bell-shape response surface is meant. UQO is similar to CQO (cqo) except there are no environmental/explanatory variables. Here, a GLM is fitted to each column (species) that is a quadratic function of hypothetical latent variables or gradients. Thus each row of the response has an associated site score, and each column of the response has an associated optimum and tolerance matrix. UQO can be performed here under the assumption that all species have the same tolerance matrices. See Yee and Hadi (2014) for details. It is not recommended that presence/absence data be inputted because the information content is so low for each site-species cell. The example below uses Poisson counts.

**Value**

An object of class "grc", which currently is the same as an "rrvglm" object. Currently, a rank-0 `rcim()` object is of class `rcim0-class`, else of class "rcim" (this may change in the future).

**Warning**

The function `rcim()` is experimental at this stage and may have bugs. Quite a lot of expertise is needed when fitting and in its interpretation thereof. For example, the constraint matrices applies the reduced-rank regression to the first (see `which.linpred`) linear predictor and the other linear predictors are intercept-only and have a common value throughout the entire data set. This means that, by default, `family = zipoissonff` is appropriate but not `family = zipoisson`. Else set `family = zipoisson` and `which.linpred = 2`. To understand what is going on, do examine the constraint matrices of the fitted object, and reconcile this with Equations (4.3) to (4.5) of Yee and Hastie (2003).

The functions temporarily create a permanent data frame called `.grc.df` or `.rcim.df`, which used to be needed by `summary.rrvglm()`. Then these data frames are deleted before exiting the function. If an error occurs then the data frames may be present in the workspace.

**Note**

These functions set up the indicator variables etc. before calling `rrvglm` or `vglm`. The ... is passed into `rrvglm.control` or `vglm.control`, This means, e.g., Rank = 1 is default for `grc()`.

The data should be labelled with `rownames` and `colnames`. Setting `trace = TRUE` is recommended to monitor convergence. Using `criterion = "coefficients"` can result in slow convergence.

If `summary = TRUE` then `y` can be a "grc" object, in which case a summary can be returned. That is, `grc(y, summary = TRUE)` is equivalent to `summary(grc(y))`. It is not possible to plot a `grc(y, summary = TRUE)` or `rcim(y, summary = TRUE)` object.
Author(s)

Thomas W. Yee, with assistance from Alfian F. Hadi.

References


See Also

`rrvglm`, `rrvglm.control`, `rrvglm-class`, `summary.grc`, `moffset`, `Rcim`, `Select`, `Qvar`, `plotrcim0`, `cqo`, `multinomial`, `alcoff`, `crashi`, `auuc`, `olym08`, `olym12`, `poissonff`, `medpolish`.

Examples

```r
# Example 1: Undergraduate enrolments at Auckland University in 1990
fitted(grc1 <- grc(auuc))
summary(grc1)

grc2 <- grc(auuc, Rank = 2, Index.corner = c(2, 5))
fitted(grc2)
summary(grc2)

model3 <- rcim(auuc, Rank = 1, fam = multinomial,
                M = ncol(auuc)-1, cindex = 2:(ncol(auuc)-1), trace = TRUE)
fitted(model3)
summary(model3)

# Median polish but not 100 percent reliable. Maybe call alaplace2()...
## Not run:
rcim0 <- rcim(auuc, fam = alaplace1(tau = 0.5), trace=FALSE, maxit = 500)
round(fitted(rcim0), digits = 0)
round(100 * (fitted(rcim0) - auuc) / auuc, digits = 0) # Discrepancy
depvar(rcim0)
round(coef(rcim0, matrix = TRUE), digits = 2)
Coef(rcim0, matrix = TRUE)
# constraints(rcim0)
names(constraints(rcim0))

# Compare with medpolish():
(med.a <- medpolish(auuc))
fv <- med.a$overall + outer(med.a$row, med.a$col, "+")
round(100 * (fitted(rcim0) - fv) / fv) # Hopefully should be all 0s

## End(Not run)
```
# Example 2: 2012 Summer Olympic Games in London
## Not run: top10 <- head(olymp12, 10)
grc1.oly12 <- with(top10, grc(cbind(gold, silver, bronze)))
round(fitted(grc1.oly12))
round(resid(grc1.oly12, type = "response"), digits = 1)  # Resp. resids
summary(grc1.oly12)
Coef(grc1.oly12)
## End(Not run)

# Example 3: UQO; see Yee and Hadi (2014)
## Not run:
n <- 100; p <- 5; S <- 10
pdata <- rcqo(n, p, S, es.opt = FALSE, eq.max = FALSE,
  eq.tol = TRUE, sd.latvar = 0.75)  # Poisson counts
true.nu <- attr(pdata, "latvar")  # The 'truth'; site scores
attr(pdata, "tolerances")  # The 'truth'; tolerances
Y <- Select(pdata, "y", sort = FALSE)  # Y matrix (n x S); the "y" vars
uqo.rcim1 <- rcim(Y, Rank = 1,
  str0 = NULL,  # Delta covers entire n x M matrix
  iindex = 1:nrow(Y),  # RRR covers the entire Y
  has.intercept = FALSE)  # Suppress the intercept

# Plot 1
par(mfrow = c(2, 2))
plot(attr(pdata, "optimums"), Coef(uqo.rcim1)@A,
  col = "blue", type = "p", main = "(a) UQO optimums",
  xlab = "True optimums", ylab = "Estimated (UQO) optimums")
mylm <- lm(Coef(uqo.rcim1)@A ~ attr(pdata, "optimums"))
abline(coef = coef(mylm), col = "orange", lty = "dashed")

# Plot 2
fill.val <- NULL  # Choose this for the new parameterization
plot(attr(pdata, "latvar"), c(fill.val, concoef(uqo.rcim1)),
  las = 1, col = "blue", type = "p", main = "(b) UQO site scores",
  xlab = "True site scores", ylab = "Estimated (UQO) site scores")
mylm1 <- lm(c(fill.val, concoef(uqo.rcim1)) ~ attr(pdata, "latvar"))
abline(coef = coef(mylm1), col = "orange", lty = "dashed")

# Plots 3 and 4
myform <- attr(pdata, "formula")
plut <- cqo(myform, family = poissonff,
  eq.tol = FALSE, trace = FALSE, data = pdata)
clut <- cqo(Select(pdata, "y", sort = FALSE) ~ scale(latvar(uqo.rcim1)),
  family = poissonff, eq.tol = FALSE, trace = FALSE, data = pdata)
lvplot(plut, lcol = 1:S, y = TRUE, pcol = 1:S, pch = 1:S, pcex = 0.5,
  main = "(c) CQO fitted to the original data",
  xlab = "Estimated (CQO) site scores")
lvplot(clut, lcol = 1:S, y = TRUE, pcol = 1:S, pch = 1:S, pcex = 0.5,
gumbel

Gumbel Regression Family Function

Description

Maximum likelihood estimation of the 2-parameter Gumbel distribution.

Usage

```
gumbel(llocation = "identitylink", lscale = "loglink", 
iscale = NULL, R = NA, percentiles = c(95, 99), 
mpv = FALSE, zero = NULL)
gumbelff(llocation = "identitylink", lscale = "loglink", 
iscale = NULL, R = NA, percentiles = c(95, 99), 
zero = "scale", mpv = FALSE)
```

Arguments

- `llocation, lscale` Parameter link functions for $\mu$ and $\sigma$. See Links for more choices.
- `iscale` Numeric and positive. Optional initial value for $\sigma$. Recycled to the appropriate length. In general, a larger value is better than a smaller value. A NULL means an initial value is computed internally.
- `R` Numeric. Maximum number of values possible. See Details for more details.
- `percentiles` Numeric vector of percentiles used for the fitted values. Values should be between 0 and 100. This argument uses the argument $R$ if assigned. If `percentiles = NULL` then the mean will be returned as the fitted values.
- `mpv` Logical. If `mpv = TRUE` then the median predicted value (MPV) is computed and returned as the (last) column of the fitted values. This argument is ignored if `percentiles = NULL`. See Details for more details.
- `zero` A vector specifying which linear/additive predictors are modelled as intercepts only. The value (possibly values) can be from the set {1, 2} corresponding respectively to $\mu$ and $\sigma$. By default all linear/additive predictors are modelled as a linear combination of the explanatory variables. See CommonVGAMffArguments for more details.
Details
The Gumbel distribution is a generalized extreme value (GEV) distribution with shape parameter \( \xi = 0 \). Consequently it is more easily estimated than the GEV. See \texttt{gev} for more details.

The quantity \( R \) is the maximum number of observations possible, for example, in the Venice data below, the top 10 daily values are recorded for each year, therefore \( R = 365 \) because there are about 365 days per year. The MPV is the value of the response such that the probability of obtaining a value greater than the MPV is 0.5 out of \( R \) observations. For the Venice data, the MPV is the sea level such that there is an even chance that the highest level for a particular year exceeds the MPV. If \texttt{mpv = TRUE} then the column labelled "MPV" contains the MPVs when \texttt{fitted()} is applied to the fitted object.

The formula for the mean of a response \( Y \) is \( \mu + \sigma \times Euler \) where \( Euler \) is a constant that has value approximately equal to 0.5772. The formula for the percentiles are (if \( R \) is not given) \( \mu - \sigma \times \log[\log(1 - P/100)] \) where \( P \) is the percentile argument value(s). If \( R \) is given then the percentiles are \( \mu - \sigma \times \log[R(1 - P/100)] \).

Value
An object of class "\texttt{vglmXf}" (see \texttt{vglmXf-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning
When \( R \) is not given (the default) the fitted percentiles are that of the data, and not of the overall population. For example, in the example below, the 50 percentile is approximately the running median through the data, however, the data are the highest sea level measurements recorded each year (it therefore equates to the median predicted value or MPV).

Note
Like many other usual VGAM family functions, \texttt{gumbelff()} handles (independent) multiple responses.
\texttt{gumbel()} can handle more of a multivariate response, i.e., a matrix with more than one column. Each row of the matrix is sorted into descending order. Missing values in the response are allowed but require \texttt{na.action = na.pass}. The response matrix needs to be padded with any missing values. With a multivariate response one has a matrix \( y \), say, where \( y[1, 2] \) contains the second order statistics, etc.

Author(s)
T. W. Yee

References


See Also

rgumbel, dgumbelII, cens.gumbel, guplot, gev, gevff, venice.

Examples

# Example 1: Simulated data
gdata <- data.frame(y1 = rgumbel(n = 1000, loc = 100, scale = exp(1)))
fit1 <- vglm(y1 ~ 1, gumbelff(perc = NULL), data = gdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
head(fitted(fit1))
with(gdata, mean(y1))

# Example 2: Venice data
(fit2 <- vglm(cbind(r1, r2, r3, r4, r5) ~ year, data = venice,
gumbel(R = 365, mpv = TRUE), trace = TRUE))
head(fitted(fit2))
coef(fit2, matrix = TRUE)
sqrt(diag(vcov(summary(fit2)))) # Standard errors

# Example 3: Try a nonparametric fit ---------------------
# Use the entire data set, including missing values
# Same as as.matrix(venice[, paste0("r", 1:10)]):
Y <- Select(venice, "r", sort = FALSE)
fit3 <- vgam(Y ~ s(year, df = 3), gumbel(R = 365, mpv = TRUE),
data = venice, trace = TRUE, na.action = na.pass)
depvar(fit3)[4:5, ] # NAs used to pad the matrix

# Not run: # Plot the component functions
par(mfrow = c(2, 3), mar = c(6, 4, 1, 2) + 0.3, xpd = TRUE)
plot(fit3, se = TRUE, lcol = "blue", scl = "limegreen", lty = 1,
lwd = 2, slwd = 2, slty = "dashed")

# Quantile plot --- plots all the fitted values
qtplot(fit3, mpv = TRUE, lcol = c(1, 2, 5), tcol = c(1, 2, 5), lwd = 2,
pcol = "blue", tadj = 0.1, ylab = "Sea level (cm)"

# Plot the 99 percentile only
year <- venice["year""]
matplot(year, Y, ylab = "Sea level (cm)", type = "n")
matpoints(year, Y, pch = "*", col = "blue")
lines(year, fitted(fit3)[, "99%"], lwd = 2, col = "orange")

# Check the 99 percentiles with a smoothing spline.
Gumbel-II

The Gumbel-II Distribution

Description

Density, cumulative distribution function, quantile function and random generation for the Gumbel-II distribution.

Usage

dgumbelII(x, scale = 1, shape, log = FALSE)
pgumbelII(q, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
qgumbelII(p, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
rgumbelII(n, scale = 1, shape)

Arguments

x, q
vector of quantiles.
p
vector of probabilities.
n
number of observations. Same as in runif.
log
Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p
Same meaning as in pnorm or qnorm.
shape, scale
positive shape and scale parameters.

Details

See gumbelII for details.

Value

dgumbelII gives the density, pgumbelII gives the cumulative distribution function, qgumbelII gives the quantile function, and rgumbelII generates random deviates.

Author(s)

T. W. Yee and Kai Huang
gumbelII

Gumbel-II Regression Family Function

Description

Maximum likelihood estimation of the 2-parameter Gumbel-II distribution.

Usage

gumbelII(lscale = "loglink", lshape = "loglink", iscale = NULL, ishape = NULL, 
probs.y = c(0.2, 0.5, 0.8), perc.out = NULL, imethod = 1, 
zero = "shape", nowarning = FALSE)

Arguments

nowarning Logical. Suppress a warning?

lshape, lscale Parameter link functions applied to the (positive) shape parameter (called s below) and (positive) scale parameter (called b below). See Links for more choices.

Parameter link functions applied to the

ishape, iscale Optional initial values for the shape and scale parameters.

imethod See weibullR.
Details

The Gumbel-II density for a response $Y$ is

$$f(y; b, s) = sy^{s-1} \exp[-(y/b)^s]/(b^s)$$

for $b > 0$, $s > 0$, $y > 0$. The cumulative distribution function is

$$F(y; b, s) = \exp[-(y/b)^{-s}]$$

The mean of $Y$ is $b \Gamma(1 - 1/s)$ (returned as the fitted values) when $s > 1$, and the variance is $b^2 \Gamma(1 - 2/s)$ when $s > 2$. This distribution looks similar to `weibullR`, and is due to Gumbel (1954).

This VGAM family function currently does not handle censored data. Fisher scoring is used to estimate the two parameters. Probably similar regularity conditions hold for this distribution compared to the Weibull distribution.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

See weibullR. This VGAM family function handles multiple responses.

Author(s)

T. W. Yee

References


See Also

dgumbelII, gumbel.gev.

Examples

gdata <- data.frame(x2 = runif(nn <- 1000))
gdata <- transform(gdata, heta1 = +1,
                   heta2 = -1 + 0.1 * x2,
                   ceta1 = 0,
                   ceta2 = 1)
```r
gdata <- transform(gdata, shape1 = exp(heta1),
                   shape2 = exp(heta2),
                   scale1 = exp(ceta1),
                   scale2 = exp(ceta2))

gdata <- transform(gdata,
                   y1 = rgumbelII(nn, scale = scale1, shape = shape1),
                   y2 = rgumbelII(nn, scale = scale2, shape = shape2))

fit <- vglm(cbind(y1, y2) ~ x2,
            gumbelII(zero = c(1, 2, 3)), data = gdata, trace = TRUE)
coef(fit, matrix = TRUE)
vcov(fit)
summary(fit)
```

---

**The Gumbel Distribution**

**Description**

Density, distribution function, quantile function and random generation for the Gumbel distribution with location parameter `location` and scale parameter `scale`.

**Usage**

```r
dgumbel(x, location = 0, scale = 1, log = FALSE)
pgumbel(q, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
qgumbel(p, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
rgumbel(n, location = 0, scale = 1)
```

**Arguments**

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `location` the location parameter \( \mu \). This is not the mean of the Gumbel distribution (see **Details** below).
- `scale` the scale parameter \( \sigma \). This is not the standard deviation of the Gumbel distribution (see **Details** below).
- `log` Logical. If `log = TRUE` then the logarithm of the density is returned.
- `lower.tail, log.p` Same meaning as in `punif` or `qunif`.

---

**Description**

Density, distribution function, quantile function and random generation for the Gumbel distribution with location parameter `location` and scale parameter `scale`.

**Usage**

```r
dgumbel(x, location = 0, scale = 1, log = FALSE)
pgumbel(q, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
qgumbel(p, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
rgumbel(n, location = 0, scale = 1)
```

**Arguments**

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `location` the location parameter \( \mu \). This is not the mean of the Gumbel distribution (see **Details** below).
- `scale` the scale parameter \( \sigma \). This is not the standard deviation of the Gumbel distribution (see **Details** below).
- `log` Logical. If `log = TRUE` then the logarithm of the density is returned.
- `lower.tail, log.p` Same meaning as in `punif` or `qunif`.

---

**Description**

Density, distribution function, quantile function and random generation for the Gumbel distribution with location parameter `location` and scale parameter `scale`.
Details

The Gumbel distribution is a special case of the generalized extreme value (GEV) distribution where the shape parameter $\xi = 0$. The latter has 3 parameters, so the Gumbel distribution has two. The Gumbel distribution function is

$$G(y) = \exp \left( - \exp \left[ -\frac{y - \mu}{\sigma} \right] \right)$$

where $-\infty < y < \infty$, $-\infty < \mu < \infty$ and $\sigma > 0$. Its mean is

$$\mu - \sigma \gamma$$

and its variance is

$$\sigma^2 \pi^2 / 6$$

where $\gamma$ is Euler’s constant (which can be obtained as $-\text{digamma}(1)$).

See gumbel, the VGAM family function for estimating the two parameters by maximum likelihood estimation, for formulae and other details. Apart from n, all the above arguments may be vectors and are recyled to the appropriate length if necessary.

Value
dgumbel gives the density, pgumbel gives the distribution function, qgumbel gives the quantile function, and rgumbel generates random deviates.

Note

The VGAM family function gumbel can estimate the parameters of a Gumbel distribution using maximum likelihood estimation.

Author(s)

T. W. Yee

References


See Also
gumbel, gumbelff, gev, dgompertz.

Examples

```r
mu <- 1; sigma <- 2;
y <- rgumbel(n = 100, loc = mu, scale = sigma)
c(mean(y), mu - sigma * digamma(1)) # Sample and population means
c(var(y), sigma^2 * pi^2 / 6) # Sample and population variances

## Not run: x <- seq(-2.5, 3.5, by = 0.01)
```
loc <- 0; sigma <- 1
plot(x, dgumbel(x, loc, sigma), type = "l", col = "blue",
     main = "Blue is density, red is the CDF", ylim = c(0, 1),
     sub = "Purple are 5,10,...,95 percentiles", ylab = "", las = 1)
abline(h = 0, col = "blue", lty = 2)
lines(qgumbel(seq(0.05, 0.95, by = 0.05), loc, sigma),
     dgumbel(qgumbel(seq(0.05, 0.95, by = 0.05), loc, sigma), loc, sigma),
     col = "purple", lty = 3, type = "h")
lines(x, pgumbel(x, loc, sigma), type = "l", col = "red")
abline(h = 0, lty = 2)
## End(Not run)

---

**guplot**

**Gumbel Plot**

**Description**

Produces a Gumbel plot, a diagnostic plot for checking whether the data appears to be from a Gumbel distribution.

**Usage**

```r
guplot(object, ...)  
guplot.default(y, main = "Gumbel Plot",  
              xlab = "Reduced data", ylab = "Observed data", type = "p", ...)  
guplot.vlm(object, ...)
```

**Arguments**

- `y` A numerical vector. NAs etc. are not allowed.
- `main` Character. Overall title for the plot.
- `xlab` Character. Title for the x axis.
- `ylab` Character. Title for the y axis.
- `type` Type of plot. The default means points are plotted.
- `object` An object that inherits class "vlm", usually of class `vglm-class` or `vgam-class`.
- `...` Graphical argument passed into `plot`. See `par` for an exhaustive list. The arguments `xlim` and `ylim` are particularly useful.

**Details**

If $Y$ has a Gumbel distribution then plotting the sorted values $y_i$ versus the reduced values $r_i$ should appear linear. The reduced values are given by

$$r_i = -\log(-\log(p_i))$$

where $p_i$ is the $i$th plotting position, taken here to be $(i - 0.5)/n$. Here, $n$ is the number of observations. Curvature upwards/downwards may indicate a Frechet/Weibull distribution, respectively. Outliers may also be detected using this plot.

The function `guplot` is generic, and `guplot.default` and `guplot.vlm` are some methods functions for Gumbel plots.
Value
A list is returned invisibly with the following components.

x The reduced data.
y The sorted y data.

Note
The Gumbel distribution is a special case of the GEV distribution with shape parameter equal to zero.

Author(s)
T. W. Yee

References

See Also
gumbel, gumbelff, gev, venice.

Examples
```r
## Not run: guplot(rnorm(500), las = 1) -> ii
names(ii)

  guplot(with(venice, r1), col = "blue") # Venice sea levels data

## End(Not run)
```

Description
Looks at the formula to see if it has an intercept term.

Usage
```r
has.intercept(object, ...)
has.interceptvlm(object, form.number = 1, ...)
```
hatvalues

Arguments

object A fitted model object.
form.number Formula number, is 1 or 2. which correspond to the arguments formula and form2 respectively.
... Arguments that are might be passed from one function to another.

Details

This methods function is a simple way to determine whether a fitted vglm object etc. has an intercept term or not. It is not entirely foolproof because one might suppress the intercept from the formula and then add in a variable in the formula that has a constant value.

Value

Returns a single logical.

Author(s)

Thomas W. Yee

See Also

formavlm, termsvlm.

Examples

# Example: this is based on a glm example
counts <- c(18,17,15,20,10,20,25,13,12)
outcome <- gl(3, 1, 9); treatment <- gl(3, 3)
pdata <- data.frame(counts, outcome, treatment) # Better style
vglm.D93 <- vglm(counts ~ outcome + treatment, poissonff, data = pdata)
formula(vglm.D93)
term.names(vglm.D93)
responseName(vglm.D93)
has.intercept(vglm.D93)

hatvalues

Hat Values and Regression Deletion Diagnostics

Description

When complete, a suite of functions that can be used to compute some of the regression (leave-one-out deletion) diagnostics, for the VGLM class.
hatvalues

hatvalues(model, ...)  
hatvaluesvlm(model, type = c("diagonal", "matrix", "centralBlocks"), ...)  
hatplot(model, ...)  
hatplot.vlm(model, multiplier = c(2, 3), lty = "dashed",  
           xlab = "Observation", ylab = "Hat values", ylim = NULL, ...)  
dfbetavlm(model, maxit.new = 1,  
          trace.new = FALSE,  
          smallno = 1.0e-8, ...)  

Arguments

model  
an R object, typically returned by vglm.

type  
Character. The default is the first choice, which is a $nM \times nM$ matrix. If type = "matrix" then the entire hat matrix is returned. If type = "centralBlocks" then $n$ central $M \times M$ block matrices, in matrix-band format.

multiplier  
Numeric, the multiplier. The usual rule-of-thumb is that values greater than two or three times the average leverage (at least for the linear model) should be checked.

lty, xlab, ylab, ylim  
Graphical parameters, see par etc. The default of ylim is c(0, max(hatvalues(model))) which means that if the horizontal dashed lines cannot be seen then there are no particularly influential observations.

maxit.new, trace.new, smallno  
Having maxit.new = 1 will give a one IRLS step approximation from the ordinary solution (and no warnings!). Else having maxit.new = 10, say, should usually mean convergence will occur for all observations when they are removed one-at-a-time. Else having maxit.new = 2, say, should usually mean some lack of convergence will occur when observations are removed one-at-a-time. Setting trace.new = TRUE will produce some running output at each IRLS iteration and for each individual row of the model matrix. The argument smallno multiplies each value of the original prior weight (often unity); setting it identically to zero will result in an error, but setting a very small value effectively removes that observation.

...  
 further arguments, for example, graphical parameters for hatplot.vlm().

Details

The invocation hatvalues(vglmObject) should return a $n \times M$ matrix of the diagonal elements of the hat (projection) matrix of a vglm object. To do this, the QR decomposition of the object is retrieved or reconstructed, and then straightforward calculations are performed.

The invocation hatplot(vglmObject) should plot the diagonal of the hat matrix for each of the $M$ linear/additive predictors. By default, two horizontal dashed lines are added; hat values higher than these ought to be checked.
Note

It is hoped, soon, that the full suite of functions described at \texttt{influence.measures} will be written for VGLMs. This will enable general regression deletion diagnostics to be available for the entire VGLM class.

Author(s)

T. W. Yee.

See Also

\texttt{vglm, cumulative, influence.measures}.

Examples

# Proportional odds model, p.179, in McCullagh and Nelder (1989)
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, cumulative, data = pneumo)
hatvalues(fit) # n x M matrix, with positive values
all.equal(sum(hatvalues(fit)), fit@rank) # Should be TRUE
## Not run: par(mfrow = c(1, 2))
hatplot(fit, ylim = c(0, 1), las = 1, col = "blue")
## End(Not run)

hdeff

\textit{Hauck-Donner Effects: A Detection Test for Wald Tests}

Description

A detection test for the Hauck-Donner effect on each regression coefficient of a VGLM regression or 2 x 2 table.

Usage

\begin{verbatim}
  hdeff(object, ...)
  hdeff.vglm(object, derivative = NULL, se.arg = FALSE,
            subset = NULL, theta0 = 0, hstep = 0.005,
            fd.only = FALSE, ...)
  hdeff.numeric(object, byrow = FALSE, ...)
  hdeff.matrix(object, ...)
\end{verbatim}

Arguments

\begin{itemize}
  \item \texttt{object} Usually a \texttt{vglm} object. Although only a limited number of family functions have an analytical solution to the HDE detection test (\texttt{binomialff, borel.tanner, cumulative, erlang, felix, lindley, poissonff, topple, uninormal, zipoissonff, and zipoisson}; hopefully some more will be implemented in the short future!)
\end{itemize}
the finite-differences (FDs) method can be applied to almost all VGAM family functions to get a numerical solution.

Alternatively object may represent a 2 x 2 table of positive counts. If so, then the first row corresponds to \( x^2 = 0 \) (baseline group) and the second row \( x^2 = 1 \).
The first column corresponds to \( y = 0 \) (failure) and the second column \( y = 1 \) (success).

Another alternative is that object is a numerical vector of length 4, representing a 2 x 2 table of positive counts. If so then it is fed into hdeff.matrix using the argument byrow, which matches matrix. See the examples below.

derivative Numeric. Either 1 or 2. Currently only a few models having one linear predictor are handled analytically for \( \text{derivative} = 2 \), e.g., binomialff, poissonff. However, the numerical method can return the first two derivatives for almost all models.

se.arg Logical. If TRUE then the derivatives of the standard errors are returned as well, because usually the derivatives of the Wald statistics are of central interest. Requires derivative to be assigned the value 1 or 2 for this argument to operate.

subset Logical or vector of indices, to select the regression coefficients of interest. The default is to select all coefficients. Recycled if necessary if logical. If numeric then they should comprise elements from 1:length(coef(object)). This argument can be useful for computing the derivatives of a Cox regression (coxph) fitted using artificially created Poisson data; then there are many coefficients that are effectively nuisance parameters.

theta0 Numeric. Vector recycled to the necessary length which is the number of regression coefficients. The null hypotheses for the regression coefficients are that they equal those respective values, and the alternative hypotheses are all two-sided. It is not recommended that argument subset be used if a vector of values is assigned here because theta0[subset] is implied and might not work.

hstep Positive numeric and recycled to length 2; it is the so-called step size when using finite-differences and is often called \( h \) in the calculus literature, e.g., \( f'(x) \) is approximately \( (f(x + h) - f(x))/h \). For the 2nd-order partial derivatives, there are two step sizes and hence this argument is recycled to length 2. The default is to have the same values. The 1st-order derivatives use the first value only. It is recommended that a few values of this argument be tried because values of the first and second derivatives can vary accordingly. If any values are too large then the derivatives may be inaccurate; and if too small then the derivatives may be unstable and subject to too much round-off/cancellation error (in fact it may create an error or a NA).

fd.only Logical; if TRUE then finite-differences are used to estimate the derivatives even if an analytical solution has been coded. By default, finite-differences will be used when an analytical solution has not been implemented.

It is possible that NAs are returned. If so, and if fd.only = FALSE, then a warning is issued and a recursive call is made with fd.only = TRUE—this is more likely to return an answer without any NAs.

byrow Logical; fed into matrix if object is a vector of length 4 so that there are two choices in the order of the elements.

... currently unused but may be used in the future for further arguments passed into the other methods functions.
Details

Almost all of statistical inference based on the likelihood assumes that the parameter estimates are located in the interior of the parameter space. The nonregular case of being located on the boundary is not considered very much and leads to very different results from the regular case. Practically, an important question is: how close is close to the boundary? One might answer this as: the parameter estimates are too close to the boundary when the Hauck-Donner effect (HDE) is present, whereby the Wald statistic becomes aberrant.

Hauck and Donner (1977) first observed an aberration of the Wald test statistic not monotonically increasing as a function of increasing distance between the parameter estimate and the null value. This "disturbing" and "undesirable" underappreciated effect has since been observed in other regression models by various authors. This function computes the first, and possibly second, derivative of the Wald statistic for each regression coefficient. A negative value of the first derivative is indicative of the HDE being present. More information can be obtained from hdeffsev regarding HDE severity: there may be none, faint, weak, moderate, strong and extreme amounts of HDE present.

In general, most models have derivatives that are computed numerically using finite-difference approximations. The reason is that it takes a lot of work to program in the analytical solution (this includes a few very common models, such as poissonff and binomlalf, where the first two derivatives have been implemented).

Value

By default this function returns a labelled logical vector; a TRUE means the HDE is affirmative for that coefficient (negative slope). Hence ideally all values are FALSE. Any TRUE values suggests that the MLE is too near the boundary of the parameter space, and that the p-value for that regression coefficient is biased upwards. When present a highly significant variable might be deemed nonsignificant, and thus the HDE can create havoc for variable selection. If the HDE is present then more accurate p-values can generally be obtained by conducting a likelihood ratio test (see lrt.stat.vlm) or Rao’s score test (see score.stat.vlm); indeed the default of wald.stat.vlm does not suffer from the HDE.

Setting deriv = 1 returns a numerical vector of first derivatives of the Wald statistics. Setting deriv = 2 returns a 2-column matrix of first and second derivatives of the Wald statistics. Then setting se.arg = TRUE returns an additional 1 or 2 columns.

Some 2nd derivatives are NA if only a partial analytic solution has been programmed in.

For those VGAM family functions whose HDE test has not yet been implemented explicitly (the vast majority of them), finite-difference approximations to the derivatives will be used—see the arguments hstep and fd.only for getting some control on them.

Note

The function summaryvglm conducts the HDE detection test if possible and prints out a line at the bottom if the HDE is detected for some regression coefficients. By “if possible”, only a few family functions are exempt and they have an infos slot with component hadof = FALSE; such as normal.vcm, rec.normal because it uses the BFGS-IRLS method for computing the working weights. For these few a NULL is returned by hdeff.

If the second derivatives are of interest then it is recommended that crit = "c" be added to the fitting so that a slightly more accurate model results (usually one more IRLS iteration). This is
because the FD approximation is very sensitive to values of the working weights, so they need to be computed accurately. Occasionally, if the coefficient is close to 0, then its Wald statistic’s second derivative may be unusually large in magnitude (this could be due to something such as roundoff error).

This function is currently under development and may change a little in the short future. For HDE severity measures see `hdeffsev`.

Author(s)

Thomas W. Yee.

References


See Also

`summaryvglm, hdeffsev, alogitlink, asinlink, vglm, lrt.stat, score.stat, wald.stat, confintvglm, profilevglm`.

Examples

```r
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, data = pneumo,
      trace = TRUE, crit = "c", # Get some more accuracy
      cumulative(reverse = TRUE, parallel = TRUE))
cumulative()@infos()$hadof # Analytical solution implemented
hdeff(fit)
```

```r
hdeff(fit, deriv = 1) # Analytical solution
```

```r
hdeff(fit, deriv = 2) # It is a partial analytical solution
```

```r
hdeff(fit, deriv = 2, se.arg = TRUE,
      fd.only = TRUE) # All derivatives solved numerically by FDs
```

```r
# 2 x 2 table of counts
R0 <- 25; N0 <- 100 # Hauck Donner (1977) data set
mymat <- c(N0-R0, R0, 8, 92) # HDE present
(mymat <- matrix(mymat, 2, 2, byrow = TRUE))
hdeff(mymat)
hdeff(c(mymat)) # Input is a vector
```

```r
hdeff(c(t(mymat)), byrow = TRUE) # Reordering of the data
```
hdeffsev

Hauck-Donner Effects: Severity Measures

Description

Computes the severity of the Hauck-Donner effect for each regression coefficient of a VGLM regression.

Usage

hdeffsev(x, y, dy, ddy, allofit = FALSE, eta0 = 0, COPS0 = eta0,
severity.table = c("None", "Faint", "Weak",
"Moderate", "Strong", "Extreme", "Undetermined"))

Arguments

x, y    Numeric vectors; x are the estimates (sorted), and y are the signed Wald statistics.
dy, ddy Numeric vectors; the first and second derivatives of the Wald statistics. They can be computed by hdeff.
allofit Logical. If TRUE then other quantities are returned in a list. The default is a vector with elements selected from the argument severity.table.
severity.table Character vector with 6 values. The last value is used for initialization. Usually users should not assign anything to this argument.
eta0    Numeric. The hypothesized value. The default is appropriate for most symmetric binomial links, and also for Poisson regression with the natural parameter.
COPS0   Numeric. See Yee (2021).

Details

Note: This function has a bug or two in it but they should be fixed later this year (2024).

This function is rough-and-ready. It is possible to use the first two derivatives obtained from hdeff to categorize the severity of the Hauck-Donner effect (HDE). It is effectively assumed that, starting at the origin and going right, the curve is made up of a convex segment followed by a concave segment and then the convex segment. Midway in the concave segment the derivative is 0, and beyond that the HDE is really manifest because the derivative is negative.

For "none" the estimate lies on the convex part of the curve near the origin, hence there is very little HDE at all.

For "weak" the estimate lies on the concave part of the curve but the Wald statistic is still increasing as estimate gets away from 0, hence it is only a mild form of the HDE.

Previously "faint" was used but now it has been omitted.

For "moderate", "strong" and "extreme" the Wald statistic is decreasing as the estimate gets away from eta0, hence it really does exhibit the HDE. It is recommended that lrt.stat be used to compute LRT p-values, as they do not suffer from the HDE.
**Value**

By default this function returns a labelled vector with elements selected from severity.table. If allofit = TRUE then Yee (2022) gives details about some of the other list components, e.g., a quantity called \( \zeta \) is the normal line projected onto the \( x \)-axis, and its first derivative gives additional information about the position of the estimate along the curve.

**Note**

This function is likely to change in the short future because it is experimental and far from complete. Improvements are intended.

Currently, in order for "Strong" to be assigned correctly, at least one such value is needed on the LHS and/or RHS each. From those, two other boundary points are obtained so that it creates two intervals.

**Author(s)**

Thomas W. Yee.

**References**


**See Also**

seglines, hdeff.

**Examples**

```r
deg <- 4 # myfun is a function that approximates the HDE
myfun <- function(x, deriv = 0) switch(as.character(deriv),
'0' = x^deg * exp(-x),
'1' = (deg * x^(deg-1) - x^deg) * exp(-x),
'2' = (deg*(deg-1)*x^(deg-2) - 2*deg*x^(deg-1) + x^deg)*exp(-x))

xgrid <- seq(0, 10, length = 101)
ansm <- hdeffsev(xgrid, myfun(xgrid), myfun(xgrid, deriv = 1),
myfun(xgrid, deriv = 2), allofit = TRUE)
digg <- 4
cbind(severity = ansm$sev, 
  fun = round(myfun(xgrid), digg),
  deriv1 = round(myfun(xgrid, deriv = 1), digg),
  deriv2 = round(myfun(xgrid, deriv = 2), digg),
  zderiv1 = round((1 + (myfun(xgrid, deriv = 1))^2 + myfun(xgrid, deriv = 2) * myfun(xgrid), digg)))
```
A hormone assay data set from Carroll and Ruppert (1988).

Usage

data(hormone)

Format

A data frame with 85 observations on the following 2 variables.

X  a numeric vector, suitable as the x-axis in a scatter plot. The reference method.

Y  a numeric vector, suitable as the y-axis in a scatter plot. The test method.

Details

The data is given in Table 2.4 of Carroll and Ruppert (1988), and was downloaded from http://www.stat.tamu.edu/~carroll prior to 2019. The book describes the data as follows. The data are the results of two assay methods for hormone data; the scale of the data as presented is not particularly meaningful, and the original source of the data refused permission to divulge further information. As in a similar example of Leurgans (1980), the old or reference method is being used to predict the new or test method. The overall goal is to see whether we can reproduce the test-method measurements with the reference-method measurements. Thus calibration might be of interest for the data.

References


See Also

uninormal, rrvglm.
### Not run:
```r
data(hormone)
summary(hormone)
```

```r
modelI <- rrvglm(Y ~ 1 + X, data = hormone, trace = TRUE,
                 uninormal(zero = NULL, lsd = "identitylink", imethod = 2))
```

```r
# Alternative way to fit modelI
modell.other <- vglm(Y ~ 1 + X, data = hormone, trace = TRUE,
                    uninormal(zero = NULL, lsd = "identitylink"))
```

```r
# Inferior to modelI
modelII <- vglm(Y ~ 1 + X, data = hormone, trace = TRUE,
                family = uninormal(zero = NULL))
```

```r
logLik(modelI)
logLik(modelII)  # Less than logLik(modelI)
```

# Reproduce the top 3 equations on p.65 of Carroll and Ruppert (1988).
# They are called Equations (1)---(3) here.

#### Equation (1)
```r
hormone <- transform(hormone, rX = 1 / X)
clist <- list("(Intercept)" = diag(2), X = diag(2), rX = rbind(0, 1))
fit1 <- vglm(Y ~ 1 + X + rX, family = uninormal(zero = NULL),
             constraints = clist, data = hormone, trace = TRUE)
```

```r
coef(fit1, matrix = TRUE)
```

```r
summary(fit1)  # Actually, the intercepts do not seem significant
```

```r
plot(Y ~ X, hormone, col = "blue")
lines(fitted(fit1) ~ X, hormone, col = "orange")
```

#### Equation (2)
```r
fit2 <- rrvglm(Y ~ 1 + X, uninormal(zero = NULL), hormone, trace = TRUE)
```

```r
coef(fit2, matrix = TRUE)
```

```r
plot(Y ~ X, hormone, col = "blue")
lines(fitted(fit2) ~ X, hormone, col = "red")
```

```r
# Add +- 2 SEs
lines(fitted(fit2) + 2 * exp(predict(fit2)[, "loglink(sd)"]) ~ X,
     hormone, col = "orange")
lines(fitted(fit2) - 2 * exp(predict(fit2)[, "loglink(sd)"]) ~ X,
     hormone, col = "orange")
```

#### Equation (3)
```r
# Does not fit well because the loglink link for the mean is not good.
fit3 <- rrvglm(Y ~ 1 + X, maxit = 300, data = hormone, trace = TRUE,
               uninormal(lmean = "loglink", zero = NULL))
```

```r
coef(fit3, matrix = TRUE)  # Does not look okay.
```

```r
plot(Y ~ X, hormone, col = "blue")
lines(exp(predict(fit3)[, 1]) ~ X, hormone, col = "red")
```

# Add +- 2 SEs
## hspider

### Hunting Spider Data

**Description**

Abundance of hunting spiders in a Dutch dune area.

**Usage**

```r
data(hspider)
```

**Format**

A data frame with 28 observations (sites) on the following 18 variables.

- **WaterCon**: Log percentage of soil dry mass.
- **BareSand**: Log percentage cover of bare sand.
- **FallTwig**: Log percentage cover of fallen leaves and twigs.
- **CoveMoss**: Log percentage cover of the moss layer.
- **CoveHerb**: Log percentage cover of the herb layer.
- **ReflLux**: Reflection of the soil surface with cloudless sky.
- **Alopacec**: Abundance of *Alopecosa accentuata*.
- **Alopcune**: Abundance of *Alopecosa cuneata*.
- **Alopfabr**: Abundance of *Alopecosa fabrilis*.
- **Arctlute**: Abundance of *Arctosa lutetiana*.
- **Arctperi**: Abundance of *Arctosa perita*.
- **Auloalbi**: Abundance of *Aulonia albimana*.
- **Pardlugu**: Abundance of *Pardosa lugubris*.
- **Pardmont**: Abundance of *Pardosa monticola*.
- **Pardnigr**: Abundance of *Pardosa nigriceps*.
- **Pardpull**: Abundance of *Pardosa pullata*.
- **Trocterr**: Abundance of *Trochosa terricola*.
- **Zoraspin**: Abundance of *Zora spinimana*.
Details

The data, which originally came from Van der Aart and Smeek-Enserink (1975) consists of abundances (numbers trapped over a 60 week period) and 6 environmental variables. There were 28 sites.

This data set has been often used to illustrate ordination, e.g., using canonical correspondence analysis (CCA). In the example below, the data is used for constrained quadratic ordination (CQO; formerly called canonical Gaussian ordination or CGO), a numerically intensive method that has many superior qualities. See `cqo` for details.

References


Examples

```r
summary(hspider)
## Not run:
# Standardize the environmental variables:
hs <- scale(subset(hspider, select = WaterCon:ReflLux))

# Fit a rank-1 binomial CAO
hsbin <- hspider # Binary species data
hsbin[, -(1:6)] <- as.numeric(hsbin[, -(1:6)] > 0)
set.seed(123)
ahsb1 <- cao(cbind(Alopcune, Arctlute, Auloalbi, Zoraspin) ~ WaterCon + ReflLux,
             family = binomialff(multiple.responses = TRUE),
             df1.nl = 2.2, Bestof = 3, data = hsbin)
par(mfrow = 2:1, las = 1)
lvplot(ahsb1, type = "predictors", llwd = 2,
ylab = "logitlink(p)", lcol = 1:9)
persp(ahsb1, rug = TRUE, col = 1:10, lwd = 2)
coef(ahsb1)
## End(Not run)
```

huber2

*Huber’s Least Favourable Distribution Family Function*

Description

M-estimation of the two parameters of Huber’s least favourable distribution. The one parameter case is also implemented.
**Usage**

huber1(llocation = "identitylink", k = 0.862, imethod = 1)
huber2(llocation = "identitylink", lscale = "loglink",
  k = 0.862, imethod = 1, zero = "scale")

**Arguments**

- **llocation**, lscale
  Link functions applied to the location and scale parameters. See **Links** for more choices.
- **k**
  Tuning constant. See **rhuber** for more information.
- **imethod**, zero
  See **CommonVGAMffArguments** for information. The default value of zero means the scale parameter is modelled as intercept-only.

**Details**

Huber's least favourable distribution family function is popular for resistant/robust regression. The center of the distribution is normal and its tails are double exponential.

By default, the mean is the first linear/additive predictor (returned as the fitted values; this is the location parameter), and the log of the scale parameter is the second linear/additive predictor. The Fisher information matrix is diagonal; Fisher scoring is implemented.

The **VGAM** family function **huber1()** estimates only the location parameter. It assumes a scale parameter of unit value.

**Value**

An object of class "vglmff" (see **vglmff-class**). The object is used by modelling functions such as **vglm**, and **vgam**.

**Note**

Warning: actually, **huber2()** may be erroneous since the first derivative is not continuous when there are two parameters to estimate. **huber1()** is fine in this respect.

The response should be univariate.

**Author(s)**

T. W. Yee. Help was given by Arash Ardalan.

**References**


**See Also**

**rhuber**, **uninormal**, **laplace**, **CommonVGAMffArguments**.
Examples

```r
set.seed(1231); NN <- 30; coef1 <- 1; coef2 <- 10
hdata <- data.frame(x2 = sort(runif(NN)))
hdata <- transform(hdata, y = rhuber(NN, mu = coef1 + coef2 * x2))

hdata$x2[1] <- 0.0 # Add an outlier
hdata$y[1] <- 10

fit.huber2 <- vglm(y ~ x2, huber2(imethod = 3), hdata, trace = TRUE)
fit.huber1 <- vglm(y ~ x2, huber1(imethod = 3), hdata, trace = TRUE)

coef(fit.huber2, matrix = TRUE)
summary(fit.huber2)

## Not run: # Plot the results
plot(y ~ x2, data = hdata, col = "blue", las = 1)
lines(fitted(fit.huber2) ~ x2, data = hdata, col = "darkgreen", lwd = 2)

fit.lm <- lm(y ~ x2, hdata) # Compare to a LM:
lines(fitted(fit.lm) ~ x2, data = hdata, col = "lavender", lwd = 3)

# Compare to truth:
lines(coef1 + coef2 * x2 ~ x2, data = hdata, col = "orange",
     lwd = 2, lty = "dashed")

legend("bottomright", legend = c("truth", "huber", "lm"),
       col = c("orange", "darkgreen", "lavender"),
       lty = c("dashed", "solid", "solid"), lwd = c(2, 2, 3))
## End(Not run)
```

---

### Table 1 of Huggins (1989)

**Description**

Simulated capture data set for the linear logistic model depending on an occasion covariate and an individual covariate for 10 trapping occasions and 20 individuals.

**Usage**

```r
data(Huggins89table1)
data(Huggins89.t1)
```

**Format**

The format is a data frame.
Details

Table 1 of Huggins (1989) gives this toy data set. Note that variables $t_1, \ldots, t_{10}$ are occasion-specific variables. They correspond to the response variables $y_1, \ldots, y_{10}$ which have values 1 for capture and 0 for not captured.

Both Huggins89table1 and Huggins89.t1 are identical. The latter used variables beginning with $z$, not $t$, and may be withdrawn very soon.

References


Examples

```r
## Not run:
Huggins89table1 <-
  transform(Huggins89table1, x3.tij = t01,
    T02 = t02, T03 = t03, T04 = t04, T05 = t05, T06 = t06,
    T07 = t07, T08 = t08, T09 = t09, T10 = t10)
small.table1 <- subset(Huggins89table1,
  y01 + y02 + y03 + y04 + y05 + y06 + y07 + y08 + y09 + y10 > 0)
# fit.tbh is the bottom equation on p.133.
# It is a M.tbh model.
fit.tbh <-
  vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~
    x2 + x3.tij,
    xij = list(x3.tij ~
      t01 + t02 + t03 + t04 + t05 +
      t06 + t07 + t08 + t09 + t10 +
      T02 + T03 + T04 + T05 + T06 +
      T07 + T08 + T09 + T10 - 1),
    posbernoulli.tb(parallel.t = TRUE ~ x2 + x3.tij),
    data = small.table1, trace = TRUE,
    form2 = ~
    x2 + x3.tij +
    t01 + t02 + t03 + t04 + t05 + t06 +
    t07 + t08 + t09 + t10 +
    T02 + T03 + T04 + T05 + T06 +
    T07 + T08 + T09 + T10)

# These results differ a bit from Huggins (1989), probably because
# two animals had to be removed here (they were never caught):
coef(fit.tbh) # First element is the behavioural effect
sqrt(diag(vcov(fit.tbh))) # SEs
constraints(fit.tbh, matrix = TRUE)
summary(fit.tbh, presid = FALSE)
fit.tbh@extra$N.hat # Estimate of the population site N; cf. 20.86
fit.tbh@extra$SE.N.hat # Its standard error; cf. 1.87 or 4.51

fit.th <-
  vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~ x2,
    posbernoulli.t, data = small.table1, trace = TRUE)
coef(fit.th)
constraints(fit.th)
```

```
coef(fit.th, matrix = TRUE) # M_th model
summary(fit.th, presid = FALSE)
fit.th@extra$N.hat # Estimate of the population size N
fit.th@extra$SE.N.hat # Its standard error

fit.bh <-
vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~ x2,
posbernoulli.b(I2 = FALSE), data = small.table1, trace = TRUE)
coef(fit.bh)
constraints(fit.bh)
coef(fit.bh, matrix = TRUE) # M_bh model
summary(fit.bh, presid = FALSE)
fit.bh@extra$N.hat
fit.bh@extra$SE.N.hat

fit.h <-
vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~ x2,
posbernoulli.b, data = small.table1, trace = TRUE)
coef(fit.h, matrix = TRUE) # M_h model (version 1)
coef(fit.h)
summary(fit.h, presid = FALSE)
fit.h@extra$N.hat
fit.h@extra$SE.N.hat

Fit.h <-
vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~ x2,
posbernoulli.t(parallel.t = TRUE ~ x2),
data = small.table1, trace = TRUE)
coef(Fit.h)
coef(Fit.h, matrix = TRUE) # M_h model (version 2)
summary(Fit.h, presid = FALSE)
Fit.h@extra$N.hat
Fit.h@extra$SE.N.hat

## End(Not run)
```

---

**hunua**

*Hunua Ranges Data*

### Description

The hunua data frame has 392 rows and 18 columns. Altitude is explanatory, and there are binary responses (presence/absence = 1/0 respectively) for 17 plant species.

### Usage

```
data(hunua)
```
Format

This data frame contains the following columns:

- **agaaus**: Agathis australis, or Kauri
- **beitaw**: Beilschmiedi a tawa, or Tawa
- **corlae**: Corynocarpus laevigatus
- **cyadea**: Cyathea dealbata
- **cyamed**: Cyathea medullaris
- **daccup**: Dacrydium cupressinum
- **daedac**: Dacrycarpus dacrydoides
- **eladen**: Elaeocarpus dentatus
- **hedarb**: Hedycarya arborea
- **hohpop**: Species name unknown
- **kniexc**: Knightia excelsa, or Rewarewa
- **kuneri**: Kunzea ericoides
- **lepsco**: Leptospermum scoparium
- **metrob**: Metrosideros robusta
- **neslan**: Nestegis lanceolata
- **rhosap**: Rhopalostylis sapida
- **vitluc**: Vitex lucens, or Puriri
- **altitude**: meters above sea level

Details

These were collected from the Hunua Ranges, a small forest in southern Auckland, New Zealand. At 392 sites in the forest, the presence/absence of 17 plant species was recorded, as well as the altitude. Each site was of area size 200$m^2$.

Source

Dr Neil Mitchell, University of Auckland.

See Also

- *waitakere*

Examples

```r
# Fit a GAM using vgam() and compare it with the Waitakere Ranges one
fit.h <- vgam(agaaus ~ s(altitude, df = 2), binomialff, data = hunua)
## Not run:
plot(fit.h, se = TRUE, lcol = "orange", scol = "orange",
     llwd = 2, slwd = 2, main = "Orange is Hunua, Blue is Waitakere")
## End(Not run)
```
head(predict(fit.h, hunua, type = "response"))

fit.w <- vgam(agaus ~ s(altitude, df = 2), binomialff, data = waitakere)
## Not run:
plot(fit.w, se = TRUE, lcol = "blue", scol = "blue", add = TRUE)
## End(Not run)
head(predict(fit.w, hunua, type = "response"))  # Same as above?

---

**Hurea**

*The Husler-Reiss Angular Surface Distribution*

**Description**

Density for the Husler-Reiss angular surface distribution.

**Usage**

dhurea(x, shape, log = FALSE)

**Arguments**

- **x**  
  Same as *Uniform*.

- **shape**  
  the positive (shape) parameter. It is often called *lambda* and it might not be a shape parameter at all.

- **log**  
  Logical. If log = TRUE then the logarithm of the density is returned.

**Details**

See hurea, the VGAM family function for estimating the (shape) parameter \( s \) by maximum likelihood estimation, for the formula of the probability density function.

**Value**

dhurea gives the density.

**Warning**

The cases \( x = 0, x = 1, \) shape \( = 0 \) and shape \( = \infty \) may not be handled correctly.

**Note**

Difficulties are encountered as the shape parameter approaches 0 with respect to *integrate* because the density converges to a degenerate distribution with probability mass at 0 and 1. That is, when \( s \) is around 0.5 the density is “u” shaped and the area around the endpoints becomes concentrated at the two points. See the examples below. Approximately, the density is “u” shaped for \( s < 1 \) and unimodal for \( s > 2 \).
#### hurea

**Author(s)**

T. W. Yee

**See Also**

hurea.

**Examples**

```r
integrate(dhurea, 0, 1, shape = 0.20) # Incorrect
integrate(dhurea, 0, 1, shape = 0.35) # struggling but okay
## Not run: x <- seq(0, 1, length = 501)
par(mfrow = c(2, 2))
plot(x, dhurea(x, 0.7), col = "blue", type = "l")
plot(x, dhurea(x, 1.1), col = "blue", type = "l")
plot(x, dhurea(x, 1.4), col = "blue", type = "l")
plot(x, dhurea(x, 3.0), col = "blue", type = "l")
## End(Not run)
```

---

**hurea**  

*Husler-Reiss Angular Surface Distribution Family Function*

**Description**

Estimating the parameter of the Husler-Reiss angular surface distribution by maximum likelihood estimation.

**Usage**

```r
hurea(lshape = "loglink", zero = NULL, nrfs = 1,
gshape = exp(3 * ppoints(5) - 1), parallel = FALSE)
```

**Arguments**

- `lshape`, `gshape`  
  Details at `CommonVGAMffArguments`.
- `nrfs`, `zero`, `parallel`  
  Details at `CommonVGAMffArguments`.

**Details**

The Husler-Reiss angular surface distribution has a probability density function that can be written

\[ f(y; s) = \frac{s}{(4 \sqrt{2 \pi} y(1 - y)^2)} \exp \left( -\frac{(2 + s^2 \log y)^2}{8s^2} \right) \]

for \(0 < y < 1\) and positive shape parameter \(s\). The mean of \(Y\) is currently unknown to me, as well as its quantiles. Hence \(s\) is currently returned as the fitted values. Fisher-scoring is implemented.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

This VGAM family function handles multiple responses. It may struggle and/or fail when s is close to 0. Some comments about “u”-shaped versus unimodal densities accommodated by this distribution are at dhurea.

Author(s)

T. W. Yee

References


See Also

hurea.

Examples

```r
nn <- 100; set.seed(1)
hdata <- data.frame(x2 = runif(nn))
hdata <-
  transform(hdata, # Cannot generate proper random variates!
    y1 = rbeta(nn, shape1 = 0.5, shape2 = 0.5), # "U" shaped
    y2 = rnorm(nn, 0.65, sd = exp(-3 - 4 * x2)))
# Multiple responses:
hfit <- vglm(cbind(y1, y2) ~ x2, hurea, hdata, trace = TRUE)
coef(hfit, matrix = TRUE)
summary(hfit)
```

---

**hyperg**  
*Hypergeometric Family Function*

Description

Family function for a hypergeometric distribution where either the number of white balls or the total number of white and black balls are unknown.

Usage

```r
hyperg(N = NULL, D = NULL, lprob = "logitlink", iprob = NULL)
```
Arguments

N  Total number of white and black balls in the urn. Must be a vector with positive values, and is recycled, if necessary, to the same length as the response. One of N and D must be specified.

D  Number of white balls in the urn. Must be a vector with positive values, and is recycled, if necessary, to the same length as the response. One of N and D must be specified.

lprob  Link function for the probabilities. See Links for more choices.

iprob  Optional initial value for the probabilities. The default is to choose initial values internally.

Details

Consider the scenario from dhyper where there are $N = m + n$ balls in an urn, where $m$ are white and $n$ are black. A simple random sample (i.e., without replacement) of $k$ balls is taken. The response here is the sample proportion of white balls. In this document, $N$ is $N = m + n$, $D$ is $m$ (for the number of “defectives”, in quality control terminology, or equivalently, the number of marked individuals). The parameter to be estimated is the population proportion of white balls, viz. $\text{prob} = m/(m + n)$.

Depending on which one of $N$ and $D$ is inputted, the estimate of the other parameter can be obtained from the equation $\text{prob} = m/(m + n)$, or equivalently, $\text{prob} = D/N$. However, the log-factorials are computed using lgamma and both $m$ and $n$ are not restricted to being integer. Thus if an integer $N$ is to be estimated, it will be necessary to evaluate the likelihood function at integer values about the estimate, i.e., at trunc(Nhat) and ceiling(Nhat) where Nhat is the (real) estimate of $N$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, vgam, rrvglm, cqo, and cao.

Warning

No checking is done to ensure that certain values are within range, e.g., $k \leq N$.

Note

The response can be of one of three formats: a factor (first level taken as success), a vector of proportions of success, or a 2-column matrix (first column = successes) of counts. The argument weights in the modelling function can also be specified. In particular, for a general vector of proportions, you will need to specify weights because the number of trials is needed.

Author(s)

Thomas W. Yee

References

See Also

dhyper, binomialff.

Examples

```r
nn <- 100
m <- 5  # Number of white balls in the population
k <- rep(4, len = nn)  # Sample sizes
n <- 4  # Number of black balls in the population
y <- rhyper(nn = nn, m = m, n = n, k = k)
yprop <- y / k  # Sample proportions

# N is unknown, D is known. Both models are equivalent:
fit <- vglm(cbind(y, k-y) ~ 1, hyperg(D = m), trace = TRUE, crit = "c")
fit <- vglm(yprop ~ 1, hyperg(D = m), weight = k, trace = TRUE, crit = "c")

# N is known, D is unknown. Both models are equivalent:
fit <- vglm(cbind(y, k-y) ~ 1, hyperg(N = m+n), trace = TRUE, crit = "l")
fit <- vglm(yprop ~ 1, hyperg(N = m+n), weight = k, trace = TRUE, crit = "l")

coef(fit, matrix = TRUE)
Coef(fit)  # Should be equal to the true population proportion
unique(m / (m+n))  # The true population proportion
fit@extra
head(fitted(fit))
summary(fit)
```

---

**hypersecant**  
Hyperbolic Secant Regression Family Function

**Description**

Estimation of the parameter of the hyperbolic secant distribution.

**Usage**

```r
hypersecant(link.theta = extlogitlink(min = -pi/2, max = pi/2),
            init.theta = NULL)
hypersecant01(link.theta = extlogitlink(min = -pi/2, max = pi/2),
              init.theta = NULL)
```

**Arguments**

- `link.theta`  
  Parameter link function applied to the parameter $\theta$. See `Links` for more choices.

- `init.theta`  
  Optional initial value for $\theta$. If failure to converge occurs, try some other value. The default means an initial value is determined internally.
Details

The probability density function of the hyperbolic secant distribution is given by

\[ f(y; \theta) = \frac{\exp(\theta y + \log(\cos(\theta))}{2 \cosh(\pi y/2)}, \]

for parameter \(-\pi/2 < \theta < \pi/2\) and all real \(y\). The mean of \(Y\) is \(\tan(\theta)\) (returned as the fitted values). Morris (1982) calls this model NEF-HS (Natural Exponential Family-Hyperbolic Secant). It is used to generate NEFs, giving rise to the class of NEF-GHS (G for Generalized).

Another parameterization is used for \(\text{hypersecant01()}: \) let \(Y = (\logit U)/\pi\). Then this uses

\[ f(u; \theta) = \frac{(\cos(\theta)/\pi) \times u^{-0.5+\theta/\pi} \times (1 - u)^{-0.5-\theta/\pi}}, \]

for parameter \(-\pi/2 < \theta < \pi/2\) and \(0 < u < 1\). Then the mean of \(U\) is \(0.5 + \theta/\pi\) (returned as the fitted values) and the variance is \((\pi^2 - 4\theta^2)/(8\pi^2)\).

For both parameterizations Newton-Raphson is same as Fisher scoring.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Author(s)

T. W. Yee

References


See Also

gensh, extlogitlink.

Examples

```r
hdata <- data.frame(x2 = rnorm(nn <- 200))
hdata <- transform(hdata, y = rnorm(nn)) # Not very good data!
fit1 <- vglm(y ~ x2, hypersecant, hdata, trace = TRUE, crit = "c")
coef(fit1, matrix = TRUE)
fit1@misc$earg

# Not recommended:
fit2 <- vglm(y ~ x2, hypersecant(link = "identitylink"), hdata)
coef(fit2, matrix = TRUE)
fit2@misc$earg
```
**Description**

Density, distribution function, quantile function and random generation for Haight’s zeta distribution with parameter `shape`.

**Usage**

```r
dhzeta(x, shape, log = FALSE)
phzeta(q, shape, log.p = FALSE)
qhzeta(p, shape)
rhzeta(n, shape)
```

**Arguments**

- `x, q, p, n`: Same meaning as `runif`.
- `shape`: The positive shape parameter. Called $\alpha$ below.
- `log, log.p`: Same meaning as in `pnorm` or `qnorm`.

**Details**

The probability function is

$$f(x) = (2x - 1)^{(-\alpha)} - (2x + 1)^{(-\alpha)},$$

where $\alpha > 0$ and $x = 1, 2, \ldots$.

**Value**

- `dhzeta` gives the density, `phzeta` gives the distribution function, `qhzeta` gives the quantile function, and `rhzeta` generates random deviates.

**Note**

Given some response data, the VGAM family function `hzeta` estimates the parameter `shape`.

**Author(s)**

T. W. Yee and Kai Huang

**See Also**

`hzeta`, `zeta`, `zetaff`, `simulate.vlm`. 
Examples

dhzeta(1:20, 2.1)
rhzeta(20, 2.1)

round(1000 * dhzeta(1:8, 2))
table(rhzeta(1000, 2))

## Not run: shape <- 1.1; x <- 1:10
plot(x, dhzeta(x, shape = shape), type = "h", ylim = 0:1,
    sub = paste("shape =", shape), las = 1, col = "blue",
    ylab = "Probability", lwd = 2,
    main = "Haight's zeta: blue = density; orange = CDF")
lines(x+0.1, phzeta(x, shape = shape), col = "orange", lty = 3, lwd = 2,
    type = "h")

## End(Not run)

hzeta

Haight's Zeta Family Function

Description

Estimating the parameter of Haight's zeta distribution

Usage

hzeta(lshape = "logloglink", ishape = NULL, nsimEIM = 100)

Arguments

lshape Parameter link function for the parameter, called $\alpha$ below. See Links for more choices. Here, a log-log link keeps the parameter greater than one, meaning the mean is finite.

ishape,nsimEIM See CommonVGAMffArguments for more information.

Details

The probability function is

$$f(y) = (2y - 1)^{-\alpha} - (2y + 1)^{-\alpha},$$

where the parameter $\alpha > 0$ and $y = 1, 2, \ldots$. The function dhzeta computes this probability function. The mean of $Y$, which is returned as fitted values, is $(1 - 2^{-\alpha})\zeta(\alpha)$ provided $\alpha > 1$, where $\zeta$ is Riemann's zeta function. The mean is a decreasing function of $\alpha$. The mean is infinite if $\alpha \leq 1$, and the variance is infinite if $\alpha \leq 2$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgaml.
Author(s)
T. W. Yee

References

See Also
*Hzeta, zeta, zetaff, loglog, simulate.vlm*.

Examples
```r
shape <- exp(exp(-0.1))  # The parameter
data <- data.frame(y = rhzeta(n = 1000, shape))
fit <- vglm(y ~ 1, hzeta, data = data, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)  # Useful for intercept-only models; should be same as shape
c(with(data, mean(y)), head(fitted(fit), 1))
summary(fit)
```

iam

*Index from Array to Matrix*

Description
Maps the elements of an array containing symmetric positive-definite matrices to a matrix with sufficient columns to hold them (called matrix-band format.)

Usage
```r
iam(j, k, M, both = FALSE, diag = TRUE)
```

Arguments

- **j**
  Usually an integer from the set \{1:M\} giving the row number of an element. However, the argument can also be a vector of length M, for selecting an entire row or column, e.g., `iam(1:M, 1, M)` or `iam(1, 1:M, M)`.

- **k**
  An integer from the set \{1:M\} giving the column number of an element.

- **M**
  The number of linear/additive predictors. This is the dimension of each positive-definite symmetric matrix.

- **both**
  Logical. Return both the row and column indices? See below for more details.

- **diag**
  Logical. Return the indices for the diagonal elements? If FALSE then only the strictly upper triangular part of the matrix elements are used.
Suppose we have \( n \) symmetric positive-definite square matrices, each \( M \) by \( M \), and these are stored in an array of dimension \( \mathbf{c}(n,M,M) \). Then these can be more compactly represented by a matrix of dimension \( \mathbf{c}(n,K) \) where \( K \) is an integer between \( M \) and \( M*(M+1)/2 \) inclusive. The mapping between these two representations is given by this function. It firstly enumerates by the diagonal elements, followed by the band immediately above the diagonal, then the band above that one, etc. The last element is \((1,M)\). This function performs the mapping from elements \((j,k)\) of symmetric positive-definite square matrices to the columns of another matrix representing such. This is called the \textit{matrix-band} format and is used by the \textsc{VGAM} package.

This function has a dual purpose depending on the value of \( \text{both} \). If \( \text{both} = \text{FALSE} \) then the column number corresponding to the \( j-k \) element of the matrix is returned. If \( \text{both} = \text{TRUE} \) then \( j \) and \( k \) are ignored and a list with the following components are returned.

- \texttt{row.index} \textbullet{} The row indices of the upper triangular part of the matrix (This may or may not include the diagonal elements, depending on the argument \texttt{diagonal}).
- \texttt{col.index} \textbullet{} The column indices of the upper triangular part of the matrix (This may or may not include the diagonal elements, depending on the argument \texttt{diagonal}).

This function is used in the weight slot of many \textsc{VGAM} family functions (see \texttt{vglmff-class}), especially those whose \( M \) is determined by the data, e.g., \texttt{dirichlet}, \texttt{multinomial}.

T. W. Yee

\texttt{vglmff-class}.

\textbf{Examples}

\begin{verbatim}
iam(1, 2, M = 3) # The 4th coln represents elt (1,2) of a 3x3 matrix
iam(NULL, NULL, M = 3, both = TRUE) # Return the row & column indices
dirichlet()@weight

M <- 4
temp1 <- iam(NA, NA, M = M, both = TRUE)
mat1 <- matrix(NA, M, M)
mat1[cbind(temp1$row, temp1$col)] = 1:length(temp1$row)
mat1 # More commonly used

temp2 <- iam(NA, NA, M = M, both = TRUE, diag = FALSE)
mat2 <- matrix(NA, M, M)
mat2[cbind(temp2$row, temp2$col)] = 1:length(temp2$row)
mat2 # Rarely used
\end{verbatim}
Identity Link Function

Description
Computes the identity transformation, including its inverse and the first two derivatives.

Usage

\[
identitylink(\theta, \text{inverse} = \text{FALSE}, \text{deriv} = 0, \text{short} = \text{TRUE}, \text{tag} = \text{FALSE}) \\
negidentitylink(\theta, \text{inverse} = \text{FALSE}, \text{deriv} = 0, \text{short} = \text{TRUE}, \text{tag} = \text{FALSE})
\]

Arguments

- \(\theta\) Numeric or character. See below for further details.
- inverse, deriv, short, tag Details at Links.

Details

The identity link function \(g(\theta) = \theta\) should be available to every parameter estimated by the VGAM library. However, it usually results in numerical problems because the estimates lie outside the permitted range. Consequently, the result may contain Inf, -Inf, NA or NaN.

The function negidentitylink is the negative-identity link function and corresponds to \(g(\theta) = -\theta\). This is useful for some models, e.g., in the literature supporting the gevff function it seems that half of the authors use \(\xi = -k\) for the shape parameter and the other half use \(k\) instead of \(\xi\).

Value

For identitylink(): for deriv = 0, the identity of theta, i.e., theta when inverse = FALSE, and if inverse = TRUE then theta. For deriv = 1, then the function returns \(d\eta/d\theta\) as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

For negidentitylink(): the results are similar to identitylink() except for a sign change in most cases.

Author(s)

Thomas W. Yee

References

Influence

Description

Returns a matrix containing the influence function of a fitted model, e.g., a "vglm" object.

Usage

Influence(object, ...)
Influence.vglm(object, weighted = TRUE, ...)

Arguments

object an object, especially that of class "vglm"—see \texttt{vglm-class}. Currently other classes such as "vgam" are not yet implemented.
weighted Logical. Include the prior weights? Currently only \texttt{TRUE} is accepted. This might change in the future and/or the default value might change.
... any additional arguments such as to allow or disallow the prior weights.

Details

Influence functions are useful in fields such as sample survey theory, e.g., \texttt{survey}, \texttt{svyVGAM}. For each \( i = 1, \ldots, n \), the formula is approximately \(-IU\) where \( I \) is the weighted Fisher information matrix and \( U \) is the \( i \)th score vector.

Value

An \( n \) by \( p.vlm \) matrix.

Warning

This function is currently experimental and defaults may change. Use with caution! The functions here should not be confused with \texttt{lm.influence}.

See Also

\texttt{Links, loglink, logitlink, probitlink, powerlink}.

Examples

identitylink((-5):5)
identitylink((-5):5, deriv = 1)
identitylink((-5):5, deriv = 2)
negidentitylink((-5):5)
negidentitylink((-5):5, deriv = 1)
negidentitylink((-5):5, deriv = 2)
inv.binomial

Inverse Binomial Distribution Family Function

Description

Estimates the two parameters of an inverse binomial distribution by maximum likelihood estimation.

Usage

inv.binomial(lrho = extlogitlink(min = 0.5, max = 1),
               llambda = "loglink", irho = NULL, ilambda = NULL, zero = NULL)

Arguments

lrho, llambda Link function for the $\rho$ and $\lambda$ parameters. See Links for more choices.
irho, ilambda Numeric. Optional initial values for $\rho$ and $\lambda$.
zero Refer to CommonVGAMffArguments.

Details

The inverse binomial distribution of Yanagimoto (1989) has density function

$$f(y; \rho, \lambda) = \frac{\lambda \Gamma(2y + \lambda)}{\Gamma(y + 1) \Gamma(y + \lambda + 1)} \{\rho(1 - \rho)\}^y \rho^\lambda$$

where $y = 0, 1, 2, \ldots$ and $\frac{1}{2} < \rho < 1$, and $\lambda > 0$. The first two moments exist for $\rho > \frac{1}{2}$; then the mean is $\lambda(1 - \rho)/(2\rho - 1)$ (returned as the fitted values) and the variance is $\lambda \rho(1 - \rho)/(2\rho - 1)^3$. The inverse binomial distribution is a special case of the generalized negative binomial distribution of Jain and Consul (1971). It holds that $Var(Y) > E(Y)$ so that the inverse binomial distribution is overdispersed compared with the Poisson distribution.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

See Also

vglm, vglm-class, survey.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, acat, data = pneumo)
coef(fit) # 8-vector
Influence(fit) # 8 x 4
all(abs(colSums(Influence(fit))) < 1e-6) # TRUE
Note

This VGAM family function only works reasonably well with intercept-only models. Good initial values are needed; if convergence failure occurs use irho and/or ilambda.

Some elements of the working weight matrices use the expected information matrix while other elements use the observed information matrix. Yet to do: using the mean and the reciprocal of $\lambda$ results in an EIM that is diagonal.

Author(s)

T. W. Yee

References


See Also

`negbinomial`, `poissonff`.

Examples

```r
idata <- data.frame(y = rnbinom(n = 1000, mu = exp(3), size = exp(1)))
fit <- vglm(y ~ 1, inv.binomial, data = idata, trace = TRUE)
with(idata, c(mean(y), head(fitted(fit), 1)))
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit)
sum(weights(fit)) # Sum of the prior weights
sum(weights(fit, type = "work")) # Sum of the working weights
```

---

**Inv.gaussian**  
*The Inverse Gaussian Distribution*

Description

Density, distribution function and random generation for the inverse Gaussian distribution.

Usage

```r
dinv.gaussian(x, mu, lambda, log = FALSE)
pinv.gaussian(q, mu, lambda)
rinv.gaussian(n, mu, lambda)
```
Arguments

- **x, q**: vector of quantiles.
- **n**: number of observations. If `length(n) > 1` then the length is taken to be the number required.
- **mu**: the mean parameter.
- **lambda**: the \( \lambda \) parameter.
- **log**: Logical. If `log = TRUE` then the logarithm of the density is returned.

Details

See `inv.gaussianff`, the VGAM family function for estimating both parameters by maximum likelihood estimation, for the formula of the probability density function.

Value

- `dinv.gaussian` gives the density.
- `pinv.gaussian` gives the distribution function.
- `rinv.gaussian` generates random deviates.

Note

Currently `qinv.gaussian` is unavailable.

Author(s)

T. W. Yee

References


See Also

- `inv.gaussianff`
- `waldff`

Examples

```r
## Not run: x <- seq(-0.05, 4, len = 300)
plot(x, dinv.gaussian(x, mu = 1, lambda = 1), type = "l",
    col = "blue", las = 1, main =
    "blue is density, orange is cumulative distribution function")
abline(h = 0, col = "gray", lty = 2)
lines(x, pinv.gaussian(x, mu = 1, lambda = 1), type = "l", col = "orange")
## End(Not run)
```
inv.gaussianff

Inverse Gaussian Distribution Family Function

Description

Estimates the two parameters of the inverse Gaussian distribution by maximum likelihood estimation.

Usage

```r
inv.gaussianff(lmu = "loglink", llambda = "loglink",
imethod = 1, ilambda = NULL,
parallel = FALSE, ishrinkage = 0.99, zero = NULL)
```

Arguments

- `lmu, llambda` Parameter link functions for the \( \mu \) and \( \lambda \) parameters. See \texttt{Links} for more choices.
- `ilambda, parallel` See \texttt{CommonVGAMffArguments} for more information. If \texttt{parallel = TRUE} then the constraint is not applied to the intercept.
- `imethod, ishrinkage, zero` See \texttt{CommonVGAMffArguments} for information.

Details

The standard ("canonical") form of the inverse Gaussian distribution has a density that can be written as

\[
f(y; \mu, \lambda) = \sqrt{\lambda/(2\pi y^3)} \exp \left(-\lambda(y - \mu)^2/(2y\mu^2)\right)
\]

where \( y > 0 \), \( \mu > 0 \), and \( \lambda > 0 \). The mean of \( Y \) is \( \mu \) and its variance is \( \mu^3/\lambda \). By default, \( \eta_1 = \log(\mu) \) and \( \eta_2 = \log(\lambda) \). The mean is returned as the fitted values. This \texttt{VGAM} family function can handle multiple responses (inputted as a matrix).

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, \texttt{rrvglm} and \texttt{vgam}.

Note

The inverse Gaussian distribution can be fitted (to a certain extent) using the usual GLM framework involving a scale parameter. This family function is different from that approach in that it estimates both parameters by full maximum likelihood estimation.

Author(s)

T. W. Yee
References


See Also

`Inv.gaussian, waldf, bisa`.

The R package *SuppDists* has several functions for evaluating the density, distribution function, quantile function and generating random numbers from the inverse Gaussian distribution.

Examples

```r
idata <- data.frame(x2 = runif(nn <- 1000))
idata <- transform(idata, mymu = exp(2 + 1 * x2),
                   Lambda = exp(2 + 1 * x2))
idata <- transform(idata, y = rinv.gaussian(nn, mu = mymu, Lambda))
fit1 <- vglm(y ~ x2, inv.gaussianff, data = idata, trace = TRUE)
rrig <- rrvglm(y ~ x2, inv.gaussianff, data = idata, trace = TRUE)
coef(fit1, matrix = TRUE)
coef(rrig, matrix = TRUE)
Coeff(rrig)
summary(fit1)
```

Inv.lomax  

*The Inverse Lomax Distribution*

Description

Density, distribution function, quantile function and random generation for the inverse Lomax distribution with shape parameter `p` and scale parameter `scale`.

Usage

```r
dinv.lomax(x, scale = 1, shape2.p, log = FALSE)
pinv.lomax(q, scale = 1, shape2.p, lower.tail = TRUE, log.p = FALSE)
qinv.lomax(p, scale = 1, shape2.p, lower.tail = TRUE, log.p = FALSE)
rinv.lomax(n, scale = 1, shape2.p)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1`, the length is taken to be the number required.
shape2.p  shape parameter.
scale    scale parameter.
log      Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p
          Same meaning as in pnorm or qnorm.

Details

See inv.lomax, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.

Value

dinv.lomax gives the density, pinv.lomax gives the distribution function, qinv.lomax gives the quantile function, and rinv.lomax generates random deviates.

Note

The inverse Lomax distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)

T. W. Yee

References


See Also

inv.lomax, genbetaII.

Examples

data <- data.frame(y = rinv.lomax(n = 1000, exp(2), exp(1)))
fit <- vglm(y ~ 1, inv.lomax, data, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
inv.lomax

Inverse Lomax Distribution Family Function

Description

Maximum likelihood estimation of the 2-parameter inverse Lomax distribution.

Usage

```r
inv.lomax(lscale = "loglink", lshape2.p = "loglink", iscale = NULL,
          ishape2.p = NULL, imethod = 1, gscale = exp(-5:5),
          gshape2.p = exp(-5:5), probs.y = c(0.25, 0.5, 0.75),
          zero = "shape2.p")
```

Arguments

- `lscale, lshape2.p`  
  Parameter link functions applied to the (positive) parameters $b$, and $p$. See Links for more choices.
- `iscale, ishape2.p, imethod, zero`  
  See CommonVGAMffArguments for information. For `imethod = 2` a good initial value for `ishape2.p` is needed to obtain a good estimate for the other parameter.
- `gscale, gshape2.p`  
  See CommonVGAMffArguments for information.
- `probs.y`  
  See CommonVGAMffArguments for information.

Details

The 2-parameter inverse Lomax distribution is the 4-parameter generalized beta II distribution with shape parameters $a = q = 1$. It is also the 3-parameter Dagum distribution with shape parameter $a = 1$, as well as the beta distribution of the second kind with $q = 1$. More details can be found in Kleiber and Kotz (2003).

The inverse Lomax distribution has density

$$f(y) = py^{p-1}/[b^p(1 + y/b)^{p+1}]$$

for $b > 0$, $p > 0$, $y \geq 0$. Here, $b$ is the scale parameter scale, and $p$ is a shape parameter. The mean does not seem to exist; the median is returned as the fitted values. This family function handles multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

See the notes in genbetaII.
**Inv.paralogistic**

The Inverse Paralogistic Distribution

**Description**

Density, distribution function, quantile function and random generation for the inverse paralogistic distribution with shape parameters \(a\) and \(p\), and scale parameter \(scale\).

**Usage**

```r
dinv.paralogistic(x, scale = 1, shape1.a, log = FALSE)
pinv.paralogistic(q, scale = 1, shape1.a, lower.tail = TRUE, log.p = FALSE)
qinv.paralogistic(p, scale = 1, shape1.a, lower.tail = TRUE, log.p = FALSE)
rinv.paralogistic(n, scale = 1, shape1.a)
```

**Arguments**

- \(x, q\) vector of quantiles.
- \(p\) vector of probabilities.
- \(n\) number of observations. If \(\text{length}(n) > 1\), the length is taken to be the number required.
- \(shape1.a\) shape parameter.

**Examples**

```r
idata <- data.frame(y = rinv.lomax(2000, sc = exp(2), exp(1)))
fit <- vglm(y ~ 1, inv.lomax, data = idata, trace = TRUE)
fit <- vglm(y ~ 1, inv.lomax(iscale = exp(3)), data = idata, 
            trace = TRUE, epsilon = 1e-8, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```

**Author(s)**

T. W. Yee

**References**


**See Also**

`inv.lomax, genbetaII, betaII, dagum, sinmad, fisk, lomax, paralogistic, inv.paralogistic, simulate.vlm`
scale  scale parameter.
log    Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p

Same meaning as in pnorm or qnorm.

Details

See inv.paralogistic, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.

Value

dinv.paralogistic gives the density, pinv.paralogistic gives the distribution function, qinv.paralogistic gives the quantile function, and rinv.paralogistic generates random deviates.

Note

The inverse paralogistic distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)

T. W. Yee

References


See Also

inv.paralogistic, genbetaII.

Examples

ida <- data.frame(y = rinv.paralogistic(3000, exp(1), sc = exp(2)))
fit <- vglm(y ~ 1, inv.paralogistic(1ss = FALSE, ishape1.a = 2.1),
    data = ida, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
Inverse Paralogistic Distribution Family Function

Description

Maximum likelihood estimation of the 2-parameter inverse paralogistic distribution.

Usage

```r
inv.paralogistic(lscale = "loglink", lshape1.a = "loglink", iscale = NULL, ishape1.a = NULL, imethod = 1, lss = TRUE, gscale = exp(-5:5), gshape1.a = seq(0.75, 4, by = 0.25), probs.y = c(0.25, 0.5, 0.75), zero = "shape")
```

Arguments

- `lss` See CommonVGAMffArguments for important information.
- `lshape1.a`, `lscale` Parameter link functions applied to the (positive) parameters $a$ and scale. See Links for more choices.
- `iscale`, `ishape1.a`, `imethod`, `zero` See CommonVGAMffArguments for information. For `imethod = 2` a good initial value for `ishape1.a` is needed to obtain a good estimate for the other parameter.
- `gscale`, `gshape1.a` See CommonVGAMffArguments for information.
- `probs.y` See CommonVGAMffArguments for information.

Details

The 2-parameter inverse paralogistic distribution is the 4-parameter generalized beta II distribution with shape parameter $q = 1$ and $a = p$. It is the 3-parameter Dagum distribution with $a = p$. More details can be found in Kleiber and Kotz (2003).

The inverse paralogistic distribution has density

$$f(y) = a^2 y^{a^2 - 1} / [b^{a^2} \{1 + (y/b)^a\}^{a+1}]$$

for $a > 0$, $b > 0$, $y \geq 0$. Here, $b$ is the scale parameter scale, and $a$ is the shape parameter. The mean is

$$E(Y) = b \Gamma(a + 1/a) \Gamma(1 - 1/a)/\Gamma(a)$$

provided $a > 1$; these are returned as the fitted values. This family function handles multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.
Note

See the notes in `genbetaII`.

Author(s)

T. W. Yee

References


See Also

`Inv.paralogistic`, `genbetaII`, `betaII`, `dagum`, `sinmad`, `fisk`, `inv.lomax`, `lomax`, `paralogistic`, `simulate.vlm`.

Examples

```r
idata <- data.frame(y = rinv.paralogistic(3000, exp(1), sc = exp(2)))
fit <- vglm(y ~ 1, inv.paralogistic(lss = FALSE), idata, trace = TRUE)
fit <- vglm(y ~ 1, inv.paralogistic(imethod = 2, ishape1.a = 4),
            data = idata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```

---

### is.buggy

**Does the Fitted Object Suffer from a Known Bug?**

**Description**

Checks to see if a fitted object suffers from some known bug.

**Usage**

```r
is.buggy(object, ...)
is.buggy.vlm(object, each.term = FALSE, ...)
```

**Arguments**

- **object**
  A fitted *VGAM* object, e.g., from `vgam`.
- **each.term**
  Logical. If TRUE then a logical is returned for each term.
- **...**
  Unused for now.
Details

It is known that `vgam` with `s` terms do not correctly handle constraint matrices (`cmat`, say) when `crossprod(cmat)` is not diagonal. This function detects whether this is so or not. Note that probably all VGAM family functions have defaults where all `crossprod(cmat)`s are diagonal, therefore do not suffer from this bug. It is more likely to occur if the user inputs constraint matrices using the `constraints` argument (and setting `zero = NULL` if necessary).

Second-generation VGAMs based on `sm.ps` are a modern alternative to using `s`. It does not suffer from this bug. However, G2-VGAMs require a reasonably large sample size in order to work more reliably.

Value

The default is a single logical (true if any term is true), otherwise a vector of such with each element corresponding to a term. If the value is true then I suggest replacing the VGAM by a similar model fitted by `vglm` and using regression splines, e.g., `bs, ns`.

Note

When the bug is fixed this function may be withdrawn, otherwise always return FALSEs!

Author(s)

T. W. Yee

See Also

`vgam, vglm, s, sm.ps, bs, ns`.

Examples

```r
    fit1 <- vgam(cbind(agaaus, kniexc) ~ s(altitude, df = c(3, 4)),
                 binomialff(multiple.responses = TRUE), data = hunua)
    is.buggy(fit1)  # Okay
    is.buggy(fit1, each.term = TRUE)  # No terms are buggy
    fit2 <-
      vgam(cbind(agaaus, kniexc) ~ s(altitude, df = c(3, 4)),
           binomialff(multiple.responses = TRUE), data = hunua,
           constraints =
             list("(Intercept)" = diag(2),
                "s(altitude, df = c(3, 4))" = matrix(c(1, 1, 0, 1), 2, 2)))
    is.buggy(fit2)  # TRUE
    is.buggy(fit2, each.term = TRUE)
    constraints(fit2)
    # fit2b is an approximate alternative to fit2:
    fit2b <-
      vglm(cbind(agaaus, kniexc) ~ bs(altitude, df=3) + bs(altitude, df=4),
           binomialff(multiple.responses = TRUE), data = hunua,
           constraints =
             list("(Intercept)" = diag(2),
                "s(altitude, df = c(3, 4))" = matrix(c(1, 1, 0, 1), 2, 2)))
```
is.crossing

Quantile Crossing Detection

Description

Returns a logical from testing whether an object such as an extlogF1() VGLM object has crossing quantiles.

Usage

is.crossing.vglm(object, ...)

Arguments

object an object such as a vglm object with family function extlogF1.
... additional optional arguments. Currently unused.

Details

This function was specifically written for a vglm with family function extlogF1. It examines the fitted quantiles to see if any cross. Note that if one uses regression splines such as bs and ns then it is possible that they cross at values of the covariate space that are not represented by actual data. One could use linear interpolation between fitted values to get around this problem.

Value

A logical. If TRUE then one can try fit a similar model by combining columns of the constraint matrices so that crossing no longer holds; see fix.crossing. For LMS-Box-Cox type quantile regression models it is impossible for the quantiles to cross, by definition, hence FALSE is returned; see lms.bcn.

See Also

extlogF1, fix.crossing, lms.bcn, vglm.
Examples

```r
## Not run: ooo <- with(bmi.nz, order(age))
bmi.nz <- bmi.nz[ooo,]  # Sort by age
with(bmi.nz, plot(age, BMI, col = "blue"))
mytau <- c(50, 93, 95, 97) / 100  # Some quantiles are quite close
fit1 <- vglm(BMI ~ ns(age, 7), extlogF1(mytau), bmi.nz, trace = TRUE)
plot(BMI ~ age, bmi.nz, col = "blue", las = 1,
     main = "Partially parallel (darkgreen) & nonparallel quantiles",
     sub = "Crossing quantiles are orange")
is.crossing(fit1)
matlines(with(bmi.nz, age), fitted(fit1), lty = 1, col = "orange")
## End(Not run)
```

is.parallel

Parallelism Constraint Matrices

Description

Returns a logical vector from a test of whether an object such as a matrix or VGLM object corresponds to a parallelism assumption.

Usage

```r
is.parallel.matrix(object, ...)  
is.parallel.vglm(object, type = c("term", "lm"), ...)
```

Arguments

- **object**: an object such as a constraint matrix or a `vglm` object.
- **type**: passed into `constraints`.
- **...**: additional optional arguments. Currently unused.

Details

These functions may be useful for categorical models such as `propodds`, `cumulative`, `acat`, `cratio`, `sratio`, `multinomial`.

Value

A vector of logics, testing whether each constraint matrix is a one-column matrix of ones. Note that parallelism can still be thought of as holding if the constraint matrix has a non-zero but constant values, however, this is currently not implemented. No checking is done that the constraint matrices have the same number of rows.

See Also

- `constraints`, `vglm`
### is.smart

**Test For a Smart Object**

**Description**
Tests an object to see if it is smart.

**Usage**

```r
is.smart(object)
```

**Arguments**

- `object`: a function or a fitted model.

**Details**

If `object` is a function then this function looks to see whether `object` has the logical attribute `"smart"`. If so then this is returned, else FALSE.

If `object` is a fitted model then this function looks to see whether `object@smart.prediction` or `object\$smart.prediction` exists. If it does and it is not equal to `list(smart.arg=FALSE)` then a TRUE is returned, else FALSE. The reason for this is because, e.g., `lm(...,smart=FALSE)` and `vglm(...,smart=FALSE)`, will return such a specific list.

Writers of smart functions manually have to assign this attribute to their smart function after it has been written.

**Value**

Returns TRUE or FALSE, according to whether the object is smart or not.

**Examples**

```r
is.smart(sm.min1) # TRUE
is.smart(sm.poly) # TRUE
library(splines)
is.smart(sm.bs)   # TRUE
is.smart(sm.ns)   # TRUE
is.smart(tan)     # FALSE
# Not run:
```
is.zero <- data.frame(x2 = rnorm(9))
fit1 <- vglm(rnorm(9) ~ x2, uninormal, data = udata)
is.smart(fit1)  # TRUE
fit2 <- vglm(rnorm(9) ~ x2, uninormal, data = udata, smart = FALSE)
is.smart(fit2)  # FALSE
fit2@smart.prediction

## End(Not run)

### is.zero Zero Constraint Matrices

**Description**

Returns a logical vector from a test of whether an object such as a matrix or VGLM object corresponds to a 'zero' assumption.

**Usage**

```r
is.zero.matrix(object, ...)
is.zero.vglm(object, ...)
```

**Arguments**

- `object` an object such as a coefficient matrix of a `vglm` object, or a `vglm` object.
- `...` additional optional arguments. Currently unused.

**Details**

These functions test the effect of the `zero` argument on a `vglm` object or the coefficient matrix of a `vglm` object. The latter is obtained by `coef(vglmObject, matrix = TRUE)`.

**Value**

A vector of logics, testing whether each linear/additive predictor has the `zero` argument applied to it. It is `TRUE` if that linear/additive predictor is intercept-only, i.e., all other regression coefficients are set to zero.

No checking is done for the intercept term at all, i.e., that it was estimated in the first place.

**See Also**

`constraints, vglm, CommonVGAMffArguments`.

**Examples**

```r
coalminers <- transform(coalminers, Age = (age - 42) / 5)
fit <- vglm(cbind(nBnW,nBW,BnW,BW) ~ Age, binom2.or(zero = NULL),
            data = coalminers)
is.zero(fit)
is.zero(coef(fit, matrix = TRUE))
```
kendall.tau

Kendall’s Tau Statistic

Description

Computes Kendall’s Tau, which is a rank-based correlation measure, between two vectors.

Usage

kendall.tau(x, y, exact = FALSE, max.n = 3000)

Arguments

x, y  
Numeric vectors. Must be of equal length. Ideally their values are continuous and not too discrete. Let length(x) be N, say.

exact  
Logical. If TRUE then the exact value is computed.

max.n  
Numeric. If exact = FALSE and length(x) is more than max.n then a random sample of max.n pairs are chosen.

Details

Kendall’s tau is a measure of dependency in a bivariate distribution. Loosely, two random variables are concordant if large values of one random variable are associated with large values of the other random variable. Similarly, two random variables are discordant if large values of one random variable are associated with small values of the other random variable. More formally, if (x[i] - x[j])*(y[i] - y[j]) > 0 then that comparison is concordant (i ≠ j). And if (x[i] - x[j])*(y[i] - y[j]) < 0 then that comparison is discordant (i ≠ j). Out of choose(N, 2) comparisons, let c and d be the number of concordant and discordant pairs. Then Kendall’s tau can be estimated by (c - d)/(c + d). If there are ties then half the ties are deemed concordant and half discordant so that (c - d)/(c + d + t) is used.

Value

Kendall’s tau, which lies between -1 and 1.

Warning

If length(x) is large then the cost is O(N^2), which is expensive! Under these circumstances it is not advisable to set exact = TRUE or max.n to a very large number.

See Also

binormalcop, cor.
Examples

```r
N <- 5000; x <- 1:N; y <- runif(N)
true.rho <- -0.8
ymat <- rbinorm(N, cov12 = true.rho)  # Bivariate normal, aka N_2
x <- ymat[, 1]
y <- ymat[, 2]

## Not run: plot(x, y, col = "blue")

kendall.tau(x, y)  # A random sample is taken here
kendall.tau(x, y)  # A random sample is taken here

kendall.tau(x, y, exact = TRUE)  # Costly if length(x) is large
kendall.tau(x, y, max.n = N)    # Same as exact = TRUE

(rhohat <- sin(kendall.tau(x, y) * pi / 2))  # Holds for N_2 actually
true.rho  # rhohat should be near this value
```

KLD  

**Kullback-Leibler Divergence**

Description

Calculates the Kullback-Leibler divergence for certain fitted model objects

Usage

```r
KLD(object, ...)
KLDvglm(object, ...)
```

Arguments

- `object`  
  Some VGAM object, for example, having class `vglm-class`. Currently object must be intercept-only.

- `...`  
  Other possible arguments fed into `KLDvglm` in order to compute the KLD.

Details

The *Kullback-Leibler divergence* (KLD), or *relative entropy*, is a measure of how one probability distribution differs from a second reference probability distribution. Currently the VGAM package computes the KLD for GAITD regression models (e.g., see `gaitdpoisson` and `gaitdnbinomial`) where the reference distribution is the (unscaled) parent or base distribution. For such, the formula for the KLD simplifies somewhat. Hence one can obtain a quantitative measure for the overall effect of altering, inflating, truncating and deflating certain (special) values.

Value

Returns a numeric nonnegative value with the corresponding KLD. A 0 value means no difference between an ordinary parent or base distribution.
Warning

Numerical problems might occur if any of the evaluated probabilities of the unscaled parent distribution are very close to 0.

Author(s)

T. W. Yee.

References


See Also

gaitdpoisson, gaitdnbinomial.

Examples

# McKendrick (1925): Data from 223 Indian village households
cholera <- data.frame(ncases = 0:4, # Number of cholera cases,
                      wfreq = c(168, 32, 16, 6, 1)) # Frequencies
fit7 <- vglm(ncases ~ 1, gaitdpoisson(i.mlm = 0, ilambda.p = 1),
             weight = wfreq, data = cholera, trace = TRUE)
coef(fit7, matrix = TRUE)
KLD(fit7)
Arguments

- **x**, q: vector of quantiles.
- **p**: vector of probabilities.
- **n**: number of observations. If \( \text{length}(n) > 1 \) then the length is taken to be the number required.
- **shape1**, **shape2**: positive shape parameters.
- **log**: Logical. If \( \text{log} = \text{TRUE} \) then the logarithm of the density is returned.
- **lower.tail**, **log.p**: Same meaning as in \( \text{pnorm} \) or \( \text{qnorm} \).

Details

See **kumar**, the **VGAM** family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dkumar gives the density, pkumar gives the distribution function, qkumar gives the quantile function, and rkumar generates random deviates.

Author(s)

T. W. Yee and Kai Huang

See Also

kumar.

Examples

```r
## Not run:
shape1 <- 2; shape2 <- 2; nn <- 201; shape1 <- shape2 <- 0.5;
x <- seq(-0.05, 1.05, len = nn)
plot(x, dkumar(x, shape1, shape2), type = "l", las = 1,
ylab = paste("dkumar(shape1 = ", shape1,
"shape2 = ", shape2, ")"),
col = "blue", cex.main = 0.8, ylim = c(0,1.5),
main = "Blue is density, orange is the CDF",
sub = "Red lines are the 10,20,...,90 percentiles")
lines(x, pkumar(x, shape1, shape2), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qkumar(probs, shape1, shape2)
lines(Q, dkumar(Q, shape1, shape2), col = "red", lty = 3, type = "h")
lines(Q, pkumar(Q, shape1, shape2), col = "red", lty = 3, type = "h")
abline(h = probs, col = "red", lty = 3)
max(abs(pkumar(Q, shape1, shape2) - probs)) # Should be 0

## End(Not run)
```
**kumar**

**Kumaraswamy Regression Family Function**

**Description**

Estimates the two parameters of the Kumaraswamy distribution by maximum likelihood estimation.

**Usage**

```r
kumar(lshape1 = "loglink", lshape2 = "loglink",
     ishape1 = NULL, ishape2 = NULL,
     gshape1 = exp(2*ppoints(5) - 1), tol12 = 1.0e-4, zero = NULL)
```

**Arguments**

- `lshape1, lshape2`
  Link function for the two positive shape parameters, respectively, called \(a\) and \(b\) below. See Links for more choices.

- `ishape1, ishape2`
  Numeric. Optional initial values for the two positive shape parameters.

- `tol12`
  Numeric and positive. Tolerance for testing whether the second shape parameter is either 1 or 2. If so then the working weights need to handle these singularities.

- `gshape1`
  Values for a grid search for the first shape parameter. See CommonVGAMffArguments for more information.

- `zero`
  See CommonVGAMffArguments.

**Details**

The Kumaraswamy distribution has density function

\[
f(y; a = \text{shape}1, b = \text{shape}2) = aby^{a-1}(1 - y^a)^{b-1}
\]

where \(0 < y < 1\) and the two shape parameters, \(a\) and \(b\), are positive. The mean is \(b \times \text{Beta}(1 + 1/a, b)\) (returned as the fitted values) and the variance is \(b \times \text{Beta}(1 + 2/a, b) - (b \times \text{Beta}(1 + 1/a, b))^2\). Applications of the Kumaraswamy distribution include the storage volume of a water reservoir. Fisher scoring is implemented. Handles multiple responses (matrix input).

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

**Author(s)**

T. W. Yee
lakeO

References


See Also
dkumar, beta1ff, simulate.vlm.

Examples

```r
shape1 <- exp(1); shape2 <- exp(2)
kdata <- data.frame(y = rkumar(n = 1000, shape1, shape2))
fit <- vglm(y ~ 1, kumar, data = kdata, trace = TRUE)
c(with(kdata, mean(y)), head(fitted(fit), 1))
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```

---

**lakeO**

*Annual catches on Lake Otamangakau from October 1974 to October 1989*

Description

Rainbow and brown trout catches by a Mr Swainson at Lake Otamangakau in the central North Island of New Zealand during the 1970s and 1980s.

Usage

data(lakeO)

Format

A data frame with 15 observations on the following 5 variables.

- **year** a numeric vector, the season began on 1 October of the year and ended 12 months later.
- **total.fish** a numeric vector, the total number of fish caught during the season. Simply the sum of brown and rainbow trout.
- **brown** a numeric vector, the number of brown trout (*Salmo trutta*) caught.
- **rainbow** a numeric vector, the number of rainbow trout (*Oncorhynchus mykiss*) caught.
- **visits** a numeric vector, the number of visits during the season that the angler made to the lake.

It is necessary to assume that the visits were of an equal time length in order to interpret the usual Poisson regressions.
Details

The data was extracted from the season summaries at Lake Otamangakau by Anthony Swainson for the seasons 1974–75 to 1988–89.

Mr Swainson was one of a small group of regular fly fishing anglers and kept a diary of his catches. Lake Otamangakau is a lake of area 1.8 squared km and has a maximum depth of about 12m, and is located in the central North Island of New Zealand. It is trout-infested and known for its trophy-sized fish.

See also trapO.

Source

Table 7.2 of the reference below. Thanks to Dr Michel Dedual for a copy of the report and for help reading the final year’s data. The report is available from TWY on request.

References


Examples

data(lakeO)
lakeO
summary(lakeO)

---

lambertW

The Lambert W Function

Description

Computes the Lambert W function for real values.

Usage

lambertW(x, tolerance = 1e-10, maxit = 50)

Arguments

x A vector of reals.
tolerance Accuracy desired.
maxit Maximum number of iterations of third-order Halley’s method.

Details

The Lambert W function is the root of the equation \(W(z)\exp(W(z)) = z\) for complex \(z\). If \(z\) is real and \(-1/e < z < 0\) then it has two possible real values, and currently only the upper branch (often called \(W_0\)) is computed so that a value that is \(\geq -1\) is returned.
This function returns the principal branch of the $W$ function for real $z$. It returns $W(z) \geq -1$, and NA for $z < -1/e$.

Note
If convergence does not occur then increase the value of maxit and/or tolerance.
Yet to do: add an argument lbranch = TRUE to return the lower branch (often called $W_{-1}$) for real $-1/e \leq z < 0$; this would give $W(z) \leq -1$.

Author(s)
T. W. Yee

References

See Also
log, exp, bell. There is also a package called LambertW.

Examples
```r
## Not run:
curve(lambertW, -exp(-1), 3, xlim = c(-1, 3), ylim = c(-2, 1),
       las = 1, col = "orange", n = 1001)
abline(v = -exp(-1), h = -1, lwd = 2, lty = "dotted", col = "gray")
abline(h = 0, v = 0, lty = "dashed", col = "blue")
## End(Not run)
```

laplace

Laplace Regression Family Function

Description
Maximum likelihood estimation of the 2-parameter classical Laplace distribution.

Usage
```r
laplace(llocation = "identitylink", lscale = "loglink",
        ilocation = NULL, iscale = NULL, imethod = 1, zero = "scale")
```
Arguments

- `ilocation, iscale`
  Character. Parameter link functions for location parameter \(a\) and scale parameter \(b\). See Links for more choices.

- `ilocation, iscale`
  Optional initial values. If given, it must be numeric and values are recycled to the appropriate length. The default is to choose the value internally.

- `imethod`
  Initialization method. Either the value 1 or 2.

- `zero`
  See CommonVGAMffArguments for information.

Details

The Laplace distribution is often known as the double-exponential distribution and, for modelling, has heavier tail than the normal distribution. The Laplace density function is

\[
f(y) = \frac{1}{2b} \exp\left(-\frac{|y-a|}{b}\right)
\]

where \(-\infty < y < \infty\), \(-\infty < a < \infty\) and \(b > 0\). Its mean is \(a\) and its variance is \(2b^2\). This parameterization is called the classical Laplace distribution by Kotz et al. (2001), and the density is symmetric about \(a\).

For \(y \sim 1\) (where \(y\) is the response) the maximum likelihood estimate (MLE) for the location parameter is the sample median, and the MLE for \(b\) is \(\text{mean(abs}(y\sim\text{location}))\) (replace location by its MLE if unknown).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

This family function has not been fully tested. The MLE regularity conditions do not hold for this distribution, therefore misleading inferences may result, e.g., in the summary and vcov of the object. Hence this family function might be withdrawn from VGAM in the future.

Note

This family function uses Fisher scoring. Convergence may be slow for non-intercept-only models; half-stepping is frequently required.

Author(s)

T. W. Yee

References

The Laplace Distribution

Density, distribution function, quantile function and random generation for the Laplace distribution with location parameter location and scale parameter scale.

Usage

dlapse(x, location = 0, scale = 1, log = FALSE)
plapse(q, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
qlapse(p, location = 0, scale = 1, lower.tail = TRUE, log.p = FALSE)
rlapse(n, location = 0, scale = 1)

Arguments

x, q  vector of quantiles.
p  vector of probabilities.
n  number of observations. Same as in runif.
location  the location parameter \(a\), which is the mean.
scale  the scale parameter \(b\). Must consist of positive values.
log  Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p  Same meaning as in pnorm or qnorm.
Details

The Laplace distribution is often known as the double-exponential distribution and, for modelling, has heavier tail than the normal distribution. The Laplace density function is

\[ f(y) = \frac{1}{2b} \exp\left(-\frac{|y-a|}{b}\right) \]

where \(-\infty < y < \infty, -\infty < a < \infty\) and \(b > 0\). The mean is \(a\) and the variance is \(2b^2\).

See laplace, the VGAM family function for estimating the two parameters by maximum likelihood estimation, for formulae and details. Apart from \(n\), all the above arguments may be vectors and are recycled to the appropriate length if necessary.

Value

dlaplace gives the density, plaplace gives the distribution function, qlaplace gives the quantile function, and rlaplace generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


See Also

laplace.

Examples

```r
loc <- 1; b <- 2
y <- rlaplace(n = 100, loc = loc, scale = b)
mean(y)  # sample mean
loc      # population mean
var(y)   # sample variance
2 * b^2  # population variance

## Not run: loc <- 0; b <- 1.5; x <- seq(-5, 5, by = 0.01)
plot(x, dlaplace(x, loc, b), type = "l", col = "blue",
     main = "Blue is density, orange is the CDF", ylim = c(0,1),
     sub = "Purple are 5,10,...,95 percentiles", las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(qlaplace(seq(0.05, 0.95, by = 0.05), loc, b),
      dlaplace(qlaplace(seq(0.05, 0.95, by = 0.05), loc, b), loc, b),
      col = "purple", lty = 3, type = "h")
lines(x, plaplace(x, loc, b), type = "l", col = "orange")
abline(h = 0, lty = 2)
## End(Not run)
plaplace(qlaplace(seq(0.05, 0.95, by = 0.05), loc, b), loc, b)
```
**Description**

Generic function for the *latent variables* of a model.

**Usage**

```r
latvar(object, ...)
lv(object, ...)
```

**Arguments**

- `object` 
  An object for which the extraction of latent variables is meaningful.
- `...` 
  Other arguments fed into the specific methods function of the model. Sometimes they are fed into the methods function for `Coef`.

**Details**

Latent variables occur in reduced-rank regression models, as well as in quadratic and additive ordination models. For the latter two, latent variable values are often called *site scores* by ecologists. Latent variables are linear combinations of the explanatory variables.

**Value**

The value returned depends specifically on the methods function invoked.

**Warning**

`latvar` and `lv` are identical, but the latter will be deprecated soon.

Latent variables are not really applicable to `vglm/vgam` models.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

`latvar.qrrvglm, latvar.rrvglm, latvar.cao, lvplot`
Examples

```r
## Not run:
hs[1:6] <- scale(hspider[, 1:6])  # Standardized environmental vars
set.seed(123)
pl <- cao(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull, Zoraspin) ~
          WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
          family = poissonff, data = hspider, Rank = 1, df1.nl =
          c(Zoraspin = 2.5, 3), Bestof = 3, Crow1positive = TRUE)
var(latvar(pl))  # Scaled to unit variance  # Scaled to unit variance
c(latvar(pl))    # Estimated site scores
```

```r
## End(Not run)
```

leipnik

*Leipnik Regression Family Function*

Description

Estimates the two parameters of a (transformed) Leipnik distribution by maximum likelihood estimation.

Usage

```r
leipnik(lmu = "logitlink", llambda = logofflink(offset = 1),
imu = NULL, ilambda = NULL)
```

Arguments

- `lmu`, `llambda` Link function for the \(\mu\) and \(\lambda\) parameters. See *Links* for more choices.
- `imu`, `ilambda` Numeric. Optional initial values for \(\mu\) and \(\lambda\).

Details

The (transformed) Leipnik distribution has density function

\[
f(y; \mu, \lambda) = \frac{y(1 - y)}{B(e^{\lambda + 1}/2, 1/2)} \left[ 1 + \frac{(y - \mu)^2}{y(1 - y)} \right]^{-\frac{1}{2}}
\]

where \(0 < y < 1\) and \(\lambda > -1\). The mean is \(\mu\) (returned as the fitted values) and the variance is \(1/\lambda\).

Jorgensen (1997) calls the above the *transformed* Leipnik distribution, and if \(y = (x + 1)/2\) and \(\mu = (\theta + 1)/2\), then the distribution of \(X\) as a function of \(x\) and \(\theta\) is known as the the (untransformed) Leipnik distribution. Here, both \(x\) and \(\theta\) are in \((-1, 1)\).

Value

An object of class "vglmff" (see *vglmff-class*). The object is used by modelling functions such as *vglm*, *rrvglm* and *vgam*.
Note

Convergence may be slow or fail. Until better initial value estimates are forthcoming try assigning
the argument ilambda some numerical value if it fails to converge. Currently, Newton-Raphson
is implemented, not Fisher scoring. Currently, this family function probably only really works for
intercept-only models, i.e., y ~ 1 in the formula.

Author(s)

T. W. Yee

References


See Also

mccullagh89.

Examples

ldata <- data.frame(y = rnorm(2000, 0.5, 0.1)) # Improper data
fit <- vglm(y ~ 1, leipnik(ilambda = 1), ldata, trace = TRUE)
head(fitted(fit))
with(ldata, mean(y))
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit)

sum(weights(fit)) # Sum of the prior weights
sum(weights(fit, type = "work")) # Sum of the working weights

lerch

Lerch Phi Function

Description

Computes the Lerch Phi function.

Usage

lerch(x, s, v, tolerance = 1.0e-10, iter = 100)
Arguments

- \( x, s, v \) Numeric. This function recycles values of \( x, s, \) and \( v \) if necessary.
- tolerance Numeric. Accuracy required, must be positive and less than 0.01.
- iter Maximum number of iterations allowed to obtain convergence. If \( \text{iter} \) is too small then a result of \( \text{NA} \) may occur; if so, try increasing its value.

Details

Also known as the Lerch transcendent, it can be defined by an integral involving analytical continuation. An alternative definition is the series

\[
\Phi(x, s, v) = \sum_{n=0}^{\infty} \frac{x^n}{(n + v)^s}
\]

which converges for \(|x| < 1\) as well as for \(|x| = 1\) with \(s > 1\). The series is undefined for integers \(v <= 0\). Actually, \(x\) may be complex but this function only works for real \(x\). The algorithm used is based on the relation

\[
\Phi(x, s, v) = x^m \Phi(x, s, v + m) + \sum_{n=0}^{m-1} \frac{x^n}{(n + v)^s}.
\]

See the URL below for more information. This function is a wrapper function for the C code described below.

Value

Returns the value of the function evaluated at the values of \( x, s, v \). If the above ranges of \(x\) and \(v\) are not satisfied, or some numeric problems occur, then this function will return an \( \text{NA} \) for those values. (The C code returns 6 possible return codes, but this is not passed back up to the R level.)

Warning

This function has not been thoroughly tested and contains limitations, for example, the zeta function cannot be computed with this function even though \(\zeta(s) = \Phi(x = 1, s, v = 1)\). Several numerical problems can arise, such as lack of convergence, overflow and underflow, especially near singularities. If any problems occur then an \( \text{NA} \) will be returned. For example, if \(|x| = 1\) and \(s > 1\) then convergence may be so slow that changing \text{tolerance} and/or \text{iter} may be needed to get an answer (that is treated cautiously).

Note

There are a number of special cases, e.g., the Riemann zeta-function is \(\zeta(s) = \Phi(x = 1, s, v = 1)\). Another example is the Hurwitz zeta function \(\zeta(s, v) = \Phi(x = 1, s, v = v)\). The special case of \(s = 1\) corresponds to the hypergeometric \(2\text{F}1\), and this is implemented in the \text{gsl} package. The Lerch Phi function should not be confused with the Lerch zeta function though they are quite similar.
**Author(s)**

S. V. Aksenov and U. D. Jentschura wrote the C code (called Version 1.00). The R wrapper function was written by T. Yee.

**References**


**See Also**

*zeta*.

**Examples**

```r
## Not run:
s <- 2; v <- 1; x <- seq(-1.1, 1.1, length = 201)
plot(x, lerch(x, s = s, v = v), type = "l", col = "blue",
     las = 1, main = paste0("lerch(x, s = ", s, ", v = ", v, ", )"))
abline(v = 0, h = 1, lty = "dashed", col = "gray")
## End(Not run)
```

---

**leukemia**

*Acute Myelogenous Leukemia Survival Data*

**Description**

Survival in patients with Acute Myelogenous Leukemia

**Usage**

```r
data(leukemia)
```

**Format**

- time: survival or censoring time
- status: censoring status
- x: maintenance chemotherapy given? (factor)

**Note**

This data set has been transferred from `survival` and renamed from `aml` to `leukemia`. 
**levy**

*Levy Distribution Family Function*

**Description**
Estimates the scale parameter of the Levy distribution by maximum likelihood estimation.

**Usage**

```r
levy(location = 0, lscale = "loglink", iscale = NULL)
```

**Arguments**

- `location`: Location parameter. Must have a known value. Called \( a \) below.
- `lscale`: Parameter link function for the (positive) scale parameter \( b \). See `Links` for more choices.
- `iscale`: Initial value for the \( b \) parameter. By default, an initial value is chosen internally.

**Details**

The Levy distribution is one of three stable distributions whose density function has a tractable form. The formula for the density is

\[
f(y; b) = \sqrt{\frac{b}{2\pi}} \exp\left(\frac{-b}{2(y-a)}\right) / (y-a)^{3/2}
\]

where \( a < y < \infty \) and \( b > 0 \). Note that if \( a \) is very close to \( \min(y) \) (where \( y \) is the response), then numerical problem will occur. The mean does not exist. The median is returned as the fitted values.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

**Author(s)**

T. W. Yee

**References**


**See Also**

The Nolan article was at http://academic2.american.edu/~jpnolan/stable/chap1.pdf.
**Examples**

```r
nen <- 1000; loc1 <- 0; loc2 <- 10
gamma <- 1 # log link => 0 is the answer
ldata <-
data.frame(y1 = loc1 + gamma/rnorm(nn)^2, # Levy(gamma, a)
y2 = rlevy(nn, loc = loc2, scale = exp(+2)))
# Cf. Table 1.1 of Nolan for Levy(1,0)
with(ldata, sum(y1 > 1) / length(y1)) # Should be 0.6827
with(ldata, sum(y1 > 2) / length(y1)) # Should be 0.5205

fit1 <- vglm(y1 ~ 1, levy(location = loc1), ldata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
summary(fit1)
head(weights(fit1, type = "work"))

fit2 <- vglm(y2 ~ 1, levy(location = loc2), ldata, trace = TRUE)
coef(fit2, matrix = TRUE)
Coef(fit2)
c(median = with(ldata, median(y2)),
   fitted.median = head(fitted(fit2), 1))
```

---

**lgamma1**

*Log-gamma Distribution Family Function*

**Description**

Estimation of the parameter of the standard and nonstandard log-gamma distribution.

**Usage**

```r
lgamma1(lshape = "loglink", ishape = NULL)
lgamma3(llocation = "identitylink", lscale = "loglink",
        lshape = "loglink", ilocation = NULL, iscale = NULL, ishape = 1,
        zero = c("scale", "shape"))
```

**Arguments**

- **llocation, lscale**
  Parameter link function applied to the location parameter \(a\) and the positive scale parameter \(b\). See `Links` for more choices.

- **lshape**
  Parameter link function applied to the positive shape parameter \(k\). See `Links` for more choices.

- **ishape**
  Initial value for \(k\). If given, it must be positive. If failure to converge occurs, try some other value. The default means an initial value is determined internally.

- **ilocation, iscale**
  Initial value for \(a\) and \(b\). The defaults mean an initial value is determined internally for each.
An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \{1,2,3\}. The default value means none are modelled as intercept-only terms. See `CommonVGAMffArguments` for more information.

Details

The probability density function of the standard log-gamma distribution is given by

\[ f(y; k) = \exp[ky - \exp(y)]/\Gamma(k), \]

for parameter \( k > 0 \) and all real \( y \). The mean of \( Y \) is \( \text{digamma}(k) \) (returned as the fitted values) and its variance is \( \text{trigamma}(k) \).

For the non-standard log-gamma distribution, one replaces \( y \) by \((y - a)/b\), where \( a \) is the location parameter and \( b \) is the positive scale parameter. Then the density function is

\[ f(y) = \exp[k(y - a)/b - \exp((y - a)/b)]/(b \Gamma(k)). \]

The mean and variance of \( Y \) are \( a + b \times \text{digamma}(k) \) (returned as the fitted values) and \( b^2 \times \text{trigamma}(k) \), respectively.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Note

The standard log-gamma distribution can be viewed as a generalization of the standard type 1 extreme value density: when \( k = 1 \) the distribution of \(-Y\) is the standard type 1 extreme value distribution.

The standard log-gamma distribution is fitted with `lgamma1` and the non-standard (3-parameter) log-gamma distribution is fitted with `lgamma3`.

Author(s)

T. W. Yee

References


See Also

`rlgamma, gengamma.stacy, prentice74, gamma1, lgamma`. 
Examples

ldata <- data.frame(y = rlgamma(100, shape = exp(1)))
fit <- vglm(y ~ 1, lgamma1, ldata, trace = TRUE, crit = "coef")
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit)

ldata <- data.frame(x2 = runif(nn <- 5000)) # Another example
ldata <- transform(ldata, loc = -1 + 2 * x2, Scale = exp(1))
ldata <- transform(ldata, y = rlgamma(nn, loc, sc = Scale, sh = exp(0)))
fit2 <- vglm(y ~ x2, lgamma3, data = ldata, trace = TRUE, crit = "c")
coef(fit2, matrix = TRUE)

The Log-Gamma Distribution

Description

Density, distribution function, quantile function and random generation for the log-gamma distribution with location parameter location, scale parameter scale and shape parameter k.

Usage

dlgamma(x, location = 0, scale = 1, shape = 1, log = FALSE)
plgamma(q, location = 0, scale = 1, shape = 1,
  lower.tail = TRUE, log.p = FALSE)
qlgamma(p, location = 0, scale = 1, shape = 1,
  lower.tail = TRUE, log.p = FALSE)
rlgamma(n, location = 0, scale = 1, shape = 1)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. Same as runif.
location the location parameter a.
scale the (positive) scale parameter b.
shape the (positive) shape parameter k.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.

Details

See lgamma1, the VGAM family function for estimating the one parameter standard log-gamma distribution by maximum likelihood estimation, for formulae and other details. Apart from n, all the above arguments may be vectors and are recyled to the appropriate length if necessary.
Value
dlgamma gives the density, plgamma gives the distribution function, qlgamma gives the quantile function, and rlgamma generates random deviates.

Note
The VGAM family function lgamma3 is for the three parameter (nonstandard) log-gamma distribution.

Author(s)
T. W. Yee and Kai Huang

References

See Also
lgamma1, prentice74.

Examples
```
## Not run: loc <- 1; Scale <- 1.5; shape <- 1.4
x <- seq(-3.2, 5, by = 0.01)
plot(x, dlgamma(x, loc = loc, Scale, shape = shape), type = "l",
     col = "blue", ylim = 0:1,
     main = "Blue is density, orange is the CDF",
     sub = "Red are 5,10,...,95 percentiles", las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(qlgamma(seq(0.05, 0.95, by = 0.05), loc = loc, Scale, sh = shape),
      dlgamma(qlgamma(seq(0.05, 0.95, by = 0.05), loc = loc, sc = Scale, shape = shape),
              loc = loc, Scale, shape = shape), col = "red", lty = 3, type = "h")
lines(x, plgamma(x, loc = loc, Scale, shape = shape), col = "orange")
abline(h = 0, lty = 2)
## End(Not run)
```

Lindley

The Lindley Distribution

Description
Density, cumulative distribution function, and random generation for the Lindley distribution.
Usage

dlind(x, theta, log = FALSE)
plind(q, theta, lower.tail = TRUE, log.p = FALSE)
rlind(n, theta)

Arguments

x, q  
vector of quantiles.

n  
number of observations. Same as in runif.

log  
Logical. If log = TRUE then the logarithm of the density is returned.

theta  
positive parameter.

lower.tail, log.p  
Same meaning as in pnorm or qnorm.

Details

See lindley for details.

Value

dlind gives the density, plind gives the cumulative distribution function, and rlind generates random deviates.

Author(s)

T. W. Yee and Kai Huang

See Also

lindley.

Examples

theta <- exp(-1); x <- seq(0.0, 17, length = 700)
dlind(0:10, theta)
## Not run:
plot(x, dlind(x, theta), type = "l", las = 1, col = "blue",
     main = "dlind(x, theta = exp(-1))")
abline(h = 1, col = "grey", lty = "dashed")
## End(Not run)
lindley  

1-parameter Gamma Distribution

Description

Estimates the (1-parameter) Lindley distribution by maximum likelihood estimation.

Usage

lindley(link = "loglink", itheta = NULL, zero = NULL)

Arguments

link       Link function applied to the (positive) parameter. See Links for more choices.
itheta, zero See CommonVGAMffArguments for information.

Details

The density function is given by

\[ f(y; \theta) = \theta^2 (1 + y) \exp(-\theta y)/(1 + \theta) \]

for \( \theta > 0 \) and \( y > 0 \). The mean of \( Y \) (returned as the fitted values) is \( \mu = (\theta + 2)/(\theta(\theta + 1)) \). The variance is \( (\theta^2 + 4\theta + 2)/(\theta(\theta + 1))^2 \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

This VGAM family function can handle multiple responses (inputted as a matrix). Fisher scoring is implemented.

Author(s)

T. W. Yee

References


See Also
dlind, gammaR, simulate.vlm.

Examples
ldata <- data.frame(y = rlind(n = 1000, theta = exp(3)))
fit <- vglm(y ~ 1, lindley, data = ldata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

Description
Returns the link functions, and parameter names, for vector generalized linear models (VGLMs).

Usage

\[
\text{linkfun(object, \ldots)} \\
\text{linkfunvlm(object, earg = FALSE, \ldots)}
\]

Arguments

- **object**: An object which has parameter link functions, e.g., has class "vglm".
- **earg**: Logical. Return the extra arguments associated with each link function? If TRUE then a list is returned.
- **\ldots**: Arguments that might be used in the future.

Details

All fitted VGLMs have a link function applied to each parameter. This function returns these, and optionally, the extra arguments associated with them.

Value

Usually just a (named) character string, with the link functions in order. It is named with the parameter names. If earg = TRUE then a list with the following components.

\[
\begin{align*}
\text{link} & \quad \text{The default output.} \\
\text{earg} & \quad \text{The extra arguments, in order.}
\end{align*}
\]

Note

Presently, the multinomial logit model has only one link function, multilogitlink, so a warning is not issued for that link. For other models, if the number of link functions does not equal \(M\) then a warning may be issued.
Description

The VGAM package provides a number of (parameter) link functions which are described in general here. Collectively, they offer the user considerable choice and flexibility for modelling data.

Usage

TypicalVGAMlink(theta, someParameter = 0, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)

Arguments

theta Numeric or character. This is usually $\theta$ (default) but can sometimes be $\eta$, depending on the other arguments. If theta is character then inverse and deriv are ignored. The name theta should always be the name of the first argument.

someParameter Some parameter, e.g., an offset.

bvalue Boundary value, positive if given. If $0 < \text{theta}$ then values of theta which are less than or equal to 0 can be replaced by bvalue before computing the link function value. Values of theta which are greater than or equal to 1 can be replaced by 1 minus bvalue before computing the link function value. The value bvalue = .Machine$double.eps is sometimes a reasonable value, or something slightly higher.

inverse Logical. If TRUE and deriv = 0 then the inverse link value $\theta$ is returned, hence the argument theta is really $\eta$. In all other cases, the argument theta is really $\theta$. 

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit1 <- vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo)
   coef(fit1), matrix = TRUE)
linkfun(fit1)
linkfun(fit1, earg = TRUE)

fit2 <- vglm(cbind(normal, mild, severe) ~ let, multinomial, data = pneumo)
   coef(fit2), matrix = TRUE)
linkfun(fit2)
linkfun(fit2, earg = TRUE)
Links

deriv Integer. Either 0, 1, or 2, specifying the order of the derivative. Some link functions handle values up to 3 or 4.

short, tag Logical. These are used for labelling the blurb slot of a vglmff-class object. These arguments are used only if theta is character, and gives the formula for the link in character form. If tag = TRUE then the result is preceeded by a little more information.

Details

Almost all VGAM link functions have something similar to the argument list as given above. In this help file we have $\eta = g(\theta)$ where $g$ is the link function, $\theta$ is the parameter and $\eta$ is the linear/additive predictor. The link $g$ must be strictly monotonic and twice-differentiable in its range.

The following is a brief enumeration of all VGAM link functions.

For parameters lying between 0 and 1 (e.g., probabilities): logitlink, probitlink, clogloglink, cauchitlink, foldsqrtlink, logclink.

For positive parameters (i.e., greater than 0): loglink, negloglink, sqrtlink, powerlink.

For parameters greater than 1: logloglink, loglogloglink (greater than $e$).

For parameters between $-1$ and $1$: fisherzlink, rhobitlink.

For parameters between finite $A$ and $B$: extlogitlink, logofflink ($B = \infty$).

For unrestricted parameters (i.e., any value): identitylink, negidentitylink,/reciprocallink, negreciprocallink.

Value

Returns one of: the link function value or its first or second derivative, the inverse link or its first or second derivative, or a character description of the link.

Here are the general details. If inverse = FALSE and deriv = 0 (default) then the ordinary link function $\eta = g(\theta)$ is returned.

If inverse = TRUE and deriv = 0 then the inverse link function value is returned, hence theta is really $\eta$ (the only occasion this happens).

If inverse = FALSE and deriv = 1 then it is $d\eta/d\theta$ as a function of $\theta$. If inverse = FALSE and deriv = 2 then it is $d^2\eta/d\theta^2$ as a function of $\theta$.

If inverse = TRUE and deriv = 1 then it is $d\theta/d\eta$ as a function of $\theta$. If inverse = TRUE and deriv = 2 then it is $d^2\theta/d\eta^2$ as a function of $\theta$.

It is only when deriv = 1 that linkfun(theta, deriv = 1, inverse = TRUE) and linkfun(theta, deriv = 1, inverse = FALSE) are reciprocals of each other. In particular, linkfun(theta, deriv = 2, inverse = TRUE) and linkfun(theta, deriv = 2, inverse = FALSE) are not reciprocals of each other in general.

Warning

The output of link functions changed at VGAM 0.9-9 (date was around 2015-07). Formerly, linkfun(theta, deriv = 1) is now linkfun(theta, deriv = 1, inverse = TRUE), or equivalently, 1 / linkfun(theta, deriv = 1, inverse = TRUE). Also, formerly, linkfun(theta, deriv = 2)
was 1 / linkfun(theta, deriv = 2, inverse = TRUE). This was a bug. Altogether, these are big changes and the user should beware!

In VGAM 1.0-7 (January 2019) all link function names were made to end in the characters "link", e.g., loglink replaces loge, logitlink replaces logit. For this most of them were renamed. Upward compatibility holds for older link function names, however, users should adopt the new names immediately.

Note

VGAM link functions are generally not compatible with other functions outside the package. In particular, they won’t work with glm or any other package for fitting GAMs.

From October 2006 onwards, all VGAM family functions will only contain one default value for each link argument rather than giving a vector of choices. For example, rather than binomialff(link = c("logitlink", "probitlink", "clogloglink", "cauchitlink", "identitylink"), ...) it is now binomialff(link = "logitlink", ...). No checking will be done to see if the user’s choice is reasonable. This means that the user can write his/her own VGAM link function and use it within any VGAM family function. Altogether this provides greater flexibility. The downside is that the user must specify the full name of the link function, by either assigning the link argument the full name as a character string, or just the name itself. See the examples below.

From August 2012 onwards, a major change in link functions occurred. Argument esigna (and the like such as earg) used to be in VGAM prior to version 0.9-0 (released during the 2nd half of 2012). The major change is that arguments such as offset that used to be passed in via those arguments can done directly through the link function. For example, gev(lshape = "logofflink", eshape = list(offset = 0.5)) is replaced by gev(lshape = logofflink(offset = 0.5)). The @misc slot no longer has link and earg components, but two other components replace these. Functions such as dtheta.deta(), d2theta.deta2(), d3theta.deta3(), eta2theta(), theta2eta() are modified.

From January 2019 onwards, all link function names ended in "link". See above for details.

Author(s)

T. W. Yee

References


See Also

TypicalVGAMfamilyFunction, linkfun, vglm, vgam, rrvglm. cqo, cao.

Examples

logitlink("a")
logitlink("a", short = FALSE)
logitlink("a", short = FALSE, tag = TRUE)

logofflink(1:5, offset = 1) # Same as log(1:5 + 1)
powerlink(1:5, power = 2)  # Same as (1:5)^2

## Not run:  # This is old and no longer works:
logofflink(1:5, earg = list(offset = 1))
powerlink(1:5, earg = list(power = 2))

## End(Not run)

fit1 <- vgam(agaau ~ altitude,  
binomialff(link = "clogloglink"), hunua)  # best
fit2 <- vgam(agaau ~ altitude,  
binomialff(link = clogloglink), hunua)  # okay

## Not run:
# This no longer works since "clog" is not a valid VGAM link function:
fit3 <- vgam(agaau ~ altitude,  
binomialff(link = "clog"), hunua)  # not okay

# No matter what the link, the estimated var-cov matrix is the same
y <- rbeta(n = 1000, shape1 = exp(0), shape2 = exp(1))
fit1 <- vglm(y ~ 1, betaR(lshape1 = "identitylink",  
lshape2 = "identitylink"),  
trace = TRUE, crit = "coef")
fit2 <- vglm(y ~ 1, betaR(lshape1 = logofflink(offset = 1.1),  
lshape2 = logofflink(offset = 1.1)), trace=TRUE)
vcov(fit1, untransform = TRUE)
vcov(fit1, untransform = TRUE) -
vcov(fit2, untransform = TRUE)  # Should be all 0s
\dontrun{  # This is old:
fit1@misc$earg  # Some 'special' parameters
fit2@misc$earg  # Some 'special' parameters are here}

par(mfrow = c(2, 2))
p <- seq(0.05, 0.95, len = 200)  # A rather restricted range
x <- seq(-4, 4, len = 200)
plot(p, logitlink(p), type = "l", col = "blue")
plot(x, logitlink(x, inverse = TRUE), type = "l", col = "blue")
plot(p, logitlink(p, deriv=1), type="l", col="blue") # 1 / (p*(1-p))
plot(p, logitlink(p, deriv=2), type="l", col="blue") # (2*p-1)/(p*(1-p))^2

## End(Not run)
Description
Density, distribution function, quantile function and random generation for the generalized beta distribution, as proposed by Libby and Novick (1982).

Usage

\[
\text{dlino}(x, \text{shape1}, \text{shape2}, \text{lambda} = 1, \text{log} = \text{FALSE})
\]
\[
\text{plino}(q, \text{shape1}, \text{shape2}, \text{lambda} = 1, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE})
\]
\[
\text{qlino}(p, \text{shape1}, \text{shape2}, \text{lambda} = 1, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE})
\]
\[
\text{rlino}(n, \text{shape1}, \text{shape2}, \text{lambda} = 1)
\]

Arguments

- \(x, q\) vector of quantiles.
- \(p\) vector of probabilities.
- \(n\) number of observations. Same as in \text{runif}.
- \(\text{shape1}, \text{shape2}, \text{lambda}\)

See \text{lino}.
- \(\text{log}\) Logical. If \(\text{log} = \text{TRUE}\) then the logarithm of the density is returned.
- \(\text{lower.tail}, \text{log.p}\)

Same meaning as in \text{pnorm} or \text{qnorm}.

Details

See \text{lino}, the \text{VGAM} family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dlino gives the density, plino gives the distribution function, qlino gives the quantile function, and rlino generates random deviates.

Author(s)

T. W. Yee and Kai Huang

See Also

\text{lino}.

Examples

\[
\text{## Not run: lambda <- 0.4; shape1 <- exp(1.3); shape2 <- exp(1.3)}
\]
\[
\text{x <- seq(0.0, 1.0, len = 101)}
\]
\[
\text{plot(x, dlino(x, shape1 = shape1, shape2 = shape2, lambda = lambda),}
\]
\[
\text{type = "l", col = "blue", las = 1, ylab = "",}
\]
\[
\text{main = "Blue is PDF, orange is the CDF",}
\]
\[
\text{sub = "Purple lines are the 10,20,...,90 percentiles")}
\]
\[
\text{abline(h = 0, col = "blue", lty = 2)}
\]
lino

491

lines(x, plino(x, shape1, shape2, lambda = lambda), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qlino(probs, shape1 = shape1, shape2 = shape2, lambda = lambda)
lines(Q, dlino(Q, shape1 = shape1, shape2 = shape2, lambda = lambda),
col = "purple", lty = 3, type = "h")
plino(Q, shape1, shape2, lambda = lambda) - probs # Should be all 0

## End(Not run)

lino

Generalized Beta Distribution Family Function

Description


Usage

lino(lshape1 = "loglink", lshape2 = "loglink", llambda = "loglink",
ishape1 = NULL, ishape2 = NULL, ilambda = 1, zero = NULL)

Arguments

lshape1, lshape2
Parameter link functions applied to the two (positive) shape parameters a and b. See Links for more choices.

llambda
Parameter link function applied to the parameter \( \lambda \). See Links for more choices.

ishape1, ishape2, ilambda
Initial values for the parameters. A NULL value means one is computed internally. The argument ilambda must be numeric, and the default corresponds to a standard beta distribution.

zero
Can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. Here, the values must be from the set \{1,2,3\} which correspond to \( a \), \( b \), \( \lambda \), respectively. See CommonVGAMffArguments for more information.

Details

Proposed by Libby and Novick (1982), this distribution has density

\[
    f(y; a, b, \lambda) = \frac{\lambda^a y^{a-1}(1-y)^{b-1}}{B(a, b)(1-(1-\lambda)y)^{a+b}}
\]

for \( a > 0, b > 0, \lambda > 0, 0 < y < 1 \). Here \( B \) is the beta function (see beta). The mean is a complicated function involving the Gauss hypergeometric function. If \( X \) has a lino distribution with parameters shape1, shape2, lambda, then \( Y = \lambda X/(1 - (1 - \lambda)X) \) has a standard beta distribution with parameters shape1, shape2.
Since \(\log(\lambda) = 0\) corresponds to the standard beta distribution, a summary of the fitted model performs a t-test for whether the data belongs to a standard beta distribution (provided the loglink link for \(\lambda\) is used; this is the default).

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

**Note**

The fitted values, which is usually the mean, have not been implemented yet. Currently the median is returned as the fitted values.

Although Fisher scoring is used, the working weight matrices are positive-definite only in a certain region of the parameter space. Problems with this indicate poor initial values or an ill-conditioned model or insufficient data etc.

This model is can be difficult to fit. A reasonably good value of \(\text{ilambda}\) seems to be needed so if the self-starting initial values fail, try experimenting with the initial value arguments. Experience suggests \(\text{ilambda}\) is better a little larger, rather than smaller, compared to the true value.

**Author(s)**

T. W. Yee

**References**


**See Also**

`Lino`, `genbetaII`.

**Examples**

```r
ldata <- data.frame(y1 = rbeta(n = 1000, exp(0.5), exp(1))) # Std beta
fit <- vglm(y1 ~ 1, lino, data = ldata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(fitted(fit))
summary(fit)

# Nonstandard beta distribution
ldata <- transform(ldata, y2 = rlino(1000, shape1 = exp(1),
                        shape2 = exp(2), lambda = exp(1)))
fit2 <- vglm(y2 ~ 1,
            lino(lshape1 = "identitylink", lshape2 = "identitylink",
                 ilamb = 10), data = ldata, trace = TRUE)
```

Description

Low-iron rat teratology data.

Usage

data(lirat)

Format

A data frame with 58 observations on the following 4 variables.

- N  Litter size.
- R  Number of dead fetuses.
- hb  Hemoglobin level.
- grp  Group number. Group 1 is the untreated (low-iron) group, group 2 received injections on day 7 or day 10 only, group 3 received injections on days 0 and 7, and group 4 received injections weekly.

Details

The following description comes from Moore and Tsiatis (1991). The data comes from the experimental setup from Shepard et al. (1980), which is typical of studies of the effects of chemical agents or dietary regimens on fetal development in laboratory rats.

Female rats were put in iron-deficient diets and divided into 4 groups. One group of controls was given weekly injections of iron supplement to bring their iron intake to normal levels, while another group was given only placebo injections. Two other groups were given fewer iron-supplement injections than the controls. The rats were made pregnant, sacrificed 3 weeks later, and the total number of fetuses and the number of dead fetuses in each litter were counted.

For each litter the number of dead fetuses may be considered to be Binomial(N, p) where N is the litter size and p is the probability of a fetus dying. The parameter p is expected to vary from litter to litter, therefore the total variance of the proportions will be greater than that predicted by a binomial model, even when the covariates for hemoglobin level and experimental group are accounted for.

Source


References

Examples

```r
## Not run:
# cf. Figure 3 of Moore and Tsiatis (1991)
plot(R / N ~ hb, data = lirat, pch = as.character(grp), col = grp,
     las = 1, xlab = "Hemoglobin level", ylab = "Proportion Dead")
## End(Not run)
```

### lms.bcg

LMS Quantile Regression with a Box-Cox transformation to a Gamma Distribution

Description

LMS quantile regression with the Box-Cox transformation to the gamma distribution.

Usage

```r
lms.bcg(percentiles = c(25, 50, 75), zero = c("lambda", "sigma"),
         llambda = "identitylink", lmu = "identitylink", lsigma = "loglink",
         idf.mu = 4, idf.sigma = 2, ilambda = 1, isigma = NULL)
```

Arguments

- `percentiles`: A numerical vector containing values between 0 and 100, which are the quantiles. They will be returned as ‘fitted values’.
- `zero`: See `lms.bcn`. See CommonVGAMffArguments for more information.
- `llambda, lmu, lsigma`: See `lms.bcn`.
- `idf.mu, idf.sigma`: See `lms.bcn`.
- `ilambda, isigma`: See `lms.bcn`.

Details

Given a value of the covariate, this function applies a Box-Cox transformation to the response to best obtain a gamma distribution. The parameters chosen to do this are estimated by maximum likelihood or penalized maximum likelihood. Similar details can be found at `lms.bcn`.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

This VGAM family function comes with the same warnings as `lms.bcn`. Also, the expected value of the second derivative with respect to lambda may be incorrect (my calculations do not agree with the Lopatatzidis and Green manuscript.)
Note

Similar notes can be found at `lms.bcn`.

Author(s)

Thomas W. Yee

References

Lopatatzidis A. and Green, P. J. (unpublished manuscript). Semiparametric quantile regression using the gamma distribution.


See Also

`lms.bcn`, `lms.yjn`, `qtplot.lmscreg`, `deplot.lmscreg`, `cdf.lmscreg`, `bmi.nz`, `amlexponential`.

Examples

```r
# This converges, but deplot(fit) and qtplot(fit) do not work
fit0 <- vglm(BMI ~ sm.bs(age, df = 4), lms.bcg, bmi.nz, trace = TRUE)
coef(fit0, matrix = TRUE)
## Not run:
par(mfrow = c(1, 1))
plotvgam(fit0, se = TRUE) # Plot mu function (only)
## End(Not run)

# Use a trick: fit0 is used for initial values for fit1.
fit1 <- vgam(BMI ~ s(age, df = c(4, 2)), etastart = predict(fit0),
             lms.bcg(zero = 1), bmi.nz, trace = TRUE)
# Difficult to get a model that converges. Here, we prematurely stop iterations because it fails near the solution.
fit2 <- vgam(BMI ~ s(age, df = c(4, 2)), maxit = 4,
             lms.bcg(zero = 1, ilam = 3), bmi.nz, trace = TRUE)
summary(fit1)
head(predict(fit1))
head(fitted(fit1))
head(bmi.nz)
# Person 1 is near the lower quartile of BMI amongst people his age
head(cdf(fit1))
## Not run:
# Quantile plot
par(bty = "l", mar=c(5, 4, 4, 3) + 0.1, xpd = TRUE)
qtplot(fit1, percentiles=c(5, 50, 90, 99), main = "Quantiles",
xlim = c(15, 90), las = 1, ylab = "BMI", lwd = 2, lcol = 4)
# Density plot
```
lms.bcn

LMS Quantile Regression with a Box-Cox Transformation to Normality

Description

LMS quantile regression with the Box-Cox transformation to normality.

Usage

lms.bcn(percentiles = c(25, 50, 75), zero = c("lambda", "sigma"),
llambda = "identitylink", lmu = "identitylink",
lsigma = "loglink", idf.mu = 4, idf.sigma = 2, ilambda = 1,
isigma = NULL, tol0 = 0.001)

Arguments

percentiles A numerical vector containing values between 0 and 100, which are the quantiles. They will be returned as ‘fitted values’.

zero Can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set {1,2,3}. The default value usually increases the chance of successful convergence. Setting zero = NULL means they all are functions of the covariates. For more information see CommonVGAMffArguments.

llambda, lmu, lsigma Parameter link functions applied to the first, second and third linear/additive predictors. See Links for more choices, and CommonVGAMffArguments.

idf.mu Degrees of freedom for the cubic smoothing spline fit applied to get an initial estimate of mu. See vsmooth.spline.

idf.sigma Degrees of freedom for the cubic smoothing spline fit applied to get an initial estimate of sigma. See vsmooth.spline. This argument may be assigned NULL to get an initial value using some other algorithm.

ilambda Initial value for lambda. If necessary, it is recycled to be a vector of length $n$ where $n$ is the number of (independent) observations.
### Details

Given a value of the covariate, this function applies a Box-Cox transformation to the response to best obtain normality. The parameters chosen to do this are estimated by maximum likelihood or penalized maximum likelihood.

In more detail, the basic idea behind this method is that, for a fixed value of $x$, a Box-Cox transformation of the response $Y$ is applied to obtain standard normality. The 3 parameters ($\lambda$, $\mu$, $\sigma$, which start with the letters “L-M-S” respectively, hence its name) are chosen to maximize a penalized log-likelihood ($\text{vgam}$). Then the appropriate quantiles of the standard normal distribution are back-transformed onto the original scale to get the desired quantiles. The three parameters may vary as a smooth function of $x$.

The Box-Cox power transformation here of the $Y$, given $x$, is

$$Z = [(Y/\mu(x))^\lambda(x) - 1]/(\sigma(x) \lambda(x))$$

for $\lambda(x) \neq 0$. (The singularity at $\lambda(x) = 0$ is handled by a simple function involving a logarithm.) Then $Z$ is assumed to have a standard normal distribution. The parameter $\sigma(x)$ must be positive, therefore $\text{VGAM}$ chooses $\eta(x)^T = (\lambda(x), \mu(x), \log(\sigma(x)))$ by default. The parameter $\mu$ is also positive, but while $\log(\mu)$ is available, it is not the default because $\mu$ is more directly interpretable. Given the estimated linear/additive predictors, the $100\alpha$ percentile can be estimated by inverting the Box-Cox power transformation at the $100\alpha$ percentile of the standard normal distribution.

Of the three functions, it is often a good idea to allow $\mu(x)$ to be more flexible because the functions $\lambda(x)$ and $\sigma(x)$ usually vary more smoothly with $x$. This is somewhat reflected in the default value for the argument `zero`, viz. `zero = c(1, 3)`.

### Value

An object of class “vglmff” (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `rrvglm` and `vgam`.

### Warning

The computations are not simple, therefore convergence may fail. Set `trace = TRUE` to monitor convergence if it isn’t set already. Convergence failure will occur if, e.g., the response is bimodal at any particular value of $x$. In case of convergence failure, try different starting values. Also, the estimate may diverge quickly near the solution, in which case try prematurely stopping the iterations by assigning `maxits` to be the iteration number corresponding to the highest likelihood value.

One trick is to fit a simple model and use it to provide initial values for a more complex model; see in the examples below.
Note

The response must be positive because the Box-Cox transformation cannot handle negative values. In theory, the LMS-Yeo-Johnson-normal method can handle both positive and negative values.

In general, the lambda and sigma functions should be more smoother than the mean function. Having zero = 1, zero = 3 or zero = c(1, 3) is often a good idea. See the example below.

Author(s)

Thomas W. Yee

References


See Also

lms.bcg, lms.yjn, qtplot.lmsreg, deplot.lmsreg, cdf.lmsreg, eCDF, extlogF1, alaplace1, amlnormal, denorm, CommonVGAMffArguments.

Examples

```r
## Not run: require("VGAMdata")
mysub <- subset(xs.nz, sex == "M" & ethnicity == "Maori" & study1)
mysub <- transform(mysub, BMI = weight / height^2)
BMIdata <- na.omit(mysub)
BMIdata <- subset(BMIdata, BMI < 80 & age < 65,
                  select = c(age, BMI)) # Delete an outlier
summary(BMIdata)

fit <- vgam(BMI ~ s(age, df = c(4, 2)), lms.bcn(zero = 1), BMIdata)

par(mfrow = c(1, 2))
plot(fit, scol = "blue", se = TRUE) # The two centered smooths
head(predict(fit))
head(fitted(fit))
head(BMIdata)
head(cdf(fit)) # Person 46 is probably overweight, given his age
100 * colMeans(c(depvar(fit)) < fitted(fit)) # Empirical proportions

# Correct for "vgam" objects but not very elegant:
fit@family@linkinv(eta = predict(fit, data.frame(age = 60)),
                   extra = list(percentiles = c(10, 50)))
```

# These work for "vglm" objects:
fit2 <- vglm(BMI ~ bs(age, df = 4), lms.bcn(zero = 3), BMIdata)
predict(fit2, percentiles = c(10, 50),
       newdata = data.frame(age = 60), type = "response")
head(fitted(fit2, percentiles = c(10, 50))) # Different percentiles

# Convergence problems? Use fit0 for initial values for fit1
fit0 <- vgam(BMI ~ s(age, df = 4), lms.bcn(zero = c(1, 3)), BMIdata)
fit1 <- vgam(BMI ~ s(age, df = c(4, 2)), lms.bcn(zero = 1), BMIdata,
etastart = predict(fit0))
## End(Not run)

## Not run: # Quantile plot
par(bty = "l", mar = c(5, 4, 4, 3) + 0.1, xpd = TRUE)
qtplot(fit, percentiles = c(5, 50, 90, 99), main = "Quantiles",
       xlim = c(15, 66), las = 1, ylab = "BMI", lwd = 2, lcol = 4)

# Density plot
ygrid <- seq(15, 43, len = 100) # BMI ranges
par(mfrow = c(1, 1), lwd = 2)
(aa <- deplot(fit, x0 = 20, y = ygrid, xlab = "BMI", col = "black",
     main = "PDFs at Age = 20 (black), 42 (red) and 55 (blue") ))
aa <- deplot(fit, x0 = 42, y = ygrid, add = TRUE, llty = 2, col = "red")
aa <- deplot(fit, x0 = 55, y = ygrid, add = TRUE, llty = 4, col = "blue",
     Attach = TRUE)
aa@post$deplot # Contains density function values
## End(Not run)

---

**Description**

LMS quantile regression with the Yeo-Johnson transformation to normality. This family function is experimental and the LMS-BCN family function is recommended instead.

**Usage**

```r
lms.yjn(percentiles = c(25, 50, 75), zero = c("lambda", "sigma"),
        llambda = "identitylink", lsigma = "loglink",
        idf.mu = 4, idf.sigma = 2,
        ilambda = 1, isigma = NULL, rule = c(10, 5),
        yoffset = NULL, diagW = FALSE, iters.diagW = 6)
```

```r
lms.yjn2(percentiles = c(25, 50, 75), zero = c("lambda", "sigma"),
         llambda = "identitylink", lmu = "identitylink", lsigma = "loglink",
         idf.mu = 4, idf.sigma = 2, ilambda = 1.0,
         isigma = NULL, yoffset = NULL, nsimEIM = 250)
```
Arguments

**percentiles**  
A numerical vector containing values between 0 and 100, which are the quantiles. They will be returned as 'fitted values'.

**zero**  
See `lms.bcn`. See `CommonVGAMffArguments` for more information.

**llambda, lmu, lsigma**  
See `lms.bcn`.

**idf.mu, idf.sigma**  
See `lms.bcn`.

**ilambda, isigma**  
See `lms.bcn`.

**rule**  
Number of abscissae used in the Gaussian integration scheme to work out elements of the weight matrices. The values given are the possible choices, with the first value being the default. The larger the value, the more accurate the approximation is likely to be but involving more computational expense.

**yoffset**  
A value to be added to the response y, for the purpose of centering the response before fitting the model to the data. The default value, NULL, means \(-\text{median}(y)\) is used, so that the response actually used has median zero. The `yoffset` is saved on the object and used during prediction.

**diagW**  
Logical. This argument is offered because the expected information matrix may not be positive-definite. Using the diagonal elements of this matrix results in a higher chance of it being positive-definite, however convergence will be very slow.

If `TRUE`, then the first `iters.diagW` iterations will use the diagonal of the expected information matrix. The default is `FALSE`, meaning faster convergence.

**iters.diagW**  
Integer. Number of iterations in which the diagonal elements of the expected information matrix are used. Only used if `diagW = TRUE`.

**nsimEIM**  
See `CommonVGAMffArguments` for more information.

Details

Given a value of the covariate, this function applies a Yeo-Johnson transformation to the response to best obtain normality. The parameters chosen to do this are estimated by maximum likelihood or penalized maximum likelihood. The function `lms.yjn2()` estimates the expected information matrices using simulation (and is consequently slower) while `lms.yjn()` uses numerical integration. Try the other if one function fails.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

Warning

The computations are not simple, therefore convergence may fail. In that case, try different starting values.

The generic function `predict`, when applied to a `lms.yjn` fit, does not add back the `yoffset` value.
As described above, this family function is experimental and the LMS-BCN family function is recommended instead.

**Note**

The response may contain both positive and negative values. In contrast, the LMS-Box-Cox-normal and LMS-Box-Cox-gamma methods only handle a positive response because the Box-Cox transformation cannot handle negative values.

Some other notes can be found at `lms.bcn`.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

`lms.bcn`, `lms.bcg`, `qtplot.lmscreg`, `deplot.lmscreg`, `cdf.lmscreg`, `bmi.nz`, `amlnormal`.

**Examples**

```r
fit <- vgam(BMI ~ s(age, df = 4), lms.yjn, bmi.nz, trace = TRUE)
head(predict(fit))
head(fitted(fit))
head(bmi.nz)
# Person 1 is near the lower quartile of BMI amongst people his age
head(cdf(fit))
```

```r
## Not run:
# Quantile plot
par(bty = "l", mar = c(5, 4, 4, 3) + 0.1, xpd = TRUE)
qtplot(fit, percentiles = c(5, 50, 90, 99), main = "Quantiles",
xlim = c(15, 90), las = 1, ylab = "BMI", lwd = 2, lcol = 4)
```

```r
# Density plot
ygrid <- seq(15, 43, len = 100) # BMI ranges
par(mfrow = c(1, 1), lwd = 2)
(Z <- deplot(fit, x0 = 20, y = ygrid, xlab = "BMI", col = "black",
main = "PDFs at Age = 20 (black), 42 (red) and 55 (blue)"))
Z <- deplot(fit, x0 = 42, y = ygrid, add = TRUE, lty = 2, col = "red")
Z <- deplot(fit, x0 = 55, y = ygrid, add = TRUE, lty = 4, col = "blue")
```
Log

Description

Density, distribution function, quantile function, and random generation for the logarithmic distribution.

Usage

dlog(x, shape, log = FALSE)
plog(q, shape, lower.tail = TRUE, log.p = FALSE)
qlog(p, shape)
rlog(n, shape)

Arguments

x, q, p, n, lower.tail
   Same interpretation as in runif.
shape    The shape parameter value c described in in logff.
log, log.p Logical. If log.p = TRUE then all probabilities p are given as log(p).

Details

The details are given in logff.

Value

dlog gives the density, plog gives the distribution function, qlog gives the quantile function, and rlog generates random deviates.

Note

Given some response data, the VGAM family function logff estimates the parameter shape. For plog(), if argument q contains large values and/or q is long in length then the memory requirements may be very high. Very large values in q are handled by an approximation by Owen (1965).

Author(s)

T. W. Yee
log1mexp

Logarithms with an Unit Offset and Exponential Term

Description

Computes \( \log(1 + \exp(x)) \) and \( \log(1 - \exp(-x)) \) accurately.

Usage

log1mexp(x)
log1pexp(x)

Arguments

x A vector of reals (numeric). Complex numbers not allowed since \( \expm1 \) and \( \log1p \) do not handle these.

Details

Computes \( \log(1 + \exp(x)) \) and \( \log(1 - \exp(-x)) \) accurately. An adjustment is made when \( x \) is away from 0 in value.

Value

\( \log1mexp(x) \) gives the value of \( \log(1 - \exp(-x)) \).
\( \log1pexp(x) \) gives the value of \( \log(1 + \exp(x)) \).

References


See Also

logff, Gaitdlog, Oilog, Otlog.

Examples

dlog(1:20, 0.5)
rlog(20, 0.5)

## Not run: shape <- 0.8; x <- 1:10
plot(x, dlog(x, shape = shape), type = "h", ylim = 0:1,
    sub = "shape=0.8", las = 1, col = "blue", ylab = "shape",
    main = "Logarithmic distribution: blue=PDF; orange=CDF")
lines(x + 0.1, plog(x, shape = shape), col = "orange", lty = 3, type = "h")
## End(Not run)
**Note**

If NA or NaN is present in the input, the corresponding output will be NA.

**Author(s)**

This is a direct translation of the function in Martin Maechler's (2012) paper by Xiangjie Xue and T. W. Yee.

**References**

Maechler, Martin (2012). Accurately Computing log(1-exp(-|a|)). Assessed from the **Rmpfr** package.

**See Also**

`log1p, expm1, exp, log`

**Examples**

```r
x <- c(10, 50, 100, 200, 400, 500, 800, 1000, 1e4, 1e5, 1e20, Inf, NA)
log1pexp(x)
log(1 + exp(x)) # Naive; suffers from overflow
log1mexp(x)
log(1 - exp(-x))
y <- -x
log1pexp(y)
log(1 + exp(y)) # Naive; suffers from inaccuracy
```

---

**Description**

Computes the Complementary-log Transformation, Including its Inverse and the First Two Derivatives.

**Usage**

```r
logclink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
```

**Arguments**

- **theta**: Numeric or character. See below for further details.
- **bvalue**: See **Links**.
- **inverse**: See **Links**.
- **deriv**: See **Links**.
- **short**: See **Links**.
- **tag**: See **Links**.

Details at **Links**.
**Details**

The complementary-log link function is suitable for parameters that are less than unity. Numerical values of \(\theta\) close to 1 or out of range result in \(\text{Inf}, -\text{Inf}, \text{NA}\) or \(\text{NaN}\).

**Value**

For \(\text{deriv} = 0\), the log of \(\theta\), i.e., \(\log(1-\theta)\) when \(\text{inverse} = \text{FALSE}\), and if \(\text{inverse} = \text{TRUE}\) then \(1-\exp(\theta)\).

For \(\text{deriv} = 1\), then the function returns \(d\ eta / d\ theta\) as a function of \(\theta\) if \(\text{inverse} = \text{FALSE}\), else if \(\text{inverse} = \text{TRUE}\) then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base \(e\).

**Note**

Numerical instability may occur when \(\theta\) is close to 1. One way of overcoming this is to use \(bvalue\).

**Author(s)**

Thomas W. Yee

**References**


**See Also**

Links, loglink, clogloglink, logloglink, logofflink.

**Examples**

```r
## Not run:
logclink(seq(-0.2, 1.1, by = 0.1))  # Has NAs

## End(Not run)
logclink(seq(-0.2, 1.1, by = 0.1), bvalue = 1-L.Machine$double.eps)  # Has no NAs
```

---

**Description**

Maximum likelihood estimation of the 2-parameter log F distribution.
Usage

logF(lshape1 = "loglink", lshape2 = "loglink",
    ishape1 = NULL, ishape2 = 1, imethod = 1)

Arguments

lshape1, lshape2
Parameter link functions for the shape parameters. Called α and β respectively.
See Links for more choices.

ishape1, ishape2
Optional initial values for the shape parameters. If given, it must be numeric
and values are recycled to the appropriate length. The default is to choose the
value internally. See CommonVGAMffArguments for more information.

imethod
Initialization method. Either the value 1, 2, or .... See CommonVGAMffArguments
for more information.

Details

The density for this distribution is

\[ f(y; \alpha, \beta) = \exp(\alpha y) / \left[ B(\alpha, \beta)(1 + e^y)^{\alpha+\beta} \right] \]

where \( y \) is real, \( \alpha > 0, \beta > 0 \), \( B(\cdot, \cdot) \) is the beta function \( \text{beta} \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such
as vglm and vgam.

Author(s)

Thomas W. Yee

References

Jones, M. C. (2008). On a class of distributions with simple exponential tails. Statistica Sinica,
18(3), 1101–1110.

See Also

dlogF, extlogFl, logff.

Examples

nn <- 1000
ldata <- data.frame(y1 = rnorm(nn, +1, sd = exp(2)), # Not proper data
    x2 = rnorm(nn, -1, sd = exp(2)),
y2 = rnorm(nn, -1, sd = exp(2))) # Not proper data
fit1 <- vglm(y1 ~ 1 , logF, ldata, trace = TRUE)
fit2 <- vglm(y2 ~ x2, logF, ldata, trace = TRUE)
estimation of the (single) parameter of the logarithmic distribution.

Usage

```r
logff(lshape = "logitlink", gshape = -expm1(-7 * points(4)),
     zero = NULL)
```

Arguments

- **lshape**: Parameter link function for the parameter \( c \), which lies between 0 and 1. See Links for more choices and information. Soon logfflink() will hopefully be available for event-rate data.
- **gshape, zero**: Details at CommonVGAMffArguments. Practical experience shows that having the initial value for \( c \) being close to the solution is quite important.

Details

The logarithmic distribution is a generalized power series distribution that is based specifically on the logarithmic series (scaled to a probability function). Its probability function is \( f(y) = ac^y/y \), for \( y = 1, 2, 3, \ldots \), where \( 0 < c < 1 \) (called shape), and \( a = -1/\log(1 - c) \). The mean is \( ac/(1 - c) \) (returned as the fitted values) and variance is \( ac(1 - ac)/(1 - c)^2 \). When the sample mean is large, the value of \( c \) tends to be very close to 1, hence it could be argued that logitlink is not the best choice.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.
Note

The function \texttt{log} computes the natural logarithm. In the \texttt{VGAM} library, a link function with option \texttt{loglink} corresponds to this.

Multiple responses are permitted.

The “logarithmic distribution” has various meanings in the literature. Sometimes it is also called the \textit{log-series distribution}. Some others call some continuous distribution on \([a, b]\) by the name “logarithmic distribution”.

Author(s)

T. W. Yee

References


See Also

\texttt{log}, \texttt{gaitdlog}, \texttt{oalog}, \texttt{oilog}, \texttt{otlog}, \texttt{log}, \texttt{loglink}, \texttt{logofflink}, \texttt{explogff}, \texttt{simulate.vlm}.

Examples

```r
nn <- 1000
ldata <- data.frame(y = rlog(nn, shape = logitlink(0.2, inv = TRUE)))
fit <- vglm(y ~ 1, logff, data = ldata, trace = TRUE, crit = "c")
coef(fit, matrix = TRUE)
Coef(fit)
## Not run: with(ldata, spikeplot(y, col = "blue", capped = TRUE))
x <- seq(1, with(ldata, max(y)), by = 1)
with(ldata, lines(x + 0.1, dlog(x, Coef(fit)[1]), col = "orange",
                 type = "h", lwd = 2))
## End(Not run)

# Example: Corbet (1943) butterfly Malaya data
corbet <- data.frame(nindiv = 1:24,
                     ofreq = c(118, 74, 44, 24, 29, 22, 20, 19, 20, 15, 29,
                              6, 12, 6, 9, 6, 18, 10, 11, 5, 3, 3))
fit <- vglm(nindiv ~ 1, logff, data = corbet, weights = ofreq)
coef(fit, matrix = TRUE)
shapehat <- Coef(fit)["shape"]
pdf2 <- dlog(x = with(corbet, nindiv), shape = shapehat)
print(with(corbet, cbind(nindiv, ofreq, fitted = pdf2 * sum(ofreq)),
       digits = 1))
```
Logistic Distribution Family Function

Description

Estimates the location and scale parameters of the logistic distribution by maximum likelihood estimation.

Usage

logistic1(llocation = "identitylink", scale.arg = 1, imethod = 1)
logistic(llocation = "identitylink", lscale = "loglink",
   llocation = NULL, iscale = NULL, imethod = 1, zero = "scale")

Arguments

llocation, lscale
Parameter link functions applied to the location parameter \( l \) and scale parameter \( s \). See Links for more choices, and CommonVGAMffArguments for more information.

scale.arg
Known positive scale parameter (called \( s \) below).

llocation, iscale
See CommonVGAMffArguments for information.

imethod, zero
See CommonVGAMffArguments for information.

Details

The two-parameter logistic distribution has a density that can be written as

\[
f(y; l, s) = \frac{\exp[-(y - l)/s]}{s \left(1 + \exp[-(y - l)/s]\right)}^2
\]

where \( s > 0 \) is the scale parameter, and \( l \) is the location parameter. The response \( -\infty < y < \infty \). The mean of \( Y \) (which is the fitted value) is \( l \) and its variance is \( \pi^2 s^2 / 3 \).

A logistic distribution with \( \text{scale} = 0.65 \) (see dlogis) resembles \( \text{dt} \) with \( \text{df} = 7 \); see logistic1 and studentt.

logistic1 estimates the location parameter only while logistic estimates both parameters. By default, \( \eta_1 = l \) and \( \eta_2 = \log(s) \) for logistic.

logistic can handle multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.
Note

Fisher scoring is used, and the Fisher information matrix is diagonal.

Author(s)

T. W. Yee

References


See Also

rlogis, CommonVGAMffArguments, logitlink, gensh, cumulative, bilogistic, simulate.vlm.

Examples

```r
# Location unknown, scale known
ldata <- data.frame(x2 = runif(nn <- 500))
ldata <- transform(ldata, y1 = rlogis(nn, loc = 1+5*x2, sc = exp(2)))
fit1 <- vglm(y1 ~ x2, logistic1(scale = exp(2)), ldata, trace = TRUE)
coef(fit1, matrix = TRUE)

# Both location and scale unknown
ldata <- transform(ldata, y2 = rlogis(nn, loc = 1 + 5*x2, exp(x2)))
fit2 <- vglm(cbind(y1, y2) ~ x2, logistic, data = ldata, trace = TRUE)
coef(fit2, matrix = TRUE)
vcov(fit2)
summary(fit2)
```

---

**logitlink**

*Logit Link Function*

Description

Computes the logit transformation, including its inverse and the first two derivatives.
Usage

logitlink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)

extlogitlink(theta, min = 0, max = 1, bminvalue = NULL, bmaxvalue = NULL, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)

Arguments

theta Numeric or character. See below for further details.
bvalue, bminvalue, bmaxvalue See Links. These are boundary values. For extlogitlink, values of theta less than or equal to A or greater than or equal to B can be replaced by bminvalue and bmaxvalue.
min, max For extlogitlink, min gives A, max gives B, and for out of range values, bminvalue and bmaxvalue.
inverse, deriv, short, tag Details at Links.

Details

The logit link function is very commonly used for parameters that lie in the unit interval. It is the inverse CDF of the logistic distribution. Numerical values of theta close to 0 or 1 or out of range result in Inf, -Inf, NA or NaN.

The extended logit link function extlogitlink should be used more generally for parameters that lie in the interval (A, B), say. The formula is

$$\log((\theta - A)/(B - \theta))$$

and the default values for A and B correspond to the ordinary logit function. Numerical values of theta close to A or B or out of range result in Inf, -Inf, NA or NaN. However these can be replaced by values bminvalue and bmaxvalue first before computing the link function.

Value

For logitlink with deriv = 0, the logit of theta, i.e., log(theta/(1-theta)) when inverse = FALSE, and if inverse = TRUE then exp(theta)/(1+exp(theta)).

For deriv = 1, then the function returns \(d \eta / d \theta\) theta as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base e.

Note

Numerical instability may occur when theta is close to 1 or 0 (for logitlink), or close to A or B for extlogitlink. One way of overcoming this is to use, e.g., bvalue.

In terms of the threshold approach with cumulative probabilities for an ordinal response this link function corresponds to the univariate logistic distribution (see logistic).
Author(s)
Thomas W. Yee

References

See Also
Links, alogitlink, asinlink, logitoffsetlink, probitlink, clogloglink, cauchitlink, logistic1, loglink, Logistic, multilogitlink.

Examples

```r
p <- seq(0.01, 0.99, by = 0.01)
logitlink(p)
max(abs(logitlink(logitlink(p), inverse = TRUE) - p)) # 0?

p <- c(seq(-0.02, 0.02, by = 0.01), seq(0.97, 1.02, by = 0.01))
logitlink(p) # Has NAs
logitlink(p, bvalue = .Machine$double.eps) # Has no NAs

p <- seq(0.9, 2.2, by = 0.1)
extrlogitlink(p, min = 1, max = 2,
             bminvalue = 1 + .Machine$double.eps,
             bmaxvalue = 2 - .Machine$double.eps) # Has no NAs

## Not run: par(mfrow = c(2,2), lwd = (mylwd <- 2))
y <- seq(-4, 4, length = 100)
p <- seq(0.01, 0.99, by = 0.01)
for (d in 0:1) {
  myinv <- (d > 0)
  matplot(p, cbind( logitlink(p, deriv = d, inv = myinv),
                   probitlink(p, deriv = d, inv = myinv)),
          las = 1,
          type = "n", col = "purple", ylab = "transformation",
          main = if (d == 0) "Some probability link functions"
          else "1 / first derivative")
  lines(p, logitlink(p, deriv = d, inverse = myinv), col = "limegreen")
  lines(p, probitlink(p, deriv = d, inverse = myinv), col = "purple")
  lines(p, clogloglink(p, deriv = d, inverse = myinv), col = "chocolate")
  lines(p, cauchitlink(p, deriv = d, inverse = myinv), col = "tan")
  if (d == 0) {
    abline(v = 0.5, h = 0, lty = "dashed")
    legend(0, 4.5, c("logitlink", "probitlink",
    "clogloglink", "cauchitlink"), col = c("limegreen", "purple",
    "chocolate", "tan"), lwd = mylwd)
  } else
    abline(v = 0.5, lty = "dashed")
}
for (d in 0) {

```
logitoffsetlink

**Logit-with-an-Offset Link Function**

---

**Description**

Computes the logitoffsetlink transformation, including its inverse and the first two derivatives.

**Usage**

```r
logitoffsetlink(theta, offset = 0, inverse = FALSE, deriv = 0,
short = TRUE, tag = FALSE)
```

**Arguments**

- `theta` Numeric or character. See below for further details.
- `offset` The offset value(s), which must be non-negative. It is called $K$ below.
- `inverse`, `deriv`, `short`, `tag`
  Details at Links.

**Details**

This link function allows for some asymmetry compared to the ordinary `logitlink` link. The formula is

$$\log(\theta/(1 - \theta) - K)$$
and the default value for the offset $K$ is corresponds to the ordinary \texttt{logitlink} link. When \texttt{inverse = TRUE} will mean that the value will lie in the interval $(K/(1 + K), 1)$.

**Value**

For \texttt{logitoffsetlink} with \texttt{deriv = 0}, the \texttt{logitoffsetlink} of theta, i.e., \( \log(\theta/(1-\theta) - K) \) when \texttt{inverse = FALSE}, and if \texttt{inverse = TRUE} then \((K + \exp(\theta))/(1 + \exp(\theta) + K)\).

For \texttt{deriv = 1}, then the function returns \( \frac{d \theta}{d \theta} \) as a function of \( \theta \) if \texttt{inverse = FALSE}, else if \texttt{inverse = TRUE} then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base $e$.

**Note**

This function is numerical less stability than \texttt{logitlink}.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

\texttt{Links}, \texttt{logitlink}.

**Examples**

```r
p <- seq(0.05, 0.99, by = 0.01); myoff <- 0.05
logitoffsetlink(p, myoff)
max(abs(logitoffsetlink(logitoffsetlink(p, myoff),
               myoff, inverse = TRUE) - p))  # Should be 0
```

---

\texttt{loglaplace} \hfill \textit{Log-Laplace and Logit-Laplace Distribution Family Functions}

**Description**

Maximum likelihood estimation of the 1-parameter log-Laplace and the 1-parameter logit-Laplace distributions. These may be used for quantile regression for counts and proportions respectively.
Usage

loglaplace1(tau = NULL, ilocation = "loglink",
           ilocation = NULL, kappa = sqrt(tau/(1 - tau)), Scale.arg = 1,
           ishrinkage = 0.95, parallel.locat = FALSE, digt = 4,
           idf.mu = 3, rep0 = 0.5, minquantile = 0, maxquantile = Inf,
           imethod = 1, zero = NULL)
logitlaplace1(tau = NULL, ilocation = "logitlink",
              ilocation = NULL, kappa = sqrt(tau/(1 - tau)),
              Scale.arg = 1, ishrinkage = 0.95, parallel.locat = FALSE,
              digt = 4, idf.mu = 3, rep01 = 0.5, imethod = 1, zero = NULL)

Arguments

tau, kappa
   See alaplace1.

ilocation
   Character. Parameter link functions for location parameter ξ. See Links for
   more choices. However, this argument should be left unchanged with count data
   because it restricts the quantiles to be positive. With proportions data ilocation
   can be assigned a link such as logitlink, probitlink, clogloglink, etc.

ilocation
   Optional initial values. If given, it must be numeric and values are recycled to
   the appropriate length. The default is to choose the value internally.

parallel.locat
   Logical. Should the quantiles be parallel on the transformed scale (argument
   ilocation)? Assigning this argument to TRUE circumvents the seriously em-
   barrassing quantile crossing problem.

imethod
   Initialization method. Either the value 1, 2, or ....

digt, ishrinkage, Scale.arg, zero
   See alaplace1. See CommonVGAMffArguments for information.

rep0, rep01
   Numeric, positive. Replacement values for 0s and 1s respectively. For count
   data, values of the response whose value is 0 are replaced by rep0; it avoids
   computing log(0). For proportions data values of the response whose value is
   0 or 1 are replaced by min(rangey01[1]/2, rep01/w[y==0]) and
   max((1 + rangey01[2])/2, 1-rep01/w[y>=1]) respectively; e.g., it avoids computing
   logitlink(0) or logitlink(1). Here, rangey01 is the 2-vector
   range(y[(y > 0) & (y < 1)]) of the response.

minquantile
   Numeric. The minimum and maximum values possible in the quantiles. These
   argument are effectively ignored by default since loglink keeps all quantiles
   positive. However, if ilocation = logofflink(offset = 1) then it is possible
   that the fitted quantiles have value 0 because minquantile = 0.

Details

These VGAM family functions implement translations of the asymmetric Laplace distribution
(ALD). The resulting variants may be suitable for quantile regression for count data or sample
proportions. For example, a log link applied to count data is assumed to follow an ALD. Another
example is a logit link applied to proportions data so as to follow an ALD. A positive random vari-
able Y is said to have a log-Laplace distribution if Y = e^W where W has an ALD. There are many
variants of ALDs and the one used here is described in alaplace1.
Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

In the extra slot of the fitted object are some list components which are useful. For example, the sample proportion of values which are less than the fitted quantile curves, which is \( \text{sum}(\text{wprior}[y \leq \text{location}]) / \text{sum}(\text{wprior}) \) internally. Here, \( \text{wprior} \) are the prior weights (called `ssize` below), \( y \) is the response and \( \text{location} \) is a fitted quantile curve. This definition comes about naturally from the transformed ALD data.

Warning

The **VGAM** family function `logitlaplace1` will not handle a vector of just 0s and 1s as the response; it will only work satisfactorily if the number of trials is large.

See `alaplace1` for other warnings. Care is needed with `tau` values which are too small, e.g., for count data the sample proportion of zeros must be less than all values in `tau`. Similarly, this also holds with `logitlaplace1`, which also requires all `tau` values to be less than the sample proportion of ones.

Note

The form of input for `logitlaplace1` as response is a vector of proportions (values in \([0, 1]\)) and the number of trials is entered into the weights argument of `vglm/vgam`. See Example 2 below. See `alaplace1` for other notes in general.

Author(s)

Thomas W. Yee

References


See Also

`alaplace1`, `dloglap`.

Examples

```r
# Example 1: quantile regression of counts with regression splines
set.seed(123); my.k <- exp(0)
adata <- data.frame(x2 = sort(runif(n <- 500)))
mymu <- function(x) exp(1 + 3*sin(2*x) / (x+0.5)^2)
adata <- transform(adata, y = rnbinom(n, mu = mymu(x2), my.k))
```

mytau <- c(0.1, 0.25, 0.5, 0.75, 0.9); mydof = 3

# halfstepping is usual:

fitp <- vglm(y ~ sm.bs(x2, df = mydof), data = adata, trace = TRUE,
            loglaplace1(tau = mytau, parallel.locat = TRUE))

## Not run: par(las = 1) # Plot on a log1p() scale

mylwd <- 1.5

plot(jitter(log1p(y), factor = 1.5) ~ x2, adata, col = "red",
     pch = "o", cex = 0.75,
     main = "Example 1; green=truth, blue=estimated")

with(adata, matlines(x2, log1p(fitted(fitp)), col = "blue",
                    lty = 1, lwd = mylwd))

finexgrid <- seq(0, 1, len = 201)

for (ii in 1:length(mytau))
  lines(finexgrid, col = "green", lwd = mylwd,
        log1p(qnbinom(mytau[ii], mu = mymu(finexgrid), my.k)))

## End(Not run)

fitp@extra # Contains useful information

# Example 2: sample proportions

set.seed(123); nnn <- 1000; ssize <- 100 # ssize = 1 wont work!

adata <- data.frame(x2 = sort(runif(nnn)))

mymu <- function(x) logitlink(1.0 + 4*x, inv = TRUE)

adata <- transform(adata, ssize = ssize,
                    y2 = rbinom(nnn, ssize, prob = mymu(x2)) / ssize)

mytau <- c(0.25, 0.50, 0.75)

fit1 <- vglm(y2 ~ sm.bs(x2, df = 3),
             logitlaplace1(tau = mytau, lloc = "clogloglink", paral = TRUE),
             data = adata, weights = ssize, trace = TRUE)

## Not run:

# Check the solution. Note: this is like comparing apples with oranges.

plotvgam(fit1, se = TRUE, scol = "red", lcol = "blue",
         main = "Truth = 'Var'")

# Centered approximately!

linkFunctionChar <- as.character(fit1@misc$link)

adata <- transform(adata, trueFunction =
                   theta2eta(theta = mymu(x2), link = linkFunctionChar))

with(adata, lines(x2, trueFunction - mean(trueFunction), col = "green"))

# Plot the data + fitted quantiles (on the original scale)

myylim <- with(adata, range(y2))

plot(y2 ~ x2, adata, col = "blue", ylim = myylim, las = 1,
     pch = ".", cex = 2.5)

with(adata, matplot(x2, fitted(fit1), add = TRUE, lwd = 3, type = "l")
truecol <- rep(1:3, len = fit1@misc$M) # Add the 'truth'

smallxgrid <- seq(0, 1, len = 501)

for (ii in 1:length(mytau))
  lines(smallxgrid, col = truecol[ii], lwd = 2,
        log1p(qnbinom(mytau[ii], mu = mymu(smallxgrid), my.k)))
loglapUC

The Log-Laplace Distribution

Description

Density, distribution function, quantile function and random generation for the 3-parameter log-Laplace distribution with location parameter location.ald, scale parameter scale.ald (on the log scale), and asymmetry parameter kappa.

Usage

dloglap(x, location.ald = 0, scale.ald = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)), log = FALSE)
ploglap(q, location.ald = 0, scale.ald = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)), lower.tail = TRUE, log.p = FALSE)
qloglap(p, location.ald = 0, scale.ald = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)), lower.tail = TRUE, log.p = FALSE)
rloglap(n, location.ald = 0, scale.ald = 1, tau = 0.5, kappa = sqrt(tau/(1-tau)))

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. If length(n) > 1 then the length is taken to be the number required.
location.ald, scale.ald the location parameter \( \xi \) and the (positive) scale parameter \( \sigma \), on the log scale.
tau the quantile parameter \( \tau \). Must consist of values in \((0, 1)\). This argument is used to specify kappa and is ignored if kappa is assigned.
kappa the asymmetry parameter \( \kappa \). Must consist of positive values.
log if TRUE, probabilities p are given as \( \log(p) \).
lower.tail, log.p Same meaning as in \( \text{pnorm} \) or \( \text{qnorm} \).
Details

A positive random variable $Y$ is said to have a log-Laplace distribution if $\log(Y)$ has an asymmetric Laplace distribution (ALD). There are many variants of ALDs and the one used here is described in `alaplace3`.

Value

dloglap gives the density, ploglap gives the distribution function, qloglap gives the quantile function, and rloglap generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


See Also

dalap, alaplace3, loglaplace1.

Examples

```r
loc <- 0; sigma <- exp(0.5); kappa <- 1
x <- seq(-0.2, 5, by = 0.01)
## Not run: plot(x, dloglap(x, loc, sigma, kappa = kappa),
## type = "l", col = "blue", ylim = c(0,1),
## main = "Blue is density, red is the CDF",
## sub = "Purple are 5,10,...,95 percentiles", las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(qloglap(seq(0.05,0.95,by = 0.05), loc, sigma, kappa = kappa),
dloglap(qloglap(seq(0.05,0.95,by = 0.05), loc, sigma, kappa = kappa),
loc, sigma, kappa = kappa),
col = "purple", lty = 3, type = "h")
lines(x, ploglap(x, loc, sigma, kappa = kappa), type = "l", col = 2)
abline(h = 0, lty = 2)
## End(Not run)
ploglap(qloglap(seq(0.05,0.95,by = 0.05), loc, sigma, kappa = kappa),
loc, sigma, kappa = kappa)
```

Description
Calculates the log-likelihood value or the element-by-element contributions of the log-likelihood.

Usage
## S3 method for class 'vlm'
logLik(object, summation = TRUE, ...)

Arguments
- object: Some VGAM object, for example, having class vglmff-class.
- summation: Logical, apply sum? If FALSE then a n-vector or n-row matrix (with the number of responses as the number of columns) is returned. Each element is the contribution to the log-likelihood.
- ...: Currently unused. In the future: other possible arguments fed into logLik in order to compute the log-likelihood.

Details
By default, this function returns the log-likelihood of the object. Thus this code relies on the log-likelihood being defined, and computed, for the object.

Value
Returns the log-likelihood of the object. If summation = FALSE then a n-vector or n-row matrix (with the number of responses as the number of columns) is returned. Each element is the contribution to the log-likelihood. The prior weights are assimilated within the answer.

Warning
Not all VGAM family functions have had the summation checked.

Note
Not all VGAM family functions currently have the summation argument implemented.

Author(s)
T. W. Yee.

See Also
VGLMs are described in vglm-class; VGAMs are described in vgam-class; RR-VGLMs are described in rrvglm-class; AIC: anova.vglm.
Examples

```r
zdata <- data.frame(x2 = runif(nn <- 50))
zdata <- transform(zdata, Ps01 = logitlink(-0.5, inverse = TRUE),
                   Ps02 = logitlink(0.5, inverse = TRUE),
                   lambda1 = loglink(-0.5 + 2*x2, inverse = TRUE),
                   lambda2 = loglink(0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata, y1 = rzipois(nn, lambda = lambda1, pstr0 = Ps01),
                   y2 = rzipois(nn, lambda = lambda2, pstr0 = Ps02))

with(zdata, table(y1))  # Eyeball the data
with(zdata, table(y2))
fit2 <- vglm(cbind(y1, y2) ~ x2, zipoisson(zero = NULL), data = zdata)
logLik(fit2)  # Summed over the two responses
sum(logLik(fit2, sum = FALSE))  # For checking purposes
(ll.matrix <- logLik(fit2, sum = FALSE))  # nn x 2 matrix
colSums(ll.matrix)  # log-likelihood for each response
```

loglinb2

Loglinear Model for Two Binary Responses

Description

Fits a loglinear model to two binary responses.

Usage

```r
loglinb2(exchangeable = FALSE, zero = "u12")
```

Arguments

- `exchangeable` Logical. If `TRUE`, the two marginal probabilities are constrained to be equal. Should be set `TRUE` for ears, eyes, etc. data.
- `zero` Which linear/additive predictors are modelled as intercept-only? A NULL means none of them. See `CommonVGAMffArguments` for more information.

Details

The model is

\[ P(Y_1 = y_1, Y_2 = y_2) = \exp(u_0 + u_1 y_1 + u_2 y_2 + u_{12} y_1 y_2) \]

where \( y_1 \) and \( y_2 \) are 0 or 1, and the parameters are \( u_1, u_2, u_{12} \). The normalizing parameter \( u_0 \) can be expressed as a function of the other parameters, viz.,

\[ u_0 = -\log[1 + \exp(u_1) + \exp(u_2) + \exp(u_1 + u_2 + u_{12})]. \]

The linear/additive predictors are \((\eta_1, \eta_2, \eta_3)^T = (u_1, u_2, u_{12})^T\).
Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, \texttt{rrvglm} and \texttt{vgam}.

When fitted, the fitted.values slot of the object contains the four joint probabilities, labelled as \((Y_1, Y_2) = (0,0), (0,1), (1,0), (1,1)\), respectively.

Note

The response must be a two-column matrix of ones and zeros only. This is more restrictive than \texttt{binom2.or}, which can handle more types of input formats. Note that each of the 4 combinations of the multivariate response need to appear in the data set. After estimation, the response attached to the object is also a two-column matrix; possibly in the future it might change into a four-column matrix.

Author(s)

Thomas W. Yee

References


See Also

\texttt{binom2.or}, \texttt{binom2.rho}, \texttt{loglinb3}.

Examples

calminers <- transform(coalminers, Age = (age - 42) / 5)
# Get the n x 4 matrix of counts
fit0 <- vglm(cbind(nBnW, nBW, BnW, BW) ~ Age, binom2.or, coalminers)
counts <- round(c(weights(fit0, type = "prior")) * depvar(fit0))
# Create a n x 2 matrix response for loglinb2()
# bmat <- matrix(c(0,0, 0,1, 1,0, 1,1), 4, 2, byrow = TRUE)
bmat <- cbind(bln = c(0,0,1,1), wheeze = c(0,1,0,1))
matof1 <- matrix(1, nrow(counts), 1)
newminers <-
data.frame(bln = kronecker(matof1, bmat[, 1]),
    wheeze = kronecker(matof1, bmat[, 2]),
    wt = c(t(counts)),
    Age = with(coalminers, rep(1, length(age))))
newminers <- newminers[with(newminers, wt) > 0,]
fit <- vglm(cbind(bln, wheeze) ~ Age, loglinb2(zero = NULL),
    weight = wt, data = newminers)
coef(fit, matrix = TRUE)  # Same! (at least for the log odds-ratio)
loglinb3

Loglinear Model for Three Binary Responses

Description

Fits a loglinear model to three binary responses.

Usage

loglinb3(exchangeable = FALSE, zero = c("u12", "u13", "u23"))

Arguments

  exchangeable Logical. If TRUE, the three marginal probabilities are constrained to be equal.

  zero Which linear/additive predictors are modelled as intercept-only? A NULL means none. See CommonVGAMffArguments for further information.

Details

The model is \( P(Y_1 = y_1, Y_2 = y_2, Y_3 = y_3) = \exp(u_0 + u_1y_1 + u_2y_2 + u_3y_3 + u_{12}y_1y_2 + u_{13}y_1y_3 + u_{23}y_2y_3) \)

where \( y_1, y_2 \) and \( y_3 \) are 0 or 1, and the parameters are \( u_1, u_2, u_3, u_{12}, u_{13}, u_{23} \). The normalizing parameter \( u_0 \) can be expressed as a function of the other parameters. Note that a third-order association parameter, \( u_{123} \) for the product \( y_1y_2y_3 \), is assumed to be zero for this family function.

The linear/additive predictors are \((\eta_1, \eta_2, \ldots, \eta_6)^T = (u_1, u_2, u_3, u_{12}, u_{13}, u_{23})^T\).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

When fitted, the fitted.values slot of the object contains the eight joint probabilities, labelled as \((Y_1, Y_2, Y_3) = (0,0,0), (0,0,1), (0,1,0), (0,1,1), (1,0,0), (1,0,1), (1,1,0), (1,1,1), \) respectively.

Note

The response must be a 3-column matrix of ones and zeros only. Note that each of the 8 combinations of the multivariate response need to appear in the data set, therefore data sets will need to be large in order for this family function to work. After estimation, the response attached to the object is also a 3-column matrix; possibly in the future it might change into a 8-column matrix.
**Author(s)**

Thomas W. Yee

**References**


**See Also**

`loglinb2, binom2.or, hunua`.

**Examples**

```r
lfit <- vglm(cbind(cyadea, beitaw, kniexc) ~ altitude, loglinb3, 
             data = hunua, trace = TRUE)
coef(lfit, matrix = TRUE)
head(fitted(lfit))
summary(lfit)
```

---

**loglink**  
*Log Link Function, and Variants*

**Description**

Computes the log transformation, including its inverse and the first two derivatives.

**Usage**

```r
loglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
        short = TRUE, tag = FALSE)
negloglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
           short = TRUE, tag = FALSE)
logneglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
           short = TRUE, tag = FALSE)
```

**Arguments**

- `theta` (Numeric or character. See below for further details.)
- `bvalue` (See *Links*.
- `inverse`, `deriv`, `short`, `tag` (Details at *Links*.)
loglink

Details

The log link function is very commonly used for parameters that are positive. Here, all logarithms are natural logarithms, i.e., to base $e$. Numerical values of theta close to 0 or out of range result in \text{Inf}, \text{-Inf}, \text{NA} or \text{NaN}.

The function loglink computes $\log(\theta)$ whereas negloglink computes $-\log(\theta) = \log(1/\theta)$.

The function logneglink computes $\log(-\theta)$, hence is suitable for parameters that are negative, e.g., a trap-shy effect in \texttt{posbernoulli.b}.

Value

The following concerns loglink. For deriv = 0, the log of theta, i.e., $\log(\theta)$ when inverse = FALSE, and if inverse = TRUE then $\exp(\theta)$. For deriv = 1, then the function returns $d \theta$/d $\theta$ as a function of $\theta$ if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

This function was called \texttt{loge} to avoid conflict with the \texttt{log} function. Numerical instability may occur when theta is close to 0 unless bvalue is used.

Author(s)

Thomas W. Yee

References


See Also

\texttt{Links}, \texttt{explink}, \texttt{logitlink}, \texttt{logclink}, \texttt{logloglink}, \texttt{log}, \texttt{logoflink}, \texttt{lambertW}, \texttt{posbernoulli.b}.

Examples

```r
## Not run: loglink(seq(-0.2, 0.5, by = 0.1))
  loglink(seq(-0.2, 0.5, by = 0.1), bvalue = .Machine$double.xmin)
  negloglink(seq(-0.2, 0.5, by = 0.1))
  negloglink(seq(-0.2, 0.5, by = 0.1), bvalue = .Machine$double.xmin)
## End(Not run)
logneglink(seq(-0.5, -0.2, by = 0.1))
```
logloglink

*Log-log and Log-log-log Link Functions*

Description

Computes the two transformations, including their inverse and the first two derivatives.

Usage

```r
logloglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, 
short = TRUE, tag = FALSE)
loglogloglink(theta, bvalue = NULL, inverse = FALSE, deriv = 0, 
short = TRUE, tag = FALSE)
```

Arguments

- `theta`: Numeric or character. See below for further details.
- `bvalue`: Values of `theta` which are less than or equal to 1 or e can be replaced by `bvalue` before computing the link function value. The component name `bvalue` stands for “boundary value”. See `Links` for more information.
- `inverse`, `deriv`, `short`, `tag`: Details at `Links`.

Details

The log-log link function is commonly used for parameters that are greater than unity. Similarly, the log-log-log link function is applicable for parameters that are greater than e. Numerical values of `theta` close to 1 or e or out of range result in Inf, -Inf, NA or NaN. One possible application of `loglogloglink()` is to the `k` parameter (also called `size`) of `negbinomial` to Poisson-like data but with only a small amount of overdispersion; then `k` is a large number relative to `munb`. In such situations a `loglink` or `loglog` link may not be sufficient to draw the estimate toward the interior of the parameter space. Using a more stronger link function can help mitigate the Hauck-Donner effect `hdeff`.

Value

For `logloglink()`: for `deriv = 0`, the log of log(`theta`), i.e., `log(log(theta))` when `inverse = FALSE`, and if `inverse = TRUE` then `exp(exp(theta))`.

For `loglogloglink()`: for `deriv = 0`, the log of log(log(`theta`)), i.e., `log(log(log(theta)))` when `inverse = FALSE`, and if `inverse = TRUE` then `exp(exp(exp(theta)))`.

For `deriv = 1`, then the function returns \( \frac{d \theta}{d \eta} \) as a function of `theta` if `inverse = FALSE`, else if `inverse = TRUE` then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base e.

Note

Numerical instability may occur when `theta` is close to 1 or e unless `bvalue` is used.
**lognormal**

**References**

**See Also**
Links, loglink, logofflink.

**Examples**

```r
x <- seq(0.8, 1.5, by = 0.1)
logloglink(x)  # Has NAs
logloglink(x, bvalue = 1.0 + .Machine$double.eps)  # Has no NAs
x <- seq(1.01, 10, len = 100)
logloglink(x)
max(abs(logloglink(logloglink(x), inverse = TRUE) - x))  # 0?
```

---

### Lognormal Distribution

**Description**

Maximum likelihood estimation of the (univariate) lognormal distribution.

**Usage**

```r
lognormal(lmeanlog = "identitylink", lsdlog = "loglink", zero = "sdlog")
```

**Arguments**

- `lmeanlog, lsdlog`
  Parameter link functions applied to the mean and (positive) \( \sigma \) (standard deviation) parameter. Both of these are on the log scale. See Links for more choices.

- `zero`
  Specifies which linear/additive predictor is modelled as intercept-only. For `lognormal()`, the values can be from the set \{1,2\} which correspond to mu, sigma, respectively. See CommonVGAMffArguments for more information.

**Details**

A random variable \( Y \) has a 2-parameter lognormal distribution if \( \log(Y) \) is distributed \( N(\mu, \sigma^2) \). The expected value of \( Y \), which is

\[
E(Y) = \exp(\mu + 0.5\sigma^2)
\]

and not \( \mu \), make up the fitted values. The variance of \( Y \) is

\[
Var(Y) = (\exp(\sigma^2) - 1)\exp(2\mu + \sigma^2).
\]
Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Author(s)

T. W. Yee

References


See Also

\texttt{Lognormal}, \texttt{uninormal}, \texttt{CommonVGAMffArguments}, \texttt{simulate.vlm}.

Examples

```r
ldata2 <- data.frame(x2 = runif(nn <- 1000))
ldata2 <- transform(ldata2, y1 = rlnorm(nn, 1 + 2 * x2, sd = exp(-1)),  
y2 = rlnorm(nn, 1, sd = exp(-1 + x2)))
fit1 <- vglm(y1 ~ x2, lognormal(zero = 2), data = ldata2, trace = TRUE)
fit2 <- vglm(y2 ~ x2, lognormal(zero = 1), data = ldata2, trace = TRUE)
coef(fit1, matrix = TRUE)
coef(fit2, matrix = TRUE)
```
**logofflink**

**Details**

The log-offset link function is very commonly used for parameters that are greater than a certain value. In particular, it is defined by log(theta + offset) where offset is the offset value. For example, if offset = 0.5 then the value of theta is restricted to be greater than \(-0.5\).

Numerical values of theta close to -offset or out of range result in Inf, -Inf, NA or NaN.

The offset is implicitly 1 in log1plink. It is equivalent to logofflink(offset = 1) but is more accurate if abs(theta) is tiny. It may be used for lrho in extbetabinomial provided an offset log(size - 1) for \(\eta_2\) is included.

**Value**

For deriv = 0, the log of theta+offset, i.e., log(theta+offset) when inverse = FALSE, and if inverse = TRUE then exp(theta)-offset.

For deriv = 1, then the function returns \(d\ \thetaeta\) as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Here, all logarithms are natural logarithms, i.e., to base \(e\).

**Note**

The default means this function is identical to loglink.

Numerical instability may occur when theta is close to -offset.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

Links, loglink, extbetabinomial.

**Examples**

```r
## Not run:
logofflink(seq(-0.2, 0.5, by = 0.1))
logofflink(seq(-0.2, 0.5, by = 0.1), offset = 0.5)
    log(seq(-0.2, 0.5, by = 0.1) + 0.5)
## End(Not run)
```
Description

Density, distribution function, quantile function and random generation for the Lomax distribution with scale parameter scale and shape parameter q.

Usage

dlomax(x, scale = 1, shape3.q, log = FALSE)
plomax(q, scale = 1, shape3.q, lower.tail = TRUE, log.p = FALSE)
qlomax(p, scale = 1, shape3.q, lower.tail = TRUE, log.p = FALSE)
rlomax(n, scale = 1, shape3.q)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. If length(n) > 1, the length is taken to be the number required.
scale scale parameter.
shape3.q shape parameter.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.

Details

See lomax, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.

Value

dlomax gives the density, plomax gives the distribution function, qlomax gives the quantile function, and rlomax generates random deviates.

Note

The Lomax distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)

T. W. Yee and Kai Huang
lomax

References


See Also

lomax, genbetaII.

Examples

```r
probs <- seq(0.1, 0.9, by = 0.1)
max(abs(plomax(qlomax(p = probs, shape3.q = 1),
       shape3.q = 1) - probs)) # Should be 0

## Not run: par(mfrow = c(1, 2))
x <- seq(-0.01, 5, len = 401)
plot(x, dexp(x), type = "l", col = "black", ylab = "", ylim = c(0, 3),
     main = "Black is std exponential, others are dlomax(x, shape3.q")
lines(x, dlomax(x, shape3.q = 1), col = "orange")
lines(x, dlomax(x, shape3.q = 2), col = "blue")
lines(x, dlomax(x, shape3.q = 5), col = "green")
legend("topright", col = c("orange","blue","green"), lty = rep(1, 3),
       legend = paste("shape3.q =", c(1, 2, 5)))

plot(x, pexp(x), type = "l", col = "black", ylab = "", las = 1,
     main = "Black is std exponential, others are plomax(x, shape3.q")
lines(x, plomax(x, shape3.q = 1), col = "orange")
lines(x, plomax(x, shape3.q = 2), col = "blue")
lines(x, plomax(x, shape3.q = 5), col = "green")
legend("bottomright", col = c("orange","blue","green"), lty = rep(1, 3),
       legend = paste("shape3.q =", c(1, 2, 5)))

## End(Not run)
```

---

lomax

**Lomax Distribution Family Function**

Description

Maximum likelihood estimation of the 2-parameter Lomax distribution.

Usage

```r
lomax(lscale = "loglink", lshape3.q = "loglink", iscale = NULL,
     ishape3.q = NULL, imethod = 1, gscale = exp(-5:5),
     gshape3.q = seq(0.75, 4, by = 0.25),
     probs.y = c(0.25, 0.5, 0.75), zero = "shape")
```
Arguments

lscale, lshape3.q

Parameter link function applied to the (positive) parameters scale and q. See Links for more choices.

iscale, ishape3.q, imethod

See CommonVGAMffArguments for information. For imethod = 2 a good initial value for iscale is needed to obtain a good estimate for the other parameter.

gscale, gshape3.q, zero, probs.y

See CommonVGAMffArguments.

Details

The 2-parameter Lomax distribution is the 4-parameter generalized beta II distribution with shape parameters \( a = p = 1 \). It is probably more widely known as the Pareto (II) distribution. It is also the 3-parameter Singh-Maddala distribution with shape parameter \( a = 1 \), as well as the beta distribution of the second kind with \( p = 1 \). More details can be found in Kleiber and Kotz (2003).

The Lomax distribution has density

\[
f(y) = \frac{q}{[b(1 + y/b)]^{1+q}}
\]

for \( b > 0, \ q > 0, \ y \geq 0 \). Here, \( b \) is the scale parameter \( \text{scale} \), and \( q \) is a shape parameter. The cumulative distribution function is

\[
F(y) = 1 - [1 + (y/b)]^{-q}.
\]

The mean is

\[
E(Y) = \frac{b}{(q - 1)}
\]

provided \( q > 1 \); these are returned as the fitted values. This family function handles multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

See the notes in genbetaII.

Author(s)

T. W. Yee

References

See Also

Lomax, genbetaII, betaII, dagum, sinmad, fisk, inv.lomax, paralogistic, inv.paralogistic, simulate.vlm.

Examples

ldata <- data.frame(y = rlomax(n = 1000, scale = exp(1), exp(2)))
fit <- vglm(y ~ 1, lomax, data = ldata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

lpossums

Leadbeater's Possums

Description

Abundance of Leadbeater's Possums observed in the field.

Usage

data(lpossums)

Format

A data frame with the following variables.

number Values between 0 and 10 excluding 6.
ofreq Observed frequency, i.e., the number of sites.

Details

A small data set recording the abundance of Leadbeater’s Possums Gymnobelideus leadbeateri observed in the montane ash forests of the Central Highlands of Victoria, in south-eastern Australia. There are 151 3-hectare sites. The data has more 0s than usual relative to the Poisson, as well as exhibiting overdispersion too.

Source


See Also

zipoissonff.
Examples

```r
lpossums
(samplemean <- with(lpossums, weighted.mean(number, ofreq)))
with(lpossums, var(rep(number, times = ofreq)) / samplemean)
sum(with(lpossums, ofreq))
## Not run: spikeplot(with(lpossums, rep(number, times = ofreq)),
    main = "Leadbeater's possums", col = "blue", xlab = "Number")
## End(Not run)
```

---

**lqnorm**

*Minimizing the L-q norm Family Function*

### Description

Minimizes the L-q norm of residuals in a linear model.

### Usage

```r
lqnorm(qpower = 2, link = "identitylink",
    imethod = 1, imu = NULL, ishrinkage = 0.95)
```

### Arguments

- **qpower**
  
  A single numeric, must be greater than one, called \( q \) below. The absolute value of residuals are raised to the power of this argument, and then summed. This quantity is minimized with respect to the regression coefficients.

- **link**
  
  Link function applied to the ‘mean’ \( \mu \). See **Links** for more details.

- **imethod**
  
  Must be 1, 2 or 3. See **CommonVGAMffArguments** for more information. Ignored if `imu` is specified.

- **imu**
  
  Numeric, optional initial values used for the fitted values. The default is to use `imethod = 1`.

- **ishrinkage**
  
  How much shrinkage is used when initializing the fitted values. The value must be between 0 and 1 inclusive, and a value of 0 means the individual response values are used, and a value of 1 means the median or mean is used. This argument is used in conjunction with `imethod = 3`.

### Details

This function minimizes the objective function

\[
\sum_{i=1}^{n} w_i (|y_i - \mu_i|)^q
\]

where \( q \) is the argument `qpower`, \( \eta_i = g(\mu_i) \) where \( g \) is the link function, and \( \eta_i \) is the vector of linear/additive predictors. The prior weights \( w_i \) can be inputted using the `weights` argument of...
vlm/vglm/vgam etc.; it should be just a vector here since this function handles only a single vector or one-column response.

Numerical problem will occur when \( q \) is too close to one. Probably reasonable values range from 1.5 and up, say. The value \( q = 2 \) corresponds to ordinary least squares while \( q = 1 \) corresponds to the MLE of a double exponential (Laplace) distribution. The procedure becomes more sensitive to outliers the larger the value of \( q \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

Convergence failure is common, therefore the user is advised to be cautious and monitor convergence!

Note

This VGAM family function is an initial attempt to provide a more robust alternative for regression and/or offer a little more flexibility than least squares. The @misc slot of the fitted object contains a list component called objectiveFunction which is the value of the objective function at the final iteration.

Author(s)

Thomas W. Yee

References


See Also

uninormal.

Examples

```r
set.seed(123)
ldata <- data.frame(x = sort(runif(nn <- 10 )))
realfun <- function(x) 4 + 5*x
ldata <- transform(ldata, y = realfun(x) + rnorm(nn, sd = exp(-1)))
# Make the first observation an outlier
ldata <- transform(ldata, y = c(4*y[1], y[-1]), x = c(-1, x[-1]))
fit <- vglm(y ~ x, lqnorm(qpower = 1.2), data = ldata)
coef(fit, matrix = TRUE)
head(fitted(fit))
fit@misc$qpower
fit@misc$objectiveFunction
```
## Not run:
# Graphical check
with(ldata, plot(x, y,
    main = paste0("LS = red, lqnorm = blue (qpower = ",
    fit@misc$qpower, "), truth = black), col = "blue")
lmfit <- lm(y ~ x, data = ldata)
with(ldata, lines(x, fitted(fit), col = "blue")
with(ldata, lines(x, lmfit$fitted, col = "red")
with(ldata, lines(x, realfun(x), col = "black")
## End(Not run)

---

### lrt.stat

**Likelihood Ratio Test Statistics Evaluated at the Null Values**

#### Description

Generic function that computes likelihood ratio test (LRT) statistics evaluated at the null values (consequently they do not suffer from the Hauck-Donner effect).

#### Usage

```r
lrt.stat(object, ...)
lrt.stat.vlm(object, values0 = 0, subset = NULL, omit1s = TRUE,
    all.out = FALSE, trace = FALSE, ...)
```

#### Arguments

- `object, values0, subset`
  
  Same as in `wald.stat.vlm`.
- `omit1s, all.out, trace`
  
  Same as in `wald.stat.vlm`.
- `...`
  
  Ignored for now.

#### Details

When `summary()` is applied to a `vglm` object a 4-column Wald table is produced. The corresponding p-values are generally viewed as inferior to those from a likelihood ratio test (LRT). For example, the Hauck and Donner (1977) effect (HDE) produces p-values that are biased upwards (see `hdeff`). Other reasons are that the Wald test is often less accurate (especially in small samples) and is not invariant to parameterization. By default, this function returns p-values based on the LRT by deleting one column at a time from the big VLM matrix and then restarting IRLS to obtain convergence (hopefully). Twice the difference between the log-likelihoods (or equivalently, the difference in the deviances if they are defined) is asymptotically chi-squared with 1 degree of freedom. One might expect the p-values from this function therefore to be more accurate and not suffer from the HDE. Thus this function is a recommended alternative (if it works) to `summaryvglm` for testing for the significance of a regression coefficient.
**lrtest**

### Value

By default, a vector of signed square root of the LRT statistics; these are asymptotically standard normal under the null hypotheses. If all.out = TRUE then a list is returned with the following components: \( \text{lrt.stat} \) the signed LRT statistics, \( pvalues \) the 2-sided p-values, \( \text{Lrt.stat2} \) the usual LRT statistic, \( \text{values0} \) the null values.

### Warning

See `wald.stat.vlm`.

### Author(s)

T. W. Yee.

### See Also

`score.stat`, `wald.stat`, `summaryvglm`, `anova.vglm`, `vglm`, `lrtest`, `confintvglm`, `pchisq`, `profilevglm`, `hdeff`.

### Examples

```r
set.seed(1)
pneumo <- transform(pneumo, let = log(exposure.time),
                    x3 = rnorm(nrow(pneumo)))
fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo)
ct <- cbind(coef(summary(fit)),
            "signed LRT stat" = lrt.stat(fit, omit1s = FALSE))
summary(fit, lrt0 = TRUE) # Easy way to get it
```

---

**lrtest**

**Likelihood Ratio Test of Nested Models**

### Description

`lrtest` is a generic function for carrying out likelihood ratio tests. The default method can be employed for comparing nested VGLMs (see details below).

### Usage

```r
lrtest(object, ...)

lrtest_vglm(object, ..., no.warning = FALSE, name = NULL)
```
Arguments

object a `vglm` object. See below for details.

... further object specifications passed to methods. See below for details.

no.warning logical; if `TRUE` then no warning is issued. For example, setting `TRUE` might be a good idea when testing for linearity of a variable for a "pvgam" object.

name a function for extracting a suitable name/description from a fitted model object. By default the name is queried by calling `formula`.

Details

`lrtest` is intended to be a generic function for comparisons of models via asymptotic likelihood ratio tests. The default method consecutively compares the fitted model object with the models passed in ... Instead of passing the fitted model objects in ... several other specifications are possible. The updating mechanism is the same as for `waldtest()` in `lmtest`: the models in ... can be specified as integers, characters (both for terms that should be eliminated from the previous model), update formulas or fitted model objects. Except for the last case, the existence of an `update` method is assumed. See `waldtest()` in `lmtest` for details.

Subsequently, an asymptotic likelihood ratio test for each two consecutive models is carried out: Twice the difference in log-likelihoods (as derived by the `logLik` methods) is compared with a Chi-squared distribution.

Value

An object of class "VGAManova" which contains a slot with the log-likelihood, degrees of freedom, the difference in degrees of freedom, likelihood ratio Chi-squared statistic and corresponding p value. These are printed by `stats:::print.anova()`; see `anova`.

Warning

Several VGAM family functions implement distributions which do not satisfying the usual regularity conditions needed for the LRT to work. No checking or warning is given for these.

Note

The code was adapted directly from `lmtest` (written by T. Hothorn, A. Zeileis, G. Millo, D. Mitchell) and made to work for VGLMs and S4. This help file also was adapted from `lmtest`.

Approximate LRTs might be applied to VGAMs, as produced by `vgam`, but it is probably better in inference to use `vglm` with regression splines (`bs` and `ns`). This methods function should not be applied to other models such as those produced by `rrvglm`, by `cqo`, by `cao`.

See Also

`lmtest`, `vglm`, `lrt.stat.vlm`, `score.stat.vlm`, `wald.stat.vlm`, `anova.vglm`.
Examples

```r
set.seed(1)
pneumo <- transform(pneumo, let = log(exposure.time),
                    x3 = runif(nrow(pneumo)))
fit1 <- vglm(cbind(normal, mild, severe) ~ let , propodds, pneumo)
fit2 <- vglm(cbind(normal, mild, severe) ~ let + x3, propodds, pneumo)
fit3 <- vglm(cbind(normal, mild, severe) ~ let , cumulative, pneumo)
# Various equivalent specifications of the LR test for testing x3
(ans1 <- lrtest(fit2, fit1))
ans2 <- lrtest(fit2, 2)
ans3 <- lrtest(fit2, "x3")
ans4 <- lrtest(fit2, . ~ . - x3)
c(all.equal(ans1, ans2), all.equal(ans1, ans3), all.equal(ans1, ans4))

# Doing it manually
(testStatistic <- 2 * (logLik(fit2) - logLik(fit1)))
(pval <- pchisq(testStatistic, df = df.residual(fit1) - df.residual(fit2),
                 lower.tail = FALSE))
(ans4 <- lrtest(fit3, fit1))  # Test PO (parallelism) assumption
```

---

**lvplot**

*Latent Variable Plot*

**Description**

Generic function for a latent variable plot (also known as an ordination diagram by ecologists).

**Usage**

```r
lvplot(object, ...)
```

**Arguments**

- `object` An object for a latent variable plot is meaningful.
- `...` Other arguments fed into the specific methods function of the model. They usually are graphical parameters, and sometimes they are fed into the methods function for `Coef`.

**Details**

Latent variables occur in reduced-rank regression models, as well as in quadratic and additive ordination. For the latter, latent variables are often called the site scores. Latent variable plots were coined by Yee (2004), and have the latent variable as at least one of its axes.

**Value**

The value returned depends specifically on the methods function invoked.
Note

Latent variables are not really applicable to \texttt{vglm/vgam} models.

Author(s)

Thomas W. Yee

References


See Also

\texttt{lvplot.qrrvglm}, \texttt{lvplot.cao}, \texttt{latvar}, \texttt{trplot}.

Examples

```r
## Not run:
hspider[,1:6] <- scale(hspider[,1:6])  # Stdz environmental vars
set.seed(123)
p1 <- cao(cbind(Pardlugu, Pardmont, Pardnigr, Pardpull, Zoraspin) ~
  WaterCon + BareSand + FallTwig +
  CoveMoss + CoveHerb + ReflLux,
  family = poissonff, data = hspider, Bestof = 3,
  df1.nl = c(Zoraspin = 2.5, 3), Crow1positive = TRUE)
index <- 1:ncol(depvar(p1))
lvplot(p1, lcol = index, pcol = index, y = TRUE, las = 1)
## End(Not run)
```

\texttt{lvplot.qrrvglm} \hspace{1cm} \textit{Latent Variable Plot for QO models}

Description

Produces an ordination diagram (latent variable plot) for quadratic ordination (QO) models. For rank-1 models, the x-axis is the first ordination/constrained/canonical axis. For rank-2 models, the x- and y-axis are the first and second ordination axes respectively.

Usage

\begin{verbatim}
lvplot.qrrvglm(object, varI.latvar = FALSE, refResponse = NULL,
  add = FALSE, show.plot = TRUE,
  rug = TRUE, y = FALSE, type = c("fitted.values", "predictors"),
  xlab = paste0("Latent Variable", if (Rank == 1) "" else " 1"),
  ylab = if (Rank == 1) switch(type, predictors = "Predictors",
```
fitted.values = "Fitted values") else "Latent Variable 2",
pdex = par()$cex, pcol = par()$col, pch = par()$pch,
llty = par()$lty, lcol = par()$col, llwd = par()$lwd,
label.arg = FALSE, adj.arg = -0.1,
ellipse = 0.95, Absolute = FALSE, elty = par()$lty,
ecol = par()$col, elwd = par()$lwd, egrid = 200,
chull.arg = FALSE, cty = 2, ccol = par()$col, clwd = par()$lwd,
cpch = " ",
C = FALSE, OriginC = c("origin", "mean"),
Clty = par()$lty, Ccol = par()$col, Clwd = par()$lwd,
Ccxex = par()$cex, Cadj.arg = -0.1, stretchC = 1,
sites = FALSE, spch = NULL, scol = par()$col, scex = par()$cex,
sfont = par()$font, check.ok = TRUE, jitter.y = FALSE, ...)

Arguments

object A CQO object.

varI.latvar Logical that is fed into Coef.qrrvglm.

refResponse Integer or character that is fed into Coef.qrrvglm.

add Logical. Add to an existing plot? If FALSE, a new plot is made.

show.plot Logical. Plot it?

rug Logical. If TRUE, a rug plot is plotted at the foot of the plot (applies to rank-1 models only). These values are jittered to expose ties.

y Logical. If TRUE, the responses will be plotted (applies only to rank-1 models and if type = "fitted.values").

type Either "fitted.values" or "predictors", specifies whether the y-axis is on the response or eta-scales respectively.

xlab Caption for the x-axis. See par.

ylab Caption for the y-axis. See par.

pcex Character expansion of the points. Here, for rank-1 models, points are the response y data. For rank-2 models, points are the optimums. See the cex argument in par.

pcol Color of the points. See the col argument in par.

pch Either an integer specifying a symbol or a single character to be used as the default in plotting points. See par. The pch argument can be of length $M$, the number of species.

llty Line type. Rank-1 models only. See the lty argument of par.

lcol Line color. Rank-1 models only. See the col argument of par.

llwd Line width. Rank-1 models only. See the lwd argument of par.

label.arg Logical. Label the optimums and C? (applies only to rank-2 models only).

adj.arg Justification of text strings for labelling the optimums (applies only to rank-2 models only). See the adj argument of par.
ellipse  Numerical, of length 0 or 1 (applies only to rank-2 models only). If Absolute is TRUE then ellipse should be assigned a value that is used for the elliptical contouring. If Absolute is FALSE then ellipse should be assigned a value between 0 and 1, for example, setting ellipse = 0.9 means an ellipse with contour = 90% of the maximum will be plotted about each optimum. If ellipse is a negative value, then the function checks that the model is an equal-tolerances model and varI.latvar = FALSE, and if so, plots circles with radius = -ellipse. For example, setting ellipse = -1 will result in circular contours that have unit radius (in latent variable units). If ellipse is NULL or FALSE then no ellipse is drawn around the optimums.

Absolute  Logical. If TRUE, the contours corresponding to ellipse are on an absolute scale. If FALSE, the contours corresponding to ellipse are on a relative scale.

elty  Line type of the ellipses. See the lty argument of par.

ecol  Line color of the ellipses. See the col argument of par.

elwd  Line width of the ellipses. See the lwd argument of par.

egrid  Numerical. Line resolution of the ellipses. Choosing a larger value will result in smoother ellipses. Useful when ellipses are large.

chull.arg  Logical. Add a convex hull around the site scores?

clty  Line type of the convex hull. See the lty argument of par.

ccol  Line color of the convex hull. See the col argument of par.

clwd  Line width of the convex hull. See the lwd argument of par.

cpch  Character to be plotted at the intersection points of the convex hull. Having white spaces means that site labels are not obscured there. See the pch argument of par.

C  Logical. Add C (represented by arrows emanating from OriginC) to the plot?

OriginC  Character or numeric. Where the arrows representing C emanate from. If character, it must be one of the choices given. By default the first is chosen. The value "origin" means c(0,0). The value "mean" means the sample mean of the latent variables (centroid). Alternatively, the user may specify a numerical vector of length 2.

Clty  Line type of the arrows representing C. See the lty argument of par.

Ccol  Line color of the arrows representing C. See the col argument of par.

Clwd  Line width of the arrows representing C. See the lwd argument of par.

Ccex  Numeric. Character expansion of the labelling of C. See the cex argument of par.

Cadj.arg  Justification of text strings when labelling C. See the adj argument of par.

stretchC  Numerical. Stretching factor for C. Instead of using C, stretchC * C is used.

sites  Logical. Add the site scores (aka latent variable values, nu's) to the plot? (applies only to rank-2 models only).

spch  Plotting character of the site scores. The default value of NULL means the row labels of the data frame are used. They often are the site numbers. See the pch argument of par.
scol  Color of the site scores. See the col argument of par.
scex  Character expansion of the site scores. See the cex argument of par.
sfont Font used for the site scores. See the font argument of par.
check.ok Logical. Whether a check is performed to see that noRRR = ~ 1 was used. It doesn't make sense to have a latent variable plot unless this is so.
jitter.y Logical. If y is plotted, jitter it first? This may be useful for counts and proportions.
... Arguments passed into the plot function when setting up the entire plot. Useful arguments here include xlim and ylim.

Details

This function only works for rank-1 and rank-2 QRR-VGLMs with argument noRRR = ~ 1.

For unequal-tolerances models, the latent variable axes can be rotated so that at least one of the tolerance matrices is diagonal; see Coef.qrrvglm for details.

Arguments beginning with "p" correspond to the points e.g., pce x and pcol correspond to the size and color of the points. Such "p" arguments should be vectors of length 1, or n, the number of sites.

For the rank-2 model, arguments beginning with "p" correspond to the optimums.

Value

Returns a matrix of latent variables (site scores) regardless of whether a plot was produced or not.

Warning

Interpretation of a latent variable plot (CQO diagram) is potentially very misleading in terms of distances if (i) the tolerance matrices of the species are unequal and (ii) the contours of these tolerance matrices are not included in the ordination diagram.

Note

A species which does not have an optimum will not have an ellipse drawn even if requested, i.e., if its tolerance matrix is not positive-definite.

Plotting C gives a visual display of the weights (loadings) of each of the variables used in the linear combination defining each latent variable.

The arguments elty, ecol and elwd, may be replaced in the future by llty, lcol and llwd, respectively.

For rank-1 models, a similar function to this one is perspqrrvglm. It plots the fitted values on a more fine grid rather than at the actual site scores here. The result is a collection of smooth bell-shaped curves. However, it has the weakness that the plot is more divorced from the data; the user thinks it is the truth without an appreciation of the statistical variability in the estimates.

In the example below, the data comes from an equal-tolerances model. The species’ tolerance matrices are all the identity matrix, and the optimums are at (0,0), (1,1) and (-2,0) for species 1, 2, 3 respectively.
Author(s)

Thomas W. Yee

References


See Also

lvplot, perspqrrvglm, Coef.qrrvglm, par, cqo.

Examples

```r
set.seed(123); nn <- 200
cdata <- data.frame(x2 = rnorm(nn), # Mean 0 (needed when I.tol=TRUE)
                    x3 = rnorm(nn), # Mean 0 (needed when I.tol=TRUE)
                    x4 = rnorm(nn)) # Mean 0 (needed when I.tol=TRUE)
cdata <- transform(cdata, latvar1 = x2 + x3 - 2*x4,
                    latvar2 = -x2 + x3 + 0*x4)
# Nb. latvar2 is weakly correlated with latvar1

cdata <- transform(cdata,
                    lambda1 = exp(6 - 0.5 * (latvar1-0)^2 - 0.5 * (latvar2-0)^2),
                    lambda2 = exp(5 - 0.5 * (latvar1-1)^2 - 0.5 * (latvar2-1)^2),
                    lambda3 = exp(5 - 0.5 * (latvar1+2)^2 - 0.5 * (latvar2-0)^2))
cdata <- transform(cdata,
                    spp1 = rpois(nn, lambda1),
                    spp2 = rpois(nn, lambda2),
                    spp3 = rpois(nn, lambda3))
set.seed(111)
## Not run:
p2 <- cqo(cbind(spp1, spp2, spp3) ~ x2 + x3 + x4, poissonff,
           data = cdata, Rank = 2, I.tolerances = TRUE,
           Crow1positive = c(TRUE, FALSE)) # deviance = 505.81
if (deviance(p2) > 506) stop("suboptimal fit obtained")
sort(deviance(p2, history = TRUE)) # A history of the iterations
Coef(p2)
## End(Not run)

## Not run:

lvplot(p2, sites = TRUE, spch = "+", scol = "darkgreen", scex = 1.5,
       chull = TRUE, label = TRUE, Absolute = TRUE, ellipse = 140,
       adj = -0.5, pcol = "blue", pcex = 1.3, las = 1, Ccol = "orange",
       C = TRUE, Cadj = c(-0.3, -0.3, 1), Clwd = 2, Ccex = 1.4,
       main = paste("Contours at Abundance = 140 with",
                    "convex hull of the site scores"))
## End(Not run)

## Not run:

var(latvar(p2)) # A diagonal matrix, i.e., uncorrelated latent vars
var(latvar(p2, varI.latvar = TRUE)) # Identity matrix
Tol(p2)[, , 1:2] # Identity matrix
```
lvplot.rrvglm

Latent Variable Plot for RR-VGLMs

Description

Produces an ordination diagram (also known as a biplot or latent variable plot) for reduced-rank vector generalized linear models (RR-VGLMs). For rank-2 models only, the x- and y-axis are the first and second canonical axes respectively.

Usage

```r
lvplot.rrvglm(object, A = TRUE, C = TRUE, scores = FALSE, show.plot = TRUE, groups = rep(1, n), gapC = sqrt(sum(par()$cxy^2)), scaleA = 1, xlab = "Latent Variable 1", ylab = "Latent Variable 2", Alabels = if (length(object@misc$predictors.names)) object@misc$predictors.names else param.names("LP", M), Aadj = par()$adj, Acex = par()$cex, Acol = par()$col, Apch = NULL, Clabels = rownames(Cmat), Cadj = par()$adj, Ccex = par()$cex, Ccol = par()$col, Clty = par()$lty, Clwd = par()$lwd, chull.arg = FALSE, ccex = par()$cex, ccol = par()$col, clty = par()$lty, clwd = par()$lwd, spch = NULL, scex = par()$cex, scol = par()$col, slabels = rownames(x2mat), ...)```

Arguments

- `object`: Object of class "rrvglm".
- `A`: Logical. Allow the plotting of A?
- `C`: Logical. Allow the plotting of C? If TRUE then C is represented by arrows emanating from the origin.
- `scores`: Logical. Allow the plotting of the n scores? The scores are the values of the latent variables for each observation.
- `show.plot`: Logical. Plot it? If FALSE, no plot is produced and the matrix of scores (n latent variable values) is returned. If TRUE, the rank of object need not be 2.
- `groups`: A vector whose distinct values indicate which group the observation belongs to. By default, all the observations belong to a single group. Useful for the multinomial logit model (see `multinomial`).
- `gapC`: The gap between the end of the arrow and the text labelling of C, in latent variable units.
scaleA Numerical value that is multiplied by A, so that C is divided by this value.
xlab Caption for the x-axis. See par.
ylab Caption for the y-axis. See par.
Alabels Character vector to label A. Must be of length M.
Aadj Justification of text strings for labelling A. See the adj argument of par.
Aces Numeric. Character expansion of the labelling of A. See the cex argument of par.
Acol Line color of the arrows representing C. See the col argument of par.
Apch Either an integer specifying a symbol or a single character to be used as the default in plotting points. See par. The pch argument can be of length M, the number of species.
Clabels Character vector to label C. Must be of length p2.
Cadj Justification of text strings for labelling C. See the adj argument of par.
Ccex Numeric. Character expansion of the labelling of C. See the cex argument of par.
Ccol Line color of the arrows representing C. See the col argument of par.
Clty Line type of the arrows representing C. See the lty argument of par.
Clwd Line width of the arrows representing C. See the lwd argument of par.
chull.arg Logical. Plot the convex hull of the scores? This is done for each group (see the group argument).
ccex Numeric. Character expansion of the labelling of the convex hull. See the cex argument of par.
ccol Line color of the convex hull. See the col argument of par.
cclty Line type of the convex hull. See the lty argument of par.
cclwd Line width of the convex hull. See the lwd argument of par.
spch Either an integer specifying a symbol or a single character to be used as the default in plotting points. See par. The spch argument can be of length M, the number of species.
scex Numeric. Character expansion of the labelling of the scores. See the cex argument of par.
scol Line color of the arrows representing C. See the col argument of par.
slabels Character vector to label the scores. Must be of length n.
... Arguments passed into the plot function when setting up the entire plot. Useful arguments here include xlim and ylim.

Details

For RR-VGLMs, a biplot and a latent variable plot coincide. In general, many of the arguments starting with “A” refer to A (of length M), “C” to C (of length p2), “c” to the convex hull (of length length(unique(groups))), and “s” to scores (of length n).

As the result is a biplot, its interpretation is based on the inner product.
**Value**

The matrix of scores ($n$ latent variable values) is returned regardless of whether a plot was produced or not.

**Note**

The functions `lvplot.rvglm` and `biplot.rvglm` are equivalent.

In the example below the predictor variables are centered, which is a good idea.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

`lvplot`, `par`, `rvglm`, `Coef.rvglm`, `rvglm.control`.

**Examples**

```r
set.seed(1)
nn <- nrow(pneumo)  # x1--x3 are some unrelated covariates
pneumo <- transform(pneumo, slet = scale(log(exposure.time)),
                     imag = severe + 3,  # Fictitional!
                     x1 = rnorm(nn), x2 = rnorm(nn), x3 = rnorm(nn))
fit <- rvglm(cbind(normal, mild, severe, imag) ~ slet + x1 + x2 + x3,
            multinomial, data = pneumo, Rank = 2)
## Not run:
lvplot(fit, chull = TRUE, scores = TRUE, clty = 2, ccol = 4, scol = "red", Ccol = "green3", Clwd = 2, Ccex = 2, main = "Biplot of some fictitional data")
## End(Not run)
```

**Description**

A small count data set involving 414 machinists from a three months study, of accidents around the end of WWI.
Usage

data(machinists)

Format

A data frame with the following variables.

- **accidents**  The number of accidents
- **ofreq**     Observed frequency, i.e., the number of machinists with that many accidents

Details

The data was collected over a period of three months. There were 414 machinists in total. Also, there were data collected over six months, but it is not given here.

Source


References


See Also

- negbinomial
- poissonff

Examples

```
machinists
mean(with(machinists, rep(accidents, times = ofreq)))
var(with(machinists, rep(accidents, times = ofreq)))
## Not run: barplot(with(machinists, ofreq),
## names.arg = as.character(with(machinists, accidents)),
## main = "Machinists accidents",
## col = "lightblue", las = 1,
## ylab = "Frequency", xlab = "accidents")
## End(Not run)
```
The Makeham Distribution

Description

Density, cumulative distribution function, quantile function and random generation for the Makeham distribution.

Usage

dmakeham(x, scale = 1, shape, epsilon = 0, log = FALSE)

pmakeham(q, scale = 1, shape, epsilon = 0, lower.tail = TRUE, log.p = FALSE)

qmakeham(p, scale = 1, shape, epsilon = 0, lower.tail = TRUE, log.p = FALSE)

rmakeham(n, scale = 1, shape, epsilon = 0)

Arguments

x, q        vector of quantiles.
p          vector of probabilities.
n          number of observations. Same as in runif.
log          Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p          Same meaning as in pnorm or qnorm.
scale, shape          positive scale and shape parameters.
epsilon          another parameter. Must be non-negative. See below.

Details

See makeham for details. The default value of epsilon = 0 corresponds to the Gompertz distribution. The function pmakeham uses lambertW.

Value

dmakeham gives the density, pmakeham gives the cumulative distribution function, qmakeham gives the quantile function, and rmakeham generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References

See Also

`makeham`, `lambertW`.

Examples

```r
probs <- seq(0.01, 0.99, by = 0.01)
Shape <- exp(-1); Scale <- exp(1); eps <- Epsilon <- exp(-1)
max(abs(pmakeham(qmakeham(probs, sca = Scale, Shape, eps = Epsilon),
    sca = Scale, Shape, eps = Epsilon) - probs)) # Should be 0

## Not run: x <- seq(-0.1, 2.0, by = 0.01);
plot(x, dmakeham(x, sca = Scale, Shape, eps = Epsilon), type = "l",
    main = "Blue is density, orange is the CDF",
    sub = "Purple lines are the 10,20,...,90 percentiles",
    col = "blue", las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(x, pmakeham(x, sca = Scale, Shape, eps = Epsilon), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qmakeham(probs, sca = Scale, Shape, eps = Epsilon)
lines(Q, dmakeham(Q, sca = Scale, Shape, eps = Epsilon),
    col = "purple", lty = 3, type = "h")

pmakeham(Q, sca = Scale, Shape, eps = Epsilon) - probs # Should be all 0
abline(h = probs, col = "purple", lty = 3)
## End(Not run)
```

makeham

`Makeham Regression Family Function`

Description

Maximum likelihood estimation of the 3-parameter Makeham distribution.

Usage

```r
makeham(lscale = "loglink", lshape = "loglink", lepsilon = "loglink",
    iscale = NULL, ishape = NULL, iepsilon = NULL,
    gscale = exp(-5:5), gshape = exp(-5:5), gepsilon = exp(-4:1),
    nsimEIM = 500, oim.mean = TRUE, zero = NULL, nowarning = FALSE)
```

Arguments

- `nowarning` Logical. Suppress a warning? Ignored for `VGAM` 0.9-7 and higher.
- `lshape, lscale, lepsilon` Parameter link functions applied to the shape parameter `shape`, scale parameter `scale`, and other parameter `epsilon`. All parameters are treated as positive here (cf. `dmakeham` allows `epsilon = 0`, etc.). See `Links` for more choices.
- `ishape, iscale, iepsilon` Optional initial values. A `NULL` means a value is computed internally. A value must be given for `iepsilon` currently, and this is a sensitive parameter!
The Makeham distribution, which adds another parameter to the Gompertz distribution, has cumulative distribution function

\[ F(y; \alpha, \beta, \varepsilon) = 1 - \exp \left\{ -y\varepsilon + \frac{\alpha}{\beta} \left[ 1 - e^{\beta y} \right] \right\} \]

which leads to a probability density function

\[ f(y; \alpha, \beta, \varepsilon) = \left[ \varepsilon + \alpha e^{\beta y} \right] \exp \left\{ -y\varepsilon + \frac{\alpha}{\beta} \left[ 1 - e^{\beta y} \right] \right\}, \]

for \( \alpha > 0, \beta > 0, \varepsilon \geq 0, y > 0 \). Here, \( \beta \) is called the scale parameter \textit{scale}, and \( \alpha \) is called a shape parameter. The moments for this distribution do not appear to be available in closed form.

Simulated Fisher scoring is used and multiple responses are handled.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning

A lot of care is needed because this is a rather difficult distribution for parameter estimation, especially when the shape parameter is large relative to the scale parameter. If the self-starting initial values fail then try experimenting with the initial value arguments, especially \texttt{iepsilon}. Successful convergence depends on having very good initial values. More improvements could be made here. Also, monitor convergence by setting \texttt{trace = TRUE}.

A trick is to fit a \texttt{gompertz} distribution and use it for initial values; see below. However, this family function is currently numerically fraught.

Author(s)

T. W. Yee

See Also

dmakeham, gompertz, simulate.vlm.
Examples

```r
## Not run: set.seed(123)
mdata <- data.frame(x2 = runif(nn <- 1000))
mdata <- transform(mdata, eta1 = -1,
ceta1 = 1,
eeta1 = -2)
mdata <- transform(mdata, shape1 = exp(eta1),
scale1 = exp(ceta1),
epsil1 = exp(eeta1))
mdata <- transform(mdata, y1 = rmakeham(nn, shape = shape1, scale = scale1, eps = epsil1))

# A trick is to fit a Gompertz distribution first
fit0 <- vglm(y1 ~ 1, gompertz, data = mdata, trace = TRUE)
fit1 <- vglm(y1 ~ 1, makeham, data = mdata,
etastart = cbind(predict(fit0), log(0.1)), trace = TRUE)

coef(fit1, matrix = TRUE)
summary(fit1)

## End(Not run)
```

---

**margeff**

Marginal Effects for Several Categorical Response Models

**Description**
Marginal effects for the multinomial logit model and cumulative logit/probit/... models and continuation ratio models and stopping ratio models and adjacent categories models: the derivative of the fitted probabilities with respect to each explanatory variable.

**Usage**
margeff(object, subset = NULL, ...)

**Arguments**

- **object** A vglm object, with one of the following family functions: multinomial, cumulative, cratio, sratio, acat, poissonff, negbinomial, or posnegbinomial.
- **subset** Numerical or logical vector, denoting the required observation(s). Recycling is used if possible. The default means all observations.
- **...** further arguments passed into the other methods functions.
Details

Computes the derivative of the fitted probabilities of the categorical response model with respect to each explanatory variable. Formerly one big function, this function now uses S4 dispatch to break up the computations.

The function `margeff()` is *not* generic. However, it calls the function `margeffS4VGAM()` which *is*. This is based on the class of the `VGAMff` argument, and it uses the S4 function `setMethod` to correctly dispatch to the required methods function. The inheritance is given by the `vfamily` slot of the `VGAM` family function.

Value

A $p$ by $M + 1$ by $n$ array, where $p$ is the number of explanatory variables and the (hopefully) nominal response has $M + 1$ levels, and there are $n$ observations.

In general, if `is.numeric(subset)` and `length(subset) == 1` then a $p$ by $M + 1$ matrix is returned.

Warning

Care is needed in interpretation, e.g., the change is not universally accurate for a unit change in each explanatory variable because eventually the ‘new’ probabilities may become negative or greater than unity. Also, the ‘new’ probabilities will not sum to one.

This function is not applicable for models with data-dependent terms such as `bs` and `poly`. Also the function should not be applied to models with any terms that have generated more than one column of the LM model matrix, such as `bs` and `poly`. For such try using numerical methods such as finite-differences. The formula in object should comprise of simple terms of the form $\sim x2 + x3 + x4$, etc.

Some numerical problems may occur if the fitted values are close to 0 or 1 for the `cratio` and `sratio` models. Models with offsets may result in an incorrect answer.

Note

For `multinomial` this function should handle any value of `refLevel` and also any constraint matrices. However, it does not currently handle the `xij` or `form2` arguments, nor `vgam` objects.

If marginal effects are to be computed for some values not equal to those used in the training set, then the `@x` and the `@predictors` slots both need to be assigned. See Example 3 below.

Some other limitations are imposed, e.g., for `acat` models only a `loglink` link is allowed.

Author(s)

T. W. Yee, with some help and motivation from Stasha Rmandic.

See Also

`multinomial`, `cumulative`, `propodds`, `acat`, `cratio`, `sratio`, `poissonff`, `negbinomial`, `vglm`. 
Examples

```r
# Not a good example for multinomial() since the response is ordinal!!
ii <- 3; hh <- 1/100
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, multinomial, pneumo)
fitted(fit)[ii, ]

mynewdata <- with(pneumo, data.frame(let = let[ii] + hh))
(newp <- predict(fit, newdata = mynewdata, type = "response"))

# Compare the difference. Should be the same as hh --> 0.
round((newp - fitted(fit)[ii, ] / hh), 3) # Finite-diff approxn
round(margeff(fit, subset = ii)["let",], 3)

# Other examples
round(margeff(fit), 3)
round(margeff(fit, subset = 2)["let",], 3)
round(margeff(fit, subset = c(FALSE, TRUE))["let",], 3) # Recycling
round(margeff(fit, subset = c(2, 4, 6, 8))["let",], 3)

# Example 3; margeffs at a new value
mynewdata2a <- data.frame(let = 2) # New value
mynewdata2b <- data.frame(let = 2 + hh) # For finite-diff approxn
(neweta2 <- predict(fit, newdata = mynewdata2a))
fit@x[1, ] <- c(1, unlist(mynewdata2a))
fit@predictors[1, ] <- neweta2 # Needed
max(abs(margeff(fit, subset = 1)["let",] - (
    predict(fit, newdata = mynewdata2b, type = "response") -
    predict(fit, newdata = mynewdata2a, type = "response")) / hh)) # Should be 0
```

marital.nz

New Zealand Marital Data

Description

Some marital data mainly from a large NZ company collected in the early 1990s.

Usage

data(marital.nz)

Format

A data frame with 6053 observations on the following 3 variables.

age a numeric vector, age in years
Max

ethnicity a factor with levels European Maori Other Polynesian. Only Europeans are included in the data set.
mstatus a factor with levels Divorced/Separated, Married/Partnered, Single, Widowed.

Details

This is a subset of a data set collected from a self-administered questionnaire administered in a large New Zealand workforce observational study conducted during 1992–3. The data were augmented by a second study consisting of retirees. The data can be considered a reasonable representation of the white male New Zealand population in the early 1990s.

Source

Clinical Trials Research Unit, University of Auckland, New Zealand.

References

See bmi.nz and chest.nz.

Examples

summary(marital.nz)

<table>
<thead>
<tr>
<th>Max</th>
<th>Maximums</th>
</tr>
</thead>
</table>

Description

Generic function for the *maximums* (maxima) of a model.

Usage

Max(object, ...)

Arguments

object An object for which the computation or extraction of a maximum (or maximums) is meaningful.

... Other arguments fed into the specific methods function of the model. Sometimes they are fed into the methods function for Coef.

Details

Different models can define a maximum in different ways. Many models have no such notion or definition.

Maximums occur in quadratic and additive ordination, e.g., CQO or CAO. For these models the maximum is the fitted value at the optimum. For quadratic ordination models there is a formula for the optimum but for additive ordination models the optimum must be searched for numerically. If it occurs on the boundary, then the optimum is undefined. For a valid optimum, the fitted value at the optimum is the maximum.
Value

The value returned depends specifically on the methods function invoked.

Author(s)

Thomas W. Yee

References


See Also

Max.qrrvglm, Tol, Opt.

Examples

```r
## Not run:
set.seed(111) # This leads to the global solution
hspider[,1:6] <- scale(hspider[,1:6]) # Standardized environmental vars
p1 <- cqo(cbind(Alopacce, Alopcur, Alopfabr, Arctlute, Arctperi,
    Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
    Trocterr, Zoraspin) ~
    WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
    poissonff, Bestof = 2, data = hspider, Crow1positive = FALSE)
Max(p1)

index <- 1:ncol(depvar(p1))
persp(p1, col = index, las = 1, llwd = 2)
abline(h = Max(p1), lty = 2, col = index)

## End(Not run)
```

---

Maxwell

The Maxwell Distribution

Description

Density, distribution function, quantile function and random generation for the Maxwell distribution.

Usage

```r
dmaxwell(x, rate, log = FALSE)
pmaxwell(q, rate, lower.tail = TRUE, log.p = FALSE)
qumaxwell(p, rate, lower.tail = TRUE, log.p = FALSE)
rmaxwell(n, rate)
```
Maxwell

Arguments

- `x, q, p, n`  
  Same as `Uniform`.
- `rate`  
  the (rate) parameter.
- `log`  
  Logical. If `log = TRUE` then the logarithm of the density is returned.
- `lower.tail, log.p`  
  Same meaning as in `pnorm` or `qnorm`.

Details

See `maxwell`, the `VGAM` family function for estimating the (rate) parameter \( \alpha \) by maximum likelihood estimation, for the formula of the probability density function.

Value

dmaxwell gives the density, pmaxwell gives the distribution function, qmaxwell gives the quantile function, and rmaxwell generates random deviates.

Note

The Maxwell distribution is related to the Rayleigh distribution.

Author(s)

T. W. Yee and Kai Huang

References


See Also

`maxwell`, `Rayleigh`, `rayleigh`.

Examples

```
## Not run: rate <- 3; x <- seq(-0.5, 3, length = 100)
plot(x, dmaxwell(x, rate = rate), type = "l", col = "blue",
     main = "Blue is density, orange is CDF", ylab = "", las = 1,
     sub = "Purple lines are the 10,20,...,90 percentiles")
abline(h = 0, col = "blue", lty = 2)
lines(x, pmaxwell(x, rate = rate), type = "l", col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qmaxwell(probs, rate = rate)
lines(Q, dmaxwell(Q, rate), col = "purple", lty = 3, type = "h")
lines(Q, pmaxwell(Q, rate), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pmaxwell(Q, rate) - probs))  # Should be zero
```

## End(Not run)
`maxwell`  

**Maxwell Regression Family Function**

**Description**

Estimating the parameter of the Maxwell distribution by maximum likelihood estimation.

**Usage**

```r
maxwell(link = "loglink", zero = NULL, parallel = FALSE,
        type.fitted = c("mean", "percentiles", "Qlink"),
        percentiles = 50)
```

**Arguments**

- **link**: Parameter link function applied to \( a \), which is called the parameter rate. See **Links** for more choices and information; a log link is the default because the parameter is positive. More information is at **CommonVGAMffArguments**.
- **zero**, **parallel**: See **CommonVGAMffArguments**.
- **type.fitted**, **percentiles**: See **CommonVGAMffArguments** for information. Using "Qlink" is for quantile-links in **VGAMextra**.

**Details**

The Maxwell distribution, which is used in the area of thermodynamics, has a probability density function that can be written

\[
f(y; a) = \sqrt{\frac{2}{\pi}} a^{3/2} y^2 \exp(-0.5ay^2)
\]

for \( y > 0 \) and \( a > 0 \). The mean of \( Y \) is \( \sqrt{8/(\pi a)} \) (returned as the fitted values), and its variance is \((3\pi-8)/(\pi a)\).

**Value**

An object of class "vglmff" (see **vglmff-class**). The object is used by modelling functions such as **vglm**, **rrvglm** and **vgam**.

**Note**

Fisher-scoring and Newton-Raphson are the same here. A related distribution is the Rayleigh distribution. This **VGAM** family function handles multiple responses. This **VGAM** family function can be mimicked by **poisson.points**(ostatistic = 1.5, dimension = 2).

**Author(s)**

T. W. Yee
mccullagh89

References

See Also
*Maxwell, rayleigh, poisson.points*.

Examples
```r
mdata <- data.frame(y = rmaxwell(1000, rate = exp(2)))
fit <- vglm(y ~ 1, maxwell, mdata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
```

---

mccullagh89

*McCullagh (1989) Distribution Family Function*

Description

Usage
```r
mccullagh89(ltheta = "rhobitlink", lnu = logofflink(offset = 0.5),
          itheta = NULL, inu = NULL, zero = NULL)
```

Arguments
- `ltheta`, `lnu` Link functions for the `\theta` and `\nu` parameters. See `Links` for general information.
- `itheta`, `inu` Numeric. Optional initial values for `\theta` and `\nu`. The default is to internally compute them.
- `zero` See `CommonVGAMffArguments` for information.

Details
The McCullagh (1989) distribution has density function
\[
f(y; \theta, \nu) = \frac{(1 - y^2)^{-\frac{1}{2}}}{(1 - 2\theta y + \theta^2)^{\nu} \text{Beta}(\nu + \frac{1}{2}, \frac{1}{2})}
\]
where \(-1 < y < 1\) and \(-1 < \theta < 1\). This distribution is equation (1) in that paper. The parameter `\nu` satisfies `\nu > -1/2`, therefore the default is to use an log-offset link with offset equal to 0.5, i.e., 
\[\eta_2 = \log(\nu + 0.5)\]. The mean is of `Y` is `\nu \theta / (1 + \nu)`, and these are returned as the fitted values.

This distribution is related to the Leipnik distribution (see Johnson et al. (1995)), is related to ultraspherical functions, and under certain conditions, arises as exit distributions for Brownian motion. Fisher scoring is implemented here and it uses a diagonal matrix so the parameters are globally orthogonal in the Fisher information sense. McCullagh (1989) also states that, to some extent, `\theta` and `\nu` have the properties of a location parameter and a precision parameter, respectively.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Note

Convergence may be slow or fail unless the initial values are reasonably close. If a failure occurs, try assigning the argument iniu and/or itheta. Figure 1 of McCullagh (1989) gives a broad range of densities for different values of \( \theta \) and \( \nu \), and this could be consulted for obtaining reasonable initial values if all else fails.

Author(s)

T. W. Yee

References


See Also

leipnik, rhobitlink, logofflink.

Examples

```r
# Limit as theta = 0, nu = Inf:
mdata <- data.frame(y = rnorm(1000, sd = 0.2))
fit <- vglm(y ~ 1, mccullagh89, data = mdata, trace = TRUE)
head(fitted(fit))
with(mdata, mean(y))
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit)
```

meangaitd

*Mean of the GAITD Combo Density*

Description

Returns the mean of a 1- or 2-parameter GAITD combo probability mass function.
meangaitd

Usage

meangaitd(theta.p, fam = c("pois", "log", "zeta"),
    a.mix = NULL, i.mix = NULL, d.mix = NULL,
    a.mlm = NULL, i.mlm = NULL, d.mlm = NULL,
    truncate = NULL, max.support = Inf,
    pobs.mix = 0, pobs.mlm = 0,
    pstr.mix = 0, pstr.mlm = 0,
    pdip.mix = 0, pdip.mlm = 0, byrow.aid = FALSE,
    theta.a = theta.p, theta.i = theta.p, theta.d = theta.p, ...)

Arguments

theta.p  Same as dgaiddplot; usually of length 1 but may be of length 2.
fam  Same as dgaiddplot. The default is the first one. All other choices are listed in that vector.
a.mix, i.mix, a.mlm, i.mlm
    Same as dgaiddplot.
d.mix, d.mlm  Same as dgaiddplot.
truncate, max.support
    Same as dgaiddplot.
pobs.mix, pobs.mlm, byrow.aid
    Same as dgaiddplot.
pstr.mix, pstr.mlm, pdip.mix, pdip.mlm
    Same as dgaiddplot.
theta.a, theta.i, theta.d
    Same as dgaiddplot.
...
    Currently unused.

Details

This function returns the mean of the PMF of the GAITD combo model. Many of its arguments are the same as dgaiddplot. More functionality may be added in the future, such as returning the variance.

Value

The mean.

Note

This utility function may change a lot in the future.

Author(s)

T. W. Yee.
See Also
dgaitdplot, Gaitdpois, gaitdpoisson.

Examples

```r
i.mix <- seq(0, 15, by = 5)
lambda.p <- 10
meangaitd(lambda.p, a.mix = i.mix + 1, i.mix = i.mix,
         max.support = 17, pobs.mix = 0.1, pstr.mix = 0.1)
```

---

**melbmaxtemp**

*Melbourne Daily Maximum Temperatures*

Description

Melbourne daily maximum temperatures in degrees Celsius over the ten-year period 1981–1990.

Usage

data(melbmaxtemp)

Format

A vector with 3650 observations.

Details

This is a time series data from Melbourne, Australia. It is commonly used to give a difficult quantile regression problem since the data is bimodal. That is, a hot day is likely to be followed by either an equally hot day or one much cooler. However, an independence assumption is typically made.

References


See Also

lms.bcn.

Examples

```r
summary(melbmaxtemp)
## Not run:
melb <- data.frame(today = melbmaxtemp[-1],
                   yesterday = melbmaxtemp[-length(melbmaxtemp)])
plot(today ~ yesterday, data = melb,
     xlab = "Yesterday's Max Temperature",
     ylab = "Today's Max Temperature", cex = 1.4, type = "n")
```
points(today ~ yesterday, melb, pch = 0, cex = 0.50, col = "blue")
abline(a = 0, b = 1, lty = 3)

## End(Not run)

### meplot

**Mean Excess Plot**

**Description**

Mean excess plot (also known as a mean residual life plot), a diagnostic plot for the generalized Pareto distribution (GPD).

**Usage**

```r
meplot(object, ...)
meplot.default(y, main = "Mean Excess Plot",
               xlab = "Threshold", ylab = "Mean Excess", lty = c(2, 1:2),
               conf = 0.95, col = c("blue", "black", "blue"), type = "l", ...)
meplot.vlm(object, ...)
```

**Arguments**

- `y` A numerical vector. NAs etc. are not allowed.
- `main`, `xlab`, `ylab` Character. Overall title for the plot, and titles for the x- and y-axes.
- `lty` Line type. The second value is for the mean excess value, the first and third values are for the envelope surrounding the confidence interval.
- `conf` Confidence level. The default results in approximate 95 percent confidence intervals for each mean excess value.
- `col` Colour of the three lines.
- `type` Type of plot. The default means lines are joined between the mean excesses and also the upper and lower limits of the confidence intervals.
- `object` An object that inherits class "vlm", usually of class `vglm-class` or `vgam-class`.
- `...` Graphical argument passed into `plot`. See `par` for an exhaustive list. The arguments `xlim` and `ylim` are particularly useful.

**Details**

If $Y$ has a GPD with scale parameter $\sigma$ and shape parameter $\xi < 1$, and if $y > 0$, then

$$E(Y - u|Y > u) = \frac{\sigma + \xi u}{1 - \xi}.$$  

It is a linear function in $u$, the threshold. Note that $Y - u$ is called the *excess* and values of $Y$ greater than $u$ are called *exceedances*. The empirical versions used by these functions is to use
sample means to estimate the left hand side of the equation. Values of $u$ in the plot are the values of $y$ itself. If the plot is roughly a straight line then the GPD is a good fit; this plot can be used to select an appropriate threshold value. See gpd for more details. If the plot is flat then the data may be exponential, and if it is curved then it may be Weibull or gamma. There is often a lot of variance/fluctuation at the RHS of the plot due to fewer observations.

The function meplot is generic, and meplot.default and meplot.vlm are some methods functions for mean excess plots.

Value

A list is returned invisibly with the following components.

threshold The x axis values.
meanExcess The y axis values. Each value is a sample mean minus a value $u$.
plusminus The amount which is added or subtracted from the mean excess to give the confidence interval. The last value is a NA because it is based on one observation.

Note

The function is designed for speed and not accuracy, therefore huge data sets with extremely large values may cause failure (the function cumsum is used.) Ties may not be well handled.

Author(s)

T. W. Yee

References


See Also

gpd.

Examples

```r
### Not run: meplot(with(venice90, sealevel), las = 1) -> ii
names(ii)
abline(h = ii$meanExcess[1], col = "orange", lty = "dashed")

par(mfrow = c(2, 2))
for (ii in 1:4)
  meplot(rgpd(1000), col = c("orange", "blue", "orange"))

### End(Not run)
```
Description

Fits a Michaelis-Menten nonlinear regression model.

Usage

`micmen(rpar = 0.001, divisor = 10, init1 = NULL, init2 = NULL,`  
`imethod = 1, oim = TRUE, link1 = "identitylink",`  
`link2 = "identitylink", firstDeriv = c("nsimEIM", "rpar"),`  
`probs.x = c(0.15, 0.85), nsimEIM = 500, dispersion = 0,`  
`zero = NULL)`

Arguments

- `rpar` Numeric. Initial positive ridge parameter. This is used to create positive-definite weight matrices.
- `divisor` Numerical. The divisor used to divide the ridge parameter at each iteration until it is very small but still positive. The value of `divisor` should be greater than one.
- `init1, init2` Numerical. Optional initial value for the first and second parameters, respectively. The default is to use a self-starting value.
- `link1, link2` Parameter link function applied to the first and second parameters, respectively. See Links for more choices.
- `firstDeriv` Character. Algorithm for computing the first derivatives and working weights. The first is the default.
- `imethod, probs.x` See CommonVGAMffArguments for information.
- `nsimEIM, zero` See CommonVGAMffArguments for information.
- `oim` Use the OIM? See CommonVGAMffArguments for information.

Details

The Michaelis-Menten model is given by

\[ E(Y_i) = \frac{\theta_1 u_i}{\theta_2 + u_i} \]

where \( \theta_1 \) and \( \theta_2 \) are the two parameters.

The relationship between iteratively reweighted least squares and the Gauss-Newton algorithm is given in Wedderburn (1974). However, the algorithm used by this family function is different. Details are given at the Author’s web site.
Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Warning

This function is not (nor could ever be) entirely reliable. Plotting the fitted function and monitoring convergence is recommended.

Note

The regressor values $u_i$ are inputted as the RHS of the `form2` argument. It should just be a simple term; no smart prediction is used. It should just a single vector, therefore omit the intercept term. The LHS of the formula `form2` is ignored.

To predict the response at new values of $u_i$ one must assign the `@extra$Xm2` slot in the fitted object these values, e.g., see the example below.

Numerical problems may occur. If so, try setting some initial values for the parameters. In the future, several self-starting initial values will be implemented.

Author(s)

T. W. Yee

References


See Also

`enzyme`.

Examples

```r
mfit <- vglm(velocity ~ 1, micmen, data = enzyme, trace = TRUE, 
             crit = "coef", form2 = ~ conc - 1)
summary(mfit)
## Not run:
plot(velocity ~ conc, enzyme, xlab = "concentration", las = 1, 
     col = "blue", 
     main = "Michaelis-Menten equation for the enzyme data", 
     ylim = c(0, max(velocity)), xlim = c(0, max(conc)))
points(fitted(mfit) ~ conc, enzyme, col = 2, pch = "+", cex = 2)
# This predicts the response at a finer grid:
```

```
mills.ratio <- data.frame(conc = seq(0, max(with(enzyme, conc)), len = 200))
mfit@extra$Xm2 <- newenzyme$conc # This is needed for prediction
lines(predict(mfit, newenzyme, "response") - conc, newenzyme,
col = "red")
## End(Not run)

mills.ratio  Mills Ratio

Description
Computes the Mills ratio.

Usage
mills.ratio(x)
mills.ratio2(x)

Arguments
x Numeric (real).

Details
The Mills ratio here is \( \frac{dnorm(x)}{pnorm(x)} \) (some use \( \frac{1 - pnorm(x)}{dnorm(x)} \)). Some care is needed as \( x \) approaches \(-\infty\); when \( x \) is very negative then its value approaches \(-x\).

Value
mills.ratio returns the Mills ratio, and mills.ratio2 returns \( \frac{dnorm(x) \times dnorm(x)}{pnorm(x)} \).

Author(s)
T. W. Yee

References

See Also
Normal, tobit, cens.poisson.
mix2exp

## Not run:
curve(mills.ratio, -5, 5, col = "orange", las = 1)
curve(mills.ratio, -5, 5, col = "orange", las = 1, log = "y")
## End(Not run)

### Description
Estimates the three parameters of a mixture of two exponential distributions by maximum likelihood estimation.

### Usage
```r
mix2exp(lphi = "logitlink", llambda = "loglink", iphi = 0.5,
il1 = NULL, il2 = NULL, qmu = c(0.8, 0.2), nsimEIM = 100,
zero = "phi")
```

### Arguments
- `lphi, llambda`: Link functions for the parameters $\phi$ and $\lambda$. The latter is the rate parameter and note that the mean of an ordinary exponential distribution is $1/\lambda$. See Links for more choices.
- `iphi, il1, il2`: Initial value for $\phi$, and optional initial value for $\lambda_1$ and $\lambda_2$. The last two have values that must be positive. The default is to compute initial values internally using the argument `qmu`.
- `qmu`: Vector with two values giving the probabilities relating to the sample quantiles for obtaining initial values for $\lambda_1$ and $\lambda_2$. The two values are fed in as the `probs` argument into `quantile`.
- `nsimEIM, zero`: See CommonVGAMffArguments.

### Details
The probability density function can be loosely written as

$$f(y) = \phi \text{Exponential}(\lambda_1) + (1 - \phi) \text{Exponential}(\lambda_2)$$

where $\phi$ is the probability an observation belongs to the first group, and $y > 0$. The parameter $\phi$ satisfies $0 < \phi < 1$. The mean of $Y$ is $\phi/\lambda_1 + (1 - \phi)/\lambda_2$ and this is returned as the fitted values. By default, the three linear/additive predictors are $(\text{logit}(\phi), \log(\lambda_1), \log(\lambda_2))^T$.

### Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as `vglm` and `vgam`. 

---

**Examples**

```r
## Not run:
curve(mills.ratio, -5, 5, col = "orange", las = 1)
curve(mills.ratio, -5, 5, col = "orange", las = 1, log = "y")
## End(Not run)
```
Warning

This **VGAM** family function requires care for a successful application. In particular, good initial values are required because of the presence of local solutions. Therefore running this function with several different combinations of arguments such as iphi, il1, il2, qmu is highly recommended. Graphical methods such as `hist` can be used as an aid.

This **VGAM** family function is experimental and should be used with care.

Note

Fitting this model successfully to data can be difficult due to local solutions, uniqueness problems and ill-conditioned data. It pays to fit the model several times with different initial values and check that the best fit looks reasonable. Plotting the results is recommended. This function works better as $\lambda_1$ and $\lambda_2$ become more different. The default control argument `trace = TRUE` is to encourage monitoring convergence.

Author(s)

T. W. Yee

See Also

`rexp`, `exponential`, `mix2poisson`.

Examples

```r
## Not run: lambda1 <- exp(1); lambda2 <- exp(3)
(phi <- logitlink(-1, inverse = TRUE))
mdata <- data.frame(y1 = rexp(nn <- 1000, lambda1))
mdata <- transform(mdata, y2 = rexp(nn, lambda2))
mdata <- transform(mdata, Y = ifelse(runif(nn) < phi, y1, y2))
fit <- vglm(Y ~ 1, mix2exp, data = mdata, trace = TRUE)
coef(fit, matrix = TRUE)

# Compare the results with the truth
round(rbind('Estimated' = Coef(fit),
            'Truth' = c(phi, lambda1, lambda2)), digits = 2)

with(mdata, hist(Y, prob = TRUE, main = "Orange=estimate, blue=truth"))
abline(v = 1 / Coef(fit)[c(2, 3)], lty = 2, col = "orange", lwd = 2)
abline(v = 1 / c(lambda1, lambda2), lty = 2, col = "blue", lwd = 2)

## End(Not run)
```
mix2normal

Mixture of Two Univariate Normal Distributions

Description

Estimates the five parameters of a mixture of two univariate normal distributions by maximum likelihood estimation.

Usage

mix2normal(lphi = "logitlink", lmu = "identitylink", lsd = "loglink", iphi = 0.5, imu1 = NULL, imu2 = NULL, isd1 = NULL, isd2 = NULL, qmu = c(0.2, 0.8), eq.sd = TRUE, nsimEIM = 100, zero = "phi")

Arguments

lphi,lmu,lsd Link functions for the parameters \( \phi \), \( \mu \), and \( \sigma \). See Links for more choices.

iphi Initial value for \( \phi \), whose value must lie between 0 and 1.

imu1, imu2 Optional initial value for \( \mu_1 \) and \( \mu_2 \). The default is to compute initial values internally using the argument qmu.

isd1, isd2 Optional initial value for \( \sigma_1 \) and \( \sigma_2 \). The default is to compute initial values internally based on the argument qmu. Currently these are not great, therefore using these arguments where practical is a good idea.

qmu Vector with two values giving the probabilities relating to the sample quantiles for obtaining initial values for \( \mu_1 \) and \( \mu_2 \). The two values are fed in as the probs argument into quantile.

eq.sd Logical indicating whether the two standard deviations should be constrained to be equal. If TRUE then the appropriate constraint matrices will be used.

nsimEIM See CommonVGAMffArguments.

zero May be an integer vector specifying which linear/additive predictors are modelled as intercept-only. If given, the value or values can be from the set \{1, 2, \ldots, 5\}. The default is the first one only, meaning \( \phi \) is a single parameter even when there are explanatory variables. Set zero = NULL to model all linear/additive predictors as functions of the explanatory variables. See CommonVGAMffArguments for more information.

Details

The probability density function can be loosely written as

\[
f(y) = \phi N(\mu_1, \sigma_1) + (1 - \phi) N(\mu_2, \sigma_2)
\]

where \( \phi \) is the probability an observation belongs to the first group. The parameters \( \mu_1 \) and \( \mu_2 \) are the means, and \( \sigma_1 \) and \( \sigma_2 \) are the standard deviations. The parameter \( \phi \) satisfies \( 0 < \phi < 1 \).
The mean of \( Y \) is \( \phi \mu_1 + (1 - \phi) \mu_2 \) and this is returned as the fitted values. By default, the five linear/additive predictors are \((\text{logit}(\phi), \mu_1, \log(\sigma_1), \mu_2, \log(\sigma_2))^T\). If eq.sd = TRUE then \( \sigma_1 = \sigma_2 \) is enforced.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

**Warning**

Numerical problems can occur and half-stepping is not uncommon. If failure to converge occurs, try inputting better initial values, e.g., by using iphi, qmu, imu1, imu2, isd1, isd2, etc.

This VGAM family function is experimental and should be used with care.

**Note**

Fitting this model successfully to data can be difficult due to numerical problems and ill-conditioned data. It pays to fit the model several times with different initial values and check that the best fit looks reasonable. Plotting the results is recommended. This function works better as \( \mu_1 \) and \( \mu_2 \) become more different.

Convergence can be slow, especially when the two component distributions are not well separated. The default control argument trace = TRUE is to encourage monitoring convergence. Having eq.sd = TRUE often makes the overall optimization problem easier.

**Author(s)**

T. W. Yee

**References**


**See Also**

uninormal, Normal, mix2poisson.

**Examples**

```r
## Not run: mu1 <- 99; mu2 <- 150; nn <- 1000
sd1 <- sd2 <- exp(3)
(phi <- logitlink(-1, inverse = TRUE))
rrn <- runif(nn)
mdata <- data.frame(y = ifelse(rrn < phi, rnorm(nn, mu1, sd1), rnorm(nn, mu2, sd2)))
fit <- vglm(y ~ 1, mix2normal(eq.sd = TRUE), data = mdata)
# Compare the results
cfit <- coef(fit)
```
mix2poisson

Mixture of Two Poisson Distributions

Description

Estimates the three parameters of a mixture of two Poisson distributions by maximum likelihood estimation.

Usage

mix2poisson(lphi = "logitlink", llambda = "loglink",
  iphi = 0.5, il1 = NULL, il2 = NULL,
  qmu = c(0.2, 0.8), nsimEIM = 100, zero = "phi")

Arguments

lphi, llambda Link functions for the parameter \( \phi \) and \( \lambda \). See Links for more choices.
iphi Initial value for \( \phi \), whose value must lie between 0 and 1.
il1, il2 Optional initial value for \( \lambda_1 \) and \( \lambda_2 \). These values must be positive. The default is to compute initial values internally using the argument qmu.
qmu Vector with two values giving the probabilities relating to the sample quantiles for obtaining initial values for \( \lambda_1 \) and \( \lambda_2 \). The two values are fed in as the probs argument into quantile.
nsimEIM, zero See CommonVGAMffArguments.
mix2poisson

Details

The probability function can be loosely written as

\[ P(Y = y) = \phi \text{Poisson}(\lambda_1) + (1 - \phi) \text{Poisson}(\lambda_2) \]

where \( \phi \) is the probability an observation belongs to the first group, and \( y = 0, 1, 2, \ldots \). The parameter \( \phi \) satisfies \( 0 < \phi < 1 \). The mean of \( Y \) is \( \phi \lambda_1 + (1 - \phi) \lambda_2 \) and this is returned as the fitted values. By default, the three linear/additive predictors are \((\logit(\phi), \log(\lambda_1), \log(\lambda_2))^T\).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

This VGAM family function requires care for a successful application. In particular, good initial values are required because of the presence of local solutions. Therefore running this function with several different combinations of arguments such as iphi, il1, il2, qmu is highly recommended. Graphical methods such as hist can be used as an aid.

With grouped data (i.e., using the weights argument) one has to use a large value of nsimEIM; see the example below.

This VGAM family function is experimental and should be used with care.

Note

The response must be integer-valued since dpois is invoked.

Fitting this model successfully to data can be difficult due to local solutions and ill-conditioned data. It pays to fit the model several times with different initial values, and check that the best fit looks reasonable. Plotting the results is recommended. This function works better as \( \lambda_1 \) and \( \lambda_2 \) become more different. The default control argument trace = TRUE is to encourage monitoring convergence.

Author(s)

T. W. Yee

See Also

rpois, poissonff, mix2normal.

Examples

```R
## Not run: # Example 1: simulated data
nn <- 1000
mu1 <- exp(2.5) # Also known as lambda1
mu2 <- exp(3)
(phi <- logitlink(-0.5, inverse = TRUE))
mdata <- data.frame(y = rpois(nn, ifelse(runif(nn) < phi, mu1, mu2)))
```
mfit <- vglm(y ~ 1, mix2poisson, data = mdata)
coef(mfit, matrix = TRUE)

# Compare the results with the truth
round(rbind('Estimated' = Coef(mfit), 'Truth' = c(phi, mu1, mu2)), 2)

ty <- with(mdata, table(y))
plot(names(ty), ty, type = "h", main = "Orange=estimate, blue=truth",
     ylab = "Frequency", xlab = "y")
abline(v = Coef(mfit)[-1], lty = 2, col = "orange", lwd = 2)
abline(v = c(mu1, mu2), lty = 2, col = "blue", lwd = 2)

# Example 2: London Times data (Lange, 1997, p.31)
ltdata1 <- data.frame(deaths = 0:9,
                      freq = c(162,267,271, 185,111,61,27,8,3,1))
ltdata2 <- data.frame(y = with(ltdata1, rep(deaths, freq)))

# Usually this does not work well unless nsimEIM is large
Mfit <- vglm(deaths ~ 1, weight = freq, data = ltdata1,
             mix2poisson(iphi=0.3, il1=1, il2=2.5, nsimEIM=5000))

# This works better in general
Mfit = vglm(y ~ 1, mix2poisson(iphi=0.3, il1=1, il2=2.5), ltdata2)
coef(Mfit, matrix = TRUE)
Coef(Mfit)

## End(Not run)

---

### MNSs

**The MNSs Blood Group System**

**Description**

Estimates the three independent parameters of the MNSs blood group system.

**Usage**

```r
MNSs(link = "logitlink", imS = NULL, ims = NULL, inS = NULL)
```

**Arguments**

- `link` Link function applied to the three parameters. See `Links` for more choices.
- `imS`, `ims`, `inS` Optional initial value for `mS`, `ms` and `nS` respectively. A NULL means they are computed internally.

**Details**

There are three independent parameters: `m_S`, `m_s`, `n_S`, say, so that `n_s = 1 - m_S - m_s - n_S`. We let the eta vector (transposed) be `(g(m_S), g(m_s), g(n_S))` where `g` is the link function.
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

The input can be a 6-column matrix of counts, where the columns are MS, Ms, MNS, MNs, NS, Ns (in order). Alternatively, the input can be a 6-column matrix of proportions (so each row adds to 1) and the weights argument is used to specify the total number of counts for each row.

T. W. Yee


AA.Aa.aa, AB.Ab.aB.ab, ABO, A1A2A3.

# Order matters only:
y <- cbind(MS = 295, Ms = 107, MNS = 379, MNs = 322, NS = 102, Ns = 214)
fit <- vglm(y ~ 1, MNSs("logitlink", .25, .28, .08), trace = TRUE)
fit <- vglm(y ~ 1, MNSs(link = logitlink), trace = TRUE, crit = "coef")
Coef(fit)
rbind(y, sum(y)*fitted(fit))
sqrt(diag(vcov(fit)))

model.framevlm(object, setupsmart = TRUE, wrapupsmart = TRUE, ...)

This function returns a data.frame with the variables. It is applied to an object which inherits from class "vlm" (e.g., a fitted model of class "vglm").
Arguments

- `object`: a model object from the VGAM R package that inherits from a `vector linear model` (VLM), e.g., a model of class "glm".
- `...`: further arguments such as `data`, `na.action`, `subset`. See `model.frame` for more information on these.
- `setupsmart`, `wrapupsmart`: Logical. Arguments to determine whether to use smart prediction.

Details

Since `object` is an object which inherits from class "vlm" (e.g., a fitted model of class "glm"), the method will either return the saved model frame used when fitting the model (if any, selected by argument `model = TRUE`) or pass the call used when fitting on to the default method.

This code implements smart prediction (see `smartpred`).

Value

A `data.frame` containing the variables used in the `object` plus those specified in `...`.

References


See Also

- `model.frame`, `model.matrixvlm`, `predictvlm`, `smartpred`.

Examples

```r
# Illustrates smart prediction
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ poly(c(scale(let)), 2),
            multinomial, pneumo, trace = TRUE, x = FALSE)
class(fit)

check1 <- head(model.frame(fit))
check1
check2 <- model.frame(fit, data = head(pneumo))
check2
all.equal(unlist(check1), unlist(check2))  # Should be TRUE

q0 <- head(predict(fit))
q1 <- head(predict(fit, newdata = pneumo))
q2 <- predict(fit, newdata = head(pneumo))
all.equal(q0, q1)  # Should be TRUE
all.equal(q1, q2)  # Should be TRUE
```
model.matrixqrrvglm

**Construct the Model Matrix of a QRR-VGLM Object**

**Description**

Creates a model matrix. Two types can be returned: a large one (class "vlm" or one that inherits from this such as "vglm") or a small one (such as returned if it were of class "lm").

**Usage**

```r
model.matrixqrrvglm(object, type = c("latvar", "lm", "vlm"), ...)
```

**Arguments**

- `object` an object of a class "qrrvglm", i.e., a `cqo` object.
- `type` Type of model (or design) matrix returned. The first is the default. The value "latvar" is model matrix mainly comprising of the latent variable values (sometimes called the site scores). The value "lm" is the LM matrix directly corresponding to the formula argument. The value "vlm" is the big VLM model matrix given C.
- `...` further arguments passed to or from other methods.

**Details**

This function creates one of several design matrices from object. For example, this can be a small LM object or a big VLM object.

When type = "vlm" this function calls `fnumat2R()` to construct the big model matrix given C. That is, the constrained coefficients are assumed known, so that something like a large Poisson or logistic regression is set up. This is because all responses are fitted simultaneously here. The columns are labelled in the following order and with the following prefixes: "A" for the A matrix (linear in the latent variables), "D" for the D matrix (quadratic in the latent variables), "x1." for the B1 matrix (usually contains the intercept; see the argument noRRR in `qrrvglm.control`).

**Value**

The design matrix after scaling for a regression model with the specified formula and data. By after scaling, it is meant that it matches the output of `coef(qrrvglmObject)` rather than the original scaling of the fitted object.

**See Also**

`model.matrixvlm`, `cqo`, `vcovqrrvglm`.
Examples

```r
## Not run:
set.seed(1); n <- 40; p <- 3; S <- 4; myrank <- 1
mydata <- rcqo(n, p, S, Rank = myrank, es.opt = TRUE, eq.max = TRUE)
(myform <- attr(mydata, "formula"))
mycqo <- cqo(myform, poissonff, data = mydata,
I.tol = TRUE, Rank = myrank, Bestof = 5)
model.matrix(mycqo, type = "latvar")
model.matrix(mycqo, type = "lm")
model.matrix(mycqo, type = "vlm")

## End(Not run)
```

---

**model.matrixvlm**  
*Construct the Design Matrix of a VLM Object*

**Description**

Creates a design matrix. Two types can be returned: a large one (class "vlm" or one that inherits from this such as "vglm") or a small one (such as returned if it were of class "lm").

**Usage**

```r
model.matrixvlm(object, type = c("vlm", "lm", "lm2", "bothlmlm2"),
linpred.index = NULL, label.it = TRUE, ...)
```

**Arguments**

- **object**: an object of a class that inherits from the vector linear model (VLM).
- **type**: Type of design matrix returned. The first is the default. The value "vlm" is the VLM model matrix corresponding to the formula argument. The value "lm" is the LM model matrix corresponding to the formula argument. The value "lm2" is the second (LM) model matrix corresponding to the form2 argument. The value "bothlmlm2" means both LM and VLM model matrices.
- **linpred.index**: Vector of integers. The index for a linear/additive predictor, it must have values from the set 1:M. Also, if length(linpred.index) == 1 then type = "lm" must be assigned, whereas if length(linpred.index) > 1 then type = "vlm" must be assigned. Then it returns a subset of the VLM matrix corresponding to the linpred.indexth linear/additive predictor(s); this is a LM-type matrix when it is of unit length. Currently some attributes are returned, but these may change in value in the future because of ongoing development work.
- **label.it**: Logical. Label the row and columns with character names? If FALSE, time and memory might be saved if the big model matrix is very large. The argument is only used when type = "vlm".
- **...**: further arguments passed to or from other methods. These include data (which is a data frame created with `model.framevlm`), contrasts.arg, and xlev. See `model.matrix` for more information.
This function creates a design matrix from object. This can be a small LM object or a big VLM object (default). The latter is constructed from the former and the constraint matrices. This code implements smart prediction (see smartpred).

The design matrix for a regression model with the specified formula and data. If type = "bothlm1m2" then a list is returned with components "X" and "Xm2".

Sometimes (especially if x = TRUE when calling vglm) the model matrix has attributes: "assign" ("lm"-type) and "vassign" ("vlm"-type) and "orig.assign.lm" ("lm"-type). These are used internally a lot for bookkeeping, especially regarding the columns of both types of model matrices. In particular, constraint matrices and variable selection relies on this information a lot. The "orig.assign.lm" is the ordinary "assign" attribute for lm and glm objects.


Examples

# (I) Illustrates smart prediction ,,,,,,,,,,,,,,,,,,,,,,,,,
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~
  sm.poly(c(sm.scale(let)), 2),
  multinomial, data = pneumo, trace = TRUE, x = FALSE)
class(fit)
fitted@smart.prediction # Data-dependent parameters
fitted$x # Not saved on the object
model.matrix(fitted)
model.matrix(fitted, linpred.index = 1, type = "lm")
model.matrix(fitted, linpred.index = 2, type = "lm")

(Check1 <- head(model.matrix(fitted, type = "lm")))
(Check2 <- model.matrix(fitted, data = head(pneumo), type = "lm"))
all.equal(c(Check1), c(Check2)) # Should be TRUE

q0 <- head(predict(fitted))
q1 <- head(predict(fitted, newdata = pneumo))
q2 <- predict(fitted, newdata = head(pneumo))
all.equal(q0, q1) # Should be TRUE
all.equal(q1, q2) # Should be TRUE

# (II) Attributes ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,

fit2 <- vglm(cbind(normal, mild, severe) ~ let, # x = TRUE
multinomial, data = pneumo, trace = TRUE)
fit2@x  # "lm"-type; saved on the object; note the attributes
model.matrix(fit2, type = "lm")  # Note the attributes
model.matrix(fit2, type = "vlm")  # Note the attributes

---

moffset

**Matrix Offset**

**Description**

Modify a matrix by shifting successive elements.

**Usage**

```r
moffset(mat, roffset = 0, coffset = 0, postfix = "",
         rprefix = "Row.", cprefix = "Col.")
```

**Arguments**

- `mat` Data frame or matrix. This ought to have at least three rows and three columns. The elements are shifted in the order of `c(mat)`, i.e., going down successive columns, as the columns go from left to right. Wrapping of values is done.
- `roffset, coffset` Numeric or character. If numeric, the amount of shift (offset) for each row and column. The default is no change to `mat`. If character, the offset is computed by matching with the row or column names. For example, for the `alcoff`, put `roffset = "6"` means that we make an effective day's dataset start from 6:00 am, and this wraps around to include midnight to 05.59 am on the next day.
- `postfix` Character. Modified rows and columns are renamed by pasting this argument to the end of each name. The default is no change.
- `rprefix, cprefix` Same as `rcim`.

**Details**

This function allows a matrix to be rearranged so that element `(roffset + 1, coffset + 1)` becomes the `(1, 1)` element. The elements are assumed to be ordered in the same way as the elements of `c(mat)`. This function is applicable to, e.g., `alcoff`, where it is useful to define the *effective day* as starting at some other hour than midnight, e.g., 6.00am. This is because partying on Friday night continues on into Saturday morning, therefore it is more interpretable to use the effective day when considering a daily effect.

This is a data preprocessing function for `rcim` and `plotrcim0`. The differences between `Rcim` and `moffset` is that `Rcim` only reorders the level of the rows and columns so that the data is shifted but not moved. That is, a value in one row stays in that row, and ditto for column. But in `moffset` values in one column can be moved to a previous column. See the examples below.
Value

A matrix of the same dimensional as its input.

Note

The input mat should have row names and column names.

Author(s)

T. W. Yee, Alfian F. Hadi.

See Also

Rcim, rcim, plotrcim, alcoff, crashi.

Examples

# Some day's data is moved to previous day:
omset(alcoff, 3, 2, "x")
Rcim(alcoff, 3 + 1, 2 + 1)  # Data does not move as much.
alcoff  # Original data
nomset(alcoff, 3, 2, "x") -
Rcim(alcoff, 3+1, 2+1)  # Note the differences

# An 'effective day' data set:
alcoff.e <- nomset(alcoff, roffset = "6", postfix = "x")
fit.o <- rcim(alcoff)  # default baselines are 1st row and col
fit.e <- rcim(alcoff.e)  # default baselines are 1st row and col

## Not run: par(mfrow = c(2, 2), mar = c(9, 4, 2, 1))
plot(fit.o, rsub = "Not very interpretable",
csub = "Not very interpretable")
plot(fit.e, rsub = "More interpretable",
csub = "More interpretable")

## End(Not run)

# Some checking
al.equal(nomset(alcoff), alcoff)  # Should be no change
nomset(alcoff, 1, 1, "*")
nomset(alcoff, 2, 3, "*")
nomset(alcoff, 1, 0, "*")
nomset(alcoff, 0, 1, "*")
nomset(alcoff, "6", "Mon", "*")  # This one is good

# Customise row and column baselines
fit2 <- rcim(Rcim(alcoff.e, rbaseline = "11", cbaseline = "Mon*"))
multilogitlink  

Multi-logit Link Function

Description
Computes the multilogit transformation, including its inverse and the first two derivatives.

Usage
multilogitlink(theta, refLevel = "(Last)", M = NULL, whitespace = FALSE,  
        bvalue = NULL, inverse = FALSE, deriv = 0, all.derivs = FALSE,  
        short = TRUE, tag = FALSE)

Arguments
theta  Numeric or character. See below for further details.
refLevel, M, whitespace  
        See multinomial.
bvalue  See Links.
allderivs  Logical. This is currently experimental only.
inverse, deriv, short, tag  
        Details at Links.

Details
The multilogitlink() link function is a generalization of the logitlink link to M levels/classes. It forms the basis of the multinomial logit model. It is sometimes called the multi-logit link or the multinomial logit link; some people use softmax too. When its inverse function is computed it returns values which are positive and add to unity.

Value
For multilogitlink with deriv = 0, the multilogit of theta, i.e., \log(\theta[, j]/\theta[, M+1]) when inverse = FALSE, and if inverse = TRUE then \exp(\theta[, j])/(1+\text{rowSums}(\exp(\theta))).  
For deriv = 1, then the function returns \frac{d\text{eta}}{d\theta} as a function of \theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.  
Here, all logarithms are natural logarithms, i.e., to base e.

Note
Numerical instability may occur when \theta is close to 1 or 0 (for multilogitlink). One way of overcoming this is to use, e.g., bvalue. Currently \text{care.exp()} is used to avoid NAs being returned if the probability is too close to 1.

Author(s)
Thomas W. Yee
multinomial

References


See Also

Links, multinomial, logitlink, gaitdpoisson, normal.vcm, CommonVGAMffArguments.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, # For illustration only!
multinomial, trace = TRUE, data = pneumo)
fitted(fit)
predict(fit)

multilogitlink(fitted(fit))
multilogitlink(fitted(fit)) - predict(fit)  # Should be all 0s

multilogitlink(predict(fit), inverse = TRUE)  # rowSums() add to unity
multilogitlink(predict(fit), inverse = TRUE, refLevel = 1)
multilogitlink(predict(fit), inverse = TRUE) -
fitted(fit)  # Should be all 0s

multilogitlink(fitted(fit), deriv = 1)
multilogitlink(fitted(fit), deriv = 2)

multinomial

Multinomial Logit Model

Description

Fits a multinomial logit model (MLM) to a (preferably unordered) factor response.

Usage

multinomial(zero = NULL, parallel = FALSE, nointercept = NULL,
reflevel = "(Last)", ynames = FALSE,
imethod = 1, imu = NULL, byrow.arg = FALSE,
Thresh = NULL, Trev = FALSE,
Tref = if (Trev) "M" else 1, whitespace = FALSE)

Arguments

zero Can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. Any values must be from the set \{1,2,...,M\}. The default value means none are modelled as intercept-only terms. See CommonVGAMffArguments for more information.
parallel

A logical, or formula specifying which terms have equal/unequal coefficients.

ynames

Logical. If TRUE then "mu[1]" is replaced by the probability of the first named response category, etc. (e.g., "P[normal]"), so that the output is more readable, albeit less compact. This is seen in output such as predict(fit) and coef(fit, matrix = TRUE). Of course, "mu" stands for the fitted probabilities, and it remains the default for upward compatibility and predictability.

nointercept, whitespace

See CommonVGAMffArguments for details.

imu, byrow.arg

See CommonVGAMffArguments for details.

refLevel

Either a (1) single positive integer or (2) a value of the factor or (3) a character string. If inputted as an integer then it specifies which column of the response matrix is the reference or baseline level. The default is the last one (the \((M + 1)\)th one). If used, this argument will be usually assigned the value 1. If inputted as a value of a factor then beware of missing values of certain levels of the factor (drop.unused.levels = TRUE or drop.unused.levels = FALSE). See the example below. If inputted as a character string then this should be equal to (A) one of the levels of the factor response, else (B) one of the column names of the matrix response of counts; e.g., vglm(cbind(normal, mild, severe) ~ let, multinomial(refLevel = "severe"), data = pneumo) if it was (incorrectly because the response is ordinal) applied to the pneumo data set. Another example is vglm(ethnicity ~ age, multinomial(refLevel = "European"), data = xs.nz) if it was applied to the xs.nz data set.

imethod

Choosing 2 will use the mean sample proportions of each column of the response matrix, which corresponds to the MLEs for intercept-only models. See CommonVGAMffArguments for more details.

Thresh, Trev, Tref

Same as cumulative. Because these arguments concern the intercepts, they should not be confused with the stereotype model where they would be applied to the A matrix instead.

Details

In this help file the response \(Y\) is assumed to be a factor with unordered values \(1, 2, \ldots, M + 1\), so that \(M\) is the number of linear/additive predictors \(\eta_j\).

The default model can be written

\[
\eta_j = \log(P[Y = j]/P[Y = M + 1])
\]

where \(\eta_j\) is the \(j\)th linear/additive predictor. Here, \(j = 1, \ldots, M\), and \(\eta_{M + 1}\) is 0 by definition. That is, the last level of the factor, or last column of the response matrix, is taken as the reference level or baseline—this is for identifiability of the parameters. The reference or baseline level can be changed with the refLevel argument.

In almost all the literature, the constraint matrices associated with this family of models are known. For example, setting parallel = TRUE will make all constraint matrices (including the intercept) equal to a vector of \(M\) 1’s; to suppress the intercepts from being parallel then set parallel = FALSE \sim 1. If the constraint matrices are unknown and to be estimated, then this can be achieved by fitting the model as a reduced-rank vector generalized linear model (RR-VGLM; see rrvglm).
In particular, a multinomial logit model with unknown constraint matrices is known as a stereotype model (Anderson, 1984), and can be fitted with `rrvglm`.

The above details correspond to the ordinary MLM where all the levels are altered (in the terminology of GAITD regression).

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `rrvglm` and `vgam`.

**Warning**

No check is made to verify that the response is nominal.

See `CommonVGAMffArguments` for more warnings.

**Note**

The response should be either a matrix of counts (with row sums that are all positive), or a factor. In both cases, the y slot returned by `vglm/vgam/rrvglm` is the matrix of sample proportions.

The multinomial logit model is more appropriate for a nominal (unordered) factor response than for an ordinal (ordered) factor response. Models more suited for the latter include those based on cumulative probabilities, e.g., `cumulative`.

`multinomial` is prone to numerical difficulties if the groups are separable and/or the fitted probabilities are close to 0 or 1. The fitted values returned are estimates of the probabilities $P[Y = j]$ for $j = 1, \ldots, M + 1$. See `safeBinaryRegression` for the logistic regression case.

Here is an example of the usage of the `parallel` argument. If there are covariates $x_2$, $x_3$ and $x_4$, then `parallel = TRUE ~ x2 + x3 - 1` and `parallel = FALSE ~ x4` are equivalent. This would constrain the regression coefficients for $x_2$ and $x_3$ to be equal; those of the intercepts and $x_4$ would be different.

In Example 4 below, a conditional logit model is fitted to an artificial data set that explores how cost and travel time affect people's decision about how to travel to work. Walking is the baseline group. The variable `Cost.car` is the difference between the cost of travel to work by car and walking, etc. The variable `Time.car` is the difference between the travel duration/time to work by car and walking, etc. For other details about the `xij` argument see `vglm.control` and `fill1`.

The `multinom` function in the `nnet` package uses the first level of the factor as baseline, whereas the last level of the factor is used here. Consequently the estimated regression coefficients differ.

**Author(s)**

Thomas W. Yee

**References**


multinomial


See Also

`multilogitlink`, `margeff`, `cumulative`, `acat`, `cratio`, `sratio`, `CM.equid`, `CommonVGAMffArguments`, `dirichlet`, `dirmultinomial`, `rrvglm`, `fill1`, `Multinomial`, `gaitdpoisson`, `Gaitdpois`, `iris`.

Examples

# Example 1: Regn spline VGAM: marital status versus age
```r
data(marital.nz)
ooo <- with(marital.nz, order(age))
om.nz <- marital.nz[ooo,]
fit1 <- vglm(mstatus ~ sm.bs(age), multinomial, om.nz)
coef(fit1, matrix = TRUE) # Mostly meaningless
```

# Example 2a: a simple example
```r
ycounts <- t(rmultinom(10, size = 20, prob = c(0.1, 0.2, 0.8)))
fit <- vglm(ycounts ~ 1, multinomial)
head(fitted(fit)) # Proportions
```

# Example 2b: Different reference level used as the baseline
```r
fit2 <- vglm(ycounts ~ 1, multinomial(refLevel = 2))
coef(fit2, matrix = TRUE)
```

# Example 3: The response is a factor.
```r
nn <- 10
dframe3 <- data.frame(yfac = gl(3, nn, labels = c("Ctrl", "Trt1", "Trt2")),
                      x2 = runif(3 * nn))
```
myrefLevel <- with(dframe3, yfac[12])
fit3a <- vglm(yfac ~ x2, multinomial(reflevel = myrefLevel), dframe3)
fit3b <- vglm(yfac ~ x2, multinomial(reflevel = 2), dframe3)
coef(fit3a, matrix = TRUE) # "Trt1" is the reference level
coef(fit3b, matrix = TRUE) # "Trt1" is the reference level
margeff(fit3b)

# Example 4: Fit a rank-1 stereotype model
fit4 <- rrvglm(Country ~ Width + Height + HP, multinomial, car.all)
coef(fit4) # Contains the C matrix
constraints(fit4)$HP # The A matrix
coeff(fit4, matrix = TRUE) # The B matrix
Coeff(fit4)$C # The C matrix
concoef(fit4) # Better to get the C matrix this way
Coeff(fit4)$A # The A matrix
svd(coef(fit4, matrix = TRUE)[-1, ])$d # Has rank 1; = C %*% t(A)

# Classification (but watch out for NAs in some of the variables):
apply(fitted(fit4), 1, which.max) # Classification
# Classification:
apply(predict(fit4, car.all, type = "response"), 1, which.max) # Ditto

# Example 5: Using the xij argument (aka conditional logit model)
set.seed(111)

nn <- 100 # Number of people who travel to work
M <- 3 # There are M+1 models of transport to go to work
ycounts <- matrix(0, nn, M+1)
ycounts[cbind(1:nn, sample(x = M+1, size = nn, replace = TRUE))] = 1
dimnames(ycounts) <- list(NULL, c("bus","train","car","walk"))
gotowork <- data.frame(cost.bus = runif(nn), time.bus = runif(nn),
                       cost.train= runif(nn), time.train= runif(nn),
                       cost.car = runif(nn), time.car = runif(nn),
                       cost.walk = runif(nn), time.walk = runif(nn))
gotowork <- round(gotowork, digits = 2) # For convenience

gotowork <- transform(gotowork,
  Cost.bus = cost.bus - cost.walk,
  Cost.car = cost.car - cost.walk,
  Cost.train = cost.train - cost.walk,
  Cost = cost.train - cost.walk, # for labelling
  Time.bus = time.bus - time.walk,
  Time.car = time.car - time.walk,
  Time.train = time.train - time.walk,
  Time = time.train - time.walk) # for labelling

fit <- vglm(ycounts ~ Cost + Time,
            multinomial(parall = TRUE ~ Cost + Time - 1),
            xij = list(Cost ~ Cost.bus + Cost.train + Cost.car,
                       Time ~ Time.bus + Time.train + Time.car),
            form2 = ~ Cost + Cost.bus + Cost.train + Cost.car +
                       Time + Time.bus + Time.train + Time.car,
            data = gotowork, trace = TRUE)

head(model.matrix(fit, type = "lm")) # LM model matrix
N1binom

Linear Model and Binomial Mixed Data Type Distribution

Description
Density, and random generation for the (four parameter bivariate) Linear Model–Bernoulli copula distribution.

Usage
dN1binom(x1, x2, mean = 0, sd = 1, prob, apar = 0,
copula = "gaussian", log = FALSE)

rN1binom(n, mean = 0, sd = 1, prob,
apar = 0, copula = "gaussian")

Arguments
x1, x2 vector of quantiles. The valid values of x2 are 0 and 1.
n number of observations. Same as rnorm.
copula See N1binomial.
mean, sd, prob, apar See N1binomial.
log Logical. If TRUE then the logarithm is returned.

Details
See N1binomial, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for details.

Value
dN1binom gives the probability density/mass function, rN1binom generates random deviate and returns a two-column matrix.

Author(s)
T. W. Yee

See Also
N1binomial, rnorm, rbinom.
Examples

```r
## Not run:
nn <- 1000; apar <- rhobitlink(1.5, inverse = TRUE)
prob <- logitlink(0.5, inverse = TRUE)
mymu <- 1; sdev <- exp(1)
mat <- rN1binom(nn, mymu, sdev, prob, apar)
bndata <- data.frame(y1 = mat[, 1], y2 = mat[, 2])
with(bndata, plot(jitter(y1), jitter(y2), col = "blue"))
## End(Not run)
```

Description

Estimate the four parameters of the (bivariate) $N_1$–binomial copula mixed data type model by maximum likelihood estimation.

Usage

```r
N1binomial(lmean = "identitylink", lsd = "loglink",
            lvar = "loglink", lprob = "logitlink", lapar = "rhobitlink",
            zero = c(if (var.arg) "var" else "sd", "apar"),
            nnodes = 20, copula = "gaussian", var.arg = FALSE,
            imethod = 1, isd = NULL, iprob = NULL, iapar = NULL)
```

Arguments

- `lmean`, `lsd`, `lvar`, `lprob`, `lapar` Details at `CommonVGAMffArguments`. See Links for more link function choices.
- `imethod`, `isd`, `iprob`, `iapar` Initial values. Details at `CommonVGAMffArguments`.
- `zero` Details at `CommonVGAMffArguments`.
- `nnodes` Number of nodes and weights for the Gauss–Hermite (GH) quadrature. While a higher value should be more accurate, setting an excessive value runs the risk of evaluating some special functions near the boundary of the parameter space and producing numerical problems.
- `copula` Type of copula used. Currently only the bivariate normal is used but more might be implemented in the future.
- `var.arg` See `uninormal`. 
Details

The bivariate response comprises \( Y_1 \) from the linear model having parameters mean and sd for \( \mu_1 \) and \( \sigma_1 \), and the binary \( Y_2 \) having parameter prob for its mean \( \mu_2 \). The joint probability density/mass function is \( P(y_1, Y_2 = 0) = \phi_1(y_1; \mu_1, \sigma_1)(1 - \Delta) \) and \( P(y_1, Y_2 = 1) = \phi_1(y_1; \mu_1, \sigma_1)\Delta \) where \( \Delta \) adjusts \( \mu_2 \) according to the association parameter \( \alpha \). The quantity \( \Delta \) is \( \Phi((\Phi^{-1}(\mu_2) - \alpha Z_1)/\sqrt{1 - \alpha^2}) \). The quantity \( Z_1 \) is \((Y_1 - \mu_1)/\sigma_1 \). Thus there is an underlying bivariate normal distribution, and a copula is used to bring the two marginal distributions together. Here, \(-1 < \alpha < 1\), and \( \Phi \) is the cumulative distribution function \texttt{pnorm} of a standard univariate normal.

The first marginal distribution is a normal distribution for the linear model. The second column of the response must have values 0 or 1, e.g., Bernoulli random variables. When \( \alpha = 0 \) then \( \Delta = \mu_2 \). Together, this family function combines \texttt{uninormal} and \texttt{binomialff}. If the response are correlated then a more efficient joint analysis should result.

This \texttt{VGAM} family function cannot handle multiple responses. Only a two-column matrix is allowed. The two-column fitted value matrix has columns \( \mu_1 \) and \( \mu_2 \).

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Note

This \texttt{VGAM} family function is fragile. Because the EIMs are approximated by GH quadrature it is found that convergence may be a little slower than for other models whose EIM is tractable. Also, the log-likelihood may be flat at the MLE with respect to \( \alpha \) especially because the correlation between the two mixed data types may be weak.

It pays to set \texttt{trace = TRUE} to monitor convergence, especially when \( \text{abs}(\text{apur}) \) is high.

Author(s)

T. W. Yee

References


See Also

\texttt{rN1binom}, \texttt{N1poisson}, \texttt{binormalcop}, \texttt{uninormal}, \texttt{binomialff}, \texttt{pnorm}.

Examples

\begin{verbatim}
nn <- 1000; mymu <- 1; sdev <- exp(1)
apar <- rhobitlink(0.5, inverse = TRUE)
prob <- logitlink(0.5, inverse = TRUE)
mat <- rN1binom(nn, mymu, sdev, prob, apar)
nbdata <- data.frame(y1 = mat[, 1], y2 = mat[, 2])
fit1 <- vglm(cbind(y1, y2) ~ 1, N1binomial, nbdata, trace = TRUE)
\end{verbatim}
N1pois

Linear Model and Poisson Mixed Data Type Distribution

Description

Density, and random generation for the (four parameter bivariate) Linear Model–Poisson copula distribution.

Usage

dN1pois(x1, x2, mean = 0, sd = 1, lambda, apar = 0,
  doff = 5, copula = "gaussian", log = FALSE)
rN1pois(n, mean = 0, sd = 1, lambda, apar = 0,
  doff = 5, copula = "gaussian")

Arguments

- x1, x2: vector of quantiles. The valid values of x2 are nonnegative integers.
- n: number of observations. Same as rnorm.
- copula: See N1poisson.
- mean, sd, lambda, apar: See N1poisson.
- doff: See N1poisson.
- log: Logical. If TRUE then the logarithm is returned.

Details

See N1poisson, the VGAM family functions for estimating the parameter by maximum likelihood estimation, for details.

Value

dN1pois gives the probability density/mass function, rN1pois generates random deviate and returns a two-column matrix.

Author(s)

T. W. Yee

See Also

N1poisson, rnorm, rpois.
Examples

```r
## Not run:
nn <- 1000; mymu <- 1; sdev <- exp(1)
apar <- rhobitlink(0.4, inverse = TRUE)
lambda <- loglink(1, inverse = TRUE)
mat <- rN1pois(nn, mymu, sdev, lambda, apar)
pndata <- data.frame(y1 = mat[,1], y2 = mat[,2])
with(pndata, plot(jitter(y1), jitter(y2), col = 4))

## End(Not run)
```

N1poisson

Linear Model and Poisson Mixed Data Type Family Function

Description

Estimate the four parameters of the (bivariate) $N_1$–Poisson copula mixed data type model by maximum likelihood estimation.

Usage

```r
N1poisson(lmean = "identitylink", lsd = "loglink",
        lvar = "loglink", llambda = "loglink", lapar = "rhobitlink",
        zero = c(if (var.arg) "var" else "sd", "apar"),
        doff = 5, nnodes = 20, copula = "gaussian",
        var.arg = FALSE, imethod = 1, isd = NULL,
        ilambda = NULL, iapar = NULL)
```

Arguments

- `lmean`, `lsd`, `lvar`, `llambda`, `lapar`:
  Details at `CommonVGAMffArguments`. See `Links` for more link function choices. The second response is primarily controlled by the parameter $\lambda_2$.

- `imethod`, `isd`, `ilambda`, `iapar`:
  Initial values. Details at `CommonVGAMffArguments`.

- `zero`:
  Details at `CommonVGAMffArguments`.

- `doff`:
  Numeric of unit length, the denominator offset $\delta > 0$. A monotonic transformation $\Delta^* = \frac{\lambda_2^{2/3}}{([\delta] + \lambda_2^{2/3})}$ is taken to map the Poisson mean onto the unit interval. This argument is $\delta$. The default reflects the property that the normal approximation to the Poisson work well for $\lambda_2 \geq 10$ or thereabouts, hence that value is mapped to the origin by `qnorm`. That’s because $10^{2/3}$ is approximately 5. It is known that the $\lambda_2$ rate parameter raised to the power of $2/3$ is a transformation that approximates the normal density more closely. Alternatively, `delta` may be assigned a single negative value. If so, then $\Delta^* = \log(1+\lambda_2)/([\delta]+\log(1+\lambda_2))$ is used. For this, `doff = -log1p(10)` is suggested.

- `nnodes`, `copula`:
  Details at `N1binomial`.

- `var.arg`:
  See `uninormal`.
The bivariate response comprises $Y_1$ from a linear model having parameters mean and sd for $\mu_1$ and $\sigma_1$, and the Poisson count $Y_2$ having parameter $\lambda_2$ for its mean $\lambda_2$. The joint probability density/mass function is $P(y_1, Y_2 = y_2) = \phi_1(y_1; \mu_1, \sigma_1) \exp(-h^{-1}(\Delta))[h^{-1}(\Delta)]^{y_2}/y_2!$ where $\Delta$ adjusts $\lambda_2$ according to the association parameter $\alpha$. The quantity $\Delta$ is $\Phi((\Phi^{-1}(h(\lambda_2)) - \alpha Z_1)/\sqrt{1-\alpha^2})$ where $h$ maps $\lambda_2$ onto the unit interval. The quantity $Z_1$ is $(Y_1 - \mu_1)/\sigma_1$. Thus there is an underlying bivariate normal distribution, and a copula is used to bring the two marginal distributions together. Here, $-1 < \alpha < 1$, and $\Phi$ is the cumulative distribution function $\text{pnorm}$ of a standard univariate normal.

The first marginal distribution is a normal distribution for the linear model. The second column of the response must have nonnegative integer values. When $\alpha = 0$ then $\Delta = \Delta^*$. Together, this family function combines uninormal and poissonff. If the response are correlated then a more efficient joint analysis should result.

The second marginal distribution allows for overdispersion relative to an ordinary Poisson distribution—a property due to $\alpha$.

This VGAM family function cannot handle multiple responses. Only a two-column matrix is allowed. The two-column fitted value matrix has columns $\mu_1$ and $\lambda_2$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Note

This VGAM family function is based on N1binomial and shares many properties with it. It pays to set trace = TRUE to monitor convergence, especially when abs(apar) is high.

Author(s)

T. W. Yee

See Also

rN1pois, N1binomial, binormalcop, uninormal, poissonff, dpois.

Examples

apar <- rhobitlink(0.3, inverse = TRUE)
nn <- 1000; mymu <- 1; sdev <- exp(1)
lambda <- loglink(1, inverse = TRUE)
mat <- rN1pois(nn, mymu, sdev, lambda, apar)
npdata <- data.frame(y1 = mat[, 1], y2 = mat[, 2])
with(npdata, var(y2) / mean(y2)) # Overdispersion
fit1 <- vglm(cbind(y1, y2) ~ 1, N1poisson,
              npdata, trace = TRUE)
coef(fit1, matrix = TRUE)
Coef(fit1)
head(fitted(fit1))
Nakagami Distribution

Description

Density, cumulative distribution function, quantile function and random generation for the Nakagami distribution.

Usage

dnaka(x, scale = 1, shape, log = FALSE)
pnaka(q, scale = 1, shape, lower.tail = TRUE, log.p = FALSE)
qnaka(p, scale = 1, shape, ...)  
rnaka(n, scale = 1, shape, Smallno = 1.0e-6)

Arguments

x, q
vector of quantiles.
p
vector of probabilities.
n
number of observations. Same as in runif.
scale, shape
arguments for the parameters of the distribution. See nakagami for more details. For rnaka, arguments shape and scale must be of length 1.
Smallno
Numeric, a small value used by the rejection method for determining the upper limit of the distribution. That is, pnaka(U) > 1-Smallno where \( U \) is the upper limit.

...  
Arguments that can be passed into uniroot.
log
Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p
Same meaning as in pnorm or qnorm.

Details

See nakagami for more details.

Value

dnaka gives the density, pnaka gives the cumulative distribution function, qnaka gives the quantile function, and rnaka generates random deviates.

Author(s)

T. W. Yee and Kai Huang
See Also

nakagami.

Examples

```r
## Not run: x <- seq(0, 3.2, len = 200)
plot(x, dgamma(x, shape = 1), type = "n", col = "black", ylab = "",
     ylim = c(0,1.5), main = "dnaka(x, shape = shape)"
lines(x, dnaka(x, shape = 1), col = "orange")
lines(x, dnaka(x, shape = 2), col = "blue")
lines(x, dnaka(x, shape = 3), col = "green")
legend(2, 1.0, col = c("orange","blue","green"), lty = rep(1, len = 3),
      legend = paste("shape =", c(1, 2, 3)))

plot(x, pnorm(x), type = "n", col = "black", ylab = "",
     ylim = 0:1, main = "pnaka(x, shape = shape)"
lines(x, pnaka(x, shape = 1), col = "orange")
lines(x, pnaka(x, shape = 2), col = "blue")
lines(x, pnaka(x, shape = 3), col = "green")
legend(2, 0.6, col = c("orange","blue","green"), lty = rep(1, len = 3),
      legend = paste("shape =", c(1, 2, 3)))
## End(Not run)

probs <- seq(0.1, 0.9, by = 0.1)
pnaka(qnaka(p = probs, shape = 2), shape = 2) - probs # Should be all 0
```

nakagami

Nakagami Regression Family Function

Description

Estimation of the two parameters of the Nakagami distribution by maximum likelihood estimation.

Usage

nakagami(lscale = "loglink", lshape = "loglink", iscale = 1,
         ishape = NULL, nowarning = FALSE, zero = "shape")

Arguments

- **nowarning**: Logical. Suppress a warning?
- **lscale**, **lshape**: Parameter link functions applied to the scale and shape parameters. Log links ensure they are positive. See `Links` for more choices and information.
- **iscale**, **ishape**: Optional initial values for the shape and scale parameters. For ishape, a NULL value means it is obtained in the initialize slot based on the value of iscale. For iscale, assigning a NULL means a value is obtained in the initialize slot, however, setting another numerical value is recommended if convergence fails or is too slow.
The Nakagami distribution, which is useful for modelling wireless systems such as radio links, can be written

\[ f(y) = 2(\text{shape}/\text{scale})^{\text{shape}} y^{2\times\text{shape}-1} \exp(-\text{shape} \times y^2/\text{scale})/\Gamma(\text{shape}) \]

for \( y > 0, \text{shape} > 0, \text{scale} > 0 \). The mean of \( Y \) is \( \sqrt{\text{scale}/\text{shape}} \times \Gamma(\text{shape} + 0.5)/\Gamma(\text{shape}) \) and these are returned as the fitted values. By default, the linear/additive predictors are \( \eta_1 = \log(\text{scale}) \) and \( \eta_2 = \log(\text{shape}) \). Fisher scoring is implemented.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Note

The Nakagami distribution is also known as the Nakagami-\( m \) distribution, where \( m = \text{shape} \) here. Special cases: \( m = 0.5 \) is a one-sided Gaussian distribution and \( m = 1 \) is a Rayleigh distribution. The second moment is \( E(Y^2) = m \).

If \( Y \) has a Nakagami distribution with parameters \( \text{shape} \) and \( \text{scale} \) then \( Y^2 \) has a gamma distribution with shape parameter \( \text{shape} \) and scale parameter \( \text{scale}/\text{shape} \).

Author(s)

T. W. Yee

References


See Also

`rnaka`, `gamma2`, `rayleigh`.

Examples

```r
nn <- 1000; shape <- exp(0); Scale <- exp(1)
data <- data.frame(y1 = sqrt(rgamma(nn, shape = shape, scale = Scale/shape)))
fit <- vglm(y1 ~ 1, nakagami, data = ndata, trace = TRUE, crit = "coef")
data <- transform(ndata, y2 = rnaka(nn, scale = Scale, shape = shape))
fit <- vglm(y2 ~ 1, nakagami(iscale = 3), data = ndata, trace = TRUE)
head(fitted(fit))
with(ndata, mean(y2))
coef(fit, matrix = TRUE)
(Cfit <- Coef(fit))
```
```r
## Not run: sy <- with(ndata, sort(y2))
hist(with(ndata, y2), prob = TRUE, main = "", xlab = "y", ylim = c(0, 0.6),
col = "lightblue")
lines(dnaka(sy, scale = Cfit["scale"], shape = Cfit["shape"])) ~ sy,
data = ndata, col = "orange")
## End(Not run)
```

---

**nbcanlink**

### Negative Binomial Canonical Link Function

#### Description

Computes the negative binomial canonical link transformation, including its inverse and the first two derivatives.

#### Usage

```r
nbcanlink(theta, size = NULL, wrt.param = NULL, bvalue = NULL,
    inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
```

#### Arguments

- `theta`  Numeric or character. Typically the mean of a negative binomial distribution (NBD). See below for further details.
- `size, wrt.param`  size contains the \( k \) matrix which must be of a conformable dimension as `theta`. Also, if \( \text{deriv} > 0 \) then `wrt.param` is either 1 or 2 (1 for with respect to the first parameter, and 2 for with respect to the second parameter (`size`).
- `bvalue`  Details at [Links](#).
- `inverse, deriv, short, tag`  Details at [Links](#).

#### Details

The NBD canonical link is \( \log(\theta/(\theta + k)) \) where \( \theta \) is the NBD mean. The canonical link is used for theoretically relating the NBD to GLM class.

This link function was specifically written for `negbinomial` and `negbinomial.size`, and should not be used elsewhere (these [VGAM](#) family functions have code that specifically handles `nbcanlink()`).

Estimation with the NB canonical link has a somewhat interesting history. If we take the problem as beginning with the admission of McCullagh and Nelder (1983; first edition, p.195) [see also McCullagh and Nelder (1989, p.374)] that the NB is little used in applications and has a “problematical” canonical link then it appears only one other publicized attempt was made to solve the problem seriously. This was Hilbe, who produced a defective solution. However, Miranda and Yee (2023) solve this four-decade old problem using total derivatives and it is implemented by using `nbcanlink` with `negbinomial`. Note that early versions of [VGAM](#) had a defective solution.
Value

For deriv = 0, the above equation when inverse = FALSE, and if inverse = TRUE then kmatrix / expm1(-theta) where theta is really eta. For deriv = 1, then the function returns d eta / d theta as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

While theoretically nice, this function is not recommended in general since its value is always negative (linear predictors ought to be unbounded in general). A loglink link for argument lmu is recommended instead.

Numerical instability may occur when theta is close to 0 or 1. Values of theta which are less than or equal to 0 can be replaced by bvalue before computing the link function value. See Links.

Author(s)

Victor Miranda and Thomas W. Yee.

References


See Also

negbinomial, negbinomial.size.

Examples

nbcanlink("mu", short = FALSE)

mymu <- 1:10  # Test some basic operations:
kmatrix <- cbind(runif(length(mymu)))
etal <- nbcanlink(mymu, size = kmatrix)
ans2 <- nbcanlink(etal, size = kmatrix, inverse = TRUE)
mmax(abs(ans2 - mymu))  # Should be 0

## Not run: mymu <- seq(0.5, 10, length = 101)
kmatrix <- matrix(10, length(mymu), 1)
plot(nbcanlink(mymu, size = kmatrix) - mymu, las = 1,
     type = "l", col = "blue", xlab = expression(mu))

## End(Not run)
# Estimate the parameters from some simulated data
ndata <- data.frame(x2 = runif(nn <- 500))
ndata <- transform(ndata, eta1 = -1 - 1 * x2, # eta1 < 0
                   size1 = exp(1),
                   size2 = exp(2))
ndata <- transform(ndata,
                   mu1 = nbcanlink(eta1, size = size1, inverse = TRUE),
                   mu2 = nbcanlink(eta1, size = size2, inverse = TRUE))
ndata <- transform(ndata, y1 = rnbinom(nn, mu = mu1, size1),
                   y2 = rnbinom(nn, mu = mu2, size2))
summary(ndata)
nbcfit <-
vglm(cbind(y1, y2) ~ x2, # crit = "c",
     negbinomial(lmu = "nbcanlink"),
     data = ndata, trace = TRUE)
coef(nbcfit, matrix = TRUE)
summary(nbcfit)

description

Maximum likelihood estimation of the two parameters of a negative binomial distribution.

Usage

negbinomial(zero = "size", parallel = FALSE, deviance.arg = FALSE,
            type.fitted = c("mean", "quantiles"),
            percentiles = c(25, 50, 75), vf1 = FALSE,
            mds.min = 1e-3, nsimEIM = 500, cutoff.prob = 0.999,
            eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
            lmu = "loglink", lsize = "loglink",
            imethod = 1, imu = NULL, iprobs.y = NULL,
            gprobs.y = ppoints(6), isize = NULL,
            gsize.mux = exp(c(-30, -20, -15, -10, -6:3)))
polya(zero = "size", type.fitted = c("mean", "prob"),
      mds.min = 1e-3, nsimEIM = 500, cutoff.prob = 0.999,
      eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
      lprob = "logitlink", lsize = "loglink", imethod = 1, iprob = NULL,
      iprobs.y = NULL, gprobs.y = ppoints(6), isize = NULL,
      gsize.mux = exp(c(-30, -20, -15, -10, -6:3)), imunb = NULL)
polyaR(zero = "size", type.fitted = c("mean", "prob"),
       mds.min = 1e-3, nsimEIM = 500, cutoff.prob = 0.999,
       eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
       lsize = "loglink", lprob = "logitlink", imethod = 1, iprob = NULL,
       iprobs.y = NULL, gprobs.y = ppoints(6), isize = NULL,
       gsize.mux = exp(c(-30, -20, -15, -10, -6:3)), imunb = NULL)
Arguments

zero Can be an integer-valued vector, and if so, then it is usually assigned \(-2\) or \(2\). Specifies which of the two linear/additive predictors are modelled as an intercept only. By default, the \(k\) parameter (after lsize is applied) is modelled as a single unknown number that is estimated. It can be modelled as a function of the explanatory variables by setting zero = NULL; this has been called a NB-H model by Hilbe (2011). A negative value means that the value is recycled, so setting \(-2\) means all \(k\) are intercept-only. See CommonVGAMffArguments for more information.

lmu, lsize, lprob

Link functions applied to the \(\mu\), \(k\) and \(p\) parameters. See Links for more choices. Note that the \(\mu\), \(k\) and \(p\) parameters are the \(\text{mu}\), \(\text{size}\) and \(\text{prob}\) arguments of \text{rnbinom} respectively. Common alternatives for lsize are \text{negloglink} and \text{reciprocallink}, and \text{logloglink} (if \(k > 1\)).

imu, imunb, isize, iprob

Optional initial values for the mean and \(k\) and \(p\). For \(k\), if failure to converge occurs then try different values (and/or use imethod). For a \(S\)-column response, isize can be of length \(S\). A value NULL means an initial value for each response is computed internally using a gridsearch based on gsize.max. The last argument is ignored if used within cqo; see the iKvector argument of qrrvglm.control instead. In the future isize and iprob might be depreciated.

nsimEIM

This argument is used for computing the diagonal element of the expected information matrix (EIM) corresponding to \(k\) based on the simulated Fisher scoring (SFS) algorithm. See CommonVGAMffArguments for more information and the notes below. SFS is one of two algorithms for computing the EIM elements (so that both algorithms may be used on a given data set). SFS is faster than the exact method when Qmax is large.

cutoff.prob

Fed into the \(p\) argument of \text{qnbinom} in order to obtain an upper limit for the approximate support of the distribution, called Qmax, say. Similarly, the value \(1-p\) is fed into the \(p\) argument of \text{qnbinom} in order to obtain a lower limit for the approximate support of the distribution, called Qmin, say. Hence the approximate support is Qmin:Qmax. This argument should be a numeric and close to 1 but never exactly 1. Used to specify how many terms of the infinite series for computing the second diagonal element of the EIM are actually used. The closer this argument is to 1, the more accurate the standard errors of the regression coefficients will be. If this argument is too small, convergence will take longer.

max.chunk.MB, max.support

max.support is used to describe the eligibility of individual observations to have their EIM computed by the exact method. Here, we are concerned about computing the EIM wrt \(k\). The exact method algorithm operates separately on each response variable, and it constructs a large matrix provided that the number of columns is less than max.support. If so, then the computations are done in chunks, so that no more than about max.chunk.MB megabytes of memory is used at a time (actually, it is proportional to this amount). Regarding eligibility of this algorithm, each observation must have the length of the vector, starting from the 1-cutoff.prob quantile and finishing up at the cutoff.prob quantile, less than
max. support (as its approximate support). If you have abundant memory then you might try setting max. chunk.MB = Inf, but then the computations might take a very long time. Setting max. chunk.MB = 0 or max. support = 0 will force the EIM to be computed using the SFS algorithm only (this used to be the default method for all the observations). When the fitted values of the model are large and k is small, the computation of the EIM will be costly with respect to time and memory if the exact method is used. Hence the argument max. support limits the cost in terms of time. For intercept-only models max. support is multiplied by a number (such as 10) because only one inner product needs be computed.

Note: max. support is an upper bound and limits the number of terms dictated by the eps.trig argument.

mds.min Numeric. Minimum value of the NBD mean divided by size parameter. The closer this ratio is to 0, the closer the distribution is to a Poisson. Iterations will stop when an estimate of k is so large, relative to the mean, than it is below this threshold (this is treated as a boundary of the parameter space).

vfl Logical. Fit the Variance–variance Factorized Loglinear (VFL) model? If TRUE then the constraint matrix rbind(0, -1) is assigned to all covariates which are not parallel. Hence parallel must be used in conjunction with this argument to specify the set of covariates used for modelling the mean. Note that the constraint matrix for the intercept should be parallel too. The overall resulting parameterization is the same as Evans (1953). Some general information is at CommonVGAMArguments.

eps.trig Numeric. A small positive value used in the computation of the EIMs. It focuses on the denominator of the terms of a series. Each term in the series (that is used to approximate an infinite series) has a value greater than size / sqrt(eps.trig), thus very small terms are ignored. It’s a good idea to set a smaller value that will result in more accuracy, but it will require a greater computing time (when k is close to 0). And adjustment to max. support may be needed. In particular, the quantity computed by special means is \( \psi'(k) - E[\psi'(Y + k)] \), which is the difference between two trigamma functions. It is part of the calculation of the EIM with respect to the size parameter.

gsize.mux Similar to gsigma in CommonVGAMArguments. However, this grid is multiplied by the initial estimates of the NBD mean parameter. That is, it is on a relative scale rather than on an absolute scale. If the counts are very large in value then convergence fail might occur; if so, then try a smaller value such as gsize.mux = exp(-40).

type.fitted, percentiles See CommonVGAMArguments for more information.

deviance.arg Logical. If TRUE, the deviance is computed after convergence. It only works in the NB-2 model. It is also necessary to set criterion = "coefficients" or half.step = FALSE since one cannot use that criterion properly for the minimization within the IRLS algorithm. It should be set TRUE when used with cqo under the fast algorithm.

imethod An integer with value 1 or 2 etc. which specifies the initialization method for the \( \mu \) parameter. If failure to converge occurs try another value and/or else specify a value for iprobs.y and/or else specify a value for isize.
Setting `parallel = TRUE` is useful in order to get something similar to `quasipoisson` or what is known as NB-1. If `parallel = TRUE` then the parallelism constraint does not apply to any intercept term. You should set `zero = NULL` too if `parallel = TRUE` to avoid a conflict. See `CommonVGAMffArguments` for more information.

Argument `vfl` requires the use of `parallel` to fit the VFL model.

`gprobs.y` A vector representing a grid; passed into the `probs` argument of `quantile` when `imethod = 1` to obtain an initial value for the mean of each response. Is overwritten by any value of `iprobs.y`.

`iprobs.y` Passed into the `probs` argument of `quantile` when `imethod = 1` to obtain an initial value for the mean of each response. Overwrites any value of `gprobs.y`.

This argument might be deleted in the future.

Details

The negative binomial distribution (NBD) can be motivated in several ways, e.g., as a Poisson distribution with a mean that is gamma distributed. There are several common parametrizations of the NBD. The one used by `negbinomial()` uses the mean $\mu$ and an index parameter $k$, both which are positive. Specifically, the density of a random variable $Y$ is

$$f(y; \mu, k) = \binom{y + k - 1}{y} \left( \frac{\mu}{\mu + k} \right)^y \left( \frac{k}{\mu + k} \right)^k$$

where $y = 0, 1, 2, \ldots$, and $\mu > 0$ and $k > 0$. Note that the dispersion parameter is $1/k$, so that as $k$ approaches infinity the NBD approaches a Poisson distribution. The response has variance $\text{Var}(Y) = \mu + \mu^2/k$. When fitted, the `fitted.values` slot of the object contains the estimated value of the $\mu$ parameter, i.e., of the mean $E(Y)$. It is common for some to use $\alpha = 1/k$ as the ancillary or heterogeneity parameter; so common alternatives for `lsize` are `negloglink` and `reciprocallink`.

For `polya` the density is

$$f(y; p, k) = \binom{y + k - 1}{y} (1 - p)^y p^k$$

where $y = 0, 1, 2, \ldots$, and $k > 0$ and $0 < p < 1$.

Family function `polyaR()` is the same as `polya()` except the order of the two parameters are switched. The reason is that `polyaR()` tries to match with `rnbinom` closely in terms of the argument order, etc. Should the probability parameter be of primary interest, probably, users will prefer using `polya()` rather than `polyaR()`. Possibly `polyaR()` will be decommissioned one day.

The NBD can be coerced into the classical GLM framework with one of the parameters being of interest and the other treated as a nuisance/scale parameter (this is implemented in the `MASS` library). The `VGAM` family function `negbinomial()` treats both parameters on the same footing, and estimates them both by full maximum likelihood estimation.

The parameters $\mu$ and $k$ are independent (diagonal EIM), and the confidence region for $k$ is extremely skewed so that its standard error is often of no practical use. The parameter $1/k$ has been used as a measure of aggregation. For the NB-C the EIM is not diagonal.

These `VGAM` family functions handle multiple responses, so that a response matrix can be inputted. The number of columns is the number of species, say, and setting `zero = -2` means that all species have a $k$ equalling a (different) intercept only.
Conlisk, et al. (2007) show that fitting the NBD to presence-absence data will result in identifiability problems. However, the model is identifiable if the response values include 0, 1 and 2.

For the NB canonical link (NB-C), its estimation has a somewhat interesting history. Some details are at nbcanlink.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

Poisson regression corresponds to \(k\) equalling infinity. If the data is Poisson or close to Poisson, numerical problems may occur. Some corrective measures are taken, e.g., \(k\) is effectively capped (relative to the mean) during estimation to some large value and a warning is issued. And setting \(\text{stepsize} = 0.5\) for half stepping is probably a good idea too when the data is extreme.

The NBD is a strictly unimodal distribution. Any data set that does not exhibit a mode (somewhere in the middle) makes the estimation problem difficult. Set \(\text{trace} = \text{TRUE}\) to monitor convergence.

These functions are fragile; the maximum likelihood estimate of the index parameter is fraught (see Lawless, 1987). Other alternatives to \texttt{negbinomial} are to fit a NB-1 or RR-NB (aka NB-P) model; see Yee (2014). Also available are the NB-C, NB-H and NB-G. Assigning values to the \(\text{isize}\) argument may lead to a local solution, and smaller values are preferred over large values when using this argument.

If one wants to force SFS to be used on all observations, then set \(\text{max.support} = 0\) or \(\text{max.chunk.MB} = 0\). If one wants to force the exact method to be used for all observations, then set \(\text{max.support} = \text{Inf}\). If the computer has \textit{much} memory, then trying \(\text{max.chunk.MB} = \text{Inf}\) and \(\text{max.support} = \text{Inf}\) may provide a small speed increase. If SFS is used at all, then the working weights (\@weights) slot of the fitted object will be a matrix; otherwise that slot will be a 0 x 0 matrix.

An alternative to the NBD is the generalized Poisson distribution, \texttt{genpoisson1}, \texttt{genpoisson2} and \texttt{genpoisson0}, since that also handles overdispersion wrt Poisson. It has one advantage in that its EIM can be computed straightforwardly.

Yet to do: write a family function which uses the methods of moments estimator for \(k\).

Note

These 3 functions implement 2 common parameterizations of the negative binomial (NB). Some people called the NB with integer \(k\) the \textit{Pascal} distribution, whereas if \(k\) is real then this is the \textit{Polya} distribution. I don’t. The one matching the details of \texttt{rnbinom} in terms of \(p\) and \(k\) is \texttt{polya()}.

For \texttt{polya()} the code may fail when \(p\) is close to 0 or 1. It is not yet compatible with \texttt{cqo} or \texttt{cao}.

Suppose the response is called \texttt{ymat}. For \texttt{negbinomial()} the diagonal element of the \textit{expected information matrix} (EIM) for parameter \(k\) involves an infinite series; consequently SFS (see \texttt{nSIM}) is used as the backup algorithm only. SFS should be better if \(\text{max(ymat)}\) is large, e.g., \(\text{max(ymat)} > 1000\), or if there are any outliers in \texttt{ymat}. The default algorithm involves a finite series approximation to the support 0:Inf; the arguments \texttt{max.memory}, \texttt{min.size} and \texttt{cutoff.prob} are pertinent.

Regardless of the algorithm used, convergence problems may occur, especially when the response has large outliers or is large in magnitude. If convergence failure occurs, try using arguments
The function `negbinomial` can be used by the fast algorithm in `cqo`, however, setting `eq.tolerances = TRUE` and `I.tolerances = FALSE` is recommended.

In the first example below (Bliss and Fisher, 1953), from each of 6 McIntosh apple trees in an orchard that had been sprayed, 25 leaves were randomly selected. On each of the leaves, the number of adult female European red mites were counted.

There are two special uses of `negbinomial` for handling count data. Firstly, when used by `rrvglm` this results in a continuum of models in between and inclusive of quasi-Poisson and negative binomial regression. This is known as a reduced-rank negative binomial model (RR-NB). It fits a negative binomial log-linear regression with variance function $\text{Var}(Y) = \mu + \delta_1 \mu \delta_2$ where $\delta_1$ and $\delta_2$ are parameters to be estimated by MLE. Confidence intervals are available for $\delta_2$, therefore it can be decided upon whether the data are quasi-Poisson or negative binomial, if any.

Secondly, the use of `negbinomial` with `parallel = TRUE` inside `vglm` can result in a model similar to `quasipoisson`. This is named the NB-1 model. The dispersion parameter is estimated by MLE whereas `glm` uses the method of moments. In particular, it fits a negative binomial log-linear regression with variance function $\text{Var}(Y) = \phi_0 \mu$ where $\phi_0$ is a parameter to be estimated by MLE. Confidence intervals are available for $\phi_0$.

**Author(s)**

Thomas W. Yee, and with a lot of help by Victor Miranda to get it going with `nbcanlink`.

**References**


See Also

quasipoisson, gaitdtnbinomial, poissonff, zinegbinomial, negbinomial.size (e.g., NB-G),
nbcanlink (NB-C), posnegbinomial, genpoisson1, genpoisson2, genpoisson0, inv.binomial,
NegBinomial, rrvglm, cao, cqq, CommonVGAMffArguments, simulate.vlm, ppoints, margeff.

Examples

# Example 1: apple tree data (Bliss and Fisher, 1953)
appletree <- data.frame(y = 0:7, w = c(70, 38, 17, 10, 9, 3, 2, 1))
fit <- vglm(y ~ 1, negbinomial(deviance = TRUE), data = appletree,
weights = w, crit = "coef") # Obtain the deviance
fit <- vglm(y ~ 1, negbinomial(deviance = TRUE), data = appletree,
weights = w, half.step = FALSE) # Alternative method
summary(fit)
coef(fit, matrix = TRUE)
Coef(fit) # For intercept-only models
deviance(fit) # NB2 only; needs 'crit="coef"' & 'deviance=T' above

# Example 2: simulated data with multiple responses
# Not run:
ndata <- data.frame(x2 = runif(nn <- 200))
ndata <- transform(ndata, y1 = rnbinom(nn, exp(1), mu = exp(3+x2)),
y2 = rnbinom(nn, exp(0), mu = exp(2-x2)))
fit1 <- vglm(cbind(y1, y2) ~ x2, negbinomial, ndata, trace = TRUE)
coef(fit1, matrix = TRUE)
## End(Not run)

# Example 3: large counts implies SFS is used
# Not run:
ndata <- transform(ndata, y3 = rnbinom(nn, exp(1), mu = exp(10+x2)))
with(ndata, range(y3)) # Large counts
fit2 <- vglm(y3 ~ x2, negbinomial, data = ndata, trace = TRUE)
coef(fit2, matrix = TRUE)
head(weights(fit2, type = "working")) # Non-empty; SFS was used
## End(Not run)

# Example 4: a NB-1 to estimate a NB with Var(Y)=phi0*mu
nn <- 200 # Number of observations
phi0 <- 10 # Specify this; should be greater than unity
delta0 <- 1 / (phi0 - 1)
mydata <- data.frame(x2 = runif(nn), x3 = runif(nn))
mydata <- transform(mydata, mu = exp(2 + 3 * x2 + 0 * x3))
mydata <- transform(mydata, y3 = rnbinom(nn, delta0 * mu, mu = mu))
# Not run:
plot(y3 ~ x2, data = mydata, pch = "+", col = "blue",
main = paste("Var(Y) = " , phi0, " * mu", sep = ""), las = 1)
# End(Not run)
nb1 <- vglm(y3 ~ x2 + x3, negbinomial(parallel = TRUE, zero = NULL),
data = mydata, trace = TRUE)
# Extracting out some quantities:
negbinomial.size

Description

Maximum likelihood estimation of the mean parameter of a negative binomial distribution with known size parameter.

Usage

negbinomial.size(size = Inf, lmu = "loglink", imu = NULL, iprobs.y = 0.35, imethod = 1, ishrinkage = 0.95, zero = NULL)

Arguments

size Numeric, positive. Same as argument size of rnbinom. If the response is a matrix then this is recycled to a matrix of the same dimension, by row (matrix with byrow = TRUE).

lmu, imu Same as negbinomial.

iprobs.y, imethod Same as negbinomial.

zero, ishrinkage Same as negbinomial. See CommonVGAMffArguments for information.

Details

This VGAM family function estimates only the mean parameter of the negative binomial distribution. See negbinomial for general information. Setting size = 1 gives what might be called the NB-G (geometric model; see Hilbe (2011)). The default, size = Inf, corresponds to the Poisson distribution.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Note

If lmu = "nbcanlink" in negbinomial.size() then the size argument here should be assigned and these values are recycled.

Author(s)

Thomas W. Yee

References


See Also

negbinomial, nbcanlink (NB-C model), poissonff, rnbinom, simulate.vlm.

Examples

```r
# Simulated data with various multiple responses
size1 <- exp(1); size2 <- exp(2); size3 <- exp(0); size4 <- Inf
ndata <- data.frame(x2 = runif(nn <- 1000))
ndata <- transform(ndata, eta1 = -1 - 2 * x2, # eta1 must be negative
                   size1 = size1)
ndata <- transform(ndata, 
                   mu1 = nbcanlink(eta1, size = size1, inv = TRUE))
ndata <- transform(ndata, 
                   y1 = rnbinom(nn, mu = mu1, size = size1), # NB-C
                   y2 = rnbinom(nn, mu = exp(2 - x2), size = size2),
                   y3 = rnbinom(nn, mu = exp(3 + x2), size = size3), # NB-G
                   y4 = rpois(nn, lambda = exp(1 + x2)))

# Also known as NB-C with size known (Hilbe, 2011)
fit1 <- vglm(y1 ~ x2, negbinomial.size(size = size1, lmu = "nbcanlink"),
            data = ndata, trace = TRUE)
coef(fit1, matrix = TRUE)
head(fit1@misc$size) # size saved here

fit2 <- vglm(cbind(y2, y3, y4) ~ x2, data = ndata, trace = TRUE,
             negbinomial.size(size = c(size2, size3, size4)))
coef(fit2, matrix = TRUE)
head(fit2@misc$size) # size saved here
```
Description

Maximum likelihood estimation of all the coefficients of a LM where each of the usual regression coefficients is modelled with other explanatory variables via parameter link functions. Thus this is a basic varying-coefficient model.

Usage

```r
normal.vcm(link.list = list("(Default)" = "identitylink"),
            earg.list = list("(Default)" = list()),
            lsd = "loglink", lvar = "loglink",
            esd = list(), evar = list(),
            var.arg = FALSE, imethod = 1,
            icoefficients = NULL, isd = NULL, zero = "sd",
            sd.inflation.factor = 2.5)
```

Arguments

- `link.list`, `earg.list`  
  Link functions and extra arguments applied to the coefficients of the LM, excluding the standard deviation/variance. See `CommonVGAMffArguments` for more information. The default is for an identity link to be applied to each of the regression coefficients.

- `lsd`, `esd`, `lvar`, `evar`  
  Link function and extra argument applied to the standard deviation/variance. See `CommonVGAMffArguments` for more information. Same as `uninormal`.

- `icoefficients`  
  Optional initial values for the coefficients. Recycled to length $M - 1$ (does not include the standard deviation/variance). Try using this argument if there is a link function that is not programmed explicitly to handle range restrictions in the `initialize` slot.

- `var.arg`, `imethod`, `isd`  
  Same as, or similar to, `uninormal`.

- `zero`  
  See `CommonVGAMffArguments` for more information. The default applies to the last one, viz. the standard deviation/variance parameter.

- `sd.inflation.factor`  
  Numeric, should be greater than 1. The initial value of the standard deviation is multiplied by this, unless `isd` is inputted. Experience has shown that it is safer to start off with a larger value rather than a smaller one.

Details

This function allows all the usual LM regression coefficients to be modelled as functions of other explanatory variables via parameter link functions. For example, we may want some of them to be
positive. Or we may want a subset of them to be positive and add to unity. So a class of such models have been named **varying-coefficient models** (VCMs).

The usual linear model is specified through argument `form2`. As with all other **VGAM** family functions, the linear/additive predictors are specified through argument `formula`.

The **multilogitlink** link allows a subset of the coefficients to be positive and add to unity. Either none or more than one call to **multilogitlink** is allowed. The last variable will be used as the baseline/reference group, and therefore excluded from the estimation.

By default, the log of the standard deviation is the last linear/additive predictor. It is recommended that this parameter be estimated as intercept-only, for numerical stability.

Technically, the Fisher information matrix is of unit-rank for all but the last parameter (the standard deviation/variance). Hence an approximation is used that pools over all the observations.

This **VGAM** family function cannot handle multiple responses. Also, this function will probably not have the full capabilities of the class of varying-coefficient models as described by Hastie and Tibshirani (1993). However, it should be able to manage some simple models, especially involving the following links: **identitylink**, **loglink**, **logofflink**, **logloglink**, **logitlink**, **probitlink**, **cauchitlink**, **clogloglink**, **rhobitlink**, **fisherzlink**.

**Value**

An object of class "vglmff" (see **vglmff-class**). The object is used by modelling functions such as **vglm**, and **vgam**.

**Warning**

This **VGAM** family function is fragile. One should monitor convergence, and possibly enter initial values especially when there are non-**identity**-link functions. If the initial value of the standard deviation/variance is too small then numerical problems may occur. One trick is to fit an intercept-only only model and feed its `predict()` output into argument `etastart` of a more complicated model. The use of the zero argument is recommended in order to keep models as simple as possible.

**Note**

The standard deviation/variance parameter is best modelled as intercept-only.

Yet to do: allow an argument such as **parallel** that enables many of the coefficients to be equal.

Fix a bug: **Coef()** does not work for intercept-only models.

**Author(s)**

T. W. Yee

**References**


**See Also**

**uninormal**, **lm**.
Examples

ndata <- data.frame(x2 = runif(nn <- 2000))
# Note that coeff1 + coeff2 + coeff5 == 1. So try "multilogitlink".
myoffset <- 10
ndata <- transform(ndata,
    coeff1 = 0.25, # "multilogitlink"
    coeff2 = 0.25, # "multilogitlink"
    coeff3 = exp(-0.5), # "loglink"
    # "logofflink" link:
    coeff4 = logofflink(+0.5, offset = myoffset, inverse = TRUE),
    coeff5 = 0.50, # "multilogitlink"
    coeff6 = 1.00, # "identitylink"
    v2 = runif(nn),
    v3 = runif(nn),
    v4 = runif(nn),
    v5 = rnorm(nn),
    v6 = rnorm(nn))
ndata <- transform(ndata,
    Coeff1 = 0.25 - 0 * x2,
    Coeff2 = 0.25 - 0 * x2,
    Coeff3 = logitlink(-0.5 - 1 * x2, inverse = TRUE),
    Coeff4 = logloglink(0.5 - 1 * x2, inverse = TRUE),
    Coeff5 = 0.50 - 0 * x2,
    Coeff6 = 1.00 + 1 * x2)
ndata <- transform(ndata,
    y1 = coeff1 * 1 +
    coeff2 * v2 +
    coeff3 * v3 +
    coeff4 * v4 +
    coeff5 * v5 +
    coeff6 * v6 + rnorm(nn, sd = exp(0)),
    y2 = Coeff1 * 1 +
    Coeff2 * v2 +
    Coeff3 * v3 +
    Coeff4 * v4 +
    Coeff5 * v5 +
    Coeff6 * v6 + rnorm(nn, sd = exp(0)))
# An intercept-only model
fit1 <- vglm(y1 ~ 1,
    form2 = ~ 1 + v2 + v3 + v4 + v5 + v6,
    normal.vcm(link.list = list("(Intercept)" = "multilogitlink",
    "v2"  = "multilogitlink",
    "v3"  = "loglink",
    "v4"  = "logofflink",
    "(Default)"  = "identitylink",
    "v5"  = "multilogitlink"),
    earg.list = list("(Intercept)" = list(),
    "v2"  = list(),
    "v4"  = list(offset = myoffset),
    "v3"  = list(),
    "(Default)"  = list()),
nparam.vlm

Number of Parameters

Description

Returns the number of parameters in a fitted model object.

Usage

nparam(object, ...)
nparam.vlm(object, dpar = TRUE, ...)
nparam.vgam(object, dpar = TRUE, linear.only = FALSE, ...)
nparam.rrvglm(object, dpar = TRUE, ...)
nparam.drrvglm(object, dpar = TRUE, ...)
nparam.qrrvglm(object, dpar = TRUE, ...)
nparam.rrvgam(object, dpar = TRUE, ...)

Arguments

object Some VGAM object, for example, having class vglmff-class.
... Other possible arguments fed into the function.

dpar Logical, include any (estimated) dispersion parameters as a parameter?
linear.only Logical, include only the number of linear (parametric) parameters?

Details

The code was copied from the AIC() methods functions.

Value

Returns a numeric value with the corresponding number of parameters. For vgam objects, this may be real rather than integer, because the nonlinear degrees of freedom is real-valued.

Warning

This code has not been double-checked.

Author(s)

T. W. Yee.

See Also

VGLMs are described in vglm-class; VGAMs are described in vgam-class; RR-VGLMs are described in rrvglm-class; AICvlm.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo))
coef(fit1)
coef(fit1, matrix = TRUE)
nparam(fit1)
(fit2 <- vglm(hits ~ 1, poissonff, weights = ofreq, data = V1))
coef(fit2)
coef(fit2, matrix = TRUE)
nparam(fit2)
nparam(fit2, dpar = FALSE)

olympics 2008 and 2012 Summer Olympic Final Medal Count Data

Description

Final medal count, by country, for the Summer 2008 and 2012 Olympic Games.
Usage

data(olym08)
data(olym12)

Format

A data frame with 87 or 85 observations on the following 6 variables.

rank   a numeric vector, overall ranking of the countries.
country a factor.
gold   a numeric vector, number of gold medals.
silver a numeric vector, number of silver medals.
bronze  a numeric vector, number of bronze medals.
totalmedal a numeric vector, total number of medals.

Details

The events were held during (i) August 8–24, 2008, in Beijing; and (ii) 27 July–12 August, 2012, in London.

References

The official English website was/is http://en.beijing2008.cn and http://www.london2012.com. Help from Viet Hoang Quoc is gratefully acknowledged.

See Also

grc.

Examples

summary(olym08)
summary(olym12)
## maybe str(olym08) ; plot(olym08) ...
## Not run: par(mfrow = c(1, 2))
myylim <- c(0, 55)
with(head(olym08, n = 8),
  barplot(rbind(gold, silver, bronze),
          col = c("gold", "grey", "brown"), # No "silver" or "bronze"!
          main = "2008 Summer Olympic Final Medal Count",
          ylab = "Medal count", las = 1,
          beside = TRUE,
          names.arg = country,
          cex.names = 0.5, ylim = myylim,
          # "gold", "grey71", "chocolate4",
          # "gold", "grey71", "chocolate4",
          # names.arg = country, cex.names = 0.5, ylim = myylim,
          beside = TRUE, main = "2008 Summer Olympic Final Medal Count",
          ylab = "Medal count", las = 1,
          sub = "Top 8 countries; 'gold'=gold, 'grey'=silver, 'brown'=bronze")
  with(head(olym12, n = 8),
      barplot(rbind(gold, silver, bronze),
              col = c("gold", "grey", "brown"), # No "silver" or "bronze"!
              main = "2012 Summer Olympic Final Medal Count",
              names.arg = country,
              cex.names = 0.5, ylim = myylim,
Opt

Optimums

Description

Generic function for the optimums (or optima) of a model.

Usage

Opt(object, ...)

Arguments

object An object for which the computation or extraction of an optimum (or optimums) is meaningful.

... Other arguments fed into the specific methods function of the model. Sometimes they are fed into the methods function for Coef.

Details

Different models can define an optimum in different ways. Many models have no such notion or definition.

Optimums occur in quadratic and additive ordination, e.g., CQO or CAO. For these models the optimum is the value of the latent variable where the maximum occurs, i.e., where the fitted value achieves its highest value. For quadratic ordination models there is a formula for the optimum but for additive ordination models the optimum must be searched for numerically. If it occurs on the boundary, then the optimum is undefined. At an optimum, the fitted value of the response is called the maximum.

Value

The value returned depends specifically on the methods function invoked.

Note

In ordination, the optimum of a species is sometimes called the species score.

Author(s)

Thomas W. Yee
ordpoisson

References


See Also

Opt.qrrvglm, Max, Tol.

Examples

```r
set.seed(111) # This leads to the global solution
hsper[,1:6] <- scale(hspider[,1:6]) # Standardized environmental vars
p1 <- cco(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
    Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
    Trocterr, Zoraspin) ~
    WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
    family = poissonff, data = hspider, Crow1positive = FALSE)
Opt(p1)

## Not run:
clr <- (1:(ncol(depvar(p1))+1))[-7] # Omits yellow
persp(p1, col = clr, las = 1, main = "Vertical lines at the optimums")
abline(v = Opt(p1), lty = 2, col = clr)
## End(Not run)
```

ordpoisson

*Ordinal Poisson Family Function*

Description

Fits a Poisson regression where the response is ordinal (the Poisson counts are grouped between known cutpoints).

Usage

```
ordpoisson(cutpoints, countdata = FALSE, NOS = NULL,
        Levels = NULL, init.mu = NULL, parallel = FALSE,
        zero = NULL, link = "loglink")
```

Arguments

- **cutpoints**: Numeric. The cutpoints, \( K_i \). These must be non-negative integers. Inf values may be included. See below for further details.
countdata Logical. Is the response (LHS of formula) in count-data format? If not then the response is a matrix or vector with values 1, 2, ..., L, say, where L is the number of levels. Such input can be generated with cut with argument labels = FALSE. If countdata = TRUE then the response is expected to be in the same format as depvar(fit) where fit is a fitted model with ordpoisson as the VGAM family function. That is, the response is matrix of counts with L columns (if NOS = 1).

NOS Integer. The number of species, or more generally, the number of response random variates. This argument must be specified when countdata = TRUE. Usually NOS = 1.

Levels Integer vector, recycled to length NOS if necessary. The number of levels for each response random variate. This argument should agree with cutpoints. This argument must be specified when countdata = TRUE.

init.mu Numeric. Initial values for the means of the Poisson regressions. Recycled to length NOS if necessary. Use this argument if the default initial values fail (the default is to compute an initial value internally).

parallel, zero, link
See poissonff. See CommonVGAMffArguments for information.

Details
This VGAM family function uses maximum likelihood estimation (Fisher scoring) to fit a Poisson regression to each column of a matrix response. The data, however, is ordinal, and is obtained from known integer cutpoints. Here, \( l = 1, \ldots, L \) where \( L \) (\( L \geq 2 \)) is the number of levels. In more detail, let \( Y^* = l \) if \( K_{l-1} < Y \leq K_l \) where the \( K_i \) are the cutpoints. We have \( K_0 = -\infty \) and \( K_L = \infty \). The response for this family function corresponds to \( Y^* \) but we are really interested in the Poisson regression of \( Y \).

If NOS=1 then the argument cutpoints is a vector \((K_1, K_2, \ldots, K_L)\) where the last value (Inf) is optional. If NOS>1 then the vector should have NOS-1 Inf values separating the cutpoints. For example, if there are NOS=3 responses, then something like ordpoisson(cut = c(0, 5, 10, Inf, 20, 30, Inf, 0, 10, 40, Inf)) is valid.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning
The input requires care as little to no checking is done. If fit is the fitted object, have a look at fit@extra and depvar(fit) to check.

Note
Sometimes there are no observations between two cutpoints. If so, the arguments Levels and NOS need to be specified too. See below for an example.
Author(s)

Thomas W. Yee

References


See Also

poissonff, polf, ordered.

Examples

```r
set.seed(123)  # Example 1
x2 <- runif(n <- 1000); x3 <- runif(n)
mymu <- exp(3 - 1 * x2 + 2 * x3)
y1 <- rpois(n, lambda = mymu)
cutpts <- c(-Inf, 20, 30, Inf)
fcutpts <- cutpts[is.finite(cutpts)]  # finite cutpoints
ystar <- cut(y1, breaks = cutpts, labels = FALSE)
## Not run:
plot(x2, x3, col = ystar, pch = as.character(ystar))
## End(Not run)
table(ystar) / sum(table(ystar))
fit <- vglm(ystar ~ x2 + x3, fam = ordpoisson(cutpoi = fcutpts))
head(depvar(fit))  # This can be input if countdata = TRUE
head(fitted(fit))
head(predict(fit))
coef(fit, matrix = TRUE)
fit@extra

# Example 2: multivariate and there are no obsns between some cutpoints
cutpts2 <- c(-Inf, 0, 9, 10, 20, 70, 200, 201, Inf)
fcutpts2 <- cutpts2[is.finite(cutpts2)]  # finite cutpoints
y2 <- rpois(n, lambda = mymu)  # Same model as y1
ystar2 <- cut(y2, breaks = cutpts2, labels = FALSE)
table(ystar2) / sum(table(ystar2))
fit <- vglm(cbind(ystar,ystar2) ~ x2 + x3, fam = ordpoisson(cutpoi = c(fcutpts,Inf,fcutpts2,Inf),
Levels = c(length(fcutpts)+1,length(fcutpts2)+1),
parallel = TRUE), trace = TRUE)
coef(fit, matrix = TRUE)
fit@extra
constraints(fit)
summary(depvar(fit))  # Some columns have all zeros
```
**Ordinal Superiority Measures**

**Description**

Ordinal superiority measures for the linear model and cumulative link models: the probability that an observation from one distribution falls above an independent observation from the other distribution, adjusted for explanatory variables in a model.

**Usage**

```r
ordsup(object, ...)
ordsup.vglm(object, all.vars = FALSE, confint = FALSE, ...)
```

**Arguments**

- `object`: A `vglm` fit. Currently it must be one of: `cumulative`, `uninormal`. The links for `cumulative` must be `logitlink` or `probitlink`, and `parallel = TRUE` is also needed. For `uninormal` the mean must use `identitylink` and model the sd as intercept-only.

- `all.vars`: Logical. The default is to use explanatory variables which are binary, but all variables are used (except the intercept) if set to `TRUE`.

- `confint`: Logical. If `TRUE` then `confintvglm` is called to return confidence intervals for $\gamma$ and $\Delta$. By default, Wald intervals are produced, but they can be replaced by profile intervals by setting `method = "profile"`.

- `...`: Parameters that can be fed into `confintvglm`, e.g., `level = 0.95` and `method = c("wald", "profile")`.

**Details**

Details are given in Agresti and Kateri (2017) and this help file draws directly from this. This function returns two quantities for comparing two groups on an ordinal categorical response variable, while adjusting for other explanatory variables. They are called “ordinal superiority” measures, and the two groups can be compared without supplementary explanatory variables. Let $Y_1$ and $Y_2$ be independent random variables from groups A and B, say, for a quantitative ordinal categorical scale. Then $\Delta = P(Y_1 > Y_2) - P(Y_2 > Y_1)$ summarizes their relative size. A second quantity is $\gamma = P(Y_1 > Y_2) - 0.5 \times P(Y_2 = Y_1)$. Then $\Delta = 2 \times \gamma - 1$, whereas $\gamma = (\Delta + 1)/2$. The range of $\gamma$ is $[0, 1]$, while the range of $\Delta$ is $[-1, 1]$. The examples below are based on that paper. This function is currently implemented for a very limited number of specific models.

**Value**

By default, a list with components `gamma` and `Delta`, where each is a vector with elements corresponding to binary explanatory variables (i.e., 0 or 1), and if no explanatory variables are binary then a `NULL` is returned. If `confint = TRUE` then the list contains 4 more components: `lower.gamma`, `upper.gamma`, `Lower.Delta`, `Upper.Delta`.
**oxtemp**

**Author(s)**

Thomas W. Yee

**References**


**See Also**

cumulative, propodds, uninormal.

**Examples**

```r
## Not run:
Mental <- read.table("http://www.stat.ufl.edu/~aa/glm/data/Mental.dat",
                     header = TRUE)  # Make take a while to load in
Mental$impair <- ordered(Mental$impair)
pfit3 <- vglm(impair ~ ses + life, data = Mental,
             cumulative(link = "probitlink", reverse = FALSE, parallel = TRUE))
coef(pfit3, matrix = TRUE)
ordsup(pfit3)  # The 'ses' variable is binary

# Fit a crude LM
fit7 <- vglm(as.numeric(impair) ~ ses + life, uninormal, data = Mental)
coef(fit7, matrix = TRUE)  # 'sd' is estimated by MLE
ordsup(fit7)
ordsup(fit7, all.vars = TRUE)  # Some output may not be meaningful
ordsup(fit7, confint = TRUE, method = "profile")

## End(Not run)
```

---

**oxtemp**

*Oxford Temperature Data*

**Description**

Annual maximum temperatures collected at Oxford, UK.

**Usage**

data(oxtemp)

**Format**

A data frame with 80 observations on the following 2 variables.

- **maxtemp** Annual maximum temperatures (in degrees Fahrenheit).
- **year** The values 1901 to 1980.
Paralogistic

Details

The data were collected from 1901 to 1980.

Source

Unknown.

Examples

## Not run: fit <- vglm(maxtemp ~ 1, gevff, data = oxtemp, trace = TRUE)

---

Paralogistic Distribution

The Paralogistic Distribution

Description

Density, distribution function, quantile function and random generation for the paralogistic distribution with shape parameter \( a \) and scale parameter \( \text{scale} \).

Usage

dparalogistic(x, scale = 1, shape1.a, log = FALSE)
pparalogistic(q, scale = 1, shape1.a, lower.tail = TRUE, log.p = FALSE)
qparalogistic(p, scale = 1, shape1.a, lower.tail = TRUE, log.p = FALSE)
rparalogistic(n, scale = 1, shape1.a)

Arguments

- \( x, q \) : vector of quantiles.
- \( p \) : vector of probabilities.
- \( n \) : number of observations. If \( \text{length}(n) > 1 \), the length is taken to be the number required.
- \( \text{shape1.a} \) : shape parameter.
- \( \text{scale} \) : scale parameter.
- \( \text{log} \) : Logical. If \( \text{log}=\text{TRUE} \) then the logarithm of the density is returned.
- \( \text{lower.tail}, \text{log.p} \) : Same meaning as in \( \text{pnorm} \) or \( \text{qnorm} \).

Details

See paralogistic, which is the VGAM family function for estimating the parameters by maximum likelihood estimation.

Value

dparalogistic gives the density, pparalogistic gives the distribution function, qparalogistic gives the quantile function, and rparalogistic generates random deviates.
Note
The paralogistic distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)
T. W. Yee and Kai Huang

References

See Also
paralogistic, genbetaII.

Examples
```r
pdata <- data.frame(y = rparalogistic(n = 3000, scale = exp(1), exp(2)))
fit <- vglm(y ~ 1, paralogistic(lss = FALSE, ishape1.a = 4.1),
           data = pdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
```

paralogistic  
*Paralogistic Distribution Family Function*

Description
Maximum likelihood estimation of the 2-parameter paralogistic distribution.

Usage
```r
paralogistic(lscale = "loglink", lshape1.a = "loglink", iscale = NULL,
             ishape1.a = NULL, imethod = 1, lss = TRUE, gscale = exp(-5:5),
             gshape1.a = seq(0.75, 4, by = 0.25), probs.y = c(0.25, 0.5, 0.75),
             zero = "shape")
```

Arguments
```
1ss
  See CommonVGAMffArguments for important information.
1shape1.a, lscale
  Parameter link functions applied to the (positive) parameters a and scale. See Links for more choices.
isspace, ishape1.a, imethod, zero
  See CommonVGAMffArguments for information. For imethod = 2 a good initial value for ishape1.a is needed to obtain good estimates for the other parameter.
```
The 2-parameter paralogistic distribution is the 4-parameter generalized beta II distribution with shape parameter $p = 1$ and $a = q$. It is the 3-parameter Singh-Maddala distribution with $a = q$. More details can be found in Kleiber and Kotz (2003).

The 2-parameter paralogistic has density

$$f(y) = \frac{a^2 y^{a-1}}{b^a \{1 + (y/b)^a\}^{1+a}}$$

for $a > 0$, $b > 0$, $y \geq 0$. Here, $b$ is the scale parameter scale, and $a$ is the shape parameter. The mean is

$$E(Y) = b \Gamma(1 + 1/a) \Gamma(a - 1/a)/\Gamma(a)$$

provided $a > 1$; these are returned as the fitted values. This family function handles multiple responses.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

**Note**

See the notes in genbetaII.

**Author(s)**

T. W. Yee

**References**


**See Also**

Paralogistic, sinmad, genbetaII, betaII, dagum, fisk, inv.lomax, lomax, inv.paralogistic.

**Examples**

```r
pdata <- data.frame(y = rparalogistic(n = 3000, exp(1), scale = exp(1)))
fit <- vglm(y ~ 1, paralogistic(lss = FALSE), data = pdata, trace = TRUE)
fit <- vglm(y ~ 1, paralogistic(ishape1.a = 2.3, iscale = 5),
            data = pdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```
Description

Density, distribution function, quantile function and random generation for the Pareto(I) distribution with parameters scale and shape.

Usage

\begin{align*}
\text{dpareto}(x, \text{scale} = 1, \text{shape}, \text{log} = \text{FALSE}) \\
\text{ppareto}(q, \text{scale} = 1, \text{shape}, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE}) \\
\text{qpareto}(p, \text{scale} = 1, \text{shape}, \text{lower.tail} = \text{TRUE}, \text{log.p} = \text{FALSE}) \\
\text{rpareto}(n, \text{scale} = 1, \text{shape})
\end{align*}

Arguments

- \text{x, q} vector of quantiles.
- \text{p} vector of probabilities.
- \text{n} number of observations. Same as in \text{runif}.
- \text{scale, shape} the \(\alpha\) and \(k\) parameters.
- \text{log} Logical. If \text{log} = \text{TRUE} then the logarithm of the density is returned.
- \text{lower.tail, log.p} Same meaning as in \text{pnorm} or \text{qnorm}.

Details

See \text{paretoff}, the \text{VGAM} family function for estimating the parameter \(k\) by maximum likelihood estimation, for the formula of the probability density function and the range restrictions imposed on the parameters.

Value

- \text{dpareto} gives the density, \text{ppareto} gives the distribution function, \text{qpareto} gives the quantile function, and \text{rpareto} generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


### Description

Estimates one of the parameters of the Pareto(I) distribution by maximum likelihood estimation. Also includes the upper truncated Pareto(I) distribution.

### Usage

```r
paretoff(scale = NULL, lshape = "loglink")
truncpareto(lower, upper, lshape = "loglink", ishape = NULL, imethod = 1)
```

### Arguments

- **lshape**: Parameter link function applied to the parameter \( k \). See [Links](#) for more choices. A log link is the default because \( k \) is positive.
- **scale**: Numeric. The parameter \( \alpha \) below. If the user inputs a number then it is assumed known with this value. The default means it is estimated by maximum likelihood estimation, which means \( \min(y) \) is used, where \( y \) is the response vector.
- **lower, upper**: Numeric. Lower and upper limits for the truncated Pareto distribution. Each must be positive and of length 1. They are called \( \alpha \) and \( U \) below.
- **ishape**: Numeric. Optional initial value for the shape parameter. A NULL means a value is obtained internally. If failure to converge occurs try specifying a value, e.g., 1 or 2.
- **imethod**: See [CommonVGAMffArguments](#) for information. If failure to converge occurs then try specifying a value for ishape.

### Examples

```r
alpha <- 3; k <- exp(1); x <- seq(2.8, 8, len = 300)
## Not run:
plot(x, dpareto(x, scale = alpha, shape = k), type = "l",
     main = "Pareto density split into 10 equal areas")
abline(h = 0, col = "blue", lty = 2)
qvec <- qpareto(seq(0.1, 0.9, by = 0.1), scale = alpha, shape = k)
lines(qvec, dpareto(qvec, scale = alpha, shape = k),
      col = "purple", lty = 3, type = "h")
## End(Not run)
pvec <- seq(0.1, 0.9, by = 0.1)
qvec <- qpareto(pvec, scale = alpha, shape = k)
ppareto(qvec, scale = alpha, shape = k)
qpareto(ppareto(qvec, scale = alpha, shape = k),
       scale = alpha, shape = k) - qvec # Should be 0
```
Details

A random variable $Y$ has a Pareto distribution if

$$P[Y > y] = C/y^k$$

for some positive $k$ and $C$. This model is important in many applications due to the power law probability tail, especially for large values of $y$.

The Pareto distribution, which is used a lot in economics, has a probability density function that can be written

$$f(y; \alpha, k) = k\alpha^k / y^{k+1}$$

for $0 < \alpha < y$ and $0 < k$. The $\alpha$ is called the scale parameter, and it is either assumed known or else $\min(y)$ is used. The parameter $k$ is called the shape parameter. The mean of $Y$ is $\alpha k/(k - 1)$ provided $k > 1$. Its variance is $\alpha^2 k/((k - 1)^2 (k - 2))$ provided $k > 2$.

The upper truncated Pareto distribution has a probability density function that can be written

$$f(y) = k\alpha^k / [y^{k+1} (1 - (\alpha/U)^k)]$$

for $0 < \alpha < y < U < \infty$ and $k > 0$. Possibly, better names for $k$ are the index and tail parameters. Here, $\alpha$ and $U$ are known. The mean of $Y$ is $k\alpha^k (U^{-k} - \alpha^{-1-k})/[(1 - k) (1 - (\alpha/U)^k)]$.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

The usual or unbounded Pareto distribution has two parameters (called $\alpha$ and $k$ here) but the family function paretoff estimates only $k$ using iteratively reweighted least squares. The MLE of the $\alpha$ parameter lies on the boundary and is $\min(y)$ where $y$ is the response. Consequently, using the default argument values, the standard errors are incorrect when one does a summary on the fitted object. If the user inputs a value for alpha then it is assumed known with this value and then summary on the fitted object should be correct. Numerical problems may occur for small $k$, e.g., $k < 1$.

Note

Outside of economics, the Pareto distribution is known as the Bradford distribution.

For paretoff, if the estimate of $k$ is less than or equal to unity then the fitted values will be NAs. Also, paretoff fits the Pareto(I) distribution. See paretoIV for the more general Pareto(IV/III/II) distributions, but there is a slight change in notation: $s = k$ and $b = \alpha$.

In some applications the Pareto law is truncated by a natural upper bound on the probability tail. The upper truncated Pareto distribution has three parameters (called $\alpha$, $U$ and $k$ here) but the family function truncpareto() estimates only $k$. With known lower and upper limits, the ML estimator of $k$ has the usual properties of MLEs. Aban (2006) discusses other inferential details.

Author(s)

T. W. Yee
References


See Also

Pareto, Truncpareto, paretoIV, gpd, benini1.

Examples

```r
alpha <- 2; kay <- exp(3)
pdata <- data.frame(y = rpareto(n = 1000, scale = alpha, shape = kay))
fit <- vglm(y ~ 1, paretoff, data = pdata, trace = TRUE)
fit@extra  # The estimate of alpha is here
head(fitted(fit))
with(pdata, mean(y))
coef(fit, matrix = TRUE)
summary(fit)  # Standard errors are incorrect!!

# Here, alpha is assumed known
fit2 <- vglm(y ~ 1, paretoff(scale = alpha), data = pdata, trace = TRUE)
fit2@extra  # alpha stored here
head(fitted(fit2))
coef(fit2, matrix = TRUE)
summary(fit2)  # Standard errors are okay

# Upper truncated Pareto distribution
lower <- 2; upper <- 8; kay <- exp(2)
pdata3 <- data.frame(y = rtruncpareto(n = 100, lower = lower,
                        upper = upper, shape = kay))
fit3 <- vglm(y ~ 1, truncpareto(lower, upper), data = pdata3, trace = TRUE)
coef(fit3, matrix = TRUE)
c(fit3@misc$lower, fit3@misc$upper)
```

ParetoIV

The Pareto(IV/III/II) Distributions

Description

Density, distribution function, quantile function and random generation for the Pareto(IV/III/II) distributions.
Usage

dparetoIV(x, location = 0, scale = 1, inequality = 1, shape = 1, 
    log = FALSE)
pparetoIV(q, location = 0, scale = 1, inequality = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
qparetoIV(p, location = 0, scale = 1, inequality = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
rparetoIV(n, location = 0, scale = 1, inequality = 1, shape = 1)
dparetoIII(x, location = 0, scale = 1, inequality = 1, log = FALSE) 
pparetoIII(q, location = 0, scale = 1, inequality = 1, 
    lower.tail = TRUE, log.p = FALSE)
qparetoIII(p, location = 0, scale = 1, inequality = 1, 
    lower.tail = TRUE, log.p = FALSE)
rparetoIII(n, location = 0, scale = 1, inequality = 1) 
dparetoII(x, location = 0, scale = 1, shape = 1, log = FALSE) 
pparetoII(q, location = 0, scale = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
qparetoII(p, location = 0, scale = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
rparetoII(n, location = 0, scale = 1, shape = 1) 
dparetoI(x, scale = 1, shape = 1, log = FALSE) 
pparetoI(q, scale = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
qparetoI(p, scale = 1, shape = 1, 
    lower.tail = TRUE, log.p = FALSE)
rparetoI(n, scale = 1, shape = 1)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. Same as in runif.
location the location parameter.
scale, shape, inequality the (positive) scale, inequality and shape parameters.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.

Details

For the formulas and other details see paretoIV.

Value

Functions beginning with the letters d give the density, p give the distribution function, q give the quantile function, and r generates random deviates.
Note
The functions \([dpqr]paretoI\) are the same as \([dpqr]pareto\) except for a slight change in notation: \(s = k\) and \(b = \alpha\); see \texttt{Pareto}.

Author(s)
T. W. Yee and Kai Huang

References

See Also
\texttt{paretoIV, Pareto}.

Examples
```r
## Not run:
x <- seq(-0.2, 4, by = 0.01)
loc <- 0; Scale <- 1; ineq <- 1; shape <- 1.0
plot(x, dparetoIV(x, loc, Scale, ineq, shape), type = "l",
     main = "Blue is density, orange is the CDF", col = "blue",
     sub = "Purple are 5,10,...,95 percentiles", ylim = 0:1,
     las = 1, ylab = "")
abline(h = 0, col = "blue", lty = 2)
Q <- qparetoIV(seq(0.05, 0.95,by = 0.05), loc, Scale, ineq, shape)
lines(Q, dparetoIV(Q, loc, Scale, ineq, shape), col = "purple",
     lty = 3, type = "h")
lines(x, pparetoIV(x, loc, Scale, ineq, shape), col = "orange")
abline(h = 0, lty = 2)
```

## End(Not run)

### Description
Estimates three of the parameters of the Pareto(IV) distribution by maximum likelihood estimation. Some special cases of this distribution are also handled.
Usage

paretoIV(location = 0, lscale = "loglink", linequality = "loglink", lshape = "loglink", iscale = 1, iinequality = 1, ishape = NULL, imethod = 1)
paretoIII(location = 0, lscale = "loglink", linequality = "loglink", iscale = NULL, iinequality = NULL)
paretoII(location = 0, lscale = "loglink", lshape = "loglink", iscale = NULL, ishape = NULL)

Arguments

location Location parameter, called \(a\) below. It is assumed known.
lscale, linequality, lshape Parameter link functions for the scale parameter (called \(b\) below), inequality parameter (called \(g\) below), and shape parameter (called \(s\) below). See Links for more choices. A log link is the default for all because all these parameters are positive.
iscale, iinequality, ishape Initial values for the parameters. A NULL value means that it is obtained internally. If convergence failure occurs, use these arguments to input some alternative initial values.
imethod Method of initialization for the shape parameter. Currently only values 1 and 2 are available. Try the other value if convergence failure occurs.

Details

The Pareto(IV) distribution, which is used in actuarial science, economics, finance and telecommunications, has a cumulative distribution function that can be written

\[ F(y) = 1 - \left[ 1 + \left( \frac{(y - a)}{b} \right)^{1/g} \right]^{-s} \]

for \(y > a, b > 0, g > 0\) and \(s > 0\). The \(a\) is called the location parameter, \(b\) the scale parameter, \(g\) the inequality parameter, and \(s\) the shape parameter.

The location parameter is assumed known otherwise the Pareto(IV) distribution will not be a regular family. This assumption is not too restrictive in modelling because in typical applications this parameter is known, e.g., in insurance and reinsurance it is pre-defined by a contract and can be represented as a deductible or a retention level.

The inequality parameter is so-called because of its interpretation in the economics context. If we choose a unit shape parameter value and a zero location parameter value then the inequality parameter is the Gini index of inequality, provided \(g \leq 1\).

The fitted values are currently the median, e.g., \texttt{qparetoIV} is used for \texttt{paretoIV()}. There are a number of special cases of the Pareto(IV) distribution. These include the Pareto(I), Pareto(II), Pareto(III), and Burr family of distributions. Denoting \(PIV(a, b, g, s)\) as the Pareto(IV) distribution, the Burr distribution \(Burr(b, g, s)\) is \(PIV(a = 0, b, 1/g, s)\), the Pareto(III) distribution \(PIII(a, b, g)\) is \(PIV(a, b, g, s = 1)\), the Pareto(II) distribution \(PII(a, b, s)\) is \(PIV(a, b, g = 1, s)\), and the Pareto(I) distribution \(PI(b, s)\) is \(PIV(b, b, g = 1, s)\). Thus the Burr distribution can be fitted using the negloglink link function and using the default location=0 argument. The
Pareto(I) distribution can be fitted using `paretoff` but there is a slight change in notation: $s = k$ and $b = \alpha$.

**Value**

An object of class "`vglmff`" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

**Warning**

The Pareto(IV) distribution is very general, for example, special cases include the Pareto(I), Pareto(II), Pareto(III), and Burr family of distributions. [Johnson et al. (1994) says on p.19 that fitting Type IV by ML is very difficult and rarely attempted]. Consequently, reasonably good initial values are recommended, and convergence to a local solution may occur. For this reason setting `trace=TRUE` is a good idea for monitoring the convergence. Large samples are ideally required to get reasonable results.

**Note**

The extra slot of the fitted object has a component called "location" which stores the location parameter value(s).

**Author(s)**

T. W. Yee

**References**


**See Also**

`ParetoIV`, `paretoff`, `gpd`.

**Examples**

```r
pdata <- data.frame(y = rparetoIV(2000, scale = exp(1),
                      ineq = exp(-0.3), shape = exp(1)))
## Not run: par(mfrow = c(2, 1))
with(pdata, hist(y)); with(pdata, hist(log(y)))
## End(Not run)
fit <- vglm(y ~ 1, paretoIV, data = pdata, trace = TRUE)
head(fitted(fit))
summary(pdata)
coef(fit, matrix = TRUE)
```
Perks

The Perks Distribution

Description
Density, cumulative distribution function, quantile function and random generation for the Perks distribution.

Usage
\[
\begin{align*}
\text{dperks}(x, \text{scale} = 1, \text{shape}, \log = \text{FALSE}) \\
\text{pperks}(q, \text{scale} = 1, \text{shape}, \text{lower.tail} = \text{TRUE}, \log.p = \text{FALSE}) \\
\text{qperks}(p, \text{scale} = 1, \text{shape}, \text{lower.tail} = \text{TRUE}, \log.p = \text{FALSE}) \\
\text{rperks}(n, \text{scale} = 1, \text{shape})
\end{align*}
\]

Arguments
\[
\begin{align*}
x, q & \quad \text{vector of quantiles.} \\
p & \quad \text{vector of probabilities.} \\
n & \quad \text{number of observations. Same as in } \text{runif}. \\
\log & \quad \text{Logical. If } \log = \text{TRUE} \text{ then the logarithm of the density is returned.} \\
\text{lower.tail}, \log.p & \quad \text{Same meaning as in } \text{pnorm} \text{ or } \text{qnorm}. \\
\text{shape}, \text{scale} & \quad \text{positive shape and scale parameters.}
\end{align*}
\]

Details
See \textit{perks} for details.

Value
\[
\begin{align*}
d\text{perks} & \quad \text{gives the density, } p\text{perks} \text{ gives the cumulative distribution function, } q\text{perks} \text{ gives the quantile function, and } r\text{perks} \text{ generates random deviates.}
\end{align*}
\]

Author(s)
T. W. Yee and Kai Huang

See Also
\textit{perks}.
Examples

```r
probs <- seq(0.01, 0.99, by = 0.01)
Shape <- exp(-1.0); Scale <- exp(1);
max(abs(pperks(qperks(p = probs, Shape, Scale),
    Shape, Scale) - probs))  # Should be 0
```

```r
## Not run: x <- seq(-0.1, 0.7, by = 0.01);
plot(x, dperks(x, Shape, Scale), type = "l", col = "blue", las = 1,
    main = "Blue is density, orange is cumulative distribution function",
    sub = "Purple lines are the 10,20,...,90 percentiles",
    ylab = "", ylim = 0:1)
abline(h = 0, col = "blue", lty = 2)
lines(x, pperks(x, Shape, Scale), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qperks(probs, Shape, Scale)
lines(Q, dperks(Q, Shape, Scale), col = "purple", lty = 3, type = "h")
pperks(Q, Shape, Scale) - probs  # Should be all zero
abline(h = probs, col = "purple", lty = 3)
## End(Not run)
```

---

**perks**  
*Perks Distribution Family Function*

Description

Maximum likelihood estimation of the 2-parameter Perks distribution.

Usage

```r
perks(lscale = "loglink", lshape = "loglink",
    iscale = NULL, ishape = NULL,
    gscale = exp(-5:5), gshape = exp(-5:5),
    nsimEIM = 500, oim.mean = FALSE, zero = NULL,
    nowarning = FALSE)
```

Arguments

- **nowarning**  
  Logical. Suppress a warning? Ignored for VGAM 0.9-7 and higher.

- **lscale, lshape**  
  Parameter link functions applied to the shape parameter `shape`, scale parameter `scale`. All parameters are treated as positive here See Links for more choices.

- **iscale, ishape**  
  Optional initial values. A NULL means a value is computed internally.

- **gscale, gshape**  
  See CommonVGAMffArguments.

- **nsimEIM, zero**  
  See CommonVGAMffArguments.

- **oim.mean**  
  To be currently ignored.
Details

The Perks distribution has cumulative distribution function

\[ F(y; \alpha, \beta) = 1 - \left\{ \frac{1 + \alpha}{1 + e^{\beta y}} \right\}^{1/\beta} \]

which leads to a probability density function

\[ f(y; \alpha, \beta) = \left[ 1 + \alpha \right]^{1/\beta} \frac{\alpha e^{\beta y}}{(1 + \alpha e^{\beta y})^{1+1/\beta}} \]

for \( \alpha > 0, \beta > 0, y > 0 \). Here, \( \beta \) is called the scale parameter scale, and \( \alpha \) is called a shape parameter. The moments for this distribution do not appear to be available in closed form.

Simulated Fisher scoring is used and multiple responses are handled.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

A lot of care is needed because this is a rather difficult distribution for parameter estimation. If the self-starting initial values fail then try experimenting with the initial value arguments, especially iscale. Successful convergence depends on having very good initial values. Also, monitor convergence by setting trace = TRUE.

Author(s)

T. W. Yee

References


See Also

dperks, simulate.vlm

Examples

```r
# Not run:  set.seed(123)
pdata <- data.frame(x2 = runif(nn <- 1000))  # x2 unused
pdata <- transform(pdata, eta1 = -1,
                   ceta1 = 1)
pdata <- transform(pdata, shape1 = exp(eta1),
                   scale1 = exp(ceta1))
pdata <- transform(pdata, y1 = rperks(nn, sh = shape1, sc = scale1))
```
```r
# Code snippet
fit1 <- vglm(y1 ~ 1, perks, data = pdata, trace = TRUE)
coef(fit1, matrix = TRUE)
summary(fit1)
```

---

### perspqrqrglm

**Perspective plot for QRR-VGLMs**

**Description**

Produces a perspective plot for a CQO model (QRR-VGLM). It is only applicable for rank-1 or rank-2 models with argument `noRRR = ~1`.

**Usage**

```r
perspqrqrglm(x, varI.latvar = FALSE, refResponse = NULL, show.plot = TRUE, 
  xlim = NULL, ylim = NULL, zlim = NULL, 
  gridlength = if (Rank == 1) 301 else c(51,51), 
  which.species = NULL, 
  xlab = if (Rank == 1) "Latent Variable" else "Latent Variable 1", 
  ylab = if (Rank == 1) "Expected Value" else "Latent Variable 2", 
  zlab = "Expected value", labelSpecies = FALSE, 
  stretch = 1.05, main = "", ticktype = "detailed", 
  col = if (Rank == 1) par()$col else "white", 
  lty = par()$lty, lwd = par()$lwd, 
  add1 = FALSE, ...)```

**Arguments**

- **x**: Object of class "qrrvglm", i.e., a constrained quadratic ordination (CQO) object.
- **varI.latvar**: Logical that is fed into `Coef.qrrvglm`.
- **refResponse**: Integer or character that is fed into `Coef.qrrvglm`.
- **show.plot**: Logical. Plot it?
- **xlim, ylim**: Limits of the x- and y-axis. Both are numeric of length 2. See `par`.
- **zlim**: Limits of the z-axis. Numeric of length 2. Ignored if rank is 1. See `par`.
- **gridlength**: Numeric. The fitted values are evaluated on a grid, and this argument regulates the fineness of the grid. If `Rank = 2` then the argument is recycled to length 2, and the two numbers are the number of grid points on the x- and y-axes respectively.
- **which.species**: Numeric or character vector. Indicates which species are to be plotted. The default is to plot all of them. If numeric, it should contain values in the set \{1,2,...,S\} where \(S\) is the number of species.
- **xlab, ylab**: Character caption for the x-axis and y-axis. By default, a suitable caption is found. See the `xlab` argument in `plot` or `title`.
Character caption for the z-axis. Used only if Rank = 2. By default, a suitable caption is found. See the xlab argument in plot or title.

Logical. Whether the species should be labelled with their names. Used for Rank = 1 only. The position of the label is just above the species’ maximum.

Numeric. A value slightly more than 1, this argument adjusts the height of the y-axis. Used for Rank = 1 only.

Character, giving the title of the plot. See the main argument in plot or title.

Tick type. Used only if Rank = 2. See persp for more information.

Color. See persp for more information.

Line type. Rank-1 models only. See the lty argument of par.

Line width. Rank-1 models only. See the lwd argument of par.

Logical. Add to an existing plot? Used only for rank-1 models.

Arguments passed into persp. Useful arguments here include theta and phi, which control the position of the eye.

For a rank-1 model, a perspective plot is similar to lvplot.qrrvglm but plots the curves along a fine grid and there is no rugplot to show the site scores.

For a rank-2 model, a perspective plot has the first latent variable as the x-axis, the second latent variable as the y-axis, and the expected value (fitted value) as the z-axis. The result of a CQO is that each species has a response surface with elliptical contours. This function will, at each grid point, work out the maximum fitted value over all the species. The resulting response surface is plotted. Thus rare species will be obscured and abundant species will dominate the plot. To view rare species, use the which.species argument to select a subset of the species.

A perspective plot will be performed if noRRR = ~ 1, and Rank = 1 or 2. Also, all the tolerance matrices of those species to be plotted must be positive-definite.

For a rank-1 model, the components latvar2grid and max.fitted are NULL.

Yee (2004) does not refer to perspective plots. Instead, contour plots via lvplot.qrrvglm are used.

For rank-1 models, a similar function to this one is lvplot.qrrvglm. It plots the fitted values at the actual site score values rather than on a fine grid here. The result has the advantage that the user sees the curves as a direct result from a model fitted to data whereas here, it is easy to think that the smooth bell-shaped curves are the truth because the data is more of a distance away.
Author(s)
Thomas W. Yee

References

See Also
persp, cpo, Coef.qrrvglm, lvplot.qrrvglm, par, title.

Examples
## Not run:
hs(pside[, 1:6] <- scale(hspider[, 1:6]) # Good idea when I.tolerances = TRUE
set.seed(111)
r1 <- cpo(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
            Auloalbi, Pardmont, Pardnigr, Pardpull, Trocterr) ~
            WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
            poissonff, data = hspider, trace = FALSE, I.tolerances = TRUE)
set.seed(111) # r2 below is an ill-conditioned model
r2 <- cpo(cbind(Alopacce, Alopcune, Alopfabr, Arctlute, Arctperi,
            Auloalbi, Pardmont, Pardnigr, Pardpull, Trocterr) ~
            WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
            isd.lv = c(2.4, 1.0), Muxfactor = 3.0, trace = FALSE,
            poissonff, data = hspider, Rank = 2, eq.tolerances = TRUE)

sort(deviance(r1, history = TRUE)) # A history of all the fits
sort(deviance(r2, history = TRUE)) # A history of all the fits
if (deviance(r2) > 857) stop("suboptimal fit obtained")
persp(r1, xlim = c(-6, 5), col = 1:4, label = TRUE)

# Involves all species
persp(r2, xlim = c(-6, 5), ylim = c(-4, 5), theta = 10, phi = 20, zlim = c(0, 220))
# Omit the two dominant species to see what is behind them
persp(r2, xlim = c(-6, 5), ylim = c(-4, 5), theta = 10, phi = 20, zlim = c(0, 220),
      which = (1:10)[-c(8, 10)]) # Use zlim to retain the original z-scale

## End(Not run)
pgamma.deriv

Usage

pgamma.deriv(q, shape, tmax = 100)

Arguments

- q, shape: As in `pgamma` but these must be vectors of positive values only and finite.
- tmax: Maximum number of iterations allowed in the computation (per q value).

Details

Write \( x = q \) and \( \text{shape} = a \). The first and second derivatives with respect to \( q \) and \( a \) are returned. This function is similar in spirit to `pgamma`; define

\[
P(a, x) = \frac{1}{\Gamma(a)} \int_0^x t^{a-1} e^{-t} dt
\]

so that \( P(a, x) \) is `pgamma(x, a)`. Currently a 6-column matrix is returned (in the future this may change and an argument may be supplied so that only what is required by the user is computed.)

The computations use a series expansion for \( a \leq x \leq 1 \) or \( x < a \), else otherwise a continued fraction expansion. Machine overflow can occur for large values of \( x \) when \( x \) is much greater than \( a \).

Value

The first 5 columns, running from left to right, are the derivatives with respect to: \( x, x^2, a, a^2, xa \). The 6th column is \( P(a, x) \) (but it is not as accurate as calling `pgamma` directly).

Note

If convergence does not occur then try increasing the value of `tmax`.

Yet to do: add more arguments to give greater flexibility in the accuracy desired and to compute only quantities that are required by the user.

Author(s)

T. W. Yee wrote the wrapper function to the Fortran subroutine written by R. J. Moore. The subroutine was modified to run using double precision. The original code came from http://lib.stat.cmu.edu/apstat/187. but this website has since become stale.

References


See Also

`pgamma.deriv.unscaled, pgamma`
Examples

```r
x <- seq(2, 10, length = 501)
head(ans <- pgamma.deriv(x, 2))
## Not run: par(mfrow = c(2, 3))
for (jay in 1:6)
  plot(x, ans[, jay], type = "l", col = "blue", cex.lab = 1.5,
       cex.axis = 1.5, las = 1, log = "x",
       main = colnames(ans)[jay], xlab = "q", ylab = "")
## End(Not run)
```

---

**pgamma.deriv.unscaled**  
*Derivatives of the Incomplete Gamma Integral (Unscaled Version)*

**Description**

The first two derivatives of the incomplete gamma integral with scaling.

**Usage**

```r
pgamma.deriv.unscaled(q, shape)
```

**Arguments**

- `q, shape`  
  As in `pgamma` and `pgamma.deriv` but these must be vectors of positive values only and finite.

**Details**

Define

\[ G(x, a) = \int_0^x t^{a-1} e^{-t} dt \]

so that \( G(x, a) \) is \( \text{pgamma}(x, a) * \text{gamma}(a) \). Write \( x = q \) and \( \text{shape} = a \). The 0th and first and second derivatives with respect to \( a \) of \( G \) are returned. This function is similar in spirit to `pgamma.deriv` but here there is no gamma function to scale things. Currently a 3-column matrix is returned (in the future this may change and an argument may be supplied so that only what is required by the user is computed.) This function is based on Wingo (1989).

**Value**

The 3 columns, running from left to right, are the 0:2th derivatives with respect to \( a \).

**Warning**

These function seems inaccurate for \( q = 1 \) and \( q = 2 \); see the plot below.

**Author(s)**

T. W. Yee.
plotdeplot.lmscreg

References

See truncweibull.

See Also

pgamma.deriv, pgamma.

Examples

```r
x <- 3; aa <- seq(0.3, 0.4, by = 0.01)
ans.u <- pgamma.deriv.unscaled(x, aa)
head(ans.u)

## Not run: par(mfrow = c(1, 3))
for (jay in 1:3) {
  plot(aa, ans.u[, jay], type = "l", col = "blue", cex.lab = 1.5,
       cex.axis = 1.5, las = 1, main = colnames(ans.u)[jay],
       log = "", xlab = "shape", ylab = "")
  abline(h = 0, v = 1:2, lty = "dashed", col = "gray")  # Inaccurate at 1 and 2
}

## End(Not run)
```

plotdeplot.lmscreg  

Density Plot for LMS Quantile Regression

Description

Plots a probability density function associated with a LMS quantile regression.

Usage

```r
plotdeplot.lmscreg(answer, y.arg, add.arg = FALSE,
                    xlab = "", ylab = "density", xlim = NULL, ylim = NULL,
                    lty.arg = par()$lty, col.arg = par()$col,
                    lwd.arg = par()$lwd, ...)
```

Arguments

- `answer` Output from functions of the form `deplot.??` where `??` is the name of the VGAM LMS family function, e.g., `lms.yjn`. See below for details.
- `y.arg` Numerical vector. The values of the response variable at which to evaluate the density. This should be a grid that is fine enough to ensure the plotted curves are smooth.
- `add.arg` Logical. Add the density to an existing plot?
- `xlab, ylab` Caption for the x- and y-axes. See `par`.
- `xlim, ylim` Limits of the x- and y-axes. See `par`.
llty.arg  Line type. See the lty argument of \texttt{par}.
col.arg  Line color. See the col argument of \texttt{par}.
llwd.arg  Line width. See the lwd argument of \texttt{par}.
...
Arguments passed into the \texttt{plot} function when setting up the entire plot. Useful arguments here include \texttt{main} and \texttt{las}.

Details
The above graphical parameters offer some flexibility when plotting the quantiles.

Value
The list \texttt{answer}, which has components
\begin{itemize}
  \item \texttt{newdata}  The argument \texttt{newdata} above from the argument list of \texttt{deplot.lmscreg}, or a one-row data frame constructed out of the \texttt{x0} argument.
  \item \texttt{y}  The argument \texttt{y.arg} above.
  \item \texttt{density}  Vector of the density function values evaluated at \texttt{y.arg}.
\end{itemize}

Note
While the graphical arguments of this function are useful to the user, this function should not be called directly.

Author(s)
Thomas W. Yee

References

See Also
\texttt{deplot.lmscreg}.

Examples
\begin{verbatim}
  fit <- vgam(BMI ~ s(age, df = c(4,2)), lms.bcn(zero = 1), bmi.nz)
  ## Not run: y = seq(15, 43, by = 0.25)
  deplot(fit, x0 = 20, y = y, xlab = "BMI", col = "green", llwd = 2,
         main = "BMI distribution at ages 20 (green), 40 (blue), 60 (orange)"
  deplot(fit, x0 = 40, y = y, add = TRUE, col = "blue", llwd = 2)
  deplot(fit, x0 = 60, y = y, add = TRUE, col = "orange", llwd = 2) -> aa

  names(aa$post$deplot)
  aa$post$deplot$newdata
  head(aa$post$deplot$y)
  head(aa$post$deplot$density)
  ## End(Not run)
\end{verbatim}
plotdgaitd.vglm  Plotting the GAITD Combo Density from a GAITD Regression Object

Description
Given a GAITD regression object, plots the probability mass function.

Usage
plotdgaitd(object, ...)
plotdgaitd.vglm(object, ...)

Arguments
object A fitted GAITD combo regression, e.g., gaitdpoisson.
... Graphical arguments passed into dgaitdplot.

Details
This is meant to be a more convenient function for plotting the PMF of the GAITD combo model from a fitted regression model. The fit should be intercept-only and the distribution should have 1 or 2 parameters. Currently it should work for a gaitdpoisson fit. As much information as needed such as the special values is extracted from the object and fed into dgaitdplot.

Value
Same as dgaitdplot.

Note
This function is subject to change.

Author(s)
T. W. Yee.

See Also
dgaitdplot, spikeplot, gaitdpoisson.

Examples
## Not run:
example(gaitdpoisson)
gaitpfit2 <-
  vglm(y1 ~ 1, crit = "coef", trace = TRUE, data = gdata,
  gaitdpoisson(a.mix = a.mix, i.mix = i.mix,
  i.mlm = i.mlm, eq.ap = TRUE, eq.ip = TRUE,
plotqrrvglm

Model Diagnostic Plots for QRR-VGLMs

Description

The residuals of a QRR-VGLM are plotted for model diagnostic purposes.

Usage

plotqrrvglm(object, rtype = c("response", "pearson", "deviance", "working"),
ask = FALSE,
main = paste(Rtype, "residuals vs latent variable(s)"),
xlab = "Latent Variable",
I.tolerances = object@control$eq.tolerances, ...)

Arguments

object
character string giving residual type. By default, the first one is chosen.
ask
Logical. If TRUE, the user is asked to hit the return key for the next plot.
main
Character string giving the title of the plot.
xlab
Character string giving the x-axis caption.
I.tolerances
Logical. This argument is fed into Coef(object, I.tolerances = I.tolerances).
... Other plotting arguments (see par).

Details

Plotting the residuals can be potentially very useful for checking that the model fit is adequate.

Value

The original object.

Note

An ordination plot of a QRR-VGLM can be obtained by lvplot.qrrvglm.

Author(s)

Thomas W. Yee
References


See Also

`lvplot.qrrvglm`, `cqo`.

Examples

```r
## Not run:
# QRR-VGLM on the hunting spiders data
# This is computationally expensive
set.seed(111) # This leads to the global solution
hspider[, 1:6] <- scale(hspider[, 1:6]) # Standardize environ vars
p1 <- cqo(cbind(Alopacce, Alopcone, Alopfabr, Arctlute, Arctperi,
              Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
              Trocterr, Zoraspin) ~
             WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
             poissonff, data = hspider, Crow1positive = FALSE)
par(mfrow = c(3, 4))
plot(p1, rtype = "response", col = "blue", pch = 4, las = 1, main = "")
## End(Not run)
```

---

**plotqtplot.lmscreg**

Quantile Plot for LMS Quantile Regression

Description

Plots the quantiles associated with a LMS quantile regression.

Usage

```r
plotqtplot.lmscreg(fitted.values, object, newdata = NULL,
percentiles = object@misc$percentiles, lp = NULL,
add.arg = FALSE, y = if (length(newdata)) FALSE else TRUE,
spline.fit = FALSE, label = TRUE, size.label = 0.06,
xlab = NULL, ylab = "",
pch = par()$pch, pcex = par()$cex, pcol.arg = par()$col,
xlim = NULL, ylim = NULL,
llty.arg = par()$lty, lcol.arg = par()$col, llwd.arg = par()$lwd,
tcol.arg = par()$col, tadj = 1, ...)
```
Arguments

- **fitted.values**: Matrix of fitted values.
- **object**: A VGAM quantile regression model, i.e., an object produced by modelling functions such as `vglm` and `vgam` with a family function beginning with "lms.", e.g., `lms.yjn`.
- **newdata**: Data frame at which predictions are made. By default, the original data are used.
- **percentiles**: Numerical vector with values between 0 and 100 that specify the percentiles (quantiles). The default is to use the percentiles when fitting the model. For example, the value 50 corresponds to the median.
- **lp**: Length of percentiles.
- **add.arg**: Logical. Add the quantiles to an existing plot?
- **y**: Logical. Add the response as points to the plot?
- **spline.fit**: Logical. Add a spline curve to the plot?
- **label**: Logical. Add the percentiles (as text) to the plot?
- **size.label**: Numeric. How much room to leave at the RHS for the label. It is in percent (of the range of the primary variable).
- **xlab**: Caption for the x-axis. See `par`.
- **ylab**: Caption for the x-axis. See `par`.
- **pch**: Plotting character. See `par`.
- **pcex**: Character expansion of the points. See `par`.
- **pcol.arg**: Color of the points. See the `col` argument of `par`.
- **xlim**: Limits of the x-axis. See `par`.
- **ylim**: Limits of the y-axis. See `par`.
- **l1ty.arg**: Line type. Line type. See the `lty` argument of `par`.
- **l1col.arg**: Color of the lines. See the `col` argument of `par`.
- **llwd.arg**: Line width. See the `lwd` argument of `par`.
- **tcol.arg**: Color of the text (if `label` is TRUE). See the `col` argument of `par`.
- **tadj**: Text justification. See the `adj` argument of `par`.
- **...**: Arguments passed into the `plot` function when setting up the entire plot. Useful arguments here include `main` and `las`.

Details

The above graphical parameters offer some flexibility when plotting the quantiles.

Value

The matrix of fitted values.

Note

While the graphical arguments of this function are useful to the user, this function should not be called directly.
Main Effects Plot for a Row-Column Interaction Model (RCIM)

Description

Produces a main effects plot for Row-Column Interaction Models (RCIMs).

Usage

```
plotrcim0(object, centered = TRUE, which.plots = c(1, 2),
          hline0 = TRUE, hlty = "dashed", hcol = par()$col, hlwd = par()$lwd,
          rfirst = 1, cfirst = 1,
          rtype = "h", ctype = "h",
          rcex.lab = 1, rcex.axis = 1, rtick = FALSE,
          ccex.lab = 1, ccex.axis = 1, ctick = FALSE,
          rmain = "Row effects", rsub = "",
          rxlabel = "", rylab = "Row effects",
          cmain = "Column effects", csub = "",
          cxlabel = "", cylab = "Column effects",
          rcol = par()$col, ccol = par()$col,
          no.warning = FALSE, ...)
```
Arguments

object  An rcim object. This should be of rank-0, i.e., main effects only and no interactions.

which.plots  Numeric, describing which plots are to be plotted. The row effects plot is 1 and the column effects plot is 2. Set the value 0, say, for no plots at all.

centered  Logical. If TRUE then the row and column effects are centered (but not scaled) by scale. If FALSE then the raw effects are used (of which the first are zero by definition).

hline0, hly, hcol, hlwd

hline0 is logical. If TRUE then a horizontal line is plotted at 0 and the other arguments describe this line. Probably having hline0 = TRUE only makes sense when centered = TRUE.

rfirst, cfirst  rfirst is the level of row that is placed first in the row effects plot, etc.

rmain, cmain  Character. rmain is the main label in the row effects plot, etc.

rtype, ctype, rs, csub

See the type and sub arguments of plot.default.

rxlab, rylab, cxlab, cylab

Character. For the row effects plot, rxlab is xlab and rylab is ylab; see par. Ditto for cxlab and cylab for the column effects plot.

rcex.lab, ccex.lab  Numeric. rcex.lab is cex for the row effects plot label, etc.

rcex.axis, ccex.axis  Numeric. rcex.axis is the cex argument for the row effects axis label, etc.

rtick, ctick  Logical. If rtick = TRUE then add ticks to the row effects plot, etc.

rcol, ccol  rcol give a colour for the row effects plot, etc.

no.warning  Logical. If TRUE then no warning is issued if the model is not rank-0.

...  Arguments fed into plot.default, etc.

Details

This function plots the row and column effects of a rank-0 RCIM. As the result is a main effects plot of a regression analysis, its interpretation when centered = FALSE is relative to the baseline (reference level) of a row and column, and should also be considered in light of the link function used. Many arguments that start with "r" refer to the row effects plot, and "c" for the column effects plot.

Value

The original object with the post slot assigned additional information from the plot.

Note

This function should be only used to plot the object of rank-0 RCIM. If the rank is positive then it will issue a warning.

Using an argument ylim will mean the row and column effects are plotted on a common scale; see plot.window.
Author(s)
T. W. Yee, A. F. Hadi.

See Also
moffset, Rcim, rcim.

Examples

```r
alcoff.e <- moffset(alcoff, "6", "Mon", postfix = "+")  # Effective day
fit0 <- rcim(alcoff.e, family = poissonff)
## Not run: par(oma = c(0, 0, 4, 0), mfrow = 1:2)  # For all plots below too
ii <- plot(fit0, rcol = "blue", ccol = "orange",
           lwd = 4, ylim = c(-2, 2),  # A common ylim
cylab = "Effective daily effects", rylab = "Hourly effects",
         rxlab = "Hour", cxlab = "Effective day")
ii@post  # Endowed with additional information
## End(Not run)

# Negative binomial example
## Not run:
fit1 <- rcim(alcoff.e, negbinomial, trace = TRUE)
plot(fit1, ylim = c(-2, 2))
## End(Not run)

# Univariate normal example
fit2 <- rcim(alcoff.e, uninormal, trace = TRUE)
## Not run: plot(fit2, ylim = c(-200, 400))

# Median-polish example
## Not run:
fit3 <- rcim(alcoff.e, alaplace1(tau = 0.5), maxit = 1000, trace = FALSE)
plot(fit3, ylim = c(-200, 250))
## End(Not run)

# Zero-inflated Poisson example on "crashp" (no 0s in alcoff)
## Not run:
cbind(rowSums(crashp))  # Easy to see the data
cbind(colSums(crashp))  # Easy to see the data
fit4 <- rcim(Rcim(crashp, rbaseline = "5", cbaseline = "Sun"),
              zipoissonff, trace = TRUE)
plot(fit4, ylim = c(-3, 3))
## End(Not run)
```
Description

Component functions of a \texttt{vgam-class} object can be plotted with \texttt{plotvgam()}. These are on the scale of the linear/additive predictor.

Usage

\begin{verbatim}
plotvgam(x, newdata = NULL, y = NULL, residuals = NULL,
       rugplot = TRUE, se = FALSE, scale = 0, raw = TRUE,
       offset.arg = 0, deriv.arg = 0, overlay = FALSE,
       type.residuals = c("deviance", "working", "pearson", "response"),
       plot.arg = TRUE, which.term = NULL, which.cf = NULL,
       control = plotvgam.control(...), varxij = 1, ...)
\end{verbatim}

Arguments

- \texttt{x}: A fitted \texttt{VGAM} object, e.g., produced by \texttt{vgam}, \texttt{vglm}, or \texttt{rrvglm}.
- \texttt{newdata}: Data frame. May be used to reconstruct the original data set.
- \texttt{y}: Unused.
- \texttt{residuals}: Logical. If \texttt{TRUE} then residuals are plotted. See \texttt{type.residuals}
- \texttt{rugplot}: Logical. If \texttt{TRUE} then a rug plot is plotted at the foot of each plot. These values are jittered to expose ties.
- \texttt{se}: Logical. If \texttt{TRUE} then approximate $\pm 2$ pointwise standard error bands are included in the plot.
- \texttt{scale}: Numerical. By default, each plot will have its own y-axis scale. However, by specifying a value, each plot's y-axis scale will be at least scale wide.
- \texttt{raw}: Logical. If \texttt{TRUE} then the smooth functions are those obtained directly by the algorithm, and are plotted without having to premultiply with the constraint matrices. If \texttt{FALSE} then the smooth functions have been premultiply by the constraint matrices. The \texttt{raw} argument is directly fed into \texttt{predict.vgam}.
- \texttt{offset.arg}: Numerical vector of length $r$. These are added to the component functions. Useful for separating out the functions when \texttt{overlay} is \texttt{TRUE}. If \texttt{overlay} is \texttt{TRUE} and there is one covariate then using the intercept values as the offsets can be a good idea.
- \texttt{deriv.arg}: Numerical. The order of the derivative. Should be assigned a small integer such as 0, 1, 2. Only applying to \texttt{s()} terms, it plots the derivative.
- \texttt{overlay}: Logical. If \texttt{TRUE} then component functions of the same covariate are overlaid on each other. The functions are centered, so \texttt{offset.arg} can be useful when \texttt{overlay} is \texttt{TRUE}.
- \texttt{type.residuals}: if \texttt{residuals} is \texttt{TRUE} then the first possible value of this vector, is used to specify the type of residual.
- \texttt{plot.arg}: Logical. If \texttt{FALSE} then no plot is produced.
- \texttt{which.term}: Character or integer vector containing all terms to be plotted, e.g., \texttt{which.term} = \texttt{c("s(age)", "s(height")}) or \texttt{which.term} = \texttt{c(2, 5, 9)}. By default, all are plotted.
which.cf
An integer-valued vector specifying which linear/additive predictors are to be plotted. The values must be from the set \{1,2,\ldots,r\}. By default, all are plotted.

control
Other control parameters. See \texttt{plotvgam.control}.

...
Other arguments that can be fed into \texttt{plotvgam.control}. This includes line colors, line widths, line types, etc.

varxij
Positive integer. Used if xij of \texttt{vglm.control} was used, this chooses which inner argument the component is plotted against. This argument is related to \texttt{raw} = TRUE and terms such as NS(dum1, dum2) and constraint matrices that have more than one column. The default would plot the smooth against dum1 but setting \texttt{varxij} = 2 could mean plotting the smooth against dum2. See the \texttt{VGAM} website for further information.

Details
In this help file \(M\) is the number of linear/additive predictors, and \(r\) is the number of columns of the constraint matrix of interest.

Many of \texttt{plotvgam()}’s options can be found in \texttt{plotvgam.control}, e.g., line types, line widths, colors.

Value
The original object, but with the \texttt{preplot} slot of the object assigned information regarding the plot.

Note
While \texttt{plot(fit)} will work if \texttt{class(fit)} is "vgam", it is necessary to use \texttt{plotvgam(fit)} explicitly otherwise.

\texttt{plotvgam()} is quite buggy at the moment.

Author(s)

Thomas W. Yee

See Also
\texttt{vgam, plotvgam.control, predict.vgam, plotvglm, vglm}.

Examples

\begin{verbatim}
coalminers <- transform(coalminers, Age = (age - 42) / 5)
fit <- vgam(cbind(nBnW, nBW, BnW, BW) ~ s(Age),
            binom2.or(zero = NULL), data = coalminers)
## Not run: par(mfrow = c(1,3))
plot(fit, se = TRUE, ylim = c(-3, 2), las = 1)
plot(fit, se = TRUE, which.cf = 1:2, lcol = "blue", scol = "orange",
     ylim = c(-3, 2))
plot(fit, se = TRUE, which.cf = 1:2, lcol = "blue", scol = "orange",
     overlay = TRUE)
## End(Not run)
\end{verbatim}
plotvgam.control

Control Function for plotvgam()

Description

Provides default values for many arguments available for plotvgam().

Usage

.plotvgam.control(which.cf = NULL,
xlim = NULL, ylim = NULL, llty = par()$lty, slty = "dashed",
pcex = par()$cex, pch = par()$pch, pcol = par()$col,
lcol = par()$col, rcol = par()$col, scol = par()$col,
llwd = par()$lwd, slwd = par()$lwd, add.arg = FALSE,
one.at.a.time = FALSE, .include.dots = TRUE, noxmean = FALSE,
shade = FALSE, shcol = "gray80", main = "", ...)  

Arguments

which.cf  Integer vector specifying which component functions are to be plotted (for each
covariate). Must have values from the set \{1,2,...,M\}.
xlim  Range for the x-axis.
ylim  Range for the y-axis.
llty  Line type for the fitted functions (lines). Fed into par(lty).
slty  Line type for the standard error bands. Fed into par(lty).
pcex  Character expansion for the points (residuals). Fed into par(cex).
pch  Character used for the points (residuals). Same as par(pch).
pcol  Color of the points. Fed into par(col).
lcol  Color of the fitted functions (lines). Fed into par(col).
rcol  Color of the rug plot. Fed into par(col).
llwd  Line width of the fitted functions (lines). Fed into par(lwd).
slwd  Line width of the standard error bands. Fed into par(lwd).
add.arg  Logical. If TRUE then the plot will be added to an existing plot, otherwise a new
plot will be made.
one.at.a.time  Logical. If TRUE then the plots are done one at a time, with the user having to
hit the return key between the plots.
.include.dots  Not to be used by the user.
oxmean  Logical. If TRUE then the point at the mean of \(x\), which is added when standard
errors are specified and it thinks the function is linear, is not added. One might
use this argument if ylab is specified.
shade, shcol shade is logical; if TRUE then the pointwise SE band is shaded gray by default. The colour can be adjusted by setting shcol. These arguments are ignored unless se = TRUE and overlay = FALSE; If shade = TRUE then scol is ignored.

main Character vector, recycled to the number needed.
...
Other arguments that may be fed into par().

In the above, $M$ is the number of linear/additive predictors.

Details

The most obvious features of `plotvgam` can be controlled by the above arguments.

Value

A list with values matching the arguments.

Author(s)

Thomas W. Yee

References


See Also

`plotvgam`.

Examples

```r
plotvgam.control(lcol = c("red", "blue"), scol = "darkgreen", se = TRUE)
```

```
plotvglm

Plots for VGLMs
```

Description

Currently this function plots the Pearson residuals versus the linear predictors ($M$ plots) and plots the Pearson residuals versus the hat values ($M$ plots).

Usage

```r
plotvglm(x, which = "(All)", ...)
```
Arguments

- **x**: An object of class "vglm" (see `vglm-class`) or inherits from that class.
- **which**: If a subset of the plots is required, specify a subset of the numbers `1:(2*M)`. The default is to plot them all.
- **...**: Arguments fed into the primitive `plot` functions.

Details

This function is under development. Currently it plots the Pearson residuals against the predicted values (on the transformed scale) and the hat values. There are `2M` plots in total, therefore users should call `par` to assign, e.g., the `mfrow` argument. Note: Section 3.7 of Yee (2015) describes the Pearson residuals and hat values for VGLMs.

Value

Returns the object invisibly.

Author(s)

T. W. Yee

See Also

`plotvgam`, `plotvgam.control`, `vglm`.

Examples

```r
## Not run:
data <- data.frame(x2 = runif(nn <- 200))
data <- transform(ndata, y1 = rnbinom(nn, mu = exp(3+x2), size = exp(1)))
fit1 <- vglm(y1 ~ x2, negbinomial, data = ndata, trace = TRUE)
coef(fit1, matrix = TRUE)
par(mfrow = c(2, 2))
plot(fit1)
# Manually produce the four plots
plot(fit1, which = 1, col = "blue", las = 1, main = "main1")
abline(h = 0, lty = "dashed", col = "gray50")
plot(fit1, which = 2, col = "blue", las = 1, main = "main2")
abline(h = 0, lty = "dashed", col = "gray50")
plot(fit1, which = 3, col = "blue", las = 1, main = "main3")
plot(fit1, which = 4, col = "blue", las = 1, main = "main4")
## End(Not run)
```
The `pneumo` data frame has 8 rows and 4 columns. Exposure time is explanatory, and there are 3 ordinal response variables.

```r
# Fit the proportional odds model, p.179, in McCullagh and Nelder (1989)
pneumo <- transform(pneumo, let = log(exposure.time))
vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo)
```
Description

Estimating the density parameter of the distances from a fixed point to the u-th nearest point, in a plane or volume.

Usage

poisson.points(ostatistic, dimension = 2, link = "loglink", idensity = NULL, imethod = 1)

Arguments

- **ostatistic**: Order statistic. A single positive value, usually an integer. For example, the value 5 means the response are the distances of the fifth nearest value to that point (usually over many planes or volumes). Non-integers are allowed because the value 1.5 coincides with maxwell when dimension = 2. Note: if ostatistic = 1 and dimension = 2 then this VGAM family function coincides with rayleigh.
- **dimension**: The value 2 or 3; 2 meaning a plane and 3 meaning a volume.
- **link**: Parameter link function applied to the (positive) density parameter, called λ below. See Links for more choices.
- **idensity**: Optional initial value for the parameter. A NULL value means a value is obtained internally. Use this argument if convergence failure occurs.
- **imethod**: An integer with value 1 or 2 which specifies the initialization method for λ. If failure to converge occurs try another value and/or else specify a value for idensity.

Details

Suppose the number of points in any region of area A of the plane is a Poisson random variable with mean λA (i.e., λ is the density of the points). Given a fixed point P, define D₁, D₂,... to be the distance to the nearest point to P, second nearest to P, etc. This VGAM family function estimates λ since the probability density function for D_u is easily derived, u = 1, 2, .... Here, u corresponds to the argument ostatistic.

Similarly, suppose the number of points in any volume V is a Poisson random variable with mean λV where, once again, λ is the density of the points. This VGAM family function estimates λ by specifying the argument ostatistic and using dimension = 3.

The mean of D_u is returned as the fitted values. Newton-Raphson is the same as Fisher-scoring.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.
Warning

Convergence may be slow if the initial values are far from the solution. This often corresponds to
the situation when the response values are all close to zero, i.e., there is a high density of points.

Formulae such as the means have not been fully checked.

Author(s)

T. W. Yee

See Also

poissonff, maxwell, rayleigh.

Examples

```r
pdata <- data.frame(y = rgamma(10, shape = exp(-1))) # Not proper data!
ostat <- 2
fit <- vglm(y ~ 1, poisson.points(ostat, 2), data = pdata,
            trace = TRUE, crit = "coef")
fit <- vglm(y ~ 1, poisson.points(ostat, 3), data = pdata,
            trace = TRUE, crit = "coef") # Slow convergence?
fit <- vglm(y ~ 1, poisson.points(ostat, 3, idensi = 1), data = pdata,
            trace = TRUE, crit = "coef")
head(fitted(fit))
with(pdata, mean(y))
coef(fit, matrix = TRUE)
Coef(fit)
```

poissonff  Poisson Regression

Description

Family function for a generalized linear model fitted to Poisson responses.

Usage

```r
poissonff(link = "loglink", imu = NULL, imethod = 1,
          parallel = FALSE, zero = NULL, bred = FALSE,
          earg.link = FALSE, type.fitted = c("mean", "quantiles"),
          percentiles = c(25, 50, 75))
```
Arguments

**link**
Link function applied to the mean or means. See [Links](#) for more choices and information.

**parallel**
A logical or formula. Used only if the response is a matrix.

**imu, imethod**
See [CommonVGAMffArguments](#) for more information.

**zero**
Can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \{1,2,...,M\}, where \(M\) is the number of columns of the matrix response. See [CommonVGAMffArguments](#) for more information.

**bred, earg.link**
Details at [CommonVGAMffArguments](#). Setting `bred = TRUE` should work for multiple responses and all VGAM link functions; it has been tested for `loglink`, `identity` but further testing is required.

**type.fitted, percentiles**
Details at [CommonVGAMffArguments](#).

Details

\(M\) defined above is the number of linear/additive predictors. With overdispersed data try `negbinomial`.

Value

An object of class "vglmff" (see [vglmff-class](#)). The object is used by modelling functions such as `vglm`, `vgam`, `rrvglm`, `cqo`, and `cao`.

Warning

With multiple responses, assigning a known dispersion parameter for each response is not handled well yet. Currently, only a single known dispersion parameter is handled well.

Note

This function will handle a matrix response automatically.

Regardless of whether the dispersion parameter is to be estimated or not, its value can be seen from the output from the `summary()` of the object.

Author(s)

Thomas W. Yee

References

### PoissonPoints

**Poisson Points Distribution**

**Description**

Density for the PoissonPoints distribution.

**Usage**

```r
dpois.points(x, lambda, ostatistic, dimension = 2, log = FALSE)
```

**Arguments**

- `x` vector of quantiles.
- `lambda` the mean density of points.
- `ostatistic` positive values, usually integers.
- `dimension` Either 2 and/or 3.
- `log` Logical; if TRUE, the logarithm is returned.
Details

See `poisson.points`, the `VGAM` family function for estimating the parameters, for the formula of the probability density function and other details.

Value
dpois.points gives the density.

See Also

`poisson.points`, `dpois`, `Maxwell`.

Examples

```r
## Not run:  lambda <- 1;  xvec <- seq(0, 2, length = 400)
plot(xvec, dpois.points(xvec, lambda, ostat = 1, dimension = 2),
     type = "l", las = 1, col = "blue",
     sub = "First order statistic",
     main = paste("PDF of PoissonPoints distribution with lambda = ",
                   lambda, " and on the plane", sep = ""))
## End(Not run)
```

Polono

The Poisson Lognormal Distribution

Description

Density, distribution function and random generation for the Poisson lognormal distribution.

Usage

```r
dpolono(x, meanlog = 0, sdlog = 1, bigx = 170, ...)
ppolono(q, meanlog = 0, sdlog = 1,
       isOne = 1 - sqrt( .Machine$double.eps ), ...)
rpolono(n, meanlog = 0, sdlog = 1)
```

Arguments

- `x, q` vector of quantiles.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `meanlog, sdlog` the mean and standard deviation of the normal distribution (on the log scale). They match the arguments in `Lognormal`.

```
bigx Numeric. This argument is for handling large values of \(x\) and/or when `integrate` fails. A first order Taylor series approximation [Equation (7) of Bulmer (1974)] is used at values of \(x\) that are greater or equal to this argument. For `bigx = 10`, he showed that the approximation has a relative error less than 0.001 for values of `meanlog` and `sdlog` “likely to be encountered in practice”. The argument can be assigned `Inf` in which case the approximation is not used.

`isOne` Used to test whether the cumulative probabilities have effectively reached unity.

... Arguments passed into `integrate`.

Details

The Poisson lognormal distribution is similar to the negative binomial in that it can be motivated by a Poisson distribution whose mean parameter comes from a right skewed distribution (gamma for the negative binomial and lognormal for the Poisson lognormal distribution).

Value

dpolono gives the density, ppolono gives the distribution function, and rpolono generates random deviates.

Note

By default, dpolono involves numerical integration that is performed using `integrate`. Consequently, computations are very slow and numerical problems may occur (if so then the use of ... may be needed). Alternatively, for extreme values of \(x\), `meanlog`, `sdlog`, etc., the use of `bigx = Inf` avoids the call to `integrate`, however the answer may be a little inaccurate.

For the maximum likelihood estimation of the 2 parameters a `VGAM` family function called `polono()`, say, has not been written yet.

Author(s)

T. W. Yee. Some anonymous soul kindly wrote `ppolono()` and improved the original `dpolono()`.

References


See Also

`lognormal`, `poissonff`, `negbinomial`.

Examples

```r
meanlog <- 0.5; sdlog <- 0.5; yy <- 0:19
sum(proby <- dpolono(yy, m = meanlog, sd = sdlog))  # Should be 1
max(abs(cumsum(proby) - ppolono(yy, m = meanlog, sd = sdlog)))  # 0?

## Not run: opar = par(no.readonly = TRUE)
par(mfrow = c(2, 2))
```
### Description

Fits a GLM-/GAM-like model to multiple Bernoulli responses where each row in the capture history matrix response has at least one success (capture). Capture history behavioural effects are accommodated.

### Usage

```r
posbernoulli.b(link = "logitlink", drop.b = FALSE ~ 1,
    type.fitted = c("likelihood.cond", "mean.uncond"), I2 = FALSE,
    ipcapture = NULL, iprecapture = NULL,
    p.small = 1e-4, no.warning = FALSE)
```

### Arguments

- `link, drop.b, ipcapture, iprecapture`
  
  See `CommonVGAMffArguments` for information about these arguments. By default the parallelism assumption does not apply to the intercept. With an intercept-only model setting drop.b = TRUE ~ 1 results in the $M_0/M_h$ model.

- `I2`
  
  Logical. This argument is used for terms that are not parallel. If TRUE then the constraint matrix diag(2) (the general default constraint matrix in `VGAM`) is used, else cbind(0:1, 1). The latter means the first element/column corresponds to the behavioural effect. Consequently it and its standard error etc. can be accessed directly without subtracting two quantities.

- `type.fitted`
  
  Details at `posbernoulli.tb`.

- `p.small, no.warning`
  
  See `posbernoulli.t`. 
Details

This model (commonly known as $M_b/M_{bh}$ in the capture–recapture literature) operates on a capture history matrix response of 0s and 1s ($n \times \tau$). See posbernoulli.t for details, e.g., common assumptions with other models. Once an animal is captured for the first time, it is marked/tagged so that its future capture history can be recorded. The effect of the recapture probability is modelled through a second linear/additive predictor. It is well-known that some species of animals are affected by capture, e.g., trap-shy or trap-happy. This VGAM family function does allow the capture history to be modelled via such behavioural effects. So does posbernoulli.tb but posbernoulli.t cannot.

The number of linear/additive predictors is $M = 2$, and the default links are $(\logit p_c, \logit p_r)^T$ where $p_c$ is the probability of capture and $p_r$ is the probability of recapture. The fitted value returned is of the same dimension as the response matrix, and depends on the capture history: prior to being first captured, it is $p_{capture}$. Afterwards, it is $p_{precapture}$.

By default, the constraint matrices for the intercept term and the other covariates are set up so that $p_r$ differs from $p_c$ by a simple binary effect, on a logit scale. However, this difference (the behavioural effect) is more directly estimated by having $I2 = FALSE$. Then it allows an estimate of the trap-happy/trap-shy effect; these are positive/negative values respectively. If $I2 = FALSE$ then the (nonstandard) constraint matrix used is cbind(0:1, 1), meaning the first element can be interpreted as the behavioural effect.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

The dependent variable is not scaled to row proportions. This is the same as posbernoulli.t and posbernoulli.tb but different from posbinomial and binomialff.

Author(s)

Thomas W. Yee.

References

See posbernoulli.t.

See Also

posbernoulli.t and posbernoulli.tb (including estimating $N$), deermice, dposbern, rposbern, posbinomial, aux.posbernoulli.t, prinia.

Examples

# deermice data ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
# Fit a M_b model
M.b <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ 1,
posbernoulli.b, data = deermice, trace = TRUE)
coef(M.b)["(Intercept):1"] # Behavioural effect on logit scale
coefficients(M.b, matrix = TRUE)
constraints(M.b, matrix = TRUE)
summary(M.b, presid = FALSE)

# Fit a M_bh model
M.bh <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + weight,
             posbernoulli.b, data = deermice, trace = TRUE)
coefficients(M.bh, matrix = TRUE)
coef(M.bh)["(Intercept):1"] # Behavioural effect on logit scale
# (2,1) elt is for the behavioural effect:
constraints(M.bh)["(Intercept)"]
summary(M.bh, presid = FALSE) # Significant trap-happy effect
# Approx. 95 percent confidence for the behavioural effect:
SE.M.bh <- coef(summary(M.bh))["(Intercept):1", "Std. Error"]
coef(M.bh)["(Intercept):1"] + c(-1, 1) * 1.96 * SE.M.bh

# Fit a M_h model
M.h <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + weight,
posbernoulli.b(drop.b = TRUE ~ sex + weight),
data = deermice, trace = TRUE)
coefficients(M.h, matrix = TRUE)
constraints(M.h, matrix = TRUE)
summary(M.h, presid = FALSE)

# Fit a M_0 model
M.0 <- vglm(cbind( y1 + y2 + y3 + y4 + y5 + y6,
                  6 - y1 - y2 - y3 - y4 - y5 - y6) ~ 1,
             posbinomial, data = deermice, trace = TRUE)
coefficients(M.0, matrix = TRUE)
summary(M.0, presid = FALSE)

# Simulated data set ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
set.seed(123); nTimePts <- 5; N <- 1000 # N is the popn size
pdata <- rposbern(N, nTimePts=nTimePts, pvars=2, is.popn=TRUE)
nrow(pdata) # < N (because some animals were never captured)
# The truth: xcoeffs are c(-2, 1, 2) and cap.effect = +1
M.bh.2 <- vglm(cbind(y1, y2, y3, y4, y5) ~ x2,
posbernoulli.b, data = pdata, trace = TRUE)
coefficients(M.bh.2)
coef(M.bh.2, matrix = TRUE)
constraints(M.bh.2, matrix = TRUE)
summary(M.bh.2, presid = FALSE)
head(depvar(M.bh.2)) # Capture history response matrix
head(M.bh.2@extra$cap.hist1) # Info on its capture history
head(M.bh.2@extra$cap1) # When it was first captured
head(fitted(M.bh.2)) # Depends on capture history
(trap.effect <- coef(M.bh.2)["(Intercept):1"]) # Should be +1
head(model.matrix(M.bh.2, type = "vlm"), 21)
head(pdata)
summary(pdata)
dim(depvar(M.bh.2))
vcov(M.bh.2)

M.bh.2@extra$N.hat # Population size estimate; should be about N
M.bh.2@extra$SE.N.hat # SE of the estimate of the population size
# An approximate 95 percent confidence interval:
round(M.bh.2@extra$N.hat + c(-1, 1) * 1.96 * M.bh.2@extra$SE.N.hat, 1)

posbernoulli.t  Positive Bernoulli Family Function with Time Effects

Description
Fits a GLM/GAM-like model to multiple Bernoulli responses where each row in the capture history matrix response has at least one success (capture). Sampling occasion effects are accommodated.

Usage
posbernoulli.t(link = "logitlink", parallel.t = FALSE ~ 1,
iprob = NULL, p.small = 1e-4, no.warning = FALSE,
type.fitted = c("probs", "onempall0"))

Arguments
link, iprob, parallel.t
See CommonVGAMffArguments for information. By default, the parallelism assumption does not apply to the intercept. Setting parallel.t = FALSE ~ 1, or equivalently parallel.t = FALSE ~ 0, results in the $M_0$/$M_h$ model.

p.small, no.warning
A small probability value used to give a warning for the Horvitz–Thompson estimator. Any estimated probability value less than p.small will result in a warning. However, setting no.warning = TRUE will suppress this warning if it occurs. This is because the Horvitz-Thompson estimator is the sum of the reciprocal of such probabilities, therefore any probability that is too close to 0 will result in an unstable estimate.

type.fitted See CommonVGAMffArguments for information. The default is to return a matrix of probabilities. If "onempall0" is chosen then the probability that each animal is captured at least once in the course of the study is returned. The abbreviation stands for one minus the probability of all 0s, and the quantity appears in the denominator of the usual formula.

Details
These models (commonly known as $M_t$ or $M_{th}$ (no prefix $h$ means it is an intercept-only model) in the capture–recapture literature) operate on a capture history matrix response of 0s and 1s ($n \times \tau$). Each column is a sampling occasion where animals are potentially captured (e.g., a field trip), and each row is an individual animal. Capture is a 1, else a 0. No removal of animals from the population
is made (closed population), e.g., no immigration or emigration. Each row of the response matrix has at least one capture. Once an animal is captured for the first time, it is marked/tagged so that its future capture history can be recorded. Then it is released immediately back into the population to remix. It is released immediately after each recapture too. It is assumed that the animals are independent and that, for a given animal, each sampling occasion is independent. And animals do not lose their marks/tags, and all marks/tags are correctly recorded.

The number of linear/additive predictors is equal to the number of sampling occasions, i.e., \( M = \tau \), say. The default link functions are \( (\text{logit} \, p_1, \ldots, \text{logit} \, p_{\tau})^T \) where each \( p_j \) denotes the probability of capture at time point \( j \). The fitted value returned is a matrix of probabilities of the same dimension as the response matrix.

A conditional likelihood is maximized here using Fisher scoring. Each sampling occasion has a separate probability that is modelled here. The probabilities can be constrained to be equal by setting \( \text{parallel}.t = \text{FALSE} \sim 0 \); then the results are effectively the same as \text{posbinomial} except the binomial constants are not included in the log-likelihood. If \( \text{parallel}.t = \text{TRUE} \sim 0 \) then each column should have at least one 1 and at least one 0.

It is well-known that some species of animals are affected by capture, e.g., trap-shy or trap-happy. This \text{VGAM} family function does \textit{not} allow any behavioral effect to be modelled (\text{posbernoulli.b} and \text{posbernoulli.tb} do) because the denominator of the likelihood function must be free of behavioral effects.

Value

An object of class "\text{vglmff}" (see \text{vglmff-class}). The object is used by modelling functions such as \text{vglm}, and \text{vgam}.

Upon fitting the extra slot has a (list) component called \( \text{N.hat} \) which is a point estimate of the population size \( N \) (it is the Horvitz-Thompson (1952) estimator). And there is a component called \( \text{SE.N.hat} \) containing its standard error.

Note

The \text{weights} argument of \text{vglm} need not be assigned, and the default is just a matrix of ones.

Fewer numerical problems are likely to occur for \( \text{parallel}.t = \text{TRUE} \). Data-wise, each sampling occasion may need at least one success (capture) and one failure. Less stringent conditions in the data are needed when \( \text{parallel}.t = \text{TRUE} \). Ditto when parallelism is applied to the intercept too.

The response matrix is returned unchanged; i.e., not converted into proportions like \text{posbinomial}. If the response matrix has column names then these are used in the labelling, else \text{prob1}, \text{prob2}, etc. are used.

Using \text{AIC()} or \text{BIC()} to compare \text{posbernoulli.t}, \text{posbernoulli.b}, \text{posbernoulli.tb} models with a \text{posbinomial} model requires \text{posbinomial(omit.constant = TRUE)} because one needs to remove the normalizing constant from the log-likelihood function. See \text{posbinomial} for an example.

Author(s)

Thomas W. Yee.
References


See Also

`posbernoulli.b`, `posbernoulli.tb`, `Select`, `deermice`, `Huggins89table1`, `Huggins89.t1`, `dposbern`, `rposbern`, `posbinomial`, `AICvlm`, `BICvlm`, `prinia`.

Examples

```r
M.t <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ 1, posbernoulli.t, 
data = deermice, trace = TRUE)
coef(M.t, matrix = TRUE)
constraints(M.t, matrix = TRUE)
summary(M.t, presid = FALSE)

M.h.1 <- vglm(Select(deermice, "y") ~ sex + weight, trace = TRUE, 
posbernoulli.t(parallel.t = FALSE ~ -1), deermice)
coef(M.h.1, matrix = TRUE)
constraints(M.h.1)
summary(M.h.1, presid = FALSE)
head(depvar(M.h.1))  # Response capture history matrix
dim(depvar(M.h.1))

M.th.2 <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + weight, 
posbernoulli.t(parallel.t = FALSE), deermice)
# Test the parallelism assumption wrt sex and weight:
lrtest(M.h.1, M.th.2)
coef(M.th.2)
constraints(M.th.2)
summary(M.th.2, presid = FALSE)
head(model.matrix(M.th.2, type = "vlm"), 21)

M.th.2@extra$N.hat  # Population size estimate; should be about N
M.th.2@extra$SE.N.hat  # SE of the estimate of the population size
# An approximate 95 percent confidence interval:
round(M.th.2@extra$N.hat + c(-1, 1)*1.96* M.th.2@extra$SE.N.hat, 1)

# Fit a M.h model, effectively the parallel M.t model:
deermice <- transform(deermice, ysum = y1 + y2 + y3 + y4 + y5 + y6, 
tau = 6)
```
M.h.3 <- vglm(cbind(ysum, tau - ysum) ~ sex + weight, posbinomial(omit.constant = TRUE), data = deermice)
max(abs(coef(M.h.1) - coef(M.h.3))) # Should be zero
# Difference is due to the binomial constants:
logLik(M.h.3) - logLik(M.h.1)

---

**Description**

Fits a GLM/GAM-like model to multiple Bernoulli responses where each row in the capture history matrix response has at least one success (capture). Sampling occasion effects and behavioural effects are accommodated.

**Usage**

```r
posbernoulli.tb(link = "logitlink", parallel.t = FALSE ~ 1,
                 parallel.b = FALSE ~ 0, drop.b = FALSE ~ 1,
                 type.fitted = c("likelihood.cond", "mean.uncond"),
                 imethod = 1, iprob = NULL,
                 p.small = 1e-4, no.warning = FALSE,
                 ridge.constant = 0.0001, ridge.power = -4)
```

**Arguments**

- `link`, `imethod`, `iprob`
  - See CommonVGAMffArguments for information.

- `parallel.t`, `parallel.b`, `drop.b`
  - A logical, or formula with a logical as the response. See CommonVGAMffArguments for information. The `parallel.-type` arguments specify whether the constraint matrices have a parallelism assumption for the temporal and behavioural effects. Argument `parallel.t` means parallel with respect to time, and matches the same argument name in `posbernoulli.t`. Suppose the model is intercept-only. Setting `parallel.t = FALSE ~ 0` results in the $M_0$ model. Setting `drop.b = FALSE ~ 0` results in the $M_t$ model because it drops columns off the constraint matrices corresponding to any behavioural effect. Setting `parallel.t = FALSE ~ 0` and setting `parallel.b = FALSE ~ 0` results in the $M_0$ model. Setting `parallel.t = FALSE ~ 0`, `parallel.b = FALSE ~ 0` and `drop.b = FALSE ~ 0` results in the $M_0$ model. Note the default for `parallel.t` and `parallel.b` may be unsuitable for data sets which have a large $\tau$ because of the large number of parameters; it might be too flexible. If it is desired to have the behaviour affect some of the other covariates then set `drop.b = TRUE ~ 0`.
  - The default model has a different intercept for each sampling occasion, a time-parallelism assumption for all other covariates, and a dummy variable representing a single behavioural effect (also in the intercept).
The most flexible model is to set `parallel.b = TRUE ~ 0`, `parallel.t = TRUE ~ 0` and `drop.b = TRUE ~ 0`. This means that all possible temporal and behavioural effects are estimated, for the intercepts and other covariates. Such a model is not recommended; it will contain a lot of parameters.

**type.fitted**: Character, one of the choices for the type of fitted value returned. The default is the first one. Partial matching is okay. For "likelihood.cond": the probability defined by the conditional likelihood. For "mean.uncond": the unconditional mean, which should agree with `colMeans` applied to the response matrix for intercept-only models.

**ridge.constant, ridge.power**: Determines the ridge parameters at each IRLS iteration. They are the constant and power (exponent) for the ridge adjustment for the working weight matrices (the capture probability block matrix, hence the first $\tau$ diagonal values). At iteration $a$ of the IRLS algorithm a positive value is added to the first $\tau$ diagonal elements of the working weight matrices to make them positive-definite. This adjustment is the mean of the diagonal elements of $wz$ multiplied by $K \times a^p$ where $K$ is `ridge.constant` and $p$ is `ridge.power`. This is always positive but decays to zero as iterations proceed (provided $p$ is negative etc.).

**p.small, no.warning**: See `posbernoulli.t`.

**Details**

This model (commonly known as $M_{tb}/M_{tbh}$ in the capture–recapture literature) operates on a response matrix of 0s and 1s ($n \times \tau$). See `posbernoulli.t` for information that is in common. It allows time and behavioural effects to be modelled.

Evidently, the expected information matrix (EIM) seems not of full rank (especially in early iterations), so `ridge.constant` and `ridge.power` are used to try fix up the problem. The default link functions are $(\logit p_{c1}, \ldots, \logit p_{c\tau}, \logit p_{r2}, \ldots, \logit p_{r\tau})^T$ where the subscript $c$ denotes capture, the subscript $r$ denotes recapture, and it is not possible to recapture the animal at sampling occasion 1. Thus $M = 2\tau - 1$. The parameters are currently prefixed by `pcapture` and `precapture` for the capture and recapture probabilities. This VGAM family function may be further modified in the future.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Note**

It is a good idea to apply the parallelism assumption to each sampling occasion except possibly with respect to the intercepts. Also, a simple behavioural effect such as being modelled using the intercept is recommended; if the behavioural effect is not parallel and/or allowed to apply to other covariates then there will probably be too many parameters, and hence, numerical problems. See $M_{tbh.1}$ below.

It is a good idea to monitor convergence. Simpler models such as the $M_0/M_h$ models are best fitted with `posbernoulli.t` or `posbernoulli.b` or `posbinomial`. 
Author(s)

Thomas W. Yee.

References

See posbernoulli.t.

See Also

posbernoulli.b (including N.hat), posbernoulli.t, posbinomial, Select, fill1, Huggins89table1, Huggins89.t1, deermice, prinia.

Examples

```r
## Not run:
# Example 1: simulated data
nTimePts <- 5  # (aka tau == # of sampling occasions)
nnn <- 1000    # Number of animals
pdata <- rposbern(n = nnn, nTimePts = nTimePts, pvars = 2)
dim(pdata); head(pdata)

M_tbh.1 <- vglm(cbind(y1, y2, y3, y4, y5) ~ x2,
                posbernoulli.tb, data = pdata, trace = TRUE)
coef(M_tbh.1) # First element is the behavioural effect
coef(M_tbh.1, matrix = TRUE)
constraints(M_tbh.1, matrix = TRUE)
summary(M_tbh.1, presid = FALSE) # Std errors are approximate
head(fitted(M_tbh.1))
head(model.matrix(M_tbh.1, type = "vlm"), 21)
dim(depvar(M_tbh.1))

M_tbh.2 <- vglm(cbind(y1, y2, y3, y4, y5) ~ x2,
                posbernoulli.tb(parallel.t = FALSE ~ 0),
                data = pdata, trace = TRUE)
coef(M_tbh.2) # First element is the behavioural effect
coef(M_tbh.2, matrix = TRUE)
constraints(M_tbh.2, matrix = TRUE)
summary(M_tbh.2, presid = FALSE) # Std errors are approximate
head(fitted(M_tbh.2))
head(model.matrix(M_tbh.2, type = "vlm"), 21)
dim(depvar(M_tbh.2))

# Example 2: deermice subset data
fit1 <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + weight,
             posbernoulli.t, data = deermice, trace = TRUE)
coef(fit1)
coef(fit1, matrix = TRUE)
constraints(fit1, matrix = TRUE)
summary(fit1, presid = FALSE) # Standard errors are approximate

# fit1 is the same as Fit1 (a M_{th} model): 
Fit1 <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ sex + weight,
```

Description

Density, and random generation for multiple Bernoulli responses where each row in the response matrix has at least one success.

Usage

```r
rposbern(n, nTimePts = 5, pvars = length(xcoeff),
  xcoeff = c(-2, 1, 2), Xmatrix = NULL, cap.effect = 1,
  is.popn = FALSE, link = "logitlink", earg.link = FALSE)
dposbern(x, prob, prob0 = prob, log = FALSE)
```

Arguments

- `x` response vector or matrix. Should only have 0 and 1 values, at least two columns, and each row should have at least one 1.
- `nTimePts` Number of sampling occasions. Called \( \tau \) in `posbernoulli.b` and `posbernoulli.t`.
- `n` number of observations. Usually a single positive integer, else the length of the vector is used. See argument `is.popn`.
- `is.popn` Logical. If TRUE then argument `n` is the population size and what is returned may have substantially less rows than `n`. That is, if an animal has at least one one in its sequence then it is returned, else that animal is not returned because it never was captured.
- `Xmatrix` Optional \( X \) matrix. If given, the \( X \) matrix is not generated internally.
- `cap.effect` Numeric, the capture effect. Added to the linear predictor if captured previously. A positive or negative value corresponds to a trap-happy and trap-shy effect respectively.
- `pvars` Number of other numeric covariates that make up the linear predictor. Labelled \( x_1, x_2, \ldots \), where the first is an intercept, and the others are independent standard runif random variates. The first `pvars` elements of `xcoeff` are used.
- `xcoeff` The regression coefficients of the linear predictor. These correspond to \( x_1, x_2, \ldots \), and the first is for the intercept. The length of `xcoeff` must be at least `pvars`.
- `link`, `earg.link` The former is used to generate the probabilities for capture at each occasion. Other details at `CommonVGAMffArguments`. 
prob, prob0  Matrix of probabilities for the numerator and denominators respectively. The default does not correspond to the $M_b$ model since the $M_b$ model has a denominator which involves the capture history.

log  Logical. Return the logarithm of the answer?

Details

The form of the conditional likelihood is described in *posbernoulli.b* and/or *posbernoulli.t* and/or *posbernoulli.tb*. The denominator is equally shared among the elements of the matrix $x$.

Value

rposbern returns a data frame with some attributes. The function generates random deviates ($\tau$ columns labelled $y_1, y_2, \ldots$) for the response. Some indicator columns are also included (those starting with ch are for previous capture history). The default setting corresponds to a $M_{bh}$ model that has a single trap-happy effect. Covariates $x_1, x_2, \ldots$ have the same affect on capture/recapture at every sampling occasion (see the argument parallel.t in, e.g., *posbernoulli.tb*).

The function dposbern gives the density.

Note

The r-type function is experimental only and does not follow the usual conventions of r-type R functions. It may change a lot in the future. The d-type function is more conventional and is less likely to change.

Author(s)

Thomas W. Yee.

See Also

*posbernoulli.tb*, *posbernoulli.b*, *posbernoulli.t*.

Examples

```r
rposbern(n = 10)
attributes(pdata <- rposbern(n = 100))
M.bh <- vglm(cbind(y1, y2, y3, y4, y5) ~ x2 + x3,
              posbernoulli.b(I2 = FALSE), pdata, trace = TRUE)
constraints(M.bh)
summary(M.bh)
```
Description

Fits a positive binomial distribution.

Usage

posbinomial(link = "logitlink", multiple.responses = FALSE,
parallel = FALSE, omit.constant = FALSE, p.small = 1e-4,
no.warning = FALSE, zero = NULL)

Arguments

link, multiple.responses, parallel, zero

Details at CommonVGAMffArguments.

omit.constant Logical. If TRUE then the constant (lchoose(size, size * yprop) is omitted from the loglikelihood calculation. If the model is to be compared using AIC() or BIC() (see AICvlm or BICvlm) to the likes of posbernoulli.tb etc. then it is important to set omit.constant = TRUE because all models then will not have any normalizing constants in the likelihood function. Hence they become comparable. This is because the $M_0$ Otis et al. (1978) model coincides with posbinomial(). See below for an example. Also see posbernoulli.t regarding estimating the population size ($N.hat$ and $SE.N.hat$) if the number of trials is the same for all observations.

p.small, no.warning

See posbernoulli.t.

Details

The positive binomial distribution is the ordinary binomial distribution but with the probability of zero being zero. Thus the other probabilities are scaled up (i.e., divided by $1 - P(Y = 0)$). The fitted values are the ordinary binomial distribution fitted values, i.e., the usual mean.

In the capture–recapture literature this model is called the $M_0$ if it is an intercept-only model. Otherwise it is called the $M_h$ when there are covariates. It arises from a sum of a sequence of $\tau$-Bernoulli random variates subject to at least one success (capture). Here, each animal has the same probability of capture or recapture, regardless of the $\tau$ sampling occasions. Independence between animals and between sampling occasions etc. is assumed.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

Under- or over-flow may occur if the data is ill-conditioned.
Note

The input for this family function is the same as `binomialff`.

If `multiple.responses = TRUE` then each column of the matrix response should be a count (the number of successes), and the weights argument should be a matrix of the same dimension as the response containing the number of trials. If `multiple.responses = FALSE` then the response input should be the same as `binomialff`.

Yet to be done: a `quasi.posbinomial()` which estimates a dispersion parameter.

Author(s)

Thomas W. Yee

References


See Also

`posbernoulli.b, posbernoulli.t, posbernoulli.tb, binomialff, AICvlm, BICvlm, simulate.vlm`.

Examples

```r
# Albinotic children in families with 5 kids (from Patil, 1962) ,,,
albinos <- data.frame(y = c(rep(1, 25), rep(2, 23), rep(3, 10), 4, 5),
n = rep(5, 60))
fit1 <- vglm(cbind(y, n-y) ~ 1, posbinomial, albinos, trace = TRUE)
summary(fit1)
Coef(fit1)  # = MLE of p = 0.3088
head(fitted(fit1))
sqrt(vcov(fit1, untransform = TRUE))  # SE = 0.0322

# Fit a M_0 model (Otis et al. 1978) to the deermice data ,,,,,,,
M.0 <- vglm(cbind( y1 + y2 + y3 + y4 + y5 + y6,
6 - y1 - y2 - y3 - y4 - y5 - y6) ~ 1, trace = TRUE,
posbinomial(omit.constant = TRUE), data = deermice)
coef(M.0, matrix = TRUE)
Coef(M.0)
constraints(M.0, matrix = TRUE)
summary(M.0)
c(  N.hat = M.0@extra$N.hat,  # As tau = 6, i.e., 6 Bernoulli trials
SE.N.hat = M.0@extra$SE.N.hat)  # per obsn is the same for each obsn

# Compare it to the M_b using AIC and BIC
M.b <- vglm(cbind(y1, y2, y3, y4, y5, y6) ~ 1, trace = TRUE,
posbernoulli.b, data = deermice)
```
sort(c(M.0 = AIC(M.0), M.b = AIC(M.b))) # Ok since omit.constant=TRUE
sort(c(M.0 = BIC(M.0), M.b = BIC(M.b))) # Ok since omit.constant=TRUE

---

**Posgeom**

*Positive-Geometric Distribution*

**Description**

Density, distribution function, quantile function and random generation for the positive-geometric distribution.

**Usage**

- `dposgeom(x, prob, log = FALSE)`
- `pposgeom(q, prob)`
- `qposgeom(p, prob)`
- `rposgeom(n, prob)`

**Arguments**

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. Fed into `runif`.
- `prob` vector of probabilities of success (of an ordinary geometric distribution). Short vectors are recycled.
- `log` logical.

**Details**

The positive-geometric distribution is a geometric distribution but with the probability of a zero being zero. The other probabilities are scaled to add to unity. The mean therefore is $1/prob$.

As `prob` decreases, the positive-geometric and geometric distributions become more similar. Like similar functions for the geometric distribution, a zero value of `prob` is not permitted here.

**Value**

- `dposgeom` gives the density, `pposgeom` gives the distribution function, `qposgeom` gives the quantile function, and `rposgeom` generates random deviates.

**Author(s)**

T. W. Yee

**See Also**

`zageometric`, `zigeometric`, `rgeom`. 
Examples

```r
prob <- 0.75; y <- rposgeom(n = 1000, prob)
mean(y)  # Sample mean
1 / prob  # Population mean

(ii <- dposgeom(0:7, prob))
cumsum(ii) - pposgeom(0:7, prob)  # Should be 0s
table(rposgeom(100, prob))

table(dposgeom(runif(1000), prob))
round(dposgeom(1:10, prob) * 1000)  # Should be similar

## Not run:
x <- 0:5
barplot(rbind(dposgeom(x, prob), dgeom(x, prob)),
        beside = TRUE, col = c("blue", "orange"),
        main = paste("Positive geometric(" , prob, " ) (blue) vs",
                      " geometric(" , prob, " ) (orange)", sep = ""),
        names.arg = as.character(x), las = 1, lwd = 2)
## End(Not run)
```

---

### posnegbinomial

**Positive Negative Binomial Distribution Family Function**

**Description**

Maximum likelihood estimation of the two parameters of a positive negative binomial distribution.

**Usage**

```r
posnegbinomial(zero = "size",
                type.fitted = c("mean", "munb", "prob0"),
                mds.min = 0.001, nsimEIM = 500, cutoff.prob = 0.999,
                eps.trig = 1e-07, max.support = 4000, max.chunk.MB = 30,
                lmunb = "loglink", isize = "loglink", imethod = 1,
                imunb = NULL, iprobs.y = NULL,
                gprobs.y = ppoints(8), isize = NULL,
                gsize.mux = exp(c(-30, -20, -15, -10, -6:3)))
```

**Arguments**

- `lmunb`: Link function applied to the `munb` parameter, which is the mean $\mu_{nb}$ of an ordinary negative binomial distribution. See `Links` for more choices.
- `lsize`: Parameter link function applied to the dispersion parameter, called $k$. See `Links` for more choices.
posnegbinomial

Optional initial value for \( k \), an index parameter. The value \( 1/k \) is known as a dispersion parameter. If failure to converge occurs try different values (and/or use \( \text{imethod} \)). If necessary this vector is recycled to length equal to the number of responses. A value \( \text{NULL} \) means an initial value for each response is computed internally using a range of values.

\text{nsimEIM, zero, eps.trig}

See \textit{CommonVGAMffArguments}.

\text{mds.min, iprobs.y, cutoff.prob}

Similar to \textit{negbinomial}.

\text{imunb, max.support}

Similar to \textit{negbinomial}.

\text{max.chunk.MB, gsize.mux}

Similar to \textit{negbinomial}.

\text{imethod, gprobs.y}

See \textit{negbinomial}.

\text{type.fitted}

See \textit{CommonVGAMffArguments} for details.

Details

The positive negative binomial distribution is an ordinary negative binomial distribution but with the probability of a zero response being zero. The other probabilities are scaled to sum to unity.

This family function is based on \textit{negbinomial} and most details can be found there. To avoid confusion, the parameter \( \text{munb} \) here corresponds to the mean of an ordinary negative binomial distribution \textit{negbinomial}. The mean of \textit{posnegbinomial} is

\[ \mu_{nb} / (1 - p(0)) \]

where \( p(0) = (k / (k + \mu_{nb}))^k \) is the probability an ordinary negative binomial distribution has a zero value.

The parameters \( \text{munb} \) and \( k \) are not independent in the positive negative binomial distribution, whereas they are in the ordinary negative binomial distribution.

This function handles \textit{multiple} responses, so that a matrix can be used as the response. The number of columns is the number of species, say, and setting \textit{zero} = -2 means that all species have a \( k \) equalling a (different) intercept only.

Value

An object of class "\textit{vglmff}" (see \textit{vglmff-class}). The object is used by modelling functions such as \textit{vglm}, \textit{rrvglm} and \textit{vgam}.

Warning

This family function is fragile; at least two cases will lead to numerical problems. Firstly, the positive-Poisson model corresponds to \( k \) equalling infinity. If the data is positive-Poisson or close to positive-Poisson, then the estimated \( k \) will diverge to \( \text{Inf} \) or some very large value. Secondly, if the data is clustered about the value 1 because the \( \text{munb} \) parameter is close to 0 then numerical problems will also occur. Users should set \textit{trace} = \text{TRUE} to monitor convergence. In the situation
when both cases hold, the result returned (which will be untrustworthy) will depend on the initial values.

The negative binomial distribution (NBD) is a strictly unimodal distribution. Any data set that does not exhibit a mode (in the middle) makes the estimation problem difficult. The positive NBD inherits this feature. Set trace = TRUE to monitor convergence.

See the example below of a data set where posbinomial() fails; the so-called solution is extremely poor. This is partly due to a lack of a unimodal shape because the number of counts decreases only. This long tail makes it very difficult to estimate the mean parameter with any certainty. The result too is that the size parameter is numerically fraught.

This VGAM family function inherits the same warnings as negbinomial. And if k is much less than 1 then the estimation may be slow.

**Note**

If the estimated k is very large then fitting a pospoisson model is a good idea.

If both munb and k are large then it may be necessary to decrease eps.trig and increase max.support so that the EIMs are positive-definite, e.g., eps.trig = 1e-8 and max.support = Inf.

**Author(s)**

Thomas W. Yee

**References**


**See Also**

gaitdnbinomial, pospoisson, negbinomial, zanegbinomial, rnbimom, CommonVGAMffArguments, corbet, logff, simulate.vlm, margeff.

**Examples**

```r
## Not run:
pdata <- data.frame(x2 = runif(nn <- 1000))
pdata <- transform(pdata,
    y1 = rgaitdnbinom(nn, exp(1), munb.p = exp(0+2*x2), truncate = 0),
    y2 = rgaitdnbinom(nn, exp(3), munb.p = exp(1+2*x2), truncate = 0))
fit <- vglm(cbind(y1, y2) ~ x2, posnegbinomial, pdata, trace = TRUE)
coef(fit, matrix = TRUE)
dim(depvar(fit)) # Using dim(fit@y) is not recommended

# Another artificial data example
pdata2 <- data.frame(munb = exp(2), size = exp(3)); nn <- 1000
pdata2 <- transform(pdata2,
```
The Positive-Normal Distribution

Description

Density, distribution function, quantile function and random generation for the univariate positive-normal distribution.

Usage

dposnorm(x, mean = 0, sd = 1, log = FALSE)
pposnorm(q, mean = 0, sd = 1, lower.tail = TRUE, log.p = FALSE)
qposnorm(p, mean = 0, sd = 1, lower.tail = TRUE, log.p = FALSE)
rposnorm(n, mean = 0, sd = 1)

Arguments

\texttt{x, q} \quad \text{vector of quantiles.}

\texttt{p} \quad \text{vector of probabilities.}

\texttt{n} \quad \text{number of observations. If length(n) > 1 then the length is taken to be the number required.}

mean, sd, log, lower.tail, log.p

see rnorm.

Details

See \texttt{posnormal}, the VGAM family function for estimating the parameters, for the formula of the probability density function and other details.

Value

dposnorm gives the density, pposnorm gives the distribution function, qposnorm gives the quantile function, and rposnorm generates random deviates.

Author(s)

T. W. Yee

See Also

posnormal.

Examples

```r
## Not run: m <- 0.8; x <- seq(-1, 4, len = 501)
plot(x, dposnorm(x, m = m), type = "l", las = 1, ylim = 0:1,
ylab = paste("posnorm(m = ", m, ", sd = 1)"), col = "blue",
main = "Blue is density, orange is the CDF",
sub = "Purple lines are the 10, 20, ..., 90 percentiles")
abline(h = 0, col = "grey")
lines(x, pposnorm(x, m = m), col = "orange", type = "l")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qposnorm(probs, m = m)
lines(Q, dposnorm(Q, m = m), col = "purple", lty = 3, type = "h")
lines(Q, pposnorm(Q, m = m), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(pposnorm(Q, m = m) - probs)) # Should be 0
## End(Not run)
```
Description
Fits a positive (univariate) normal distribution.

Usage
```
posnormal(lmean = "identitylink", lsd = "loglink",
  eq.mean = FALSE, eq.sd = FALSE,
  gmean = exp((-5:5)/2), gsd = exp((-1:5)/2),
  imean = NULL, isd = NULL, probs.y = 0.10, imethod = 1,
  nsimEIM = NULL, zero = "sd")
```

Arguments
- `lmean, lsd` Link functions for the mean and standard deviation parameters of the usual univariate normal distribution. They are $\mu$ and $\sigma$ respectively. See Links for more choices.
- `gmean, gsd, imethod` See CommonVGAMffArguments for more information. `gmean` and `gsd` currently operate on a multiplicative scale, on the sample mean and the sample standard deviation, respectively.
- `imean, isd` Optional initial values for $\mu$ and $\sigma$. A NULL means a value is computed internally. See CommonVGAMffArguments for more information.
- `eq.mean, eq.sd` See CommonVGAMffArguments for more information. The fact that these arguments are supported results in default constraint matrices being a permutation of the identity matrix (effectively trivial constraints).
- `zero, nsimEIM, probs.y` See CommonVGAMffArguments for information.

Details
The positive normal distribution is the ordinary normal distribution but with the probability of zero or less being zero. The rest of the probability density function is scaled up. Hence the probability density function can be written

$$f(y) = \frac{1}{\sqrt{2\pi}\sigma} \exp \left( -\frac{1}{2} \frac{(y - \mu)^2}{\sigma^2} \right) \left[ 1 - \Phi(-\mu/\sigma) \right]$$

where $\Phi()$ is the cumulative distribution function of a standard normal (pnorm). Equivalently, this is

$$f(y) = \frac{\phi(\{(y - \mu)/\sigma\})}{\sigma \left[ 1 - \Phi(-\mu/\sigma) \right]}$$

where $\phi()$ is the probability density function of a standard normal distribution (dnorm).
The mean of \( Y \) is

\[
E(Y) = \mu + \sigma \frac{\phi(-\mu/\sigma)}{1 - \Phi(-\mu/\sigma)}.
\]

This family function handles multiple responses.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning

It is recommended that \texttt{trace = TRUE} be used to monitor convergence; sometimes the estimated mean is \(-\text{Inf}\) and the estimated mean standard deviation is \text{Inf}, especially when the sample size is small. Under- or over-flow may occur if the data is ill-conditioned.

Note

The response variable for this family function is the same as \texttt{uninormal} except positive values are required. Reasonably good initial values are needed.

The distribution of the reciprocal of a positive normal random variable is known as an alpha distribution.

Author(s)

Thomas W. Yee

See Also

\texttt{uninormal, tobit}.

Examples

```r
pdata <- data.frame(Mean = 1.0, SD = exp(1.0))
pdata <- transform(pdata, y = rposnorm(n = 1000, m = Mean, sd = SD))

## Not run: with(pdata, hist(y, prob = TRUE, border = "blue",
main = paste("posnorm(m =", Mean[1], ", sd =", round(SD[1], 2), ")")))
## End(Not run)
fit <- vglm(y ~ 1, posnormal, data = pdata, trace = TRUE)
coef(fit, matrix = TRUE)
(Cfit <- Coef(fit))
mygrid <- with(pdata, seq(min(y), max(y), len = 200))
## Not run: lines(mygrid, dposnorm(mygrid, Cfit[1], Cfit[2]), col = "red")
```
Description
Fits a positive Poisson distribution.

Usage
pospoisson(link = "loglink", type.fitted = c("mean", "lambda", "prob0"), expected = TRUE, ilambda = NULL, imethod = 1, zero = NULL, gt.1 = FALSE)

Arguments
- link: Link function for the usual mean (lambda) parameter of an ordinary Poisson distribution. See Links for more choices.
- expected: Logical. Fisher scoring is used if expected = TRUE, else Newton-Raphson.
- ilambda, imethod, zero: See CommonVGAMffArguments for information.
- type.fitted: See CommonVGAMffArguments for details.
- gt.1: Logical. Enforce lambda > 1? The default is to enforce lambda > 0.

Details
The positive Poisson distribution is the ordinary Poisson distribution but with the probability of zero being zero. Thus the other probabilities are scaled up (i.e., divided by \(1 - P(Y = 0)\)). The mean, \(\lambda/(1 - \exp(-\lambda))\), can be obtained by the extractor function fitted applied to the object.

A related distribution is the zero-inflated Poisson, in which the probability \(P(Y = 0)\) involves another parameter \(\phi\). See zipoisson.

Value
An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning
Under- or over-flow may occur if the data is ill-conditioned.

Note
This family function can handle multiple responses.
Yet to be done: a quasi.pospoisson which estimates a dispersion parameter.
powerlink

Power Link Function

Description
Computes the power transformation, including its inverse and the first two derivatives.

Usage
powerlink(theta, power = 1, inverse = FALSE, deriv = 0,
          short = TRUE, tag = FALSE)

Arguments
theta
  Numeric or character. See below for further details.

power
  This denotes the power or exponent.

inverse, deriv, short, tag
  Details at Links.
Details

The power link function raises a parameter by a certain value of power. Care is needed because it is very easy to get numerical problems, e.g., if power=0.5 and theta is negative.

Value

For powerlink with deriv = 0, then theta raised to the power of power. And if inverse = TRUE then theta raised to the power of 1/power.

For deriv = 1, then the function returns \( \frac{d \theta}{d \eta} \) as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

Numerical problems may occur for certain combinations of theta and power. Consequently this link function should be used with caution.

Author(s)

Thomas W. Yee

See Also

Links, loglink.

Examples

```r
powerlink("a", power = 2, short = FALSE, tag = TRUE)
powerlink(x <- 1:5)
powerlink(x, power = 2)
max(abs(powerlink(powerlink(x, power = 2),
                  power = 2, inverse = TRUE) - x)) # Should be 0
powerlink(x <- (-5):5, power = 0.5) # Has NAs

# 1/2 = 0.5
pdata <- data.frame(y = rbeta(n = 1000, shape1 = 2^2, shape2 = 3^2))
fit <- vglm(y ~ 1, betaR(lshape1 = powerlink(power = 0.5), i1 = 3,
               lshape2 = powerlink(power = 0.5), i2 = 7), data = pdata)
t(coef(fit, matrix = TRUE))
Coef(fit) # Useful for intercept-only models
vcov(fit, untransform = TRUE)
```

---

**prats**

*Pregnant Rats Toxological Experiment Data*

Description

A small toxological experiment data. The subjects are fetuses from two randomized groups of pregnant rats, and they were given a placebo or chemical treatment. The number with birth defects were recorded, as well as each litter size.
Usage
data(prats)

Format
A data frame with the following variables.

treatment A 0 means control; a 1 means the chemical treatment.

alive, litter.size The number of fetuses alive at 21 days, out of the number of fetuses alive at 4 days (the litter size).

Details
The data concerns a toxicological experiment where the subjects are fetuses from two randomized groups of 16 pregnant rats each, and they were given a placebo or chemical treatment. The number with birth defects and the litter size were recorded. Half the rats were fed a control diet during pregnancy and lactation, and the diet of the other half was treated with a chemical. For each litter the number of pups alive at 4 days and the number of pups that survived the 21 day lactation period, were recorded.

Source
Weil, C. S. (1970) Selection of the valid number of sampling units and a consideration of their combination in toxicological studies involving reproduction, teratogenesis or carcinogenesis. Food and Cosmetics Toxicology, 8(2), 177–182.

References

See Also
betabinomial, betabinomialff.

Examples
prats
colSums(subset(prats, treatment == 0))
colSums(subset(prats, treatment == 1))
summary(prats)
predictqrrvglm

Predict Method for a CQO fit

Description

Predicted values based on a constrained quadratic ordination (CQO) object.

Usage

```r
predictqrrvglm(object, newdata = NULL,
    type = c("link", "response", "latvar", "terms"),
    se.fit = FALSE, deriv = 0, dispersion = NULL,
    extra = object@extra, varI.latvar = FALSE, refResponse = NULL, ...)
```

Arguments

- `object`: Object of class inheriting from "qrrvglm".
- `newdata`: An optional data frame in which to look for variables with which to predict. If omitted, the fitted linear predictors are used.
- `type`, `se.fit`, `dispersion`, `extra`: See `predictvglm`.
- `deriv`: Derivative. Currently only 0 is handled.
- `varI.latvar`, `refResponse`: Arguments passed into `Coef.qrrvglm`.
- `...`: Currently undocumented.

Details

Obtains predictions from a fitted CQO object. Currently there are lots of limitations of this function; it is unfinished.

Value

See `predictvglm`.

Note

This function is not robust and has not been checked fully.

Author(s)

T. W. Yee

References

See Also
cqo, calibrate.qrrvglm.

Examples

```r
## Not run: set.seed(1234)
hspider[, 1:6] <- scale(hspider[, 1:6]) # Standardize the X vars
p1 <- cqo(cbind(Alopacce, AlopCune, AlopFabr, Arctlute, Arctperi, Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull, Trocterr, Zoraspin) ~ WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux, poissonff, data = hspider, Crowlpositive = FALSE, l.toler = TRUE)
sort(deviance(p1, history = TRUE)) # A history of all the iterations
head(predict(p1))

# The following should be all 0s:
max(abs(predict(p1, newdata = head(hspider)) - head(predict(p1))))
max(abs(predict(p1, newdata = head(hspider), type = "res")-head(fitted(p1))))
## End(Not run)
```

predictvglm

Predict Method for a VGLM fit

Description

Predicted values based on a vector generalized linear model (VGLM) object.

Usage

```r
predictvglm(object, newdata = NULL, 
type = c("link", "response", "terms"), 
se.fit = FALSE, deriv = 0, dispersion = NULL, 
untransform = FALSE, 
type.fitted = NULL, percentiles = NULL, ...)
```

Arguments

- **object**
  - Object of class inheriting from "vlm", e.g., `vglm`.

- **newdata**
  - An optional data frame in which to look for variables with which to predict. If omitted, the fitted linear predictors are used.

- **type**
  - The value of this argument can be abbreviated. The type of prediction required. The default is the first one, meaning on the scale of the linear predictors. This should be a \( n \times M \) matrix.
  - The alternative "response" is on the scale of the response variable, and depending on the family function, this may or may not be the mean. Often this is the fitted value, e.g., `fitted(vglmObject)` (see `fittedvlm`). Note that the
response is output from the \texttt{linkinv} slot, where the \texttt{eta} argument is the $n \times M$ matrix of linear predictors. The "terms" option returns a matrix giving the fitted values of each term in the model formula on the linear predictor scale. The terms have been centered.

\texttt{se.fit} logical: return standard errors?

\texttt{deriv} Non-negative integer. Currently this must be zero. Later, this may be implemented for general values.

\texttt{dispersion} Dispersion parameter. This may be inputted at this stage, but the default is to use the dispersion parameter of the fitted model.

\texttt{type.fitted} Some \texttt{VGAM} family functions have an argument by the same name. If so, then one can obtain fitted values by setting \texttt{type = "response"} and choosing a value of \texttt{type.fitted} from what's available. If \texttt{type.fitted = "quantiles"} is available then the \texttt{percentiles} argument can be used to specify what quantile values are requested.

\texttt{percentiles} Used only if \texttt{type.fitted = "quantiles"} is available and is selected.

\texttt{untransform} Logical. Reverses any parameter link function. This argument only works if \texttt{type = "link"}, \texttt{se.fit = FALSE}, \texttt{deriv = 0}. Setting \texttt{untransform = TRUE} does not work for all \texttt{VGAM} family functions; only ones where there is a one-to-one correspondence between a simple link function and a simple parameter might work.

... Arguments passed into \texttt{predictvlm}.

\textbf{Details}

Obtains predictions and optionally estimates standard errors of those predictions from a fitted \texttt{vglm} object. By default, each row of the matrix returned can be written as $\eta_i^T$, comprising of $M$ components or linear predictors. If there are any offsets, these are included. This code implements \textit{smart prediction} (see \texttt{smartpred}).

\textbf{Value}

If \texttt{se.fit = FALSE}, a vector or matrix of predictions. If \texttt{se.fit = TRUE}, a list with components

\texttt{fitted.values} Predictions

\texttt{se.fit} Estimated standard errors

\texttt{df} Degrees of freedom

\texttt{sigma} The square root of the dispersion parameter (but these are being phased out in the package)

\textbf{Warning}

This function may change in the future.

\textbf{Note}

Setting \texttt{se.fit = TRUE} and \texttt{type = "response"} will generate an error.

The arguments \texttt{type.fitted} and \texttt{percentiles} are provided in this function to give more convenience than modifying the \texttt{extra} slot directly.
Author(s)

Thomas W. Yee

References


See Also

`predict`, `vglm`, `predictvlm`, `smartpred`, `calibrate`.

Examples

```r
# Illustrates smart prediction
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ poly(c(scale(let)), 2),
            propodds, pneumo, trace = TRUE, x.arg = FALSE)
class(fit)

(q0 <- head(predict(fit)))
(q1 <- predict(fit, newdata = head(pneumo)))
(q2 <- predict(fit, newdata = head(pneumo)))
all.equal(q0, q1) # Should be TRUE
all.equal(q1, q2) # Should be TRUE

head(predict(fit))
head(predict(fit, untransform = TRUE))

p0 <- head(predict(fit, type = "response"))
p1 <- head(predict(fit, type = "response", newdata = pneumo))
p2 <- head(predict(fit, type = "response", newdata = pneumo))
p3 <- head(fitted(fit))
all.equal(p0, p1) # Should be TRUE
all.equal(p1, p2) # Should be TRUE
all.equal(p2, p3) # Should be TRUE

predict(fit, type = "terms", se = TRUE)
```

Description

Estimation of a 3-parameter log-gamma distribution described by Prentice (1974).
Usage

prentice74(llocation = "identitylink", lscale = "loglink",
      lshape = "identitylink", ilocation = NULL, iscale = NULL,
      ishape = NULL, imethod = 1,
      glocation.mux = exp((-4:4)/2), gscale.mux = exp((-4:4)/2),
      gshape = qt(ppoints(6), df = 1), probs.y = 0.3,
      zero = c("scale", "shape"))

Arguments

llocation, lscale, lshape
  Parameter link function applied to the location parameter \(a\), positive scale parameter \(b\) and the shape parameter \(q\), respectively. See Links for more choices.

ilocation, iscale
  Initial value for \(a\) and \(b\), respectively. The defaults mean an initial value is determined internally for each.

ishape
  Initial value for \(q\). If failure to converge occurs, try some other value. The default means an initial value is determined internally.

imethod, zero
  See CommonVGAMffArguments for information.

glocation.mux, gscale.mux, gshape, probs.y
  See CommonVGAMffArguments for information.

Details

The probability density function is given by

\[
f(y; a, b, q) = |q| \exp\left(\frac{w}{q^2} - \frac{e^w}{2}\right) / (b \Gamma(1/q^2)),
\]

for shape parameter \(q \neq 0\), positive scale parameter \(b > 0\), location parameter \(a\), and all real \(y\). Here, \(w = (y - a)q/b + \psi(1/q^2)\) where \(\psi\) is the digamma function, \texttt{digamma}. The mean of \(Y\) is \(a\) (returned as the fitted values). This is a different parameterization compared to \texttt{lgamma3}.

Special cases: \(q = 0\) is the normal distribution with standard deviation \(b\), \(q = -1\) is the extreme value distribution for maximums, \(q = 1\) is the extreme value distribution for minima (Weibull). If \(q > 0\) then the distribution is left skew, else \(q < 0\) is right skew.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning

The special case \(q = 0\) is not handled, therefore estimates of \(q\) too close to zero may cause numerical problems.

Note

The notation used here differs from Prentice (1974): \(\alpha = a, \sigma = b\). Fisher scoring is used.
Author(s)

T. W. Yee

References


See Also

`lgamma3, lgamma, gengamma.stacy`.

Examples

```r
pdata <- data.frame(x2 = runif(nn <- 1000))
pdata <- transform(pdata, loc = -1 + 2*x2, Scale = exp(1))
pdata <- transform(pdata, y = rlgamma(nn, loc = loc, scale = Scale, shape = 1))
fit <- vglm(y ~ x2, prentice74(zero = 2:3), data = pdata, trace = TRUE)
coef(fit, matrix = TRUE) # Note the coefficients for location
```

---

**prinia**

*Yellow-bellied Prinia*

Description

A data frame with yellow-bellied Prinia.

Usage

`data(prinia)`

Format

A data frame with 151 observations on the following 23 variables.

- **length** a numeric vector, the scaled wing length (zero mean and unit variance).
- **fat** a numeric vector, fat index; originally 1 (no fat) to 4 (very fat) but converted to 0 (no fat) versus 1 otherwise.
- **cap** a numeric vector, number of times the bird was captured or recaptured.
- **noncap** a numeric vector, number of times the bird was not captured.
- **y01, y02, y03, y04, y05, y06** a numeric vector of 0s and 1s; for noncapture and capture resp.
- **y07, y08, y09, y10, y11, y12** same as above.
- **y13, y14, y15, y16, y17, y18, y19** same as above.
Details

The yellow-bellied Prinia *Prinia flaviventris* is a common bird species located in Southeast Asia. A capture–recapture experiment was conducted at the Mai Po Nature Reserve in Hong Kong during 1991, where captured individuals had their wing lengths measured and fat index recorded. A total of 19 weekly capture occasions were considered, where 151 distinct birds were captured.

More generally, the prinias are a genus of small insectivorous birds, and are sometimes referred to as *wren-warblers*. They are a little-known group of the tropical and subtropical Old World, the roughly 30 species being divided fairly equally between Africa and Asia.

Source

Thanks to Paul Yip for permission to make this data available.


Examples

```r
head(prinia)
summary(prinia)
rowSums(prinia[, c("cap", "noncap")]) # 19s

# Fit a positive-binomial distribution (M.h) to the data:
fit1 <- vglm(cbind(cap, noncap) ~ length + fat, posbinomial, prinia)

# Fit another positive-binomial distribution (M.h) to the data:
# The response input is suitable for posbernoulli.*-type functions.
fit2 <- vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10,
                   y11, y12, y13, y14, y15, y16, y17, y18, y19) ~
              length + fat, posbernoulli.b(drop.b = FALSE ~ 0), prinia)
```

---

### probitlink

**Probit Link Function**

**Description**

Computes the probit transformation, including its inverse and the first two derivatives.

**Usage**

```r
probitlink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
          short = TRUE, tag = FALSE)
```

**Arguments**

- `theta` Numeric or character. See below for further details.
- `bvalue` See *Links*.
- `inverse, deriv, short, tag` Details at *Links*. 

*Links*
Details

The probit link function is commonly used for parameters that lie in the unit interval. It is the inverse CDF of the standard normal distribution. Numerical values of theta close to 0 or 1 or out of range result in Inf, -Inf, NA or NaN.

Value

For deriv = 0, the probit of theta, i.e., qnorm(theta) when inverse = FALSE, and if inverse = TRUE then pnorm(theta).

For deriv = 1, then the function returns d eta / d theta as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

Numerical instability may occur when theta is close to 1 or 0. One way of overcoming this is to use bvalue.

In terms of the threshold approach with cumulative probabilities for an ordinal response this link function corresponds to the univariate normal distribution (see uninormal).

Author(s)

Thomas W. Yee

References


See Also

Links, logitlink, clogloglink, cauchitlink, Normal.

Examples

```r
p <- seq(0.01, 0.99, by = 0.01)
probitlink(p)
max(abs(probitlink(probitlink(p), inverse = TRUE) - p)) # Should be 0

p <- c(seq(-0.02, 0.02, by = 0.01), seq(0.97, 1.02, by = 0.01))
probitlink(p) # Has NAs
probitlink(p, bvalue = .Machine$double.eps) # Has no NAs

## Not run: p <- seq(0.01, 0.99, by = 0.01); par(lwd = (mylwd <- 2))
plot(p, logitlink(p), type = "l", col = "limegreen", ylab = "transformation",
     las = 1, main = "Some probability link functions")
lines(p, probitlink(p), col = "purple")
lines(p, clogloglink(p), col = "chocolate")
lines(p, cauchitlink(p), col = "tan")
abline(v = 0.5, h = 0, lty = "dashed")
legend(0.1, 4, c("logitlink", "probitlink", "clogloglink", "cauchitlink"),
```
Description

Investigates the profile log-likelihood function for a fitted model of class "vglm".

Usage

profilevglm(object, which = 1:p.vlm, alpha = 0.01, maxsteps = 10, del = zmax/5, trace = NULL, ...)

Arguments

object the original fitted model object.
which the original model parameters which should be profiled. This can be a numeric or character vector. By default, all parameters are profiled.
alpha highest significance level allowed for the profiling.
maxsteps maximum number of points to be used for profiling each parameter.
del suggested change on the scale of the profile t-statistics. Default value chosen to allow profiling at about 10 parameter values.
trace logical: should the progress of profiling be reported? The default is to use the trace value from the fitted object; see vglm.control for details.
...

Details

This function is called by confintvglm to do the profiling. See also profile.glm for details.

Value

A list of classes "profile.glm" and "profile" with an element for each parameter being profiled. The elements are data-frames with two variables

par.vals a matrix of parameter values for each fitted model.
tau the profile t-statistics.

Author(s)

T. W. Yee adapted this function from profile.glm, written originally by D. M. Bates and W. N. Venables. (For S in 1996.) The help file was also used as a template.
propodds

See Also

vglm, confint.vglm, lrt.stat, profile, profile.glm, plot.profile in MASS or stats.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit1 <- vglm(cbind(normal, mild, severe) ~ let, propodds, trace = TRUE, data = pneumo)
pfit1 <- profile(fit1, trace = FALSE)
confint(fit1, method = "profile", trace = FALSE)

propodds

Propotional Odds Model for Ordinal Regression

Description

Fits the proportional odds model to a (preferably ordered) factor response.

Usage

propodds(reverse = TRUE, whitespace = FALSE, ynames = FALSE, Thresh = NULL, Trev = reverse, Tref = if (Trev) "M" else 1)

Arguments

reverse, whitespace
Logical. Fed into arguments of the same name in cumulative.

ynames See multinomial for information.
Thresh, Trev, Tref
Fed into arguments of the same name in cumulative.

Details

The proportional odds model is a special case from the class of cumulative link models. It involves a logit link applied to cumulative probabilities and a strong parallelism assumption. A parallelism assumption means there is less chance of numerical problems because the fitted probabilities will remain between 0 and 1; however the parallelism assumption ought to be checked, e.g., via a likelihood ratio test. This VGAM family function is merely a shortcut for cumulative(reverse = reverse, link = "logit", parallel = TRUE). Please see cumulative for more details on this model.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.
prplot

Warning

No check is made to verify that the response is ordinal if the response is a matrix; see ordered.

Author(s)

Thomas W. Yee

References

See cumulative.

See Also

cumulative, R2latvar.

Examples

# Fit the proportional odds model, McCullagh and Nelder (1989,p.179)
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo))

depvar(fit)  # Sample proportions
weights(fit, type = "prior")  # Number of observations
coef(fit, matrix = TRUE)
constraints(fit)  # Constraint matrices
summary(fit)

# Check that the model is linear in let ----------------------
fit2 <- vgam(cbind(normal, mild, severe) ~ s(let, df = 2), propodds, pneumo)

## Not run: plot(fit2, se = TRUE, lcol = 2, scol = 2)

# Check the proportional odds assumption with a LRT ----------
(fit3 <- vglm(cbind(normal, mild, severe) ~ let,
              cumulative(parallel = FALSE, reverse = TRUE), pneumo))

pchisq(deviance(fit) - deviance(fit3),
       df = df.residual(fit) - df.residual(fit3), lower.tail = FALSE)

lrtest(fit3, fit)  # Easier

prplot

Probability Plots for Categorical Data Analysis

Description

Plots the fitted probabilities for some very simplified special cases of categorical data analysis models.
Usage

prplot(object, control = prplot.control(...), ...)

prplot.control(xlab = NULL, ylab = "Probability", main = NULL, xlim = NULL, ylim = NULL, lty = par()$lty, col = par()$col, rcol = par()$col, lwd = par()$lwd, rlwd = par()$lwd, las = par()$las, rug.arg = FALSE, ...)

Arguments

object Currently only an cumulative object. This includes a propodds object since that VGAM family function is a special case of cumulative.
control List containing some basic graphical parameters.
xlab, ylab, main, xlim, ylim, lty

See par and ... below.
col, rcol, lwd, rlwd, las, rug.arg

See par and ... below. Arguments starting with r refer to the rug. Argument rug.arg is logical: add a rug for the distinct values of the explanatory variable?
...

Arguments such as xlab which are fed into prplot.control(). Only a small selection of graphical arguments from par are offered.

Details

For models involving one term in the RHS of the formula this function plots the fitted probabilities against the single explanatory variable.

Value

The object is returned invisibly with the preplot slot assigned. This is obtained by a call to plotvgam().

Note

This function is rudimentary.

See Also

cumulative.

Examples

pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo)
M <- npred(fit) # Or fit@misc$M
## Not run: prplot(fit)
prplot(fit, lty = 1:M, col = (1:M)+2, rug = TRUE, las = 1, ylim = c(0, 1), rlwd = 2)
## End(Not run)
**put.smart**

* Adds a List to the End of the List "`.smart.prediction`"

---

**Description**

Adds a list to the end of the list `.smart.prediction` in `smartpredenv`.  

**Usage**

```r
put.smart(smart)
```

**Arguments**

- `smart`: a list containing parameters needed later for smart prediction.

**Details**

`put.smart` is used in "write" mode within a smart function. It saves parameters at the time of model fitting, which are later used for prediction. The function `put.smart` is the opposite of `get.smart`, and both deal with the same contents.

**Value**

Nothing is returned.

**Side Effects**

The variable `.smart.prediction.counter` in `smartpredenv` is incremented beforehand, and `.smart.prediction[[.smart.prediction.counter]]` is assigned the list `smart`. If the list `.smart.prediction` in `smartpredenv` is not long enough to hold `smart`, then it is made larger, and the variable `.max.smart` in `smartpredenv` is adjusted accordingly.

**See Also**

`get.smart`.

**Examples**

```r
print(sm.min1)
```
Description

Algorithmic constants and parameters for a constrained quadratic ordination (CQO), by fitting a quadratic reduced-rank vector generalized linear model (QRR-VGLM), are set using this function. It is the control function for `cqo`.

Usage

```r
qrrvglm.control(Rank = 1, Bestof = if (length(Cinit)) 1 else 10,
                 checkwz = TRUE, Cinit = NULL, Crow1positive = TRUE,
                 epsilon = 1.0e-06, EqualTolerances = NULL, eq.tolerances = TRUE,
                 Etamat.colmax = 10, FastAlgorithm = TRUE, GradientFunction = TRUE,
                 Hstep = 0.001, isd.latvar = rep_len(c(2, 1, rep_len(0.5, Rank)),
                 Rank), iKvector = 0.1, iShape = 0.1, ITolerances = NULL,
                 I.tolerances = FALSE, maxit1 = 40, imethod = 1,
                 Maxit.optim = 250, MUXfactor = rep_len(7, Rank),
                 noRRR = ~ 1, Norrr = NA, optim.maxit = 20,
                 Parscale = if (I.tolerances) 0.001 else 1.0,
                 sd.Cinit = 0.02, SmallNo = 5.0e-13, trace = TRUE,
                 Use.Init.Poisson.QO = TRUE,
                 wzepsilon = .Machine$double.eps^0.75, ...)
```

Arguments

In the following, \( R \) is the Rank, \( M \) is the number of linear predictors, and \( S \) is the number of responses (species). Thus \( M = S \) for binomial and Poisson responses, and \( M = 2S \) for the negative binomial and 2-parameter gamma distributions.

- **Rank**: The numerical rank \( R \) of the model, i.e., the number of ordination axes. Must be an element from the set \{1, 2, ..., \( \min(M, p^2) \)\} where the vector of explanatory variables \( x \) is partitioned into \((x_1, x_2)\), which is of dimension \( p_1 + p_2 \). The variables making up \( x_1 \) are given by the terms in the `noRRR` argument, and the rest of the terms comprise \( x_2 \).

- **Bestof**: Integer. The best of `Bestof` models fitted is returned. This argument helps guard against local solutions by (hopefully) finding the global solution from many fits. The argument has value 1 if an initial value for \( C \) is inputted using `Cinit`.

- **checkwz**: Logical indicating whether the diagonal elements of the working weight matrices should be checked whether they are sufficiently positive, i.e., greater than `wzepsilon`. If not, any values less than `wzepsilon` are replaced with this value.

- **Cinit**: Optional initial \( C \) matrix, which must be a \( p_2 \) by \( R \) matrix. The default is to apply `.Init.Poisson.QO()` to obtain initial values.
Crow1positive  Logical vector of length Rank (recycled if necessary): are the elements of the first row of C positive? For example, if Rank is 4, then specifying Crow1positive = c(FALSE, TRUE) will force C[1,1] and C[1,3] to be negative, and C[1,2] and C[1,4] to be positive. This argument allows for a reflection in the ordination axes because the coefficients of the latent variables are unique up to a sign.

epsilon  Positive numeric. Used to test for convergence for GLMs fitted in C. Larger values mean a loosening of the convergence criterion. If an error code of 3 is reported, try increasing this value.

eq.tolerances  Logical indicating whether each (quadratic) predictor will have equal tolerances. Having eq.tolerances = TRUE can help avoid numerical problems, especially with binary data. Note that the estimated (common) tolerance matrix may or may not be positive-definite. If it is then it can be scaled to the R by R identity matrix, i.e., made equivalent to I.tolerances = TRUE. Setting I.tolerances = TRUE will force a common R by R identity matrix as the tolerance matrix to the data even if it is not appropriate. In general, setting I.tolerances = TRUE is preferred over eq.tolerances = TRUE because, if it works, it is much faster and uses less memory. However, I.tolerances = TRUE requires the environmental variables to be scaled appropriately. See Details for more details.

EqualTolerances  Defunct argument. Use eq.tolerances instead.

Etamat.colmax  Positive integer, no smaller than Rank. Controls the amount of memory used by .Init.Poisson.QO(). It is the maximum number of columns allowed for the pseudo-response and its weights. In general, the larger the value, the better the initial value. Used only if Use.Init.Poisson.QO = TRUE.

FastAlgorithm  Logical. Whether a new fast algorithm is to be used. The fast algorithm results in a large speed increases compared to Yee (2004). Some details of the fast algorithm are found in Appendix A of Yee (2006). Setting FastAlgorithm = FALSE will give an error.

GradientFunction  Logical. Whether optim’s argument gr is used or not, i.e., to compute gradient values. Used only if FastAlgorithm is TRUE. The default value is usually faster on most problems.

Hstep  Positive value. Used as the step size in the finite difference approximation to the derivatives by optim.

isd.latvar  Initial standard deviations for the latent variables (site scores). Numeric, positive and of length R (recycled if necessary). This argument is used only if I.tolerances = TRUE. Used by .Init.Poisson.QO() to obtain initial values for the constrained coefficients C adjusted to a reasonable value. It adjusts the spread of the site scores relative to a common species tolerance of 1 for each ordination axis. A value between 0.5 and 10 is recommended; a value such as 10 means that the range of the environmental space is very large relative to the niche width of the species. The successive values should decrease because the first ordination axis should have the most spread of site scores, followed by the second ordination axis, etc.

iKvector, iShape  Numeric, recycled to length S if necessary. Initial values used for estimating the positive k and λ parameters of the negative binomial and 2-parameter
gamma distributions respectively. For further information see `negbinomial` and `gamma2`. These arguments override the `ik` and `ishape` arguments in `negbinomial` and `gamma2`.

I.tolerances Logical. If TRUE then the (common) tolerance matrix is the \( R \) by \( R \) identity matrix by definition. Note that having I.tolerances = TRUE implies eq.tolerances = TRUE, but not vice versa. Internally, the quadratic terms will be treated as offsets (in GLM jargon) and so the models can potentially be fitted very efficiently. However, it is a very good idea to center and scale all numerical variables in the \( x_2 \) vector. See Details for more details. The success of I.tolerances = TRUE often depends on suitable values for `isd.latvar` and/or `MUXfactor`.

ITolerances Defunct argument. Use I.tolerances instead.

maxitl Maximum number of times the optimizer is called or restarted. Most users should ignore this argument.

imethod Method of initialization. A positive integer 1 or 2 or 3 etc. depending on the VGAM family function. Currently it is used for `negbinomial` and `gamma2` only, and used within the C.

Maxit.optim Positive integer. Number of iterations given to the function `optim` at each of the optim.maxit iterations.

MUXfactor Multiplication factor for detecting large offset values. Numeric, positive and of length \( R \) (recycled if necessary). This argument is used only if I.tolerances = TRUE. Offsets are \(-0.5\) multiplied by the sum of the squares of all \( R \) latent variable values. If the latent variable values are too large then this will result in numerical problems. By too large, it is meant that the standard deviation of the latent variable values are greater than `MUXfactor[r] * isd.latvar[r]` for \( r=1:R \). (This is why centering and scaling all the numerical predictor variables in \( x_2 \) is recommended). A value about 3 or 4 is recommended. If failure to converge occurs, try a slightly lower value.

optim.maxit Positive integer. Number of times optim is invoked. At iteration \( i \), the \( i \)th value of Maxit.optim is fed into optim.

noRRR Formula giving terms that are not to be included in the reduced-rank regression (or formation of the latent variables), i.e., those belong to \( x_1 \). Those variables which do not make up the latent variable (reduced-rank regression) correspond to the \( B_1 \) matrix. The default is to omit the intercept term from the latent variables.

Norrr Defunct. Please use noRRR. Use of Norrr will become an error soon.

Parscale Numerical and positive-valued vector of length \( C \) (recycled if necessary). Passed into `optim(..., control = list(parscale = Parscale))`; the elements of \( C \) become \( C / \text{Parscale} \). Setting I.tolerances = TRUE results in line searches that are very large, therefore \( C \) has to be scaled accordingly to avoid large step sizes. See Details for more information. It’s probably best to leave this argument alone.

sd.Cinit Standard deviation of the initial values for the elements of \( C \). These are normally distributed with mean zero. This argument is used only if Use.Init.Poisson.QO = FALSE and \( C \) is not inputted using Cinit.
trace Logical indicating if output should be produced for each iteration. The default is TRUE because the calculations are numerically intensive, meaning it may take a long time, so that the user might think the computer has locked up if trace = FALSE.

SmallNo Positive numeric between .Machine$double.eps and 0.0001. Used to avoid under- or over-flow in the IRLS algorithm. Used only if FastAlgorithm is TRUE.

Use.Init.Poisson.QO Logical. If TRUE then the function .Init.Poisson.QO() is used to obtain initial values for the canonical coefficients C. If FALSE then random numbers are used instead.

wzepsilon Small positive number used to test whether the diagonals of the working weight matrices are sufficiently positive.

... Ignored at present.

Details

Recall that the central formula for CQO is

$$\eta = B_1^T x_1 + A \nu + \sum_{m=1}^{M} (\nu^T D_m \nu) e_m$$

where $x_1$ is a vector (usually just a 1 for an intercept), $x_2$ is a vector of environmental variables, $\nu = C^T x_2$ is a $R$-vector of latent variables, $e_m$ is a vector of 0s but with a 1 in the $m$th position.

QRR-VGLMs are an extension of RR-VGLMs and allow for maximum likelihood solutions to constrained quadratic ordination (CQO) models.

Having I.tolerances = TRUE means all the tolerance matrices are the order-$R$ identity matrix, i.e., it forces bell-shaped curves/surfaces on all species. This results in a more difficult optimization problem (especially for 2-parameter models such as the negative binomial and gamma) because of overflow errors and it appears there are more local solutions. To help avoid the overflow errors, scaling $C$ by the factor Parscale can help enormously. Even better, scaling $C$ by specifying isd.latvar is more understandable to humans. If failure to converge occurs, try adjusting Parscale, or better, setting eq.tolerances = TRUE (and hope that the estimated tolerance matrix is positive-definite). To fit an equal-tolerances model, it is firstly best to try setting I.tolerances = TRUE and varying isd.latvar and/orMUXfactor if it fails to converge. If it still fails to converge after many attempts, try setting eq.tolerances = TRUE, however this will usually be a lot slower because it requires a lot more memory.

With a $R > 1$ model, the latent variables are always uncorrelated, i.e., the variance-covariance matrix of the site scores is a diagonal matrix.

If setting eq.tolerances = TRUE is used and the common estimated tolerance matrix is positive-definite then that model is effectively the same as the I.tolerances = TRUE model (the two are transformations of each other). In general, I.tolerances = TRUE is numerically more unstable and presents a more difficult problem to optimize; the arguments isd.latvar and/or MUXfactor often must be assigned some good value(s) (possibly found by trial and error) in order for convergence to occur. Setting I.tolerances = TRUE forces a bell-shaped curve or surface onto all the species data, therefore this option should be used with deliberation. If unsuitable, the resulting fit may be very misleading. Usually it is a good idea for the user to set eq.tolerances = FALSE to see which
species appear to have a bell-shaped curve or surface. Improvements to the fit can often be achieved using transformations, e.g., nitrogen concentration to log nitrogen concentration.

Fitting a CAO model (see \texttt{cao}) first is a good idea for pre-examining the data and checking whether it is appropriate to fit a CQO model.

\textbf{Value}

A list with components matching the input names.

\textbf{Warning}

The default value of \texttt{Bestof} is a bare minimum for many datasets, therefore it will be necessary to increase its value to increase the chances of obtaining the global solution.

\textbf{Note}

When \texttt{I.tolerances} = \texttt{TRUE} it is a good idea to apply \texttt{scale} to all the numerical variables that make up the latent variable, i.e., those of \texttt{x2}. This is to make them have mean 0, and hence avoid large offset values which cause numerical problems.

This function has many arguments that are common with \texttt{rrvglm.control} and \texttt{vglm.control}.

It is usually a good idea to try fitting a model with \texttt{I.tolerances} = \texttt{TRUE} first, and if convergence is unsuccessful, then try \texttt{eq.tolerances} = \texttt{TRUE} and \texttt{I.tolerances} = \texttt{FALSE}. Ordination diagrams with \texttt{eq.tolerances} = \texttt{TRUE} have a natural interpretation, but with \texttt{eq.tolerances} = \texttt{FALSE} they are more complicated and requires, e.g., contours to be overlaid on the ordination diagram (see \texttt{lvplot.qrrvglm}).

In the example below, an equal-tolerances CQO model is fitted to the hunting spiders data. Because \texttt{I.tolerances} = \texttt{TRUE}, it is a good idea to center all the \texttt{x2} variables first. Upon fitting the model, the actual standard deviation of the site scores are computed. Ideally, the \texttt{isd.latvar} argument should have had this value for the best chances of getting good initial values. For comparison, the model is refitted with that value and it should run more faster and reliably.

\textbf{Author(s)}

Thomas W. Yee

\textbf{References}


\textbf{See Also}

\texttt{cqo, rcqo, Coef.qrrvglm, Coef.qrrvglm-class, optim, binomialff, poissonff, negbinomial, gamma2}. 

\texttt{qrrvglm.control}
Examples

```r
## Not run: # Poisson CQO with equal tolerances
set.seed(111) # This leads to the global solution
hsider[,1:6] <- scale(hsider[,1:6]) # Good when I.tolerances = TRUE
p1 <- cqo(cbind(Alopacce, Alopcune, Aolfabr,
    Arctlute, Arctperi, Auloalbi,
    Pardlugu, Pardmont, Pardnigr,
    Pardpull, Trocterr, Zoraspin) ~
    WaterCon + BareSand + FallTwig +
    CoveMoss + CoveHerb + Refllux,
    poissonff, data = hsider, eq.tolerances = TRUE)
sort(deviance(p1, history = TRUE)) # Iteration history

(isd.latvar <- apply(latvar(p1), 2, sd)) # Approx isd.latvar

# Refit the model with better initial values
set.seed(111) # This leads to the global solution
p1 <- cqo(cbind(Alopacce, Alopcune, Aolfabr,
    Arctlute, Arctperi, Auloalbi,
    Pardlugu, Pardmont, Pardnigr,
    Pardpull, Trocterr, Zoraspin) ~
    WaterCon + BareSand + FallTwig +
    CoveMoss + CoveHerb + Refllux,
    I.tolerances = TRUE, poissonff, data = hsider,
    isd.latvar = isd.latvar) # Note this
sort(deviance(p1, history = TRUE)) # Iteration history

## End(Not run)
```

qtplot.gumbel

**Quantile Plot for Gumbel Regression**

**Description**

Plots quantiles associated with a Gumbel model.

**Usage**

```r
qtplot.gumbel(object, show.plot = TRUE,
    y.arg = TRUE, spline.fit = FALSE, label = TRUE,
    R = object@misc$R, percentiles = object@misc$percentiles,
    add.arg = FALSE, mpv = object@misc$mpv,
    xlab = NULL, ylab = "", main = "",
    pch = par()$pch, pcol.arg = par()$col,
    lty.arg = par()$lty, lcol.arg = par()$col, lwd.arg = par()$lwd,
    tcol.arg = par()$col, tadj = 1, ...)```
Arguments

object  A VGAM extremes model of the Gumbel type, produced by modelling functions such as vglm and vgam, and with a family function that is either gumbel or gumbelff.

show.plot  Logical. Plot it? If FALSE no plot will be done.

y.arg  Logical. Add the raw data on to the plot?

spline.fit  Logical. Use a spline fit through the fitted percentiles? This can be useful if there are large gaps between some values along the covariate.

label  Logical. Label the percentiles?

R  See gumbel.

percentiles  See gumbel.

add.arg  Logical. Add the plot to an existing plot?

mpv  See gumbel.

xlab  Caption for the x-axis. See par.

ylab  Caption for the y-axis. See par.

main  Title of the plot. See title.

pch  Plotting character. See par.

pcol.arg  Color of the points. See the col argument of par.

llty.arg  Line type. Line type. See the lty argument of par.

lcol.arg  Color of the lines. See the col argument of par.

llwd.arg  Line width. See the lwd argument of par.

tcol.arg  Color of the text (if label is TRUE). See the col argument of par.

tadj  Text justification. See the adj argument of par.

...  Arguments passed into the plot function when setting up the entire plot. Useful arguments here include sub and las.

Details

There should be a single covariate such as time. The quantiles specified by percentiles are plotted.

Value

The object with a list called qtplot in the post slot of object. (If show.plot = FALSE then just the list is returned.) The list contains components

fitted.values  The percentiles of the response, possibly including the MPV.

percentiles  The percentiles (small vector of values between 0 and 100).

Note

Unlike gumbel, one cannot have percentiles = NULL.
Description

Plots quantiles associated with a LMS quantile regression.

Usage

qtplot.lmscreg(object, newdata = NULL, percentiles = object@misc$percentiles, show.plot = TRUE, ...)

Arguments

object A VGAM quantile regression model, i.e., an object produced by modelling functions such as vgelm and vgam with a family function beginning with "lms.", e.g., lms.yjn.
newdata Optional data frame for computing the quantiles. If missing, the original data is used.
percentiles Numerical vector with values between 0 and 100 that specify the percentiles (quantiles). The default are the percentiles used when the model was fitted.
show.plot Logical. Plot it? If FALSE no plot will be done.
... Graphical parameter that are passed into plotqtplot.lmscreg.
Details
The ‘primary’ variable is defined as the main covariate upon which the regression or smoothing is performed. For example, in medical studies, it is often the age. In VGAM, it is possible to handle more than one covariate, however, the primary variable must be the first term after the intercept.

Value
A list with the following components.
- fitted.values: A vector of fitted percentile values.
- percentiles: The percentiles used.

Note
plotqtplot.lmscreg does the actual plotting.

Author(s)
Thomas W. Yee

References

See Also
plotqtplot.lmscreg, deplot.lmscreg, lms.bcn, lms.bcg, lms.yjn.

Examples
```r
## Not run:
fit <- vgam(BMI ~ s(age, df = c(4, 2)), lms.bcn(zero=1), bmi.nz)
qtplot(fit)
qtplot(fit, perc = c(25, 50, 75, 95), lcol = 4, tcol = 4, llwd = 2)
## End(Not run)
```

Description
Takes a vglm fit or a variance-covariance matrix, and preprocesses it for rcim and uninormal so that quasi-variances can be computed.
Usage

\texttt{Qvar(object, factorname = NULL, which.linpred = 1,}
\texttt{ coef.indices = NULL, labels = NULL,}
\texttt{ dispersion = NULL, reference.name = "(reference)", estimates = NULL)}

Arguments

- **object**: A "\texttt{vglm}\" object or a variance-covariance matrix, e.g., \texttt{vcov(vglm.object)}. The former is preferred since it contains all the information needed. If a matrix then factorname and/or coef.indices should be specified to identify the factor.

- **which.linpred**: A single integer from the set 1:M. Specifies which linear predictor to use. Let the value of which.linpred be called \( j \). Then the factor should appear in that linear predictor, hence the \( j \)th row of the constraint matrix corresponding to the factor should have at least one nonzero value. Currently the \( j \)th row must have exactly one nonzero value because programming it for more than one nonzero value is difficult.

- **factorname**: Character. If the \texttt{vglm} object contains more than one factor as explanatory variable then this argument should be the name of the factor of interest. If object is a variance-covariance matrix then this argument should also be specified.

- **labels**: Character. Optional, for labelling the variance-covariance matrix.

- **dispersion**: Numeric. Optional, passed into \texttt{vcov()} with the same argument name.

- **reference.name**: Character. Label for for the reference level.

- **coef.indices**: Optional numeric vector of length at least 3 specifying the indices of the factor from the variance-covariance matrix.

- **estimates**: an optional vector of estimated coefficients (redundant if object is a model).

Details

Suppose a factor with \( L \) levels is an explanatory variable in a regression model. By default, R treats the first level as baseline so that its coefficient is set to zero. It estimates the other \( L - 1 \) coefficients, and with its associated standard errors, this is the conventional output. From the complete variance-covariance matrix one can compute \( L \) quasi-variances based on all pairwise difference of the coefficients. They are based on an approximation, and can be treated as uncorrelated. In minimizing the relative (not absolute) errors it is not hard to see that the estimation involves a RCIM (\texttt{rcim}) with an exponential link function (\texttt{explink}).

If object is a model, then at least one of factorname or coef.indices must be non-NULL. The value of coef.indices, if non-NULL, determines which rows and columns of the model’s variance-covariance matrix to use. If coef.indices contains a zero, an extra row and column are included at the indicated position, to represent the zero variances and covariances associated with a reference level. If coef.indices is NULL, then factorname should be the name of a factor effect in the model, and is used in order to extract the necessary variance-covariance estimates.

Quasi-variances were first implemented in R with \texttt{qvcalc}. This implementation draws heavily from that.
Value

A $L$ by $L$ matrix whose $i$-$j$ element is the logarithm of the variance of the $i$th coefficient minus the $j$th coefficient, for all values of $i$ and $j$. The diagonal elements are arbitrary and are set to zero.

The matrix has an attribute that corresponds to the prior weight matrix; it is accessed by `uninormal` and replaces the usual `weights` argument of `vglm`. This weight matrix has ones on the off-diagonals and some small positive number on the diagonals.

Warning

Negative quasi-variances may occur (one of them and only one), though they are rare in practice. If so then numerical problems may occur. See `qvcalc()` for more information.

Note

This is an adaptation of `qvcalc()` in `qvcalc`. It should work for all `vglm` models with one linear predictor, i.e., $M = 1$. For $M > 1$ the factor should appear only in one of the linear predictors.

It is important to set `maxit` to be larger than usual for `rcim` since convergence is slow. Upon successful convergence the $i$th row effect and the $i$th column effect should be equal. A simple computation involving the fitted and predicted values allows the quasi-variances to be extracted (see example below).

A function to plot comparison intervals has not been written here.

Author(s)

T. W. Yee, based heavily on `qvcalc()` in `qvcalc` written by David Firth.

References


See Also

`rcim`, `vglm`, `qvar`, `uninormal`, `explink`, `qvcalc()` in `qvcalc`, `ships`.

Examples

```r
# Example 1
data("ships", package = "MASS")

Shipmodel <- vglm(incidents ~ type + year + period,
poissonff, offset = log(service),
# trace = TRUE, model = TRUE,
data = ships, subset = (service > 0))
```
# Easiest form of input
fit1 <- rcim(Qvar(Shipmodel, "type"), uninormal("explink"), maxit = 99)
qvar(fit1) # Easy method to get the quasi-variances
qvar(fit1, se = TRUE) # Easy method to get the quasi-standard errors

(quasiVar <- exp(diag(fitted(fit1)) / 2)) # Version 1
(quasiVar <- diag(predict(fit1)[, c(TRUE, FALSE)]) / 2) # Version 2
(quasiSE <- sqrt(quasiVar))

# Another form of input
fit2 <- rcim(Qvar(Shipmodel, coef.ind = c(0, 2:5), reference.name = "typeA"),
             uninormal("explink"), maxit = 99)
## Not run: qvplot(fit2, col = "green", lwd = 3, scl = "blue", slwd = 2, las = 1)

# The variance-covariance matrix is another form of input (not recommended)
fit3 <- rcim(Qvar(cbind(0, rbind(0, vcov(Shipmodel)[2:5, 2:5])),
              labels = c("typeA", "typeB", "typeC", "typeD", "typeE"),
              estimates = c(typeA = 0, coef(Shipmodel)[2:5]),
              uninormal("explink"), maxit = 99)

(QuasiVar <- exp(diag(fitted(fit3)) / 2)) # Version 1
(QuasiVar <- diag(predict(fit3)[, c(TRUE, FALSE)]) / 2) # Version 2
(QuasiSE <- sqrt(QuasiVar))
## Not run: qvplot(fit3)

# Example 2: a model with M > 1 linear predictors
## Not run: require("VGAMdata")
xs.nz.f <- subset(xs.nz, sex == "F")
xs.nz.f <- subset(xs.nz.f, !is.na(babies) & !is.na(age) & !is.na(ethnicity))
xs.nz.f <- subset(xs.nz.f, ethnicity != "Other")

clist <- list("sm.bs(age, df = 4)" = rbind(1, 0),
              "sm.bs(age, df = 3)" = rbind(0, 1),
              "ethnicity" = diag(2),
              "(Intercept)" = diag(2))
fit1 <- vglm(babies ~ sm.bs(age, df = 4) + sm.bs(age, df = 3) + ethnicity,
           zipoissonff(zero = NULL), xs.nz.f,
           constraints = clist, trace = TRUE)
Fit1 <- rcim(Qvar(fit1, "ethnicity", which.linpred = 1),
             uninormal("explink", imethod = 1), maxit = 99, trace = TRUE)
Fit2 <- rcim(Qvar(fit1, "ethnicity", which.linpred = 2),
             uninormal("explink", imethod = 1), maxit = 99, trace = TRUE)
## End(Not run)
## Not run: par(mfrow = c(1, 2))
qvplot(Fit1, scl = "blue", pch = 16, main = expression(eta[1]),
       slwd = 1.5, las = 1, length.arrows = 0.07)
qvplot(Fit2, scl = "blue", pch = 16, main = expression(eta[2]),
       slwd = 1.5, las = 1, length.arrows = 0.07)
## End(Not run)
qvar  

Quasi-variances Extraction Function

Description

Takes a \texttt{rcim} fit of the appropriate format and returns either the quasi-variances or quasi-standard errors.

Usage

\begin{verbatim}
qvar(object, se = FALSE, ...)
\end{verbatim}

Arguments

- **object**: A \texttt{rcim} object that has family function \texttt{uninormal} with the \texttt{explink} link. See below for an example.
- **se**: Logical. If \texttt{FALSE} then the quasi-variances are returned, else the square root of them, called quasi-standard errors.
- **...**: Currently unused.

Details

This simple function is ad hoc and simply is equivalent to computing the quasi-variances by \texttt{diag(predict(fit1[, c(TRUE, FALSE)]) / 2}. This function is for convenience only. Serious users of quasi-variances ought to understand why and how this function works.

Value

A vector of quasi-variances or quasi-standard errors.

Author(s)

T. W. Yee.

See Also

\texttt{rcim, uninormal, explink, Qvar, ships}.

Examples

\begin{verbatim}
data("ships", package = "MASS")
Shipmodel <- vglm(incidents ~ type + year + period,
                 poissonff, offset = log(service),
                 data = ships, subset = (service > 0))

# Easiest form of input
fit1 = rcim(Qvar(Shipmodel, "type"), uninormal("explink"), maxit=99)
qvar(fit1)  # Quasi-variances
\end{verbatim}
qvar(fit1, se = TRUE)  # Quasi-standard errors

# Manually compute them:
(quasiVar <- exp(diag(fitted(fit1))) / 2)  # Version 1
(quasiVar <- diag(predict(fit1)[, c(TRUE, FALSE)]) / 2)  # Version 2
(quasiSE <- sqrt(quasiVar))

## Not run: qvplot(fit1, col = "green", lwd = 3, scol = "blue",
    slwd = 2, las = 1)
## End(Not run)

R2latvar  R-squared for Latent Variable Models

Description
R-squared goodness of fit for latent variable models, such as cumulative link models. Some software such as Stata call the quantity the McKelvey–Zavoina R-squared, which was proposed in their 1975 paper for cumulative probit models.

Usage
R2latvar(object)

Arguments
object  A cumulative or binomialff fit using vglm. Only a few selected link functions are currently permitted: logitlink, probitlink, clogloglink. For models with more than one linear predictor, a parallelism assumption is needed also, i.e., the constraint matrices must be a 1-column matrix of 1s (except for the intercept). The model is assumed to have an intercept term.

Details
Models such as the proportional odds model have a latent variable interpretation (see, e.g., Section 6.2.6 of Agresti (2018), Section 14.4.1.1 of Yee (2015), Section 5.2.2 of McCullagh and Nelder (1989)). It is possible to summarize the predictive power of the model by computing $R^2$ on the transformed scale, e.g., on a standard normal distribution for a probitlink link. For more details see Section 6.3.7 of Agresti (2018).

Value
The $R^2$ value. Approximately, that amount is the variability in the latent variable of the model explained by all the explanatory variables. Then taking the positive square-root gives an approximate multiple correlation $R$.

Author(s)
Thomas W. Yee
Rank

References

See Also
`vglm`, `cumulative`, `propodds`, `logitlink`, `probitlink`, `clogloglink`, `summary.lm`.

Examples
```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, data = pneumo))
R2latvar(fit)
```

<table>
<thead>
<tr>
<th>Rank</th>
<th>Rank</th>
</tr>
</thead>
</table>

Description
Returns the rank of reduced-rank regression-type models in the VGAM package.

Usage
```r
Rank(object, ...)
Rank.rrvglm(object, ...)
Rank.qrrvglm(object, ...)
Rank.rrvgam(object, ...)
```

Arguments
- **object**: Some VGAM object, for example, having class `rrvglm-class`. The class `vglm-class` is not included since this is not based on reduced-rank regression.
- **...**: Other possible arguments fed into the function later (used for added flexibility for the future).

Details
Regression models based on reduced-rank regression have a quantity called the *rank*, which is 1 or 2 or 3 etc. The smaller the value the more dimension reduction, so that there are fewer parameters. This function was not called `rank()` to avoid conflict with `rank`.

Value
Returns an integer value, provided the rank of the model makes sense.
Rayleigh

Note
This function has not been defined for VGLMs yet. It might refer to the rank of the VL model matrix, but for now this function should not be applied to \texttt{vglm} fits.

Author(s)
T. W. Yee.

See Also
RR-VGLMs are described in \texttt{rrvglm-class}; QRR-VGLMs are described in \texttt{qrrvglm-class}.

Examples
pneumo <- transform(pneumo, let = log(exposure.time),
                      x3 = runif(nrow(pneumo)))
(fit1 <- rrvglm(cbind(normal, mild, severe) ~ let + x3,
                acat, data = pneumo))
coef(fit1, matrix = TRUE)
constraints(fit1)
Rank(fit1)

Rayleigh  Rayleigh Distribution

Description
Density, distribution function, quantile function and random generation for the Rayleigh distribution with parameter $a$.

Usage
drayleigh(x, scale = 1, log = FALSE)
prayleigh(q, scale = 1, lower.tail = TRUE, log.p = FALSE)
qrayleigh(p, scale = 1, lower.tail = TRUE, log.p = FALSE)
rrayleigh(n, scale = 1)

Arguments
\begin{itemize}
  \item \texttt{x, q} vector of quantiles.
  \item \texttt{p} vector of probabilities.
  \item \texttt{n} number of observations. Fed into \texttt{runif}.
  \item \texttt{scale} the scale parameter $b$.
  \item \texttt{log} Logical. If \texttt{log = TRUE} then the logarithm of the density is returned.
  \item \texttt{lower.tail, log.p} Same meaning as in \texttt{pnorm} or \texttt{qnorm}.
\end{itemize}
Details

See `rayleigh`, the VGAM family function for estimating the scale parameter \( b \) by maximum likelihood estimation, for the formula of the probability density function and range restrictions on the parameter \( b \).

Value

drayleigh gives the density, prayleigh gives the distribution function, qrayleigh gives the quantile function, and rrayleigh generates random deviates.

Note

The Rayleigh distribution is related to the Maxwell distribution.

Author(s)

T. W. Yee and Kai Huang

References


See Also

`rayleigh`, `maxwell`.

Examples

```r
# Not run: Scale <- 2; x <- seq(-1, 8, by = 0.1)
plot(x, drayleigh(x, scale = Scale), type = "l", ylim = c(0,1),
     las = 1, ylab = "",
     main = "Rayleigh density divided into 10 equal areas; red = CDF")
abline(h = 0, col = "blue", lty = 2)
quq <- qrayleigh(seq(0.1, 0.9, by = 0.1), scale = Scale)
lines(qq, drayleigh(qq, scale = Scale), col = 2, lty = 3, type = "h")
lines(x, prayleigh(x, scale = Scale), col = "red")
# End(Not run)
```

---

**rayleigh**

*Rayleigh Regression Family Function*

**Description**

Estimating the parameter of the Rayleigh distribution by maximum likelihood estimation. Right-censoring is allowed.
Usage

```r
rayleigh(lscale = "loglink", nrfs = 1/3 + 0.01,
    oim.mean = TRUE, zero = NULL, parallel = FALSE,
    type.fitted = c("mean", "percentiles", "Qlink"),
    percentiles = 50)
cens.rayleigh(lscale = "loglink", oim = TRUE)
```

Arguments

- `lscale`: Parameter link function applied to the scale parameter \( b \). See `Links` for more choices. A log link is the default because \( b \) is positive.
- `nrfs`: Numeric, of length one, with value in \([0, 1]\). Weighting factor between Newton-Raphson and Fisher scoring. The value 0 means pure Newton-Raphson, while 1 means pure Fisher scoring. The default value uses a mixture of the two algorithms, and retaining positive-definite working weights.
- `oim.mean`: Logical, used only for intercept-only models. `TRUE` means the mean of the OIM elements are used as working weights. If `TRUE` then this argument has top priority for working out the working weights. `FALSE` means use another algorithm.
- `oim`: Logical. For censored data only, `TRUE` means the Newton-Raphson algorithm, and `FALSE` means Fisher scoring.
- `zero`, `parallel`: Details at `CommonVGAMffArguments`.
- `type.fitted`, `percentiles`: See `CommonVGAMffArguments` for information. Using "Qlink" is for quantile-links in `VGAMextra`.

Details

The Rayleigh distribution, which is used in physics, has a probability density function that can be written

\[
f(y) = y \exp(-0.5(y/b)^2)/b^2
\]

for \( y > 0 \) and \( b > 0 \). The mean of \( Y \) is \( b\sqrt{\pi/2} \) (returned as the fitted values) and its variance is \( b^2(4 - \pi)/2 \).

The `VGAM` family function `cens.rayleigh` handles right-censored data (the true value is greater than the observed value). To indicate which type of censoring, input `extra = list(rightcensored = vec2)` where `vec2` is a logical vector the same length as the response. If the component of this list is missing then the logical values are taken to be `FALSE`. The fitted object has this component stored in the `extra` slot.

The `VGAM` family function `rayleigh` handles multiple responses.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `rrvglm` and `vgam`.

Warning

The theory behind the argument `oim` is not fully complete.
Note

The `poisson.points` family function is more general so that if `ostatistic = 1` and `dimension = 2` then it coincides with `rayleigh`. Other related distributions are the Maxwell and Weibull distributions.

Author(s)

T. W. Yee

References


See Also

`Rayleigh`, `genrayleigh`, `riceff`, `maxwell`, `weibullR`, `poisson.points`, `simulate.vlm`.

Examples

```R
nn <- 1000; Scale <- exp(2)
rdata <- data.frame(ystar = rrayleigh(nn, scale = Scale))
fit <- vglm(ystar ~ 1, rayleigh, data = rdata, trace = TRUE)
head(fitted(fit))
with(rdata, mean(ystar))
coef(fit, matrix = TRUE)
Coef(fit)

# Censored data
rdata <- transform(rdata, U = runif(nn, 5, 15))
rdata <- transform(rdata, y = pmin(U, ystar))
## Not run: par(mfrow = c(1, 2))
hist(with(rdata, ystar)); hist(with(rdata, y))
## End(Not run)
extra <- with(rdata, list(rightcensored = ystar > U))
fit <- vglm(y ~ 1, cens.rayleigh, data = rdata, trace = TRUE,
extra = extra, crit = "coef")
table(fit@extra$rightcen)
coef(fit, matrix = TRUE)
head(fitted(fit))
```

---

### Description

Rearrange the rows and columns of the input so that the first row and first column are baseline. This function is for rank-zero row-column interaction models (RCIMs; i.e., general main effects models).
Rcim

Usage

Rcim(mat, rbaseline = 1, cbaseline = 1)

Arguments

mat              Matrix, of dimension \( r \) by \( c \). It is best that it is labelled with row and column names.
rbaseline, cbaseline
   Numeric (row number of the matrix mat) or character (matching a row name of mat) that the user wants as the row baseline or reference level. Similarly cbaseline for the column.

Details

This is a data preprocessing function for rcim. For rank-zero row-column interaction models this function establishes the baseline (or reference) levels of the matrix response with respect to the row and columns—these become the new first row and column.

Value

Matrix of the same dimension as the input, with rbaseline and cbaseline specifying the first rows and columns. The default is no change in mat.

Note

This function is similar to moffset; see moffset for information about the differences. If numeric, the arguments rbaseline and cbaseline differ from arguments roffset and coffset in moffset by 1 (when elements of the matrix agree).

Author(s)

Alfian F. Hadi and T. W. Yee.

See Also

moffset, rcim, plotrcim0.

Examples

(alcoff.e <- moffset(alcoff, roffset = "6", postfix = "+"))
(aa <- Rcim(alcoff, rbaseline = "11", cbaseline = "Sun"))
(bb <- moffset(alcoff, rbaseline = "11", cbaseline = "Sun", postfix = "+"))

aa - bb  # Note the difference!
Constrained Quadratic Ordination

**Description**

Random generation for constrained quadratic ordination (CQO).

**Usage**

```r
cqo(n, p, S, Rank = 1,
   family = c("poisson", "negbinomial", "binomial-poisson",
     "Binomial-negbinomial", "ordinal-poisson",
     "Ordinal-negbinomial", "gamma2"),
   eq.maximums = FALSE, eq.tolerances = TRUE, es.optimums = FALSE,
   lo.abundance = if (eq.maximums) hi.abundance else 10,
   hi.abundance = 100, sd.latvar = head(1.5/2^(0:3), Rank),
   sd.optimums = ifelse(es.optimums, 1.5/Rank, 1) *
     ifelse(scale.latvar, sd.latvar, 1),
   sd.tolerances = 0.25, Kvector = 1, Shape = 1,
   sqrt.arg = FALSE, log.arg = FALSE, rhox = 0.5, breaks = 4,
   seed = NULL, optimums1.arg = NULL, Crow1positive = TRUE,
   xmat = NULL, scale.latvar = TRUE)
```

**Arguments**

- `n`: Number of sites. It is denoted by `n` below.
- `p`: Number of environmental variables, including an intercept term. It is denoted by `p` below. Must be no less than `1 + R` in value.
- `S`: Number of species. It is denoted by `S` below.
- `Rank`: The rank or the number of latent variables or true dimension of the data on the reduced space. This must be either 1, 2, 3 or 4. It is denoted by `R`.
- `family`: What type of species data is to be returned. The first choice is the default. If binomial then a 0 means absence and 1 means presence. If ordinal then the breaks argument is passed into the breaks argument of `cut`. Note that either the Poisson or negative binomial distributions are used to generate binomial and ordinal data, and that an upper-case choice is used for the negative binomial distribution (this makes it easier for the user). If "gamma2" then this is the 2-parameter gamma distribution.
- `eq.maximums`: Logical. Does each species have the same maximum? See arguments `lo.abundance` and `hi.abundance`.
- `eq.tolerances`: Logical. Does each species have the same tolerance? If `TRUE` then the common value is 1 along every latent variable, i.e., all species' tolerance matrices are the order-`R` identity matrix.
es.optimums Logical. Do the species have equally spaced optimums? If TRUE then the quantity $S^{1/R}$ must be an integer with value 2 or more. That is, there has to be an appropriate number of species in total. This is so that a grid of optimum values is possible in $R$-dimensional latent variable space in order to place the species’ optimums. Also see the argument sd.tolerances.

lo.abundance, hi.abundance Numeric. These are recycled to a vector of length $S$. The species have a maximum between lo.abundance and hi.abundance. That is, at their optimal environment, the mean abundance of each species is between the two componentwise values. If eq.maximums is TRUE then lo.abundance and hi.abundance must have the same values. If eq.maximums is FALSE then the logarithm of the maximums are uniformly distributed between log(lo.abundance) and log(hi.abundance).

sd.latvar Numeric, of length $R$ (recycled if necessary). Site scores along each latent variable have these standard deviation values. This must be a decreasing sequence of values because the first ordination axis contains the greatest spread of the species’ site scores, followed by the second axis, followed by the third axis, etc.

sd.optimums Numeric, of length $R$ (recycled if necessary). If es.optimums = FALSE then, for the $r$th latent variable axis, the optimums of the species are generated from a normal distribution centered about 0. If es.optimums = TRUE then the $S$ optimums are equally spaced about 0 along every latent variable axis. Regardless of the value of es.optimums, the optimums are then scaled to give standard deviation sd.optimums[$r$].

sd.tolerances Logical. If eq.tolerances = FALSE then, for the $r$th latent variable, the species’ tolerances are chosen from a normal distribution with mean 1 and standard deviation sd.tolerances[$r$]. However, the first species $y_1$ has its tolerance matrix set equal to the order-$R$ identity matrix. All tolerance matrices for all species are diagonal in this function. This argument is ignored if eq.tolerances is TRUE, otherwise it is recycled to length $R$ if necessary.

Kvector A vector of positive $k$ values (recycled to length $S$ if necessary) for the negative binomial distribution (see negbinomial for details). Note that a natural default value does not exist, however the default value here is probably a realistic one, and that for large values of $\mu$ one has $Var(Y) = \mu^2/k$ approximately.

Shape A vector of positive $\lambda$ values (recycled to length $S$ if necessary) for the 2-parameter gamma distribution (see gamma2 for details). Note that a natural default value does not exist, however the default value here is probably a realistic one, and that $Var(Y) = \mu^2/\lambda$.

sqrt.arg Logical. Take the square-root of the negative binomial counts? Assigning sqrt.arg = TRUE when family="negbinomial" means that the resulting species data can be considered very crudely to be approximately Poisson distributed. They will not integers in general but much easier (less numerical problems) to estimate using something like cpo(..., family="poissonff").

log.arg Logical. Take the logarithm of the gamma random variates? Assigning log.arg = TRUE when family="gamma2" means that the resulting species data can be considered very crudely to be approximately Gaussian distributed about its (quadratic) mean.

rhox Numeric, less than 1 in absolute value. The correlation between the environmental variables. The correlation matrix is a matrix of 1’s along the diagonal and
rhox in the off-diagonals. Note that each environmental variable is normally distributed with mean 0. The standard deviation of each environmental variable is chosen so that the site scores have the determined standard deviation, as given by argument sd.latvar.

**breaks**
If family is assigned an ordinal value then this argument is used to define the cutpoints. It is fed into the breaks argument of `cut`.

**seed**
If given, it is passed into `set.seed`. This argument can be used to obtain reproducible results. If set, the value is saved as the "seed" attribute of the returned value. The default will not change the random generator state, and return `Random.seed` as "seed" attribute.

**optimums1.arg**
If assigned and Rank = 1 then these are the explicitly optimums. Recycled to length S.

**Crow1positive**
See `qrrvglm.control` for details.

**xmat**
The \( n \) by \( p-1 \) environmental matrix can be inputted.

**scale.latvar**
Logical. If FALSE the argument sd.latvar is ignored and no scaling of the latent variable values is performed.

**Details**
This function generates data coming from a constrained quadratic ordination (CQO) model. In particular, data coming from a species packing model can be generated with this function. The species packing model states that species have equal tolerances, equal maximums, and optimums which are uniformly distributed over the latent variable space. This can be achieved by assigning the arguments `es.optimums = TRUE`, `eq.maximums = TRUE`, `eq.tolerances = TRUE`.

At present, the Poisson and negative binomial abundances are generated first using `lo.abundance` and `hi.abundance`, and if family is binomial or ordinal then it is converted into these forms.

In CQO theory the \( n \) by \( p \) matrix \( X \) is partitioned into two parts \( X_1 \) and \( X_2 \). The matrix \( X_2 \) contains the ‘real’ environmental variables whereas the variables in \( X_1 \) are just for adjustment purposes; they contain the intercept terms and other variables that one wants to adjust for when (primarily) looking at the variables in \( X_2 \). This function has \( X_1 \) only being a matrix of ones, i.e., containing an intercept only.

**Value**
A \( n \) by \( p-1+S \) data frame with components and attributes. In the following the attributes are labelled with double quotes.

- **x2, x3, x4, ..., xp**
The environmental variables. This makes up the \( n \) by \( p-1 \) \( X_2 \) matrix. Note that \( x1 \) is not present; it is effectively a vector of ones since it corresponds to an intercept term when `cqo` is applied to the data.

- **y1, y2, x3, ..., yS**
The species data. This makes up the \( n \) by \( S \) matrix \( Y \). This will be of the form described by the argument family.

- "concoefficients"
The \( p-1 \) by \( R \) matrix of constrained coefficients (or canonical coefficients). These are also known as weights or loadings.
The formula involving the species and environmental variable names. This can be used directly in the formula argument of `cqo`.

The \( S \)-vector of species' maximums, on a log scale. These are uniformly distributed between \( \log(\text{lo.abundance}) \) and \( \log(\text{hi.abundance}) \).

The \( n \) by \( R \) matrix of site scores. Each successive column (latent variable) has sample standard deviation equal to successive values of `sd.latvar`.

The linear/additive predictor value.

The \( S \) by \( R \) matrix of species' optimums.

The \( S \) by \( R \) matrix of species' tolerances. These are the square root of the diagonal elements of the tolerance matrices (recall that all tolerance matrices are restricted to being diagonal in this function).

Other attributes are "break", "family", "Rank", "lo.abundance", "hi.abundance", "eq.tolerances", "eq.maximums", "seed" as used.

Note

This function is under development and is not finished yet. There may be a few bugs.

Yet to do: add an argument that allows absences to be equal to the first level if ordinal data is requested.

Author(s)

T. W. Yee

References


See Also

cqo, qrrvglm.control, cut, binomialff, poissonff, negbinomial, gamma2.

Examples

```r
## Not run:
# Example 1: Species packing model:
n <- 100; p <- 5; S <- 5
mydata <- rcqo(n, p, S, es.opt = TRUE, eq.max = TRUE)
names(mydata)
(myform <- attr(mydata, "formula"))
fit <- cqo(myform, poissonff, mydata, Bestof = 3) # eq.tol = TRUE
matplot(attr(mydata, "latvar"), mydata[,-(1:(p-1))], col = 1:S)
persp(fit, col = 1:S, add = TRUE)
```
rvplot(fit, lcol = 1:S, y = TRUE, pcol = 1:S) # Same plot as above
# Compare the fitted model with the 'truth'
concoef(fit) # The fitted model
attr(mydata, "concoefficients") # The 'truth'

c(apply(attr(mydata, "latvar"), 2, sd),
apply(latvar(fit), 2, sd)) # Both values should be approx equal

# Example 2: negative binomial data fitted using a Poisson model:
n <- 200; p <- 5; S <- 5
mydata <- rcqo(n, p, S, fam = "negbin", sqrt = TRUE)
myform <- attr(mydata, "formula")
fit <- cqo(myform, fam = poissonff, dat = mydata) # I.tol = TRUE,
rvplot(fit, lcol = 1:S, y = TRUE, pcol = 1:S)
# Compare the fitted model with the 'truth'
concoef(fit) # The fitted model
attr(mydata, "concoefficients") # The 'truth'

## End(Not run)

---

**rdiric**

*The Dirichlet distribution*

**Description**

Generates Dirichlet random variates.

**Usage**

```r
diric(n, shape, dimension = NULL, is.matrix.shape = FALSE)
```

**Arguments**

- `n`: number of observations. Note it has two meanings, see `is.matrix.shape` below.
- `shape`: the shape parameters. These must be positive. If dimension is specified, values are recycled if necessary to length `dimension`.
- `dimension`: the dimension of the distribution. If dimension is not numeric then it is taken to be `length(shape)` (or `ncol(shape)` if `is.matrix.shape == TRUE`).
- `is.matrix.shape`: Logical. If TRUE then shape must be a matrix, and then n is no longer the number of rows of the answer but the answer has n * nrow(shape) rows. If FALSE (the default) then shape is a vector and each of the n rows of the answer have shape as its shape parameters.
Details

This function is based on a relationship between the gamma and Dirichlet distribution. Random
gamma variates are generated, and then Dirichlet random variates are formed from these.

Value

A n by dimension matrix of Dirichlet random variates. Each element is positive, and each row will
sum to unity. If shape has names then these will become the column names of the answer.

Author(s)

Thomas W. Yee

References

Springer-Verlag.

See Also

dirichlet is a VGAM family function for fitting a Dirichlet distribution to data.

Examples

ddata <- data.frame(rdiric(n = 1000, shape = c(y1 = 3, y2 = 1, y3 = 4)))
fit <- vglm(cbind(y1, y2, y3) ~ 1, dirichlet, data = ddata, trace = TRUE)
Coef(fit)
coef(fit, matrix = TRUE)

Description

Maximum likelihood estimation of the rate parameter of a 1-parameter exponential distribution
when the observations are upper record values.

Usage

rec.exp1(lrate = "loglink", irate = NULL, imethod = 1)

Arguments

lrate Link function applied to the rate parameter. See Links for more choices.
irate Numeric. Optional initial values for the rate. The default value NULL means they are computed internally, with the help of imethod.
imethod Integer, either 1 or 2 or 3. Initial method, three algorithms are implemented. Choose the another value if convergence fails, or use irate.
Details

The response must be a vector or one-column matrix with strictly increasing values.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

By default, this family function has the intercept-only MLE as the initial value, therefore convergence may only take one iteration. Fisher scoring is used.

Author(s)

T. W. Yee

References


See Also

exponential.

Examples

rawy <- rexp(n <- 10000, rate = exp(1))
y <- unique(cummax(rawy))  # Keep only the records
length(y) / y[length(y)]  # MLE of rate

fit <- vglm(y ~ 1, rec.exp1, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
rec.normal

Arguments

lmean, lsd Link functions applied to the mean and sd parameters. See Links for more choices.
imean, isn Numeric. Optional initial values for the mean and sd. The default value NULL means they are computed internally, with the help of imethod.
imethod Integer, either 1 or 2 or 3. Initial method, three algorithms are implemented. Choose the another value if convergence fails, or use imean and/or isn.
zero Can be an integer vector, containing the value 1 or 2. If so, the mean or standard deviation respectively are modelled as an intercept only. Usually, setting zero = 2 will be used, if used at all. The default value NULL means both linear/additive predictors are modelled as functions of the explanatory variables. See CommonVGAMffArguments for more information.

Details

The response must be a vector or one-column matrix with strictly increasing values.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

This family function tries to solve a difficult problem, and the larger the data set the better. Convergence failure can commonly occur, and convergence may be very slow, so set maxit = 200, trace = TRUE, say. Inputting good initial values are advised.

This family function uses the BFGS quasi-Newton update formula for the working weight matrices. Consequently the estimated variance-covariance matrix may be inaccurate or simply wrong! The standard errors must be therefore treated with caution; these are computed in functions such as vcov() and summary().

Author(s)

T. W. Yee

References


See Also

uninormal, double.cens.normal.
Examples

```r
nn <- 10000; mymean <- 100
# First value is reference value or trivial record
Rdata <- data.frame(rawy = c(mymean, rnorm(nn, mymean, exp(3))))
# Keep only observations that are records:
rdata <- data.frame(y = unique(cummax(with(Rdata, rawy))))
fit <- vglm(y ~ 1, rec.normal, rdata, trace = TRUE, maxit = 200)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
```

recipcallink  
*Reciprocal Link Function*

### Description
Computes the reciprocal transformation, including its inverse and the first two derivatives.

### Usage
```r
recipcallink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
short = TRUE, tag = FALSE)
negrecipcallink(theta, bvalue = NULL, inverse = FALSE, deriv = 0,
short = TRUE, tag = FALSE)
```

### Arguments
- `theta`: Numeric or character. See below for further details.
- `bvalue`: See Links.
- `inverse`, `deriv`, `short`, `tag`: Details at Links.

### Details
The `recipcallink` link function is a special case of the power link function. Numerical values of `theta` close to 0 result in Inf, -Inf, NA or NaN.

The `negrecipcallink` link function computes the negative reciprocal, i.e., $-1/\theta$.

### Value
For `recipcallink`: for `deriv = 0`, the reciprocal of `theta`, i.e., $1/\theta$ when `inverse = FALSE`, and if `inverse = TRUE` then $1/\theta$. For `deriv = 1`, then the function returns $d\ theta / d\ eta$ as a function of `theta` if `inverse = FALSE`, else if `inverse = TRUE` then it returns the reciprocal.

### Note
Numerical instability may occur when `theta` is close to 0.
residualsvglm

Author(s)
Thomas W. Yee

References

See Also
identitylink, powerlink.

Examples
reciprocallink(1:5)
reciprocallink(1:5, inverse = TRUE, deriv = 2)
negreciprocallink(1:5)
negreciprocallink(1:5, inverse = TRUE, deriv = 2)

x <- (-3):3
reciprocallink(x)  # Has Inf
reciprocallink(x, bvalue = .Machine$double.eps)  # Has no Inf

residualsvglm

Residuals for a VGLM fit

Description
Residuals for a vector generalized linear model (VGLM) object.

Usage
residualsvglm(object, type = c("working", "pearson", "response",
"deviance", "ldot", "stdres", "rquantile"), matrix.arg = TRUE)

Arguments
object Object of class "vglm", i.e., a vglm fit.
type The value of this argument can be abbreviated. The type of residuals to be returned. The default is the first one: working residuals corresponding to the IRLS algorithm. These are defined for all models. They are sometimes added to VGAM plots of estimated component functions (see plotvgam). Pearson residuals for GLMs, when squared and summed over the data set, total to the Pearson chi-squared statistic. For VGLMs, Pearson residuals involve the working weight matrices and the score vectors. Under certain limiting conditions, Pearson residuals have 0 means and identity matrix as the variance-covariance matrix.
Response residuals are simply the difference between the observed values and the fitted values. Both have to be of the same dimension, hence not all families have response residuals defined.

Deviance residuals are only defined for models with a deviance function. They tend to GLMs mainly. This function returns a NULL for those models whose deviance is undefined.

Randomized quantile residuals (RQRs) (Dunn and Smyth, 1996) are based on the p-type function being fed into \texttt{qnorm}. For example, for the default \texttt{exponential} it is \texttt{qnorm(pexp(y, rate = 1 / fitted(object)))}. So one should expect these residuals to have a standard normal distribution if the model and data agree well. If the distribution is discrete then \texttt{randomized} values are returned; see \texttt{runif} and \texttt{set.seed}. For example, for the default \texttt{poissonff} it is \texttt{qnorm(runif(length(y), ppois(y - 1, mu), ppois(y, mu)))} where \(\mu\) is the fitted mean. The following excerpts comes from their writings. They highly recommend quantile residuals for discrete distributions since plots using deviance and Pearson residuals may contain distracting patterns. Four replications of the quantile residuals are recommended with discrete distributions because they have a random component. Any features not preserved across all four sets of residuals are considered artifacts of the randomization. This type of residual is continuous even for discrete distributions; for both discrete and continuous distributions, the quantile residuals have an exact standard normal distribution.

The choice "ldot" should not be used currently.

Standardized residuals are currently only defined for 2 types of models: (i) GLMs (\texttt{poissonff}, \texttt{binomialff}); (ii) those fitted to a two-way table of counts, e.g., \texttt{cumulative}, \texttt{acat}, \texttt{multinomial}, \texttt{sratio}, \texttt{cratio}. For (ii), they are defined in Section 2.4.5 of Agresti (2018) and are also the output from the "stdres" component of \texttt{chisq.test}. For the test of independence they are a useful type of residual. Their formula is (observed - expected) / \sqrt(V), where \(V\) is the residual cell variance (also see Agresti, 2007, section 2.4.5). When an independence null hypothesis is true, each standardized residual (corresponding to a cell in the table) has a a large-sample standard normal distribution. Currently this function merely extracts the table of counts from object and then computes the standardized residuals like \texttt{chisq.test}.

\texttt{matrix.arg} Logical, which applies when if the pre-processed answer is a vector or a 1-column matrix. If \texttt{TRUE} then the value returned will be a matrix, else a vector.

Details

This function returns various kinds of residuals, sometimes depending on the specific type of model having been fitted. Section 3.7 of Yee (2015) gives some details on several types of residuals defined for the VGLM class.

Standardized residuals for GLMs are described in Section 4.5.6 of Agresti (2013) as the ratio of the raw (response) residuals divided by their standard error. They involve the generalized hat matrix evaluated at the final IRLS iteration. When applied to the LM, standardized residuals for GLMs simplify to \texttt{rstandard}. For GLMs they are basically the Pearson residual divided by the square root of 1 minus the leverage.
Value

If that residual type is undefined or inappropriate or not yet implemented, then NULL is returned, otherwise a matrix or vector of residuals is returned.

Warning

This function may change in the future, especially those whose definitions may change.

References


See Also

resid, vglm, chisq.test, hatvalues.

Examples

```r
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo)
resid(fit) # Same as having type = "working" (the default)
resid(fit, type = "response")
resid(fit, type = "pearson")
resid(fit, type = "stdres") # Test for independence
```

rhubitlink  Rhubit Link Function

Description

Computes the rhubit link transformation, including its inverse and the first two derivatives.

Usage

```r
rhubitlink(theta, bminvalue = NULL, bmaxvalue = NULL,
          inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
```
**Arguments**

theta Numeric or character. See below for further details.

bminvalue, bmaxvalue
Optional boundary values, e.g., values of theta which are less than or equal to -1 can be replaced by bminvalue before computing the link function value. And values of theta which are greater than or equal to 1 can be replaced by bmaxvalue before computing the link function value. See Links.

inverse, deriv, short, tag
Details at Links.

**Details**

The rhobitlink link function is commonly used for parameters that lie between $-1$ and $1$. Numerical values of theta close to $-1$ or $1$ or out of range result in Inf, -Inf, NA or NaN.

**Value**

For deriv = 0, the rhobit of theta, i.e., \( \log((1 + \theta)/(1 - \theta)) \) when inverse = FALSE, and if inverse = TRUE then \((\exp(\theta) - 1)/(\exp(\theta) + 1)\).

For deriv = 1, then the function returns \( d\theta/d\theta \) as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

**Note**

Numerical instability may occur when theta is close to $-1$ or $1$. One way of overcoming this is to use bminvalue, etc.

The correlation parameter of a standard bivariate normal distribution lies between $-1$ and $1$, therefore this function can be used for modelling this parameter as a function of explanatory variables.

The link function rhobitlink is very similar to fisherzlink, e.g., just twice the value of fisherzlink.

**Author(s)**

Thomas W. Yee

**See Also**

Links, binom2.rho, fisherz.

**Examples**

```r
theta <- seq(-0.99, 0.99, by = 0.01)
y <- rhobitlink(theta)
## Not run:
plot(theta, y, type = "l", ylab = "", main = "rhobitlink(theta)")
abline(v = 0, h = 0, lty = 2)
## End(Not run)

x <- c(seq(-1.02, -0.98, by = 0.01), seq(0.97, 1.02, by = 0.01))
```

The Rice Distribution

Description
Density, distribution function, quantile function and random generation for the Rician distribution.

Usage

```
drice(x, sigma, vee, log = FALSE)
price(q, sigma, vee, lower.tail = TRUE, log.p = FALSE, ...)
qrice(p, sigma, vee, lower.tail = TRUE, log.p = FALSE, ...)
rrice(n, sigma, vee)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. Same as in `runif`.
- `vee, sigma` See `riceff`.
- `...` Other arguments such as `lower.tail`.
- `log` Logical. If `log = TRUE` then the logarithm of the density is returned.

Details
See `riceff`, the VGAM family function for estimating the two parameters, for the formula of the probability density function and other details.
Formulas for `price()` and `qrice()` are based on the Marcum-Q function.

Value
`drice` gives the density, `price` gives the distribution function, `qrice` gives the quantile function, and `rrice` generates random deviates.

Author(s)
T. W. Yee and Kai Huang

See Also
`riceff`
Examples

```r
## Not run: x <- seq(0.01, 7, len = 201)
plot(x, drice(x, vee = 0, sigma = 1), type = "n", las = 1,
     ylab = "",
     main = "Density of Rice distribution for various v values")
sigma <- 1; vee <- c(0, 0.5, 1, 2, 4)
for (ii in 1:length(vee))
  lines(x, drice(x, vee = vee[ii], sigma), col = ii)
legend(x = 5, y = 0.6, legend = as.character(vee),
       col = 1:length(vee), lty = 1)

x <- seq(0, 4, by = 0.01); vee <- 1; sigma <- 1
probs <- seq(0.05, 0.95, by = 0.05)
plot(x, drice(x, vee = vee, sigma = sigma), type = "l",
     main = "Blue is density, orange is CDF", col = "blue",
     ylim = c(0, 1), sub = "Red are 5, 10, ..., 95 percentiles",
     las = 1, ylab = "", cex.main = 0.9)
abline(h = 0:1, col = "black", lty = 2)
Q <- qrice(probs, sigma, vee = vee)
lines(Q, drice(qrice(probs, sigma, vee = vee),
               sigma, vee = vee), col = "red", lty = 3, type = "h")
lines(x, price(x, vee = vee), type = "l", col = "orange")
lines(Q, price(Q, sigma, vee = vee), col = "red", lty = 3, type = "h")
abline(h = probs, col = "red", lty = 3)
max(abs(price(Q, sigma, vee = vee) - probs)) # Should be 0
```

## End(Not run)

---

**riceff**

**Rice Distribution Family Function**

**Description**

Estimates the two parameters of a Rice distribution by maximum likelihood estimation.

**Usage**

```r
riceff(lsigma = "loglink", lvee = "loglink", isigma = NULL,
       ivee = NULL, nsimEIM = 100, zero = NULL, nowarning = FALSE)
```

**Arguments**

- **nowarning** Logical. Suppress a warning? Ignored for VGAM 0.9-7 and higher.
- **lvee, lsigma** Link functions for the \(v\) and \(\sigma\) parameters. See **Links** for more choices and for general information.
- **ivee, isigma** Optional initial values for the parameters. If convergence failure occurs (this VGAM family function seems to require good initial values) try using these arguments. See **CommonVGAMffArguments** for more information.
- **nsimEIM, zero** See **CommonVGAMffArguments** for information.
The Rician distribution has density function

\[ f(y; v, \sigma) = \frac{y}{\sigma^2} \exp\left(-\left(\frac{y^2 + v^2}{2\sigma^2}\right)\right) I_0\left(\frac{yv}{\sigma^2}\right) \]

where \( y > 0 \), \( v > 0 \), \( \sigma > 0 \) and \( I_0 \) is the modified Bessel function of the first kind with order zero. When \( v = 0 \) the Rice distribution reduces to a Rayleigh distribution. The mean is \( \sigma \sqrt{\frac{\pi}{2}} \exp\left(\frac{z}{2}\right)((1 - z)I_0(-z/2) - zI_1(-z/2)) \) (returned as the fitted values) where \( z = -\frac{v^2}{2\sigma^2} \). Simulated Fisher scoring is implemented.

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Convergence problems may occur for data where \( v = 0 \); if so, use rayleigh or possibly use an identity link.

When \( v \) is large (greater than 3, say) then the mean is approximately \( v \) and the standard deviation is approximately \( \sigma \).

T. W. Yee


See Also
drice, rayleigh, besselI, simulate.vlm.

## Examples

```r
## Not run: sigma <- exp(1); vee <- exp(2)
  rdata <- data.frame(y = rrice(n <- 1000, sigma, vee = vee))
  fit <- vglm(y ~ 1, riceff, data = rdata, trace = TRUE, crit = "c")
  c(with(rdata, mean(y)), fitted(fit)[1])
  coef(fit, matrix = TRUE)
  Coef(fit)
  summary(fit)
## End(Not run)
```
### rigff

**Reciprocal Inverse Gaussian distribution**

**Description**

Estimation of the parameters of a reciprocal inverse Gaussian distribution.

**Usage**

```r
ingff(lmu = "identitylink", llambda = "loglink", imu = NULL, ilambda = 1)
```

**Arguments**

- `lmu, llambda`: Link functions for `mu` and `lambda`. See `Links` for more choices.
- `imu, ilambda`: Initial values for `mu` and `lambda`. A `NULL` means a value is computed internally.

**Details**

See Jorgensen (1997) for details.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

**Note**

This distribution is potentially useful for dispersion modelling.

**Author(s)**

T. W. Yee

**References**


**See Also**

`simplex`.

**Examples**

```r
data <- data.frame(y = rchisq(100, df = 14))  # Not 'proper' data!!
fit <- vglm(y ~ 1, rigff, data, trace = TRUE)
fit <- vglm(y ~ 1, rigff, data, trace = TRUE, crit = "c")
summary(fit)
```
**rlplot.gevff**

**Return Level Plot for GEV Fits**

**Description**

A return level plot is constructed for a GEV-type model.

**Usage**

```r
rlplot.gevff(object, show.plot = TRUE,
              probability = c((1:9)/100, (1:9)/10, 0.95, 0.99, 0.995, 0.999),
              add.arg = FALSE, xlab = if(log.arg) "Return Period (log-scale)" else
              "Return Period", ylab = "Return Level",
              main = "Return Level Plot",
              pch = par()$pch, pcol.arg = par()$col, pcex = par()$cex,
              lty.arg = par()$lty, lcol.arg = par()$col, llwd.arg = par()$lwd,
              slty.arg = par()$lty, scol.arg = par()$col, slwd.arg = par()$lwd,
              ylim = NULL, log.arg = TRUE, CI = TRUE, epsilon = 1e-05, ...)
```

**Arguments**

- **object**: A VGAM extremes model of the GEV-type, produced by `vglm` with a family function either "gev" or "gevff".
- **show.plot**: Logical. Plot it? If FALSE no plot will be done.
- **probability**: Numeric vector of probabilities used.
- **add.arg**: Logical. Add the plot to an existing plot?
- **xlab**: Caption for the x-axis. See `par`.
- **ylab**: Caption for the y-axis. See `par`.
- **main**: Title of the plot. See `title`.
- **pch**: Plotting character. See `par`.
- **pcol.arg**: Color of the points. See the `col` argument of `par`.
- **pcex**: Character expansion of the points. See the `cex` argument of `par`.
- **lty.arg**: Line type. Line type. See the `lty` argument of `par`.
- **lcol.arg**: Color of the lines. See the `col` argument of `par`.
- **llwd.arg**: Line width. See the `lwd` argument of `par`.
- **slty.arg, scol.arg, slwd.arg**: Corresponding arguments for the lines used for the confidence intervals. Used only if CI=TRUE.
- **ylim**: Limits for the y-axis. Numeric of length 2.
- **log.arg**: Logical. If TRUE then log="" otherwise log="x". This changes the labelling of the x-axis only.
- **CI**: Logical. Add in a 95 percent confidence interval?
epsilon

Numeric, close to zero. Used for the finite-difference approximation to the first derivatives with respect to each parameter. If too small, numerical problems will occur.

Arguments passed into the plot function when setting up the entire plot. Useful arguments here include sub and las.

Details

A return level plot plots $z_p$ versus $\log(y_p)$. It is linear if the shape parameter $\xi = 0$. If $\xi < 0$ then the plot is convex with asymptotic limit as $p$ approaches zero at $\mu - \sigma/\xi$. And if $\xi > 0$ then the plot is concave and has no finite bound. Here, $G(z_p) = 1 - p$ where $0 < p < 1$ ($p$ corresponds to the argument probability) and $G$ is the cumulative distribution function of the GEV distribution. The quantity $z_p$ is known as the **return level** associated with the **return period** $1/p$. For many applications, this means $z_p$ is exceeded by the annual maximum in any particular year with probability $p$.

The points in the plot are the actual data.

Value

In the **post** slot of the object is a list called rlplot with list components

- yp: $-\log(\text{probability})$, which is used on the x-axis.
- zp: values which are used for the y-axis.
- lower, upper: lower and upper confidence limits for the 95 percent confidence intervals evaluated at the values of probability (if CI=TRUE).

Note

The confidence intervals are approximate, being based on finite-difference approximations to derivatives.

Author(s)

T. W. Yee

References


See Also

devf.
Examples

gdata <- data.frame(y = rgev(n <- 100, scale = 2, shape = -0.1))
fit <- vglm(y ~ 1, gevff, data = gdata, trace = TRUE)

# Identity link for all parameters:
fit2 <- vglm(y ~ 1, gevff(lshape = identitylink, lscale = identitylink,
iscale = 10), data = gdata, trace = TRUE)

coef(fit2, matrix = TRUE)

## Not run:
par(mfrow = c(1, 2))
rlplot(fit) -> i1
rlplot(fit2, pcol = "darkorange", lcol = "blue", log.arg = FALSE,
scol = "darkgreen", slty = "dashed", las = 1) -> i2
range(i2@post$rlplot$upper - i1@post$rlplot$upper) # Should be near 0
range(i2@post$rlplot$lower - i1@post$rlplot$lower) # Should be near 0

## End(Not run)

---

rootogram4

Rootograms (S4 generic) for Assessing Goodness of Fit of Probability Models

Description

A graphical technique for comparing the observed and fitted counts from a probability model, on a square root scale.

Usage

rootogram4(object, ...)
rootogram4vglm(object, newdata = NULL, breaks = NULL, max = NULL,
xlab = NULL, main = NULL, width = NULL, ...)

Arguments

- **object**: an object of class "vglm". This includes "vgam" because "vlm" handles both VGLM and VGAM objects.
- **newdata**: Data upon which to base the calculations. The default is the one used to fit the model.
- **breaks**: numeric. Breaks for the histogram intervals.
- **max**: maximum count displayed. If an error message occurs regarding running out of memory then use this argument; it might occur with a very long tailed distribution such as gaitdzeta.
- **xlab, main**: graphical parameters.
- **width**: numeric. Widths of the histogram bars.
- **...**: any additional arguments to rootogram.default and plot.rootogram in countreg. Probably the most useful of these are style = c("hanging", "standing", "suspended") and scale = c("sqrt", "raw").
Details

Rootograms are a useful graphical technique for comparing the observed counts with the expected counts given a probability model.

This S4 implementation is based very heavily on rootogram coming from countreg. This package is primarily written by A. Zeileis and C. Kleiber. That package is currently on R-Forge but not CRAN, and it is based on S3. Since VGAM is written using S4, it was necessary to define an S4 generic function called rootogram4() which dispatches appropriately for S4 objects.

Currently, only a selected number of VGAM family functions are implemented. Over time, hopefully more and more will be completed.

Value

See rootogram in countreg; an object of class "rootogram0" inheriting from "data.frame" with about 8 variables.

Warning

This function is rudimentary and based totally on the implementation in countreg.

Note

The function names used coming from countreg have been renamed slightly to avoid conflict.

Author(s)

Package countreg is primarily written by A. Zeileis and C. Kleiber. Function rootogram4() is based very heavily on countreg. T. W. Yee wrote code to unpack variables from many various models and feed them into the appropriate d-type function.

References


See Also

vglm, vgam, glm, zipoisson, zapoisson, rootogram in countreg.

Examples

## Not run:
data("hspider", package = "VGAM")  # Count responses
hs.p <- vglm(Pardlugu ~ CoveHerb, poissonff, data = hspider)
hs.nb <- vglm(Pardlugu ~ CoveHerb, negbinomial, data = hspider)
hs.zip <- vglm(Pardlugu ~ CoveHerb, zipoisson, data = hspider)
hs.zap <- vglm(Pardlugu ~ CoveHerb, zapoisson, data = hspider)
opar <- par(mfrow = c(2, 2)) # Plot the rootograms
rootogram4(hs.p, max = 15, main = "poissonff")
rootogram4(hs.nb, max = 15, main = "negbinomial")
rootogram4(hs.zip, max = 15, main = "zipoisson")
rootogram4(hs.zap, max = 15, main = "zapoisson")
par(opar)

## End(Not run)

description

'round2' works like 'round' but the rounding has base 2 under consideration so that bits (binary digits) beyond a certain threshold are zeroed.

Usage

round2(x, digits10 = 0)

Arguments

x Same as round.
digits10 Same as digits in round. The "10" is to emphasize the usual base 10 used by humans.

Details

round2() is intended to allow reliable and safe for == comparisons provided both sides have the function applied to the same value of digits10. Internally a numeric has its binary representation (bits) past a certain point set to all 0s, while retaining a certain degree of accuracy. Algorithmically, x is multiplied by 2^exponent and then rounded, and then divided by 2^exponent. The value of exponent is approximately 3 * digits10 when digits10 is positive. If digits10 is negative then what is returned is round(x, digits10). The value of exponent guarantees that x has been rounded to at least digits10 decimal places (often around digits10 + 1 for safety).

Value

Something similar to round.

Author(s)

T. W. Yee.

See Also

round, tobit.
Examples

```r
cat("set.seed(1); x <- sort(rcauchy(10))")
x3 <- round2(x, 3)
x3 == round2(x, 3) # Supposed to be reliable (all TRUE)
rbind(x, x3) # Comparison
(x3[1] * 2^(0:9)) / 2^(0:9)
print((x3[1] * 2^(0:11)), digits = 14)

# Round to approx 1 d.p.
x1 <- round2(x, 1)
x1 == round2(x, 1) # Supposed to be reliable (all TRUE)
rbind(x, x1)
x1[8] == 0.75 # 3/4
print((x1[1] * 2^(0:11)), digits = 9)
seq(3) / 32
```

RRAR

Nested Reduced-rank Autoregressive Models for Multiple Time Series

Description

Estimates the parameters of a nested reduced-rank autoregressive model for multiple time series.

Usage

```r
rrar(Ranks = 1, coefstart = NULL)
```

Arguments

- **Ranks**: Vector of integers: the ranks of the model. Each value must be at least one and no more than M, where M is the number of response variables in the time series. The length of Ranks is the lag, which is often denoted by the symbol L in the literature.

- **coefstart**: Optional numerical vector of initial values for the coefficients. By default, the family function chooses these automatically.

Details

Full details are given in Ahn and Reinsel (1988). Convergence may be very slow, so setting `maxits = 50`, say, may help. If convergence is not obtained, you might like to try inputting different initial values.

Setting `trace = TRUE` in `vglm` is useful for monitoring the progress at each iteration.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

---

Find your code in Notebooks and similar resources can be found in the R package documentation.
Note

This family function should be used within \texttt{vglm} and not with \texttt{rrvglm} because it does not fit into the RR-VGLM framework exactly. Instead, the reduced-rank model is formulated as a VGLM!

A methods function \texttt{Coef.rrar}, say, has yet to be written. It would return the quantities \(A_{k1}, C, D, \omega_{\hat{\text{e}}} \), etc. as slots, and then \texttt{show.Coeff.rrar} would also need to be written.

Author(s)

T. W. Yee

References


See Also

\texttt{vglm}, \texttt{grain.us}.

Examples

```r
## Not run:
year <- seq(1961 + 1/12, 1972 + 10/12, by = 1/12)
par(mar = c(4, 4, 2, 2) + 0.1, mfilow = c(2, 2))
for (ii in 1:4) {
  plot(year, grain.us[, ii], main = names(grain.us)[ii], las = 1,
       type = "l", xlab = "", ylab = "", col = "blue")
  points(year, grain.us[, ii], pch = "*", col = "blue")
}
apply(grain.us, 2, mean) # mu vector
cgrain <- scale(grain.us, scale = FALSE) # Center the time series only
fit <- vglm(cgrain ~ 1, rrar(Ranks = c(4, 1)), trace = TRUE)
summary(fit)
print(fit@misc$Ak1, digits = 2)
print(fit@misc$Cmatrices, digits = 3)
print(fit@misc$Dmatrices, digits = 3)
print(fit@misc$omegahat, digits = 3)
print(fit@misc$Phimatrices, digits = 2)
par(mar = c(4, 4, 2, 2) + 0.1, mfilow = c(4, 1))
for (ii in 1:4) {
  plot(year, fit@misc$Z[, ii], main = paste("Z", ii, sep = ""),
       type = "l", xlab = "", ylab = "", las = 1, col = "blue")
  points(year, fit@misc$Z[, ii], pch = "*", col = "blue")
}
## End(Not run)
```
rrvglm  Fitting Reduced-Rank Vector Generalized Linear Models (RR-VGLMs) and Doubly Constrained RR-VGLMs (DRR-VGLMs)

Description

A reduced-rank vector generalized linear model (RR-VGLM) is fitted. RR-VGLMs are VGLMs but some of the constraint matrices are estimated. Doubly constrained RR-VGLMs (DRR-VGLMs) can also be fitted, and these provide structure for the two other outer product matrices.

Usage

rrvglm(formula, family = stop("'family' is unassigned"),
data = list(), weights = NULL, subset = NULL,
na.action = na.fail, etastart = NULL, mustart = NULL,
coefstart = NULL, control = rrvglm.control(...),
offset = NULL, method = "rrvglm.fit", model = FALSE,
x.arg = TRUE, y.arg = TRUE, contrasts = NULL,
constraints = NULL, extra = NULL, qr.arg = FALSE,
smart = TRUE, ...)

Arguments

formula, family  See vglm.
weights, data  See vglm.
subset, na.action  See vglm.
etastart, mustart, coefstart  See vglm.
control  a list of parameters for controlling the fitting process. See rrvglm.control for details.
offset, model, contrasts  See vglm.
method  the method to be used in fitting the model. The default (and presently only) method rrvglm.fit uses iteratively reweighted least squares (IRLS).
x.arg, y.arg  logical values indicating whether the model matrix and response vector/matrix used in the fitting process should be assigned in the x and y slots. Note the model matrix is the LM model matrix; to get the VGLM model matrix type model.matrix(vglmfit) where vglmfit is a vglm object.
constraints  See vglm.
extra, smart, qr.arg  See vglm.
...  further arguments passed into rrvglm.control.
Details

In this documentation, $M$ is the number of linear predictors. For RR-VGLMs, the central formula is given by

$$\eta = B^T x_1 + A \nu$$

where $x_1$ is a vector (usually just a 1 for an intercept), $x_2$ is another vector of explanatory variables, and $\nu = C^T x_2$ is an $R$-vector of latent variables. Here, $\eta$ is a vector of linear predictors, e.g., the $m$th element is $\eta_m = \log(E[Y_m])$ for the $m$th Poisson response. The dimension of $\eta$ is $M$ by definition. The matrices $B_1$, $A$ and $C$ are estimated from the data, i.e., contain the regression coefficients. For ecologists, the central formula represents a constrained linear ordination (CLO) since it is linear in the latent variables. It means that the response is a monotonically increasing or decreasing function of the latent variables.

For identifiability it is common to enforce corner constraints on $A$: by default, for RR-VGLMs, the top $R$ by $R$ submatrix is fixed to be the order-$R$ identity matrix and the remainder of $A$ is estimated. And by default, for DRR-VGLMs, there is also an order-$R$ identity matrix embedded in $A$ because the RRR must be separable (this is so that any existing structure in $A$ is preserved).

The underlying algorithm of RR-VGLMs is iteratively reweighted least squares (IRLS) with an optimizing algorithm applied within each IRLS iteration (e.g., alternating algorithm).

In theory, any VGAM family function that works for vglm and vgam should work for rrvglm too. The function that actually does the work is rrvglm.fit; it is essentially vglm.fit with some extra code.

Value

For RR-VGLMs, an object of class "rrvglm", which has the the same slots as a "vglm" object. The only difference is that the some of the constraint matrices are estimates rather than known. But VGAM stores the models the same internally. The slots of "vglm" objects are described in vglm-class.

For DRR-VGLMs, an object of class "drrvglm".

Note

The arguments of rrvglm are in general the same as those of glm but with some extras in rrvglm.control.

The smart prediction (smartpred) library is packed with the VGAM library.

In an example below, a rank-1 stereotype (reduced-rank multinomial logit) model of Anderson (1984) is fitted to some car data. The reduced-rank regression is performed, adjusting for two covariates. Setting a trivial constraint matrix (diag(M)) for the latent variable variables in $x_2$ avoids a warning message when it is overwritten by a (common) estimated constraint matrix. It shows that German cars tend to be more expensive than American cars, given a car of fixed weight and width.

```
If fit <- rrvglm(..., data = mydata) then summary(fit) requires corner constraints and no missing values in mydata. Sometimes the estimated variance-covariance matrix of the parameters is not positive-definite; if this occurs, try refitting the model with a different value for Index.corner.
```

For constrained quadratic ordination (CQO) see cqo for more details about QRR-VGLMs.

With multiple binary responses, one must use binomialff(multiple.responses = TRUE) to indicate that the response is a matrix with one response per column. Otherwise, it is interpreted as a single binary response variable.
To fit DRR-VGLMs see the arguments \texttt{H.A.thy} and \texttt{H.C} in \texttt{rrvglm.control}. DRR-VGLMs provide structure to the \textbf{A} and \textbf{C} matrices via constraint matrices. So instead of them being general unstructured matrices, one can make specified elements to be identically equal to 0, for example. This gives greater control over what is modelled as a latent variable, e.g., in a health study, if one subset of the covariates are physical variables and the remainder are psychological variables then a rank-2 model might have each latent variable a linear combination of each of the types of variables separately.

Incidentally before I forget, since \texttt{Corner = TRUE}, then the differences between the \texttt{@H.A.thy} and \texttt{@H.A.alt} slots are due to \texttt{Index.corner}, which specifies which rows of \textbf{A} are not estimated. However, in the alternating algorithm, it is more efficient to estimate the entire \textbf{A}, bar (effectively) rows \texttt{str0}, and then normalize it. In contrast, optimizing over the subset of \textbf{A} to be estimated is slow.

In the \texttt{@misc} slot are logical components \texttt{is.drrvglm} and \texttt{is.rrvglm}. Only one is \texttt{TRUE}. If \texttt{is.rrvglm} then (full) corner constraints are used. If \texttt{is.drrvglm} then restricted corner constraints (RCCs) are used and the reduced rank regression (RRR) must be separable. The case \texttt{is.rrvglm} means that \texttt{H.A.thy} is a vector("list", Rank) with \texttt{H.A.thy[[r]] <- diag(M)} assigned to all \texttt{r = 1, ..., R}. Because DRR-VGLMs are implemented only for separable problems, this means that all columns of \texttt{H.A.thy[[s]]} are orthogonal to all columns from \texttt{H.A.try[[t]]}, for all \texttt{s} and \texttt{t}. DRR-VGLMs are proposed in Yee et al. (2024) in the context of GAITD regression for heaped and seeped survey data.

\renewcommand*{	hefigure}{1}

\textbf{Author(s)}

Thomas W. Yee

\textbf{References}


\textbf{See Also}

\texttt{rrvglm.control}, \texttt{summary.drrvglm}, \texttt{lvplot.rrvglm} (same as \texttt{biplot.rrvglm}), \texttt{rrvglm-class}, \texttt{gcr}, \texttt{cqo}, \texttt{vlmff-class}, \texttt{vglm}, \texttt{vglm-class}, \texttt{smartpred}, \texttt{rrvglm.fit}. Special family functions include \texttt{negbinomial zipoisson} and \texttt{zinegbinomial}. (see Yee (2014) and what was formerly in \texttt{COZIGAM}). Methods functions include \texttt{Coef.rrvglm}, \texttt{calibrate.rrvglm}, etc. Data include \texttt{crashi}. 
Examples

## Not run:

```r
nn <- 1000  # Number of observations
delta1 <- 3.0  # Specify this
delta2 <- 1.5  # Specify this; should be greater than 1
a21 <- 2 - delta2
mydata <- data.frame(x2 = runif(nn), x3 = runif(nn))
mydata <- transform(mydata, mu = exp(2 + 3 * x2 + 0 * x3))
mydata <- transform(mydata,
    y2 = rnbinom(nn, mu = mu, size = (1/delta1)*mu^a21))
plot(y2 ~ x2, mydata, pch = "*", col = "blue", las = 1,
     main = paste0("Var(Y) = mu + ", delta1, " * mu^", delta2))
rrnb2 <- rrvglm(y2 ~ x2 + x3, negbinomial(zero = NULL),
                data = mydata, trace = TRUE)

a21.hat <- (Coef(rrnb2)@A)["loglink(size)", 1]
beta11.hat <- Coef(rrnb2)@B1["(Intercept)", "loglink(mu)"
beta21.hat <- Coef(rrnb2)@B1["(Intercept)", "loglink(size)"
(delta2.hat <- 2 - a21.hat)
# delta1.hat:
# exp(a21.hat * predict(rrnb2)[1,1] - predict(rrnb2)[1,2])
summary(rrnb2)
```

# Obtain a 95 percent CI for delta2:
```
se.a21.hat <- sqrt(vcov(rrnb2)["I(latvar.mat)"], "I(latvar.mat)"])
(ci.a21 <- a21.hat + c(-1, 1) * 1.96 * se.a21.hat)
(ci.delta2 <- 2 - rev(ci.a21))  # The 95 percent CI
```

Confint.rrnb(rrnb2)  # Quick way to get it

# Plot the abundances and fitted values vs the latent variable
```
plot(y2 ~ latvar(rrnb2), data = mydata, col = "blue",
     xlab = "Latent variable", las = 1)
```

# Example 2: stereotype model (RR multinomial logit model)
data(car.all)
scar <- subset(car.all, is.element(Country, c("Germany", "USA", "Japan", "Korea")))
fcols <- c(13,14,18:20,22:26,29:31,33,34,36)  # These are factors
scar[, -fcols] <- scale(scar[, -fcols])  # Stdze all numerical vars
ones <- CM.ones(3)  # matrix(1, 3, 1)
clist <- list("(Intercept)" = diag(3), Width = ones, Weight = ones,
               Disp. = diag(3), Tank = diag(3), Price = diag(3),
               Frt.Leg.Room = diag(3))
set.seed(111)
fit <- rrvglm(Country ~ Width + Weight + Disp. + Tank +
               Price + Frt.Leg.Room,
               multinomial, data = scar, Rank = 2, trace = TRUE,
               )
```
rrvglm-class

Class "rrvglm"

Description

Reduced-rank vector generalized linear models.

Objects from the Class

Objects can be created by calls to \texttt{rrvglm}.

Slots

extra: Object of class "list": the extra argument on entry to \texttt{vglm}. This contains any extra information that might be needed by the family function.

family: Object of class "vglmff". The family function.

iter: Object of class "numeric". The number of IRLS iterations used.

predictors: Object of class "matrix" with \( M \) columns which holds the \( M \) linear predictors.

assign: Object of class "list", from class "vlm". This named list gives information matching the columns and the (LM) model matrix terms.

call: Object of class "call", from class "vlm". The matched call.

coefficients: Object of class "numeric", from class "vlm". A named vector of coefficients.

constraints: Object of class "list", from class "vlm". A named list of constraint matrices used in the fitting.

corrections: Object of class "list", from class "vlm". The contrasts used (if any).

control: Object of class "list", from class "vlm". A list of parameters for controlling the fitting process. See \texttt{vglm.control} for details.

criterion: Object of class "list", from class "vlm". List of convergence criterion evaluated at the final IRLS iteration.

df.residual: Object of class "numeric", from class "vlm". The residual degrees of freedom.

df.total: Object of class "numeric", from class "vlm". The total degrees of freedom.

dispersion: Object of class "numeric", from class "vlm". The scaling parameter.
effects: Object of class "numeric", from class "vlm". The effects.
fitted.values: Object of class "matrix", from class "vlm". The fitted values. This is usually
the mean but may be quantiles, or the location parameter, e.g., in the Cauchy model.
misc: Object of class "list", from class "vlm". A named list to hold miscellaneous parameters.
model: Object of class "data.frame", from class "vlm". The model frame.
na.action: Object of class "list", from class "vlm". A list holding information about missing
values.
offset: Object of class "matrix", from class "vlm". If non-zero, a M-column matrix of offsets.
post: Object of class "list", from class "vlm" where post-analysis results may be put.
predictor: Object of class "list", from class "vlm" used by plotvgam; the plotting parameters
may be put here.
prior.weights: Object of class "matrix", from class "vlm" used by plotvgam; the plotting parameters
may be put here.
qr: Object of class "list", from class "vlm". QR decomposition at the final iteration.
R: Object of class "matrix", from class "vlm". The R matrix in the QR decomposition used in the
fitting.
rank: Object of class "integer", from class "vlm". Numerical rank of the fitted model.
residuals: Object of class "matrix", from class "vlm". The working residuals at the final IRLS
iteration.
ResSS: Object of class "numeric", from class "vlm". Residual sum of squares at the final IRLS
iteration with the adjusted dependent vectors and weight matrices.
smart.prediction: Object of class "list", from class "vlm". A list of data-dependent parameters (if any) that are used by smart prediction.
terms: Object of class "list", from class "vlm". The terms object used.
weights: Object of class "matrix", from class "vlm". The weight matrices at the final IRLS
iteration. This is in matrix-band form.
x: Object of class "matrix", from class "vlm". The model matrix (LM, not VGLM).
xlevels: Object of class "list", from class "vlm". The levels of the factors, if any, used in fitting.
y: Object of class "matrix", from class "vlm". The response, in matrix form.
xm2: Object of class "matrix", from class "vlm". See vglm-class.
ym2: Object of class "matrix", from class "vlm". See vglm-class.
callx2: Object of class "call", from class "vlm". The matched call for argument form2.
A.est, C.est: Object of class "matrix". The estimates of A and C.

Extends
Class "vglm", directly. Class "vlm", by class "vglm".

Methods

biplot signature(x = "rrvglm") biplot.
Coef signature(object = "rrvglm") more detailed coefficients giving A, B1, C, etc.
biplot signature(object = "rrvglm") biplot.
print signature(x = "rrvglm") short summary of the object.
summary signature(object = "rrvglm") a more detailed summary of the object.
Note
Two new slots for "rrvglm" were added compared to "vglm" objects, for VGAM 1.1-10. They are A.est and C.est.

Author(s)
Thomas W. Yee

References

See Also
rrvglm, lvplot.rrvglm, vglmff-class.

Examples
## Not run: # Rank-1 stereotype model of Anderson (1984)
pneumo <- transform(pneumo, let = log(exposure.time),
x3 = runif(nrow(pneumo))) # Noise
fit <- rrvglm(cbind(normal, mild, severe) ~ let + x3,
             multinomial, data = pneumo, Rank = 1)
Coef(fit)
## End(Not run)

rrvglm.control
Control Function for rrvglm()

Description
Algorithmic constants and parameters for running rrvglm are set using this function. Doubly constrained RR-VGLMs (DRR-VGLMs) are also catered for.

Usage
rrvglm.control(Rank = 1, Corner = TRUE, 
               Index.corner = head(setdiff(seq(length(str0) + 
               Rank), str0), Rank), noRRR = ~ 1, str0 = NULL, 
               Crow1positive = NULL, trace = FALSE, Bestof = 1, 
               H.A.thy = list(), H.C = list(),
               Ainit = NULL, Cinit = NULL, sd.Cinit = 0.02, 
               Algorithm = "alternating", Etamat.colmax = 10, 
               noWarning = FALSE, Use.Init.Poisson.QO = FALSE, 
               checkwz = TRUE, Check.rank = TRUE, Check.cm.rank = TRUE, 
               wzepsilon = .Machine$double.eps^0.75, ...)

Arguments

**Rank**
The numerical rank $R$ of the model. Must be an element from the set \{1,2,\ldots,\min(M,p2)\}. Here, the vector of explanatory variables $x$ is partitioned into $(x_1, x_2)$, which is of dimension $p1+p2$. The variables making up $x_1$ are given by the terms in `noRRR` argument, and the rest of the terms comprise $x_2$.

**Corner**
Logical indicating whether corner constraints are to be used. Strongly recommended as the only method for fitting RR-VGLMs and DRR-VGLMs. This is one method for ensuring a unique solution and the availability of standard errors. If TRUE then `Index.corner` specifies the position of the corner constraints. Also used by DRR-VGLMs, and this is known as RCCs (see below).

**Index.corner**
Specifies the $R$ rows of the corner constraints, e.g., they hold an order-$R$ identity matrix for RR-VGLMs. The default are the first $R$ positive integers that exclude $str0$.

For DRR-VGLMs one needs to have (restricted) corner constraints. Then argument `$str0$` will be ignored. If there are structural zeros then they should be built into the constraint matrices (see H.A.thy).

**noRRR**
Formula giving terms that are not to be included in the reduced-rank regression. That is, `noRRR` specifies which explanatory variables are in the $x_1$ vector of `rrvglm`, and the rest go into $x_2$. I will write $x_1$ as $x_1$ and $x_2$ as $x_2$ hereafter. The $x_1$ variables constitute the $B_1$ matrix in Yee and Hastie (2003). Those $x_2$ variables which are subject to the reduced-rank regression correspond to the $B_2$ matrix. Set `noRRR = NULL` for the reduced-rank regression to be applied to every explanatory variable including the intercept.

**str0**
Integer vector specifying which rows of the estimated constraint matrices ($A$) are to be all zeros. These are called structural zeros. Must not have any common value with `Index.corner`, and be a subset of the vector 1:M. The default, `str0 = NULL`, means no structural zero rows at all. This argument is ignored by DRR-VGLMs.

**Crow1positive**
Currently this argument has no effect. In the future, it may be a logical vector of length `Rank` (recycled if necessary): are the elements of the first row of $C$ positive? Because of corner constraints ($\text{diag}(\text{Rank})$) this argument currently must be `NULL`. Having a logical vector would mean some of the diagonals might be 1 and others $-1$.

**trace**
Logical indicating if output should be produced for each iteration.

**Bestof**
Integer, The best of `Bestof` models fitted is returned. This argument helps guard against local solutions by (hopefully) finding the global solution from many fits. The argument works only when the function generates its own initial value for $C$, i.e., when $C$ is not passed in as initial values.

**H.A.thy, H.C**
Lists. DRR-VGLMs are Doubly constrained RR-VGLMs where $A$ has `Rank` constraint matrices (one for each column) in a list called `H.A.thy`, and $C$ has a constraint matrix for each row, i.e., for each explanatory variable making up it. The class "drrvglm" may arise for such models. So `H.C` should be a named list of $p_2$ constraint matrices, each one for a different row of $C$, i.e., $p_2$ is the number of variables making up the latent variable. Note that if `$H.C` has names then matching is done with that, and the components of `$H.C` are reordered if
they are not sorted according to the terms in formula. If they are not named, then their order is used, for example, `H.C[[1]]` and `H.C[[2]]` are taken as the constraint matrices for the first two variables of the latent variable(s).

**Algorithm**
Character string indicating what algorithm is to be used. The default is the first one. The choice "derivative" has been withdrawn in VGAM 1.1-10.

**Ainit, Cinit**
Initial A and C matrices which may speed up convergence. They must be of the correct dimension.

**sd.Cinit**
Standard deviation of the initial values for the elements of C. These are normally distributed with mean zero. This argument is used only if `Use.Init.Poisson.QO = FALSE`.

**Etamat.colmax**
Positive integer, no smaller than Rank. Controls the amount of memory used by `.Init.Poisson.QO()`. It is the maximum number of columns allowed for the pseudo-response and its weights. In general, the larger the value, the better the initial value. Used only if `Use.Init.Poisson.QO = TRUE`.

**Use.Init.Poisson.QO**
Logical indicating whether the `.Init.Poisson.QO()` should be used to obtain initial values for the C. The function uses a new method that can work well if the data are Poisson counts coming from an equal-tolerances QRR-VGLM (CQO). This option is less realistic for RR-VGLMs compared to QRR-VGLMs.

**checkwz**
Logical indicating whether the diagonal elements of the working weight matrices should be checked whether they are sufficiently positive, i.e., greater than `wzepsilon`. If not, any values less than `wzepsilon` are replaced with this value.

**noWarning, Check.rank, Check.cm.rank**
Same as `vglm.control`. Ignored for VGAM 0.9-7 and higher.

**wzepsilon**
Small positive number used to test whether the diagonals of the working weight matrices are sufficiently positive.

... Variables in ... are passed into `vglm.control`. If the derivative algorithm is used then ... are also passed into `rrvglm.optim.control`; and if the alternating algorithm is used then ... are also passed into `valt0.control`.

In the above, R is the `Rank` and M is the number of linear predictors.

### Details

**VGAM** supported three normalizations to ensure a unique solution. But currently, only corner constraints will work with summary of RR-VGLM and DRR-VGLM objects. **Update during late-2023/early-2024**: with ongoing work implementing the "drrvglm" class, there may be disruption and changes to other normalizations. However, corner constraints should be fully supported and have the greatest priority.

### Value

A list with components matching the input names. Some error checking is done, but not much.
Note
In VGAM 1.1-11 and higher, the following arguments are no longer supported: Wmat, Norrr, Svd.arg, Uncorrelated.latvar, scaleA. Users should use corner constraints only.

The arguments in this function begin with an upper case letter to help avoid interference with those of vglm.control.

In the example below a rank-1 stereotype model (Anderson, 1984) is fitted, however, the intercepts are completely unconstrained rather than sorted.

Author(s)
Thomas W. Yee

References

See Also
rrvglm, rrvglm-class, summary.drrvglm, rrvglm.optim.control, vglm, vglm.control, TypicalVGAMfamilyFunction, CM.qnorm, cqo.

Examples
## Not run:
set.seed(111)
pneumo <- transform(pneumo, let = log(exposure.time),
                    x3 = runif(nrow(pneumo))) # Unrelated
fit <- rrvglm(cbind(normal, mild, severe) ~ let + x3,
               multinomial, pneumo, Rank = 1, Index.corner = 2)
constraints(fit)
vcov(fit)
summary(fit)

## End(Not run)
Arguments

- **Fnscale**: Passed into `optim` as `fnscale`.
- **Maxit**: Passed into `optim` as `maxit`.
- **Switch.optimizer**: Iteration number when the "Nelder-Mead" method of `optim` is switched to the quasi-Newton "BFGS" method. Assigning `Switch.optimizer` a negative number means always BFGS, while assigning `Switch.optimizer` a value greater than `maxits` means always use Nelder-Mead.
- **Abstol**: Passed into `optim` as `abstol`.
- **Reltol**: Passed into `optim` as `reltol`.
- **...**: Ignored.

Details

See `optim` for more details.

Value

A list with components equal to the arguments.

Note

The transition between optimization methods may be unstable, so users may have to vary the value of `Switch.optimizer`.

Practical experience with `Switch.optimizer` shows that setting it to too large a value may lead to a local solution, whereas setting it to a low value will obtain the global solution. It appears that, if BFGS kicks in too late when the Nelder-Mead algorithm is starting to converge to a local solution, then switching to BFGS will not be sufficient to bypass convergence to that local solution.

Author(s)

Thomas W. Yee

See Also

`rrvglm.control.optim`
Description

Decay counts of polonium recorded by Rutherford and Geiger (1910).

Usage

data(ruge)

Format

This data frame contains the following columns:

- **counts**: a numeric vector, counts or frequencies
- **number**: a numeric vector, the number of decays

Details

These are the radioactive decay counts of polonium recorded by Rutherford and Geiger (1910) representing the number of scintillations in 2608 1/8 minute intervals. For example, there were 57 frequencies of zero counts. The counts can be thought of as being approximately Poisson distributed.

Source


Examples

```r
lambdahat <- with(ruge, weighted.mean(number, w = counts))
(N <- with(ruge, sum(counts)))
with(ruge, cbind(number, counts, 
  fitted = round(N * dpois(number, lambdahat))))
```
Defining Smooths in VGAM Formulas

Description

s is used in the definition of (vector) smooth terms within vgam formulas. This corresponds to 1st-generation VGAMs that use backfitting for their estimation. The effective degrees of freedom is prespecified.

Usage

s(x, df = 4, spar = 0, ...)

Arguments

x covariate (abscissae) to be smoothed. Note that x must be a single variable and not a function of a variable. For example, s(x) is fine but s(log(x)) will fail. In this case, let logx <- log(x) (in the data frame), say, and then use s(logx). At this stage bivariate smoothers (x would be a two-column matrix) are not implemented.

df numerical vector of length r. Effective degrees of freedom: must lie between 1 (linear fit) and n (interpolation). Thus one could say that df−1 is the effective nonlinear degrees of freedom (ENDF) of the smooth. Recycling of values will be used if df is not of length r. If spar is positive then this argument is ignored. Thus s() means that the effective degrees of freedom is prespecified. If it is known that the component function(s) are more wiggly than usual then try increasing the value of this argument.

spar numerical vector of length r. Positive smoothing parameters (after scaling). Larger values mean more smoothing so that the solution approaches a linear fit for that component function. A zero value means that df is used. Recycling of values will be used if spar is not of length r.

... Ignored for now.

Details

In this help file M is the number of additive predictors and r is the number of component functions to be estimated (so that r is an element from the set {1,2,..,M}). Also, if n is the number of distinct abscissae, then s will fail if n < 7.

s, which is symbolic and does not perform any smoothing itself, only handles a single covariate. Note that s works in vgam only. It has no effect in glm (actually, it is similar to the identity function I so that s(x2) is the same as x2 in the LM model matrix). It differs from the s() of the gam package and the s of the mgcv package; they should not be mixed together. Also, terms involving s should be simple additive terms, and not involving interactions and nesting etc. For example, myfactor:s(x2) is not a good idea.
Value

A vector with attributes that are (only) used by vgam.

Note

The vector cubic smoothing spline which s() represents is computationally demanding for large M. The cost is approximately $O(nM^3)$ where n is the number of unique abscissae.

Currently a bug relating to the use of s() is that only constraint matrices whose columns are orthogonal are handled correctly. If any s() term has a constraint matrix that does not satisfy this condition then a warning is issued. See is.buggy for more information.

A more modern alternative to using s with vgam is to use sm.os or sm.ps. This does not require backfitting and allows automatic smoothing parameter selection. However, this alternative should only be used when the sample size is reasonably large (> 500, say). These are called Generation-2 VGAMs.

Another alternative to using s with vgam is bs and/or ns with vglm. The latter implements half-stepping, which is helpful if convergence is difficult.

Author(s)

Thomas W. Yee

References


See Also

vgam, is.buggy, sm.os, sm.ps, vsmooth.spline.

Examples

```r
# Nonparametric logistic regression
fit1 <- vgam(agaau ~ s(altitude, df = 2), binomialff, data = hunua)
## Not run: plot(fit1, se = TRUE)

# Bivariate logistic model with artificial data
nn <- 300
bdata <- data.frame(x1 = runif(nn), x2 = runif(nn))
bdata <- transform(bdata,
    y1 = rbinom(nn, size = 1, prob = logitlink(sin(2 * x2), inverse = TRUE)),
    y2 = rbinom(nn, size = 1, prob = logitlink(sin(2 * x2), inverse = TRUE)))
fit2 <- vgam(cbind(y1, y2) ~ x1 + s(x2, 3), trace = TRUE,
            binom2.or(exchangeable = TRUE), data = bdata)
coef(fit2, matrix = TRUE) # Hard to interpret
## Not run: plot(fit2, se = TRUE, which.term = 2, scol = "blue")
```
sc.studentt2  

Scaled Student t Distribution with 2 df Family Function

Description

Estimates the location and scale parameters of a scaled Student t distribution with 2 degrees of freedom, by maximum likelihood estimation.

Usage

sc.studentt2(percentile = 50, llocation = "identitylink",  
lscale = "loglink", ilocation = NULL, iscale = NULL,  
imethod = 1, zero = "scale")

Arguments

percentile  
A numerical vector containing values between 0 and 100, which are the quantiles and expectiles. They will be returned as ‘fitted values’.

llocation, lscale  
See Links for more choices, and CommonVGAMffArguments.

ilocation, iscale, imethod, zero  
See CommonVGAMffArguments for details.

Details

Koenker (1993) solved for the distribution whose quantiles are equal to its expectiles. Its canonical form has mean and mode at 0, and has a heavy tail (in fact, its variance is infinite).

The standard (“canonical”) form of this distribution can be endowed with a location and scale parameter. The standard form has a density that can be written as

\[ f(z) = \frac{2}{(4 + z^2)^{3/2}} \]

for real \( y \). Then \( z = (y - a)/b \) for location and scale parameters \( a \) and \( b > 0 \). The mean of \( Y \) is \( a \). By default, \( \eta_1 = a \) and \( \eta_2 = \log(b) \). The expectiles/quantiles corresponding to percentile are returned as the fitted values; in particular, percentile = 50 corresponds to the mean (0.5 expectile) and median (0.5 quantile).

Note that if \( Y \) has a standard dsc.t2 then \( Y = \sqrt{2}T_2 \) where \( T_2 \) has a Student-t distribution with 2 degrees of freedom. The two parameters here can also be estimated using studentt2 by specifying \( df = 2 \) and making an adjustment for the scale parameter, however, this VGAM family function is more efficient since the EIM is known (Fisher scoring is implemented.)

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.
score.stat

Author(s)

T. W. Yee

References


See Also
dsc.t2, studentt2.

Examples

set.seed(123); nn <- 1000
kdata <- data.frame(x2 = sort(runif(nn)))
kdata <- transform(kdata, mylocat = 1 + 3 * x2,
                   myscale = 1)
kdata <- transform(kdata, y = rsc.t2(nn, loc = mylocat, scale = myscale))
fit <- vglm(y ~ x2, sc.studentt2(perc = c(1, 50, 99)), data = kdata)
fit2 <- vglm(y ~ x2, studentt2(df = 2), data = kdata) # 'same' as fit

coef(fit, matrix = TRUE)
head(fitted(fit))
head(predict(fit))

# Nice plot of the results
## Not run: plot(y ~ x2, data = kdata, col = "blue", las = 1,
sub = paste("n =", nn),
main = "Fitted quantiles/expectiles using the sc.studentt2() distribution")
matplot(with(kdata, x2), fitted(fit), add = TRUE, type = "l", lwd = 3)
legend("bottomright", lty = 1:3, lwd = 3, legend = colnames(fitted(fit)),
col = 1:3)
## End(Not run)

fit@extra$percentile # Sample quantiles

score.stat

Rao’s Score Test Statistics Evaluated at the Null Values

Description

Generic function that computes Rao’s score test statistics evaluated at the null values.

Usage

score.stat(object, ...)
score.stat.vlm(object, values0 = 0, subset = NULL, omit1s = TRUE,
              all.out = FALSE, orig.SE = FALSE, iterate.SE = TRUE,
              iterate.score = TRUE, trace = FALSE, ...)
Arguments

object, values0, subset
   Same as in wald.stat.vlm.
omit1s, all.out
   Same as in wald.stat.vlm.
orig.SE, iterate.SE
   Same as in wald.stat.vlm.
iterate.score Logical. The score vector is evaluated at one value of values0 and at other regression coefficient values. These other values may be either the MLE obtained from the original object (FALSE), else at values obtained by further IRLS iterations—this argument enables that choice.
trace
   Same as in wald.stat.vlm.
...
   Ignored for now.

Details

The (Rao) score test (also known as the Lagrange multiplier test in econometrics) is a third general method for hypothesis testing under a likelihood-based framework (the others are the likelihood ratio test and Wald test; see lrt.stat and wald.stat). Asymptotically, the three tests are equivalent. The Wald test is not invariant to parameterization, and the usual Wald test statistics computed at the estimates make it vulnerable to the Hauck-Donner effect (HDE; see hdeff). This function is similar to wald.stat in that one coefficient is set to 0 (by default) and the other coefficients are iterated by IRLS to get their MLE subject to this constraint. The SE is almost always based on the expected information matrix (EIM) rather than the OIM, and for some models the EIM and OIM coincide.

Value

By default the signed square root of the Rao score statistics are returned. If all.out = TRUE then a list is returned with the following components: score.stat the score statistic, SE0 the standard error of that coefficient, values0 the null values. Approximately, the default score statistics output are standard normal random variates if each null hypothesis is true.

Altogether, by the eight combinations of iterate.SE, iterate.score and orig.SE, there are six different variants of the Rao score statistic that can be returned because the score vector has 2 and the SEs have 3 subvariants.

Warning

See wald.stat.vlm.

Author(s)

Thomas W. Yee

See Also

wald.stat, lrt.stat, summaryvglm, summary glm, anova.vglm, vglm, hdeff.
Examples

```
set.seed(1)
pneumo <- transform(pneumo, let = log(exposure.time), 
x3 = rnorm(nrow(pneumo)))
(pfit <- vglm(cbind(normal, mild, severe) ~ let + x3, propodds, pneumo))
score.stat(pfit)  # No HDE here; should be similar to the next line:
coef(summary(pfit))[, "z value"]  # Wald statistics computed at the MLE
summary(pfit, score0 = TRUE)
```

---

**seglines**

_Hauck-Donner Effects: Segmented Lines Plot_

**Description**

Plots the piecewise segmented curve made up of Wald statistics versus estimates, using a colour code for the HDE severity.

**Usage**

```
seglines(x, y, dy, ddy, lwd = 2, cex = 2, plot.it = TRUE, 
          add.legend = TRUE, cex.legend = 1, 
          position.legend = "topleft", eta0 = NA, COPS0 = NA, 
          lty.table = c("solid", "dashed", "solid", "dashed", 
                       "solid", "dashed", "solid"), 
          col.table = rainbow.sky[-5], pch.table = 7:1, 
          severity.table = c("None", "Faint", "Weak", "Moderate", 
                             "Strong", "Extreme", "Undetermined"), FYI = FALSE, ...)```

**Arguments**

- **x, y, dy, ddy**  
  Same as `hdeffsev`.
- **lwd, cex**  
  Graphical parameters: line width, and character expansion.
- **plot.it**  
  Logical, plot it? If FALSE then the other graphical arguments are ignored.
- **add.legend, position.legend**  
  Logical and character; add a legend? The other argument is fed into `legend`.
- **cex.legend**  
  Self-explanatory.
- **severity.table, eta0, COPS0**  
  Same as `hdeffsev`.
- **lty.table, col.table, pch.table**  
  Graphical parameters for the 7 different types of segments. Usually users should not assign anything to these arguments. Setting `pch.table = NULL` will suppress `pch` symbols from the legend.
- **FYI, ...**  
  Should be ignored.
Details

This function was written to complement `hdeffsev` and is rough-and-ready. It plots the signed Wald statistics as a function of the estimates, and uses a colour-code to indicate the severity of the Hauck-Donner effect (HDE). This can be obtained from its first two derivatives.

Value

This function returns the severity of the HDE, possibly invisibly.

Note

This function is likely to change in the short future because it is experimental and far from complete.

Author(s)

Thomas W. Yee.

See Also

`hdeff, hdeffsev`.

Examples

def <- 4  # myfun is a function that approximates the HDE
myfun <- function(x, deriv = 0) switch(as.character(deriv),
  '0' = x^def * exp(-x),
  '1' = (def * x^(def-1) - x^def) * exp(-x),
  '2' = (def * (def-1) * x^(def-2) - 2*def * x^(def-1) +
       x^def) * exp(-x))
## Not run:
curve(myfun, 0, 10, col = "white")
xgrid <- seq(0, 10, length = 101)
seglines(xgrid, myfun(xgrid), myfun(xgrid, deriv = 1),
  COPS0 = 2,
  myfun(xgrid, deriv = 2), pch.table = NULL,
  position = "bottom")
## End(Not run)
Usage

Select(data = list(), prefix = "y",
       lhs = NULL, rhs = NULL, rhs2 = NULL, rhs3 = NULL,
       as.character = FALSE, as.formula.arg = FALSE, tilde = TRUE,
       exclude = NULL, sort.arg = TRUE)

Arguments

data A data frame or a matrix.

prefix A vector of character strings, or a logical. If a character then the variables chosen from data begin with the value of prefix. If a logical then only TRUE is accepted and all the variables in data are chosen.

lhs A character string. The response of a formula.

rhs A character string. Included as part of the RHS a formula. Set rhs = "0" to suppress the intercept.

rhs2, rhs3 Same as rhs but appended to its RHS, i.e., paste0(rhs, " + ", rhs2, " + ", rhs3). If used, rhs should be used first, and then possibly rhs2 and then possibly rhs3.

as.character Logical. Return the answer as a character string?

as.formula.arg Logical. Is the answer a formula?

tilde Logical. If as.character and as.formula.arg are both TRUE then include the tilde in the formula?

exclude Vector of character strings. Exclude these variables explicitly.

sort.arg Logical. Sort the variables?

Details

This is meant as a utility function to avoid manually: (i) making a `cbind` call to construct a big matrix response, and (ii) constructing a formula involving a lot of terms. The savings can be made because the variables of interest begin with some prefix, e.g., with the character "y".

Value

If as.character = FALSE and as.formula.arg = FALSE then a matrix such as `cbind(y1, y2, y3)`. If as.character = TRUE and as.formula.arg = FALSE then a character string such as "cbind(y1, y2, y3)".

If as.character = FALSE and as.formula.arg = TRUE then a `formula` such as `lhs ~ y1 + y2 + y3`. If as.character = TRUE and as.formula.arg = TRUE then a character string such as "lhs ~ y1 + y2 + y3". See the examples below. By default, if no variables beginning the the value of prefix is found then a `NULL` is returned. Setting prefix = " " is a way of selecting no variables.

Note

This function is a bit experimental at this stage and may change in the short future. Some of its utility may be better achieved using `subset` and its select argument, e.g., `subset(pdata, TRUE, select = y01:y10).`
For some models such as `posbernoulli.t` the order of the variables in the \( x_{ij} \) argument is crucial, therefore care must be taken with the argument `sort.arg`. In some instances, it may be good to rename variables \( y_1 \) to \( y_{01} \), \( y_2 \) to \( y_{02} \), etc. when there are variables such as \( y_{14} \).

Currently `subsetcol()` and `Select()` are identical. One of these functions might be withdrawn in the future.

**Author(s)**

T. W. Yee.

**See Also**

`vglm`, `cbind`, `subset`, `formula`, `fill1`.

**Examples**

```r
Pneumo <- pneumo
colnames(Pneumo) <- c("y1", "y2", "y3", "x2")  # The "y" variables are response
Pneumo$x1 <- 1; Pneumo$x3 <- 3; Pneumo$x <- 0; Pneumo$x4 <- 4  # Add these

Select(data = Pneumo)  # Same as with(Pneumo, cbind(y1, y2, y3))
Select(Pneumo, "x")
Select(Pneumo, "x", sort = FALSE, as.char = TRUE)
Select(Pneumo, "x", exclude = "x1")
Select(Pneumo, c("x", "y"))
Select(Pneumo, "z")  # Now returns a NULL
Select(Pneumo, "")   # Now returns a NULL
Select(Pneumo, prefix = TRUE, as.formula = TRUE)
Select(Pneumo, "x", exclude = c("x3", "x1"), as.formula = TRUE,
       lhs = "cbind(y1, y2, y3)", rhs = "0")
Select(Pneumo, "x", exclude = "x1", as.formula = TRUE, as.char = TRUE,
       lhs = "cbind(y1, y2, y3)", rhs = "0")

# Now a 'real' example:
Huggins89table1 <- transform(Huggins89table1, x3.tij = t01)
tab1 <- subset(Huggins89table1,
               rowSums(Select(Huggins89table1, "y")) > 0)
 # Same as
 # subset(Huggins89table1, y1 + y2 + y3 + y4 + y5 + y6 + y7 + y8 + y9 + y10 > 0)

# Long way to do it:
fit.th <-
  vglm(cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10) ~ x2 + x3.tij,
       xij = list(x3.tij ~ t01 + t02 + t03 + t04 + t05 + t06 + t07 + t08 +
                  t09 + t10 - 1),
       posbernoulli.t(parallel.t = TRUE ~ x2 + x3.tij),
       data = tab1, trace = TRUE,
       form2 = ~ x2 + x3.tij + t01 + t02 + t03 + t04 + t05 + t06 + t07 + t08 +
               t09 + t10)

# Short way to do it:
Fit.th <- vglm(Select(tab1, "y") ~ x2 + x3.tij,
               cbind(y01, y02, y03, y04, y05, y06, y07, y08, y09, y10)
               ~ x2 + x3.tij,
               xij = list(x3.tij ~ t01 + t02 + t03 + t04 + t05 + t06 + t07 + t08 +
                          t09 + t10),
               posbernoulli.t(parallel.t = TRUE ~ x2 + x3.tij),
               data = tab1, trace = TRUE,
               form2 = ~ x2 + x3.tij + t01 + t02 + t03 + t04 + t05 + t06 + t07 + t08 +
                      t09 + t10)
```

# Short way to do it:
Fit.th <- vglm(Select(tab1, "y") ~ x2 + x3.tij,
eq2binomial

xi_j = list(Select(tab1, "t", as.formula = TRUE,
    sort = FALSE, lhs = "x3.tij", rhs = "0"),
    posbernoulli.t(parallel.t = TRUE ~ x2 + x3.tij),
    data = tab1, trace = TRUE,
    form2 = Select(tab1, prefix = TRUE, as.formula = TRUE))

---

seq2binomial

The Two-stage Sequential Binomial Distribution Family Function

Description

Estimation of the probabilities of a two-stage binomial distribution.

Usage

seq2binomial(lprob1 = "logitlink", lprob2 = "logitlink",
    iprob1 = NULL, iprob2 = NULL,
    parallel = FALSE, zero = NULL)

Arguments

lprob1, lprob2 Parameter link functions applied to the two probabilities, called \( p \) and \( q \) below. See Links for more choices.

iprob1, iprob2 Optional initial value for the first and second probabilities respectively. A NULL means a value is obtained in the initialize slot.

parallel, zero Details at Links. If parallel = TRUE then the constraint also applies to the intercept. See CommonVGAMffArguments for details.

Details

This VGAM family function fits the model described by Crowder and Sweeting (1989) which is described as follows. Each of \( m \) spores has a probability \( p \) of germinating. Of the \( y_1 \) spores that germinate, each has a probability \( q \) of bending in a particular direction. Let \( y_2 \) be the number that bend in the specified direction. The probability model for this data is

\[
P(y_1, y_2) = \binom{m}{y_1} p^{y_1} (1 - p)^{m - y_1} \binom{y_1}{y_2} q^{y_2} (1 - q)^{y_1 - y_2}
\]

for \( 0 < p < 1, 0 < q < 1, y_1 = 1, \ldots, m \) and \( y_2 = 1, \ldots, y_1 \). Here, \( p \) is prob1, \( q \) is prob2.

Although the Authors refer to this as the bivariate binomial model, I have named it the (two-stage) sequential binomial model. Fisher scoring is used.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.
### Note

The response must be a two-column matrix of sample proportions corresponding to \( y_1 \) and \( y_2 \). The \( m \) values should be inputted with the weights argument of \texttt{vglm} and \texttt{vgam}. The fitted value is a two-column matrix of estimated probabilities \( p \) and \( q \). A common form of error is when there are no trials for \( y_1 \), e.g., if \texttt{mvector} below has some values which are zero.

### Author(s)

Thomas W. Yee

### References


### See Also

\texttt{binomialff, cfibrosis}.

### Examples

```r
sdata <- data.frame(mvector = round(rnorm(nn <- 100, m = 10, sd = 2)),
                    x2 = runif(nn))

sdata <- transform(sdata, prob1 = logitlink(+2 - x2, inverse = TRUE),
                   prob2 = logitlink(-2 + x2, inverse = TRUE))

sdata <- transform(sdata, successes1 = rbinom(nn, size = mvector, prob = prob1))

sdata <- transform(sdata, successes2 = rbinom(nn, size = successes1, prob = prob2))

sdata <- transform(sdata, y1 = successes1 / mvector)

sdata <- transform(sdata, y2 = successes2 / successes1)

fit <- vglm(cbind(y1, y2) ~ x2, seq2binomial, weight = mvector,
            data = sdata, trace = TRUE)

coef(fit)
coef(fit, matrix = TRUE)
head(fitted(fit))
head(depvar(fit))

head(weights(fit, type = "prior"))  # Same as with(sdata, mvector)

# Number of first successes:
head(depvar(fit)[, 1] * c(weights(fit, type = "prior")))

# Number of second successes:
head(depvar(fit)[, 2] * c(weights(fit, type = "prior")) *
    depvar(fit)[, 1])
```

### Description

Sets up smart prediction in one of two modes: "write" and "read".
Usage

setup.smart(mode.arg, smart.prediction = NULL, max.smart = 30)

Arguments

mode.arg mode.arg must be "write" or "read". If in "read" mode then smart.prediction must be assigned the data structure .smart.prediction that was created while fitting. This is stored in object@smart.prediction or object$smart.prediction where object is the name of the fitted object.

smart.prediction

If in "read" mode then smart.prediction must be assigned the list of data dependent parameters, which is stored on the fitted object. Otherwise, smart.prediction is ignored.

max.smart

max.smart is the initial length of the list .smart.prediction. It is not important because .smart.prediction is made larger if needed.

Details

This function is only required by programmers writing a modelling function such as lm and glm, or a prediction functions of such, e.g., predict.lm. The function setup.smart operates by mimicking the operations of a first-in first-out stack (better known as a queue).

Value

Nothing is returned.

Side Effects

In "write" mode .smart.prediction in smartpredenv is assigned an empty list with max.smart components. In "read" mode .smart.prediction in smartpredenv is assigned smart.prediction. Then .smart.prediction.counter in smartpredenv is assigned the value 0, and .smart.prediction.mode and .max.smart are written to smartpredenv too.

See Also

lm, predict.lm

Examples

```r
## Not run:
setup.smart("write") # Put at the beginning of lm

## End(Not run)

## Not run: # Put at the beginning of predict.lm
setup.smart("read", smart.prediction = object$smart.prediction)

## End(Not run)
```
Simplex Distribution

Description
Density function, and random generation for the simplex distribution.

Usage

dsimplex(x, mu = 0.5, dispersion = 1, log = FALSE)
rsimplex(n, mu = 0.5, dispersion = 1)

Arguments

x
Vector of quantiles. The support of the distribution is the interval (0, 1).

mu, dispersion
Mean and dispersion parameters. The former lies in the interval (0, 1) and the latter is positive.

n, log
Same usage as runif.

Details

The VGAM family function simplex fits this model; see that online help for more information. For rsimplex() the rejection method is used; it may be very slow if the density is highly peaked, and will fail if the density asymptotes at the boundary.

Value
dsimplex(x) gives the density function, rsimplex(n) gives n random variates.

Author(s)
T. W. Yee

See Also

simplex.

Examples

sigma <- c(4, 2, 1)  # Dispersion parameter
mymu <- c(0.1, 0.5, 0.7); xxx <- seq(0, 1, len = 501)
## Not run: par(mfrow = c(3, 3))  # Figure 2.1 of Song (2007)
for (iii in 1:3)
  for (jjj in 1:3) {
    plot(xxx, dsimplex(xxx, mymu[jjj], sigma[iii]),
         type = "l", col = "blue", xlab = "", ylab = "", main =
         paste("mu = ", mymu[jjj], ", sigma = ", sigma[iii], sep = ""))
  }
## End(Not run)
simplex

**Simplex Distribution Family Function**

**Description**

The two parameters of the univariate standard simplex distribution are estimated by full maximum likelihood estimation.

**Usage**

```r
simplex(lmu = "logitlink", lsigma = "loglink", imu = NULL, isigma = NULL,
imethod = 1, ishrinkage = 0.95, zero = "sigma")
```

**Arguments**

- `lmu`, `lsigma`: Link function for `mu` and `sigma`. See [Links](#) for more choices.
- `imu`, `isigma`: Optional initial values for `mu` and `sigma`. A NULL means a value is obtained internally.
- `imethod`, `ishrinkage`, `zero`
  - `imethod, ishrinkage, zero`: See [CommonVGAMffArguments](#) for information.

**Details**

The probability density function can be written

\[
 f(y; \mu, \sigma) = [2\pi \sigma^2 (y(1-y))^3]^{-0.5} \exp[-0.5(y - \mu)^2 / (\sigma^2 y(1-y)\mu^2 (1-\mu)^2)]
\]

for \(0 < y < 1\), \(0 < \mu < 1\), and \(\sigma > 0\). The mean of \(Y\) is \(\mu\) (called `mu`, and returned as the fitted values).

The second parameter, \(\sigma\), of this standard simplex distribution is known as the dispersion parameter. The unit variance function is \(V(\mu) = \mu^3(1 - \mu)^3\). Fisher scoring is applied to both parameters.

**Value**

An object of class "vglmff" (see [vglmff-class](#)). The object is used by modelling functions such as `vglm`, and `vgam`.

**Note**

This distribution is potentially useful for dispersion modelling. Numerical problems may occur when `mu` is very close to 0 or 1.

**Author(s)**

T. W. Yee
References


See Also

dsimplex, dirichlet, rig, binomialff.

Examples

```r
sdata <- data.frame(x2 = runif(nn <- 1000))
sdata <- transform(sdata, eta1 = 1 + 2 * x2,
                   eta2 = 1 - 2 * x2)
sdata <- transform(sdata, y = rsimplex(nn, mu = logitlink(eta1, inverse = TRUE),
                                         dispersion = exp(eta2)))
(fit <- vglm(y ~ x2, simplex(zero = NULL), data = sdata, trace = TRUE))
coef(fit, matrix = TRUE)
summary(fit)
```

### simulate.vlm

_Simulate Responses for VGLMs and VGAMs_

#### Description

Simulate one or more responses from the distribution corresponding to a fitted model object.

#### Usage

```r
## S3 method for class 'vlm'
simulate(object, nsim = 1, seed = NULL, ...)
```

#### Arguments

- `object`: an object representing a fitted model. Usually an object of class `vglm-class` or `vgam-class`.
- `nsim, seed`: same as `simulate`.
- `...`: additional optional arguments.

#### Details

This is a methods function for `simulate` and hopefully should behave in a very similar manner. Only VGAM family functions with a simslot slot have been implemented for `simulate`.

#### Value

Similar to `simulate`. Note that many VGAM family functions can handle multiple responses. This can result in a longer data frame with more rows (`nsim` multiplied by `n` rather than the ordinary `n`). In the future an argument may be available so that there is always `n` rows no matter how many responses were inputted.
Warning

With multiple response and/or multivariate responses, the order of the elements may differ. For some VGAM families, the order is \( n \times N \times F \), where \( n \) is the sample size, \( N \) is \( \text{nsim} \) and \( F \) is \( \text{ncol(fitted(vglmObject))} \). For other VGAM families, the order is \( n \times F \times N \). An example of each is given below.

See Also

Currently the VGAM family functions with a simslot slot are: alaplace1, alaplace2, betabinomial, betabinomialff, betaR, betaff, biamhcop, bifrankcop, bilogistic, binomialff, binormal, binormalcop, bicalytoncop, cauchy, cauchyl, chisq, dirichlet, dagum, erlang, exponential, bifgmcop, fisk, gamma1, gamma2, gammaR, gengamma.stacy, geometric, gompertz, gumbelII, hzeta, inv.lomax, inv.paralogistic, kumar, lgamma1, lgamma3, lindley, lino, logff, logistic1, logistic, lognormal, lomax, makeham, negbinomial, negbinomial.size, paralogistic, perks, poissonff, posnegbinomial, posnormal, pospoisson, polya, polyaR, posbinomial, rayleigh, riceff, simplex, simmad, slash, studentt, studentt2, studentt3, triangle, uninormal, yulesimon, zageometric, zageometricff, zanegbinomial, zanegbinomialff, zapoisson, zapoissonff, zigeometric, zigeometricff, zinegbinomial, zipf, zipoisson, zipoissonff. Also, categorical family functions: acat, cratio, sratio, cumulative, multinomial.

See also RNG about random number generation in R, vglm, vgam for model fitting.

Examples

```r
nn <- 10; mysize <- 20; set.seed(123)
bdata <- data.frame(x2 = rnorm(nn))
bdata <- transform(bdata,
  y1 = rbinom(nn, size = mysize, p = logitlink(1+x2, inverse = TRUE)),
  y2 = rbinom(nn, size = mysize, p = logitlink(1+x2, inverse = TRUE)),
  f1 = factor(as.numeric(rbinom(nn, size = 1,
                               p = logitlink(1+x2, inverse = TRUE))))
)

(fit1 <- vglm(cbind(y1, y2) ~ x2, binomialff, data = bdata))

set.seed(123); simulate(fit1, nsim = 8)
set.seed(123); c(simulate(fit2, nsim = 3)) # Use c() when model = TRUE
```

# An n x N x F example

```r
set.seed(123); n <- 100
bdata <- data.frame(x2 = runif(n), x3 = runif(n))
bdata <- transform(bdata, y1 = rnorm(n, 1 + 2 * x2),
                    y2 = rnorm(n, 3 + 4 * x2))

fit1 <- vglm(cbind(y1, y2) ~ x2, binormal(eq.sd = TRUE), data = bdata)

nsim <- 1000 # Number of simulations for each observation
my.sims <- simulate(fit1, nsim = nsim)

# A data frame
aaa <- array(unlist(my.sims), c(n, nsim, ncol(fitted(fit1))))
summary(rowMeans(aaa[, , 1]) - fitted(fit1)[, 1]) # Should be all 0s
summary(rowMeans(aaa[, , 2]) - fitted(fit1)[, 2]) # Should be all 0s
```
# An n x F x N example

n <- 100; set.seed(111); nsim <- 1000
zdata <- data.frame(x2 = runif(n))
zdata <- transform(zdata, lambda1 = loglink(-0.5 + 2 * x2, inverse = TRUE),
                   lambda2 = loglink(0.5 + 2 * x2, inverse = TRUE),
                   pstr01 = logitlink(0, inverse = TRUE),
                   pstr02 = logitlink(-1.0, inverse = TRUE))
zdata <- transform(zdata, y1 = rzipois(n, lambda = lambda1, pstr0 = pstr01),
                   y2 = rzipois(n, lambda = lambda2, pstr0 = pstr02))
zip.fit <- vglm(cbind(y1, y2) ~ x2, zipoissonff, data = zdata, crit = "coef")
my.sims <- simulate(zip.fit, nsim = nsim)
dim(my.sims) # A data frame
aaa <- array(unlist(my.sims), c(n, ncol(fitted(zip.fit)), nsim)) # n by F by N
summary(rowMeans(aaa[, 1, ]) - fitted(zip.fit)[, 1]) # Should be all 0s
summary(rowMeans(aaa[, 2, ]) - fitted(zip.fit)[, 2]) # Should be all 0s

---

Sinmad

The Singh-Maddala Distribution

Description

Density, distribution function, quantile function and random generation for the Singh-Maddala distribution with shape parameters \(a\) and \(q\), and scale parameter \(scale\).

Usage

```r
dsinmad(x, scale = 1, shape1.a, shape3.q, log = FALSE)
psinmad(q, scale = 1, shape1.a, shape3.q, lower.tail = TRUE, log.p = FALSE)
qsinmad(p, scale = 1, shape1.a, shape3.q, lower.tail = TRUE, log.p = FALSE)
rsinmad(n, scale = 1, shape1.a, shape3.q)
```

Arguments

- \(x, q\) vector of quantiles.
- \(p\) vector of probabilities.
- \(n\) number of observations. If \(\text{length}(n) > 1\), the length is taken to be the number required.
- \(\text{shape1.a, shape3.q}\) shape parameters.
- \(\text{scale}\) scale parameter.
- \(\text{log}\) Logical. If \(\text{log} = \text{TRUE}\) then the logarithm of the density is returned.
- \(\text{lower.tail, log.p}\) Same meaning as in \text{pnorm} or \text{qnorm}.

Details

See \text{sinmad}, which is the \text{VGAM} family function for estimating the parameters by maximum likelihood estimation.
Value
dsinmad gives the density, psinmad gives the distribution function, qsinmad gives the quantile function, and rsinmad generates random deviates.

Note
The Singh-Maddala distribution is a special case of the 4-parameter generalized beta II distribution.

Author(s)
T. W. Yee and Kai Huang

References

See Also
sinmad, genbetaII.

Examples
sdata <- data.frame(y = rsinmad(n = 3000, scale = exp(2), shape1 = exp(1), shape3 = exp(1)))
fit <- vglm(y ~ 1, sinmad(lss = FALSE, ishape1.a = 2.1), data = sdata, trace = TRUE, crit = "coef")
coef(fit, matrix = TRUE)
Coef(fit)
Arguments

- **lss**: See `CommonVGAMffArguments` for important information.
- **lshape1.a, lscale, lshape3.q**: Parameter link functions applied to the (positive) parameters \( a \), \( \text{scale} \), and \( q \). See `Links` for more choices.
- **iscale, ishape1.a, ishape3.q, imethod, zero**: See `CommonVGAMffArguments` for information. For \( \text{imethod} = 2 \) a good initial value for \( \text{ishape3.q} \) is needed to obtain good estimates for the other parameters.
- **gscale, gshape1.a, gshape3.q**: See `CommonVGAMffArguments` for information.
- **probs.y**: See `CommonVGAMffArguments` for information.

Details

The 3-parameter Singh-Maddala distribution is the 4-parameter generalized beta II distribution with shape parameter \( p = 1 \). It is known under various other names, such as the Burr XII (or just the Burr distribution), Pareto IV, beta-P, and generalized log-logistic distribution. More details can be found in Kleiber and Kotz (2003).

Some distributions which are special cases of the 3-parameter Singh-Maddala are the Lomax \((a = 1)\), Fisk \((q = 1)\), and paralogistic \((a = q)\).

The Singh-Maddala distribution has density
\[
f(y) = a q y^{a-1}/[b^a[1 + (y/b)^a]^{1+q}]
\]
for \( a > 0 \), \( b > 0 \), \( q > 0 \), \( y \geq 0 \). Here, \( b \) is the scale parameter \( \text{scale} \), and the others are shape parameters. The cumulative distribution function is
\[
F(y) = 1 - [1 + (y/b)^a]^{-q}.
\]
The mean is
\[
E(Y) = b \Gamma(1 + 1/a) \Gamma(q - 1/a)/\Gamma(q)
\]
provided \(-a < 1 < aq\); these are returned as the fitted values. This family function handles multiple responses.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Note

See the notes in `genbetaII`.

Author(s)

T. W. Yee
References


See Also

Sinmad, genbetaII, betaII, dagum, fisk, inv.lomax, lomax, paralogistic, inv.paralogistic, simulate.vlm.

Examples

```r
sdata <- data.frame(y = rsinmad(n = 1000, shape1 = exp(1),
                      scale = exp(2), shape3 = exp(0)))
fit <- vglm(y ~ 1, sinmad(lss = FALSE), sdata, trace = TRUE)
fit <- vglm(y ~ 1, sinmad(lss = FALSE, ishape1.a = exp(1)),
            sdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)

# Harder problem (has the shape3.q parameter going to infinity)
set.seed(3)
sdata <- data.frame(y1 = rbeta(1000, 6, 6))
# hist(with(sdata, y1))
if (FALSE) {
  # These struggle
  fit1 <- vglm(y1 ~ 1, sinmad(lss = FALSE), sdata, trace = TRUE)
  fit1 <- vglm(y1 ~ 1, sinmad(lss = FALSE), sdata, trace = TRUE,
              crit = "coef")
  Coef(fit1)
}
# Try this remedy:
fit2 <- vglm(y1 ~ 1, data = sdata, trace = TRUE, stepsize = 0.05, maxit = 99,
            sinmad(lss = FALSE, ishape3.q = 3, lshape3.q = "logloglink")
coef(fit2, matrix = FALSE)
Coef(fit2)
```

---

**Skellam**

*The Skellam Distribution*

**Description**

Density and random generation for the Skellam distribution.

**Usage**

```r
dskellam(x, mu1, mu2, log = FALSE)
rskellam(n, mu1, mu2)
```
Arguments

- \( x \): vector of quantiles.
- \( n \): number of observations. Same as \texttt{runif}.
- \( \mu_1, \mu_2 \): See \texttt{skellam}.
- \( \log \): Logical; if TRUE, the logarithm is returned.

Details

See \texttt{skellam}, the \texttt{VGAM} family function for estimating the parameters, for the formula of the probability density function and other details.

Value

d\texttt{skellam} gives the density, and r\texttt{skellam} generates random deviates.

Warning

Numerical problems may occur for data if \( \mu_1 \) and/or \( \mu_2 \) are large. The normal approximation for this case has not been implemented yet.

See Also

\texttt{skellam}, \texttt{dpois}.

Examples

```r
## Not run: mu1 <- 1; mu2 <- 2; x <- (-7):7
plot(x, dskellam(x, mu1, mu2), type = "h", las = 1, col = "blue",
     main = paste("Density of Skellam distribution with mu1 = ", mu1,
                 " and mu2 = ", mu2, sep = ""))
## End(Not run)
```

---

### skellam

**Skellam Distribution Family Function**

**Description**

Estimates the two parameters of a Skellam distribution by maximum likelihood estimation.

**Usage**

```r
skellam(lmu1 = "loglink", lmu2 = "loglink", imu1 = NULL, imu2 = NULL,
        nsimEIM = 100, parallel = FALSE, zero = NULL)
```
Arguments

- `lmu1, lmu2`: Link functions for the $\mu_1$ and $\mu_2$ parameters. See [Links](#) for more choices and for general information.
- `imu1, imu2`: Optional initial values for the parameters. See [CommonVGAMffArguments](#) for more information. If convergence failure occurs (this VGAM family function seems to require good initial values) try using these arguments.
- `nsimEIM, parallel, zero`: See [CommonVGAMffArguments](#) for information. In particular, setting `parallel=TRUE` will constrain the two means to be equal.

Details

The Skellam distribution models the difference between two independent Poisson distributions (with means $\mu_j$, say). It has density function

$$f(y; \mu_1, \mu_2) = \left(\frac{\mu_1}{\mu_2}\right)^{y/2} \exp(-\mu_1 - \mu_2) I_{|y|}(2\sqrt{\mu_1\mu_2})$$

where $y$ is an integer, $\mu_1 > 0$, $\mu_2 > 0$. Here, $I_v$ is the modified Bessel function of the first kind with order $v$.

The mean is $\mu_1 - \mu_2$ (returned as the fitted values), and the variance is $\mu_1 + \mu_2$. Simulated Fisher scoring is implemented.

Value

An object of class "vglmff" (see [vglmff-class](#)). The object is used by modelling functions such as `vglm` and `vgam`.

Warning

This VGAM family function seems fragile and very sensitive to the initial values. Use very cautiously!!

Note

Numerical problems may occur for data if $\mu_1$ and/or $\mu_2$ are large.

References


See Also

dskellam, dpois, poissonff.
Examples

```r
## Not run:
sdata <- data.frame(x2 = runif(nn <- 1000))
sdata <- transform(sdata, mu1 = exp(1 + x2), mu2 = exp(1 + x2))
sdata <- transform(sdata, y = rskellam(nn, mu1, mu2))
fit1 <- vglm(y ~ x2, skellam, data = sdata, trace = TRUE, crit = "coef")
fit2 <- vglm(y ~ x2, skellam(parallel = TRUE), data = sdata, trace = TRUE)
coef(fit1, matrix = TRUE)
coef(fit2, matrix = TRUE)
summary(fit1)
# Likelihood ratio test for equal means:
pchisq(2 * (logLik(fit1) - logLik(fit2)),
      df = df.residual(fit2) - df.residual(fit1), lower.tail = FALSE)
lrtest(fit1, fit2) # Alternative
## End(Not run)
```

skewnorm

**Skew-Normal Distribution**

Description

Density and random generation for the univariate skew-normal distribution.

Usage

```r
dskewnorm(x, location = 0, scale = 1, shape = 0, log = FALSE)
rskewnorm(n, location = 0, scale = 1, shape = 0)
```

Arguments

- **x**: vector of quantiles.
- **n**: number of observations. Same as `runif`.
- **location**: The location parameter \(\xi\). A vector.
- **scale**: The scale parameter \(\omega\). A positive vector.
- **shape**: The shape parameter. It is called \(\alpha\) in `skewnormal`.
- **log**: Logical. If `log=TRUE` then the logarithm of the density is returned.

Details

See `skewnormal`, which currently only estimates the shape parameter. More generally here, \(Z = \xi + \omega Y\) where \(Y\) has a standard skew-normal distribution (see `skewnormal`), \(\xi\) is the location parameter and \(\omega\) is the scale parameter.

Value

`dskewnorm` gives the density, `rskewnorm` generates random deviates.
Note

The default values of all three parameters corresponds to the skew-normal being the standard normal distribution.

Author(s)

T. W. Yee

References

http://tango.stat.unipd.it/SN.

See Also

skewnormal.

Examples

```r
## Not run: N <- 200 # Grid resolution
shape <- 7; x <- seq(-4, 4, len = N)
plot(x, dskewnorm(x, shape = shape), type = "l", col = "blue", las = 1,
     ylab = "", lty = 1, lwd = 2)
abline(v = 0, h = 0, col = "grey")
lines(x, dnorm(x), col = "orange", lty = 2, lwd = 2)
legend("topleft", leg = c(paste("Blue = dskewnorm(x, ", shape,"), sep = ""),
                        "Orange = standard normal density"), lty = 1:2, lwd = 2,
                        col = c("blue", "orange"))
## End(Not run)
```

skewnormal

Univariate Skew-Normal Distribution Family Function

Description

Maximum likelihood estimation of the shape parameter of a univariate skew-normal distribution.

Usage

`skewnormal(lshape = "identitylink", ishape = NULL, nsimEIM = NULL)`

Arguments

lshape, ishape, nsimEIM

See Links and CommonVGAMffArguments.
Details

The univariate skew-normal distribution has a density function that can be written

\[ f(y) = 2 \phi(y) \Phi(\alpha y) \]

where \( \alpha \) is the shape parameter. Here, \( \phi \) is the standard normal density and \( \Phi \) its cumulative distribution function. When \( \alpha = 0 \) the result is a standard normal distribution. When \( \alpha = 1 \) it models the distribution of the maximum of two independent standard normal variates. When the absolute value of the shape parameter increases the skewness of the distribution increases. The limit as the shape parameter tends to positive infinity results in the folded normal distribution or half-normal distribution. When the shape parameter changes its sign, the density is reflected about \( y = 0 \).

The mean of the distribution is \( \mu = \alpha \sqrt{2/(\pi(1 + \alpha^2))} \) and these are returned as the fitted values. The variance of the distribution is \( 1 - \mu^2 \). The Newton-Raphson algorithm is used unless the `nsimEIM` argument is used.

Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

Warning

It is well known that the EIM of Azzalini’s skew-normal distribution is singular for skewness parameter tending to zero, and thus produces influential problems.

Note

It is a good idea to use several different initial values to ensure that the global solution is obtained. This family function will be modified (hopefully soon) to handle a location and scale parameter too.

Author(s)

Thomas W. Yee

References


See Also

skewnorm, uninormal, foldnormal.
Examples

```r
sdata <- data.frame(y1 = rskewnorm(nn <- 1000, shape = 5))
fit1 <- vglm(y1 ~ 1, skewnormal, data = sdata, trace = TRUE)
coef(fit1, matrix = TRUE)
head(fitted(fit1), 1)
with(sdata, mean(y1))
## Not run: with(sdata, hist(y1, prob = TRUE))
x <- with(sdata, seq(min(y1), max(y1), len = 200))
with(sdata, lines(x, dskewnorm(x, shape = Coef(fit1)), col = "blue"))
## End(Not run)

sdata <- data.frame(x2 = runif(nn))
sdata <- transform(sdata, y2 = rskewnorm(nn, shape = 1 + 2*x2))
fit2 <- vglm(y2 ~ x2, skewnormal, data = sdata, trace = TRUE, crit = "coef")
summary(fit2)
```

Description

Density function, distribution function, and random generation for the slash distribution.

Usage

```r
dslash(x, mu = 0, sigma = 1, log = FALSE, smallno = .Machine$double.eps*1000)
pslash(q, mu = 0, sigma = 1, very.negative = -10000, lower.tail = TRUE, log.p = FALSE)
rslash(n, mu = 0, sigma = 1)
```

Arguments

- `x, q` vector of quantiles.
- `n` Same as `runif`.
- `mu, sigma` the mean and standard deviation of the univariate normal distribution.
- `log` Logical. If TRUE then the logarithm of the density is returned.
- `very.negative` Numeric, of length 1. A large negative value. For \((q-mu)/sigma\) values less than this, the value 0 is returned because `integrate` tends to fail. A warning is issued. Similarly, if \((q-mu)/sigma\) is greater than abs(`very.negative`) then 1 is returned with a warning.
- `smallno` See `slash`.
- `lower.tail, log.p` Same meaning as in `pnorm` or `qnorm`.
Details

See `slash`, the VGAM family function for estimating the two parameters by maximum likelihood estimation, for the formula of the probability density function and other details.

Function `pslash` uses a `for()` loop and `integrate`, meaning it’s very slow. It may also be inaccurate for extreme values of q, and returns with 1 or 0 values when too extreme compared to `very.negative`.

Value

dslash gives the density, and pslash gives the distribution function, rslash generates random deviates.

Note

pslash is very slow.

Author(s)

Thomas W. Yee and C. S. Chee

See Also

slash.

Examples

```r
## Not run:
curve(dslash, col = "blue", ylab = "f(x)", -5, 5, ylim = c(0, 0.4), las = 1,
   main = "Standard slash, normal and Cauchy densities", lwd = 2)
curve(dnorm, col = "black", lty = 2, lwd = 2, add = TRUE)
curve(dcauchy, col = "orange", lty = 3, lwd = 2, add = TRUE)
legend("topleft", c("slash", "normal", "Cauchy"), lty = 1:3,
   col = c("blue", "black", "orange"), lwd = 2)

curve(pslash, col = "blue", -5, 5, ylim = 0:1)
pslash(c(-Inf, -20000, 20000, Inf)) # Gives a warning

## End(Not run)
```

slash

**Slash Distribution Family Function**

Description

Estimates the two parameters of the slash distribution by maximum likelihood estimation.
Usage

slash(lmu = "identitylink", lsigma = "loglink",
    imu = NULL, isigma = NULL, gprobs.y = ppoints(8), nsimEIM = 250,
    zero = NULL, smallno = .Machine$double.eps*1000)

Arguments

lmu, lsigma Parameter link functions applied to the $\mu$ and $\sigma$ parameters, respectively. See Links for more choices.

imu, isigma Initial values. A NULL means an initial value is chosen internally. See CommonVGAMffArguments for more information.

gprobs.y Used to compute the initial values for mu. This argument is fed into the probs argument of quantile to construct a grid, which is used to evaluate the log-likelihood. This must have values between 0 and 1.

nsimEIM, zero See CommonVGAMffArguments for information.

smallno Small positive number, used to test for the singularity.

Details

The standard slash distribution is the distribution of the ratio of a standard normal variable to an independent standard uniform (0,1) variable. It is mainly of use in simulation studies. One of its properties is that it has heavy tails, similar to those of the Cauchy.

The general slash distribution can be obtained by replacing the univariate normal variable by a general normal $N(\mu, \sigma)$ random variable. It has a density that can be written as

$$f(y) = \begin{cases} \frac{1}{(2\sigma \sqrt{2\pi})} & \text{if } y = \mu, \\ 1 - \exp(-(((y - \mu)/\sigma)^2)/2))/((\sqrt{2}\pi)(y - \mu)/\sigma)^2)) & \text{if } y \neq \mu. \end{cases}$$

where $\mu$ and $\sigma$ are the mean and standard deviation of the univariate normal distribution respectively.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and gam.

Note

Fisher scoring using simulation is used. Convergence is often quite slow. Numerical problems may occur.

Author(s)

T. W. Yee and C. S. Chee
References


See Also

`rslash`, `simulate.vlm`.

Examples

```r
## Not run:
sdata <- data.frame(y = rslash(n = 1000, mu = 4, sigma = exp(2)))
fit <- vglm(y ~ 1, slash, data = sdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
summary(fit)
## End(Not run)
```

---

**sloglink**

*Square root–Log Link Mixtures*

**Description**

Computes some square root–log mixture link transformations, including their inverse and the first few derivatives.

**Usage**

```r
sloglink(theta, bvalue = NULL, taumix.log = 1, tol = 1e-13,
         nmax = 99, inverse = FALSE, deriv = 0, short = TRUE,
         tag = FALSE, c10 = c(2, -2))
```

```r
lcsloglink(theta, bvalue = NULL, pmix.log = 0.01, tol = 1e-13,
         nmax = 99, inverse = FALSE, deriv = 0, short = TRUE,
         tag = FALSE, c10 = c(2, -2))
```

**Arguments**

- `theta`: Numeric or character. See below for further details.
- `bvalue`: See Links.
- `taumix.log`: Numeric, of length 1. Mixing parameter directed at `loglink`. Then \(1 - \exp(-\text{taumix.log} \times \theta)\) is used to weight `sqrtlink`. Thus a 0 value will result in `loglink`, and a very large numeric such as 1e4 should be roughly equivalent to `sqrtlink` over almost all of the parameter space.
pmix.log  Numeric, of length 1. Mixing probability assigned to loglink. Then $1 - \text{pmix.log}$ is used to weight sqrtlink. Thus a 0 value will result in sqrtlink and 1 is equivalent to loglink.

tol, nmax  Arguments fed into a function implementing a vectorized bisection method.
inverse, deriv, short, tag
Details at Links.
c10  See sqrtlink and loglink.

Details

For general information see alogitlink.

Value

The following holds for the linear combination (LC) variant. For deriv = 0, $(1 - \text{pmix.log}) \times \text{sqrtlink}(\mu, c10 = c10) + \text{pmix.log} \times \text{loglink}(\mu)$ when inverse = FALSE, and if inverse = TRUE then a nonlinear equation is solved for $\mu$, given $\eta$ passed in as $\theta$. For deriv = 1, then the function returns $d \eta / d \theta$ as a function of $\theta$ if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Warning

The default values for taumix.log and pmix.log may change in the future. The name and order of the arguments may change too.

Author(s)

Thomas W. Yee

See Also

alogitlink, sqrtlink, loglink, Links, poissonff, hdeff.

Examples

```r
mu <- seq(0.01, 3, length = 10)
sloglink(mu)
max(abs(sloglink(sloglink(mu), inv = TRUE) - mu)) # 0?
```
Usage

```r
sm.os(x, ..., niknots = 6, spar = -1, o.order = 2,
alg.niknots = c("s", ".nknots.smspl")[1], all.knots = FALSE,
ridge.adj = 1e-5, spillover = 0.01, maxspar = 1e12,
outer.ok = FALSE, fixspar = FALSE)
```

Arguments

- **x**: covariate (abscissae) to be smoothed. Also called the regressor. If the `xij` facility is used then these covariates are inputted via the `...` argument.
- **...**: Used to accommodate the other `M - 1` covariates when the `xij` facility is used. See Section 3.4.4 of Yee (2015) for something very similar. This argument, found in the second argument, means that the other argument names must be fully specified if used, e.g., `outer.ok` and not `outer`. See the example below. In the example below, the term in the main formula is `sm.os(gcost.air, gcost.trn, gcost.bus)` and one might be tempted to use something like `sm.os(gcost)` to represent that `xij` term. However, this is not recommended because `sm.os(gcost)` might not have the same number of columns as `sm.os(gcost.air, gcost.trn, gcost.bus)` etc. That is, it is best to select one of the diagonal elements of the block matrix to represent that term.
- **niknots**: numeric, the number of interior knots, called \( K \) below. The default is to use this value. If you want `alg.niknots` to operate then assign `NULL` to this argument.
- **alg.niknots**: character. The algorithm used to determine the number of interior knots. Only used when `all.knots = FALSE` and `niknots = NULL`. Note that `.nknots.smspl` corresponds to the default of `smooth.spline`. The value "s" corresponds to the same algorithm as `s`.
- **all.knots**: logical. If `TRUE` then all distinct points in `x` are used as the interior knots. If `FALSE` (default) then a subset of `x[]` is used, specifically `x[j]` where the `niknots` indices are quantiles that are evenly spaced with respect to the argument `probs`—see `quantile`. If `all.knots = FALSE` and `niknots = NULL` then the argument `alg.niknots` is used to compute `niknots`.
- **spar, maxspar**: `spar` is a vector of smoothing parameters. Negative values mean that `magic` will choose initial values in order to do the optimization at each P-IRLS iteration. Positive values mean that they are used as initial values for `magic`. If `fixspar = TRUE` then `spar` should be assigned a vector of positive values (but having values less than `maxspar`); then the smoothing parameters will be fixed and `magic` will not be used.
- **o.order**: The order of the O’Sullivan penalized spline. Any one value from `1:4` is acceptable. The degree of the spline is `2 * o.order - 1`, so that cubic splines are the default. Setting `o.order = 1` results in a linear spline which is a piecewise linear function.
- **ridge.adj**: small positive number to stabilize linear dependencies among B-spline bases.
- **spillover**: small and positive proportion of the range used on the outside of the boundary values. This defines the endpoints \( a \) and \( b \) that cover the data \( x_i \), i.e., we are interested in the interval \([a, b]\) which contains all the abscissae. The interior knots are strictly inside \((a, b)\).
Fed into the argument (by the same name) of `splineDesign`.

`fixspar` logical. If `TRUE` then `spar` should be a vector with positive values and the smoothing parameters are fixed at those values. If `FALSE` then `spar` contains the initial values for the smoothing parameters, and `magic` is called to determine (hopefully) some good values for the smoothing parameters.

Details

This function is currently used by `vgam` to allow automatic smoothing parameter selection based on O-splines to minimize an UBRE quantity. In contrast, `s` operates by having a prespecified amount of smoothing, e.g., its `df` argument. When the sample size is reasonably large this function is recommended over `s` also because backfitting is not required. This function therefore allows 2nd-generation VGAMs to be fitted (called G2-VGAMs, or Penalized-VGAMs).

This function should only be used with `vgam`. This function uses `quantile` to choose the knots, whereas `sm.ps` chooses equally-spaced knots. As Wand and Ormerod (2008) write, in most situations the differences will be minor, but it is possible for problems to arise for either strategy by constructing certain regression functions and predictor variable distributions. Any differences between O-splines and P-splines tend to be at the boundaries. O-splines have natural boundary constraints so that the solution is linear beyond the boundary knots.

Some arguments in decreasing order of precedence are: `all.knots`, `niknots`, `alg.niknots`.

Unlike `s`, which is symbolic and does not perform any smoothing itself, this function does compute the penalized spline when used by `vgam`—it creates the appropriate columns of the model matrix. When this function is used within `vgam`, automatic smoothing parameter selection is implemented by calling `magic` after the necessary link-ups are done.

By default this function centres the component function. This function is also smart; it can be used for smart prediction (Section 18.6 of Yee (2015)). Automatic smoothing parameter selection is performed using performance-oriented iteration whereby an optimization problem is solved at each IRLS iteration.

This function works better when the sample size is large, e.g., when in the hundreds, say.

Value

A matrix with attributes that are (only) used by `vgam`. The number of rows of the matrix is `length(x)`. The number of columns is a function of the number of interior knots $K$ and the order of the O-spline $m$: $K + 2m - 1$. In code, this is `niknots + 2 * o.order - 1`, or using `sm.ps`-like arguments, `ps.int + degree - 1` (where `ps.int` should be more generally interpreted as the number of intervals. The formula is the same as `sm.ps`). It transpires then that `sm.os` and `sm.ps` are very similar.

Warning

Being introduced into VGAM for the first time, this function (and those associated with it) should be used cautiously. Not all options are fully working or have been tested yet, and there are bound to be some bugs lurking around.
Note

This function is currently under development and may change in the future.

One might try using this function with \texttt{vglm} so as to fit a regression spline, however, the default value of \texttt{n knots} will probably be too high for most data sets.

Author(s)

T. W. Yee, with some of the essential R code coming from the appendix of Wand and Ormerod (2008).

References


See Also

\texttt{vgam, sm.ps, s, smartpred, is.smart, summarypvgam, smooth.spline, splineDesign, bs, magic}.

Examples

\begin{verbatim}
sm.os(runif(20))

## Not run:
data("TravelMode", package = "AER") # Need to install "AER" first
air.df <- subset(TravelMode, mode == "air") # Form 4 smaller data frames
bus.df <- subset(TravelMode, mode == "bus")
trn.df <- subset(TravelMode, mode == "train")
car.df <- subset(TravelMode, mode == "car")
TravelMode2 <- data.frame(income = air.df$income,
                         wait.air = air.df$wait - car.df$wait,
                         wait.trn = trn.df$wait - car.df$wait,
                         wait.bus = bus.df$wait - car.df$wait,
                         gcost.air = air.df$gcost - car.df$gcost,
                         gcost.trn = trn.df$gcost - car.df$gcost,
                         gcost.bus = bus.df$gcost - car.df$gcost,
                         wait = air.df$wait) # Value is unimportant
TravelMode2$mode <- subset(TravelMode, choice == "yes")$mode # The response
TravelMode2 <- transform(TravelMode2, incom.air = income, incom.trn = 0,
                          incom.bus = 0)
set.seed(1)
TravelMode2 <- transform(TravelMode2, junkx2 = runif(nrow(TravelMode2)))
tfit2 <-
vgam(mode ~ sm.os(gcost.air, gcost.trn, gcost.bus) + ns(junkx2, 4) +
      sm.os(incom.air, incom.trn, incom.bus) + wait ,
      crit = "coef",
      multinomial(parallel = FALSE ~ 1), data = TravelMode2,
      xij = list(sm.os(gcost.air, gcost.trn, gcost.bus) ~ sm.os(gcost.air, gcost.trn, gcost.bus) +
                                     
\end{verbatim}
### sm.ps

**Defining Penalized Spline Smooths in VGAM Formulas**

#### Description

This function represents a P-spline smooth term in a `vgam` formula and confers automatic smoothing parameter selection.

#### Usage

```r
sm.ps(x, ..., ps.int = NULL, spar = -1, degree = 3, p.order = 2,
      ridge.adj = 1e-5, spillover = 0.01, maxspar = 1e12,
      outer.ok = FALSE, mux = NULL, fixspar = FALSE)
```

#### Arguments

- `x, ...` the number of equally-spaced B-spline intervals. Note that the number of knots is equal to `ps.int + 2*degree + 1`. The default, signified by `NULL`, means that the maximum of the value 7 and `degree` is chosen. This usually means 6 interior knots for big data sets. However, if this is too high compared to the length of `x`, then some adjustment is made. In the case where `mux` is assigned a numerical value (suggestions: some value between 1 and 2) then ceiling(`mux * log(length(unique(x.index)))`) is used, where `x.index` is the combined data. No matter what, the above is not guaranteed to work on every data set. This argument may change in the future. See also argument `mux`.

- `ps.int` the number of equally-spaced B-spline intervals. Note that the number of knots is equal to `ps.int + 2*degree + 1`. The default, signified by `NULL`, means that the maximum of the value 7 and `degree` is chosen. This usually means 6 interior knots for big data sets. However, if this is too high compared to the length of `x`, then some adjustment is made. In the case where `mux` is assigned a numerical value (suggestions: some value between 1 and 2) then ceiling(`mux * log(length(unique(x.index)))`) is used, where `x.index` is the combined data. No matter what, the above is not guaranteed to work on every data set. This argument may change in the future. See also argument `mux`.

---

```r
form2 = ~ sm.os(gcost.trn, gcost.bus, gcost.air) +
sm.os(gcost.bus, gcost.air, gcost.trn),
sm.os(incom.air, incom.trn, incom.bus) -
sm.os(incom.air, incom.trn, incom.bus) +
sm.os(incom.trn, incom.bus, incom.air) +
sm.os(incom.bus, incom.air, incom.trn),
wait ~ wait.air + wait.trn + wait.bus),
```

```r
par(mfrow = c(2, 2))
plot(tfit2, se = TRUE, lcol = "orange", scol = "blue", ylim = c(-4, 4))
summary(tfit2)
```

## End(Not run)
spar, maxspar  See sm.os.

mux numeric. If given, then this argument multiplies \( \log(\text{length(unique}(x))) \) to obtain \( \text{ps.int} \). If \( \text{ps.int} \) is given then this argument is ignored.

degree degree of B-spline basis. Usually this will be 2 or 3; and the values 1 or 4 might possibly be used.

p.order order of difference penalty (0 is the ridge penalty).

ridge.adj, spillover  See sm.os.

outer.ok, fixspar  See sm.os.

Details

This function can be used by \texttt{vgam} to allow automatic smoothing parameter selection based on P-splines and minimizing an UBRE quantity.

This function should only be used with \texttt{vgam} and is an alternative to \texttt{sm.os}; see that function for some details that also apply here.

Value

A matrix with attributes that are (only) used by \texttt{vgam}. The number of rows of the matrix is \( \text{length}(x) \) and the number of columns is \( \text{ps.int} + \text{degree} - 1 \). The latter is because the function is centred.

Warning

See sm.os.

Note

This function is currently under development and may change in the future. In particular, the default for \( \text{ps.int} \) is subject to change.

Author(s)

B. D. Marx wrote the original function. Subsequent edits were made by T. W. Yee and C. Somchit.

References


See Also

\texttt{sm.os, s, vgam, smartpred, is.smart, summaryvgam, splineDesign, bs, magic}. 
Examples

```r
sm.ps(runif(20))
sm.ps(runif(20), ps.int = 5)

## Not run:
data("TravelMode", package = "AER") # Need to install "AER" first
air.df <- subset(TravelMode, mode == "air") # Form 4 smaller data frames
bus.df <- subset(TravelMode, mode == "bus")
trn.df <- subset(TravelMode, mode == "train")
car.df <- subset(TravelMode, mode == "car")
TravelMode2 <- data.frame(income = air.df$income,
                           wait.air = air.df$wait - car.df$wait,
                           wait.trn = trn.df$wait - car.df$wait,
                           wait.bus = bus.df$wait - car.df$wait,
                           gcost.air = air.df$gcost - car.df$gcost,
                           gcost.trn = trn.df$gcost - car.df$gcost,
                           gcost.bus = bus.df$gcost - car.df$gcost,
                           wait = air.df$wait) # Value is unimportant
TravelMode2$mode <- subset(TravelMode, choice == "yes")$mode # The response
TravelMode2 <- transform(TravelMode2, incom.air = income, incom.trn = 0,
                          incom.bus = 0)
set.seed(1)
TravelMode2 <- transform(TravelMode2,
junkx2 = runif(nrow(TravelMode2)))
tfit2 <-
vgam(mode ~ sm.ps(gcost.air, gcost.trn, gcost.bus) + ns(junkx2, 4) +
      sm.ps(incom.air, incom.trn, incom.bus) + wait,
crit = "coef",
multinomial(parallel = FALSE ~ 1), data = TravelMode2,
xij = list(sm.ps(gcost.air, gcost.trn, gcost.bus) ~
            sm.ps(gcost.air, gcost.trn, gcost.bus) +
            sm.ps(gcost.trn, gcost.bus, gcost.air) +
            sm.ps(gcost.bus, gcost.air, gcost.trn),
            sm.ps(incom.air, incom.trn, incom.bus) ~
            sm.ps(incom.air, incom.trn, incom.bus) +
            sm.ps(incom.trn, incom.bus, incom.air) +
            sm.ps(incom.bus, incom.air, incom.trn),
            wait ~ wait.air + wait.trn + wait.bus),
form2 = ~ sm.ps(gcost.air, gcost.trn, gcost.bus) +
sm.ps(gcost.trn, gcost.bus, gcost.air) +
sm.ps(gcost.bus, gcost.air, gcost.trn) +
wait +
sm.ps(incom.air, incom.trn, incom.bus) +
sm.ps(incom.trn, incom.bus, incom.air) +
sm.ps(incom.bus, incom.air, incom.trn) +
junkx2 + ns(junkx2, 4) +
incom.air + incom.trn + incom.bus +
gcost.air + gcost.trn + gcost.bus +
wait.air + wait.trn + wait.bus)
par(mfrow = c(2, 2))
plot(tfit2, se = TRUE, lcol = "orange", scol = "blue", ylim = c(-4, 4))```
smart.mode.is

Determine What Mode the Smart Prediction is In

Description

Determine which of three modes the smart prediction is currently in.

Usage

smart.mode.is(mode.arg = NULL)

Arguments

mode.arg a character string, either "read", "write" or "neutral".

Details

Smart functions such as \texttt{bs} and \texttt{poly} need to know what mode smart prediction is in. If it is in "write" mode then the parameters are saved to \texttt{.smart.prediction} using \texttt{put.smart}. If in "read" mode then the parameters are read in using \texttt{get.smart}. If in "neutral" mode then the smart function behaves like an ordinary function.
Value

If `mode.arg` is given, then either TRUE or FALSE is returned. If `mode.arg` is not given, then the mode ("neutral", "read" or "write") is returned. Usually, the mode is "neutral".

See Also

`put.smart`, `bs`, `poly`.

Examples

```r
print(sm.min1)
smart.mode.is()  # Returns "neutral"
smart.mode.is(smart.mode.is())  # Returns TRUE
```

smartpred

Smart Prediction

Description

Data-dependent parameters in formula terms can cause problems in when predicting. The `smartpred` package saves data-dependent parameters on the object so that the bug is fixed. The `lm` and `glm` functions have been fixed properly. Note that the `VGAM` package by T. W. Yee automatically comes with smart prediction.

Usage

```r
sm.bs(x, df = NULL, knots = NULL, degree = 3, intercept = FALSE, 
     Boundary.knots = range(x))
sm.ns(x, df = NULL, knots = NULL, intercept = FALSE, 
     Boundary.knots = range(x))
sm.poly(x, ..., degree = 1, coefs = NULL, raw = FALSE)
sm.scale(x, center = TRUE, scale = TRUE)
```

Arguments

- `x` The `x` argument is actually common to them all.
- `df`, `knots`, `intercept`, `Boundary.knots`
  See `bs` and/or `ns`.
- `degree`, `...`, `coefs`, `raw`
  See `poly`.
- `center`, `scale` See `scale`.
Details

R version 1.6.0 introduced a partial fix for the prediction problem because it does not work all the time, e.g., for terms such as \( \text{I(poly}(x, 3)) \), \( \text{poly}(c(\text{scale}(x)), 3) \), \( \text{bs}(\text{scale}(x), 3) \), \( \text{scale}(\text{scale}(x)) \).

See the examples below. Smart prediction, however, will always work.

The basic idea is that the functions in the formula are now smart, and the modelling functions make use of these smart functions. Smart prediction works in two ways: using \texttt{smart.expression}, or using a combination of \texttt{put.smart} and \texttt{get.smart}.

Value

The usual value returned by \texttt{bs}, \texttt{ns}, \texttt{poly} and \texttt{scale}. When used with functions such as \texttt{vglm} the data-dependent parameters are saved on one slot component called \texttt{smart.prediction}.

Side Effects

The variables \texttt{.max.smart}, \texttt{.smart.prediction} and \texttt{.smart.prediction.counter} are created while the model is being fitted. They are created in a new environment called \texttt{smartpredenv}. These variables are deleted after the model has been fitted. However, if there is an error in the model fitting function or the fitting model is killed (e.g., by typing control-C) then these variables will be left in \texttt{smartpredenv}. At the beginning of model fitting, these variables are deleted if present in \texttt{smartpredenv}.

During prediction, the variables \texttt{.smart.prediction} and \texttt{.smart.prediction.counter} are reconstructed and read by the smart functions when the model frame is re-evaluated. After prediction, these variables are deleted.

If the modelling function is used with argument \texttt{smart} = \texttt{FALSE} (e.g., \texttt{vglm(..., smart = FALSE)}) then smart prediction will not be used, and the results should match with the original \texttt{R} functions.

WARNING

The functions \texttt{bs}, \texttt{ns}, \texttt{poly} and \texttt{scale} are now left alone (from 2014-05 onwards) and no longer smart. They work via safe prediction. The smart versions of these functions have been renamed and they begin with "sm."

The functions \texttt{predict.bs} and \texttt{predict.ns} are not smart. That is because they operate on objects that contain attributes only and do not have list components or slots. The function \texttt{predict.poly} is not smart.

Author(s)

T. W. Yee and T. J. Hastie

See Also

\texttt{get.smart.prediction}, \texttt{get.smart}, \texttt{put.smart}, \texttt{smart.expression}, \texttt{smart.mode.is}, \texttt{setup.smart}, \texttt{wrapup.smart}. For \texttt{vgam} in \texttt{VGAM}, \texttt{sm.ps} is important. Commonly used data-dependent functions include \texttt{scale}, \texttt{poly}, \texttt{bs}, \texttt{ns}. In \texttt{R}, the functions \texttt{bs} and \texttt{ns} are in the \texttt{splines} package, and this library is automatically loaded in because it contains compiled code that \texttt{bs} and \texttt{ns} call.

The functions \texttt{vglm}, \texttt{vgam}, \texttt{rrvglm} and \texttt{cqo} in T. W. Yee’s \texttt{VGAM} package are examples of modelling functions that employ smart prediction.
Examples

# Create some data first
n <- 20
set.seed(86) # For reproducibility of the random numbers
ldata <- data.frame(x2 = sort(runif(n)), y = sort(runif(n)))
library("splines") # To get ns() in R

# This will work for R 1.6.0 and later
fit <- lm(y ~ ns(x2, df = 5), data = ldata)
## Not run:
plot(y ~ x2, data = ldata)
lines(fitted(fit) ~ x2, data = ldata)
new.ldata <- data.frame(x2 = seq(0, 1, len = n))
points(predict(fit, new.ldata) ~ x2, new.ldata, type = "b", col = 2, err = -1)
## End(Not run)

# The following fails for R 1.6.x and later. It can be
# made to work with smart prediction provided
# ns is changed to sm.ns and scale is changed to sm.scale:
fit1 <- lm(y ~ ns(scale(x2), df = 5), data = ldata)
## Not run:
plot(y ~ x2, data = ldata, main = "Safe prediction fails")
lines(fitted(fit1) ~ x2, data = ldata)
points(predict(fit1, new.ldata) ~ x2, new.ldata, type = "b", col = 2, err = -1)
## End(Not run)

# Fit the above using smart prediction
## Not run:
library("VGAM") # The following requires the VGAM package to be loaded
fit2 <- vglm(y ~ sm.ns(sm.scale(x2), df = 5), uninormal, data = ldata)
fit2@smart.prediction
plot(y ~ x2, data = ldata, main = "Smart prediction")
lines(fitted(fit2) ~ x2, data = ldata)
points(predict(fit2, new.ldata, type = "response") ~ x2, data = new.ldata,
        type = "b", col = 2, err = -1)
## End(Not run)

---

specials

Special Values or Quantities in a Fitted Object

Description

Return any special values or quantities in a fitted object, and in particular in a VGLM fit

Usage

specials(object, ...)
specialsvglm(object, ...)

---
Arguments

- **object**: an object of class "vglm" whose family function begins with "gait".
- **...**: any additional arguments, to future-proof this function.

Details

This extractor function was motivated by GAITD regression (Yee and Ma, 2024) where the values from three disjoint sets are referred to as special. More generally, S4 methods functions can be written so that specials() will work on any S4 object, where what is called special depends on the methodology at hand.

Value

Returns any ‘special’ values or quantities associated with a fitted regression model. This is often something simple such as a list or a vector.

References


See Also

vglm, vglm-class, inflated, altered, truncated, Gaitdpois, gaitdpoisson.

Examples

```r
abdata <- data.frame(y = 0:7, w = c(182, 41, 12, 2, 2, 0, 0, 1))
fit1 <- vglm(y ~ 1, gaitdpoisson(a.mix = 0), data = abdata,
            weight = w, subset = w > 0)
specials(fit1)
```

---

### spikeplot

*Spike Plot*

**Description**

Produces a spike plot of a numeric vector.

**Usage**

```r
spikeplot(x, freq = FALSE, as.table = FALSE, col = par("col"),
          lty = par("lty"), lwd = par("lwd"), lend = par("lend"),
          type = "h", xlab = deparse1(substitute(x)), ylab = NULL,
          capped = FALSE, cex = sqrt(lwd) / 2, pch = 19, pcol = col, scol = NULL,
          slty = NULL, slwd = NULL, new.plot = TRUE, offset.x = 0, ymux = 1, ...)
```
Arguments

- **x**
  - Numeric, passed into `table`.

- **freq**
  - Logical. If `TRUE` then the y-axis measures the frequencies, else the sample proportions. Intended to be as `hist`.

- **as.table**
  - Logical. If `TRUE` then the call to `plot` is closer to `plot(table(x), ...)`, meaning the labelling differs from `as.table = FALSE`. The default is to convert `table(x)` into a numeric vector which is then passed into `plot` so that the labelling is more uniform along the x-axis.

- **col, type, lty, lwd**
  - See `par`.

- **lend, xlab, ylab**
  - See `par`.

- **capped, cex, pch, pcol**
  - First argument is logical. If `TRUE` then the others argument are used to place points at the top using `points` with `pcol` being its colour. See `par`.

- **scol, slty, slwd**
  - Similar to `col, lty` and `lwd` but apply to some selected values. The input may be a named list such as `scol = list("green" = c(2, 4, 6), "blue" = 5), slty = list("dashed" = c(2, 4, 6), "dotted" = 5), slwd = list("2" = c(2, 4, 6), "3" = 5)`, else a named vector such as `scol = c("green" = 2, "green" = 4, "green" = 6, "blue" = 5), slty = c("dashed" = 2, "dashed" = 4, "dashed" = 6, "dotted" = 5), slwd = c("2" = 2, "2" = 4, "2" = 6, "3" = 5)`. The three arguments are ignored if `as.table = TRUE`.

- **new.plot, offset.x**
  - Logical and numeric. Add to an existing plot? If so, set `new.plot = FALSE` and it is useful for the spikes to be shifted by some amount `offset.x`.

- **ymux**
  - Numeric, y-multiplier. The response is multiplied by `ymux`. This can be useful when plotting subsets side-by-side so that the constituent proportions add up to the overall proportion.

- **...**
  - Additional graphical arguments passed into an ordinary `plot`, for example, `xlim`, `las`, `main`.

Details

*Heaping* is a very commonly occurring phenomenon in retrospective self-reported survey data. Also known as *digit preference* data, it is often characterized by an excess of multiples of 10 or 5 upon rounding. For this type of data this simple function is meant to be convenient for plotting the frequencies or sample proportions of a vector `x` representing a discrete random variable. This type of plot is known as a *spike plot* in STATA circles. If `table(x)` works then this function should hopefully work. The default for `type` means that any heaping and *seeping* should easily be seen. If such features exist then *GaitD regression* is potentially useful—see `gaitdpoisson` etc. Currently missing values are ignored totally because `table(x)` is used without further arguments; this might change in the future.

Value

Returns invisibly `table(x)`.
Author(s)

T. W. Yee.

See Also

table, plot, par, deparse1, dgaitplot, plotgaitd, gaitdpoisson.

Examples

## Not run:
spikeplot(with(marital.nz, age), col = "pink2", lwd = 2)
## End(Not run)

sqrtlink

Square Root and Folded Square Root Link Functions

Description

Computes the square root and folded square root transformations, including their inverse and their first two derivatives.

Usage

foldsqrtlink(theta, min = 0, max = 1, mux = sqrt(2), inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE)
sqrtlink(theta, inverse = FALSE, deriv = 0, short = TRUE, tag = FALSE, c10 = c(2, -2))

Arguments

theta Numeric or character. See below for further details.
min, max, mux These are called $L$, $U$ and $K$ below.
inverse, deriv, short, tag Details at Links.
c10 Numeric, 2-vector $c(c1, cθ)$ for a linear transformation. The plain link is multiplied by $c1$ and then $cθ$ is added so that $c1 = 1:0$ is simply $sqrt$. The default is intended to match lcsloglink for poissonff at lambda(theta) equal to 1.

details

The folded square root link function can be applied to parameters that lie between $L$ and $U$ inclusive. Numerical values of theta out of range result in NA or NaN.

More general information can be found at alogitlink.
Value

For foldsqrtlink with deriv = 0: \( K(\sqrt{\theta - L} - \sqrt{U - \theta}) \) or \( \mu x \times (\sqrt{\theta - \text{min}} - \sqrt{\text{max} - \theta}) \) when inverse = FALSE, and if inverse = TRUE then some more complicated function that returns a NA unless theta is between \(-\mu x \times \sqrt{\text{max} - \text{min}}\) and \(\mu x \times \sqrt{\text{max} - \text{min}}\).

For sqrtlink with deriv = 0 and c10 = 1:0: \( \sqrt{\theta} \) when inverse = FALSE, and if inverse = TRUE then the square is returned.

For deriv = 1, then the function returns \( d \eta /d \theta \) as a function of theta if inverse = FALSE, else if inverse = TRUE then it returns the reciprocal.

Note

For foldsqrtlink, the default has, if theta is 0 or 1, the link function value is \(-\sqrt{2}\) and \(+\sqrt{2}\) respectively. These are finite values, therefore one cannot use this link function for general modelling of probabilities because of numerical problem, e.g., with \texttt{binomialff, cumulative}.

See the example below.

Author(s)

Thomas W. Yee

See Also

\texttt{Links, poissonff, sloglink, hdeff}.

Examples

```r
p <- seq(0.01, 0.99, by = 0.01)
foldsqrtlink(p)
max(abs(foldsqrtlink(foldsqrtlink(p), inverse = TRUE) - p)) # 0

p <- c(seq(-0.02, 0.02, by = 0.01), seq(0.97, 1.02, by = 0.01))
foldsqrtlink(p) # Has NAs

## Not run:
p <- seq(0.01, 0.99, by = 0.01)
par(mfrow = c(2, 2), lwd = (mylwd <- 2))
y <- seq(-4, 4, length = 100)
for (d in 0:1) {
  matplot(p, cbind( logitlink(p, deriv = d),
                  foldsqrtlink(p, deriv = d)),
         col = "blue", ylab = "transformation",
         main = ifelse(d == 0, "Some probability links",
                        "First derivative"), type = "n", las = 1)
  lines(p, logitlink(p, deriv = d), col = "green")
  lines(p, probitlink(p, deriv = d), col = "blue")
  lines(p, clogloglink(p, deriv = d), col = "red")
  lines(p, foldsqrtlink(p, deriv = d), col = "tan")
  if (d == 0) {
    abline(v = 0.5, h = 0, lty = "dashed")
    legend(0, 4.5, c("logitlink", "probitlink",
```
for (d in 0) {
  matplot(y,
    cbind( logitlink(y, deriv = d, inverse = TRUE),
           foldsqrtlink(y, deriv = d, inverse = TRUE)),
    type = "n", col = "blue", xlab = "transformation",
    ylab = "p", lwd = 2, las = 1, main = if (d == 0)
      "Some inverse probability link functions" else
      "First derivative")
  lines(y, logitlink(y, deriv=d, inverse=TRUE), col="green")
  lines(y, probitlink(y, deriv=d, inverse=TRUE), col="blue")
  lines(y, clogloglink(y, deriv=d, inverse=TRUE), col="red")
  lines(y, foldsqrtlink(y, deriv=d, inverse=TRUE), col="tan")
  if (d == 0) {
    abline(h = 0.5, v = 0, lty = "dashed")
    legend(-4, 1, c("logitlink", "probitlink",
                     "clogloglink", "foldsqrtlink"), lwd = 2,
           col = c("green", "blue", "red", "tan"))
  }
}
par(lwd = 1)

## End(Not run)

# This is lucky to converge
fit.h <- vglm(agaus ~ sm.bs(altitude),
              binomialff(foldsqrtlink(mux = 5)),
              hunua, trace = TRUE)
## Not run:
plotvgam(fit.h, se = TRUE, lcol = "orange", scol = "orange",
         main = "Orange is Hunua, Blue is Waitakere")
## End(Not run)
head(predict(fit.h, hunua, type = "response"))

## Not run:
# The following fails.
pneumo <- transform(pneumo, let = log(exposure.time))
fit <- vglm(cbind(normal, mild, severe) ~ let,
            cumulative(foldsqrtlink(mux = 10), par = TRUE, rev = TRUE),
            data = pneumo, trace = TRUE, maxit = 200)
## End(Not run)
**Description**

Fits a stopping ratio logit/probit/cloglog/cauchit/... regression model to an ordered (preferably) factor response.

**Usage**

```r
sratio(link = "logitlink", parallel = FALSE, reverse = FALSE,
       zero = NULL, ynames = FALSE, Thresh = NULL, Trev = reverse,
       Tref = if (Trev) "M" else 1, whitespace = FALSE)
```

**Arguments**

- `link`: Link function applied to the \( M \) stopping ratio probabilities. See \textit{Links} for more choices.
- `parallel`: A logical, or formula specifying which terms have equal/unequal coefficients.
- `reverse`: Logical. By default, the stopping ratios used are \( \eta_j = \text{logit}(P[Y = j|Y \geq j]) \) for \( j = 1, \ldots, M \). If `reverse` is TRUE, then \( \eta_j = \text{logit}(P[Y = j+1|Y \leq j+1]) \) will be used.
- `ynames`: See \textit{multinomial} for information.
- `zero`: Can be an integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The values must be from the set \{1,2,\ldots,\( M \)\}. The default value means none are modelled as intercept-only terms. See \textit{CommonVGAMffArguments} for information.
- `Thresh`, `Trev`, `Tref`: See \textit{cumulative} for information. These arguments apply to ordinal categorical regression models.
- `whitespace`: See \textit{CommonVGAMffArguments} for information.

**Details**

In this help file the response \( Y \) is assumed to be a factor with ordered values \( 1, 2, \ldots, M + 1 \), so that \( M \) is the number of linear/additive predictors \( \eta_i \).

There are a number of definitions for the \textit{continuation ratio} in the literature. To make life easier, in the \textit{VGAM} package, we use \textit{continuation} ratios (see \textit{cratio}) and \textit{stopping} ratios. Continuation ratios deal with quantities such as \( \text{logit}(P[Y>j|Y\geq j]) \).

**Value**

An object of class "\textit{vglmff}" (see \textit{vglmff-class}). The object is used by modelling functions such as \textit{vglm}, \textit{rrvglm} and \textit{vgam}.

**Warning**

No check is made to verify that the response is ordinal if the response is a matrix; see \textit{ordered}.

Boersch-Supan (2021) considers a sparse data set (called \textit{budworm}) and the numerical problems encountered when fitting models such as \textit{cratio}, \textit{sratio}, \textit{cumulative}. Although improvements to links such as \textit{clogloglink} have been made, currently these family functions have not been properly adapted to handle sparse data as well as they could.
Note

The response should be either a matrix of counts (with row sums that are all positive), or a factor. In both cases, the y slot returned by vglm/vgam/rrvglm is the matrix of counts.

For a nominal (unordered) factor response, the multinomial logit model (multinomial) is more appropriate.

Here is an example of the usage of the parallel argument. If there are covariates x1, x2 and x3, then parallel = TRUE ~ x1 + x2 -1 and parallel = FALSE ~ x3 are equivalent. This would constrain the regression coefficients for x1 and x2 to be equal; those of the intercepts and x3 would be different.

Author(s)

Thomas W. Yee

References


See Also

cratio, acat, cumulative, multinomial, CM.equid, CommonVGAMffArguments, margeff, pneumo, budworm, logitlink, probitlink, clogloglink, cauchitlink.

Examples

```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let,
            sratio(parallel = TRUE), data = pneumo))
coeff(fit, matrix = TRUE)
constraints(fit)
predict(fit)
predict(fit, untransform = TRUE)
```
Choose a model by AIC in a Stepwise Algorithm

Description
Select a formula-based model by AIC.

Usage
step4(object, ...)  
step4vglm(object, scope, direction = c("both", "backward", "forward"),  
          trace = 1, keep = NULL, steps = 1000, k = 2, ...)

Arguments
object an object of class "vglm". This is used as the initial model in the stepwise search.
scope See step.
direction See step.
trace, keep See step.
steps, k See step.
... any additional arguments to extractAIC.vglm, drop1.vglm and add1.vglm.

Details
This function is a direct adaptation of step for vglm-class objects. Since step is not generic, the name step4() was adopted and it is generic, as well as being S4 rather than S3. It is the intent that this function should work as similar as possible to step.

Internally, the methods function for vglm-class objects calls add1.vglm and drop1.vglm repeatedly.

Value
The results are placed in the post slot of the stepwise-selected model that is returned. There are up to two additional components. There is an "anova" component corresponding to the steps taken in the search, as well as a "keep" component if the keep= argument was supplied in the call.

Warning
In general, the same warnings in drop1.glm and drop1.vglm apply here.

This function

See Also
add1.vglm, drop1.vglm, vglm, trim.constraints, add1.glm, drop1.glm, backPain2, step, update.
Examples

```r
data("backPain2", package = "VGAM")
summary(backPain2)
fit1 <- vglm(pain ~ x2 + x3 + x4 + x2:x3 + x2:x4 + x3:x4, 
propodds, data = backPain2)
spom1 <- step4(fit1)
summary(spom1)
spom1@post$anova
```

---

studentt  

### Student t Distribution

**Description**

Estimating the parameters of a Student t distribution.

**Usage**

```r
studentt (ldf = "logloglink", idf = NULL, tol1 = 0.1, imethod = 1)
studentt2(df = Inf, ilocation = "identitylink", lscale = "loglink", 
  iscale = NULL, imethod = 1, zero = "scale")
studentt3(llocation = "identitylink", lscale = "logloglink", 
  idf = NULL, imethod = 1, zero = c("scale", "df"))
```

**Arguments**

- `llocation`, `lscale`, `ldf`
  - Parameter link functions for each parameter, e.g., for degrees of freedom $\nu$. See [Links](#) for more choices. The defaults ensures the parameters are in range. A `loglog` link keeps the degrees of freedom greater than unity; see below.
- `ilocation`, `iscale`, `idf`
  - Optional initial values. If given, the values must be in range. The default is to compute an initial value internally.
- `tol1`
  - A positive value, the tolerance for testing whether an initial value is 1. Best to leave this argument alone.
- `df`
  - Numeric, user-specified degrees of freedom. It may be of length equal to the number of columns of a response matrix.
- `imethod`, `zero`
  - See [CommonVGAMffArguments](#).

**Details**

The Student t density function is

$$f(y; \nu) = \frac{\Gamma((\nu + 1)/2)}{\sqrt{\nu\pi}\Gamma(\nu/2)} \left(1 + \frac{y^2}{\nu}\right)^{-(\nu+1)/2}$$
for all real \( y \). Then \( E(Y) = 0 \) if \( \nu > 1 \) (returned as the fitted values), and \( \text{Var}(Y) = \nu/(\nu - 2) \) for \( \nu > 2 \). When \( \nu = 1 \) then the Student \( t \)-distribution corresponds to the standard Cauchy distribution, \texttt{cauchy1}. When \( \nu = 2 \) with a scale parameter of \( \sqrt{2} \) then the Student \( t \)-distribution corresponds to the standard (Koenker) distribution, \texttt{sc.studentt2}. The degrees of freedom can be treated as a parameter to be estimated, and as a real and not an integer. The Student \( t \) distribution is used for a variety of reasons in statistics, including robust regression.

Let \( Y = (T - \mu)/\sigma \) where \( \mu \) and \( \sigma \) are the location and scale parameters respectively. Then \texttt{studentt3} estimates the location, scale and degrees of freedom parameters. And \texttt{studentt2} estimates the location, scale parameters for a user-specified degrees of freedom, \( df \). And \texttt{studentt} estimates the degrees of freedom parameter only. The fitted values are the location parameters. By default the linear/additive predictors are \((\mu, \log(\sigma), \log \log(\nu))^T\) or subsets thereof.

In general convergence can be slow, especially when there are covariates.

Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Note

\texttt{studentt3()} and \texttt{studentt2()} can handle multiple responses.

Practical experience has shown reasonably good initial values are required. If convergence failure occurs try using arguments such as \( \text{idf} \). Local solutions are also possible, especially when the degrees of freedom is close to unity or the scale parameter is close to zero.

A standard normal distribution corresponds to a \( t \) distribution with infinite degrees of freedom. Consequently, if the data is close to normal, there may be convergence problems; best to use \texttt{uninormal} instead.

Author(s)

T. W. Yee

References


See Also

\texttt{uninormal, cauchy1, logistic, huber2, sc.studentt2, TDist, simulate.vlm}.

Examples

```r
  tdata <- data.frame(x2 = runif(nn <- 1000))
  tdata <- transform(tdata, y1 = rt(nn, df = exp(exp(0.5 - x2))),
                     y2 = rt(nn, df = exp(exp(0.5 - x2))))
  fit1 <- vglm(y1 ~ x2, studentt, data = tdata, trace = TRUE)
  coef(fit1, matrix = TRUE)
```
# df inputted into studentt2() not quite right:
fit2 <- vglm(y1 ~ x2, studentt2(df = exp(exp(0.5))), tdata)
coef(fit2, matrix = TRUE)

fit3 <- vglm(cbind(y1, y2) ~ x2, studentt3, tdata, trace = TRUE)
coef(fit3, matrix = TRUE)

## S3 method for class 'drrvglm'
summary(object, correlation = FALSE, dispersion = NULL,
digits = NULL, numerical = TRUE, h.step = 0.005, omit123 = FALSE,
omit13 = FALSE, fixA = FALSE, presid = FALSE,
signif.stars = getOption("show.signif.stars"),
npredictors = FALSE, eval0 = TRUE, ...)

## S3 method for class 'summary.drrvglm'
show(x, digits = NULL,
quote = TRUE, prefix = ",", signif.stars = NULL)

## S3 method for class 'rrvglm'
summary(object, correlation = FALSE, dispersion = NULL,
digits = NULL, numerical = TRUE, h.step = 0.005, omit123 = FALSE,
omit13 = FALSE, fixA = TRUE, presid = FALSE,
signif.stars = getOption("show.signif.stars"),
npredictors = FALSE, upgrade = FALSE, ...)

## S3 method for class 'summary.rrvglm'
show(x, digits = NULL,
quote = TRUE, prefix = ",", signif.stars = NULL)

Arguments

object an object of class "drrvglm" or "rrvglm", a result of a call to rrvglm.
x an object of class "summary.drrvglm" or "summary.rrvglm", a result of a call
to summary.drrvglm or summary.rrvglm.
dispersion used mainly for GLMs. Not really implemented in VGAM so should not be used.
correlation See summaryvglm.
digits See summaryvglm.
summary.drrvglm

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>signif.stars</td>
<td>See summaryvglm.</td>
</tr>
<tr>
<td>presid, quote</td>
<td>See summaryvglm.</td>
</tr>
<tr>
<td>nopredictors</td>
<td>Logical. Upgrade object to drrvglm-class? Treating the object as a DRR-VGLM has advantages since the framework is larger. The code for ordinary RR-VGLMs was written a long time ago so it is a good idea to check that both give the same answer.</td>
</tr>
<tr>
<td>upgrade</td>
<td>Logical. Upgrade object to drrvglm-class? Treating the object as a DRR-VGLM has advantages since the framework is larger. The code for ordinary RR-VGLMs was written a long time ago so it is a good idea to check that both give the same answer.</td>
</tr>
<tr>
<td>numerical</td>
<td>Logical, use a finite difference approximation for partial derivatives? If FALSE then theoretical formulas are used (however this option may no longer be implemented).</td>
</tr>
<tr>
<td>h.step</td>
<td>Numeric, positive and close to 0. If numerical then this is the forward step for each finite difference approximation. That is, it plays the role of $h$ in $(f(x+h) - f(x))/h$ for some function $f$. If the overall variance-covariance matrix is not positive-definite, varying this argument can make a difference, e.g., increasing it to $0.01$ is recommended.</td>
</tr>
<tr>
<td>fixA</td>
<td>Logical, if TRUE then the largest block matrix is for $B_1$ and $C$, else it is for $A$ and $B_1$. This should not make any difference because both estimates of $B_1$ should be extremely similar, including the SEs.</td>
</tr>
<tr>
<td>omit13</td>
<td>Logical, if TRUE then the (1,3) block matrix is set to $O$. That is, $A$ and $C$ are assumed to asymptotically uncorrelated. Setting this TRUE is an option when $V$ (see below) is not positive-definite. If this fails, another option that is often better is to set omit123 = TRUE.</td>
</tr>
<tr>
<td>omit123</td>
<td>Logical. If TRUE then two block matrices are set to $O$ (blocks (1,2) and (1,3), else blocks (1,3) and (2,3), depending on fixA). This will almost surely result in an overall variance-covariance matrix that is positive-definite, however, the SEs will be biased. This argument is more extreme than omit13.</td>
</tr>
<tr>
<td>prefix</td>
<td>See summaryvglm.</td>
</tr>
<tr>
<td>eval0</td>
<td>Logical. Check if $V$ is positive-definite? That is, all its eigenvalues are positive.</td>
</tr>
<tr>
<td>...</td>
<td>Logical argument check.2 might work here. If TRUE then some quantities are printed out, for checking and debugging.</td>
</tr>
</tbody>
</table>

Details

Most of this document concerns DRR-VGLMs but also apply equally well to RR-VGLMs as a special case.

The overall variance-covariance matrix The overall variance-covariance matrix (called $V$ below) is computed. Since the parameters comprise the elements of the matrices $A$, $B_1$ and $C$ (called here block matrices 1, 2, 3 respectively), and an alternating algorithm is used for estimation, then there are two overlapping submodels that are fitted within an IRLS algorithm. These have blocks 1 and 2, and 2 and 3, so that $B_1$ is common to both. They are combined into one large overall variance-covariance matrix. Argument fixA specifies which submodel the $B_1$ block is taken from. Block (1,3) is the most difficult to compute and numerical approximations based on first derivatives are used by default for this.

Sometimes the computed $V$ is not positive-definite. If so, then the standard errors will be NA. To avoid this problem, try varying h.step or refitting the model with a different Index.corner.
Argument omit13 and omit123 can also be used to give approximate answers. If V is not positive-definite then this may indicate that the model does not fit the data very well, e.g., Rank is not a good value. Potentially, there are many ways why the model may be ill-conditioned. Try several options and set trace = TRUE to monitor convergence—this is informative about how well the model and data agree.

How can one fit an ordinary RR-VGLM as a DRR-VGLM? If one uses corner constraints (default) then one should input H.A as a list containing Rank diag(M) matrices—one for each column of A. Then since Corner = TRUE by default, then object@H.A.alt has certain columns deleted due to corner constraints. In contrast, object@H.A.thy is the H.A that was inputted. FYI, the alt suffix indicates the alternating algorithm, while the suffix thy stands for theory.

Value

summary.drrvglm returns an object of class "summary.drrvglm".

Warning

DRR-VGLMs are a recent development so it will take some time to get things totally ironed out. RR-VGLMs were developed a long time ago and are more well-established, however they have only recently been documented here.

Note

Note that vcov methods exist for rrvglm-class and drrvglm-class objects.
Sometimes this function can take a long time and this is because numerical derivatives are computed.

Author(s)

T. W. Yee.

References


See Also

rrvglm, rrvglm.control, vcovdrrvglm, CM.free, summaryvglm, summary.rrvglm-class, summary.drrvglm-class.

Examples

# Fit a rank-1 RR-VGLM as a DRR-VGLM.
set.seed(1); n <- 1000; S <- 6 # S must be even
myrank <- 1
rdata <- data.frame(x1 = runif(n), x2 = runif(n),
    x3 = runif(n), x4 = runif(n))
dval <- ncol(rdata) # Number of covariates
# Involves x1, x2, ... a rank-1 model:
ymatrix <- with(rdata,
matrix(rpois(n*S, exp(3 + x1 - 0.5*x2)), n, S))
H.C <- vector("list", dval) # Ordinary "rrvglm"
for (i in 1:dval) H.C[[i]] <- CM.free(myrank)
names(H.C) <- paste0("x", 1:dval)
H.A <- list(CM.free(S)) # rank-1

rfit1 <- rrvglm(ymatrix ~ x1 + x2 + x3 + x4,
poissonff, rdata, trace = TRUE)
class(rfit1)
dfit1 <- rrvglm(ymatrix ~ x1 + x2 + x3 + x4,
   poissonff, rdata, trace = TRUE,
   H.A = H.A, # drrvglm
   H.C = H.C) # drrvglm
class(dfit1)
Coef(rfit1) # The RR-VGLM is the same as
Coef(dfit1) # the DRR-VGLM.
max(abs(predict(rfit1) - predict(dfit1))) # 0
abs(logLik(rfit1) - logLik(dfit1)) # 0
## Not run:
summary(rfit1)
summary(dfit1)
## End(Not run)

summarypvgam

**Summary Penalized Vector Generalized Additive Model Fits**

**Description**

These functions are all methods for class "pvgam" or summary.pvgam objects.

**Usage**

```r
summarypvgam(object, dispersion = NULL, digits = options()$digits - 2,
             presid = TRUE)

## S3 method for class 'summary.pvgam'
show(x, quote = TRUE, prefix = "", digits = options()$digits - 2,
     signif.stars = getOption("show.signif.stars"))
```

**Arguments**

- **object** an object of class "pvgam", which is the result of a call to vgam with at least one
  sm.os or sm.ps term.
- **x** an object of class "summary.pvgam", which is the result of a call to summarypvgam().
- **dispersion**, **digits**, **presid** See summaryvglm.
- **quote**, **prefix**, **signif.stars** See summaryvglm.
Summary of Vector Generalized Additive Model Fits

This method function reports a summary more similar to `summary.gam` from `mgcv` than `summary.gam()` from `gam`. It applies to G2-VGAMs using `sm.os` and O-splines, else `sm.ps` and P-splines. In particular, the hypothesis test for whether each `sm.os` or `sm.ps` term can be deleted follows quite closely to `summary.gam`. The p-values from this type of test tend to be biased downwards (too small) and corresponds to `p.type = 5`. It is hoped in the short future that improved p-values be implemented, somewhat like the default of `summary.gam`. This methods function was adapted from `summary.gam`.

Value

`summaryvgam` returns an object of class "summary.pvgam": see `summary.pvgam-class`.

Warning

See `sm.os`.

See Also

`vgam`, `summaryvgam`, `summary.pvgam-class`, `sm.os`, `sm.ps`, `summary.glm`, `summary.lm`, `summary.gam` from `mgcv`, `summaryvgam` for G1-VGAMs.

Examples

```r
hfit2 <- vgam(agaus ~ sm.os(altitude), binomialff, data = hunua)
coef(hfit2, matrix = TRUE)
summary(hfit2)
```

Description

These functions are all methods for class `vgam` or `summary.vgam` objects.

Usage

```r
summaryvgam(object, dispersion = NULL, digits = options$digits - 2,
             presid = TRUE, nopredictors = FALSE)
## S3 method for class 'summary.vgam'
show(x, quote = TRUE, prefix = "",
      digits = options$digits-2, nopredictors = NULL)
```
Arguments

object          an object of class "vgam", which is the result of a call to \texttt{vgam} with at least one \texttt{s} term.
\hspace{7em} x
\hspace{7em} an object of class "summary.vgam", which is the result of a call to \texttt{summaryvgam()}.
dispersion, digits, presid
    See \texttt{summaryvglm}.
quote, prefix, nopredictors
    See \texttt{summaryvglm}.

Details

This methods function reports a summary more similar to \texttt{summary.gam()} from \texttt{gam} than \texttt{summary.gam} from \texttt{mgcv}. It applies to G1-VGAMs using \texttt{s} and vector backfitting. In particular, an approximate score test for linearity is conducted for each \texttt{s} term—see Section 4.3.4 of Yee (2015) for details. The p-values from this type of test tend to be biased upwards (too large).

Value

\texttt{summaryvgam} returns an object of class "summary.vgam"; see \texttt{summary.vgam-class}.

See Also

\texttt{vgam}, \texttt{summary.glm}, \texttt{summary.lm}, \texttt{summary.gam} from \texttt{mgcv}, \texttt{summarypvgam} for P-VGAMs.

Examples

\begin{verbatim}
  hfit <- vgam(agaaua ~ s(altitude, df = 2), binomialff, data = hunua)
  summary(hfit)
  summary(hfit)@anova  # Table for (approximate) testing of linearity
\end{verbatim}

---

**summaryvglm**

### Summarizing Vector Generalized Linear Model Fits

#### Description

These functions are all \texttt{methods} for class \texttt{vglm} or \texttt{summary.vglm} objects.

#### Usage

\begin{verbatim}
  summaryvglm(object, correlation = FALSE, dispersion = NULL,
               digits = NULL, presid = FALSE,
               HDEtest = TRUE, hde.NA = TRUE, threshold.hde = 0.001,
               signif.stars = getOption("show.signif.stars"),
               nopredictors = FALSE,
               lrt0.arg = FALSE, score0.arg = FALSE, wald0.arg = FALSE,
               values0 = 0, subset = NULL, omit1s = TRUE,
               ...)\end{verbatim}
summary.vglm

## S3 method for class 'summary.vglm'
show(x, digits = max(3L, getOption("digits") - 3L),
quote = TRUE, prefix = "", presid = length(x@pearson.resid) > 0,
HDEtest = TRUE, hde.NA = TRUE, threshold.hde = 0.001,
signif.stars = NULL, nopredictors = NULL,
top.half.only = FALSE, ...)

Arguments

object an object of class "vglm", usually, a result of a call to vglm.
x an object of class "summary.vglm", usually, a result of a call to summary.vglm().
dispersion used mainly for GLMs. See summary.glm.
correlation logical; if TRUE, the correlation matrix of the estimated parameters is returned and printed.
digits the number of significant digits to use when printing.
signif.stars logical; if TRUE, 'significance stars' are printed for each coefficient.
presid Pearson residuals; print out some summary statistics of these?
HDEtest logical; if TRUE (the default) then a test for the HDE is performed, else all arguments related to the HDE are ignored.
hde.NA logical; if a test for the Hauck-Donner effect is done (for each coefficient) and it is affirmative should that Wald test p-value be replaced by an NA? The default is to do so. Setting hde.NA = FALSE will print the p-value even though it will be biased upwards. Also see argument threshold.hde.
threshold.hde numeric; used if hde.NA = TRUE and is present for some coefficients. Only p-values greater than this argument will be replaced by an NA, the reason being that small p-values will already be statistically significant. Hence setting threshold.hde = 0 will print out a NA if the HDE is present.
quote Fed into print().
nopredictors logical; if TRUE the names of the linear predictors are not printed out. The default is that they are.
lrt0.arg, score0.arg, wald0.arg Logical. If lrt0.arg = TRUE then the other arguments are passed into lrt.stat.vlm and the equivalent of the so-called Wald table is outputted. Similarly, if score0.arg = TRUE then the other arguments are passed into score.stat.vlm and the equivalent of the so-called Wald table is outputted. Similarly, if wald0.arg = TRUE then the other arguments are passed into wald.stat.vlm and the Wald table corresponding to that is outputted. See details below. Setting any of these will result in further IRLS iterations being performed, therefore may be computationally expensive.
values0, subset, omit1s These arguments are used if any of the lrt0.arg, score0.arg, wald0.arg arguments are used. They are passed into the appropriate function, such as wald.stat.vlm.
top.half.only logical; if TRUE then only print out the top half of the usual output. Used for P-VGAMs.
Details

Originally, summary.vglm() was written to be very similar to summary.glm, however now there are quite a few more options available. By default, show.summary.vglm() tries to be smart about formatting the coefficients, standard errors, etc. and additionally gives ‘significance stars’ if signif.stars is TRUE. The coefficients component of the result gives the estimated coefficients and their estimated standard errors, together with their ratio. This third column is labelled z value regardless of whether the dispersion is estimated or known (or fixed by the family). A fourth column gives the two-tailed p-value corresponding to the z ratio based on a Normal reference distribution.

In general, the t distribution is not used, but the normal distribution is.

Correlations are printed to two decimal places (or symbolically): to see the actual correlations print summary(object)@correlation directly.

The Hauck-Donner effect (HDE) is tested for almost all models; see hdeff.vglm for details. Arguments hde.NA and threshold.hde here are meant to give some control of the output if this aberration of the Wald statistic occurs (so that the p-value is biased upwards). If the HDE is present then using lrt.stat.vlm to get a more accurate p-value is a good alternative as p-values based on the likelihood ratio test (LRT) tend to be more accurate than Wald tests and do not suffer from the HDE. Alternatively, if the HDE is present then using wald0.arg = TRUE will compute Wald statistics that are HDE-free; see wald.stat.

The arguments lrt0.arg and score0.arg enable the so-called Wald table to be replaced by the equivalent LRT and Rao score test table; see lrt.stat.vlm, score.stat. Further IRLS iterations are performed for both of these, hence the computational cost might be significant.

It is possible for programmers to write a methods function to print out extra quantities when summary(vglmObject) is called. The generic function is summaryvglmS4VGAM(), and one can use the S4 function setMethod to compute the quantities needed. Also needed is the generic function isshowsummaryvglmS4VGAM() to actually print the quantities out.

Value

summaryvglm returns an object of class "summary.vglm"; see summary.vglm-class.

Warning

Currently the SE column is deleted when lrt0 = TRUE because SEs are not so meaningful with the LRT. In the future an SE column may be inserted (with NA values) so that it has 4-column output like the other tests. In the meantime, the columns of this matrix should be accessed by name and not number.

Author(s)

T. W. Yee.
See Also

vglm, confintvglm, vcovvlm, summary.rrvglm, summary.glm, summary.lm, summary, hdeff.vglm, lrt.stat.vlm, score.stat, wald.stat.

Examples

```r
## For examples see example(glm)
pneumo <- transform(pneumo, let = log(exposure.time))
(afit <- vglm(cbind(normal, mild, severe) ~ let, acat, data = pneumo))
coef(afit, matrix = TRUE)
summary(afit) # Might suffer from the Hauck-Donner effect
coef(summary(afit))
summary(afit, lrt0 = TRUE, score0 = TRUE, wald0 = TRUE)
```

---

**SURff**

**Seemingly Unrelated Regressions Family Function**

Description

Fits a system of seemingly unrelated regressions.

Usage

```r
SURff(mle.normal = FALSE, divisor = c("n", "n-max(pj,pk)", "sqrt((n-pj)*(n-pk))"), parallel = FALSE, Varcov = NULL, matrix.arg = FALSE)
```

Arguments

- `mle.normal` Logical. If TRUE then the MLE, assuming multivariate normal errors, is computed; the effect is just to add a loglikelihood slot to the returned object. Then it results in the maximum likelihood estimator.
- `divisor` Character, partial matching allowed and the first choice is the default. The divisor for the estimate of the covariances. If "n" then the estimate will be biased. If the others then the estimate will be unbiased for some elements. If mle.normal = TRUE and this argument is not "n" then a warning or an error will result.
- `parallel` See CommonVGAMffArguments. If parallel = TRUE then the constraint applies to the intercept too.
- `Varcov` Numeric. This may be assigned a variance-covariance of the errors. If matrix.arg then this is a $M \times M$ matrix. If !matrix.arg then this is a $M \times M$ matrix in matrix-band format (a vector with at least $M$ and at most $M*(M+1)/2$ elements).
- `matrix.arg` Logical. Of single length.
Details

Proposed by Zellner (1962), the basic seemingly unrelated regressions (SUR) model is a set of LMs ($M > 1$ of them) tied together at the error term level. Each LM’s model matrix may potentially have its own set of predictor variables.

Zellner’s efficient (ZEF) estimator (also known as Zellner’s two-stage Aitken estimator) can be obtained by setting maxit = 1 (and possibly divisor = "sqrt" or divisor = "n-max").

The default value of maxit (in vglm.control) probably means iterative GLS (IGLS) estimator is computed because IRLS will probably iterate to convergence. IGLS means, at each iteration, the residuals are used to estimate the error variance-covariance matrix, and then the matrix is used in the GLS. The IGLS estimator is also known as Zellner’s iterative Aitken estimator, or IZEF.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

The default convergence criterion may be a little loose. Try setting epsilon = 1e-11, especially with mle.normal = TRUE.

Note

The fitted object has slot @extra$ncols.X.lm which is a $M$ vector with the number of parameters for each LM. Also, @misc$values.divisor is the $M$-vector of divisor values.

Constraint matrices are needed in order to specify which response variables that each term on the RHS of the formula is a regressor for. See the constraints argument of vglm for more information.

Author(s)

T. W. Yee.

References


See Also

uninormal, gew.
Examples

# Obtain some of the results of p.1199 of Kmenta and Gilbert (1968)
clist <- list("(Intercept)" = diag(2),
    "capital.g" = rbind(1, 0),
    "value.g" = rbind(1, 0),
    "capital.w" = rbind(0, 1),
    "value.w" = rbind(0, 1))
zef1 <- vglm(cbind(invest.g, invest.w) ~
capital.g + value.g + capital.w + value.w,
SURff(divisor = "sqrt"), maxit = 1,
data = gew, trace = TRUE, constraints = clist)
round(coef(zef1, matrix = TRUE), digits = 4) # ZEF
zef1@extra$ncols.X.lm
zef1@misc$divisor
zef1@misc$values.divisor
round(sqrt(diag(vcov(zef1))), digits = 4) # SEs
nobs(zef1, type = "lm")
df.residual(zef1, type = "lm")

mle1 <- vglm(cbind(invest.g, invest.w) ~
capital.g + value.g + capital.w + value.w,
SURff(mle.normal = TRUE),
epsilon = 1e-11,
data = gew, trace = TRUE, constraints = clist)
round(coef(mle1, matrix = TRUE), digits = 4) # MLE
round(sqrt(diag(vcov(mle1))), digits = 4) # SEs

SurvS4

Create a Survival Object

Description

Create a survival object, usually used as a response variable in a model formula.

Usage

SurvS4(time, time2, event, type =, origin = 0)
is.SurvS4(x)

Arguments

time for right censored data, this is the follow up time. For interval data, the first argument is the starting time for the interval.
x any R object.
event The status indicator, normally 0=alive, 1=dead. Other choices are TRUE/FALSE (TRUE = death) or 1/2 (2=death). For interval censored data, the status indicator is 0=right censored, 1=event at time, 2=left censored, 3=interval censored. Although unusual, the event indicator can be omitted, in which case all subjects are assumed to have an event.

time2 ending time of the interval for interval censored or counting process data only. Intervals are assumed to be open on the left and closed on the right, \{start, end\}. For counting process data, event indicates whether an event occurred at the end of the interval.

type character string specifying the type of censoring. Possible values are "right", "left", "counting", "interval", or "interval2". The default is "right" or "counting" depending on whether the time2 argument is absent or present, respectively.

origin for counting process data, the hazard function origin. This is most often used in conjunction with a model containing time dependent strata in order to align the subjects properly when they cross over from one strata to another.

Details

Typical usages are

SurvS4(time, event)
SurvS4(time, time2, event, type=, origin=0)

In theory it is possible to represent interval censored data without a third column containing the explicit status. Exact, right censored, left censored and interval censored observation would be represented as intervals of \((a,a)\), \((a, \infty)\), \((-\infty,b)\), and \((a,b)\) respectively; each specifying the interval within which the event is known to have occurred.

If type = "interval2" then the representation given above is assumed, with NA taking the place of infinity. If 'type="interval" event must be given. If event is \(0, 1, \text{or } 2\), the relevant information is assumed to be contained in time2, the value in time2 is ignored, and the second column of the result will contain a placeholder.

Presently, the only methods allowing interval censored data are the parametric models computed by \texttt{survreg}, so the distinction between open and closed intervals is unimportant. The distinction is important for counting process data and the Cox model.

The function tries to distinguish between the use of \(0/1\) and \(1/2\) coding for left and right censored data using if \(\max(\text{status})==2\). If \(1/2\) coding is used and all the subjects are censored, it will guess wrong. Use \(0/1\) coding in this case.

Value

An object of class \texttt{SurvS4} (formerly \texttt{Surv}). There are methods for \texttt{print}, \texttt{is.na}, and subscripting survival objects. \texttt{SurvS4} objects are implemented as a matrix of 2 or 3 columns.

In the case of \texttt{is.SurvS4}, a logical value \texttt{TRUE} if \(x\) inherits from class "SurvS4", otherwise \texttt{FALSE}.
Note

The purpose of having SurvS4 in VGAM is so that the same input can be fed into vglm as functions in survival such as survreg. The class name has been changed from "Surv" to "SurvS4"; see SurvS4-class.

The format J+ is interpreted in VGAM as \( \geq J \). If type="interval" then these should not be used in VGAM: \((L,U-)\) or \((L,U+)\).

Author(s)

The code and documentation comes from survival. Slight modifications have been made for conversion to S4 by T. W. Yee. Also, for "interval" data, as.character.SurvS4() has been modified to print intervals of the form \((\text{start}, \text{end}]\) and not \([\text{start}, \text{end}]\) as previously. (This makes a difference for discrete data, such as for cens.poisson). All VGAM family functions beginning with "cen" require the packaging function Surv to format the input.

See Also

SurvS4-class, cens.poisson, survreg, leukemia.

Examples

```r
with(leukemia, SurvS4(time, status))
class(with(leukemia, SurvS4(time, status)))
```

---

**SurvS4-class**

**Class "SurvS4"**

**Description**

S4 version of the Surv class.

**Objects from the Class**

A virtual Class: No objects may be created from it.

**Extends**


**Methods**

```r
show signature(object = "SurvS4"): ...
```
Warning

This code has not been thoroughly tested.

Note

The purpose of having SurvS4 in VGAM is so that the same input can be fed into vglm as functions in survival such as survreg.

Author(s)

T. W. Yee.

References

See survival.

See Also

SurvS4.

Examples

showClass("SurvS4")

---

TIC

Takeuchi’s Information Criterion

Description

Calculates the Takeuchi information criterion for a fitted model object for which a log-likelihood value has been obtained.

Usage

TIC(object, ...)
TICvlm(object, ...)

Arguments

object A VGAM object having class vglm-class.
... Other possible arguments fed into logLik in order to compute the log-likelihood.
Details

The following formula is used for VGLMs: \(-2\log\text{-likelihood} + 2\text{trace}(VK)\), where \(V\) is the inverse of the EIM from the fitted model, and \(K\) is the outer product of the score vectors. Both \(V\) and \(K\) are order-\(p\) VLM matrices. One has \(V\) equal to \(\text{vcov}(\text{object})\), and \(K\) is computed by taking the outer product of the output from the deriv slot multiplied by the large VLM matrix and then taking their sum. Hence for the huge majority of models, the penalty is computed at the MLE and is empirical in nature. Theoretically, if the fitted model is the true model then AIC equals TIC.

When there are prior weights, the score vectors are divided by the square root of these, because \((a_iU_i/\sqrt{a_i})^2 = a_iU_i^2\).

This code relies on the log-likelihood being defined, and computed, for the object. When comparing fitted objects, the smaller the TIC, the better the fit. The log-likelihood and hence the TIC is only defined up to an additive constant.

Currently any estimated scale parameter (in GLM parlance) is ignored by treating its value as unity. Also, currently this function is written only for \text{vglm} objects and not \text{vgam} or \text{rrvglm}, etc., objects.

Value

Returns a numeric TIC value.

Warning

This code has not been double-checked. The general applicability of TIC for the VGLM/VGAM classes has not been developed fully. In particular, TIC should not be run on some VGAM family functions because of violation of certain regularity conditions, etc.

Some authors note that quite large sample sizes are needed for this IC to work reasonably well.

Note

TIC has not been defined for RR-VGLMs, QRR-VGLMs, etc., yet.

See \texttt{AICvlm} about models such as \texttt{posbernoulli.tb} that require \texttt{posbinomial(omit.constant = TRUE)}.

Author(s)

T. W. Yee.

References


See Also

VGLMs are described in \texttt{vglm-class}; \texttt{AIC}, \texttt{AICvlm}, \texttt{BICvlm}. 
Examples

```r
pneumo <- transform(pneumo, let = log(exposure.time))
(fit1 <- vglm(cbind(normal, mild, severe) ~ let,
             cumulative(parallel = TRUE, reverse = TRUE), data = pneumo))
coef(fit1, matrix = TRUE)
TIC(fit1)
(fit2 <- vglm(cbind(normal, mild, severe) ~ let,
             cumulative(parallel = FALSE, reverse = TRUE), data = pneumo))
coef(fit2, matrix = TRUE)
TIC(fit2)
```

Tobit

The Tobit Distribution

Description

Density, distribution function, quantile function and random generation for the Tobit model.

Usage

```r
dtobit(x, mean = 0, sd = 1, Lower = 0, Upper = Inf, log = FALSE)
ptobit(q, mean = 0, sd = 1, Lower = 0, Upper = Inf,
      lower.tail = TRUE, log.p = FALSE)
qtobit(p, mean = 0, sd = 1, Lower = 0, Upper = Inf,
       lower.tail = TRUE, log.p = FALSE)
rtobit(n, mean = 0, sd = 1, Lower = 0, Upper = Inf)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `Lower, Upper` vector of lower and upper thresholds.
- `mean, sd, lower.tail, log, log.p` see `rnorm`.

Details

See `tobit`, the VGAM family function for estimating the parameters, for details. Note that the density at Lower and Upper is the area to the left and right of those points. Thus there are two spikes (but less in value); see the example below. Consequently, `dtobit(Lower) + dtobit(Upper)` + the area in between equals unity.

Value

dtobit gives the density, ptobit gives the distribution function, qtobit gives the quantile function, and rtobit generates random deviates.
Author(s)

T. W. Yee

See Also

tobit, rnorm.

Examples

```r
mu <- 0.5; x <- seq(-2, 4, by = 0.01)
Lower <- -1; Upper <- 2.0

integrate(dtobit, lower = Lower, upper = Upper,
    mean = mu, Lower = Lower, Upper = Upper)$value +
dtobit(Lower, mean = mu, Lower = Lower, Upper = Upper) +
dtobit(Upper, mean = mu, Lower = Lower, Upper = Upper)  # Adds to 1

## Not run:
plot(x, ptobit(x, m = mu, Lower = Lower, Upper = Upper),
    type = "l", ylim = 0:1, las = 1, col = "orange",
    ylab = paste("ptobit(m = ", mu, ", sd = 1, Lower =", Lower,
        ", Upper =", Upper, ")"),
    main = "Orange is the CDF; blue is density",
    sub = "Purple lines are the 10,20,...,90 percentiles")
lines(x, dtobit(x, m = mu, L = Lower, U = Upper), col = "blue")

probs <- seq(0.1, 0.9, by = 0.1)
Q <- qtobit(probs, m = mu, Lower = Lower, Upper = Upper)
lines(Q, ptobit(Q, m = mu, Lower = Lower, Upper = Upper),
    col = "purple", lty = "dashed", type = "h")
lines(Q, dtobit(Q, m = mu, Lower = Lower, Upper = Upper),
    col = "darkgreen", lty = "dashed", type = "h")
abline(h = probs, col = "purple", lty = "dashed")
max(abs(ptobit(Q, mu, L = Lower, U = Upper) - probs))  # Should be 0

epts <- c(Lower, Upper)  # Endpoints have a spike (not quite, actually)
lines(epts, dtobit(epts, m = mu, Lower = Lower, Upper = Upper),
    col = "blue", lwd = 3, type = "h")

## End(Not run)
```

tobit

Tobit Regression

Description

Fits a Tobit regression model.
Usage

tobit(Lower = 0, Upper = Inf, lmu = "identitylink",
lsd = "loglink", imu = NULL, isd = NULL,
type.fitted = c("uncensored", "censored", "mean.obs"),
byrow.arg = FALSE, imethod = 1, zero = "sd")

Arguments

Lower Numeric. It is the value $L$ described below. Any value of the linear model $x_i^T \beta$ that is less than this lowerbound is assigned this value. Hence this should be the smallest possible value in the response variable. May be a vector (see below for more information).

Upper Numeric. It is the value $U$ described below. Any value of the linear model $x_i^T \beta$ that is greater than this upperbound is assigned this value. Hence this should be the largest possible value in the response variable. May be a vector (see below for more information).

lmu, lsd Parameter link functions for the mean and standard deviation parameters. See Links for more choices. The standard deviation is a positive quantity, therefore a log link is its default.

imu, isd, byrow.arg See CommonVGAMffArguments for information.

type.fitted Type of fitted value returned. The first choice is default and is the ordinary uncensored or unbounded linear model. If "censored" then the fitted values in the interval $[L, U]$. If "mean.obs" then the mean of the observations is returned; this is a doubly truncated normal distribution augmented by point masses at the truncation points (see dtobit). See CommonVGAMffArguments for more information.

imethod Initialization method. Either 1 or 2 or 3, this specifies some methods for obtaining initial values for the parameters. See CommonVGAMffArguments for information.

zero A vector, e.g., containing the value 1 or 2. If so, the mean or standard deviation respectively are modelled as an intercept-only. Setting zero = NULL means both linear/additive predictors are modelled as functions of the explanatory variables. See CommonVGAMffArguments for more information.

Details

The Tobit model can be written

$$y_i^* = x_i^T \beta + \varepsilon_i$$

where the $\varepsilon_i \sim N(0, \sigma^2)$ independently and $i = 1, \ldots, n$. However, we measure $y_i = y_i^*$ only if $y_i^* > L$ and $y_i^* < U$ for some cutpoints $L$ and $U$. Otherwise we let $y_i = L$ or $y_i = U$, whatever is closer. The Tobit model is thus a multiple linear regression but with censored responses if it is below or above certain cutpoints.

The defaults for Lower and Upper and lmu correspond to the standard Tobit model. Fisher scoring is used for the standard and nonstandard models. By default, the mean $x_i^T \beta$ is the first linear/additive predictor, and the log of the standard deviation is the second linear/additive predictor. The Fisher information matrix for uncensored data is diagonal. The fitted values are the estimates of $x_i^T \beta$. 
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

If values of the response and Lower and/or Upper are not integers then there is the danger that the value is wrongly interpreted as uncensored. For example, if the first 10 values of the response were runif(10) and Lower was assigned these values then testing y[1:10] == Lower[1:10] is numerically fraught. Currently, if any y < Lower or y > Upper then a warning is issued. The function round2 may be useful.

Note

The response can be a matrix. If so, then Lower and Upper are recycled into a matrix with the number of columns equal to the number of responses, and the recycling is done row-wise if byrow.arg = TRUE. The default order is as matrix, which is byrow.arg = FALSE. For example, these are returned in fit4@misc$Lower and fit4@misc$Upper below.

If there is no censoring then uninormal is recommended instead. Any value of the response less than Lower or greater than Upper will be assigned the value Lower and Upper respectively, and a warning will be issued. The fitted object has components censoredL and censoredU in the extra slot which specifies whether observations are censored in that direction. The function cens.normal is an alternative to tobit().

When obtaining initial values, if the algorithm would otherwise want to fit an underdetermined system of equations, then it uses the entire data set instead. This might result in rather poor quality initial values, and consequently, monitoring convergence is advised.

Author(s)

Thomas W. Yee

References


See Also

tobit, cens.normal, uninormal, double.cens.normal, posnormal, CommonVGAMffArguments, round2, mills.ratio, margeff, rnorm.

Examples

# Here, fit1 is a standard Tobit model and fit2 is nonstandard
tdata <- data.frame(x2 = seq(-1, 1, length = (nn <- 100)))
set.seed(1)
Lower <- 1; Upper <- 4  # For the nonstandard Tobit model
tdata <- transform(tdata,
  Lower.vec = rnorm(nn, Lower, 0.5),
  x2.vec = runif(nn, Lower, Upper))
fdata <- transform(fdata,
  x1 = runif(nn, Lower, Upper),
  x3 = runif(nn, Lower, Upper))
fit1 <- tobit(y ~ x1 + x2, data = tdata, type = "cm", censoredL = TRUE, censoredU = TRUE)
fit2 <- tobit(y ~ x1 + x2, data = tdata, type = "cm", censoredL = TRUE, censoredU = TRUE, lower = 0, upper = 100)

# Fit a standard Tobit model
fit1 <- tobit(y ~ x1 + x2, data = tdata, type = "cm", censoredL = TRUE, censoredU = TRUE)

# Fit a nonstandard Tobit model
fit2 <- tobit(y ~ x1 + x2, data = tdata, type = "cm", censoredL = TRUE, censoredU = TRUE, lower = 0, upper = 100)
Upper.vec = rnorm(nn, Upper, 0.5))
meanfun1 <- function(x) 0 + 2*x
meanfun2 <- function(x) 2 + 2*x
meanfun3 <- function(x) 3 + 2*x
tdata <- transform(tdata,
    y1 = rtobit(nn, mean = meanfun1(x2)),  # Standard Tobit model
    y2 = rtobit(nn, mean = meanfun2(x2), Lower = Lower, Upper = Upper),
    y3 = rtobit(nn, mean = meanfun3(x2), Lower = Lower.vec,
        Upper = Upper.vec),
    y4 = rtobit(nn, mean = meanfun3(x2), Lower = Lower.vec,
        Upper = Upper.vec))
with(tdata, table(y1 == 0))  # How many censored values?
with(tdata, table(y2 == Lower | y2 == Upper))  # Ditto
with(tdata, table(attr(y2, "cenL")))
with(tdata, table(attr(y2, "cenU")))

fit1 <- vglm(y1 ~ x2, tobit, data = tdata, trace = TRUE)
coef(fit1, matrix = TRUE)
summary(fit1)

fit2 <- vglm(y2 ~ x2, 
    tobit(Lower = Lower, Upper = Upper, type.f = "cens"),
    data = tdata, trace = TRUE)
table(fit2@extra$censoredL)
table(fit2@extra$censoredU)
coef(fit2, matrix = TRUE)

fit3 <- vglm(y3 ~ x2, tobit(Lower = with(tdata, Lower.vec),
    Upper = with(tdata, Upper.vec),
    type.f = "cens"),
    data = tdata, trace = TRUE)
table(fit3@extra$censoredL)
table(fit3@extra$censoredU)
coef(fit3, matrix = TRUE)

# fit4 is fit3 but with type.fitted = "uncen".
fit4 <- vglm(cbind(y3, y4) ~ x2,
    tobit(Lower = rep(with(tdata, Lower.vec), each = 2),
        Upper = rep(with(tdata, Upper.vec), each = 2),
        byrow.arg = TRUE),
    data = tdata, crit = "coeff", trace = TRUE)
head(fit4@extra$censoredL)  # A matrix
head(fit4@extra$censoredU)  # A matrix
head(fit4@misc$Lower)  # A matrix
head(fit4@misc$Upper)  # A matrix
coef(fit4, matrix = TRUE)

## Not run:  # Plot fit1--fit4
par(mfrow = c(2, 2))
plot(y1 ~ x2, tdata, las = 1, main = "Standard Tobit model",
    col = as.numeric(attr(y1, "cenL")) + 3,
    pch = as.numeric(attr(y1, "cenL")) + 1)
```
legend(x = "topleft", leg = c("censored", "uncensored"),
      pch = c(2, 1), col = c("blue", "green"))
legend(-1.5, 2.5, c("Truth", "Estimate", "Naive"), lwd = 2,
      col = c("purple", "orange", "black"), lty = c(1, 2, 2))
lines(meanfun1(x2) ~ x2, tdata, col = "purple", lwd = 2)
lines(fitted(fit1) ~ x2, tdata, col = "orange", lwd = 2, lty = 2)
lines(fitted(lm(y1 ~ x2, tdata)) ~ x2, tdata, col = "black",
      lty = 2, lwd = 2) # This is simplest but wrong!

plot(y2 ~ x2, data = tdata, las = 1, main = "Tobit model",
     col = as.numeric(attr(y2, "cenL")) + 3 +
     as.numeric(attr(y2, "cenU")),
     pch = as.numeric(attr(y2, "cenL")) + 1 +
     as.numeric(attr(y2, "cenU")))
legend(x = "topleft", pch = c(2, 1), col = c("blue", "green"))
legend(-1.5, 3.5, c("Truth", "Estimate", "Naive"), lwd = 2,
      col = c("purple", "orange", "black"), lty = c(1, 2, 2))
lines(meanfun2(x2) ~ x2, tdata, col = "purple", lwd = 2)
lines(fitted(fit2) ~ x2, tdata, col = "orange", lwd = 2, lty = 2)
lines(fitted(lm(y2 ~ x2, tdata)) ~ x2, tdata, col = "black",
      lty = 2, lwd = 2) # This is simplest but wrong!

plot(y3 ~ x2, data = tdata, las = 1, main = "Tobit model with nonconstant censor levels",
     col = as.numeric(attr(y3, "cenL")) + 2 +
     as.numeric(attr(y3, "cenU") * 2),
     pch = as.numeric(attr(y3, "cenL")) + 1 +
     as.numeric(attr(y3, "cenU") * 2))
legend(x = "topleft", pch = c(2, 3, 1), col = c(3, 4, 2),
       leg = c("censoredL", "censoredU", "uncensored"))
legend(-1.5, 3.5, c("Truth", "Estimate", "Naive"), lwd = 2,
      col = c("purple", "orange", "black"), lty = c(1, 2, 2))
lines(meanfun3(x2) ~ x2, tdata, col = "purple", lwd = 2)
lines(fitted(fit3) ~ x2, tdata, col = "orange", lwd = 2, lty = 2)
lines(fitted(lm(y3 ~ x2, tdata)) ~ x2, tdata, col = "black",
      lty = 2, lwd = 2) # This is simplest but wrong!
```
## Description

Generic function for the *tolerances* of a model.

### Usage

```r
Tol(object, ...)```

### Arguments

- `object`:
  
  An object for which the computation or extraction of a tolerance or tolerances is meaningful.

- `...`:
  
  Other arguments fed into the specific methods function of the model. Sometimes they are fed into the methods function for `Coef`.

### Details

Different models can define an optimum in different ways. Many models have no such notion or definition.

Tolerances occur in quadratic ordination, i.e., CQO and UQO. They have ecological meaning because a high tolerance for a species means the species can survive over a large environmental range (stenoecous species), whereas a small tolerance means the species’ niche is small (eurycous species). Mathematically, the tolerance is like the variance of a normal distribution.

### Value

The value returned depends specifically on the methods function invoked. For a `cqo` binomial or Poisson fit, this function returns a $R \times R \times S$ array, where $R$ is the rank and $S$ is the number of species. Each tolerance matrix ought to be positive-definite, and for a rank-1 fit, taking the square root of each tolerance matrix results in each species’ tolerance (like a standard deviation).

### Warning

There is a direct inverse relationship between the scaling of the latent variables (site scores) and the tolerances. One normalization is for the latent variables to have unit variance. Another normalization is for all the tolerances to be unit. These two normalization cannot simultaneously hold in general. For rank-$R > 1$ models it becomes more complicated because the latent variables are also uncorrelated. An important argument when fitting quadratic ordination models is whether `eq.tolerances` is `TRUE` or `FALSE`. See Yee (2004) for details.

### Note

Tolerances are undefined for ‘linear’ and additive ordination models. They are well-defined for quadratic ordination models.
Author(s)

Thomas W. Yee

References


See Also

*Tol.qrrvglm, Max, Opt, cqq, rcim* for UQO.

Examples

```r
## Not run:
set.seed(111)  # This leads to the global solution
hsptier[,1:6] <- scale(hspider[, 1:6])  # Standardized environmental vars
pl <- cqq(cbind(Alopacce, Alopcone, Alopfabr, Arctlute, Arctperi,
               Auloalbi, Pardlugu, Pardmont, Pardnigr, Pardpull,
               Trocterr, Zoraspin) ~
              WaterCon + BareSand + FallTwig + CoveMoss + CoveHerb + ReflLux,
              poissonff, data = hspider, Crow1positive = FALSE)

Tol(pl)
## End(Not run)
```

### Topple

*The Topp-Leone Distribution*

Description

Density, distribution function, quantile function and random generation for the Topp-Leone distribution.

Usage

```r
dtopple(x, shape, log = FALSE)
ptopple(q, shape, lower.tail = TRUE, log.p = FALSE)
qtopple(p, shape)
rtopple(n, shape)
```
Arguments

- **x, q, p, n**: Same as `Uniform`.
- **shape**: the (shape) parameter, which lies in \((0, 1)\).
- **log**: Logical. If `log = TRUE` then the logarithm of the density is returned.
- **lower.tail, log.p**: Same meaning as in `pnorm` or `qnorm`.

Details

See `topple`, the `VGAM` family function for estimating the (shape) parameter \(s\) by maximum likelihood estimation, for the formula of the probability density function.

Value

dtopple gives the density, ptopple gives the distribution function, qtopple gives the quantile function, and rtopple generates random deviates.

Note

The Topp-Leone distribution is related to the triangle distribution.

Author(s)

T. W. Yee

References


See Also

topple, **Triangle**.

Examples

```r
## Not run: shape <- 0.7; x <- seq(0.02, 0.999, length = 300)
plot(x, dtopple(x, shape = shape), type = "l", col = "blue",
     main = "Blue is density, orange is CDF", ylab = "", las = 1,
     sub = "Purple lines are the 10,20,...,90 percentiles")
abline(h = 0, col = "blue", lty = 2)
lines(x, ptopple(x, shape = shape), type = "l", col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qtopple(probs, shape = shape)
lines(Q, dtopple(Q, shape), col = "purple", lty = 3, type = "h")
lines(Q, ptopple(Q, shape), col = "purple", lty = 3, type = "h")
abline(h = probs, col = "purple", lty = 3)
max(abs(ptopple(Q, shape) - probs)) # Should be zero

## End(Not run)
```
### Description

Estimating the parameter of the Topp-Leone distribution by maximum likelihood estimation.

### Usage

```r
topple(lshape = "logitlink", zero = NULL, gshape = ppoints(8),
        parallel = FALSE, percentiles = 50,
        type.fitted = c("mean", "percentiles", "Qlink"))
```

### Arguments

- `lshape`, `gshape`: Details at `CommonVGAMffArguments`. The CIA link is `loglink`, for shape approaching unity.
- `zero`, `parallel`: Details at `CommonVGAMffArguments`.
- `type.fitted`, `percentiles`: See `CommonVGAMffArguments` for information. Using "Qlink" is for quantile-links in `VGAMextra`.

### Details

The Topple distribution has a probability density function that can be written

\[
f(y; s) = 2s(1 - y)[y(2 - y)]^{s-1}
\]

for \(0 < y < 1\) and shape parameter \(0 < s < 1\). The mean of \(Y\) is \(1 - 4^s[\Gamma(1 + s)]^2/\Gamma(2 + 2s)\) (returned as the fitted values).

### Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

### Note

Fisher-scoring and Newton-Raphson are the same here. A related distribution is the triangle distribution. This `VGAM` family function handles multiple responses.

### Author(s)

T. W. Yee

### References

See Also

Topple, Triangle.

Examples

tdata <- data.frame(y = rtopple(1000, logitlink(1, inverse = TRUE)))
tfit <- vglm(y ~ 1, topple, tdata, trace = TRUE, crit = "coef")
coef(tfit, matrix = TRUE)
Coef(tfit)

---

 toxop  

Toxoplasmosis Data

Description

Toxoplasmosis data in 34 cities in El Salvador.

Usage

data(toxop)

Format

A data frame with 34 observations on the following 4 variables.

- `rainfall` a numeric vector; the amount of rainfall in each city.
- `ssize` a numeric vector; sample size.
- `cityNo` a numeric vector; the city number.
- `positive` a numeric vector; the number of subjects testing positive for the disease.

Details

See the references for details.

Source

See the references for details.

References


See Also

double.expbinomial.
Triangle

The Triangle Distribution

Description

Density, distribution function, quantile function and random generation for the Triangle distribution with parameter theta.

Usage

dtriangle(x, theta, lower = 0, upper = 1, log = FALSE)
ptriangle(q, theta, lower = 0, upper = 1, lower.tail = TRUE, log.p = FALSE)
qtriangle(p, theta, lower = 0, upper = 1, lower.tail = TRUE, log.p = FALSE)
rtriangle(n, theta, lower = 0, upper = 1)

Arguments

x, q vector of quantiles.
p vector of probabilities.
n number of observations. Same as runif.
theta the theta parameter which lies between lower and upper.
lower, upper lower and upper limits of the distribution. Must be finite.
log Logical. If log = TRUE then the logarithm of the density is returned.
lower.tail, log.p Same meaning as in pnorm or qnorm.

Details

See triangle, the VGAM family function for estimating the parameter $\theta$ by maximum likelihood estimation.

Value

dtriangle gives the density, ptriangle gives the distribution function, qtriangle gives the quantile function, and rtriangle generates random deviates.

Author(s)

T. W. Yee and Kai Huang
See Also

triangle, topple.

Examples

```r
## Not run: x <- seq(-0.1, 1.1, by = 0.01); theta <- 0.75
plot(x, dtriangle(x, theta = theta), type = "l", col = "blue", las = 1,
     main = "Blue is density, orange is the CDF",
     sub = "Purple lines are the 10,20,...,90 percentiles",
     ylim = c(0,2), ylab = "")
abline(h = 0, col = "blue", lty = 2)
lines(x, ptriangle(x, theta = theta), col = "orange")
probs <- seq(0.1, 0.9, by = 0.1)
Q <- qtriangle(probs, theta = theta)
lines(Q, dtriangle(Q, theta = theta), col = "purple", lty = 3, type = "h")
ptriangle(Q, theta = theta) - probs # Should be all zero
abline(h = probs, col = "purple", lty = 3)
## End(Not run)
```

triangle

Triangle Distribution Family Function

Description

Estimating the parameter of the triangle distribution by maximum likelihood estimation.

Usage

```r
triangle(lower = 0, upper = 1,
         link = extlogitlink(min = 0, max = 1), itheta = NULL)
```

Arguments

- `lower`, `upper` : lower and upper limits of the distribution. Must be finite. Called `A` and `B` respectively below.
- `link` : Parameter link function applied to the parameter `θ`, which lies in `(A, B)`. See \[\text{Links}\] for more choices. The default constrains the estimate to lie in the interval.
- `itheta` : Optional initial value for the parameter. The default is to compute the value internally.

Details

The triangle distribution has a probability density function that consists of two lines joined at `θ`, which is the location of the mode. The lines intersect the `y = 0` axis at `A` and `B`. Here, Fisher scoring is used.

On fitting, the extra slot has components called `lower` and `upper` which contains the values of the above arguments (recycled to the right length). The fitted values are the mean of the distribution, which is `(A + B + θ)/3`. 
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

Warning

The MLE regularity conditions do not hold for this distribution (e.g., the first derivative evaluated at the mode does not exist because it is not continuous) so that misleading inferences may result, e.g., in the summary and vcov of the object. Additionally, convergence to the MLE often appears to fail.

Note

The response must contain values in \((A, B)\). For most data sets (especially small ones) it is very common for half-stepping to occur.

Arguments lower and upper and link must match. For example, setting lower = 0.2 and upper = 4 and link = extlogitlink(min = 0.2, max = 4.1) will result in an error. Ideally link = extlogitlink(min = lower, max = upper) ought to work but it does not (yet)! Minimal error checking is done for this deficiency.

Author(s)

T. W. Yee

References


See Also

Triangle, Topple, simulate.vlm.

Examples

```r
## Not run:
# Example 1
tdata <- data.frame(y = rtriangle(n <- 3000, theta = 3/4))
fit <- vglm(y ~ 1, triangle(link = "identitylink"), tdata,
          trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
head(fit@extra$lower)
head(fitted(fit))
with(tdata, mean(y))

# Example 2; Kotz and van Dorp (2004), p.14
rdata <- data.frame(y = c(0.1,0.25,0.3,0.4,0.45, 0.6, 0.75, 0.8))
```
fit <- vglm(y ~ 1, triangle(link = "identitylink"), rdata, trace = TRUE, crit = "coef", maxit = 1000)
Coef(fit) # The MLE is the 3rd order statistic, which is 0.3.
fit <- vglm(y ~ 1, triangle(link = "identitylink"), rdata, trace = TRUE, crit = "coef", maxit = 1001)
Coef(fit) # The MLE is the 3rd order statistic, which is 0.3.

## End(Not run)

---

**trim.constraints**

**Trimmed Constraint Matrices**

**Description**

Deletes statistically nonsignificant regression coefficients via their constraint matrices, for future refitting.

**Usage**

```r
trim.constraints(object, sig.level = 0.05, max.num = Inf, 
    intercepts = TRUE, ...)```

**Arguments**

- **object**
  Some VGAM object, especially having class `vglmff-class`. It has not yet been tested on non-"vglm" objects.

- **sig.level**
  Significance levels, with values in [0, 1]. Columns of constraint matrices whose p-values are larger than this argument are deleted. With terms that generate more than one column of the "lm" model matrix, all p-values must be greater than this argument for deletion. This argument is recycled to the total number of regression coefficients of object.

- **max.num**
  Numeric, positive and integer-valued. Maximum number of regression coefficients allowable for deletion. This allows one to limit the number of deleted coefficients. For example, if `max.num = 1` then only the largest p-value is used for the deletion, provided it is larger than `sig.level`. The default is to delete all those coefficients whose p-values are greater than `sig.level`. With a finite value, this argument will probably not work properly when there are terms that generate more than one column of the LM model matrix. Having a value greater than unity might be unsuitable in the presence of multicollinearity because all correlated variables might be eliminated at once.

- **intercepts**
  Logical. Trim the intercept term? If FALSE then the constraint matrix for the "(Intercept)" term is left unchanged.

- **...**
  Unused but for provision in the future.
Details

This utility function is intended to simplify an existing \texttt{vglm} object having variables (terms) that affect unnecessary parameters. Suppose the explanatory variables in the formula includes a simple numeric covariate called \texttt{x2}. This variable will affect every linear predictor if \texttt{zero = NULL} in the \texttt{VGAM} family function. This situation may correspond to the constraint matrices having unnecessary columns because their regression coefficients are statistically nonsignificant. This function attempts to delete those columns and return a possibly simplified list of constraint matrices that can make refitting a simpler model easy to do. P-values obtained from \texttt{summaryvglm} (with \texttt{HDEtest = FALSE} for increased speed) are compared to \texttt{sig.level} to test for statistical significance.

For terms that generate more than one column of the "lm" model matrix, such as \texttt{bs} and \texttt{poly}, the column is deleted if all regression coefficients are statistically nonsignificant. Incidentally, users should instead use \texttt{sm.bs}, \texttt{sm.ns}, \texttt{sm.poly}, etc., for smart and safe prediction.

One can think of this function as facilitating \textit{backward elimination} for variable selection, especially if \texttt{max.num = 1} and \texttt{M = 1}, however usually more than one regression coefficient is deleted here by default.

Value

A list of possibly simpler constraint matrices that can be fed back into the model using the \texttt{constraints} argument (usually \texttt{zero = NULL} is needed to avoid a warning). Consequently, they are required to be of the "term"-type. After the model is refitted, applying \texttt{summaryvglm} should result in regression coefficients that are 'all' statistically significant.

Warning

This function has not been tested thoroughly. One extreme is that a term is totally deleted because none of its regression coefficients are needed, and that situation has not yet been finalized. Ideally, object only contains terms where at least one regression coefficient has a p-value less than \texttt{sig.level}. For ordered factors and other situations, deleting certain columns may not make sense and destroy interpretability.

As stated above, \texttt{max.num} may not work properly when there are terms that generate more than one column of the LM model matrix. However, this limitation may change in the future.

Note

This function is experimental and may be replaced by some other function in the future. This function does not use S4 object oriented programming but may be converted to such in the future.

Author(s)

T. W. Yee

See Also

\texttt{constraints}, \texttt{vglm}, \texttt{summaryvglm}, \texttt{model.matrixvglm}, \texttt{drop1.vglm}, \texttt{step4vglm}, \texttt{sm.bs}, \texttt{sm.ns}, \texttt{sm.poly}. 
Trinorm

Examples

## Not run: data("xs.nz", package = "VGAMdata")

fit1 <-
  vglm(cbind(worry, worrier) ~ bs(age) + sex + ethnicity + cat + dog,
  binom2.or(zero = NULL), data = xs.nz, trace = TRUE)

summary(fit1, HDEtest = FALSE)  # 'cat' is not significant at all

(dim(constraints(fit1, matrix = TRUE))

(tclist1 <- trim.constraints(fit1))  # No 'cat'

fit2 <- # Delete 'cat' manually from the formula:
  vglm(cbind(worry, worrier) ~ bs(age) + sex + ethnicity +
  binom2.or(zero = NULL), data = xs.nz,
  constraints = tclist1, trace = TRUE)

summary(fit2, HDEtest = FALSE)  # A simplified model

(dim(constraints(fit2, matrix = TRUE))  # Fewer regression coefficients

## End(Not run)

---

Trinorm

Trivariate Normal Distribution Density and Random Variates

Description

Density and random generation for the trivariate normal distribution distribution.

Usage

dtrinorm(x1, x2, x3, mean1 = 0, mean2 = 0, mean3 = 0,
  var1 = 1, var2 = 1, var3 = 1,
  cov12 = 0, cov23 = 0, cov13 = 0, log = FALSE)

rtrinorm(n, mean1 = 0, mean2 = 0, mean3 = 0,
  var1 = 1, var2 = 1, var3 = 1,
  cov12 = 0, cov23 = 0, cov13 = 0)

Arguments

x1, x2, x3  vector of quantiles.
mean1, mean2, mean3  vectors of means.
var1, var2, var3  vectors of variances.
cov12, cov23, cov13  vectors of covariances.
n  number of observations. Same as rnorm.
log  Logical. If log = TRUE then the logarithm of the density is returned.
Details

The default arguments correspond to the standard trivariate normal distribution with correlation parameters equal to 0, which corresponds to three independent standard normal distributions. Let sd1 (say) be $\sqrt{\text{var1}}$ and written $\sigma_1$, etc. Then the general formula for each correlation coefficient is of the form $\rho_{12} = \text{cov}_{12}/(\sigma_1\sigma_2)$, and similarly for the two others. Thus if the var arguments are left alone then the cov can be inputted with $\rho$s.

Value

dtrinorm gives the density, rtrinorm generates random deviates ($n$ by 3 matrix).

Warning

dtrinorm()'s arguments might change in the future! It's safest to use the full argument names to future-proof possible changes!

Note

For rtrinorm(), if the $i$th variance-covariance matrix is not positive-definite then the $i$th row is all NAs.

See Also

pnorm, trinormal, uninormal, binormal, rbinorm.

Examples

```r
## Not run: nn <- 1000
tdata <- data.frame(x2 = sort(runif(nn)))
tdata <- transform(tdata, mean1 = 1 + 2 * x2,
                  mean2 = 3 + 1 * x2, mean3 = 4,
                  var1 = exp(1), var2 = exp(1), var3 = exp(1),
                  rho12 = rhobitlink(1, inverse = TRUE),
                  rho23 = rhobitlink(1, inverse = TRUE),
                  rho13 = rhobitlink(-1, inverse = TRUE))
ymat <- with(tdata, rtrinorm(nn, mean1, mean2, mean3,
                          var1, var2, var3,
                          sqrt(var1)*sqrt(var1)*rho12,  
                          sqrt(var2)*sqrt(var3)*rho23,  
                          sqrt(var1)*sqrt(var3)*rho13))
pairs(ymat, col = "blue")
## End(Not run)
```
Description

Maximum likelihood estimation of the nine parameters of a trivariate normal distribution.

Usage

```r
trinormal(zero = c("sd", "rho"), eq.mean = FALSE,
          eq.sd = FALSE, eq.cor = FALSE,
          lmean1 = "identitylink", lmean2 = "identitylink",
          lmean3 = "identitylink",
          lsd1 = "loglink", lsd2 = "loglink", lsd3 = "loglink",
          lrho12 = "rhobitlink", lrho23 = "rhobitlink", lrho13 = "rhobitlink",
          imean1 = NULL, imean2 = NULL, imean3 = NULL,
          isd1 = NULL, isd2 = NULL, isd3 = NULL,
          irho12 = NULL, irho23 = NULL, irho13 = NULL, imethod = 1)
```

Arguments

- `lmean1`, `lmean2`, `lmean3`, `lsd1`, `lsd2`, `lsd3`: Link functions applied to the means and standard deviations. See `Links` for more choices. Being positive quantities, a log link is the default for the standard deviations.
- `lrho12`, `lrho23`, `lrho13`: Link functions applied to the correlation parameters. See `Links` for more choices. By default the correlation parameters are allowed to have a value between -1 and 1, but that may be problematic when `eq.cor = TRUE` because they should have a value between -0.5 and 1.
- `imean1`, `imean2`, `imean3`, `isd1`, `isd2`, `isd3`: See `CommonVGAMffArguments` for more information.
- `irho12`, `irho23`, `irho13`, `imethod`, `zero`: See `CommonVGAMffArguments` for more information.
- `eq.mean`, `eq.sd`, `eq.cor`: Logical. Constrain the means or the standard deviations or correlation parameters to be equal?

Details

For the trivariate normal distribution, this fits a linear model (LM) to the means, and by default, the other parameters are intercept-only. The response should be a three-column matrix. The three correlation parameters are prefixed by `rho`, and the default gives them values between -1 and 1 however, this may be problematic when the correlation parameters are constrained to be equal, etc. The fitted means are returned as the fitted values, which is in the form of a three-column matrix. Fisher scoring is implemented.
Value

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

Warning

The default parameterization does not make the estimated variance-covariance matrix positive-definite. In order for the variance-covariance matrix to be positive-definite the quantity $1 - \rho_{12}^2 - \rho_{13}^2 - \rho_{23}^2 + 2 \times \rho_{12} \times \rho_{13} \times \rho_{23}$ must be positive, and if `eq.cor = TRUE` then this means that the $\rho$s must be between -0.5 and 1.

Author(s)

T. W. Yee

See Also

`uninormal`, `binormal`, `rtrinorm`.

Examples

```r
## Not run: set.seed(123); nn <- 1000
tdata <- data.frame(x2 = runif(nn), x3 = runif(nn))
tdata <- transform(tdata, y1 = rnorm(nn, 1 + 2 * x2),
                   y2 = rnorm(nn, 3 + 4 * x2),
                   y3 = rnorm(nn, 4 + 5 * x2))
fit1 <- vglm(cbind(y1, y2, y3) ~ x2, data = tdata,
             trinormal(eq.sd = TRUE, eq.cor = TRUE), trace = TRUE)
coef(fit1, matrix = TRUE)
constraints(fit1)
summary(fit1)
# Try this when eq.sd = TRUE, eq.cor = TRUE:
fit2 <-
  vglm(cbind(y1, y2, y3) ~ x2, data = tdata, stepsize = 0.25,
       trinormal(eq.sd = TRUE, eq.cor = TRUE,
                  lrho12 = extlogitlink(min = -0.5),
                  lrho23 = extlogitlink(min = -0.5),
                  lrho13 = extlogitlink(min = -0.5)), trace = TRUE)
coef(fit2, matrix = TRUE)
## End(Not run)
```

---

**trplot**  
**Trajectory Plot**

Description

Generic function for a trajectory plot.
Usage

trplot(object, ...)

Arguments

object  
An object for which a trajectory plot is meaningful.

...  
Other arguments fed into the specific methods function of the model. They usually are graphical parameters, and sometimes they are fed into the methods function for Coef.

Details

Trajectory plots can be defined in different ways for different models. Many models have no such notion or definition.

For quadratic and additive ordination models they plot the fitted values of two species against each other (more than two is theoretically possible, but not implemented in this software yet).

Value

The value returned depends specifically on the methods function invoked.

Author(s)

Thomas W. Yee

References


See Also

trplot.qrrvglm, perspqrrvglm, lvplot.

Examples

## Not run: set.seed(123)
hspider[, 1:6] <- scale(hspider[, 1:6])  # Stdze environ. vars
plcqo <- cquo(cbind(Alopacce, Alopcune, Aloptbr, Arctlute,
                  Arctperi, Auloalbi, Parlugu, Pardmont,
                  Pardnigr, Pardpull, Trocterr, Zoraspin) ~
                  WaterCon + BareSand + FallTwig +
                  CoveMoss + CoveHerb + ReflLux,
                  poissonoff, data = hspider, Crow1positive = FALSE)

nos <- ncol(depvar(plcqo))
clr <- 1:nos  # OR (1:(nos+1))[-7] to omit yellow

trplot(plcqo, which.species = 1:3, log = "xy", lwd = 2,
       col = c("blue", "orange", "green"), label = TRUE) -> ii
legend(0.00005, 0.3, paste(ii$species[, 1], ii$species[, 2], sep = " and "),
  lwd = 2, lty = 1, col = c("blue", "orange", "green"))
abline(a = 0, b = 1, lty = "dashed", col = "grey")
## End(Not run)

trplot.qrrvglm  Trajectory plot for QRR-VGLMs

Description

Produces a trajectory plot for quadratic reduced-rank vector generalized linear models (QRR-VGLMs). It is only applicable for rank-1 models with argument noRR = ~ 1.

Usage

trplot.qrrvglm(object, which.species = NULL, add = FALSE,
  show.plot = TRUE,
  label.sites = FALSE, sitenames = rownames(object@y),
  axes.equal = TRUE, cex = par()$cex,
  col = 1:(nos * (nos - 1)/2), log = "",
  lty = rep_len(par()$lty, nos * (nos - 1)/2),
  lwd = rep_len(par()$lwd, nos * (nos - 1)/2),
  tcol = rep_len(par()$col, nos * (nos - 1)/2),
  xlab = NULL, ylab = NULL,
  main = "", type = "b", check.ok = TRUE, ...)

Arguments

object  Object of class "qrrvglm", i.e., a CQO object.
which.species  Integer or character vector specifying the species to be plotted. If integer, these are the columns of the response matrix. If character, these must match exactly with the species’ names. The default is to use all species.
add  Logical. Add to an existing plot? If FALSE (default), a new plot is made.
show.plot  Logical. Plot it?
label.sites  Logical. If TRUE, the points on the curves/trajectories are labelled with the sitenames.
sitenames  Character vector. The names of the sites.
axes.equal  Logical. If TRUE, the x- and y-axes will be on the same scale.
cex  Character expansion of the labelling of the site names. Used only if label.sites is TRUE. See the cex argument in par.
col  Color of the lines. See the col argument in par. Here, nos is the number of species.
log  Character, specifying which (if any) of the x- and y-axes are to be on a logarithmic scale. See the log argument in par.
trplot.qrrvglm

1ty
Line type. See the lty argument of par.

lwd
Line width. See the lwd argument of par.

tcol
Color of the text for the site names. See the col argument in par. Used only if label.sites is TRUE.

xlab
Character caption for the x-axis. By default, a suitable caption is found. See the xlab argument in plot or title.

ylab
Character caption for the y-axis. By default, a suitable caption is found. See the xlab argument in plot or title.

main
Character, giving the title of the plot. See the main argument in plot or title.

type
Character, giving the type of plot. A common option is to use type="l" for lines only. See the type argument of plot.

check.ok
Logical. Whether a check is performed to see that noRRR = ~ 1 was used. It doesn’t make sense to have a trace plot unless this is so.

... Arguments passed into the plot function when setting up the entire plot. Useful arguments here include xlim and ylim.

Details
A trajectory plot plots the fitted values of a ‘second’ species against a ‘first’ species. The argument which.species must therefore contain at least two species. By default, all of the species that were fitted in object are plotted. With more than a few species the resulting plot will be very congested, and so it is recommended that only a few species be selected for plotting.

In the above, $M$ is the number of species selected for plotting, so there will be $M(M - 1)/2$ curves/trajectories in total.

A trajectory plot will be fitted only if noRRR = ~ 1 because otherwise the trajectory will not be a smooth function of the latent variables.

Value
A list with the following components.

species.names
A matrix of characters giving the ‘first’ and ‘second’ species. The number of different combinations of species is given by the number of rows. This is useful for creating a legend.

sitenames
A character vector of site names, sorted by the latent variable (from low to high).

Note
Plotting the axes on a log scale is often a good idea. The use of xlim and ylim to control the axis limits is also a good idea, so as to limit the extent of the curves at low abundances or probabilities. Setting label.sites = TRUE is a good idea only if the number of sites is small, otherwise there is too much clutter.

Author(s)
Thomas W. Yee
Trunc

Truncated Values for the GT-Expansion Method

Description

Given the minimum and maximum values in a response variable, and a positive multiplier, returns the truncated values for generally-truncated regression

Usage

Trunc(Range, mux = 2, location = 0, omits = TRUE)

Arguments

Range Numeric, of length 2 containing the minimum and maximum (in that order) of the untransformed data. Alternatively, if length(Range) > 2 then it is assumed that the entire untransformed data is passed in so that range is applied.

mux Numeric, the multiplier. A positive integer.
Trunc

location   Numeric, the location parameter, allows a shift to the right.
omits      Logical. The default is to return the truncated values (those being omitted). If FALSE then the multiples are returned.

Details

Generally-truncated regression can handle underdispersion with respect to some parent or base distribution such as the Poisson. Yee and Ma (2023) call this the \textit{GT-Expansion} (GTE) method, which is a special case of the GT-location-scale (GT-LS) method. This is a utility function to help make life easier. It is assumed that the response is a count variable.

Value

A vector of values to be fed into the truncate argument of a \texttt{VGAM} family function such as \texttt{gaitdpoisson}. If \texttt{mux = 1} then the function will return a \texttt{NULL} rather than \texttt{integer(0)}.

Author(s)

T. W. Yee

See Also

gaitdpoisson, gaitdlog, gaitdzeta, range, setdiff, goffset.

Examples

```
Trunc(c(1, 8), 2)
```

```
# Not run:
set.seed(1)  # The following example is based on the normal
mymean <- 20; m.truth <- 3  # approximation to the Poisson.
gdata <- data.frame(y1 = round(rnorm((nn <- 1000), mymean,
   sd = sqrt(mymean / m.truth))))
org1 <- with(gdata, range(y1))  # Original range of the raw data
m.max <- 5  # Try multipliers 1:m.max
logliks <- numeric(m.max)
names(logliks) <- as.character(1:m.max)
for (i in 1:m.max) {
  logliks[i] <- logLik(vglm(i * y1~ offset(rep(log(i), nn)),
    gaitdpoisson(truncate = Trunc(org1, i)), data = gdata))
}
sort(logliks, decreasing = TRUE)  # Best to worst
par(mfrow = c(1, 2))
plot(with(gdata, table(y1)))  # Underdispersed wrt Poisson
plot(logliks, col = "blue", type = "b", xlab = "Multiplier")
```

## End(Not run)
Truncpareto

The Truncated Pareto Distribution

Description

Density, distribution function, quantile function and random generation for the upper truncated Pareto(I) distribution with parameters lower, upper and shape.

Usage

\[
\begin{align*}
dtruncpareto & \quad (x, \text{lower}, \text{upper}, \text{shape}, \log = \text{FALSE}) \\
ptruncpareto & \quad (q, \text{lower}, \text{upper}, \text{shape}, \text{lower.tail = TRUE}, \log.p = \text{FALSE}) \\
qtruncpareto & \quad (p, \text{lower}, \text{upper}, \text{shape}) \\
rtruncpareto & \quad (n, \text{lower}, \text{upper}, \text{shape})
\end{align*}
\]

Arguments

- **x, q** vector of quantiles.
- **p** vector of probabilities.
- **n, log** Same meaning as `runif`.
- **lower, upper, shape** the lower, upper and shape \((k)\) parameters. If necessary, values are recycled.
- **lower.tail, log.p** Same meaning as in `pnorm` or `qnorm`.

Details

See `truncpareto`, the VGAM family function for estimating the parameter \(k\) by maximum likelihood estimation, for the formula of the probability density function and the range restrictions imposed on the parameters.

Value

- `dtruncpareto` gives the density, `ptruncpareto` gives the distribution function, `qtruncpareto` gives the quantile function, and `rtruncpareto` generates random deviates.

Author(s)

T. W. Yee and Kai Huang

References


See Also

`truncpareto`. 
Examples

```r
lower <- 3; upper <- 8; kay <- exp(0.5)
## Not run: xx <- seq(lower - 0.5, upper + 0.5, len = 401)
plot(xx, dtruncpareto(xx, low = lower, upp = upper, shape = kay),
     main = "Truncated Pareto density split into 10 equal areas",
     type = "l", ylim = 0:1, xlab = "x")
abline(h = 0, col = "blue", lty = 2)
qq <- qtruncpareto(seq(0.1, 0.9, by = 0.1), low = lower, upp = upper,
     shape = kay)
lines(qq, dtruncpareto(qq, low = lower, upp = upper, shape = kay),
     col = "purple", lty = 3, type = "h")
lines(xx, ptruncpareto(xx, low = lower, upp = upper, shape = kay),
     col = "orange")
## End(Not run)
pp <- seq(0.1, 0.9, by = 0.1)
qq <- qtruncpareto(pp, lower = lower, upper = upper, shape = kay)
ptruncpareto(qq, lower = lower, upper = upper, shape = kay)
qtruncpareto(ptruncpareto(qq, lower = lower, upper = upper, shape = kay),
     lower = lower, upper = upper, shape = kay) - qq # Should be all 0
```

### truncweibull

**Truncated Weibull Distribution Family Function**

**Description**

Maximum likelihood estimation of the 2-parameter Weibull distribution with lower truncation. No observations should be censored.

**Usage**

```r
truncweibull(lower.limit = 1e-5,
   lAlpha = "loglink", lBetaa = "loglink",
   iAlpha = NULL, iBetaa = NULL,
   nrfs = 1, probs.y = c(0.2, 0.5, 0.8),
   imethod = 1, zero = "Betaa")
```

**Arguments**

- `lower.limit` Positive lower truncation limits. Recycled to the same dimension as the response, going across rows first. The default, being close to 0, should mean effectively the same results as `weibullR` if there are no response values that are smaller.
- `lAlpha, lBetaa` Parameter link functions applied to the (positive) parameters Alpha (called $\alpha$ below) and (positive) Betaa (called $\beta$ below). See Links for more choices.
- `iAlpha, iBetaa` See CommonVGAMffArguments.
- `imethod, nrfs, zero` See CommonVGAMffArguments.

Details at `weibullR` and CommonVGAMffArguments.
Details

MLE of the two parameters of the Weibull distribution are computed, subject to lower truncation. That is, all response values are greater than lower.limit, element-wise. For a particular observation this is any known positive value. This function is currently based directly on Wingo (1989) and his parameterization is used (it differs from weibullR.) In particular, $\beta = a$ and $\alpha = (1/b)^a$ where $a$ and $b$ are as in weibullR and dweibull.

Upon fitting the extra slot has a component called lower.limit which is of the same dimension as the response. The fitted values are the mean, which are computed using pgamma.deriv and pgamma.deriv.unscaled.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Warning

This function may be converted to the same parameterization as weibullR at any time. Yet to do: one element of the EIM may be wrong (due to two interpretations of a formula; but it seems to work). Convergence is slower than usual and this may imply something is wrong; use argument maxit. In fact, it’s probably because pgamma.deriv.unscaled is inaccurate at $q = 1$ and $q = 2$. Also, convergence should be monitored, especially if the truncation means that a large proportion of the data is lost compared to an ordinary Weibull distribution.

Note

More improvements need to be made, e.g., initial values are currently based on no truncation. This VGAM family function handles multiple responses.

Author(s)

T. W. Yee

References


See Also

weibullR, dweibull, pgamma.deriv, pgamma.deriv.unscaled.

Examples

```r
nn <- 5000; prop.lost <- 0.40  # Proportion lost to truncation
wdata <- data.frame(x2 = runif(nn))  # Complete Weibull data
wdata <- transform(wdata,
   Betaa = exp(1))  # > 2 okay (satisfies regularity conds)
wdata <- transform(wdata, Alpha = exp(0.5 - 1 * x2))
wdata <- transform(wdata, Shape = Betaa,
```
# aaa = Betaa,
# bbb = 1 / Alpha\^\{(1 / Betaa),
Scale = 1 / Alpha\^\{(1 / Betaa))

wdata <- transform(wdata, y2 = rweibull(nn, Shape, scale = Scale))
summary(wdata)

# Proportion lost:
lower.limit2 <- with(wdata, quantile(y2, prob = prop.lost))
# Smaller due to truncation:
wdata <- subset(wdata, y2 > lower.limit2)

fit1 <- vglm(y2 ~ x2, maxit = 100, trace = TRUE,
truncweibull(lower.limit = lower.limit2), wdata)
coef(fit1, matrix = TRUE)
summary(fit1)
vcov(fit1)
head(fit1@extra$lower.limit)

---

### Description

University California Berkeley Graduate Admissions: counts cross-classified by acceptance/rejection and gender, for the six largest departments.

### Usage

data(ucberk)

### Format

A data frame with 6 departmental groups with the following 5 columns.

- **m.deny** Counts of men denied admission.
- **m.admit** Counts of men admitted.
- **w.deny** Counts of women denied admission.
- **w.admit** Counts of women admitted.
- **dept** Department (the six largest), called A, B, . . . , F.

### Details

From Bickel et al. (1975), the data consists of applications for admission to graduate study at the University of California, Berkeley, for the fall 1973 quarter. In the admissions cycle for that quarter, the Graduate Division at Berkeley received approximately 15,000 applications, some of which were later withdrawn or transferred to a different proposed entry quarter by the applicants. Of the applications finally remaining for the fall 1973 cycle 12,763 were sufficiently complete to permit a decision. There were about 101 graduate department and interdepartmental graduate
majors. There were 8442 male applicants and 4321 female applicants. About 44 percent of the
males and about 35 percent of the females were admitted. The data are well-known for illustrating
Simpson’s paradox.

References


Company.

Examples

summary(ucberk)

uninormal

Univariate Normal Distribution

Description

Maximum likelihood estimation of the two parameters of a univariate normal distribution.

Usage

uninormal(lmean = "identitylink", lsd = "loglink", lvar =
"loglink", var.arg = FALSE, imethod = 1, isd = NULL,
parallel = FALSE, vfl = FALSE, Form2 = NULL,
smallno = 1e-05, zero = if (var.arg)
"var" else "sd")

Arguments

lmean, lsd, lvar

Link functions applied to the mean and standard deviation/variance. See Links
for more choices. Being positive quantities, a log link is the default for the
standard deviation and variance (see var.arg).

var.arg

Logical. If TRUE then the second parameter is the variance and lsd and esd are
ignored, else the standard deviation is used and lvar and evar are ignored.

smallno

Numeric, positive but close to 0. Used specifically for quasi-variances; if the
link for the mean is explink then any non-positive value of eta is replaced by
this quantity (hopefully, temporarily and only during early iterations).

imethod, parallel, isd, zero

See CommonVGAMffArguments for information. If lmean = loglink then try
imethod = 2. If parallel = TRUE then the parallelism constraint is not applied
to the intercept.

vfl, Form2

See CommonVGAMffArguments for information.
**Details**

This fits a linear model (LM) as the first linear/additive predictor. So, by default, this is just the mean. By default, the log of the standard deviation is the second linear/additive predictor. The Fisher information matrix is diagonal. This VGAM family function can handle multiple responses.

**Value**

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

**Warning**

gaussianff() was deprecated but has been brought back into VGAM nominally. It should be called Mickey Mouse. It gives a warning and calls uninormal instead (hopefully all the arguments should pass in correctly). Users should avoid calling gaussianff(); use glm with gaussian instead. It is dangerous to treat what is an uninormal fit as a gaussianff() object.

**Note**

Yet to do: allow an argument such as eq.sd that enables the standard deviations to be the same. Also, this function used to be called normal1() too, but it has been decommissioned.

**Author(s)**

T. W. Yee

**References**


**See Also**

posnormal, mix2normal, ordsup, N1binomial, N1poisson, Qvar, tobit, cens.normal, foldnormal, skewnormal, double.cens.normal, SURff, AR1, huber2, studentt, binormal, trinormal, dnorm, simulate.vlm, hdeff.vglm.

**Examples**

```r
udata <- data.frame(x2 = rnorm(nn <- 200))
udata <- transform(udata,
  y1 = rnorm(nn, m = 1 - 3*x2, sd = exp(1 + 0.2*x2)),
  y2a = rnorm(nn, m = 1 + 2*x2, sd = exp(1 + 2.0*x2)^0.5),
  y2b = rnorm(nn, m = 1 + 2*x2, sd = exp(1 + 2.0*x2)^0.5))
fit1 <- vglm(y1 ~ x2, uninormal(zero = NULL), udata, trace = TRUE)
coef(fit1, matrix = TRUE)
fit2 <- vglm(cbind(y2a, y2b) ~ x2, data = udata, trace = TRUE,
             uninormal(var = TRUE, parallel = TRUE ~ x2,
                        zero = NULL))
coef(fit2, matrix = TRUE)
```
# Generate data from N(mu=theta=10, sigma=theta) and estimate theta.
theta <- 10
udata <- data.frame(y3 = rnorm(100, m = theta, sd = theta))
fit3a <- vglm(y3 ~ 1, uninormal(lsd = "identitylink"), data = udata,
             constraints = list("(Intercept)" = rbind(1, 1)))
fit3b <- vglm(y3 ~ 1, uninormal(lsd = "identitylink",
             parallel = TRUE ~ 1, zero = NULL), udata)
coef(fit3a, matrix = TRUE)
coef(fit3b, matrix = TRUE) # Same as fit3a

## UtilitiesVGAM

Utility Functions for the VGAM Package

### Description

A set of common utility functions used by VGAM family functions.

### Usage

```r
param.names(string, S = 1, skip1 = FALSE, sep = "")
dimm(M, hbw = M)
interleave.VGAM(.M, M1, inverse = FALSE)
```

### Arguments

- **string**: Character. Name of the parameter.
- **M, .M**: Numeric. The total number of linear/additive predictors, called \( M \). By total, it is meant summed over the number of responses. Often, \( M \) is the total number of parameters to be estimated (but this is not the same as the number of regression coefficients, unless the RHS of the formula is an intercept-only). The use of \( .M \) is unfortunate, but it is a compromise solution to what is presented in Yee (2015). Ideally, \( .M \) should be just \( M \).
- **M1**: Numeric. The number of linear/additive predictors for one response, called \( M_1 \). This argument used to be called \( M \), but is now renamed properly.
- **inverse**: Logical. Useful for the inverse function of `interleave.VGAM()`.
- **S**: Numeric. The number of responses.
- **skip1, sep**: The former is logical; should one skip (or omit) "1" when \( S = 1 \)? The latter is the same argument as `paste`.
- **hbw**: Numeric. The half-bandwidth, which measures the number of bands emanating from the central diagonal band.

### Details

See Yee (2015) for some details about some of these functions.
Value

For param.names(), this function returns the parameter names for \( S \) responses, i.e., string is returned unchanged if \( S = 1 \), else paste(string, 1:S, sep = "")

For dimm(), this function returns the number of elements to be stored for each of the working weight matrices. They are represented as columns in the matrix \( wz \) in e.g., vglm.fit(). See the *matrix-band* format described in Section 18.3.5 of Yee (2015).

For interleave.VGAM(), this function returns a reordering of the linear/additive predictors depending on the number of responses. The arguments presented in Table 18.5 may not be valid in your version of Yee (2015).

Author(s)

T. W. Yee. Victor Miranda added the inverse argument to interleave.VGAM().

References


See Also

CommonVGAMffArguments, VGAM-package.

Examples

```r
param.names("shape", 1) # "shape"
param.names("shape", 3) # c("shape1", "shape2", "shape3")

dimm(3, hbw = 1) # Diagonal matrix; the 3 elements need storage.
dimm(3) # A general 3 x 3 symmetrix matrix has 6 unique elements.
dimm(3, hbw = 2) # Tridiagonal matrix; the 3-3 element is 0 and unneeded.

M1 <- 2; ncoly <- 3; M <- ncoly * M1
mynames1 <- param.names("location", ncoly)
mynames2 <- param.names("scale", ncoly)
(parameters.names <- c(mynames1, mynames2)[interleave.VGAM(M, M1 = M1)])
# The following is/was in Yee (2015) and has a poor/deceptive style:
(parameters.names <- c(mynames1, mynames2)[interleave.VGAM(M, M = M1)])
parameters.names[interleave.VGAM(M, M1 = M1, inverse = TRUE)]
```

Description

A small count data set. During WWII V1 flying-bombs were fired from sites in France (Pas-de-Calais) and Dutch coasts towards London. The number of hits per square grid around London were recorded.
Usage
data(V1)

Format
A data frame with the following variables.

- **hits**: Values between 0 and 4, and 7. Actually, the 7 is really imputed from the paper (it was recorded as “5 and over”).
- **ofreq**: Observed frequency, i.e., the number of grids with that many hits.

Details
The data concerns 576 square grids each of 0.25 square kms about south London. The area was selected comprising 144 square kms over which the basic probability function of the distribution was very nearly constant. V1s, which were one type of flying-bomb, were a “Vergeltungswaffen” or vengeance weapon fired during the summer of 1944 at London. The V1s were informally called Buzz Bombs or Doodlebugs, and they were pulse-jet-powered with a warhead of 850 kg of explosives. Over 9500 were launched at London, and many were shot down by artillery and the RAF. Over the period considered the total number of bombs within the area was 537.

It was asserted that the bombs tended to be grouped in clusters. However, a basic Poisson analysis shows this is not the case. Their guidance system being rather primitive, the data is consistent with a Poisson distribution (random).

Compared to Clarke (1946), the more modern analysis of Shaw and Shaw (2019), shows a higher density of hits in south London, hence the distribution is not really uniform over the entire region.

Source

References

See Also
V2, poissonff.

Examples
```
V1
mean(with(V1, rep(hits, times = ofreq)))
var(with(V1, rep(hits, times = ofreq)))
sum(with(V1, rep(hits, times = ofreq)))
## Not run: barplot(with(V1, ofreq),
       names.arg = as.character(with(V1, hits)),
       main = "London V1 buzz bomb hits",
       col = "lightblue", las = 1,
```
V2 Missile Hits in London

Description

A small count data set. During WWII V2 missiles were fired from the continent mainly towards London. The number of hits per square grid around London were recorded.

Usage

data(V2)

Format

A data frame with the following variables.

- **hits** Values between 0 and 3.
- **ofreq** Observed frequency, i.e., the number of grids with that many hits.

Details

The data concerns 408 square grids each of 0.25 square kms about south London (south of the River Thames). They were picked in a rectangular region of 102 square kilometres where the density of hits were roughly uniformly distributed. The data is somewhat comparable to V1 albeit is a smaller data set.

Source


See Also

V1, poissonff.

Examples

```r
V2
mean(with(V2, rep(hits, times = ofreq)))
var(with(V2, rep(hits, times = ofreq)))
sum(with(V2, rep(hits, times = ofreq)))
## Not run: barplot(with(V2, ofreq),
# names.arg = as.character(with(V2, hits)),
# main = "London V2 rocket hits",
# col = "lightgreen", las = 1,
# ylab = "Frequency", xlab = "Hits")
## End(Not run)
```
vcovvlm

*Calculate Variance-Covariance Matrix for a Fitted VLM or RR-VGLM or DRR-VGLM or QRR-VGLM Object*

**Description**

Returns the variance-covariance matrix of the parameters of a fitted `vlm-class` or `rrvglm-class` or `drrvglm-class` object.

**Usage**

```r
vcovvlm(object, dispersion = NULL, untransform = FALSE, complete = TRUE, ...) 
vcovrrvglm(object, ...) 
vcovdrrvglm(object, ...) 
vcovqrrvglm(object, ...) 
```

**Arguments**

- `object`: A fitted model object, having class `vlm-class` or `rrvglm-class` or `drrvglm-class` or `qrrvglm-class` or a superclass of such. The former includes a `vglm` object.
- `dispersion`: Numerical. This argument should not be used as VGAM will be phasing out dispersion parameters. Formerly, a value may be specified, else it is estimated for quasi-GLMs (e.g., method of moments). For almost all other types of VGLMs it is usually unity. The value is multiplied by the raw variance-covariance matrix.
- `untransform`: logical. For intercept-only models with trivial constraints; if set `TRUE` then the parameter link function is inverted to give the answer for the untransformed/raw parameter.
- `complete`: An argument currently ignored. Added only so that `linearHypothesis()` in car can be called.
- `...`: Same as `vcov`.

**Details**

This methods function is based on the QR decomposition of the (large) VLM model matrix and working weight matrices. Currently `vcovvlm` operates on the fundamental `vlm-class` objects because pretty well all modelling functions in VGAM inherit from this. Currently `vcovrrvglm` is not entirely reliable because the elements of the A–C part of the matrix sometimes cannot be computed very accurately, so that the entire matrix is not positive-definite.

For "qrrvglm" objects, `vcovqrrvglm` is currently working with `Rank = 1` objects or when `I.tolerances = TRUE`. Then the answer is conditional given C. The code is based on `model.matrixqrrvglm` so that the dimnames are the same.

**Value**

Same as `vcov`. 
Note

For some models inflated standard errors can occur, such as parameter estimates near the boundary of the parameter space. Detection for this is available for some models using \texttt{hdeff.vglm}, which tests for an Hauck-Donner effect (HDE) for each regression coefficient. If the HDE is present, using \texttt{lrt.stat.vlm} should return more accurate p-values.

Author(s)

Thomas W. Yee

See Also

\texttt{confintvglm, summaryvglm, vcov.hdeff.vglm, lrt.stat.vlm, model.matrixqrrvglm}.

Examples

```r
## Not run:
data(venice)
data(venice90)
fit1 <- vglm(cbind(r1, r2, r3, r4, r5, r6, r7, r8, r9, r10) ~ year, negbinomial, data = venice, trace = TRUE)
fit2 <- rrvglm(r1 ~ year, negbinomial(zero = NULL), data = venice)
coef(fit1)
vcov(fit1)
vcov(fit2)
## End(Not run)
```

## venice

### Venice Maximum Sea Levels Data

Description

Some sea levels data sets recorded at Venice, Italy.

Usage

data(venice)
data(venice90)

Format

venice is a data frame with 51 observations on the following 11 variables. It concerns the maximum heights of sea levels between 1931 and 1981.

- **year** a numeric vector.
- **r1, r2, r3, r4, r5, r6, r7, r8, r9, r10** numeric vectors; \( r1 \) is the highest recorded value, \( r2 \) is the second highest recorded value, etc.
venice90 is a data frame with 455 observations on the following 7 variables.

- **year, month, day, hour** numeric vectors; actual time of the recording.
- **sealevel** numeric; sea level.
- **ohour** numeric; number of hours since the midnight of 31 Dec 1939 and 1 Jan 1940.
- **Year** numeric vector; approximate year as a real number. The formula is \( \text{start.year} + \text{ohour} / (365.26 \times 24) \) where \( \text{start.year} \) is 1940. One can treat **Year** as continuous whereas **year** can be treated as both continuous and discrete.

**Details**

Sea levels are in cm. For venice90, the value 0 corresponds to a fixed reference point (e.g., the mean sea level in 1897 at an old palace of Venice). Clearly since the relative (perceived) mean sea level has been increasing in trend over time (more than an overall 0.4 m increase by 2010), therefore the value 0 is (now) a very low and unusual measurement.

For venice, in 1935 only the top six values were recorded.

For venice90, this is a subset of a data set provided by Paolo Pirazzoli consisting of hourly sea levels from 1940 to 2009. Values greater than 90 cm were extracted, and then declustered (each cluster provides no more than one value, and each value is at least 24 hours apart). Thus the values are more likely to be independent. Of the original \((2009-1940+1) \times 365.26 \times 24\) values about 7 percent of these comprise venice90.

Yet to do: check for consistency between the data sets. Some external data sets elsewhere have some extremes recorded at times not exactly on the hour.

**Source**


Thanks to Paolo Pirazzoli and Alberto Tomasin for the venice90 data.

**References**


**See Also**

guplot, gev, gpd.

**Examples**

```r
## Not run:
matplot(venice[, "year"], venice[, -1], xlab = "Year",
ylab = "Sea level (cm)", type = "l")

ymat <- as.matrix(venice[, paste("r", 1:10, sep = ")")])
fit1 <- vgam(ymat ~ s(year, df = 3), gumbel(R = 365, mpv = TRUE),
```

```
venice, trace = TRUE, na.action = na.pass)
head(fitted(fit1))

par(mfrow = c(2, 1), xpd = TRUE)
plot(fit1, se = TRUE, lcol = "blue", l1wd = 2, slty = "dashed")

par(mfrow = c(1,1), bty = "l", xpd = TRUE, las = 1)
qtplot(fit1, mpv = TRUE, lcol = c(1, 2, 5), tcol = c(1, 2, 5),
      llwd = 2, pcol = "blue", tadj = 0.1)
plot(sealevel ~ Year, data = venice90, type = "h", col = "blue")
summary(venice90)
dim(venice90)
round(100 * nrow(venice90)/((2009-1940+1)*365.26*24), dig = 3)

## End(Not run)

vgam

Fitting Vector Generalized Additive Models

Description

Fit a vector generalized additive model (VGAM). Both 1st-generation VGAMs (based on backfit-
ing) and 2nd-generation VGAMs (based on P-splines, with automatic smoothing parameter selec-
tion) are implemented. This is a large class of models that includes generalized additive models
(GAMs) and vector generalized linear models (VGLMs) as special cases.

Usage

vgam(formula,
    family = stop("argument 'family' needs to be assigned"),
    data = list(), weights = NULL, subset = NULL,
    na.action, etastart = NULL, mustart = NULL,
    coefstart = NULL, control = vgam.control(...),
    offset = NULL, method = "vgam.fit", model = FALSE,
    x.arg = TRUE, y.arg = TRUE, contrasts = NULL,
    constraints = NULL, extra = list(), form2 = NULL,
    qr.arg = FALSE, smart = TRUE, ...

Arguments

formula a symbolic description of the model to be fit. The RHS of the formula is applied
to each linear/additive predictor, and should include at least one sm.os term or
sm.ps term or s term. Mixing both together is not allowed. Different variables
in each linear/additive predictor can be chosen by specifying constraint matrices.

family Same as for vglm.
data an optional data frame containing the variables in the model. By default the var-
ables are taken from environment(formula), typically the environment from
which vgam is called.
weights, subset, na.action
   Same as for \textit{vglm}. Note that subset may be unreliable and to get around this
   problem it is best to use \texttt{subset} to create a new smaller data frame and feed
   in the smaller data frame. See below for an example. This is a bug that needs
   fixing.

etastart, mustart, coefstart
   Same as for \textit{vglm}.

control
   a list of parameters for controlling the fitting process. See \texttt{vgam.control} for
details.

method
   the method to be used in fitting the model. The default (and presently only)
   method \texttt{vgam.fit} uses iteratively reweighted least squares (IRLS).

constraints, model, offset
   Same as for \texttt{vglm}.

x.arg, y.arg
   logical values indicating whether the model matrix and response vector/matrix
   used in the fitting process should be assigned in the \texttt{x} and \texttt{y} slots. Note the
   model matrix is the LM model matrix; to get the VGAM model matrix type
   \texttt{model.matrix(vgamfit)} where \texttt{vgamfit} is a \texttt{vgam} object.

contrasts, extra, form2, qr.arg, smart
   Same as for \texttt{vglm}.

... further arguments passed into \texttt{vgam.control}.

Details

A vector generalized additive model (VGAM) is loosely defined as a statistical model that is a
function of $M$ additive predictors. The central formula is given by

$$
\eta_j = \sum_{k=1}^{p} f_{(j)k}(x_k)
$$

where $x_k$ is the $k$th explanatory variable (almost always $x_1 = 1$ for the intercept term), and $f_{(j)k}$
are smooth functions of $x_k$ that are estimated by smoothers. The first term in the summation is
just the intercept. Currently two types of smoothers are implemented: \texttt{s} represents the older and
more traditional one, called a vector (cubic smoothing spline) smoother and is based on Yee and
Wild (1996); it is more similar to the \texttt{R} package \texttt{gam}. The newer one is represented by \texttt{sm.os}
and \texttt{sm.ps}, and these are based on O-splines and P-splines—they allow automatic smoothing parameter
selection; it is more similar to the \texttt{R} package \texttt{mgcv}.

In the above, $j = 1, \ldots, M$ where $M$ is finite. If all the functions are constrained to be linear then
the resulting model is a vector generalized linear model (VGLM). VGLMs are best fitted with \texttt{vglm}.

Vector (cubic smoothing spline) smoothers are represented by \texttt{s()} (see \texttt{s}). Local regression via
\texttt{lo()} is not supported. The results of \texttt{vgam} will differ from the \texttt{gam()} (in the \texttt{gam}) because \texttt{vgam()}
uses a different knot selection algorithm. In general, fewer knots are chosen because the computa-
tion becomes expensive when the number of additive predictors $M$ is large.

Second-generation VGAMs are based on the O-splines and P-splines. The latter is due to Eilers
and Marx (1996). Backfitting is not required, and estimation is performed using IRLS. The function
\texttt{sm.os} represents a \textit{smart} implementation of O-splines. The function \texttt{sm.ps} represents a \textit{smart}
implementation of P-splines. Written G2-VGAMs or P-VGAMs, this methodology should not be
used unless the sample size is reasonably large. Usually an UBRE predictive criterion is optimized (at each IRLS iteration) because the scale parameter for VGAMs is usually assumed to be known. This search for optimal smoothing parameters does not always converge, and neither is it totally reliable. G2-VGAMs implicitly set criterion = “coefficients” so that convergence occurs when the change in the regression coefficients between 2 IRLS iterations is sufficiently small. Otherwise the search for the optimal smoothing parameters might cause the log-likelihood to decrease between 2 IRLS iterations. Currently outer iteration is implemented, by default, rather than performance iteration because the latter is more easy to converge to a local solution; see Wood (2004) for details.

One can use performance iteration by setting Maxit.outer = 1 in vgam.control.

The underlying algorithm of VGAMs is IRLS. First-generation VGAMs (called G1-VGAMs) are estimated by modified vector backfitting using vector splines. O-splines are used as the basis functions for the vector (smoothing) splines, which are a lower dimensional version of natural B-splines.

The function vgam.fit() actually does the work. The smoothing code is based on F. O'Sullivan’s BART code.

A closely related methodology based on VGAMs called constrained additive ordination (CAO) first forms a linear combination of the explanatory variables (called latent variables) and then fits a GAM to these. This is implemented in the function cao for a very limited choice of family functions.

Value

For G1-VGAMs and G2-VGAMs, an object of class "vgam" or "pvgam" respectively (see vgam-class and pvgam-class for further information).

WARNING

For G1-VGAMs, currently vgam can only handle constraint matrices cmat, say, such that crossprod(cmat) is diagonal. It can be detected by is.buggy. VGAMs with constraint matrices that have non-orthogonal columns should be fitted with sm.os or sm.ps terms instead of s.

See warnings in vglm.control.

Note

This function can fit a wide variety of statistical models. Some of these are harder to fit than others because of inherent numerical difficulties associated with some of them. Successful model fitting benefits from cumulative experience. Varying the values of arguments in the VGAM family function itself is a good first step if difficulties arise, especially if initial values can be inputted. A second, more general step, is to vary the values of arguments in vgam.control. A third step is to make use of arguments such as etastart, coefstart and mustart.

Some VGAM family functions end in "ff" to avoid interference with other functions, e.g., binomialff, poissonff. This is because VGAM family functions are incompatible with glm (and also gam() in gam and gam in mgcv).

The smart prediction (smartpred) library is packed with the VGAM library.

The theory behind the scaling parameter is currently being made more rigorous, but it should give the same value as the scale parameter for GLMs.
Author(s)

Thomas W. Yee

References


See Also

`is.buggy`, `vgam.control`, `vgam-class`, `vglmff-class`, `plotvgam`, `summaryvgam`, `summarypvgam`, `sm.os`, `sm.ps`, `s.magic`, `vglm`, `vsmooth.spline`, `cao`.

Examples

```r
# Nonparametric proportional odds model
pneumo <- transform(pneumo, let = log(exposure.time))
vgam(cbind(normal, mild, severe) ~ s(let),
     cumulative(parallel = TRUE), data = pneumo, trace = TRUE)

# Nonparametric logistic regression
hfit <- vgam(agaaus ~ s(altitude, df = 2), binomialff, hunua)
## Not run: plot(hfit, se = TRUE)
phfit <- predict(hfit, type = "terms", raw = TRUE, se = TRUE)
names(phfit)
head(phfit$fitted)
head(phfit$se.fit)
phfit$df
phfit$sigma

# Fit two species simultaneously
hfit2 <- vgam(cbind(agaaus, kniexc) ~ s(altitude, df = c(2, 3)),
     binomialff(multiple.responses = TRUE), data = hunua)
coef(hfit2, matrix = TRUE)  # Not really interpretable
## Not run:
plot(hfit2, se = TRUE, overlay = TRUE, lcol = 3:4, scol = 3:4)
ooo <- with(hunua, order(altitude))
with(hunua, matplot(altitude[ooo], fitted(hfit2)[ooo,],
     ylim = c(0, 0.8), las = 1, type = "l", lwd = 2,
     xlab = "Altitude (m)", ylab = "Probability of presence",
     main = "Two plant species' response curves"))
with(hunua, rug(altitude))
```
vgam-class

## End(Not run)

# The 'subset' argument does not work here. Use subset() instead.
set.seed(1)
zdata <- data.frame(x2 = runif(nn <- 500))
zdata <- transform(zdata, y = rbinom(nn, 1, 0.5))
zdata <- transform(zdata, subS = runif(nn) < 0.7)
sub.zdata <- subset(zdata, subS) # Use this instead
if (FALSE)
  fit4a <- vgam(cbind(y, y) ~ s(x2, df = 2),
                binomialff(multiple.responses = TRUE),
                data = zdata, subset = subS) # This fails!!!
  fit4b <- vgam(cbind(y, y) ~ s(x2, df = 2),
                binomialff(multiple.responses = TRUE),
                data = sub.zdata) # This succeeds!!!
  fit4c <- vgam(cbind(y, y) ~ sm.os(x2),
                binomialff(multiple.responses = TRUE),
                data = sub.zdata) # This succeeds!!!
## Not run: par(mfrow = c(2, 2))
plot(fit4b, se = TRUE, shade = TRUE, shcol = "pink")
plot(fit4c, se = TRUE, shade = TRUE, shcol = "pink")
## End(Not run)

---

**vgam-class**

**Class** "vgam"

---

**Description**

Vector generalized additive models.

**Objects from the Class**

Objects can be created by calls of the form vgam(...).

**Slots**

- nl.chisq: Object of class "numeric". Nonlinear chi-squared values.
- nl.df: Object of class "numeric". Nonlinear chi-squared degrees of freedom values.
- spar: Object of class "numeric" containing the (scaled) smoothing parameters.
- s.xargument: Object of class "character" holding the variable name of any s() terms.
- var: Object of class "matrix" holding approximate pointwise standard error information.
- Bspline: Object of class "list" holding the scaled (internal and boundary) knots, and the fitted B-spline coefficients. These are used for prediction.
- extra: Object of class "list": the extra argument on entry to vglm. This contains any extra information that might be needed by the family function.
- family: Object of class "vglmff". The family function.
iter: Object of class "numeric". The number of IRLS iterations used.
predictors: Object of class "matrix" with M columns which holds the M linear predictors.
assign: Object of class "list", from class "vlm". This named list gives information matching the columns and the (LM) model matrix terms.
call: Object of class "call", from class "vlm". The matched call.
coefficients: Object of class "numeric", from class "vlm". A named vector of coefficients.
constraints: Object of class "list", from class "vlm". A named list of constraint matrices used in the fitting.
contrasts: Object of class "list", from class "vlm". The contrasts used (if any).
control: Object of class "list", from class "vlm". A list of parameters for controlling the fitting process. See vglm.control for details.
criterion: Object of class "list", from class "vlm". List of convergence criterion evaluated at the final IRLS iteration.
df.residual: Object of class "numeric", from class "vlm". The residual degrees of freedom.
df.total: Object of class "numeric", from class "vlm". The total degrees of freedom.
dispersion: Object of class "numeric", from class "vlm". The scaling parameter.
effects: Object of class "numeric", from class "vlm". The effects.
fitted.values: Object of class "matrix", from class "vlm". The fitted values. This is usually the mean but may be quantiles, or the location parameter, e.g., in the Cauchy model.
misc: Object of class "list", from class "vlm". A named list to hold miscellaneous parameters.
model: Object of class "data.frame", from class "vlm". The model frame.
na.action: Object of class "list", from class "vlm". A list holding information about missing values.
offset: Object of class "matrix", from class "vlm". If non-zero, a M-column matrix of offsets.
post: Object of class "list", from class "vlm" where post-analysis results may be put.
preplot: Object of class "list", from class "vlm" used by plotvgam; the plotting parameters may be put here.
prior.weights: Object of class "matrix", from class "vlm" holding the initially supplied weights.
qr: Object of class "list", from class "vlm". QR decomposition at the final iteration.
R: Object of class "matrix", from class "vlm". The R matrix in the QR decomposition used in the fitting.
rank: Object of class "integer", from class "vlm". Numerical rank of the fitted model.
residuals: Object of class "matrix", from class "vlm". The working residuals at the final IRLS iteration.
ResSS: Object of class "numeric", from class "vlm". Residual sum of squares at the final IRLS iteration with the adjusted dependent vectors and weight matrices.
smart.prediction: Object of class "list", from class "vlm". A list of data-dependent parameters (if any) that are used by smart prediction.
terms: Object of class "list", from class "vlm". The terms object used.
weights: Object of class "matrix", from class "vlm". The weight matrices at the final IRLS iteration. This is in matrix-band form.
x: Object of class "matrix", from class "vlm". The model matrix (LM, not VGLM).
xlevels: Object of class "list", from class "vlm". The levels of the factors, if any, used in fitting.
y: Object of class "matrix", from class "vlm". The response, in matrix form.
Xm2: Object of class "matrix", from class "vlm". See vglm-class).
Ym2: Object of class "matrix", from class "vlm". See vglm-class).
callXm2: Object of class "call", from class "vlm". The matched call for argument form2.

Extends
Class "vglm", directly. Class "vlm", by class "vglm".

Methods
cdf signature(object = "vglm") : cumulative distribution function. Useful for quantile regression and extreme value data models.
depplot signature(object = "vglm") : density plot. Useful for quantile regression models.
deviance signature(object = "vglm") : deviance of the model (where applicable).
plot signature(x = "vglm") : diagnostic plots.
predict signature(object = "vglm") : extract the additive predictors or predict the additive predictors at a new data frame.
print signature(x = "vglm") : short summary of the object.
qtplot signature(object = "vglm") : quantile plot (only applicable to some models).
resid signature(object = "vglm") : residuals. There are various types of these.
residuals signature(object = "vglm") : residuals. Shorthand for resid.
rlplot signature(object = "vglm") : return level plot. Useful for extreme value data models.
summary signature(object = "vglm") : a more detailed summary of the object.

Note
VGAMs have all the slots that vglm objects have (vglm-class), plus the first few slots described in the section above.

Author(s)
Thomas W. Yee

References

See Also
vgam.control, vglm, s, vglm-class, vglmff-class.
Examples

```r
# Fit a nonparametric proportional odds model
pneumo <- transform(pneumo, let = log(exposure.time))
vgam(cbind(normal, mild, severe) ~ s(let),
     cumulative(parallel = TRUE), data = pneumo)
```

vgam.control

Control Function for vgam()

Description

Algorithmic constants and parameters for running vgam are set using this function.

Usage

```r
vgam.control(all.knots = FALSE, bf.epsilon = 1e-07, bf.maxit = 30,
             checkwz = TRUE, Check.rank = TRUE, Check.cm.rank = TRUE,
             criterion = names(.min.criterion.VGAM),
             epsilon = 1e-07, maxit = 30, Maxit.outer = 10,
             noWarning = FALSE,
             na.action = na.fail,
             nk = NULL, save.weights = FALSE, se.fit = TRUE,
             trace = FALSE, wzepsilon = .Machine$double.eps^0.75,
             xij = NULL, gamma.arg = 1, ...)
```

Arguments

- `all.knots`: logical indicating if all distinct points of the smoothing variables are to be used as knots. By default, `all.knots=TRUE` for \( n \leq 40 \), and for \( n > 40 \), the number of knots is approximately \( 40 + (n - 40) / 2.5 \). This increases very slowly with \( n \) so that the number of knots is approximately between 50 and 60 for large \( n \).
- `bf.epsilon`: tolerance used by the modified vector backfitting algorithm for testing convergence. Must be a positive number.
- `bf.maxit`: maximum number of iterations allowed in the modified vector backfitting algorithm. Must be a positive integer.
- `checkwz`: logical indicating whether the diagonal elements of the working weight matrices should be checked whether they are sufficiently positive, i.e., greater than wzepsilon. If not, any values less than wzepsilon are replaced with this value.
- `Check.rank`, `Check.cm.rank`: See vglm.control.
- `criterion`: character variable describing what criterion is to be used to test for convergence. The possibilities are listed in .min.criterion.VGAM, but most family functions only implement a few of these.
- `epsilon`: positive convergence tolerance epsilon. Roughly speaking, the Newton-Raphson/Fisher-scoring/local-scoring iterations are assumed to have converged when two successive criterion values are within epsilon of each other.
vgam.control

maxit  maximum number of Newton-Raphson/Fisher-scoring/local-scoring iterations allowed.

Maxit.outer  maximum number of outer iterations allowed when there are \textit{sm.os} or \textit{sm.ps} terms. See \textit{vgam} for a little information about the default outer iteration. Note that one can use performance iteration by setting Maxit.outer = 1; then the smoothing parameters will be automatically chosen at each IRLS iteration (some specific programming allows this).

Note that \textit{gam} uses outer iteration by default. However, \textit{magic} is only invoked for the Gaussian family, so the results of \textit{gam} may differ substantially from \textit{sm.os} and \textit{sm.ps} in general.

na.action  how to handle missing values. Unlike the SPLUS \textit{gam} function, \textit{vgam} cannot handle NAs when smoothing.

nk  vector of length \(d\) containing positive integers. where \(d\) be the number of \(s\) terms in the formula. Recycling is used if necessary. The \(i\)th value is the number of B-spline coefficients to be estimated for each component function of the \(i\)th \(s()\) term. \(nk\) differs from the number of knots by some constant. If specified, \(nk\) overrides the automatic knot selection procedure.

save.weights  logical indicating whether the \texttt{weights} slot of a "\texttt{vglm}" object will be saved on the object. If not, it will be reconstructed when needed, e.g., \texttt{summary}.

se.fit  logical indicating whether approximate pointwise standard errors are to be saved on the object. If \texttt{TRUE}, then these can be plotted with \texttt{plot(..., se = TRUE)}.

trace  logical indicating if output should be produced for each iteration.

wzepsilon  Small positive number used to test whether the diagonals of the working weight matrices are sufficiently positive.

noWarning  Same as \texttt{vglm.control}.

xij  Same as \texttt{vglm.control}.

\texttt{gamma.arg}  Numeric; same as \texttt{gamma} in \texttt{magic}. Inflation factor for optimizing the UBRE/GCV criterion. If given, a suggested value is 1.4 to help avoid overfitting, based on the work of Gu and co-workers (values between 1.2 and 1.4 appeared reasonable, based on simulations). A warning may be given if the value is deemed out-of-range.

...  other parameters that may be picked up from control functions that are specific to the \texttt{VGAM} family function.

Details

Most of the control parameters are used within \texttt{vgam.fit} and you will have to look at that to understand the full details. Many of the control parameters are used in a similar manner by \texttt{vglm.fit} (\texttt{vglm}) because the algorithm (IRLS) is very similar.

Setting \texttt{save.weights=FALSE} is useful for some models because the \texttt{weights} slot of the object is often the largest and so less memory is used to store the object. However, for some \texttt{VGAM} family function, it is necessary to set \texttt{save.weights=TRUE} because the \texttt{weights} slot cannot be reconstructed later.
Value

A list with components matching the input names. A little error checking is done, but not much. The list is assigned to the control slot of \texttt{vgam} objects.

Warning

See \texttt{vglm.control}.

Note

\texttt{vgam} does not implement half-stepsizing, therefore parametric models should be fitted with \texttt{vglm}. Also, \texttt{vgam} is slower than \texttt{vglm} too.

Author(s)

Thomas W. Yee

References


See Also

\texttt{vgam, vglm.control, vsmooth.spline, vglm}.

Examples

\begin{verbatim}
pneumo <- transform(pneumo, let = log(exposure.time)) vgam(cbind(normal, mild, severe) ~ s(let, df = 2), multinomial, data = pneumo, trace = TRUE, eps = 1e-4, maxit = 10)
\end{verbatim}

\texttt{vglm} \hspace{1cm} \textit{Fitting Vector Generalized Linear Models}

Description

\texttt{vglm} fits vector generalized linear models (VGLMs). This very large class of models includes generalized linear models (GLMs) as a special case.

Usage

\begin{verbatim}
vglm(formula, family = stop("argument 'family' needs to be assigned"), data = list(), weights = NULL, subset = NULL, na.action, etastart = NULL, mustart = NULL, coefstart = NULL, control = vglm.control(...), offset = NULL, method = "vglm.fit", model = FALSE, x.arg = TRUE, y.arg = TRUE, contrasts = NULL, constraints = NULL, extra = list(), form2 = NULL, qr.arg = TRUE, smart = TRUE, ...)
\end{verbatim}
 Arguments

 formula a symbolic description of the model to be fit. The RHS of the formula is applied to each linear predictor. The effect of different variables in each linear predictor can be controlled by specifying constraint matrices—see constraints below.

 family a function of class "vglmff" (see vglmff-class) describing what statistical model is to be fitted. This is called a "VGAM family function". See CommonVGAMffArguments for general information about many types of arguments found in this type of function. The argument name "family" is used loosely and for the ease of existing glm users; there is no concept of a formal “error distribution” for VGLMs. Possibly the argument name should be better "model" but unfortunately that name has already been taken.

 data an optional data frame containing the variables in the model. By default the variables are taken from environment(formula), typically the environment from which vglm is called.

 weights an optional vector or matrix of (prior fixed and known) weights to be used in the fitting process. If the VGAM family function handles multiple responses ($Q > 1$ of them, say) then weights can be a matrix with $Q$ columns. Each column matches the respective response. If it is a vector (the usually case) then it is recycled into a matrix with $Q$ columns. The values of weights must be positive; try setting a very small value such as 1.0e-8 to effectively delete an observation.

 Currently the weights argument supports sampling weights from complex sampling designs via svyVGAM. Some details can be found at https://CRAN.R-project.org/package=svyVGAM.

 subset an optional logical vector specifying a subset of observations to be used in the fitting process.

 na.action a function which indicates what should happen when the data contain NAs. The default is set by the na.action setting of options, and is na.fail if that is unset. The “factory-fresh” default is na.omit which is known as complete case analysis and applied to both sides of the formula.

 etastart optional starting values for the linear predictors. It is a $M$-column matrix with the same number of rows as the response. If $M = 1$ then it may be a vector. Note that etastart and the output of predict(fit) should be comparable. Here, fit is the fitted object. Almost all VGAM family functions are self-starting.

 mustart optional starting values for the fitted values. It can be a vector or a matrix; if a matrix, then it has the same number of rows as the response. Usually mustart and the output of fitted(fit) should be comparable. Most family functions do not make use of this argument because it is not possible to compute all $M$ columns of eta from mu.

 coefstart optional starting values for the coefficient vector. The length and order must match that of coef(fit).

 control a list of parameters for controlling the fitting process. See vglm.control for details.

 offset a vector or $M$-column matrix of offset values. These are a priori known and are added to the linear/additive predictors during fitting.
method the method to be used in fitting the model. The default (and presently only) method `vglm.fit()` uses iteratively reweighted least squares (IRLS).

model a logical value indicating whether the model frame should be assigned in the model slot.

x.arg, y.arg logical values indicating whether the LM matrix and response vector/matrix used in the fitting process should be assigned in the x and y slots. Note that the model matrix is the LM matrix; to get the VGLM matrix type `model.matrix(vglmfit)` where `vglmfit` is a vglm object.

contrasts an optional list. See the contrasts.arg of `model.matrix.default`.

constraints an optional list of constraint matrices. The components of the list must be named (labelled) with the term it corresponds to (and it must match in character format exactly—see below). There are two types of input: "lm"-type and "vlm"-type. The former is a subset of the latter. The former has a matrix for each term of the LM matrix. The latter has a matrix for each column of the big VLM matrix. After fitting, the `constraints` extractor function may be applied; it returns the "vlm"-type list of constraint matrices by default. If "lm"-type are returned by `constraints` then these can be fed into this argument and it should give the same model as before. If the `constraints` argument is used then the family function’s zero argument (if it exists) needs to be set to NULL. This avoids what could be a probable contradiction. Sometimes setting other arguments related to constraint matrices to `FALSE` is also a good idea, e.g., `parallel = FALSE`, `exchangeable = FALSE`.

Properties: each constraint matrix must have \( M \) rows, and be of full-column rank. By default, constraint matrices are the \( M \) by \( M \) identity matrix unless arguments in the family function itself override these values, e.g., `parallel` (see CommonVGAMffArguments). If constraints is used then it must contain all the terms; an incomplete list is not accepted.

As mentioned above, the labelling of each constraint matrix must match exactly, e.g., `list("s(x2, df=3)"=diag(2))` will fail as `as.character(~ s(x2, df=3))` produces white spaces: "s(x2, df = 3)". Thus `list("s(x2, df = 3)" = diag(2))` is needed. See Example 6 below. More details are given in Yee (2015: Section 3.3.1.3) which is on p.101. Note that the label for the intercept is "(Intercept)".

extra an optional list with any extra information that might be needed by the VGAM family function.

form2 the second (optional) formula. If argument xij is used (see `vglm.control`) then `form2` needs to have all terms in the model. Also, some VGAM family functions such as `micmen` use this argument to input the regressor variable. If given, the slots `@Xm2` and `@Ym2` may be assigned. Note that smart prediction applies to terms in `form2` too.

qr.arg logical value indicating whether the slot `qr`, which returns the QR decomposition of the VLM model matrix, is returned on the object.

smart logical value indicating whether smart prediction (smartpred) will be used.

... further arguments passed into `vglm.control`.
Details

A vector generalized linear model (VGLM) is loosely defined as a statistical model that is a function of \( M \) linear predictors and can be estimated by Fisher scoring. The central formula is given by

\[
\eta_j = \beta_j^T x
\]

where \( x \) is a vector of explanatory variables (sometimes just a 1 for an intercept), and \( \beta_j \) is a vector of regression coefficients to be estimated. Here, \( j = 1, \ldots, M \), where \( M \) is finite. Then one can write \( \eta = (\eta_1, \ldots, \eta_M)^T \) as a vector of linear predictors.

Most users will find vglm similar in flavour to glm. The function vglm.fit actually does the work.

Value

An object of class "vglm", which has the following slots. Some of these may not be assigned to save space, and will be recreated if necessary later.

- extra: the list extra at the end of fitting.
- family: the family function (of class "vglmff").
- iter: the number of IRLS iterations used.
- predictors: a \( M \)-column matrix of linear predictors.
- assign: a named list which matches the columns and the (LM) model matrix terms.
- call: the matched call.
- coefficients: a named vector of coefficients.
- constraints: a named list of constraint matrices used in the fitting.
- contrasts: the contrasts used (if any).
- control: list of control parameter used in the fitting.
- criterion: list of convergence criterion evaluated at the final IRLS iteration.
- df.residual: the residual degrees of freedom.
- df.total: the total degrees of freedom.
- dispersion: the scaling parameter.
- effects: the effects.
- fitted.values: the fitted values, as a matrix. This is often the mean but may be quantiles, or the location parameter, e.g., in the Cauchy model.
- misc: a list to hold miscellaneous parameters.
- model: the model frame.
- na.action: a list holding information about missing values.
- offset: if non-zero, a \( M \)-column matrix of offsets.
- post: a list where post-analysis results may be put.
- preplot: used by plotvgam, the plotting parameters may be put here.
- prior.weights: initially supplied weights (the weights argument). Also see weightsvglm.
- qr: the QR decomposition used in the fitting.
the R matrix in the QR decomposition used in the fitting.
rank numerical rank of the fitted model.
residuals the working residuals at the final IRLS iteration.
ResSS residual sum of squares at the final IRLS iteration with the adjusted dependent vectors and weight matrices.
smart.prediction a list of data-dependent parameters (if any) that are used by smart prediction.
terms the terms object used.
weights the working weight matrices at the final IRLS iteration. This is in matrix-band form.
x the model matrix (linear model LM, not VGLM).
xlevels the levels of the factors, if any, used in fitting.
y the response, in matrix form.

This slot information is repeated at vglm-class.

WARNING
See warnings in vglm.control. Also, see warnings under weights above regarding sampling weights from complex sampling designs.

Note
This function can fit a wide variety of statistical models. Some of these are harder to fit than others because of inherent numerical difficulties associated with some of them. Successful model fitting benefits from cumulative experience. Varying the values of arguments in the VGAM family function itself is a good first step if difficulties arise, especially if initial values can be inputted. A second, more general step, is to vary the values of arguments in vglm.control. A third step is to make use of arguments such as etastart, coefstart and mustart.

Some VGAM family functions end in "ff" to avoid interference with other functions, e.g., binomialff, poissonff. This is because VGAM family functions are incompatible with glm (and also gam() in gam and gam in the mgcv library).

The smart prediction (smartpred) library is incorporated within the VGAM library.
The theory behind the scaling parameter is currently being made more rigorous, but it should give the same value as the scale parameter for GLMs.

In Example 5 below, the xij argument to illustrate covariates that are specific to a linear predictor. Here, lop/rop are the ocular pressures of the left/right eye (artificial data). Variables leye and reye might be the presence/absence of a particular disease on the LHS/RHS eye respectively. See vglm.control and fill1 for more details and examples.

Author(s)
Thomas W. Yee
References


See Also

`vglm.control`, `vglm-class`, `vgmff-class`, `smartpred`, `vglm.fit`, `fill1`, `rrvglm`, `vgam`. Methods functions include `add1.vglm`, `anova.vglm`, `AICvlm`, `coefvlm`, `confintvglm`, `constraints.vlm`, `drop1.vglm`, `fittedvglm`, `hatvaluesvlm`, `hdeff.vglm`, `Influence.vglm`, `linkfunvlm`, `lrt.stat.vlm`, `score.stat.vlm`, `wald.stat.vlm`, `nobs.vlm`, `npred.vlm`, `plotvglm`, `predictvglm`, `residualsvglm`, `step4vglm`, `summaryvglm`, `lrtest_vglm`, `update`, `TypicalVGAMfamilyFunction`, etc.

Examples

```r
# Example 1. See help(glm)
(d.AD <- data.frame(treatment = gl(3, 3),
                    outcome = gl(3, 1, 9),
                    counts = c(18, 17, 15, 20, 10, 20, 25, 13, 12)))

vglm.D93 <- vglm(counts ~ outcome + treatment, poissonff,
                 data = d.AD, trace = TRUE)

summary(vglm.D93)

# Example 2. Multinomial logit model
pneumo <- transform(pneumo, let = log(exposure.time))

vglm(cbind(normal, mild, severe) ~ let, multinomial, pneumo)

# Example 3. Proportional odds model
fit3 <- vglm(cbind(normal, mild, severe) ~ let, propodds, pneumo)

coef(fit3, matrix = TRUE)

constraints(fit3)

model.matrix(fit3, type = "lm")  # LM model matrix

model.matrix(fit3)               # Larger VGLM (or VLM) matrix

# Example 4. Bivariate logistic model
fit4 <- vglm(cbind(nBnW, nBW, BnW, BW) ~ age, binom2.or, coalminers)

coef(fit4, matrix = TRUE)

depvar(fit4)  # Response are proportions

weights(fit4, type = "prior")
```
# Example 5. The use of the xij argument (simple case).
# The constraint matrix for 'op' has one column.
nn <- 1000
eyesdat <- round(data.frame(lop = runif(nn),
                          rop = runif(nn),
                          op = runif(nn)), digits = 2)
eyesdat <- transform(eyesdat, eta1 = -1 + 2 * lop,
                     eta2 = -1 + 2 * lop)
eyesdat <- transform(eyesdat,
                     leye = rbinom(nn, 1, prob = logitlink(eta1, inv = TRUE)),
                     reye = rbinom(nn, 1, prob = logitlink(eta2, inv = TRUE)))
head(eyesdat)
fit5 <- vglm(cbind(leye, reye) ~ op,
             binom2.or(exchangeable = TRUE, zero = 3),
             data = eyesdat, trace = TRUE,
             xij = list(op ~ lop + rop + fill1(lop)),
             form2 = ~ op + lop + rop + fill1(lop))
coef(fit5)
coef(fit5, matrix = TRUE)
constraints(fit5)
fit5@control$xij
head(model.matrix(fit5))

# Example 6. The use of the 'constraints' argument.
as.character(~ bs(year, df=3)) # Get the white spaces right
clist <- list("(Intercept)" = diag(3),
               "bs(year, df = 3)" = rbind(1, 0, 0))
fit1 <- vglm(r1 ~ bs(year, df=3), gev(zero = NULL),
             data = venice, constraints = clist, trace = TRUE)
coef(fit1, matrix = TRUE) # Check

vglm-class  

Class “vglm”

Description

Vector generalized linear models.

Objects from the Class

Objects can be created by calls of the form vglm(...).

Slots

In the following, M is the number of linear predictors.

extra: Object of class "list"; the extra argument on entry to vglm. This contains any extra
information that might be needed by the family function.
family: Object of class "vglmff". The family function.
iter: Object of class "numeric". The number of IRLS iterations used.
predictors: Object of class "matrix" with $M$ columns which holds the $M$ linear predictors.
assign: Object of class "list", from class "vlm". This named list gives information matching the columns and the (LM) model matrix terms.
call: Object of class "call", from class "vlm". The matched call.
coefficients: Object of class "numeric", from class "vlm". A named vector of coefficients.
constraints: Object of class "list", from class "vlm". A named list of constraint matrices used in the fitting.
contrasts: Object of class "list", from class "vlm". The contrasts used (if any).
control: Object of class "list", from class "vlm". A list of parameters for controlling the fitting process. See vglm.control for details.
criterion: Object of class "list", from class "vlm". List of convergence criterion evaluated at the final IRLS iteration.
df.residual: Object of class "numeric", from class "vlm". The residual degrees of freedom.
df.total: Object of class "numeric", from class "vlm". The total degrees of freedom.
dispersion: Object of class "numeric", from class "vlm". The scaling parameter.
effects: Object of class "numeric", from class "vlm". The effects.
fitted.values: Object of class "matrix", from class "vlm". The fitted values.
misc: Object of class "list", from class "vlm". A named list to hold miscellaneous parameters.
model: Object of class "data.frame", from class "vlm". The model frame.
na.action: Object of class "list", from class "vlm". A list holding information about missing values.
offset: Object of class "matrix", from class "vlm". If non-zero, a $M$-column matrix of offsets.
pupil: Object of class "list", from class "vlm" where post-analysis results may be put.
pseudo: Object of class "list", from class "vlm" used by plotvgam; the plotting parameters may be put here.
prior.weights: Object of class "matrix", from class "vlm" holding the initially supplied weights.
qr: Object of class "list", from class "vlm". QR decomposition at the final iteration.
R: Object of class "matrix", from class "vlm". The R matrix in the QR decomposition used in the fitting.
rank: Object of class "integer", from class "vlm". Numerical rank of the fitted model.
residuals: Object of class "matrix", from class "vlm". The working residuals at the final IRLS iteration.
ResSS: Object of class "numeric", from class "vlm". Residual sum of squares at the final IRLS iteration with the adjusted dependent vectors and weight matrices.
smart.prediction: Object of class "list", from class "vlm". A list of data-dependent parameters (if any) that are used by smart prediction.
terms: Object of class "list", from class "vlm". The terms object used.
weights: Object of class "matrix", from class "vlm". The weight matrices at the final IRLS iteration. This is in matrix-band form.
x: Object of class "matrix", from class "vlm". The model matrix (LM, not VGLM).
xlevels: Object of class "list", from class "vlm". The levels of the factors, if any, used in fitting.
y: Object of class "matrix", from class "vlm". The response, in matrix form.
Xm2: Object of class "matrix", from class "vlm". See vglm-class).
Ym2: Object of class "matrix", from class "vlm". See vglm-class).
callXm2: Object of class "call", from class "vlm". The matched call for argument form2.

Extends
Class "vlm", directly.

Methods

cdf signature(object = "vglm"): cumulative distribution function. Applicable to, e.g., quantile regression and extreme value data models.
deplot signature(object = "vglm"): Applicable to, e.g., quantile regression.
deviance signature(object = "vglm"): deviance of the model (where applicable).
plot signature(x = "vglm"): diagnostic plots.
predict signature(object = "vglm"): extract the linear predictors or predict the linear predictors at a new data frame.
print signature(x = "vglm"): short summary of the object.
qtplot signature(object = "vglm"): quantile plot (only applicable to some models).
residuals signature(object = "vglm"): residuals. There are various types of these.
residuals signature(object = "vglm"): residuals. Shorthand for resid.
rlplot signature(object = "vglm"): return level plot. Useful for extreme value data models.
summary signature(object = "vglm"): a more detailed summary of the object.

Author(s)

Thomas W. Yee

References


See Also

vglm, vglmff-class, vgam-class.
Examples

# Multinomial logit model
pneumo <- transform(pneumo, let = log(exposure.time))
vglm(cbind(normal, mild, severe) ~ let, multinomial, data = pneumo)

Description

Algorithmic constants and parameters for running `vglm` are set using this function.

Usage

```r
vglm.control(checkwz = TRUE, Check.rank = TRUE, Check.cm.rank = TRUE,
criterion = names(.min.criterion.VGAM),
epsilon = 1e-07, half.stepsizing = TRUE,
maxit = 30, noWarning = FALSE,
stepsize = 1, save.weights = FALSE,
trace = FALSE, wzepsilon = .Machine$double.eps^0.75,
xij = NULL, ...)
```

Arguments

- `checkwz`: logical indicating whether the diagonal elements of the working weight matrices should be checked whether they are sufficiently positive, i.e., greater than `wzepsilon`. If not, any values less than `wzepsilon` are replaced with this value.
- `Check.rank`: logical indicating whether the rank of the VLM matrix should be checked. If this is not of full column rank then the results are not to be trusted. The default is to give an error message if the VLM matrix is not of full column rank.
- `Check.cm.rank`: logical indicating whether the rank of each constraint matrix should be checked. If this is not of full column rank then an error will occur. Under no circumstances should any constraint matrix have a rank less than the number of columns.
- `criterion`: character variable describing what criterion is to be used to test for convergence. The possibilities are listed in `.min.criterion.VGAM`, but most family functions only implement a few of these.
- `epsilon`: positive convergence tolerance `epsilon`. Roughly speaking, the Newton-Raphson/Fisher-scoring iterations are assumed to have converged when two successive `criterion` values are within `epsilon` of each other.
- `half.stepsizing`: logical indicating if half-stepsizing is allowed. For example, in maximizing a log-likelihood, if the next iteration has a log-likelihood that is less than the current value of the log-likelihood, then a half step will be taken. If the log-likelihood is still less than at the current position, a quarter-step will be taken etc. Eventually a step will be taken so that an improvement is made to the convergence criterion. `half.stepsizing` is ignored if `criterion == "coefficients".`
maxit maximum number of (usually Fisher-scoring) iterations allowed. Sometimes Newton-Raphson is used.

noWarning logical indicating whether to suppress a warning if convergence is not obtained within maxit iterations. This is ignored if maxit = 1 is set.

stepsize usual step size to be taken between each Newton-Raphson/Fisher-scoring iteration. It should be a value between 0 and 1, where a value of unity corresponds to an ordinary step. A value of 0.5 means half-steps are taken. Setting a value near zero will cause convergence to be generally slow but may help increase the chances of successful convergence for some family functions.

save.weights logical indicating whether the weights slot of a "vglm" object will be saved on the object. If not, it will be reconstructed when needed, e.g., summary. Some family functions have save.weights = TRUE and others have save.weights = FALSE in their control functions.

trace logical indicating if output should be produced for each iteration. Setting trace = TRUE is recommended in general because VGAM fits a very broad variety of models and distributions, and for some of them, convergence is intrinsically more difficult. Monitoring convergence can help check that the solution is reasonable or that a problem has occurred. It may suggest better initial values are needed, the making of invalid assumptions, or that the model is inappropriate for the data, etc.

wzepsilon small positive number used to test whether the diagonals of the working weight matrices are sufficiently positive.

xij A list of formulas. Each formula has a RHS giving M terms making up a covariate-dependent term (whose name is the response). That is, it creates a variable that takes on different values for each linear/additive predictor, e.g., the ocular pressure of each eye. The M terms must be unique; use fill1, fill2, fill3, etc. if necessary. Each formula should have a response which is taken as the name of that variable, and the M terms are enumerated in sequential order. Each of the M terms multiply each successive row of the constraint matrix. When xij is used, the use of form2 is also required to give every term used by the model.

A formula or a list of formulas.

The function Select can be used to select variables beginning with the same character string.

... other parameters that may be picked up from control functions that are specific to the VGAM family function.

Details

Most of the control parameters are used within vglm.fit and you will have to look at that to understand the full details.

Setting save.weights = FALSE is useful for some models because the weights slot of the object is the largest and so less memory is used to store the object. However, for some VGAM family function, it is necessary to set save.weights = TRUE because the weights slot cannot be reconstructed later.
Value

A list with components matching the input names. A little error checking is done, but not much. The list is assigned to the control slot of vglm objects.

Warning

For some applications the default convergence criterion should be tightened. Setting something like criterion = "coef", epsilon = 1e-09 is one way to achieve this, and also add trace = TRUE to monitor the convergence. Setting maxit to some higher number is usually not needed, and needing to do so suggests something is wrong, e.g., an ill-conditioned model, over-fitting or under-fitting.

Note

Reiterating from above, setting trace = TRUE is recommended in general.

In Example 2 below there are two covariates that have linear/additive predictor specific values. These are handled using the xij argument.

Author(s)

Thomas W. Yee

References


See Also

vglm, TypicalVGAMfamilyFunction, fill1. The author's homepage has further documentation about the xij argument; see also Select.

Examples

# Example 1.
pneumo <- transform(pneumo, let = log(exposure.time))
vglm(cbind(normal, mild, severe) ~ let, multinomial, pneumo,
    crit = "coef", step = 0.5, trace = TRUE, epsil = 1e-8,
    maxit = 40)

# Example 2. The use of the xij argument (simple case).
ymat <- rdiric(n <- 1000, shape = rep(exp(2), len = 4))
mydat <- data.frame(x1 = runif(n), x2 = runif(n), x3 = runif(n),
    x4 = runif(n),
    z1 = runif(n), z2 = runif(n), z3 = runif(n),
    z4 = runif(n))
mydat <- transform(mydat, X = x1, Z = z1)
mydat <- round(mydat, digits = 2)
fit2 <- vglm(ymat ~ X + Z,
    dirichlet(parallel = TRUE), mydat, trace = TRUE,
xij = list(Z ~ z1 + z2 + z3 + z4,
           X ~ x1 + x2 + x3 + x4),
form2 = ~ Z + z1 + z2 + z3 + z4 +
           X + x1 + x2 + x3 + x4)
head(model.matrix(fit2, type = "lm")) # LM model matrix
head(model.matrix(fit2, type = "vlm")) # Big VLM model matrix
coef(fit2)
coef(fit2, matrix = TRUE)
max(abs(predict(fit2)-predict(fit2, new = mydat))) # Predicts ok
summary(fit2)
## Not run:
# plotvgam(fit2, se = TRUE, xlab = "x1", which.term = 1)  # Bug!
# plotvgam(fit2, se = TRUE, xlab = "z1", which.term = 2)  # Bug!
plotvgam(fit2, xlab = "x1")  # Correct
plotvgam(fit2, xlab = "z1")  # Correct
## End(Not run)

# Example 3. The use of the xij argument (complex case).
set.seed(123)
coalminers <-
  transform(coalminers,
    Age = (age - 42) / 5,
    dum1 = round(runif(nrow(coalminers)), digits = 2),
    dum2 = round(runif(nrow(coalminers)), digits = 2),
    dum3 = round(runif(nrow(coalminers)), digits = 2),
    dumm = round(runif(nrow(coalminers)), digits = 2))
BS <- function(x, ..., df = 3)
  sm.bs(c(x,...), df = df)[1:length(x),,drop = FALSE]
NS <- function(x, ..., df = 3)
  sm.ns(c(x,...), df = df)[1:length(x),,drop = FALSE]
# Equivalently...
BS <- function(x, ..., df = 3)
  head(sm.bs(c(x,...), df = df), length(x), drop = FALSE)
NS <- function(x, ..., df = 3)
  head(sm.ns(c(x,...), df = df), length(x), drop = FALSE)
fit3 <- vglm(cbind(nBnW,nBW,BnW,BW) ~ Age + NS(dum1, dum2),
           fam = binom2.or(exchangeable = TRUE, zero = 3),
           xij = list(NS(dum1, dum2) ~ NS(dum1, dum2) +
                      NS(dum2, dum1) +
                      fill1(NS( dum1))),
           form2 = ~ NS(dum1, dum2) + NS(dum2, dum1) +
                      fill1(NS(dum1)) +
                      dum1 + dum2 + dum3 + Age + age + dumm,
           data = coalminers, trace = TRUE)
head(model.matrix(fit3, type = "lm")) # LM model matrix
head(model.matrix(fit3, type = "vlm")) # Big VLM model matrix
coef(fit3)
coef(fit3, matrix = TRUE)
## Not run:
plotvgam(fit3, se = TRUE, lcol = 2, scol = 4, xlab = "dum1")

## End(Not run)

---

**Description**

Family functions for the **VGAM** package

**Objects from the Class**

Objects can be created by calls of the form `new("vglmff", ...).`

**Slots**

In the following, $M$ is the number of linear/additive predictors.

- `start1`: Object of class "expression" to insert code at a special position (the very start) in `vglm.fit` or `vgam.fit`.
- `blurb`: Object of class "character" giving a small description of the model. Important arguments such as parameter link functions can be expressed here.
- `charfun`: Object of class "function" which returns the characteristic function or variance function (usually for some GLMs only). The former uses a dummy variable $x$. Both use the linear/additive predictors. The function must have arguments `function(x, eta, extra = NULL, varfun = FALSE)`. The `eta` and `extra` arguments are used to obtain the parameter values. If `varfun = TRUE` then the function returns the variance function, else the characteristic function (default). Note that one should check that the `infos` slot has a list component called `charfun` which is `TRUE` before attempting to use this slot. This is an easier way to test that this slot is operable.
- `constraints`: Object of class "expression" which sets up any constraint matrices defined by arguments in the family function. A zero argument is always fed into `cm.zero.vgam`, whereas other constraints are fed into `cm.vgam`.
- `deviance`: Object of class "function" returning the deviance of the model. This slot is optional. If present, the function must have arguments `function(mu, y, w, residuals = FALSE, eta, extra = NULL)`. Deviance residuals are returned if `residuals = TRUE`.
- `rqresslot`: Object of class "function" returning the randomized quantile residuals of the distribution. This slot is optional. If present, the function must have arguments `function(mu, y, w, eta, extra = NULL).
- `fini1`: Object of class "expression" to insert code at a special position in `vglm.fit` or `vgam.fit`. This code is evaluated immediately after the fitting.
- `first`: Object of class "expression" to insert code at a special position in `vglm` or `vgam`.
- `infos`: Object of class "function" which returns a list with components such as $M_1$. At present only a very few **VGAM** family functions have this feature implemented. Those that do do not require specifying the $M_1$ argument when used with `rcim`. 
initialize: Object of class "expression" used to perform error checking (especially for the variable \( y \)) and obtain starting values for the model. In general, \( \text{etastart} \) or \( \text{mustart} \) are assigned values based on the variables \( y, x \) and \( w \).

linkinv: Object of class "function" which returns the fitted values, given the linear/additive predictors. The function must have arguments \( \text{function}(\eta, \text{extra} = \text{NULL}) \).

last: Object of class "expression" to insert code at a special position (at the very end) of \( \text{vglm.fit()} \) or \( \text{vgam.fit()} \). This code is evaluated after the fitting. The list \( \text{misc} \) is often assigned components in this slot, which becomes the \( \text{misc} \) slot on the fitted object.

linkfun: Object of class "function" which, given the fitted values, returns the linear/additive predictors. If present, the function must have arguments \( \text{function}(\mu, \text{extra} = \text{NULL}) \). Most \text{VGAM} family functions do not have a \( \text{linkfun} \) function. They largely are for classical exponential families, i.e., GLMs.

loglikelihood: Object of class "function" returning the log-likelihood of the model. This slot is optional. If present, the function must have arguments \( \text{function}(\mu, y, w, \text{residuals} = \text{FALSE}, \eta, \text{extra} = \text{NULL}) \). The argument \( \text{residuals} \) can be ignored because log-likelihood residuals aren’t defined.

middle1: Object of class "expression" to insert code at a special position in \( \text{vglm.fit} \) or \( \text{vgam.fit} \).

middle2: Object of class "expression" to insert code at a special position in \( \text{vglm.fit} \) or \( \text{vgam.fit} \).

simslot: Object of class "function" to allow \text{simulate} to work.

hadof: Object of class "function"; experimental.

summary.dispersion: Object of class "logical" indicating whether the general VGLM formula (based on a residual sum of squares) can be used for computing the scaling/dispersion parameter. It is \text{TRUE} for most models except for nonlinear regression models.

vfamily: Object of class "character" giving class information about the family function. Although not developed at this stage, more flexible classes are planned in the future. For example, family functions \texttt{sratio}, \texttt{cratio}, \texttt{cumulative}, and \texttt{acat} all operate on categorical data, therefore will have a special class called "\text{VGAMcat}"", say. Then if \( \text{fit} \) was a \texttt{vglm} object, then \( \text{coef(fit)} \) would print out the \texttt{vglm} coefficients plus "\text{VGAMcat}" information as well.

deriv: Object of class "expression" which returns a \( M \)-column matrix of first derivatives of the log-likelihood function with respect to the linear/additive predictors, i.e., the score vector. In \text{Yee and Wild (1996)} this is the \( d_i \) vector. Thus each row of the matrix returned by this slot is such a vector.

weight: Object of class "expression" which returns the second derivatives of the log-likelihood function with respect to the linear/additive predictors. This can be either the observed or expected information matrix, i.e., Newton-Raphson or Fisher-scoring respectively. In \text{Yee and Wild (1996)} this is the \( W_i \) matrix. Thus each row of the matrix returned by this slot is such a matrix. Like the \text{weights} slot of \texttt{vglm/vgam}, it is stored in \text{matrix-band} form, whereby the first \( M \) columns of the matrix are the diagonals, followed by the upper-diagonal band, followed by the band above that, etc. In this case, there can be up to \( M(M+1) \) columns, with the last column corresponding to the \((1,M)\) elements of the weight matrices.

validfitted, validparams: Functions that test that the fitted values and all parameters are within range. These functions can issue a warning if violations are detected.

Methods

\texttt{print signature(x = "vglmff")}: short summary of the family function.
Warning

VGAM family functions are not compatible with glm, nor gam() (from either gam or mgcv).

Note

With link functions etc., one must use substitute to embed the options into the code. There are two different forms: eval(substitute(expression({...}), list(...))) for expressions, and eval(substitute( function(...) { ... }, list(...))) for functions.

The extra argument in linkinv, linkfun, deviance, loglikelihood, etc. matches with the argument extra in vglm, vgam and rrvglm. This allows input to be fed into all slots of a VGAM family function.

The expression derivative is evaluated immediately prior to weight, so there is provision for re-use of variables etc. Programmers must be careful to choose variable names that do not interfere with vglm.fit, vgam.fit() etc.

Programmers of VGAM family functions are encouraged to keep to previous conventions regarding the naming of arguments, e.g., link is the argument for parameter link functions, zero for allowing some of the linear/additive predictors to be an intercept term only, etc.

In general, Fisher-scoring is recommended over Newton-Raphson where tractable. Although usually slightly slower in convergence, the weight matrices from using the expected information are positive-definite over a larger parameter space.

Author(s)

Thomas W. Yee

References


See Also

vglm, vgam, rrvglm, rcim.

Examples

cratio()
cratio(link = "clogloglink")
cratio(link = "clogloglink", reverse = TRUE)
Description

Estimates the location and scale parameters of the von Mises distribution by maximum likelihood estimation.

Usage

\[
\text{vonmises}(llocation = \text{extlogitlink}(\text{min} = 0, \text{max} = 2\pi), \\
lscale = "\text{loglink}", ilocation = \text{NULL}, iscale = \text{NULL}, \\
imethod = 1, \text{zero = NULL})
\]

Arguments

- \(llocation, lscale\): Parameter link functions applied to the location \(a\) parameter and scale parameter \(k\), respectively. See Links for more choices. For \(k\), a log link is the default because the parameter is positive.
- \(ilocation\): Initial value for the location \(a\) parameter. By default, an initial value is chosen internally using \(imethod\). Assigning a value will override the argument \(imethod\).
- \(iscale\): Initial value for the scale \(k\) parameter. By default, an initial value is chosen internally using \(imethod\). Assigning a value will override the argument \(imethod\).
- \(imethod\): An integer with value 1 or 2 which specifies the initialization method. If failure to converge occurs try the other value, or else specify a value for \(ilocation\) and \(iscale\).
- \(zero\): An integer-valued vector specifying which linear/additive predictors are modelled as intercepts only. The default is none of them. If used, one can choose one value from the set \{1,2\}. See CommonVGAMffArguments for more information.

Details

The (two-parameter) von Mises is the most commonly used distribution in practice for circular data. It has a density that can be written as

\[
f(y; a, k) = \frac{\exp[k \cos(y - a)]}{2\pi I_0(k)}
\]

where \(0 \leq y < 2\pi, k > 0\) is the scale parameter, \(a\) is the location parameter, and \(I_0(k)\) is the modified Bessel function of order 0 evaluated at \(k\). The mean of \(Y\) (which is the fitted value) is \(a\) and the circular variance is \(1 - I_1(k)/I_0(k)\) where \(I_1(k)\) is the modified Bessel function of order 1. By default, \(\eta_1 = \log(a/(2\pi - a))\) and \(\eta_2 = \log(k)\) for this family function.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, rrvglm and vgam.

Warning

Numerically, the von Mises can be difficult to fit because of a log-likelihood having multiple maxima. The user is therefore encouraged to try different starting values, i.e., make use of ilocation and iscale.

Note

The response and the fitted values are scaled so that $0 \leq y < 2\pi$. The linear/additive predictors are left alone. Fisher scoring is used.

Author(s)

T. W. Yee

References


See Also

Bessel, cardioid.

CircStats and circular currently have a lot more R functions for circular data than the VGAM package.

Examples

vdata <- data.frame(x2 = runif(nn <- 1000))
vdata <- transform(vdata,
    y = rnorm(nn, 2+x2, exp(0.2))) # Bad data!!
fit <- vglm(y ~ x2, vonmises(zero = 2), vdata, trace = TRUE)
coef(fit, matrix = TRUE)
Coef(fit)
with(vdata, range(y)) # Original data
range(depvar(fit)) # Processed data is in [0,2*pi)
**vplot.profile**

*Plotting Functions for 'profile' Objects*

**Description**

`plot` and `pairs` methods for objects of class "profile", but renamed as `vplot` and `vpairs`.

**Usage**

```r
vplot.profile(x, ...)
vpairs.profile(x, colours = 2:3, ...)
```

**Arguments**

- `x` an object inheriting from class "profile".
- `colours` Colours to be used for the mean curves conditional on `x` and `y` respectively.
- `...` arguments passed to or from other methods.

**Details**

See `profile.glm` for details.

**Author(s)**

T. W. Yee adapted this function from `profile.glm`, written originally by D. M. Bates and W. N. Venables. (For S in 1996.)

**See Also**

`profilevglm`, `confintvglm`, `lrt.stat`, `profile glm`, `profile.nls`.

**Examples**

```r
pneumo <- transform(pneumo, let = log(exposure.time))
fit1 <- vglm(cbind(normal, mild, severe) ~ let, acat,
             trace = TRUE, data = pneumo)
pfit1 <- profile(fit1, trace = FALSE)
## Not run:
vplot.profile(pfit1)
vpairs.profile(pfit1)
## End(Not run)
```
vsmooth.spline

Vector Cubic Smoothing Spline

Description

Fits a vector cubic smoothing spline.

Usage

vsmooth.spline(x, y, w = NULL, df = rep(5, M), spar = NULL,
                i.constraint = diag(M),
                x.constraint = diag(M),
                constraints = list("(Intercepts)" = i.constraint,
                                   x = x.constraint),
                all.knots = FALSE, var.arg = FALSE, scale.w = TRUE,
                nk = NULL, control.spar = list())

Arguments

x
A vector, matrix or a list. If a list, the x component is used. If a matrix, the first column is used. x may also be a complex vector, in which case the real part is used, and the imaginary part is used for the response. In this help file, n is the number of unique values of x.

y
A vector, matrix or a list. If a list, the y component is used. If a matrix, all but the first column is used. In this help file, M is the number of columns of y if there are no constraints on the functions.

w
The weight matrices or the number of observations. If the weight matrices, then this must be a n-row matrix with the elements in matrix-band form (see iam). If a vector, then these are the number of observations. By default, w is the M by M identity matrix, denoted by matrix(1, n, M).

df
Numerical vector containing the degrees of freedom for each component function (smooth). If necessary, the vector is recycled to have length equal to the number of component functions to be estimated (M if there are no constraints), which equals the number of columns of the x-constraint matrix. A value of 2 means a linear fit, and each element of df should lie between 2 and n. The larger the values of df the more wiggly the smooths.

spar
Numerical vector containing the non-negative smoothing parameters for each component function (smooth). If necessary, the vector is recycled to have length equal to the number of component functions to be estimated (M if there are no constraints), which equals the number of columns of the x-constraint matrix. A value of zero means the smooth goes through the data and hence is wiggly. A value of Inf may be assigned, meaning the smooth will be linear. By default, the NULL value of spar means df is used to determine the smoothing parameters.

all.knots
 Logical. If TRUE then each distinct value of x will be a knot. By default, only a subset of the unique values of x are used; typically, the number of knots is $O(n^{0.25})$ for n large, but if $n \leq 40$ then all the unique values of x are used.
i.constraint  A $M$-row constraint matrix for the intercepts. It must be of full column rank. By default, the constraint matrix for the intercepts is the $M$ by $M$ identity matrix, meaning no constraints.

x.constraint  A $M$-row constraint matrix for $x$. It must be of full column rank. By default, the constraint matrix for the intercepts is the $M$ by $M$ identity matrix, meaning no constraints.

constraints  An alternative to specifying i.constraint and x.constraint, this is a list with two components corresponding to the intercept and $x$ respectively. They must both be a $M$-row constraint matrix with full column rank.

var.arg  Logical: return the pointwise variances of the fit? Currently, this corresponds only to the nonlinear part of the fit, and may be wrong.

scale.w  Logical. By default, the weights $w$ are scaled so that the diagonal elements have mean 1.

rk  Number of knots. If used, this argument overrides all.knots, and must lie between 6 and $n+2$ inclusive.

control.spar  See smooth.spline.

Details

The algorithm implemented is detailed in Yee (2000). It involves decomposing the component functions into a linear and nonlinear part, and using B-splines. The cost of the computation is $O(nM^3)$.

The argument spar contains scaled smoothing parameters.

Value

An object of class "vsmooth.spline" (see vsmooth.spline-class).

WARNING

See vgam for information about an important bug.

Note

This function is quite similar to smooth.spline but offers less functionality. For example, cross validation is not implemented here. For $M=1$, the results will be generally different, mainly due to the different way the knots are selected.

The vector cubic smoothing spline which $s()$ represents is computationally demanding for large $M$. The cost is approximately $O(nM^3)$ where $n$ is the number of unique abscissae.

Yet to be done: return the unscaled smoothing parameters.

Author(s)

Thomas W. Yee
References


See Also

vsmooth.spline-class, plot.vsmooth.spline, predict.vsmooth.spline, iam, sm.os, s, smooth.spline.

Examples

nn <- 20; x <- 2 + 5*(nn:1)/nn
y1 <- sin(x) + rnorm(nn, sd = 0.13)
y2 <- cos(x) + rnorm(nn, sd = 0.13)
y3 <- 1 + sin(x) + rnorm(nn, sd = 0.13)  # For constraints
y <- cbind(y1, y2, y3)
ww <- cbind(rep(3, nn), 4, (1:nn)/nn)

(fit <- vsmooth.spline(x, y, w = ww, df = 5))
## Not run:
plot(fit)  # The 1st & 3rd functions dont differ by a constant
## End(Not run)

mat <- matrix(c(1,0,1, 0,1,0), 3, 2)
(fit2 <- vsmooth.spline(x, y, w = ww, df = 5, i.constr = mat, x.constr = mat))
# The 1st and 3rd functions do differ by a constant:
mycols <- c("orange", "blue", "orange")  
## Not run:  plot(fit2, lcol = mycols, pcol = mycols, las = 1)

p <- predict(fit, x = model.matrix(fit, type = "lm"), deriv = 0)
max(abs(depvar(fit) - with(p, y))) # Should be 0

par(mfrow = c(3, 1))
ux <- seq(1, 8, len = 100)
for (dd in 1:3) {
  pp <- predict(fit, x = ux, deriv = dd)
  # Not run:
  with(pp, matplot(x, y, type = "l", main = paste("deriv =", dd),
  lwd = 2, ylab = "", cex.axis = 1.5, cex.lab = 1.5, cex.main = 1.5))
  # End(Not run)
}

waitakere 887

waitakere  Waitakere Ranges Data
Description

The waitakere data frame has 579 rows and 18 columns. Altitude is explanatory, and there are binary responses (presence/absence = 1/0 respectively) for 17 plant species.

Usage

data(waitakere)

Format

This data frame contains the following columns:

- agaaus  Agathis australis, or Kauri
-beitaw  Beilschmiedia tawa, or Tawa
-corlae  Corynocarpus laevigatus
-cyadea  Cyathea dealbata
-cyamed  Cyathea medullaris
-daccup  Dacrydium cupressinum
-dacdac  Dacrycarpus dacrydioides
-eladen  Elaecarpus dentatus
-hedarb  Hedycarya arborea
-holhpop  Species name unknown
-kniexc  Knightia excelsa, or Rewarewa
-kneri  Kunzea ericoides
-lepsco  Leptospermum scoparium
-metrob  Metrosideros robusta
-neslan  Nestegis lanceolata
-rhosap  Rhopalostylis sapida
-vitluc  Vitex lucens, or Puriri
-altitude  meters above sea level

Details

These were collected from the Waitakere Ranges, a small forest in northern Auckland, New Zealand. At 579 sites in the forest, the presence/absence of 17 plant species was recorded, as well as the altitude. Each site was of area size 200m².

Source

Dr Neil Mitchell, University of Auckland.

See Also

hunua.
Examples

```r
fit <- vgam(gaaus ~ s(altitude, df = 2), binomialff, waitakere)
head(predict(fit, waitakere, type = "response"))
## Not run: plot(fit, se = TRUE, lcol = "orange", scol = "blue")
```

---

wald.stat

**Wald Test Statistics Evaluated at the Null Values**

**Description**

Generic function that computes Wald test statistics evaluated at the null values (consequently they do not suffer from the Hauck-Donner effect).

**Usage**

```r
wald.stat(object, ...)
wald.stat.vlm(object, values0 = 0, subset = NULL, omit1s = TRUE,
   all.out = FALSE, orig.SE = FALSE, iterate.SE = TRUE,
   trace = FALSE, ...)
```

**Arguments**

- `object`: A `vglm` fit.
- `values0`: Numeric vector. The null values corresponding to the null hypotheses. Recycled if necessary.
- `subset`: Same as in `hdeff`.
- `omit1s`: Logical. Does one omit the intercepts? Because the default would be to test that each intercept is equal to 0, which often does not make sense or is unimportant, the intercepts are not tested by default. If they are tested then each linear predictor must have at least one coefficient (from another variable) to be estimated.
- `all.out`: Logical. If `TRUE` then a list is returned containing various quantities such as the SEs, instead of just the Wald statistics.
- `orig.SE`: Logical. If `TRUE` then the standard errors are computed at the MLE (of the original object). In practice, the (usual or unmodified) Wald statistics etc. are extracted from `summary(object)` because it was computed there. These may suffer from the HDE since all the SEs are evaluated at the MLE of the original object. If `TRUE` then argument `iterate.SE` may be ignored or overwritten. If `orig.SE = FALSE` then the kth SE uses the kth value of `values0` in its computation and `iterate.SE` specifies the choice of the other coefficients.

This argument was previously called as `summary` because if `TRUE` then the Wald statistics are the same as `summary(glm())`.

For one-parameter models setting `orig.SE = FALSE` results in what is called the *null Wald* (NW) statistic by some people, e.g., Laskar and King (1997) and Goh and King (1999). The NW statistic does not suffer from the HDE.
iterate.SE Logical, for the standard error computations. If TRUE then IRLS iterations are performed to get MLEs of the other regression coefficients, subject to one coefficient being equal to the appropriate values0 value. If FALSE then the other regression coefficients have values obtained at the original fit. It is recommended that a TRUE be used as the answer tends to be more accurate. If the large (VLM) model matrix only has one column and iterate.SE = TRUE then an error will occur because there are no other regression coefficients to estimate.

trace Logical. If TRUE then some output is produced as the IRLS iterations proceed. The value NULL means to use the trace value of the fitted object; see vglm.control.

... Ignored for now.

Details

By default, summaryvglm and most regression modelling functions such as summary.glm compute all the standard errors (SEs) of the estimates at the MLE and not at 0. This corresponds to orig.SE = TRUE and it is vulnerable to the Hauck-Donner effect (HDE; see hdeff). One solution is to compute the SEs at 0 (or more generally, at the values of the argument values0). This function does that. The two variants of Wald statistics are asymptotically equivalent; however in small samples there can be an appreciable difference, and the difference can be large if the estimates are near to the boundary of the parameter space.

None of the tests here are joint, hence the degrees of freedom is always unity. For a factor with more than 2 levels one can use anova.vglm to test for the significance of the factor. If orig.SE = FALSE and iterate.SE = FALSE then one retains the MLEs of the original fit for the values of the other coefficients, and replaces one coefficient at a time by the value 0 (or whatever specified by values0). One alternative would be to recompute the MLEs of the other coefficients after replacing one of the values; this is the default because iterate.SE = TRUE and orig.SE = FALSE. Just like with the original IRLS iterations, the iterations here are not guaranteed to converge.

Almost all VGAM family functions use the EIM and not the OIM; this affects the resulting standard errors. Also, regularity conditions are assumed for the Wald, likelihood ratio and score tests; some VGAM family functions such as alaplace1 are experimental and do not satisfy such conditions, therefore naive inference is hazardous.

The default output of this function can be seen by setting wald0.arg = TRUE in summaryvglm.

Value

By default the signed square root of the Wald statistics whose SEs are computed at one each of the null values. If all.out = TRUE then a list is returned with the following components: wald.stat the Wald statistic, SE0 the standard error of that coefficient, values0 the null values. Approximately, the default Wald statistics output are standard normal random variates if each null hypothesis is true.

Altogether, by the four combinations of iterate.SE and orig.SE, there are three different variants of the Wald statistic that can be returned.

Warning

This function has been tested but not thoroughly. Convergence failure is possible for some models applied to certain data sets; it is a good idea to set trace = TRUE to monitor convergence. For
example, for a particular explanatory variable, the estimated regression coefficients of a non-parallel cumulative logit model (see cumulative) are ordered, and perturbing one coefficient might disrupt the order and create numerical problems.

Author(s)

Thomas W. Yee

References


See Also

`lrt.stat`, `score.stat`, `summaryvglm`, `summary.glm`, `anova.vglm`, `vglm`, `hdeff`, `hdeffsev`.

Examples

```r
set.seed(1)
pneumo <- transform(pneumo, let = log(exposure.time),
                    x3 = rnorm(nrow(pneumo)))
(fit <- vglm(cbind(normal, mild, severe) ~ let + x3, propodds, pneumo))
wald.stat(fit) # No HDE here
summary(fit, wald0 = TRUE) # See them here
coef(summary(fit)) # Usual Wald statistics evaluated at the MLE
wald.stat(fit, orig.SE = TRUE) # Same as previous line
```

---

**waldff**  
*Wald Distribution Family Function*

**Description**

Estimates the parameter of the standard Wald distribution by maximum likelihood estimation.

**Usage**

```r
waldff(llambda = "loglink", ilambda = NULL)
```

**Arguments**

`llambda`, `ilambda`

See [CommonVGAMffArguments](#) for information.
Details

The standard Wald distribution is a special case of the inverse Gaussian distribution with \( \mu = 1 \). It has a density that can be written as

\[
f(y; \lambda) = \sqrt{\frac{\lambda}{2\pi y^3}} \exp\left(-\frac{\lambda(y-1)^2}{2y}\right)
\]

where \( y > 0 \) and \( \lambda > 0 \). The mean of \( Y \) is 1 (returned as the fitted values) and its variance is \( 1/\lambda \). By default, \( \eta = \log(\lambda) \).

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

The VGAM family function inv.gaussianff estimates the location parameter \( \mu \) too.

Author(s)

T. W. Yee

References


See Also

inv.gaussianff, rinv.gaussian.

Examples

```r
wdata <- data.frame(y = rinv.gaussian(1000, mu = 1, exp(1)))
wfit <- vglm(y ~ 1, waldff(ilambda = 0.2), wdata, trace = TRUE)
coef(wfit, matrix = TRUE)
Coef(wfit)
summary(wfit)
```

---

weibull.mean  Weibull Distribution Family Function, Parameterized by the Mean

Description

Maximum likelihood estimation of the 2-parameter Weibull distribution. The mean is one of the parameters. No observations should be censored.
Usage

weibull.mean(lmean = "loglink", lshape = "loglink",
    imean = NULL, ishape = NULL, probs.y = c(0.2, 0.5, 0.8),
    imethod = 1, zero = "shape")

Arguments

lmean, lshape Parameter link functions applied to the (positive) mean parameter (called \( \mu \) below) and (positive) shape parameter (called \( a \) below). See \texttt{Links} for more choices.

imean, ishape Optional initial values for the mean and shape parameters.
imethod, zero, probs.y Details at \texttt{CommonVGAMffArguments}.

Details

See \texttt{weibullR} for most of the details for this family function too. The mean of \( Y \) is \( b \Gamma(1 + 1/a) \) (returned as the fitted values), and this is the first parameter (a \texttt{loglink} link is the default because it is positive). The other parameter is the positive shape parameter \( a \), also having a default \texttt{loglink} link.

This \texttt{VGAM} family function currently does not handle censored data. Fisher scoring is used to estimate the two parameters. Although the expected information matrices used here are valid in all regions of the parameter space, the regularity conditions for maximum likelihood estimation are satisfied only if \( a > 2 \) (according to Kleiber and Kotz (2003)). If this is violated then a warning message is issued. One can enforce \( a > 2 \) by choosing \texttt{lshape = logofflink(offset = -2)}. Common values of the shape parameter lie between 0.5 and 3.5.

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Note

See \texttt{weibullR} for more details. This \texttt{VGAM} family function handles multiple responses.

Author(s)

T. W. Yee

See Also

\texttt{weibullR, dweibull, truncweibull, gev, lognormal, expexpff, maxwell, rayleigh, gumbelIII}. 
Examples

```r
wdata <- data.frame(x2 = runif(nn <- 1000)) # Complete data
wdata <- transform(wdata, mu = exp(-1 + 1 * x2),
                   x3 = rnorm(nn),
                   shape1 = exp(1),
                   shape2 = exp(2))

wdata <- transform(wdata,
                   y1 = rweibull(nn, shape1, scale = mu / gamma(1 + 1/shape1)),
                   y2 = rweibull(nn, shape2, scale = mu / gamma(1 + 1/shape2)))
fit <- vglm(cbind(y1, y2) ~ x2 + x3, weibull.mean, wdata,
           trace = TRUE)
coef(fit, matrix = TRUE)
sqrt(diag(vcov(fit))) # SEs
summary(fit, presid = FALSE)
```

WeibullR

Weibull Distribution Family Function

Description

Maximum likelihood estimation of the 2-parameter Weibull distribution. No observations should be censored.

Usage

```r
weibullR(lscale = "loglink", lshape = "loglink",
         iscale = NULL, ishape = NULL, lss = TRUE, nrfs = 1,
         probs.y = c(0.2, 0.5, 0.8), imethod = 1, zero = "shape")
```

Arguments

- `lshape, lscale`: Parameter link functions applied to the (positive) shape parameter (called \(a\) below) and (positive) scale parameter (called \(b\) below). See Links for more choices.
- `ishape, iscale`: Optional initial values for the shape and scale parameters.
- `nrfs`: Currently this argument is ignored. Numeric, of length one, with value in [0, 1]. Weighting factor between Newton-Raphson and Fisher scoring. The value 0 means pure Newton-Raphson, while 1 means pure Fisher scoring. The default value uses a mixture of the two algorithms, and retaining positive-definite working weights.
- `imethod`: Initialization method used if there are censored observations. Currently only the values 1 and 2 are allowed.
- `zero, probs.y, lss`: Details at CommonVGAMffArguments.
Details

The Weibull density for a response \( Y \) is

\[
  f(y; a, b) = ay^{a-1} \exp[-(y/b)^a]/(b^a)
\]

for \( a > 0, b > 0, y > 0 \). The cumulative distribution function is

\[
  F(y; a, b) = 1 - \exp[-(y/b)^a].
\]

The mean of \( Y \) is \( b \Gamma(1 + 1/a) \) (returned as the fitted values), and the mode is at \( b(1 - 1/a)^{1/a} \) when \( a > 1 \). The density is unbounded for \( a < 1 \). The \( k \)th moment about the origin is \( E(Y^k) = b^k \Gamma(1 + k/a) \). The hazard function is \( a^{a-1}/b^a \).

This \texttt{VGAM} family function currently does not handle censored data. Fisher scoring is used to estimate the two parameters. Although the expected information matrices used here are valid in all regions of the parameter space, the regularity conditions for maximum likelihood estimation are satisfied only if \( a > 2 \) (according to Kleiber and Kotz (2003)). If this is violated then a warning message is issued. One can enforce \( a > 2 \) by choosing \texttt{lshape = logofflink(offset = -2)}.

Common values of the shape parameter lie between 0.5 and 3.5.

Summarized in Harper et al. (2011), for inference, there are 4 cases to consider. If \( a \leq 1 \) then the MLEs are not consistent (and the smallest observation becomes a hyperefficient solution for the location parameter in the 3-parameter case). If \( 1 < a < 2 \) then MLEs exist but are not asymptotically normal. If \( a = 2 \) then the MLEs exist and are normal and asymptotically efficient but with a slower convergence rate than when \( a > 2 \). If \( a > 2 \) then MLEs have classical asymptotic properties.

The 3-parameter (location is the third parameter) Weibull can be estimated by maximizing a profile log-likelihood (see, e.g., Harper et al. (2011) and Lawless (2003)), else try \texttt{gev} which is a better parameterization.

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

Warning

This function is under development to handle other censoring situations. The version of this function which will handle censored data will be called \texttt{cenweibull()}\footnote{This implementation is currently being written and will use \texttt{SurvS4} as input. It should be released in later versions of \texttt{VGAM}.}. If the shape parameter is less than two then misleading inference may result, e.g., in the \texttt{summary} and \texttt{vcov} of the object.

Note

Successful convergence depends on having reasonably good initial values. If the initial values chosen by this function are not good, make use the two initial value arguments.

This \texttt{VGAM} family function handles multiple responses.

The Weibull distribution is often an alternative to the lognormal distribution. The inverse Weibull distribution, which is that of \( 1/Y \) where \( Y \) has a Weibull\((a, b)\) distribution, is known as the log-Gompertz distribution.
There are problems implementing the three-parameter Weibull distribution. These are because the classical regularity conditions for the asymptotic properties of the MLEs are not satisfied because the support of the distribution depends on one of the parameters.

Other related distributions are the Maxwell and Rayleigh distributions.

Author(s)

T. W. Yee

References


See Also

`weibullR`, `weibull.mean`, `dweibull`, `truncweibull`, `gev`, `lognormal`, `expexpff`, `maxwell`, `rayleigh`, `gumbelII`.

Examples

```r
wdata <- data.frame(x2 = runif(nn <- 1000)) # Complete data
wdata <- transform(wdata,
  y1 = rweibull(nn, exp(1), scale = exp(-2 + x2)),
  y2 = rweibull(nn, exp(2), scale = exp(1 - x2)))
fit <- vglm(cbind(y1, y2) ~ x2, weibullR, wdata, trace = TRUE)
coef(fit, matrix = TRUE)
vcov(fit)
summary(fit)
```
weightsvglm

Prior and Working Weights of a VGLM fit

Description

Returns either the prior weights or working weights of a VGLM object.

Usage

weightsvglm(object, type = c("prior", "working"),
            matrix.arg = TRUE, ignore.slot = FALSE,
            deriv.arg = FALSE, ...)

Arguments

- **object**: a model object from the VGAM R package that inherits from a vector generalized linear model (VGLM), e.g., a model of class "vglm".
- **type**: Character, which type of weight is to be returned? The default is the first one.
- **matrix.arg**: Logical, whether the answer is returned as a matrix. If not, it will be a vector.
- **ignore.slot**: Logical. If TRUE then object@weights is ignored even if it has been assigned, and the long calculation for object@weights is repeated. This may give a slightly different answer because of the final IRLS step at convergence may or may not assign the latest value of quantities such as the mean and weights.
- **deriv.arg**: Logical. If TRUE then a list with components deriv and weights is returned. See below for more details.
- **...**: Currently ignored.

Details

Prior weights are usually inputted with the weights argument in functions such as vglm and vgam. It may refer to frequencies of the individual data or be weight matrices specified beforehand.

Working weights are used by the IRLS algorithm. They correspond to the second derivatives of the log-likelihood function with respect to the linear predictors. The working weights correspond to positive-definite weight matrices and are returned in matrix-band form, e.g., the first $M$ columns correspond to the diagonals, etc.

If one wants to perturb the linear predictors then the fitted.values slots should be assigned to the object before calling this function. The reason is that, for some family functions, the variable mu is used directly as one of the parameter estimates, without recomputing it from eta.

Value

If type = "working" and deriv = TRUE then a list is returned with the two components described below. Otherwise the prior or working weights are returned depending on the value of type.
Typically the first derivative of the log-likelihood with respect to the linear predictors. For example, this is the variable deriv.mu in vglm.fit(), or equivalently, the matrix returned in the "deriv" slot of a VGAM family function.

weights The working weights.

Note
This function is intended to be similar to weights.glm (see glm).

Author(s)
Thomas W. Yee

See Also
glm, vglmff-class, vglm.

Examples
pneumo <- transform(pneumo, let = log(exposure.time))
(fit <- vglm(cbind(normal, mild, severe) ~ let,
    cumulative(parallel = TRUE, reverse = TRUE), pneumo))
depvar(fit) # These are sample proportions
weights(fit, type = "prior", matrix = FALSE) # No. of observations

# Look at the working residuals
nn <- nrow(model.matrix(fit, type = "lm"))
M <- ncol(predict(fit))
wwt <- weights(fit, type="working", deriv=TRUE) # Matrix-band format
wz <- m2a(wwt$weights, M = M) # In array format
wzinv <- array(apply(wz, 3, solve), c(M, M, nn))
wwt <- weights(fit, type="working", deriv=TRUE) # Matrix-band format
wz <- m2a(wwt$weights, M = M) # In array format
wzinv <- array(apply(wz, 3, solve), c(M, M, nn))
wwt <- weights(fit, type="working", deriv=TRUE) # Matrix-band format
wz <- m2a(wwt$weights, M = M) # In array format
wzinv <- array(apply(wz, 3, solve), c(M, M, nn))

for (ii in 1:nn)
    wresid[ii, ] <- wzinv[, , ii, drop = TRUE] %*% wwt$deriv[ii, ]
max(abs(c(resid(fit, type = "work")) - c(wresid))) # Should be 0

(zedd <- predict(fit) + wresid) # Adjusted dependent vector

wine

Bitterness in Wine Data

Description
This oenological data frame concerns the amount of bitterness in 78 bottles of white wine.

Usage
data(wine)
Format

A data frame with 4 rows on the following 7 variables.

- **temp**: temperature, with levels cold and warm.
- **contact**: whether contact of the juice with the skin was allowed or avoided, for a specified period. Two levels: no or yes.
- **bitter1, bitter2, bitter3, bitter4, bitter5**: numeric vectors, the counts. The order is none to most intense.

Details

The data set comes from Randall (1989) and concerns a factorial experiment for investigating factors that affect the bitterness of white wines. There are two factors in the experiment: temperature at the time of crushing the grapes and contact of the juice with the skin. Two bottles of wine were fermented for each of the treatment combinations. A panel of 9 judges were selected and trained for the ability to detect bitterness. Thus there were 72 bottles in total. Originally, the bitterness of the wine were taken on a continuous scale in the interval from 0 (none) to 100 (intense) but later they were grouped using equal lengths into five ordered categories 1, 2, 3, 4 and 5.

Source


Examples

```r
wine
summary(wine)
```

**wrapup.smart**  
*Cleans Up After Smart Prediction*

Description

**wrapup.smart** deletes any variables used by smart prediction. Needed by both the modelling function and the prediction function.

Usage

```r
wrapup.smart()
```
The variables to be deleted are .smart.prediction, .smart.prediction.counter, and .smart.prediction.mode. The function wrapup.smart is useful in R because these variables are held in smartpredenv.

See Also

setup.smart.

Examples

```r
## Not run: # Place this inside modelling functions such as lm, glm, vglm.
wrapup.smart() # Put at the end of lm
## End(Not run)
```

yeo.johnson

Yeo-Johnson Transformation

Description

Computes the Yeo-Johnson transformation, which is a normalizing transformation.

Usage

```r
yeo.johnson(y, lambda, derivative = 0,
  epsilon = sqrt(.Machine$double.eps), inverse = FALSE)
```

Arguments

- `y` Numeric, a vector or matrix.
- `lambda` Numeric. It is recycled to the same length as `y` if necessary.
- `derivative` Non-negative integer. The default is the ordinary function evaluation, otherwise the derivative with respect to `lambda`.
- `epsilon` Numeric and positive value. The tolerance given to values of `lambda` when comparing it to 0 or 2.
- `inverse` Logical. Return the inverse transformation?

Details

The Yeo-Johnson transformation can be thought of as an extension of the Box-Cox transformation. It handles both positive and negative values, whereas the Box-Cox transformation only handles positive values. Both can be used to transform the data so as to improve normality. They can be used to perform LMS quantile regression.

Value

The Yeo-Johnson transformation or its inverse, or its derivatives with respect to `lambda`, of `y`. 
Note

If inverse = TRUE then the argument derivative = 0 is required.

Author(s)

Thomas W. Yee

References


See Also

lms.yjn, boxcox.

Examples

```r
y <- seq(-4, 4, len = (nn <- 200))
ltry <- c(0, 0.5, 1, 1.5, 2)  # Try these values of lambda
lltry <- length(ltry)
psi <- matrix(NA_real_, nn, lltry)
for (ii in 1:lltry)
  psi[, ii] <- yeo.johnson(y, lambda = ltry[ii])
## Not run:
matplot(y, psi, type = "l", ylim = c(-4, 4), lwd = 2,
  lty = 1:lltry, col = 1:lltry, las = 1,
  ylab = "Yeo-Johnson transformation",
  main = "Yeo-Johnson transformation with some lambda values")
abline(v = 0, h = 0)
legend(x = 1, y = -0.5, lty = 1:lltry, legend = as.character(ltry),
  lwd = 2, col = 1:lltry)
## End(Not run)
```

Yules

Yule-Simon Distribution

Description

Density, distribution function, quantile function and random generation for the Yule-Simon distribution.
Usage

dyules(x, shape, log = FALSE)
pyules(q, shape, lower.tail = TRUE, log.p = FALSE)
qyules(p, shape)
ryules(n, shape)

Arguments

x, q, p, n  Same meaning as in Normal.
shape  See yulesimon.
log, lower.tail, log.p  Same meaning as in pnorm or qnorm.

Details

See yulesimon, the VGAM family function for estimating the parameter, for the formula of the probability density function and other details.

Value

dyules gives the density, pyules gives the distribution function, qyules gives the quantile function, and ryules generates random deviates.

Note

Numerical problems may occur with qyules() when p is very close to 1.

Author(s)

T. W. Yee

See Also

yulesimon.

Examples

dyules(1:20, 2.1)
ryules(20, 2.1)
round(1000 * dyules(1:8, 2))
table(ryules(1000, 2))

## Not run: x <- 0:6
plot(x, dyules(x, shape = 2.2), type = "h", las = 1, col = "blue")

## End(Not run)
yulesimon  

**Yule-Simon Family Function**

**Description**

Estimating the shape parameter of the Yule-Simon distribution.

**Usage**

```r
yulesimon(lshape = "loglink", ishape = NULL, nsimEIM = 200, 
zer = NULL)
```

**Arguments**

- `lshape`: Link function for the shape parameter, called \( \rho \) below. See `Links` for more choices and for general information.
- `ishape`: Optional initial value for the (positive) parameter. See `CommonVGAMffArguments` for more information. The default is to obtain an initial value internally. Use this argument if the default fails.
- `nsimEIM, zero`: See `CommonVGAMffArguments` for more information.

**Details**

The probability function is

\[
  f(y; \rho) = \rho \ast \text{beta}(y, \rho + 1),
\]

where the parameter \( \rho > 0 \), `beta` is the `beta` function, and \( y = 1, 2, \ldots \). The function `dyules` computes this probability function. The mean of \( Y \), which is returned as fitted values, is \( \rho/(\rho - 1) \) provided \( \rho > 1 \). The variance of \( Y \) is \( \rho^2/((\rho - 1)^2(\rho - 2)) \) provided \( \rho > 2 \).

The distribution was named after Udny Yule and Herbert A. Simon. Simon originally called it the Yule distribution. This family function can handle multiple responses.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Author(s)**

T. W. Yee

**References**


**See Also**

`ryules, simulate.vlm`
Examples

```r
ydata <- data.frame(x2 = runif(nn <- 1000))
ydata <- transform(ydata, y = ryules(nn, shape = exp(1.5 - x2)))
with(ydata, table(y))
fit <- vglm(y ~ x2, yulesimon, data = ydata, trace = TRUE)
coef(fit, matrix = TRUE)
summary(fit)
```

Zabinom

Zero-Altered Binomial Distribution

Description

Density, distribution function, quantile function and random generation for the zero-altered binomial distribution with parameter $p_{obs0}$.

Usage

```r
dzabinom(x, size, prob, pobs0 = 0, log = FALSE)
pzabinom(q, size, prob, pobs0 = 0)
qzabinom(p, size, prob, pobs0 = 0)
rzabinom(n, size, prob, pobs0 = 0)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `size, prob, log` Parameters from the ordinary binomial distribution (see `dbinom`).
- `pobs0` Probability of (an observed) zero, called $p_{obs0}$. The default value of $p_{obs0} = 0$ corresponds to the response having a positive binomial distribution.

Details

The probability function of $Y$ is 0 with probability $p_{obs0}$, else a positive binomial($size, prob$) distribution.

Value

`dzabinom` gives the density and `pzabinom` gives the distribution function, `qzabinom` gives the quantile function, and `rzabinom` generates random deviates.

Note

The argument `pobs0` is recycled to the required length, and must have values which lie in the interval $[0, 1]$. 

Zero-Altered Binomial Distribution

Description

Fits a zero-altered binomial distribution based on a conditional model involving a Bernoulli distribution and a positive-binomial distribution.

Usage

zabinomial(lpobs0 = "logitlink", lprob = "logitlink",
          type.fitted = c("mean", "prob", "pobs0"),
          ipobs0 = NULL, iprob = NULL, imethod = 1, zero = NULL)
zabinomialff(lprob = "logitlink", lonempobs0 = "logitlink",
            type.fitted = c("mean", "prob", "pobs0", "onempobs0"),
            iprob = NULL, ionempobs0 = NULL, imethod = 1, zero = "onempobs0")

Arguments

lprob Parameter link function applied to the probability parameter of the binomial distribution. See Links for more choices.

lpobs0 Link function for the parameter \( p_0 \), called pobs0 here. See Links for more choices.

type.fitted See CommonVGAMffArguments and fittedvlm for information.
The response $Y$ is zero with probability $p_0$, else $Y$ has a positive-binomial distribution with probability $1 - p_0$. Thus $0 < p_0 < 1$, which may be modelled as a function of the covariates. The zero-altered binomial distribution differs from the zero-inflated binomial distribution in that the former has zeros coming from one source, whereas the latter has zeros coming from the binomial distribution too. The zero-inflated binomial distribution is implemented in `zabinomial`. Some people call the zero-altered binomial a hurdle model.

The input is currently a vector or one-column matrix. By default, the two linear/additive predictors for `zabinomial()` are $(\logit(p_0), \log(p))^T$.

The VGAM family function `zabinomialff()` has a few changes compared to `zabinomial()`. These are: (i) the order of the linear/additive predictors is switched so the binomial probability comes first; (ii) argument `onempobs0` is now 1 minus the probability of an observed 0, i.e., the probability of the positive binomial distribution, i.e., `onempobs0` is $1 - \text{pobs0}$; (iii) argument `zero` has a new default so that the `onempobs0` is intercept-only by default. Now `zabinomialff()` is generally recommended over `zabinomial()`. Both functions implement Fisher scoring and neither can handle multiple responses.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, and `vgam`.

The `fitted.values` slot of the fitted object, which should be extracted by the generic function `fitted`, returns the mean $\mu$ (default) which is given by

$$\mu = \frac{(1 - p_0) \mu_b}{1 - (1 - \mu_b)^N}$$

where $\mu_b$ is the usual binomial mean. If `type.fitted = "pobs0"` then $p_0$ is returned.

**Note**

The response should be a two-column matrix of counts, with first column giving the number of successes.

Note this family function allows $p_0$ to be modelled as functions of the covariates by having `zero = NULL`. It is a conditional model, not a mixture model.

These family functions effectively combine `posbinomial` and `binomialff` into one family function.

**Author(s)**

T. W. Yee
Zageom

Zero-Altered Geometric Distribution

Description

Density, distribution function, quantile function and random generation for the zero-altered geometric distribution with parameter \( p_{obs0} \).

Usage

```r
dzageom(x, prob, pobs0 = 0, log = FALSE)
pzageom(q, prob, pobs0 = 0)
qzageom(p, prob, pobs0 = 0)
rzageom(n, prob, pobs0 = 0)
```

Arguments

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `prob, log` Parameters from the ordinary geometric distribution (see `dgeom`).
- `pobs0` Probability of (an observed) zero, called \( p_{obs0} \). The default value of \( p_{obs0} = 0 \) corresponds to the response having a positive geometric distribution.
Details

The probability function of $Y$ is 0 with probability $p_{obs0}$, else a positive geometric(prob) distribution.

Value

dzageom gives the density and pzageom gives the distribution function, qzageom gives the quantile function, and rzageom generates random deviates.

Note

The argument $p_{obs0}$ is recycled to the required length, and must have values which lie in the interval $[0, 1]$.

Author(s)

T. W. Yee

See Also

zageometric, zigeometric, rposgeom.

Examples

```r
prob <- 0.35; pobs0 <- 0.05; x <- (-1):7
dzageom(x, prob = prob, pobs0 = pobs0)
table(rzageom(100, prob = prob, pobs0 = pobs0))
## Not run: x <- 0:10
barplot(rbind(dzageom(x, prob = prob, pobs0 = pobs0),
              dgeom(x, prob = prob)), las = 1,
        beside = TRUE, col = c("blue", "orange"), cex.main = 0.7,
        ylab = "Probability", names.arg = as.character(x),
        main = paste("ZAG(prob = ", prob, ", prob0 = ", pobs0,
                      ") [blue] vs", " Geometric(prob = ", prob,
                      ") [orange] densities", sep = ""))
## End(Not run)
```

---

**zageometric**

**Zero-Altered Geometric Distribution**

Description

Fits a zero-altered geometric distribution based on a conditional model involving a Bernoulli distribution and a positive-geometric distribution.
zageometric

Usage

```r
zageometric(lpobs0 = "logitlink", lprob = "logitlink",
    type.fitted = c("mean", "prob", "pobs0", "onempobs0"),
    imethod = 1, ipobs0 = NULL, iprob = NULL, zero = NULL)
zageometricff(lprob = "logitlink", lonempobs0 = "logitlink",
    type.fitted = c("mean", "prob", "pobs0", "onempobs0"),
    imethod = 1, iprob = NULL, ionempobs0 = NULL, zero = "onempobs0")
```

Arguments

- **lpobs0** Link function for the parameter \( p_0 \) or \( \phi \), called \( pobs0 \) or \( \phi \) here. See Links for more choices.
- **lprob** Parameter link function applied to the probability of success, called \( prob \) or \( p \). See Links for more choices.
- **type.fitted** See CommonVGAMffArguments and fittedvlm for information.
- **ipobs0, iprob** Optional initial values for the parameters. If given, they must be in range. For multi-column responses, these are recycled sideways.
- **lonempobs0, ionempobs0** Corresponding argument for the other parameterization. See details below.
- **zero, imethod** See CommonVGAMffArguments.

Details

The response \( Y \) is zero with probability \( p_0 \), or \( Y \) has a positive-geometric distribution with probability \( 1 - p_0 \). Thus \( 0 < p_0 < 1 \), which is modelled as a function of the covariates. The zero-altered geometric distribution differs from the zero-inflated geometric distribution in that the former has zeros coming from one source, whereas the latter has zeros coming from the geometric distribution too. The zero-inflated geometric distribution is implemented in the VGAM package. Some people call the zero-altered geometric a hurdle model.

The input can be a matrix (multiple responses). By default, the two linear/additive predictors of zageometric are \( (\text{logit}(\phi), \text{logit}(p))^T \).

The VGAM family function zageometricff() has a few changes compared to zageometric(). These are: (i) the order of the linear/additive predictors is switched so the geometric probability comes first; (ii) argument onempobs0 is now 1 minus the probability of an observed 0, i.e., the probability of the positive geometric distribution, i.e., onempobs0 is 1-pobs0; (iii) argument zero has a new default so that the pobs0 is intercept-only by default. Now zageometricff() is generally recommended over zageometric(). Both functions implement Fisher scoring and can handle multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

The fitted.values slot of the fitted object, which should be extracted by the generic function fitted, returns the mean \( \mu \) (default) which is given by

\[
\mu = \frac{(1 - \phi)}{p}.
\]
If `type.fitted = "pobs0"` then $p_0$ is returned.

**Warning**

Convergence for this **VGAM** family function seems to depend quite strongly on providing good initial values.

Inference obtained from `summary.vglm` and `summary.vgam` may or may not be correct. In particular, the p-values, standard errors and degrees of freedom may need adjustment. Use simulation on artificial data to check that these are reasonable.

**Note**

Note this family function allows $p_0$ to be modelled as functions of the covariates. It is a conditional model, not a mixture model.

This family function effectively combines `binomialff` and `posgeometric()` and **geometric** into one family function. However, `posgeometric()` is not written because it is trivially related to **geometric**.

**Author(s)**

T. W. Yee

**See Also**

`dzageom, geometric, zigeometric, spikeplot, dgeom, CommonVGAMffArguments, simulate.vlm`.

**Examples**

```r
zdata <- data.frame(x2 = runif(nn <- 1000))
zdata <- transform(zdata, pobs0 = logitlink(-1 + 2*x2, inverse = TRUE),
                   prob = logitlink(-2 + 3*x2, inverse = TRUE))
zdata <- transform(zdata, y1 = rzageom(nn, prob = prob, pobs0 = pobs0),
                   y2 = rzageom(nn, prob = prob, pobs0 = pobs0))
with(zdata, table(y1))

fit <- vglm(cbind(y1, y2) ~ x2, zageometric, data = zdata, trace = TRUE)
coef(fit, matrix = TRUE)
head(fitted(fit))
head(predict(fit))
summary(fit)
```

---

**Zanegbin**  
Zero-Altered Negative Binomial Distribution

**Description**

Density, distribution function, quantile function and random generation for the zero-altered negative binomial distribution with parameter $pobs0$. 

Usage

dzanegbin(x, size, munb, pobs0 = 0, log = FALSE)
pzanegbin(q, size, munb, pobs0 = 0)
qzanegbin(p, size, munb, pobs0 = 0)
rzanegbin(n, size, munb, pobs0 = 0)

Arguments

x, q
vector of quantiles.
p
vector of probabilities.
n
number of observations. If length(n) > 1 then the length is taken to be the
number required.
size, munb, log
Parameters from the ordinary negative binomial distribution (see \texttt{dnbinom}). Some
arguments have been renamed slightly.
pobs0
Probability of zero, called \textit{pobs0}. The default value of \textit{pobs0} = 0 corresponds to
the response having a positive negative binomial distribution.

Details

The probability function of \( Y \) is 0 with probability \textit{pobs0}, else a positive negative binomial(\( \mu_{nb} \),
size) distribution.

Value

dzanegbin gives the density and pzanegbin gives the distribution function, qzanegbin gives the
quantile function, and rzanegbin generates random deviates.

Note

The argument \textit{pobs0} is recycled to the required length, and must have values which lie in the interval
\([0, 1]\).

Author(s)

T. W. Yee

See Also

\texttt{Gaitdnbinom}, \texttt{zanegbinomial}.

Examples

munb <- 3; size <- 4; pobs0 <- 0.3; x <- (-1):7
dzanegbin(x, munb = munb, size = size, pobs0 = pobs0)
table(rzanegbin(100, munb = munb, size = size, pobs0 = pobs0))

## Not run: x <- 0:10
barplot(rbind(dzanegbin(x, munb = munb, size = size, pobs0 = pobs0),
              dnbinom(x, mu = munb, size = size)),
          ...)
description

Fits a zero-altered negative binomial distribution based on a conditional model involving a binomial distribution and a positive-negative binomial distribution.

Usage

zanegbinomial(zero = "size", type.fitted = c("mean", "munb", "pobs0"),
  mds.min = 1e-3, nsimEIM = 500, cutoff.prob = 0.999,
  eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
  lobs0 = "logitlink", lmunb = "loglink", lsize = "loglink",
  imethod = 1, lobs0 = NULL,
  lmunb = NULL, lprobs.y = NULL, gprobs.y = (0:9)/10,
  isize = NULL, gsize.mux = exp(c(-30, -20, -15, -10, -6:3)))

Arguments

lpobs0 Link function for the parameter \( p_0 \), called pobs0 here. See Links for more choices.

lmunb Link function applied to the munb parameter, which is the mean \( \mu_{nb} \) of an ordinary negative binomial distribution. See Links for more choices.

lsize Parameter link function applied to the reciprocal of the dispersion parameter, called k. That is, as k increases, the variance of the response decreases. See Links for more choices.

type.fitted See CommonVGAMffArguments and fittedvlm for information.

lonempobs0, ionempobs0 Corresponding argument for the other parameterization. See details below.
Optional initial values for \( p_0 \) and \( m_{\text{unb}} \) and \( k \). If given then it is okay to give one value for each response/species by inputting a vector whose length is the number of columns of the response matrix.

Specifies which of the three linear predictors are modelled as intercept-only. All parameters can be modelled as a function of the explanatory variables by setting zero = NULL (not recommended). A negative value means that the value is recycled, e.g., setting \(-3\) means all \( k \) are intercept-only for \( \text{zanegbinomial} \). See \texttt{CommonVGAMffArguments} for more information.

The response \( Y \) is zero with probability \( p_0 \), or \( Y \) has a positive-negative binomial distribution with probability \( 1 - p_0 \). Thus \( 0 < p_0 < 1 \), which is modelled as a function of the covariates. The zero-altered negative binomial distribution differs from the zero-inflated negative binomial distribution in that the former has zeros coming from one source, whereas the latter has zeros coming from the negative binomial distribution too. The zero-inflated negative binomial distribution is implemented in the \texttt{VGAM} package. Some people call the zero-altered negative binomial a \textit{hurdle} model.

For one response/species, by default, the three linear/additive predictors for \texttt{zanegbinomial()} are \((\logit(p_0), \log(m_{\text{unb}}), \log(k))\). This vector is recycled for multiple species.

The \texttt{VGAM} family function \texttt{zanegbinomialff()} has a few changes compared to \texttt{zanegbinomial()}. These are: (i) the order of the linear/additive predictors is switched so the negative binomial mean comes first; (ii) argument \texttt{onempobs0} is now 1 minus the probability of an observed 0, i.e., the probability of the positive negative binomial distribution, i.e., \texttt{onempobs0} is \( 1-p_{\text{obs0}} \); (iii) argument \texttt{zero} has a new default so that the \texttt{pobs0} is intercept-only by default. Now \texttt{zanegbinomialff()} is generally recommended over \texttt{zanegbinomial()}. Both functions implement Fisher scoring and can handle multiple responses.

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm}, and \texttt{vgam}.

The \texttt{fitted.values} slot of the fitted object, which should be extracted by the generic function \texttt{fitted}, returns the mean \( \mu \) (default) which is given by

\[
\mu = (1 - p_0)m_{\text{unb}}/[1 - (k/(k + m_{\text{unb}}))^k].
\]

If \texttt{type.fitted = "pobs0"} then \( p_0 \) is returned.
Warning

This family function is fragile; it inherits the same difficulties as `posnegbinomial`. Convergence for this `VGAM` family function seems to depend quite strongly on providing good initial values. This `VGAM` family function is computationally expensive and usually runs slowly; setting `trace = TRUE` is useful for monitoring convergence.

Inference obtained from `summary.vglm` and `summary.vgam` may or may not be correct. In particular, the p-values, standard errors and degrees of freedom may need adjustment. Use simulation on artificial data to check that these are reasonable.

Note

Note this family function allows $p_0$ to be modelled as functions of the covariates provided zero is set correctly. It is a conditional model, not a mixture model. Simulated Fisher scoring is the algorithm.

This family function effectively combines `posnegbinomial` and `binomialff` into one family function.

This family function can handle multiple responses, e.g., more than one species.

Author(s)

T. W. Yee

References


See Also

`gaitdnbinomial, posnegbinomial, Gaitdnbinom, negbinomial, binomialff, zinegbinomial, zipoisson, spikeplot, dnbinom, CommonVGAMffArguments, simulate.vlm`

Examples

```r
## Not run:
zdata <- data.frame(x2 = runif(nn <- 2000))
zdata <- transform(zdata, pobs0 = logitlink(-1 + 2*x2, inverse = TRUE))
zdata <- transform(zdata,
  y1 = rzanegbin(nn, munb = exp(0+2*x2), size = exp(1), pobs0 = pobs0),
  y2 = rzanegbin(nn, munb = exp(1+2*x2), size = exp(1), pobs0 = pobs0))
with(zdata, table(y1))
with(zdata, table(y2))
fit <- vglm(cbind(y1, y2) ~ x2, zanegbinomial, data = zdata, trace = TRUE)
coef(fit, matrix = TRUE)
```
Zapois

Zero-Altered Poisson Distribution

Description

Density, distribution function, quantile function and random generation for the zero-altered Poisson distribution with parameter pobs0.

Usage

```
dzapois(x, lambda, pobs0 = 0, log = FALSE)
pzapois(q, lambda, pobs0 = 0)
qzapois(p, lambda, pobs0 = 0)
rzapois(n, lambda, pobs0 = 0)
```

Arguments

- `x`, `q` vector of quantiles.
- `p` vector of probabilities.
- `n` number of observations. If `length(n) > 1` then the length is taken to be the number required.
- `lambda` Vector of positive means.
- `pobs0` Probability of zero, called `pobs0`. The default value of `pobs0 = 0` corresponds to the response having a positive Poisson distribution.
- `log` Logical. Return the logarithm of the answer?

Details

The probability function of Y is 0 with probability `pobs0`, else a positive `Poisson(λ)`.

Value

`dzapois` gives the density, `pzapois` gives the distribution function, `qzapois` gives the quantile function, and `rzapois` generates random deviates.

Note

The argument `pobs0` is recycled to the required length, and must have values which lie in the interval [0, 1].
Author(s)
T. W. Yee

See Also
zapoisson, Gaitdpois, dzi pois.

Examples
lambda <- 3; pobs0 <- 0.2; x <- (-1):7
(ii <- dzapois(x, lambda, pobs0))
max(abs(cumsum(ii) - pzapois(x, lambda, pobs0))) # Should be 0
table(rzapois(100, lambda, pobs0))
table(qzapois(runif(100), lambda, pobs0))
round(dzapois(0:10, lambda, pobs0) * 100) # Should be similar

## Not run: x <- 0:10
barplot(rbind(dzapois(x, lambda, pobs0), dpois(x, lambda)),
beside = TRUE, col = c("blue", "green"), las = 1,
main = paste0("ZAP(" , lambda, ", pobs0 = ", pobs0, ") [blue],
"vs Poisson(" , lambda, ") [green] densities"),
names.arg = as.character(x), ylab = "Probability")
## End(Not run)

Description
Fits a zero-altered Poisson distribution based on a conditional model involving a Bernoulli distribution and a positive-Poisson distribution.

Usage
zapoisson(lpobs0 = "logitlink", llambda = "loglink", type.fitted =
c("mean", "lambda", "pobs0", "onempobs0"), imethod = 1,
ipobs0 = NULL, ilambda = NULL, ishrinkage = 0.95, probs.y = 0.35,
zero = NULL)
zapoissonff(llambda = "loglink", lonempobs0 = "logitlink", type.fitted =
c("mean", "lambda", "pobs0", "onempobs0"), imethod = 1,
ilambda = NULL, ilonempobs0 = NULL, ishrinkage = 0.95,
probs.y = 0.35, zero = "onempobs0")

Arguments
lpobs0 Link function for the parameter $p_0$, called pobs0 here. See Links for more choices.
llambda Link function for the usual $\lambda$ parameter. See Links for more choices.
zapoisson

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type.fitted  See CommonVGAMffArguments and fittedvlm for information.
lonempobs0  Corresponding argument for the other parameterization. See details below.
imethod, ipobs0, ionempobs0, ilambda, ishrinkage  
See CommonVGAMffArguments for information.
probs.y, zero  See CommonVGAMffArguments for information.

Details

The response $Y$ is zero with probability $p_0$, else $Y$ has a positive-Poisson($\lambda$) distribution with probability $1 - p_0$. Thus $0 < p_0 < 1$, which is modelled as a function of the covariates. The zero-altered Poisson distribution differs from the zero-inflated Poisson distribution in that the former has zeros coming from one source, whereas the latter has zeros coming from the Poisson distribution too. Some people call the zero-altered Poisson a hurdle model.

For one response/species, by default, the two linear/additive predictors for zapoisson() are $(\logit(p_0), \log(\lambda))^T$.

The VGAM family function zapoissonff() has a few changes compared to zapoisson(). These are: (i) the order of the linear/additive predictors is switched so the Poisson mean comes first; (ii) argument onempobs0 is now 1 minus the probability of an observed 0, i.e., the probability of the positive Poisson distribution, i.e., onempobs0 is 1-pobs0; (iii) argument zero has a new default so that the onempobs0 is intercept-only by default. Now zapoissonff() is generally recommended over zapoisson(). Both functions implement Fisher scoring and can handle multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

The fitted.values slot of the fitted object, which should be extracted by the generic function fitted, returns the mean $\mu$ (default) which is given by

$$
\mu = (1 - p_0)\lambda/[1 - \exp(-\lambda)].
$$

If type.fitted = "pobs0" then $p_0$ is returned.

Note

There are subtle differences between this family function and zipoisson and yip88. In particular, zipoisson is a mixture model whereas zapoisson() and yip88 are conditional models.

Note this family function allows $p_0$ to be modelled as functions of the covariates.

This family function effectively combines pospoisson and binomialff into one family function.

This family function can handle multiple responses, e.g., more than one species.

It is recommended that Gaitdpois be used, e.g., rgaitdpois(nn, lambda, pobs.mlm = pobs0, a.mlm = 0) instead of rzapois(nn, lambda, pobs0 = pobs0).

Author(s)

T. W. Yee
References


See Also

`Gaitdpois`, `rzapois`, `zipoisson`, `gaitdpoisson`, `pospoisson`, `posnegbinomial`, `spikeplot`, `binomialff`, `CommonVGAMffArguments`, `simulate.vlm`.

Examples

```r
zdata <- data.frame(x2 = runif(nn <- 1000))
zdata <- transform(zdata, pobs0 = logitlink(-1 + 1*x2, inverse = TRUE),
                   lambda = loglink(-0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata, y = rgaitdpois(nn, lambda, pobs.mlm = pobs0,
                                     a.mlm = 0))

with(zdata, table(y))
fit <- vglm(y ~ x2, zapoisson, data = zdata, trace = TRUE)
head(fitted(fit))
head(predict(fit))
head(predict(fit, untransform = TRUE))
coef(fit, matrix = TRUE)
summary(fit)

# Another example ----------------------------------------
# Data from Angers and Biswas (2003)
abdata <- data.frame(y = 0:7, w = c(182, 41, 12, 2, 2, 0, 0, 1))
abdata <- subset(abdata, w > 0)
Abdata <- data.frame(yy = with(abdata, rep(y, w)))
fit3 <- vglm(yy~1, zapoisson, data = Abdata, trace = TRUE, crit = "coef")
coef(fit3, matrix = TRUE)
Coef(fit3) # Estimate lambda (they get 0.6997 with SE 0.1520)
head(fitted(fit3), 1)
with(Abdata, mean(yy)) # Compare this with fitted(fit3)
```

The zero Argument in VGAM Family Functions

Description

The zero argument allows users to conveniently model certain linear/additive predictors as intercept-only.
Details

Often a certain parameter needs to be modelled simply while other parameters in the model may be more complex, for example, the $\lambda$ parameter in LMS-Box-Cox quantile regression should be modelled more simply compared to its $\mu$ parameter. Another example is the $\xi$ parameter in a GEV distribution which is should be modelled simpler than its $\mu$ parameter. Using the zero argument allows this to be fitted conveniently without having to input all the constraint matrices explicitly.

The zero argument can be assigned an integer vector from the set \{1:M\} where $M$ is the number of linear/additive predictors. Full details about constraint matrices can be found in the references. See CommonVGAMffArguments for more information.

Value

Nothing is returned. It is simply a convenient argument for constraining certain linear/additive predictors to be an intercept only.

Warning

The use of other arguments may conflict with the zero argument. For example, using constraints to input constraint matrices may conflict with the zero argument. Another example is the argument parallel. In general users should not assume any particular order of precedence when there is potential conflict of definition. Currently no checking for consistency is made.

The argument zero may be renamed in the future to something better.

Side Effects

The argument creates the appropriate constraint matrices internally.

Note

In all VGAM family functions zero = NULL means none of the linear/additive predictors are modelled as intercepts-only. Almost all VGAM family function have zero = NULL as the default, but there are some exceptions, e.g., binom2.or.

Typing something like coef(fit, matrix = TRUE) is a useful way to ensure that the zero argument has worked as expected.

Author(s)

T. W. Yee

References


See Also

CommonVGAMffArguments, constraints.
Examples

args(multinomial)
args(binom2.or)
args(gpd)

#LMS quantile regression example
fit <- vglm(BMI ~ sm.bs(age, df = 4), lms.bcg(zero = c(1, 3)),
    data = bmi.nz, trace = TRUE)
coef(fit, matrix = TRUE)

The Zeta Distribution

Description

Density, distribution function, quantile function and random generation for the zeta distribution.

Usage

dzeta(x, shape, log = FALSE)
pzeta(q, shape, lower.tail = TRUE)
qzeta(p, shape)
rzeta(n, shape)

Arguments

x, q, p, n
shape
lower.tail, log

Same as Poisson.
The positive shape parameter $s$.
Same meaning as in Normal.

Details

The density function of the zeta distribution is given by

$$y^{-s-1}/\zeta(s + 1)$$

where $s > 0$, $y = 1, 2, \ldots$, and $\zeta$ is Riemann’s zeta function.

Value

dzeta gives the density, pzeta gives the distribution function, qzeta gives the quantile function,
and rzeta generates random deviates.

Note

qzeta() runs slower and slower as shape approaches 0 and shape approaches 1. The VGAM
family function zetaff estimates the shape parameter $s$. 

Zeta
zeta

Author(s)
T. W. Yee

References

See Also
zeta, zetaff, ozeta, oizeta, ozteta.

Examples

dzeta(1:20, shape = 2)
myshape <- 0.5
max(abs(pzeta(1:200, myshape) -
cumsum(1/(1:200)^(1+myshape)) / zeta(myshape+1))) # Should be 0

## Not run: plot(1:6, dzeta(1:6, 2), type = "h", las = 1,
col = "orange", ylab = "Probability",
main = "zeta probability function; orange: shape = 2; blue: shape = 1")
points(0.10 + 1:6, dzeta(1:6, 1), type = "h", col = "blue")
## End(Not run)

zeta

*Riemann’s (and the Hurwitz) Zeta Function, With Derivatives*

Description
Computes Riemann’s zeta function and its first two derivatives. Also can compute the Hurwitz zeta function.

Usage
zeta(x, deriv = 0, shift = 1)

Arguments

x
A complex-valued vector/matrix whose real values must be ≥ 1. Otherwise, x may be real. It is called s below. If deriv is 1 or 2 then x must be real and positive.

deriv
An integer equalling 0 or 1 or 2, which is the order of the derivative. The default means it is computed ordinarily.

shift
Positive and numeric, called A below. Allows for the Hurwitz zeta to be returned. The default corresponds to the Riemann formula.
Details

The (Riemann) formula for real $s$ is

$$\sum_{n=1}^{\infty} \frac{1}{n^s}.$$  

While the usual definition involves an infinite series that converges when the real part of the argument is $>1$, more efficient methods have been devised to compute the value. In particular, this function uses Euler–Maclaurin summation. Theoretically, the zeta function can be computed over the whole complex plane because of analytic continuation.

The (Riemann) formula used here for analytic continuation is

$$\zeta(s) = 2^s \pi^{s-1} \sin(\pi s/2) \Gamma(1-s) \zeta(1-s).$$  

This is actually one of several formulas, but this one was discovered by Riemann himself and is called the functional equation.

The Hurwitz zeta function for real $s>0$ is

$$\sum_{n=0}^{\infty} \frac{1}{(A+n)^s}.$$  

where $0<A$ is known here as the shift. Since $A=1$ by default, this function will therefore return Riemann’s zeta function by default. Currently derivatives are unavailable.

Value

The default is a vector/matrix of computed values of Riemann’s zeta function. If shift contains values not equal to 1, then this is Hurwitz’s zeta function.

Warning

This function has not been fully tested, especially the derivatives. In particular, analytic continuation does not work here for complex $x$ with $\text{Re}(x)<1$ because currently the gamma function does not handle complex arguments.

Note

Estimation of the parameter of the zeta distribution can be achieved with zetaff.

Author(s)

T. W. Yee, with the help of Garry J. Tee.

References


zetaff

See Also

zetaff, Zeta, aizeta, oizeta, ozteta, lerch, gamma.

Examples

zeta(2:10)

## Not run:
curve(zeta, -13, 0.8, xlim = c(-12, 10), ylim = c(-1, 4), col = "orange",
    las = 1, main = expression({zeta}(x)))
curve(zeta, 1.2, 12, add = TRUE, col = "orange")
abline(v = 0, h = c(0, 1), lty = "dashed", col = "gray")

curve(zeta, -14, -0.4, col = "orange", main = expression({zeta}(x)))
abline(v = 0, h = 0, lty = "dashed", col = "gray")  # Close up plot

x <- seq(0.04, 0.8, len = 100)  # Plot of the first derivative
plot(x, zeta(x, deriv = 1), type = "l", las = 1, col = "blue",
    xlim = c(0.04, 3), ylim = c(-6, 0), main = "zeta'(x)")
x <- seq(1.2, 3, len = 100)
lines(x, zeta(x, deriv = 1), col = "blue")
abline(v = 0, h = 0, lty = "dashed", col = "gray")
## End(Not run)

zeta(2) - pi^2 / 6  # Should be 0
zeta(4) - pi^4 / 90  # Should be 0
zeta(6) - pi^6 / 945  # Should be 0
zeta(8) - pi^8 / 9450  # Should be 0
zeta(0, deriv = 1) + 0.5 * log(2*pi)  # Should be 0
gamma0 <- 0.5772156649
gamma1 <- -0.07281584548
zeta(0, deriv = 2) -
    gamma1 + 0.5 * (log(2*pi))^2 + pi^2/24 - gamma0^2/2  # Should be 0
zeta(0.5, deriv = 1) + 3.92264613  # Should be 0
zeta(2.0, deriv = 1) + 0.93754825431  # Should be 0

zetaff

Zeta Distribution Family Function

Description

Estimates the parameter of the zeta distribution.

Usage

zetaff(lshape = "loglink", ishape = NULL, gshape = 1 + exp(-seq(7)),
    zero = NULL)
Arguments

lshape, ishape, zero

These arguments apply to the (positive) parameter \( p \). See Links for more choices. Choosing loglog constrains \( p > 1 \), but may fail if the maximum likelihood estimate is less than one. See CommonVGAMffArguments for more information.

gshape

See CommonVGAMffArguments for more information.

Details

In this long tailed distribution the response must be a positive integer. The probability function for a response \( Y \) is

\[
P(Y = y) = 1/[y^{p+1}\zeta(p + 1)], \quad p > 0, \quad y = 1, 2, ...
\]

where \( \zeta \) is Riemann’s zeta function. The parameter \( p \) is positive, therefore a log link is the default. The mean of \( Y \) is \( \mu = \zeta(p)/\zeta(p + 1) \) (provided \( p > 1 \)) and these are the fitted values. The variance of \( Y \) is \( \zeta(p - 1)/\zeta(p + 1) - \mu^2 \) provided \( p > 2 \).

It appears that good initial values are needed for successful convergence. If convergence is not obtained, try several values ranging from values near 0 to values about 10 or more.

Multiple responses are handled.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.

Note

The zeta function may be used to compute values of the zeta function.

Author(s)

T. W. Yee

References


See Also

zeta, Zeta, gaitdzeta, oazeta, oizeta, otzeta, diffzeta, hzeta, zipf.
Examples

zdata <- data.frame(y = 1:5, w = c(63, 14, 5, 1, 2))  # Knight, p.304
fit <- vglm(y ~ 1, zetaff, data = zdata, trace = TRUE, weight = w, crit = "c")
(phat <- Coef(fit))  # 1.682557
with(zdata, cbind(round(dzeta(y, phat) * sum(w), 1), w))

with(zdata, weighted.mean(y, w))
fitted(fit, matrix = FALSE)
predict(fit)

# The following should be zero at the MLE:
with(zdata, mean(log(rep(y, w))) + zeta(1+phat, deriv = 1) / zeta(1+phat))

Zibinom  
Zero-Inflated Binomial Distribution

Description

Density, distribution function, quantile function and random generation for the zero-inflated binomial distribution with parameter pstr0.

Usage

dzibinom(x, size, prob, pstr0 = 0, log = FALSE)
pzibinom(q, size, prob, pstr0 = 0)
qzibinom(p, size, prob, pstr0 = 0)
rzibinom(n, size, prob, pstr0 = 0)

Arguments

x, q  
vector of quantiles.

p  
vector of probabilities.

size  
number of trials. It is the $N$ symbol in the formula given in zibinomial.

prob  
probability of success on each trial.

n  
Same as in runif.

log  
Same as pbinom.

pstr0  
Probability of a structural zero (i.e., ignoring the binomial distribution), called $\phi$. The default value of $\phi = 0$ corresponds to the response having an ordinary binomial distribution.

Details

The probability function of $Y$ is 0 with probability $\phi$, and $\text{Binomial}(size, prob)$ with probability $1 - \phi$. Thus

$$P(Y = 0) = \phi + (1 - \phi)P(W = 0)$$

where $W$ is distributed $\text{Binomial}(size, prob)$. 

Value

dzibinom gives the density, pzibinom gives the distribution function, qzibinom gives the quantile function, and rzibinom generates random deviates.

Note

The argument pstr0 is recycled to the required length, and must have values which lie in the interval [0, 1].

These functions actually allow for zero-deflation. That is, the resulting probability of a zero count is less than the nominal value of the parent distribution. See Zipois for more information.

Author(s)

T. W. Yee

See Also

zibinomial, Gaitdbinom, Binomial.

Examples

```r
prob <- 0.2; size <- 10; pstr0 <- 0.5
(ii <- dzibinom(0:size, size, prob, pstr0 = pstr0))
max(abs(cumsum(ii) - pzibinom(0:size, size, prob, pstr0 = pstr0))) # 0?
table(rzibinom(100, size, prob, pstr0 = pstr0))

table(qzibinom(runif(100), size, prob, pstr0 = pstr0))
round(dzibinom(0:10, size, prob, pstr0 = pstr0) * 100) # Similar?
```

## Not run:

```r
x <- 0:size
dzibinom(x, size, prob, pstr0 = pstr0)
dbinom(x, size, prob),
dzibinom(x, size, prob)),
beside = TRUE, col = c("blue", "green"), ylab = "Probability",
main = paste0("ZIB(" size, ",", prob, ", pstr0 = ", pstr0, ")",
" (blue) vs Binomial(" size, ",", prob, ") (green)"),
names.arg = as.character(x), las = 1, lwd = 2)
```

## End(Not run)

---

**Description**

Fits a zero-inflated binomial distribution by maximum likelihood estimation.
Usage

zibinomial(lpstr0 = "logitlink", lprob = "logitlink", type.fitted = c("mean", "prob", "pobs0", "pstr0", "onempstr0"), ipstr0 = NULL, zero = NULL, multiple.responses = FALSE, imethod = 1)

zibinomialff(lprob = "logitlink", lonempstr0 = "logitlink", type.fitted = c("mean", "prob", "pobs0", "pstr0", "onempstr0"), ionempstr0 = NULL, zero = "onempstr0", multiple.responses = FALSE, imethod = 1)

Arguments

lpstr0, lprob Link functions for the parameter φ and the usual binomial probability µ parameter. See Links for more choices. For the zero-deflated model see below.
type.fitted See CommonVGAMffArguments and fittedvlm.
ipstr0 Optional initial values for φ, whose values must lie between 0 and 1. The default is to compute an initial value internally. If a vector then recycling is used.
lonempstr0, ionempstr0 Corresponding arguments for the other parameterization. See details below.
multiple.responses Logical. Currently it must be FALSE to mean the function does not handle multiple responses. This is to remain compatible with the same argument in binomialff.
zero, imethod See CommonVGAMffArguments for information. Argument zero changed its default value for version 0.9-2.

Details

These functions are based on

\[ P(Y = 0) = \phi + (1 - \phi)(1 - \mu)^N, \]

for \( y = 0 \), and

\[ P(Y = y) = (1 - \phi)\left(\frac{N}{Ny}\right)^y\mu^y(1 - \mu)^{N(1-y)}. \]

for \( y = 1/N, 2/N, \ldots, 1 \). That is, the response is a sample proportion out of \( N \) trials, and the argument size in rzibinom is \( N \) here. The parameter \( \phi \) is the probability of a structural zero, and it satisfies \( 0 < \phi < 1 \). The mean of \( Y \) is \( E(Y) = (1 - \phi)\mu \) and these are returned as the fitted values by default. By default, the two linear/additive predictors for zibinomial() are \((\text{logit}(\phi), \text{logit}(\mu))^T\).

The VGAM family function zibinomialff() has a few changes compared to zibinomial(). These are: (i) the order of the linear/additive predictors is switched so the binomial probability comes first; (ii) argument onempstr0 is now 1 minus the probability of a structural zero, i.e., the probability of the parent (binomial) component, i.e., onempstr0 is \( 1 - \text{pstr0} \); (iii) argument zero has a new default so that the onempstr0 is intercept-only by default. Now zibinomialff() is generally recommended over zibinomial(). Both functions implement Fisher scoring.
Value

An object of class "vglmff" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Warning

Numerical problems can occur. Half-stepping is not uncommon. If failure to converge occurs, make use of the argument \texttt{ipstr0} or \texttt{ionempstr0}, or \texttt{imethod}.

Note

The response variable must have one of the formats described by \texttt{binomialff}, e.g., a factor or two column matrix or a vector of sample proportions with the weights argument specifying the values of \(N\).

To work well, one needs large values of \(N\) and \(\mu > 0\), i.e., the larger \(N\) and \(\mu\) are, the better. If \(N = 1\) then the model is unidentifiable since the number of parameters is excessive.

Setting \texttt{stepsize = 0.5}, say, may aid convergence.

Estimated probabilities of a structural zero and an observed zero are returned, as in \texttt{zipoisson}.

The zero-deflated binomial distribution might be fitted by setting \texttt{lpstr0 = identitylink}, albeit, not entirely reliably. See \texttt{zipoisson} for information that can be applied here. Else try the zero-altered binomial distribution (see \texttt{zabinomial}).

Author(s)

T. W. Yee

References


See Also

\texttt{rzibinom}, \texttt{binomialff}, \texttt{posbinomial}, \texttt{spikeplot}, \texttt{Binomial}.

Examples

```r
size <- 10  # Number of trials; \(N\) in the notation above
nn <- 200
zdata <- data.frame(pstr0 = logitlink(0, inverse = TRUE),  # 0.50
                     mubin = logitlink(-1, inverse = TRUE),  # Mean of usual binomial
                     sv = rep(size, length = nn))
zdata <- transform(zdata,
                   y = rzibinom(nn, size = sv, prob = mubin, pstr0 = pstr0))
with(zdata, table(y))
fit <- vglm(cbind(y, sv - y) ~ 1, zibinomialff, data = zdata, trace = TRUE)
fit <- vglm(cbind(y, sv - y) ~ 1, zibinomialff, data = zdata, trace = TRUE,
            stepsize = 0.5)
```
coef(fit, matrix = TRUE)
Coeff(fit) # Useful for intercept-only models
head(fitted(fit, type = "pobs0")) # Estimate of P(Y = 0)
head(fitted(fit))
with(zdata, mean(y)) # Compare this with fitted(fit)
summary(fit)

---

Zigeom

**Zero-Inflated Geometric Distribution**

**Description**

Density, and random generation for the zero-inflated geometric distribution with parameter pstr0.

**Usage**

```
dzigeom(x, prob, pstr0 = 0, log = FALSE)
pzigeom(q, prob, pstr0 = 0)
qzigeom(p, prob, pstr0 = 0)
rzigeom(n, prob, pstr0 = 0)
```

**Arguments**

- `x, q` vector of quantiles.
- `p` vector of probabilities.
- `prob` see `dgeom`.
- `n` Same as in `runif`.
- `pstr0` Probability of structural zero (ignoring the geometric distribution), called \( \phi \). The default value corresponds to the response having an ordinary geometric distribution.
- `log` Logical. Return the logarithm of the answer?

**Details**

The probability function of \( Y \) is 0 with probability \( \phi \), and \( \text{geometric}(\text{prob}) \) with probability \( 1 - \phi \). Thus

\[
P(Y = 0) = \phi + (1 - \phi)P(W = 0)
\]

where \( W \) is distributed \( \text{geometric}(\text{prob}) \).

**Value**

dzigeom gives the density, pzigeom gives the distribution function, qzigeom gives the quantile function, and rzigeom generates random deviates.
Note

The argument `pstr0` is recycled to the required length, and must have values which lie in the interval $[0,1]$.

These functions actually allow for zero-deflation. That is, the resulting probability of a zero count is less than the nominal value of the parent distribution. See `zipois` for more information.

Author(s)

T. W. Yee

See Also

`zigeometric`, `dgeom`.

Examples

```r
prob <- 0.5; pstr0 <- 0.2; x <- (-1):20
(ii <- dzigeom(x, prob, pstr0))
max(abs(cumsum(ii) - pzigeom(x, prob, pstr0))) # Should be 0
table(rzigeom(1000, prob, pstr0))

## Not run: x <- 0:10
barplot(rbind(dzigeom(x, prob, pstr0), dgeom(x, prob)),
       beside = TRUE, col = c("blue","orange"),
ylab = "P[Y = y]", xlab = "y", las = 1,
main = paste0("zigeometric(" prob, ", pstr0 = " pstr0,
               ") (blue) vs", " geometric(" prob, ") (orange)")",
names.arg = as.character(x))
## End(Not run)
```

---

**zigeometric**

Zero-Inflated Geometric Distribution Family Function

Description

Fits a zero-inflated geometric distribution by maximum likelihood estimation.

Usage

```r
zigeometric(lpstr0 = "logitlink", lprob = "logitlink",
            type.fitted = c("mean", "prob", "pobs0", "pstr0", "onempstr0"),
            ipstr0 = NULL, iprob = NULL,
            imethod = 1, bias.red = 0.5, zero = NULL)
zigeometricff(lprob = "logitlink", lonempstr0 = "logitlink",
              type.fitted = c("mean", "prob", "pobs0", "pstr0", "onempstr0"),
              iprob = NULL, ionempstr0 = NULL,
              imethod = 1, bias.red = 0.5, zero = "onempstr0")
```
Arguments

\texttt{lpstr0, lprob} \hspace{1em} Link functions for the parameters \( \phi \) and \( p \) (prob). The usual geometric probability parameter is the latter. The probability of a structural zero is the former. See \texttt{Links} for more choices. For the zero-deflated model see below.

\texttt{lonempstr0, ionempstr0} \hspace{1em} Corresponding arguments for the other parameterization. See details below.

\texttt{bias.red} \hspace{1em} A constant used in the initialization process of \texttt{pstr0}. It should lie between 0 and 1, with 1 having no effect.

\texttt{type.fitted} \hspace{1em} See \texttt{CommonVGAMffArguments} and \texttt{fittedvlm} for information.

\texttt{ipstr0, iprob} \hspace{1em} See \texttt{CommonVGAMffArguments} for information.

\texttt{zero, imethod} \hspace{1em} See \texttt{CommonVGAMffArguments} for information.

Details

Function \texttt{zigeometric()} is based on

\[ P(Y = 0) = \phi + (1 - \phi)p, \]

for \( y = 0 \), and

\[ P(Y = y) = (1 - \phi)p(1 - p)^y. \]

for \( y = 1, 2, \ldots \). The parameter \( \phi \) satisfies \( 0 < \phi < 1 \). The mean of \( Y \) is \( E(Y) = (1 - \phi)p/(1 - p) \) and these are returned as the fitted values by default. By default, the two linear/additive predictors are \((\logit(\phi), \logit(p))\)^T. Multiple responses are handled.

Estimated probabilities of a structural zero and an observed zero can be returned, as in \texttt{zipoisson}; see \texttt{fittedvlm} for information.

The \texttt{VGAM} family function \texttt{zigeometricff()} has a few changes compared to \texttt{zigeometric()}. These are: (i) the order of the linear/additive predictors is switched so the geometric probability comes first; (ii) argument \texttt{onempstr0} is now 1 minus the probability of a structural zero, i.e., the probability of the parent (geometric) component, i.e., \texttt{onempstr0} is \( 1 - \texttt{pstr0} \); (iii) argument \texttt{zero} has a new default so that the \texttt{onempstr0} is intercept-only by default. Now \texttt{zigeometricff()} is generally recommended over \texttt{zigeometric()}. Both functions implement Fisher scoring and can handle multiple responses.

Value

An object of class "\texttt{vglmff}" (see \texttt{vglmff-class}). The object is used by modelling functions such as \texttt{vglm} and \texttt{vgam}.

Note

The zero-deflated geometric distribution might be fitted by setting \texttt{lpstr0 = identitylink}, albeit, not entirely reliably. See \texttt{zipoisson} for information that can be applied here. Else try the zero-altered geometric distribution (see \texttt{zageometric}).

Author(s)

T. W. Yee
See Also

rzigeom, geometric, zageometric, spikeplot, rgeom, simulate.vlm.

Examples

gdata <- data.frame(x2 = runif(nn <- 1000) - 0.5)
gdata <- transform(gdata, x3 = runif(nn) - 0.5, x4 = runif(nn) - 0.5)
gdata <- transform(gdata, eta1 = 1.0 - 1.0 * x2 + 2.0 * x3, eta2 = -1.0, eta3 = 0.5)
gdata <- transform(gdata, prob1 = logitlink(eta1, inverse = TRUE), prob2 = logitlink(eta2, inverse = TRUE), prob3 = logitlink(eta3, inverse = TRUE))
gdata <- transform(gdata, y1 = rzigeom(nn, prob1, pstr0 = prob3), y2 = rzigeom(nn, prob2, pstr0 = prob3), y3 = rzigeom(nn, prob2, pstr0 = prob3))

with(gdata, table(y1))
with(gdata, table(y2))
with(gdata, table(y3))
head(gdata)

fit1 <- vglm(y1 ~ x2 + x3 + x4, zigeometric(zero = 1), data = gdata, trace = TRUE)
coef(fit1, matrix = TRUE)
head(fitted(fit1, type = "pstr0"))

fit2 <- vglm(cbind(y2, y3) ~ 1, zigeometric(zero = 1), data = gdata, trace = TRUE)
coef(fit2, matrix = TRUE)
summary(fit2)
Arguments

- `x`, `q` vector of quantiles.
- `p` vector of probabilities.
- `n` Same as in `runif`.
- `size`, `prob`, `murnb`, `log` Arguments matching `dnbinom`. The argument `murnb` corresponds to `mu` in `dnbinom` and has been renamed to emphasize the fact that it is the mean of the negative binomial component.
- `pstr0` Probability of structural zero (i.e., ignoring the negative binomial distribution), called φ.

Details

The probability function of \( Y \) is 0 with probability \( φ \), and a negative binomial distribution with probability \( 1 - φ \). Thus

\[
P(Y = 0) = φ + (1 - φ)P(W = 0)
\]

where \( W \) is distributed as a negative binomial distribution (see `rnbinom`). See `negbinomial`, a VGAM family function, for the formula of the probability density function and other details of the negative binomial distribution.

Value
dzinegbin gives the density, pzinegbin gives the distribution function, qzinegbin gives the quantile function, and rzinegbin generates random deviates.

Note

The argument `pstr0` is recycled to the required length, and must have values which lie in the interval \([0, 1]\).

These functions actually allow for zero-deflation. That is, the resulting probability of a zero count is less than the nominal value of the parent distribution. See `Zipois` for more information.

Author(s)

T. W. Yee

See Also

- `zinegbinomial`, `rnbinom`, `rzipois`.

Examples

```r
munb <- 3; pstr0 <- 0.2; size <- k <- 10; x <- 0:10
(ii <- dzinegbin(x, pstr0 = pstr0, mu = munb, size = k))
max(abs(cumsum(ii) - pzinegbin(x, pstr0 = pstr0, mu = munb, size = k)))
table(rzinegbin(100, pstr0 = pstr0, mu = munb, size = k))
table(qzinegbin(runif(1000), pstr0 = pstr0, mu = munb, size = k))
```
round(dzinegbin(x, pstr0 = pstr0, mu = munb, size = k) * 1000)  # Similar?

## Not run: barplot(rbind(dzinegbin(x, pstr0 = pstr0, mu = munb, size = k),
  dbinom(x, mu = munb, size = k)), las = 1,
  beside = TRUE, col = c("blue", "green"), ylab = "Probability",
  main = paste("ZINB(munb = ", munb, ", k = ", k, ", pstr0 = ", pstr0,
  ", size = ", k, ") (blue) vs NB(munb = ", munb,
  ", size = ", k, ") (green)", sep = ""),
  names.arg = as.character(x))
## End(Not run)

zinegbinomial

Zero-Inflated Negative Binomial Distribution Family Function

Description
Fits a zero-inflated negative binomial distribution by full maximum likelihood estimation.

Usage
zinegbinomial(zero = "size",
  type.fitted = c("mean", "munb", "pobs0", "pstr0",
  "onempstr0"),
  mds.min = 1e-3, nsimEIM = 500, cutoff.prob = 0.999,
  eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
  lpstr0 = "logitlink", lmunb = "loglink", lsize = "loglink",
  imethod = 1, ipstr0 = NULL, imunb = NULL,
  iprobs.y = NULL, isize = NULL,
  gprobs.y = (0:9)/10,
  gsize.mux = exp(c(-30, -20, -15, -10, -6:3)))

zinegbinomialff(lmunb = "loglink", lsize = "loglink", lonempstr0 = "logitlink",
  type.fitted = c("mean", "munb", "pobs0", "pstr0",
  "onempstr0"), imunb = NULL, isize = NULL, lonempstr0 =
  NULL, zero = c("size", "onempstr0"), imethod = 1,
  iprobs.y = NULL, cutoff.prob = 0.999,
  eps.trig = 1e-7, max.support = 4000, max.chunk.MB = 30,
  gprobs.y = (0:9)/10, gsize.mux = exp((-12:6)/2),
  mds.min = 1e-3, nsimEIM = 500)

Arguments
lpstr0, lmunb, lsize
Link functions for the parameters $\phi$, the mean and $k$; see negbinomial for de-
ts, and Links for more choices. For the zero-deflated model see below.

type.fitted
See CommonVGAMffArguments and fittedvlm for more information.
ipstr0, isize, imunb
Optional initial values for $\phi$ and $k$ and $\mu$. The default is to compute an initial
value internally for both. If a vector then recycling is used.
lonempstr0, ionempstr0  
Corresponding arguments for the other parameterization. See details below.

imethod  
An integer with value 1 or 2 or 3 which specifies the initialization method for the mean parameter. If failure to converge occurs try another value. See CommonVGAMffArguments for more information.

zero  
Specifies which linear/additive predictors are to be modelled as intercept-only. They can be such that their absolute values are either 1 or 2 or 3. The default is the φ and k parameters (both for each response). See CommonVGAMffArguments for more information.

nsimEIM  
See CommonVGAMffArguments for information.

iprobs.y, cutoff.prob, max.support, max.chunk.MB  
See negbinomial and/or posnegbinomial for details.

mds.min, eps.trig  
See negbinomial for details.

gprobs.y, gsize.mux  
These arguments relate to grid searching in the initialization process. See negbinomial and/or posnegbinomial for details.

Details

These functions are based on

\[ P(Y = 0) = \phi + (1 - \phi) (k/(k + \mu))^k, \]

and for \( y = 1, 2, \ldots, \)

\[ P(Y = y) = (1 - \phi) \text{dnbinom}(y, \mu, k). \]

The parameter \( \phi \) satisfies \( 0 < \phi < 1 \). The mean of \( Y \) is \( (1 - \phi) \mu \) (returned as the fitted values). By default, the three linear/additive predictors for zinegbinomial() are \((\text{logit}(\phi), \log(\mu), \log(k))^T\). See negbinomial, another VGAM family function, for the formula of the probability density function and other details of the negative binomial distribution.

Independent multiple responses are handled. If so then arguments ipstr0 and isize may be vectors with length equal to the number of responses.

The VGAM family function zinegbinomialff() has a few changes compared to zinegbinomial(). These are: (i) the order of the linear/additive predictors is switched so the NB mean comes first; (ii) onempstr0 is now 1 minus the probability of a structural 0, i.e., the probability of the parent (NB) component, i.e., onempstr0 is 1-pstr0; (iii) argument zero has a new default so that the onempstr0 is intercept-only by default. Now zinegbinomialff() is generally recommended over zinegbinomial(). Both functions implement Fisher scoring and can handle multiple responses.

Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm, and vgam.
Warning

This model can be difficult to fit to data, and this family function is fragile. The model is especially difficult to fit reliably when the estimated \( k \) parameter is very large (so the model approaches a zero-inflated Poisson distribution) or much less than 1 (and gets more difficult as it approaches 0). Numerical problems can also occur, e.g., when the probability of a zero is actually less than, and not more than, the nominal probability of zero. Similarly, numerical problems can occur if there is little or no 0-inflation, or when the sample size is small. Half-stepping is not uncommon. Successful convergence is sensitive to the initial values, therefore if failure to converge occurs, try using combinations of arguments stepsize (in \texttt{vglm.control}), imeth, imumb, ipstr0, isize, and/or zero if there are explanatory variables. Else try fitting an ordinary \texttt{negbinomial} model.

This \texttt{VGAM} family function can be computationally expensive and can run slowly; setting \texttt{trace = TRUE} is useful for monitoring convergence.

Note

Estimated probabilities of a structural zero and an observed zero can be returned, as in \texttt{zipoisson}; see \texttt{fittedvlm} for more information.

If \( k \) is large then the use of \texttt{VGAM} family function \texttt{zipoisson} is probably preferable. This follows because the Poisson is the limiting distribution of a negative binomial as \( k \) tends to infinity.

The zero-deflated negative binomial distribution might be fitted by setting \texttt{lpstr0 = identitylink}, albeit, not entirely reliably. See \texttt{zipoisson} for information that can be applied here. Else try the zero-altered negative binomial distribution (see \texttt{zaneubinomial}).

Author(s)

T. W. Yee

See Also

gaitdnbinomial, Zinegbin, negbinomial, spikeplot, rpois, CommonVGAMffArguments.

Examples

```r
## Not run:
# Example 1
ndata <- data.frame(x2 = runif(nn <- 1000))
ndata <- transform(ndata, pstr0 = logitlink(-0.5 * 1 * x2, inverse = TRUE),
    munb = exp(3 + 1 * x2),
    size = exp(0 + 2 * x2))
ndata <- transform(ndata,
    y l = rzinegbin(nn, mu = munb, size = size, pstr0 = pstr0))
with(ndata, table(yl)["0"]/sum(table(yl)))
nfit <- vglm(yl - x2, zinegbinomial(zero = NULL), data = ndata)
coef(nfit, matrix = TRUE)
summary(nfit)
head(cbind(fitted(nfit), with(ndata, (1 - pstr0) * munb)))
round(vcov(nfit), 3)
```
# Example 2: RR-ZINB could also be called a COZIVGLM-ZINB-2
ndata <- data.frame(x2 = runif(nn <- 2000))
data <- transform(ndata, x3 = runif(nn))
data <- transform(ndata, etal = 3 + 1 * x2 + 2 * x3)
data <- transform(ndata, pstr0 = logitlink(-1.5 + 0.5 * etal, inverse = TRUE),
  mumb = exp(etal),
  size = exp(4))
data <- transform(ndata,
  y1 = rzinegbin(nn, pstr0 = pstr0, mu = mumb, size = size))
with(ndata, table(y1)["0"] / sum(table(y1)))
rrzinb <- rrvglm(y1 ~ x2 + x3, zinegbinomial(zero = NULL), data = ndata,
  Index.corner = 2, str0 = 3, trace = TRUE)
coef(rrzinb, matrix = TRUE)
Coef(rrzinb)
## End(Not run)

---

zipebcom  

**Exchangeable Bivariate cloglog Odds-ratio Model From a Zero-inflated Poisson Distribution**

### Description

Fits an exchangeable bivariate odds-ratio model to two binary responses with a complementary log-log link. The data are assumed to come from a zero-inflated Poisson distribution that has been converted to presence/absence.

### Usage

```r
zipebcom(lmu12 = "clogloglink", lphi12 = "logitlink", loratio = "loglink",
  imu12 = NULL, iphi12 = NULL, ioratio = NULL,
  zero = c("phi12", "oratio"), tol = 0.001, addRidge = 0.001)
```

### Arguments

- `lmu12`, `imu12`  
  Link function, extra argument and optional initial values for the first (and second) marginal probabilities. Argument `lmu12` should be left alone. Argument `imu12` may be of length 2 (one element for each response).
- `lphi12`  
  Link function applied to the $\phi$ parameter of the zero-inflated Poisson distribution (see `zipoisson`). See `Links` for more choices.
- `loratio`  
  Link function applied to the odds ratio. See `Links` for more choices.
- `iphi12`, `ioratio`  
  Optional initial values for $\phi$ and the odds ratio. See `CommonVGAMffArguments` for more details. In general, good initial values (especially for `iphi12`) are often required, therefore use these arguments if convergence failure occurs. If inputted, the value of `iphi12` cannot be more than the sample proportions of zeros in either response.
zero Which linear/additive predictor is modelled as an intercept only? A NULL means none. The default has both $\phi$ and the odds ratio as not being modelled as a function of the explanatory variables (apart from an intercept). See CommonVGAMffArguments for information.

tol Tolerance for testing independence. Should be some small positive numerical value.

addRidge Some small positive numerical value. The first two diagonal elements of the working weight matrices are multiplied by $1 + \text{addRidge}$ to make it diagonally dominant, therefore positive-definite.

Details
This VGAM family function fits an exchangeable bivariate odds ratio model (binom2.or) with a clogloglink link. The data are assumed to come from a zero-inflated Poisson (ZIP) distribution that has been converted to presence/absence. Explicitly, the default model is

$$cloglog[P(Y_j = 1)/(1 - \phi)] = \eta_1,$$  

for the (exchangeable) marginals, and

$$logit[\phi] = \eta_2,$$  

for the mixing parameter, and

$$\log[P(Y_{00} = 1)P(Y_{11} = 1)/(P(Y_{01} = 1)P(Y_{10} = 1))] = \eta_3,$$

specifies the dependency between the two responses. Here, the responses equal 1 for a success and a 0 for a failure, and the odds ratio is often written $\psi = p_{00}p_{11} / (p_{10}p_{01})$. We have $p_{10} = p_{01}$ because of the exchangeability.

The second linear/additive predictor models the $\phi$ parameter (see zipoisson). The third linear/additive predictor is the same as binom2.or, viz., the log odds ratio.

Suppose a dataset1 comes from a Poisson distribution that has been converted to presence/absence, and that both marginal probabilities are the same (exchangeable). Then binom2.or("clogloglink", exch=TRUE) is appropriate. Now suppose a dataset2 comes from a zero-inflated Poisson distribution. The first linear/additive predictor of zipebcom() applied to dataset2 is the same as that of binom2.or("clogloglink", exch=TRUE) applied to dataset1. That is, the $\phi$ has been taken care of by zipebcom() so that it is just like the simpler binom2.or.

Note that, for $\eta_1$, $\mu_{12} = \text{prob12} / (1 - \phi \text{prob12})$ where prob12 is the probability of a 1 under the ZIP model. Here, $\mu_{12}$ correspond to $\mu_1$ and $\mu_2$ in the binom2.or-Poisson model.

If $\phi = 0$ then zipebcom() should be equivalent to binom2.or("clogloglink", exch=TRUE). Full details are given in Yee and Dirnbock (2009).

The leading $2 \times 2$ submatrix of the expected information matrix (EIM) is of rank-1, not 2! This is due to the fact that the parameters corresponding to the first two linear/additive predictors are unidentifiable. The quick fix around this problem is to use the addRidge adjustment. The model is fitted by maximum likelihood estimation since the full likelihood is specified. Fisher scoring is implemented.

The default models $\eta_2$ and $\eta_3$ as single parameters only, but this can be circumvented by setting zero=\text{NULL} in order to model the $\phi$ and odds ratio as a function of all the explanatory variables.
Value

An object of class "vglmff" (see vglmff-class). The object is used by modelling functions such as vglm and vgam.

When fitted, the fitted.values slot of the object contains the four joint probabilities, labelled as \((Y_1, Y_2) = (0,0), (0,1), (1,0), (1,1)\), respectively. These estimated probabilities should be extracted with the fitted generic function.

Warning

The fact that the EIM is not of full rank may mean the model is naturally ill-conditioned. Not sure whether there are any negative consequences wrt theory. For now it is certainly safer to fit binom2.or to bivariate binary responses.

Note

The "12" in the argument names reinforce the user about the exchangeability assumption. The name of this VGAM family function stands for zero-inflated Poisson exchangeable bivariate complementary log-log odds-ratio model or ZIP-EBCOM.

See binom2.or for details that are pertinent to this VGAM family function too. Even better initial values are usually needed here.

The \(x_{ij}\) (see vglm.control) argument enables environmental variables with different values at the two time points to be entered into an exchangeable binom2.or model. See the author's webpage for sample code.

References


See Also

binom2.or, zipoisson, clogloglink, CommonVGAMffArguments.

Examples

```r
zdata <- data.frame(x2 = seq(0, 1, len = (nsites <- 2000)))
zdata <- transform(zdata, etal = -3 + 5 * x2,
                   ph1 = logitlink(-1, inverse = TRUE),
                   oratio = exp(2))
zdata <- transform(zdata, mu12 = clogloglink(eta1, inverse = TRUE) * (1-ph1))
tmat <- with(zdata, rbinom2.or(nsites, mu1 = mu12, oratio = oratio, exch = TRUE))
zdata <- transform(zdata, ybin1 = tmat[, 1], ybin2 = tmat[, 2])

with(zdata, table(ybin1, ybin2)) / nsites # For interest only
## Not run:
# Various plots of the data, for interest only
par(mfrow = c(2, 2))
plot(jitter(ybin1) ~ x2, data = zdata, col = "blue")
```

Zipf

The Zipf Distribution

Description

Density, distribution function, quantile function and random generation for the Zipf distribution.

Usage

dzipf(x, N, shape, log = FALSE)
pzipf(q, N, shape, log.p = FALSE)
qzipf(p, N, shape)
rzipf(n, N, shape)

Arguments

x, q, p, n  Same as Poisson.
N, shape  the number of elements, and the exponent characterizing the distribution. See zipf for more details.
log, log.p  Same meaning as in Normal.

Details

This is a finite version of the zeta distribution. See zetaff for more details. In general, these functions runs slower and slower as N increases.

Value

dzipf gives the density, pzipf gives the cumulative distribution function, qzipf gives the quantile function, and rzipf generates random deviates.
Author(s)
T. W. Yee

See Also
zipf, Zipfmb.

Examples
N <- 10; shape <- 0.5; y <- 1:N
proby <- dzipf(y, N = N, shape = shape)
## Not run: plot(proby ~ y, type = "h", col = "blue",
 ylim = c(0, 0.2), ylab = "Probability", lwd = 2, las = 1,
 main = paste0("Zipf(N = ", N, ", shape = ", shape, ")))
## End(Not run)
sum(proby) # Should be 1
max(abs(cumsum(proby) - pzipf(y, N = N, shape = shape))) # 0?

zipf
Zipf Distribution Family Function

Description
Estimates the parameter of the Zipf distribution.

Usage
zipf(N = NULL, lshape = "loglink", ishape = NULL)

Arguments
N
Number of elements, an integer satisfying 1 < N < Inf. The default is to use the
maximum value of the response. If given, N must be no less that the largest
response value. If N = Inf and s > 1 then this is the zeta distribution (use
zetaff instead).

lshape
Parameter link function applied to the (positive) shape parameter s. See Links
for more choices.

ishape
Optional initial value for the parameter s. The default is to choose an initial
value internally. If converge failure occurs use this argument to input a value.

Details
The probability function for a response Y is

\[ P(Y = y) = y^{-s} / \sum_{i=1}^{N} i^{-s}, \quad s > 0, \quad y = 1, 2, \ldots, N, \]
where $s$ is the exponent characterizing the distribution. The mean of $Y$, which are returned as the fitted values, is $\mu = H_{N,s-1}/H_{N,s}$ where $H_{n,m} = \sum_{i=1}^{m} i^{-n}$ is the $n$th generalized harmonic number.

Zipf’s law is an experimental law which is often applied to the study of the frequency of words in a corpus of natural language utterances. It states that the frequency of any word is inversely proportional to its rank in the frequency table. For example, “the” and “of” are first two most common words, and Zipf’s law states that “the” is twice as common as “of”. Many other natural phenomena conform to Zipf’s law.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm` and `vgam`.

**Note**

Upon convergence, the $N$ is stored as `@misc$N`.

**Author(s)**

T. W. Yee

**References**


**See Also**

`dzipf`, `zetaff`, `simulate.vlm`.

**Examples**

```r
zdata <- data.frame(y = 1:5, ofreq = c(63, 14, 5, 1, 2))
zfit <- vglm(y ~ 1, zipf, data = zdata, trace = TRUE, weight = ofreq)
zfit <- vglm(y ~ 1, zipf(lshape = "identitylink", ishape = 3.4), data = zdata, trace = TRUE, weight = ofreq, crit = "coef")
zfit@misc$N
(shape.hat <- Coef(zfit))
with(zdata, weighted.mean(y, ofreq))
fitted(zfit, matrix = FALSE)
```
The Zipf-Mandelbrot Distribution

Description

Density, distribution function, quantile function and random generation for the Mandelbrot distribution.

Usage

dzipfmb(x, shape, start = 1, log = FALSE)
pzipfmb(q, shape, start = 1, lower.tail = TRUE, log.p = FALSE)
qzipfmb(p, shape, start = 1)
rzipfmb(n, shape, start = 1)

Arguments

- **x**: vector of (non-negative integer) quantiles.
- **q**: vector of quantiles.
- **p**: vector of probabilities.
- **n**: number of random values to return.
- **shape**: vector of positive shape parameter.
- **start**: integer, the minimum value of the support of the distribution.
- **log, log.p**: logical; if TRUE, probabilities p are given as log(p)
- **lower.tail**: logical; if TRUE (default), probabilities are P[X <= x], otherwise, P[X > x].

Details

The probability mass function of the Zipf-Mandelbrot distribution is given by

\[
\Pr(Y = y; s) = \frac{s \, \Gamma(y_{\min})}{\Gamma(y_{\min} - s)} \cdot \frac{\Gamma(y - s)}{\Gamma(y + 1)}
\]

where \(0 \leq b < 1\) and the starting value start being by default 1.

Value

dzipfmb gives the density, pzipfmb gives the distribution function, qzipfmb gives the quantile function, and rzipfmb generates random deviates.

Author(s)

M. Chou, with edits by T. W. Yee.
References


See Also

Zipf.

Examples

```r
aa <- 1:10
(pp <- pzipfmb(aa, shape = 0.5, start = 1))
cumsum(dzipfmb(aa, shape = 0.5, start = 1))  # Should be same
qzipfmb(pp, shape = 0.5, start = 1) - aa  # Should be all 0s
rdiffzeta(30, 0.5)
```

## Not run: x <- 1:10
```
plot(x, dzipfmb(x, shape = 0.5), type = "h", ylim = 0:1,
    sub = "shape=0.5", las = 1, col = "blue", ylab = "Probability",
    main = "Zipf-Mandelbrot distribution: blue=PMF; orange=CDF")
lines(x+0.1, pzipfmb(x, shape = 0.5), col = "red", lty = 3, type = "h")
```

## End(Not run)

---

## Zipois

### Zero-Inflated Poisson Distribution

**Description**

Density, distribution function, quantile function and random generation for the zero-inflated and zero-deflated Poisson distribution with parameter pstr0.

**Usage**

```r
dzipois(x, lambda, pstr0 = 0, log = FALSE)
pzipois(q, lambda, pstr0 = 0)
qzipois(p, lambda, pstr0 = 0)
rzipois(n, lambda, pstr0 = 0)
```
Arguments

\(x, q\) vector of quantiles.
\(p\) vector of probabilities.
\(n\) number of observations. Must be a single positive integer.
\(\lambda\) Vector of positive means.
\(pstr0\) Probability of a structural zero (i.e., ignoring the Poisson distribution), called \(\phi\). The default value of \(\phi = 0\) corresponds to the response having an ordinary Poisson distribution. If \(\phi\) lies in \((0, 1)\) then this is known as the zero-inflated Poisson (ZIP) distribution. This argument may be negative to allow for 0-deflation, hence its interpretation as a probability ceases.
\(\log\) Logical. Return the logarithm of the answer?

Details

The probability function of \(Y\) is 0 with probability \(\phi\), and \(\text{Poisson}(\lambda)\) with probability \(1 - \phi\). Thus

\[P(Y = 0) = \phi + (1 - \phi)P(W = 0)\]

where \(W\) is distributed \(\text{Poisson}(\lambda)\).

Value

dzipois gives the density, pzipois gives the distribution function, qzipois gives the quantile function, and rzipois generates random deviates.

Note

The argument \(pstr0\) is recycled to the required length, and must have values which lie in the interval \([0, 1]\).

These functions actually allow for the zero-deflated Poisson (ZDP) distribution. Here, \(pstr0\) is also permitted to lie in the interval \([-1/\expm1(\lambda), 0]\]. The resulting probability of a zero count is less than the nominal Poisson value, and the use of \(pstr0\) to stand for the probability of a structural zero loses its meaning. When \(pstr0\) equals \(-1/\expm1(\lambda)\) this corresponds to the positive-Poisson distribution (e.g., see \(\text{Gaitdpois}\)), also called the zero-truncated Poisson or ZTP.

The zero-modified Poisson (ZMP) is a combination of the ZIP and ZDP and ZTP distributions. The family function

Author(s)

T. W. Yee

See Also

\(\text{zipoisson, Gaitdpois, dpois, rzinegbin}\).
Examples

```r
lambda <- 3; pstr0 <- 0.2; x <- (-1):7
(ii <- dzipois(x, lambda, pstr0 = pstr0))
max(abs(cumsum(ii) -pzipois(x, lambda, pstr0 = pstr0))) # 0?
table(rzipois(100, lambda, pstr0 = pstr0))

## Not run: x <- 0:10
par(mfrow = c(2, 1)) # Zero-inflated Poisson
barplot(rbind(dzipois(x, lambda, pstr0 = pstr0), dpois(x, lambda)),
beside = TRUE, col = c("blue", "orange"),
main = paste0("ZIP(", lambda,
" , pstr0 = ", pstr0, ") (blue) vs",
" Poisson(" , lambda, ") (orange)")),
names.arg = as.character(x))
```
Arguments

lpstr0, llambda
Link function for the parameter \( \phi \) and the usual \( \lambda \) parameter. See Links for more choices; see CommonVGAMffArguments for more information. For the zero-deflated model see below.

ipstr0, ilambda
Optional initial values for \( \phi \), whose values must lie between 0 and 1. Optional initial values for \( \lambda \), whose values must be positive. The defaults are to compute an initial value internally for each. If a vector then recycling is used.

lonempstr0, ionempstr0
Corresponding arguments for the other parameterization. See details below.

type.fitted
Character. The type of fitted value to be returned. The first choice (the expected value) is the default. The estimated probability of an observed 0 is an alternative, else the estimated probability of a structural 0, or one minus the estimated probability of a structural 0. See CommonVGAMffArguments and fittedvlm for more information.

imethod
An integer with value 1 or 2 which specifies the initialization method for \( \lambda \). If failure to converge occurs try another value and/or else specify a value for ishrinkage and/or else specify a value for ipstr0. See CommonVGAMffArguments for more information.

ishrinkage
How much shrinkage is used when initializing \( \lambda \). The value must be between 0 and 1 inclusive, and a value of 0 means the individual response values are used, and a value of 1 means the median or mean is used. This argument is used in conjunction with imethod. See CommonVGAMffArguments for more information.

zero
Specifies which linear/additive predictors are to be modelled as intercept-only. If given, the value can be either 1 or 2, and the default is none of them. Setting zero = 1 makes \( \phi \) a single parameter. See CommonVGAMffArguments for more information.

gpstr0, gonempstr0, probs.y
Details at CommonVGAMffArguments.

parallel
Details at CommonVGAMffArguments, but unlikely to be practically used actually.

Details

These models are a mixture of a Poisson distribution and the value 0; it has value 0 with probability \( \phi \) else is Poisson(\( \lambda \)) distributed. Thus there are two sources for zero values, and \( \phi \) is the probability of a structural zero. The model for zipoisson() can be written

\[
P(Y = 0) = \phi + (1 - \phi) \exp(-\lambda),
\]

and for \( y = 1, 2, ..., \)

\[
P(Y = y) = (1 - \phi) \exp(-\lambda) \lambda^y/y!.
\]

Here, the parameter \( \phi \) satisfies \( 0 < \phi < 1 \). The mean of \( Y \) is \( (1 - \phi)\lambda \) and these are returned as the fitted values, by default. The variance of \( Y \) is \( (1 - \phi)\lambda(1 + \phi\lambda) \). By default, the two linear/additive predictors of zipoisson() are \((\text{logit}(\phi), \log(\lambda))^T\).
The VGAM family function `zipoissonff()` has a few changes compared to `zipoisson()`. These are: (i) the order of the linear/additive predictors is switched so the Poisson mean comes first; (ii) `onempstr0` is now 1 minus the probability of a structural 0, i.e., the probability of the parent (Poisson) component, i.e., `onempstr0` is `1-pstr0`; (iii) argument `zero` has a new default so that the `onempstr0` is intercept-only by default. Now `zipoissonff()` is generally recommended over `zipoisson()` (and definitely recommended over `yip88`). Both functions implement Fisher scoring and can handle multiple responses.

Both family functions can fit the zero-modified Poisson (ZMP), which is a combination of the ZIP and zero-deflated Poisson (ZDP); see `Zipois` for some details and the example below. The key is to set the link function to be `identitylink`. However, problems might occur when iterations get close to or go past the boundary of the parameter space, especially when there are covariates. The PMF of the ZMP is best written not as above but in terms of `onempstr0` which may be greater than unity; when using `pstr0` the above PMF is negative for non-zero values.

**Value**

An object of class "vglmff" (see `vglmff-class`). The object is used by modelling functions such as `vglm`, `rrvglm` and `vgam`.

**Warning**

Numerical problems can occur, e.g., when the probability of zero is actually less than, not more than, the nominal probability of zero. For example, in the Angers and Biswas (2003) data below, replacing 182 by 1 results in nonconvergence. Half-stepping is not uncommon. If failure to converge occurs, try using combinations of `imethod`, `ishrinkage`, `ipstr0`, and/or `zipoisson(zero = 1)` if there are explanatory variables. The default for `zipoissonff()` is to model the structural zero probability as an intercept-only.

**Note**

This family function can be used to estimate the 0-deflated model, hence `pstr0` is not to be interpreted as a probability. One should set, e.g., `lpstr0 = "identitylink"`. Likewise, the functions in `Zipois` can handle the zero-deflated Poisson distribution too. Although the iterations might fall outside the parameter space, the `validparams` slot should keep them inside. A (somewhat) similar alternative for zero-deflation is to try the zero-altered Poisson model (see `zapoission`).

The use of this VGAM family function with `rrvglm` can result in a so-called COZIGAM or CO-ZIGLM. That is, a reduced-rank zero-inflated Poisson model (RR-ZIP) is a constrained zero-inflated generalized linear model. See what used to be `COZIGAM` on CRAN. A RR-ZINB model can also be fitted easily; see `zinegbinomial`. Jargon-wise, a COZIGLM might be better described as a COZIVGLM-ZIP.

**Author(s)**

T. W. Yee

**References**


See Also

gaitdpoisson, zapoisson, Zipois, yip88, spikeplot, lpossums, rrvglm, negbinomial, zipebcom, rpois, simulate.vlm, hdeff.vglm.

Examples

```r
# Example 1: simulated ZIP data
zdata <- data.frame(x2 = runif(nn <- 1000))
zdata <- transform(zdata,
  pstr01 = logitlink(-0.5 + 1*x2, inverse = TRUE),
  pstr02 = logitlink( 0.5 - 1*x2, inverse = TRUE),
  Ps01 = logitlink(-0.5 , inverse = TRUE),
  Ps02 = logitlink( 0.5 , inverse = TRUE),
  lambda1 = loglink(-0.5 + 2*x2, inverse = TRUE),
  lambda2 = loglink( 0.5 + 2*x2, inverse = TRUE))
zdata <- transform(zdata, y1 = rzipois(nn, lambda1, pstr0 = Ps01),
  y2 = rzipois(nn, lambda2, pstr0 = Ps02))

with(zdata, table(y1)) # Eyeball the data
with(zdata, table(y2))

fit1 <- vglm(y1 ~ x2, zipoisson(zero = 1), zdata, crit = "coef")
fit2 <- vglm(y2 ~ x2, zipoisson(zero = 1), zdata, crit = "coef")
coef(fit1, matrix = TRUE) # Should agree with the above values
coef(fit2, matrix = TRUE) # Should agree with the above values

# Fit all two simultaneously, using a different parameterization:
fit12 <- vglm(cbind(y1, y2) ~ x2, zipoissonff, zdata, crit = "coef")
coef(fit12, matrix = TRUE) # Should agree with the above values

# For the first observation compute the probability that y1 is
# due to a structural zero.
(fitted(fit1, type = "pstr0") / fitted(fit1, type = "pobs0"))[1]
```

# Example 2: McKendrick (1925). From 223 Indian village households
cholera <- data.frame(ncases = 0:4, # Number of cholera cases,
  wfreq = c(168, 32, 16, 6, 1)) # Frequencies
fit <- vglm(ncases ~ 1, zipoisson, wei = wfreq, cholera)
coef(fit, matrix = TRUE)
with(cholera, cbind(actual = wfreq,
  fitted = round(dzipois(ncases, Coef(fit)[2],
```
The Zero/One-Inflated Beta Distribution

Description

Density, distribution function, and random generation for the zero/one-inflated beta distribution.
Usage

dzoabeta(x, shape1, shape2, pobs0 = 0, pobs1 = 0, log = FALSE, tol = .Machine$double.eps)
pzoabeta(q, shape1, shape2, pobs0 = 0, pobs1 = 0, lower.tail = TRUE, log.p = FALSE, tol = .Machine$double.eps)
qzoabeta(p, shape1, shape2, pobs0 = 0, pobs1 = 0, lower.tail = TRUE, log.p = FALSE, tol = .Machine$double.eps)
rzoabeta(n, shape1, shape2, pobs0 = 0, pobs1 = 0, tol = .Machine$double.eps)

Arguments

- x, q, p, n: Same as Beta.
- pobs0, pobs1: vector of probabilities that 0 and 1 are observed ($\omega_0$ and $\omega_1$).
- shape1, shape2: Same as Beta. They are called a and b in beta respectively.
- lower.tail, log, log.p: Same as Beta.
- tol: Numeric, tolerance for testing equality with 0 and 1.

Details

This distribution is a mixture of a discrete distribution with a continuous distribution. The cumulative distribution function of $Y$ is

$$F(y) = (1 - \omega_0 - \omega_1)B(y) + \omega_0 \times I[0 \leq y] + \omega_1 \times I[1 \leq y]$$

where $B(y)$ is the cumulative distribution function of the beta distribution with the same shape parameters `pbeta`, $\omega_0$ is the inflated probability at 0 and $\omega_1$ is the inflated probability at 1. The default values of $\omega_j$ mean that these functions behave like the ordinary Beta when only the essential arguments are inputted.

Value

dzoabeta gives the density, pzoabeta gives the distribution function, qzoabeta gives the quantile, and rzoabeta generates random deviates.

Author(s)

Xiangjie Xue and T. W. Yee

See Also

Examples

```r
## Not run:
N <- 1000; y <- rzoabeta(N, 2, 3, 0.2, 0.2)
hist(y, probability = TRUE, border = "blue", las = 1,
     main = "Blue = 0- and 1-altered; orange = ordinary beta")
sum(y == 0) / N # Proportion of 0s
sum(y == 1) / N # Proportion of 1s
Ngrid <- 1000
lines(seq(0, 1, length = Ngrid),
     dbeta(seq(0, 1, length = Ngrid), 2, 3), col = "orange")
lines(seq(0, 1, length = Ngrid), col = "blue",
     dzoabeta(seq(0, 1, length = Ngrid), 2, 3, 0.2, 0.2))
## End(Not run)
```

zoabetaR

Zero- and One-Inflated Beta Distribution Family Function

Description

Estimation of the shape parameters of the two-parameter beta distribution plus the probabilities of a 0 and/or a 1.

Usage

```r
zoabetaR(lshape1 = "loglink", lshape2 = "loglink", lpobs0 = "logitlink",
          lpobs1 = "logitlink", ishape1 = NULL, ishape2 = NULL, trim = 0.05,
          type.fitted = c("mean", "pobs0", "pobs1", "beta.mean"),
          parallel.shape = FALSE, parallel.pobs = FALSE, zero = NULL)
```

Arguments

- `lshape1, lshape2`: Details at `CommonVGAMffArguments`. See `Links` for more choices.
- `ishape1, ishape2`: Details at `CommonVGAMffArguments`.
- `trim`: Same as `betaR`. See `CommonVGAMffArguments` for information.
- `parallel.shape, parallel.pobs`: See `CommonVGAMffArguments` for more information.
- `type.fitted`: The choice "beta.mean" mean to return the mean of the beta distribution; the 0s and 1s are ignored. See `CommonVGAMffArguments` for more information.
Details

The standard 2-parameter beta distribution has a support on (0,1), however, many datasets have 0 and/or 1 values too. This family function handles 0s and 1s (at least one of them must be present) in the data set by modelling the probability of a 0 by a logistic regression (default link is the logit), and similarly for the probability of a 1. The remaining proportion, 1-pobs0-pobs1, of the data comes from a standard beta distribution. This family function therefore extends betaR. One has \( M = 3 \) or \( M = 4 \) per response. Multiple responses are allowed.

Value

Similar to betaR.

Author(s)

Thomas W. Yee and Xiangjie Xue.

See Also

Zoabeta, betaR, betaff, Beta, zipoisson.

Examples

```r
nn <- 1000; set.seed(1)
bdata <- data.frame(x2 = runif(nn))
bdata <- transform(bdata,
  pobs0 = logitlink(-2 + x2, inverse = TRUE),
  pobs1 = logitlink(-2 + x2, inverse = TRUE))
bdata <- transform(bdata,
  y1 = rzoabeta(nn, shape1 = exp(1 + x2), shape2 = exp(2 - x2),
               pobs0 = pobs0, pobs1 = pobs1))
summary(bdata)
fit1 <- vglm(y1 ~ x2, zoabetaR(parallel.pobs = TRUE),
             data = bdata, trace = TRUE)
coef(fit1, matrix = TRUE)
summary(fit1)
```
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