Package ‘effects’

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Depends R (>= 3.5.0), carData
Suggests pbkrtest (>= 0.4-4), nlme, MASS, poLCA, heplots, splines, ordinal, car, knitr, betareg, alr4
Imports lme4, nnet, lattice, grid, colorspace, graphics, grDevices, stats, survey, utils, estimability
LazyLoad yes
LazyData yes
Description Graphical and tabular effect displays, e.g., of interactions, for various statistical models with linear predictors.
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VignetteBuilder knitr
Author John Fox [aut, cre], Sanford Weisberg [aut], Brad Price [aut], Michael Friendly [aut], Jangman Hong [aut], Robert Andersen [ctb], David Firth [ctb], Steve Taylor [ctb], R Core Team [ctb]
Maintainer John Fox <jfox@mcmaster.ca>
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Description

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Details

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LazyData: yes
License: GPL (>= 2)
URL: https://www.r-project.org, http://socserv.socsci.mcmaster.ca/jfox/

This package creates effect displays for various kinds of models, as partly explained in the references. Typical usage is plot(allEffects(model)) or plot(predictorEffects(model)), where model is an appropriate fitted-model object. Additional arguments to allEffects, predictorEffects and plot can be used to customize the resulting displays. The function effect can be employed to produce an effect display for a particular term in the model, or to which terms in the model are marginal. The function predictorEffect can be used to construct an effect display for a particularly predictor. The function Effect may similarly be used to produce an effect display for any
combination of predictors. In any of the cases, use lattice to graph the resulting effect object. For linear and generalized linear models it is also possible to plot partial residuals to obtain (multidimensional) component+residual plots. See ?effect, ?Effect, ?predictorEffect, and ?plot.eff for details.

Author(s)
John Fox, Sanford Weisberg, Michael Friendly, Jangman Hong, Robert Anderson, David Firth, Steve Taylor, and the R Core Team.
Maintainer: John Fox <jfox@mcmaster.ca>

References

Description

Effect and effect construct an "eff" object for a term (usually a high-order term) in a linear model (fit by lm or gls) or generalized linear model (fit by glm), or an "effpoly" object for a term in a multinomial or proportional-odds logit model (fit respectively by multinom or polr), absorbing the lower-order terms marginal to the term in question, and averaging over other terms in the model. For multivariate linear models (of class "mlm", fit by lm), the function constructs a list of "eff" objects separately for the various response variables.

effect builds the required object by specifying explicitly a focal term like "a:b" for an a by b interaction. Effect specifies the predictors in the term, for example c("a", "b"), rather than the term itself. Effect is consequently more flexible and robust than effect, and will succeed with some models for which effect fails. The effect function works by constructing a call to Effect.

The Effect and effect functions can also be used with many other models; see Effect.default and the Defining Effect Methods for Other Models vignette.
allEffects identifies all of the high-order terms in a model and returns a list of "eff" or "effpoly" objects (i.e., an object of type "efflist").

For information on computing and displaying predictor effects, see predictorEffect and plot.predictoreff.

For further information about plotting effects, see plot.eff.

**Usage**

effect(term, mod, vcov.=vcov, ...)

## Default S3 method:
effect(term, mod, vcov.=vcov, ...)

Effect(focal.predictors, mod, ...)

## S3 method for class 'lm'
Effect(focal.predictors, mod, xlevels=list(),
    fixed.predictors, vcov. = vcov, se=TRUE,
    residuals=FALSE, quantiles=seq(0.2, 0.8, by=0.2),
    x.var=NULL, ...,
    #legacy arguments:
    given.values, typical, offset, confint, confidence.level,
    partial.residuals, transformation)

## S3 method for class 'multinom'
Effect(focal.predictors, mod,
    xlevels=list(), fixed.predictors,
    vcov. = vcov, se=TRUE, ...,
    #legacy arguments:
    confint, confidence.level, given.values, typical)

## S3 method for class 'polr'
Effect(focal.predictors, mod,
    xlevels=list(), fixed.predictors,
    vcov. = vcov, se=TRUE, latent=FALSE, ...,
    #legacy arguments:
    confint, confidence.level, given.values, typical)

## S3 method for class 'svyglm'
Effect(focal.predictors, mod, fixed.predictors, ...)

allEffects(mod, ...)

## Default S3 method:
allEffects(mod, ...)
Arguments

term
the quoted name of a term, usually, but not necessarily, a high-order term in
the model. The term must be given exactly as it appears in the printed model,
although either colons (:) or asterisks (*) may be used for interactions. If term
is NULL, the function returns the formula for the linear predictor.

focal.predictors
a character vector of one or more predictors in the model in any order.

mod
an object of the appropriate class. If no method exists for that class, Effect.default
will be called.

xlevels
this argument is used to set the number of levels for any focal predictor that
is not a factor (where character and logical predictors are treated as factors).
If xlevels=NULL, then each numeric predictor is represented by five values
equally spaced over its range and then rounded to 'nice' numbers. If xlevels=n
is an integer, then each numeric predictor is represented by n equally spaced val-
ues rounded to 'nice' numbers. More generally, xlevels can be a named list of
values at which to set each numeric predictor. For example, xlevels=list(x1=c(2,4,7),x2=5)
would use the values 2, 4 and 7 for the levels of x1, use 5 equally spaced lev-
els for the levels of x2, and use the default for any other numeric predictors.
If partial residuals are computed, then the focal predictor that is to appear on
the horizontal axis of an effect plot is evaluated at 100 equally spaced values
along its full range, and, by default, other numeric predictors are evaluated at
the quantiles specified in the quantiles argument, unless their values are given
explicitly in xlevels.

fixed.predictors
an optional list of specifications affecting the values at which fixed predictors
for an effect are set, potentially including:

given.values  given.values="default" specifies averaging over levels of a
non-focal factor using the default that weights levels of the factor by sample
size. given.values="equal" uses unweighted averages over factor levels
for non-focal factors. For finer control, the user can also provide a named
numeric vector of weights for particular columns of the model matrix that
correspond to regressors for the factor. Character and logical predictors are
treated as factors. For example, for a factor X with three levels a, b and
c, the regressors generated using the default parameterization for a factor
will be named Xb and Xc as the regressor for level a is usually excluded.
The specification given.values=c(Xb=1/2,Xc=1/4) would average over
the levels of X with weight 1/2 for level b, 1/4 for c, and weight 1 = 1/2 -
1/4 = 1/4 for the baseline level a. Setting given.values=c(Xb=1) will fix
X and level b.

typical  a function to be applied to the columns of the model matrix over which
the effect is "averaged"; with the exception of the "svyglm" method, the
default is mean. For "svyglm" objects, the default is to use the survey-design
weighted mean.

apply.typical.to.factors  It generally doesn't make sense to apply typical val-
ues that aren't means (e.g., medians) to the columns of the model-matrix
representing contrasts for factors. This value generally defaults to FALSE
except for "svyglm" objects, for which the default is TRUE, using the survey-design weighted mean.

**offset** a function to be applied to the offset values (if there is an offset) in a linear or generalized linear model, or a mixed-effects model fit by lmer or glmer; or a numeric value, to which the offset will be set. The default is the mean function, and thus the offset will be set to its mean; in the case of "svyglm" objects, the default is to use the survey-design weighted mean.

**Note:** Only offsets defined by the offset argument to lm, glm, svyglm, lmer, or glmer will be handled correctly; use of the offset function in the model formula is not supported.

**vcov.** A function or the name of a function that will be used to get the estimated variance-covariance matrix of the estimated coefficients. This will ordinarily be the default, vcov, which will result in the function call vcov(mod) to get the variance-covariance matrix. You can use the name of any function that takes the model object as its first argument and returns an estimated sample covariance matrix, such as the hccm function in the car package, which returns a heteroscedasticity corrected estimate for a linear model.

**se** TRUE (the default), FALSE, or a list with any or all of the following elements, controlling whether and how standard errors and confidence limits are computed for the effects: compute (default TRUE), whether or not to compute standard errors and confidence limits; level (default 0.95), confidence level for confidence limits; type, one of "pointwise" (the default), "scheffe", or "scheffe", whether to compute confidence limits with specified coverage at each point for an effect or to compute limits for a Scheffe-type confidence envelope. For mer, merMod, and lme objects, the normal distribution is used to get confidence limits.

**residuals** if TRUE, residuals for a linear or generalized linear model will be computed and saved; if FALSE (the default), residuals are suppressed. If residuals are saved, partial residuals are computed when the effect is plotted: see plot.eff and the vignette Effect Displays with Partial Residuals. This argument may also be used for mixed-effects and some other models.

**quantiles** quantiles at which to evaluate numeric focal predictors not on the horizontal axis, used only when partial residuals are displayed; superceded if the xlevels argument gives specific values for a predictor.

**x.var** the name or index of the numeric predictor to define the horizontal axis of an effect plot for a linear or generalized linear model; the default is NULL, in which case the first numeric predictor in the effect will be used if partial residuals are to be computed. This argument is intended to be used when residuals is TRUE; otherwise, the variable on the horizontal axis can be chosen when the effect object is plotted: see plot.eff.

**latent** if TRUE, effects in a proportional-odds logit model are computed on the scale of the latent response; if FALSE (the default) effects are computed as individual-level probabilities and logits.

**x** an object of class "eff", "effpoly", or "efflatent".

... arguments to be passed down.

**confint, confidence.level, given.values, typical, offset, partial.residuals, transformation** legacy arguments retained for backwards compatibility; if present, these arguments take precedence over level element of the confint list argument and the
given values, typical, and offset elements of the fixed predictors list argument; confint may be used in place of the se argument; partial residuals may be used in place of the residuals argument. See LegacyArguments for details.

Details

Normally, the functions to be used directly are allEffects, to return a list of high-order effects, and the generic plot function to plot the effects. (see plot.efflist, plot.eff, and plot.effpoly). Alternatively, Effect can be used to vary a subset of predictors over their ranges, while other predictors are held to typical values. Plots are drawn using the xyplot (or in some cases, the densityplot) function in the lattice package. Effects may also be printed (implicitly or explicitly via print) or summarized (using summary) (see print.efflist, summary.efflist, print.eff, summary.eff, print.effpoly, and summary.effpoly).

If asked, the effect function will compute effects for terms that have higher-order relatives in the model, averaging over those terms (which rarely makes sense), or for terms that do not appear in the model but are higher-order relatives of terms that do. For example, for the model Y ~ A*B + A*C + B*C, one could compute the effect corresponding to the absent term A:B:C, which absorbs the constant, the A, B, and C main effects, and the three two-way interactions. In either of these cases, a warning is printed.

See predictorEffects for an alternative paradigm for getting effects.

Value

For lm, glm, svyglm, mer and lme, effect and Effect return an "eff" object, and for multinom, polr, clm, clmm and clm2, an "effpoly" object, with the components listed below. For an "mlm" object with one response specified, an "eff" object is returned, otherwise an "efflist" object is returned, containing one "eff" object for each response.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>term</td>
<td>the term to which the effect pertains.</td>
</tr>
<tr>
<td>formula</td>
<td>the complete model formula.</td>
</tr>
<tr>
<td>response</td>
<td>a character string giving the name of the response variable.</td>
</tr>
<tr>
<td>y.levels</td>
<td>(for &quot;effpoly&quot; objects) levels of the polytomous response variable.</td>
</tr>
<tr>
<td>variables</td>
<td>a list with information about each predictor, including its name, whether it is a factor, and its levels or values.</td>
</tr>
<tr>
<td>fit</td>
<td>(for &quot;eff&quot; objects) a one-column matrix of fitted values, representing the effect on the scale of the linear predictor; this is a ravelled table, representing all combinations of predictor values.</td>
</tr>
<tr>
<td>prob</td>
<td>(for &quot;effpoly&quot; objects) a matrix giving fitted probabilities for the effect for the various levels of the the response (columns) and combinations of the focal predictors (rows).</td>
</tr>
<tr>
<td>logit</td>
<td>(for &quot;effpoly&quot; objects) a matrix giving fitted logits for the effect for the various levels of the the response (columns) and combinations of the focal predictors (rows).</td>
</tr>
<tr>
<td>x</td>
<td>a data frame, the columns of which are the predictors in the effect, and the rows of which give all combinations of values of these predictors.</td>
</tr>
</tbody>
</table>
model.matrix  the model matrix from which the effect was calculated.
data  a data frame with the data on which the fitted model was based.
discrepancy  the percentage discrepancy for the ‘safe’ predictions of the original fit; should be very close to 0. Note: except for gls models, this is now necessarily 0.
offset  value to which the offset is fixed; 0 if there is no offset.
model  (for "effpoly" objects) "multinom" or "polr", as appropriate.
vcov  (for "eff" objects) a covariance matrix for the effect, on the scale of the linear predictor.
se  (for "eff" objects) a vector of standard errors for the effect, on the scale of the linear predictor.
se.prob, se.logit  (for "effpoly" objects) matrices of standard errors for the effect, on the probability and logit scales.
lower, upper  (for "eff" objects) one-column matrices of confidence limits, on the scale of the linear predictor.
lower.prob, upper.prob, lower.logit, upper.logit  (for "effpoly" objects) matrices of confidence limits for the fitted logits and probabilities; the latter are computed by transforming the former.
confidence.level  for the confidence limits.
transformation  (for "eff" objects) a two-element list, with element link giving the link function, and element inverse giving the inverse-link (mean) function.
residuals  (working) residuals for linear or generalized linear models, to be used by plot.eff to plot partial residuals.
x.var  the name of the predictor to appear on the horizontal axis of an effect plot made from the returned object; will usually be NULL if partial residuals aren’t computed.
family  for a "glm" model, the name of the distributional family of the model; for an "lm" model, this is "gaussian"; otherwise NULL. The family controls how partial residuals are smoothed in plots.
link  the value returned by family(mod). Down-stream methods may need the link, inverse link and derivative functions.

allEffects returns an "efflist" object, a list of "eff" or "effpoly" objects corresponding to the high-order terms of the model.

If mod is of class "polCA" (from the polCA package), representing a polytomous latent class model, effects are computed for the predictors given the estimated latent classes. The result is of class "eff" if the latent class model has 2 categories and of class "effpoly" with more than 2 categories.

**Warnings and Limitations**

The Effect function handles factors and covariates differently, and is likely to be confused if one is changed to the other in a model formula. Consequently, formulas that include calls to as.factor, factor, or numeric (as, e.g., in y ~ as.factor(income)) will cause errors. Instead, create the
modified variables outside of the model formula (e.g., `fincome <- as.factor(income)`) and use these in the model formula.

Factors cannot have colons in level names (e.g., "level:A"); the effect function will confuse the colons with interactions; rename levels to remove or replace the colons (e.g., "level.A").

The functions in the effects package work properly with predictors that are numeric variables, factors, character variables, or logical variables; consequently, e.g., convert dates to numeric. Character predictors and logical predictors are treated as factors, the latter with "levels" "FALSE" and "TRUE".

Empty cells in crossed-factors are now permitted for "lm", "glm", and "multinom" models. For "multinom" models with two or more crossed factors with an empty cell, stacked area plots apparently do not work because of a bug in the barchart function in the lattice package. However, the default line plots do work.

Offsets in linear and generalized linear models are supported, as are offsets in mixed models fit by lmer or glmer, but must be supplied through the offset argument to lm, glm, lmer or glmer; offsets supplied via calls to the offset function on the right-hand side of the model formula are not supported.

Fitting ordinal mixed-models using clmm or clmm2 permits many options, including a variety of link functions, scale functions, nominal regressors, and various methods for setting thresholds. Effects are currently generated only for the default values of the arguments scale, nominal, link and threshold, which is equivalent to fitting an ordinal response mixed model with a logit link. The effect methods can also be used with objects created using clm or clm2 fitting ordinal response models with the same links permitted by polr with no random effects, with results similar to those from polr in the MASS package.

Calling any of these functions from within a user-written function may result in errors due to R’s scoping rules. See the vignette embedding.pdf for the car package for a solution to this problem.

Author(s)

John Fox <jfox@mcmaster.ca>, Sanford Weisberg <sandy@umn.edu> and Jangman Hong.

References


See Also

LegacyArguments. For information on printing, summarizing, and plotting effects: print.eff, summary.eff, plot.eff, print.summary.eff, print.effpoly, summary.effpoly, plot.effpoly, print.efflist, summary.efflist, plot.efflist, xyplot, densityplot, and the Effect Displays with Partial Residuals and Defining Effect Methods for Other Models vignettes.

Examples

```r
mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion, 
                 data=Cowles, family=binomial)

eff.cowles <- allEffects(mod.cowles, xlevels=list(extraversion=seq(0, 24, 6)),
                         fixed.predictors=list(given.values=c(sexmale=0.5)))

eff.cowles
as.data.frame(eff.cowles[[2]])

# the following are equivalent:

eff.ne <- effect("neuroticism*extraversion", mod.cowles)
Eff.ne <- Effect(c("neuroticism", "extraversion"), mod.cowles)
all.equal(eff.ne$fit, Eff.ne$fit)

plot(eff.cowles, 'sex', axes=list(y=list(lab="Prob(Volunteer)")))

plot(eff.cowles, 'neuroticism:extraversion', 
      axes=list(y=list(lab="Prob(Volunteer)",
                 ticks=list(at=c(.1,.25,.5,.75,.9)))))

plot(Effect(c("neuroticism", "extraversion"), mod.cowles, 
            se=list(type="Scheffe"), 
            xlevels=list(extraversion=seq(0, 24, 6)),
            fixed.predictors=list(given.values=c(sexmale=0.5)),
            axes=list(y=list(lab="Prob(Volunteer)",
                       ticks=list(at=c(.1,.25,.5,.75,.9)))))

plot(eff.cowles, 'neuroticism:extraversion', lines=list(multiline=TRUE),
     axes=list(y=list(lab="Prob(Volunteer)")))

plot(effect('sex:neuroticism:extraversion', mod.cowles, 
            xlevels=list(extraversion=seq(0, 24, 6))),
     lines=list(multiline=TRUE))

# a nested model:

mod <- lm(log(prestige) ~ income:type + education, data=Prestige)

plot(Effect(c("income", "type"), mod, transformation=list(link=log, inverse=exp)), 
      axes=list(y=list(lab="prestige")))

if (require(nnet)){
  mod.beps <- multinom(vote ~ age + gender + economic.cond.national +
                        education, data=attitudes)
  plot(mod.beps, "income", 
       transformation=list(link=log, inverse=exp), 
       axes=list(y=list(lab="prestige")))
```
plot(effect("Europe*political.knowledge", mod.beps,
            xlevels=list(Europe=1:11, political.knowledge=0:3),
            fixed.predictors=list(given.values=c(gendermale=0.5)),
            lines=list(col=c("blue", "red", "orange")),
            axes=list(x=list(rug=FALSE), y=list(style="stacked")))

plot(effect("Europe*political.knowledge", mod.beps, # equivalent
            xlevels=list(Europe=1:11, political.knowledge=0:3),
            fixed.predictors=list(given.values=c(gendermale=0.5)),
            lines=list(col=c("blue", "red", "orange")),
            axes=list(x=list(rug=FALSE), y=list(style="stacked")))

if (require(MASS)){
  mod.wvs <- polr(poverty ~ gender + religion + degree + country*poly(age, 3),
                     data=WVS)
  plot(effect("country*poly(age, 3)", mod.wvs))

  plot(Effect(c("country", "age"), mod.wvs),
       axes=list(y=list(style="stacked")))

  plot(effect("country*poly(age, 3)", mod.wvs),
       axes=list(y=list(style="stacked"))) # equivalent

  plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs))
  plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs,
            se=list(type="scheffe"))) # Scheffe-type confidence envelopes
}

mod.pres <- lm(prestige ~ log(income, 10) + poly(education, 3) + poly(women, 2),
                data=Prestige)
eff.pres <- allEffects(mod.pres, xlevels=50)
plot(eff.pres)
plot(eff.pres[1],
     axes=list(x=list(income=list(transform=list(trans=log10, inverse=function(x) 10^x),
                               ticks=list(at=c(1000, 2000, 5000, 10000, 20000)))))
# linear model with log-response and log-predictor
# to illustrate transforming axes and setting tick labels
mod.pres1 <- lm(log(prestige) ~ log(income) + poly(education, 3) + poly(women, 2), data=Prestige)

# effect of the log-predictor
eff.log <- Effect("income", mod.pres1)

# effect of the log-predictor transformed to the arithmetic scale
eff.trans <- Effect("income", mod.pres1, transformation=list(link=log, inverse=exp))

# variations:
# y-axis: scale is log, tick labels are log
# x-axis: scale is arithmetic, tick labels are arithmetic
plot(eff.log)

# y-axis: scale is log, tick labels are log
# x-axis: scale is arithmetic, tick labels are arithmetic
plot(eff.log, axes=list(x=list(income=list(transform=list(trans=log, inverse=exp), ticks=list(at=c(5000, 10000, 20000)), lab="income, log-scale"))))

# y-axis: scale is log, tick labels are arithmetic
# x-axis: scale is arithmetic, tick labels are arithmetic
plot(eff.trans, axes=list(y=list(lab="prestige")))

# y-axis: scale is arithmetic, tick labels are arithmetic
# x-axis: scale is arithmetic, tick labels are arithmetic
plot(eff.trans, axes=list(y=list(type="response", lab="prestige")))

# y-axis: scale is log, tick labels are arithmetic
# x-axis: scale is log, tick labels are arithmetic
plot(eff.trans, axes=list(x=list(income=list(transform=list(trans=log, inverse=exp), ticks=list(at=c(1000, 2000, 5000, 10000, 20000)), lab="income, log-scale")), y=list(lab="prestige, log-scale")), main="Both response and X in log-scale")

if (require(nlme)){ # for gls()
  mod.hart <- gls(fconvict ~ mconvict + tfr + partic + degrees, data=Hartnagel, correlation=corARMA(p=2, q=0), method="ML")
  plot(allEffects(mod.hart))
  detach(package:nlme)
if (require(lme4)){
data(cake, package="lme4")
fm1 <- lmer(angle ~ recipe * temperature + (1|recipe:replicate), cake,
REML = FALSE)
plot(Effect(c("recipe", "temperature"), fm1))
plot(effect("recipe:temperature", fm1),
axes=list(grid=TRUE)) # equivalent (plus grid)
if (any(grepl("pbkrtest", search())))) detach(package:pbktest)
detach(package:lme4)
}

if (require(nlme) && length(find.package("lme4", quiet=TRUE)) > 0){
data(cake, package="lme4")
cake$rep <- with(cake, paste( as.character(recipe), as.character(replicate), sep=""))
fm2 <- lme(angle ~ recipe * temperature, data=cake,
random = ~ 1 | rep, method="ML")
plot(Effect(c("recipe", "temperature"), fm2))
plot(effect("recipe:temperature", fm2),
axes=list(grid=TRUE)) # equivalent (plus grid)
}
detach(package:nlme)

if (require(polCA)){
data(election)
f2a <- cbind(MORALG,CARESG,KNOWG,LEADG,DISHONG,INTELG,
MORALB,CARESB,KNOWB,LEADB,DISHONB,INTELB)~PARTY*AGE
nes2a <- polCA(f2a,election,nclass=3,nrep=5)
plot(Effect(c("PARTY", "AGE"), nes2a),
axes=list(y=list(style="stacked")))
}

# mlm example
if (require(heplots)) {
data(NLSY, package="heplots")
mod <- lm(cbind(read,math) ~ income+educ, data=NLSY)
eff.inc <- Effect("income", mod)
plot(eff.inc)
eff.edu <- Effect("educ", mod)
plot(eff.edu, axes=list(x=list(rug=FALSE), grid=TRUE))
plot(Effect("educ", mod, response="read"))
detach(package:heplots)
}
# svyglm() example (adapting an example from the survey package)

```r
if (require(survey)){
  data(api)
  dstrat<-svydesign(id=~1, strata=~stype, weights=~pw,
                    data=apistrat, fpc=~fpc)
  mod <- svyglm(sch.wide ~ ell + meals + mobility, design=dstrat, 
                family=quasibinomial())
  plot(allEffects(mod),
       axes=list(y=list(lim=log(c(0.4, 0.99)/c(0.6, 0.01)),
                  ticks=list(at=c(0.4, 0.75, 0.9, 0.95, 0.99))))
}
```

# component + residual plot examples

```r
Prestige$type <- factor(Prestige$type, levels=c("bc", "wc", "prof"))

mod.prestige.1 <- lm(prestige ~ income + education, data=Prestige)
plot(allEffects(mod.prestige.1, residuals=TRUE))  # standard C+R plots
plot(allEffects(mod.prestige.1, residuals=TRUE, 
               se=list(type="scheffe"))  # with Scheffe-type confidence bands

mod.prestige.2 <- lm(prestige ~ type*(income + education), data=Prestige)
plot(allEffects(mod.prestige.2, residuals=TRUE))

mod.prestige.3 <- lm(prestige ~ type + income*education, data=Prestige)
plot(Effect(c("income", "education"), mod.prestige.3, residuals=TRUE),
     partial.residuals=list(span=1))
```

# artificial data

```r
set.seed(12345)
x1 <- runif(500, -75, 100)
x2 <- runif(500, -75, 100)
y <- 10 + 5*x1 + 5*x2 + x1^2 + x2^2 + x1*x2 + rnorm(500, 0, 1e3)
Data <- data.frame(y, x1, x2)
mod.1 <- lm(y ~ poly(x1, x2, degree=2, raw=TRUE), data=Data)  # raw=TRUE necessary for safe prediction
mod.2 <- lm(y ~ x1*x2, data=Data)
mod.3 <- lm(y ~ x1 + x2, data=Data)

plot(Effect(c("x1", "x2"), mod.1, residuals=TRUE))  # correct model
plot(Effect(c("x1", "x2"), mod.2, residuals=TRUE))  # wrong model
plot(Effect(c("x1", "x2"), mod.3, residuals=TRUE))  # wrong model
```
EffectMethods

Functions For Constructing Effect Displays for Many Modeling Paradigms

Description

The Effect, effect and predictorEffects methods are used to draw effects plots to visualize a fitted regression surface. These plots can be drawn at least in principle for any model that uses a linear predictor. Methods for modeling paradigms than the basic lm, glm, multinom and polr methods are documented here. To add methods for new classes of statistical models, see the vignette Defining Effect Methods for Other Models.

Usage

```r
## Default S3 method:
Effect(focal.predictors, mod, ..., 
sources=NULL)

## S3 method for class 'gls'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clm2'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clmm'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clm'
Effect(focal.predictors, mod, ...)

## S3 method for class 'merMod'
Effect(focal.predictors, mod, ..., 
KR=FALSE)

## S3 method for class 'rlmerMod'
Effect(focal.predictors, mod, ...)

## S3 method for class 'lme'
Effect(focal.predictors, mod, ...)

## S3 method for class 'poLCA'
Effect(focal.predictors, mod, ...)

## S3 method for class 'mlm'
Effect(focal.predictors, mod, response, ...)

## S3 method for class 'betareg'
```
Effect(focal.predictors, mod, ...)  

Arguments  

focal.predictors  
a character vector of one or more predictors in the model in any order.  
mod  
a fitted model object of the appropriate class.  
...  
additional arguments passed to other Effect. See Effect for all the arguments included.  
response  
for an "mlm" object, a vector containing the name(s) or indices of one or more response variable(s). The default is to use all responses in the model.  
sources  
This argument appears only in the default method for Effect, and allows the user to draw effects plots for fitting methods for which there are not existing methods in the effects package. Seven arguments are provided:  
type  
the default is "glm", which assumes the modeling method shares characteristics with a generalized linear model, including a univariate response, a linear predictor, and possibly an error family and link function.  
call  
For S3 objects, the default is object$call, returning the call that created the object. This is used to harvest standard arguments like data, subset and family.  
formula  
the formula for the linear predictor, defaulting to formula(object).  
family  
if the model object includes an error family, but it is not returned by family(object), specify the family with this argument; otherwise it can be ignored.  
method  
For ordinal response models only, see the method argument to polr.  
coefficients  
The estimates of the coefficients in the linear predictor, with default coef(object).  
vcov  
the estimated variance covariance matrix to be used in computing errors in the effects plots; default is codevcov(object).  
KR  
if TRUE and the pbkrtest package is installed, use the Kenward-Roger coefficient covariance matrix to compute effect standard errors for linear mixed models fit with lmer in the lme4 package. The default is FALSE because the computation can be very slow.  

Details  

Most of these methods simply call the Effect.default method with the appropriate values in the argument sources. See the vignette Effect Methods in the vignettes for the effects package. All the interesting work is done by the methods described in Effect.  

Value  

See Effect  

Author(s)  

John Fox <jfox@mcmaster.ca>, Sanford Weisberg <sandy@umn.edu>
References

The Defining Effect Methods for Other Models vignette.

See Also

Effect and the links therein.

Examples

```r
## Not run:

# lme
require(nlme)
fm1 <- lme(distance ~ age + Sex, data = Orthodont, random = ~ 1)
plot(predictorEffects(fm1))

# gls
library(nlme)
g <- gls(Employed ~ GNP + Population,
         correlation=corAR1(form= ~ Year), data=longley)
print(predictorEffects(g))

# lmer uses method Effect.lmerMod
if("package:nlme"
   require(lme4)
data("Orthodont", package="nlme")
fm2 <- lmer(distance ~ age + Sex + (1 |Subject), data = Orthodont)
plot(allEffects(fm2))

# glmer uses method Effect.lmerMod
require(lme4)
gm1 <- glmer(cbind(incidence, size - incidence) ~ period + (1 | herd),
             data = cbpp, family = binomial)
as.data.frame(predictorEffect("period", gm1))

# rlmer uses method Effect.rlmerMod
require(lme4)
fm3 <- robustlmm::rlmer(distance ~ age + Sex + (1 |Subject), data = Orthodont)
plot(effect("age:Sex", fm3))
plot(predictorEffects(fm3, ~ age + Sex))

# betareg from the betareg package
library(betareg)
library(lme4)
data("GasolineYield", package = "betareg")
gy_logit <- betareg(yield ~ batch + temp, data = GasolineYield)
summary(gy_logit)
Effect("batch", gy_logit)
predictorEffects(gy_logit)

# clm in ordinal
require(ordinal)
require(MASS)
```
```r
effectsHexsticker <- clm(poverty ~ gender + religion + degree + country*poly(age,3),
  data=WVS)
plot(Effect(c("country", "age"), effectsHexsticker),
  lines=list(multiline=TRUE), layout=c(2, 2))

# clm2
require(ordinal)
require(MASS)
v2 <- clm2(poverty ~ gender + religion + degree + country*poly(age,3), data=WVS)
plot(Effect(c("country", "age"), v2))

# clmm
require(ordinal)
require(MASS)
mm1 <- clmm(SURENESS ~ PROD + (1|RESP) + (1|RESP:PROD),
  data = soup, link = "logit", threshold = "flexible")
plot(Effect("PROD", mm1), lines=list(multiline=TRUE))

# poLCA
library(poLCA)
data(election)
f2a <- cbind(MORALG,CARESG,KNOWG,LEADG,DISHONG,INTELG,
  MORALB,CARESB,KNOWB,LEADB,DISHONB,INTELB)~PARTY
nes2a <- poLCA(f2a,election,nclass=3,nrep=5)  # log-likelihood: -16222.32
allEffects(nes2a)

# multivariate linear model
data(Baumann, package="carData")
b1 <- lm(cbind(post.test.1, post.test.2, post.test.3) ~ group +
  pretest.1 + pretest.2, data = Baumann))
plot(Effect("group", b1))
## End(Not run)
```

### Description

Open the official hex sticker for the effects package in your browser

### Usage

`effectsHexsticker()`

### Value

Used for its side effect of opening the hex sticker for the effects package in your browser.
effectsTheme

Author(s)

John Fox <jfox@mcmaster.ca>

Examples

## Not run:
effectsHexsticker()

## End(Not run)

effectsTheme

Set the lattice Theme for Effect Plots

Description

Set the lattice theme (see trellis.device) appropriately for effect plots. This function is invoked automatically when the effects package is loaded if the lattice package hasn’t previously been loaded. A typical call is lattice::trellis.par.set(effectsTheme()).

Usage

effectsTheme(strip.background = list(col = gray(seq(0.95, 0.5, length = 3))),
strip.shingle = list(col = “black”), clip = list(strip = ”off”),
superpose.line = list(lwd = c(2, rep(1, 6))), col)

Arguments

strip.background

colors for the background of conditioning strips at the top of each panel: the default uses shades of gray and makes allowance for up to three conditioning variables.

strip.shingle

when lines rather than numeric values are used to indicate the values of conditioning variables, the default sets the color of the lines to black.

clip

the default allows lines showing values of conditioning variables to extend slightly beyond the boundaries of the strips—making the lines more visible at the extremes.

superpose.line

the optional default sets the line width of the first (of seven) lines to 2.

col

an optional argument specifying the colors to use for lines and symbolst: if col = ”car”, then the color palette for the car package is used (see carPalette); col = ”R”, then the current R palette (ignoring the first entry which is “black” in the standard R palette) is used (see palette); if col = ”colorblind”, then a colorblind-friendly palette (from https://jfly.uni-koeln.de/color/ but ignoring black) is used; if a vector of color specifications, then these are used. If col isn’t specified then the current lattice colors are used.
Legacy Arguments

Value

a list suitable as an argument for `trellis.par.set`; current values of modified parameters are supplied as an attribute.

Author(s)

John Fox <jfox@mcmaster.ca>

See Also

trellis.device, trellis.par.set

Examples

```r
## Not run:
lattice::trellis.par.set(effectsTheme())
## End(Not run)
```

---

LegacyArguments Legacy Arguments for plot and Effect Methods

Description

Prior to version 4.0-0 of the `effects` package, there were many (literally dozens) of arguments to the `plot` methods for "eff" and "effpoly" objects.

In version 4.0-0 of the package, we have consolidated these arguments into a much smaller number of arguments (e.g., lines, points, axes) that take lists of specifications. We have similarly consolidated some of the arguments to `Effect` methods into the `confint` and `fixed.predictors` arguments.

For backwards compatibility, we have to the extent possible retained the older arguments. If specified, these legacy arguments take precedence over the newer list-style arguments.

Details

Here is the correspondence between the old and new arguments.

For plot methods:

- `multiline=TRUE/FALSE` \rightarrow `lines=list(multiline=TRUE/FALSE)`
- `type=c("rescale", "link", "response")` For models with a link function, "link" plots in linear predictor scale, "response" plots in the response scale, and the default "rescale" plots in linear predictor scale but labels tick-marks in response scale.
- `z.var=which.min(levels)` \rightarrow `lines=list(z.var=which.min(levels))` relevant only when `lines=list(multiline=TRUE)`
- `colors={vector of colors}` \rightarrow `lines=list(col={vector of colors})`
- `lty={vector of line types}` \rightarrow `lines=list(lty={vector of line types})`
lwd={vector of line widths} lines=list(lwd={vector of line widths})
use.splines=TRUE/FALSE lines=list(splines=TRUE/FALSE)
cex={number} points=list(cex={number})
rug=TRUE/FALSE axes=list(x=list(rug=TRUE/FALSE))
xlab="{axis title}" axes=list(x=list(lab="{axis title}"))
xlim=[c(min, max)] axes=list(x=list(lim=[c(min, max)]))
rotx={degrees} axes=list(x=list(rot={degrees}))
ticks.x=list({tick specifications}) axes=list(x=list(ticks=list({tick specifications})))
transform.x=list(link={function}, inverse={function}) axes=list(x=list(transform=list({lists of transformations by predictors})))
ylab="{axis title}" axes=list(y=list(lab="{axis title}"))
ylim=[c(min, max)] axes=list(y=list(lim=[c(min, max)]))
roty={degrees} axes=list(y=list(rot={degrees}))
ticks=list({tick specifications}) axes=list(y=list(ticks=list({tick specifications})))
alternating=TRUE/FALSE axes=list(alternating=TRUE/FALSE)
grid=TRUE/FALSE axes=list(grid=TRUE/FALSE)
ci.style="bands"/"lines"/"bars"/"none" confint=list(style="bands"/"lines"/"bars"/"none")
band.transparency={number} confint=list(alpha={number})
band.colors={vector of colors} confint=list(col={vector of colors})
residuals.color={color} partial.residuals=list(col={color})
residuals.pch={plotting character} partial.residuals=list(pch={plotting character})
residuals.cex={number} partial.residuals=list(cex={number})
smooth.residuals=TRUE/FALSE partial.residuals=list(smooth=TRUE/FALSE)
residuals.smooth.color={color} partial.residuals=list(smooth.col={color})
span={number} partial.residuals=list(span={number})
show.fitted=TRUE/FALSE partial.residuals=list(fitted=TRUE/FALSE)
factor.names=TRUE/FALSE lattice=list(strip=list(factor.names=TRUE/FALSE))
show.strip.values=TRUE/FALSE lattice=list(strip=list(values=TRUE/FALSE))
layout={lattice layout} lattice=list(layout={lattice layout})
key.args={lattice key args} lattice=list(key.args={lattice key args})
style="lines"/"stacked" for plot.effpoly, axes=list(y=list(style="lines"/"stacked"))
rescale.axis=TRUE/FALSE type="rescale"/"response"/"link"

For Effect methods:

confint=TRUE/FALSE or a list may be substituted for the se argument.
confidence.level={number} se=list(level={number})
given.values={named vector} fixed.predictors=list(given.values={named vector})
typical={function} fixed.predictors=list(typical={function})
offset={function} fixed.predictors=list(offset={function})
partial.residuals=TRUE/FALSE residuals=TRUE/FALSE

Transformation This argument to Effect is not needed to compute effects. It can now be set directly with the plot method with the argument axes = list(y = list(transformation=specification)).
Author(s)
John Fox <jfox@mcmaster.ca>

See Also
Effect, plot.eff, plot.effpoly

plot.eff

Plots of Effects and Predictor Effects

Description
plot methods for predictoreff, predictorefflist, eff, efflist and effpoly objects created by calls other methods in the effects package. The plot arguments were substantially changed in mid-2017. For more details and many examples, see the Predictor Effects Graphics Gallery vignette.

Usage

```r
## S3 method for class 'eff'
plot(x, x.var,
     main=paste(effect, "effect plot"),
     symbols=TRUE, lines=TRUE, axes, confint,
     partial.residuals, id, lattice, ...,
     # legacy arguments:
     multiline, z.var, rug, xlab, ylab, colors, cex, lty, lwd,
     ylim, xlim, factor.names, ci.style,
     band.transparency, band.colors, type, ticks,
     alternating, rotx, roty, grid, layout,
     rescale.axis, transform.x, ticks.x, show.strip.values,
     key.args, use.splines,
     residuals.color, residuals.pch, residuals.cex, smooth.residuals,
     residuals.smooth.color, show.fitted, span)

## S3 method for class 'efflist'
plot(x, selection, rows, cols, ask=FALSE, graphics=TRUE, lattice, ...)

## S3 method for class 'predictoreff'
plot(x, x.var,
     main = paste(names(x$variables)[1], "predictor effect plot"), ...)

## S3 method for class 'predictorefflist'
plot(x, selection, rows, cols, ask = FALSE,
     graphics = TRUE, lattice, ...)

## S3 method for class 'effpoly'
```
plot(x, x.var=which.max(levels),
    main=paste(effect, "effect plot"),
symbols=TRUE, lines=TRUE, axes, confint, lattice, ...
# legacy arguments:
type, multiline, rug, xlab, ylab, colors, cex, lty, lwd,
factor.names, show.strip.values,
ci.style, band.colors, band.transparency, style,
transform.x, ticks.x, xlim,
ticks, ylim, rotx, roty, alternating, grid,
layout, key.args, use.splines)

## S3 method for class 'mlm.efflist'
plot(x, ...)

Arguments

- **x**
  an object of class "predictoreff", "predictorefflist", "eff", "effpoly", "efflist", "mlm.efflist", or "summary.eff", as appropriate.

- **x.var**
  the index (number) or quoted name of the covariate or factor to place on the horizontal axis of each panel of the effect plot. The default is the predictor with the largest number of levels or values. This argument is ignored with predictoreff objects.

- **main**
  the title for the plot, printed at the top; the default title is constructed from the name of the effect.

- **symbols**
  TRUE, FALSE, or an optional list of specifications for plotting symbols; if not given, symbol properties are taken from superpose.symbol in the lattice theme. See Detailed Argument Descriptions under Details for more information.

- **lines**
  TRUE, FALSE, or an optional list of specifications for plotting lines (and possibly areas); if not given, line properties are taken from superpose.line in the lattice theme. See Detailed Argument Descriptions under Details for more information.

- **axes**
  an optional list of specifications for the x and y axes; if not given, axis properties take generally reasonable default values. See Details for more information.

- **confint**
  an optional list of specifications for plotting confidence regions and intervals; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information.

- **partial.residuals**
  an optional list of specifications for plotting partial residuals for linear and generalized linear models; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information, along with the Effect Displays with Partial Residuals vignette.

- **id**
  an optional list of specifications for identifying points when partial residuals are plotted; if not specified, no points are labelled. See Detailed Argument Descriptions under Details for more information.

- **lattice**
  an optional list of specifications for various lattice properties, such as legend placement; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information.
plot.effects

**selection**

the optional index (number) or quoted name of the effect in an efflist object to be plotted; if not supplied, a menu of high-order terms is presented or all effects are plotted.

**rows, cols**

Number of rows and columns in the “meta-array” of plots produced for an efflist object; if either argument is missing, then the meta-layout will be computed by the plot method.

**ask**

if selection is not supplied and ask is TRUE, a menu of high-order terms is presented; if ask is FALSE (the default), effects for all high-order terms are plotted in an array.

**graphics**

if TRUE (the default), then the menu of terms to plot is presented in a dialog box rather than as a text menu.

... arguments to be passed down. For "predictoreff" or "predictorefflist" objects, the arguments passed down can include all the arguments for "eff".

**multiline, z.var, rug, xlab, ylab, colors, cex, lty, lwd, ylim, xlim, factor.names, ci.style, band.transparency, ... type, residuals.color, residuals.pch, residuals.cex, smooth.residuals, residuals.smooth.color, show.fitted, span, style**

legacy arguments retained for backwards compatibility; if specified, these will take precedence over the newer list-style arguments described above. See LegacyArguments for details.

**Details**

Effects plots and predictor effects plots are produced by these methods. The plots are highly customizable using the optional arguments described here. For example, effects in a GLM are plotted on the scale of the linear predictor, but the vertical axis is labelled on the response scale. This preserves the linear structure of the model while permitting interpretation on what is usually a more familiar scale. This approach may also be used with linear models, for example to display effects on the scale of the response even if the data are analyzed on a transformed scale, such as log or square-root. See the axes argument details below to change the scale to response scale, or to linear predictor scale with tick marks labeled in response scale.

When a factor is on the x-axis, the plot method for eff objects connects the points representing the effect by line segments, creating a response “profile.” If you wish to suppress these lines, add lty=0 to the lines argument to the call to plot (see below and the examples).

In a polytomous multinomial or proportional-odds logit model, by default effects are plotted on the probability scale; they may alternatively be plotted on the scale of the individual-level logits.

All of the arguments to plot objects created by Effect or allEffects can also be used with objects created by predictorEffect or predictorEffects.

**Detailed Argument Descriptions**

For more information about these arguments and many examples, see the Predictor Effects Graphics Gallery vignette.

Maximizing the flexibility of these plot commands requires inclusion of a myriad of options. In an attempt to simplify the use of these options, they have been organized into just a few arguments that each accept a list of specifications as an argument. In a few cases the named entries in the list are themselves lists.

Each of the following arguments takes an optional list of specifications; any specification absent from the list assumes its default value. Some of the list elements are themselves lists, so in complex cases, the argument can take the form of nested lists. All of these arguments can also be used on objects created with predictorEffects.
plot.effects

symbols TRUE, FALSE, or a list of options that controls the plotting symbols and their sizes for use with factors; if FALSE symbols are suppressed; if TRUE default values are used:
  pch plotting symbols, a vector of plotting characters, with the default taken from trellis.par.get("superpose.symbol")$pch, typically a vector of 1s (circles).
  cex plotting character sizes, a vector of values, with the default taken from trellis.par.get("superpose.symbol")$cex, typically a vector of 0.8s.

lines TRUE, FALSE, or a list that controls the characteristics of lines drawn on a plot, and also whether or not multiple lines should be drawn in the same panel in the plot; if FALSE lines are suppressed; if TRUE default values are used:
  multiline display a multiline plot in each panel; the default is TRUE if there are no standard errors in the "eff" object, FALSE otherwise. For an "effpoly" object multiline=TRUE causes all of the response levels to be shown in the same panel rather than in separate panels.
  z.var for linear, generalized linear or mixed models, the index (number) or quoted name of the covariate or factor for which individual lines are to be drawn in each panel of the effect plot. The default is the predictor with the smallest number of levels or values. This argument is only used for multiline plots.
  lty vector of line types, with the default taken from trellis.par.get("superpose.line")$lty, typically a vector of 1s (solid lines).
  lwd vector of line widths, with the default taken from trellis.par.get("superpose.line")$lwd, typically a vector with 2 in the first position followed by 1s.
  col a vector of line colors, with the default taken from from trellis.par.get("superpose.line")$col, used both for lines and for areas in stacked area plots for "effpoly" objects; in the latter case, the default colors for an ordered response are instead generated by sequential_hcl in the colourSpace package.
  splines use splines to smooth plotted effect lines; the default is TRUE.
  axes a list with elements x, y, alternating, and grid that control axis limits, ticks, and labels.

  The x and y elements may themselves be lists.
  The x entry is a list with elements named for predictors, with each predictor element itself a list with the following elements:
  lab axis label, defaults to the name of the predictor; may either be a text string or a list with the text label (optionally named label) as its first element and the named element cex as its second element.
  lim a two-element vector giving the axis limits, with the default determined from the data.
  ticks a list with either element at, a vector specifying locations for the ticks marks, or n, the number of tick marks.
  transform transformations to be applied to the horizontal axis of a numeric predictor, in the form of a list of two functions, with element names trans and inverse. The trans function is applied to the values of the predictor, and inverse is used for computing proper axis tick labels. The default is not to transform the predictor axis.

  Two additional elements may appear in the x list, and apply to all predictors:
  rotate angle in degrees to rotate tick labels; the default is 0.
  rug display a rug plot showing the marginal distribution of a numeric predictor; the default is TRUE.
The y list contains lab, lim, ticks, and rotate elements (similar to those specified for individual predictors in the x list), along with the additional type, transform, and style elements:

- **type** for plotting linear or generalized linear models. "rescale" (the default) plots the vertical axis on the link scale (e.g., the logit scale for a logit model) but labels the axis on the response scale (e.g., the probability scale for a logit model); "response" plots and labels the vertical axis on the scale of the response (e.g., the probability scale for a logit model); and "link" plots and labels the vertical axis on the scale of the link (e.g., the logit scale for a logit model). For polytomous logit models, this element is either "probability" or "logit", with the former as the default.

- **transform** primarily for linear or linear mixed models, this argument is used to apply an arbitrary transformation to the vertical axis. For example, if fitting a linear model with response \( \log(y) \), then setting transform=exp would plot \( \exp(\log(y)) = y \) on the vertical axis. If the response were \( 1/y \), then use transform=function(yt) \( 1/yt \), since the reciprocal is its own inverse. The transform argument can also be a list of two functions. For example with a response \( \log(y) \), the specification transform=list(trans=log, inverse=log), type="rescale" will plot in log-scale, but will label tick marks in arithmetic scale; see the example below. The specification transform=list(trans=log, inverse=exp), type="response" is equivalent to transform=exp. When type="response" the lab argument will generally be used to get a label for the axis that matches the untransformed response. If this argument is used with a generalized linear model or another model with a non-identity link function, the function is applied to the linear predictor, and will probably not be of interest.

- **style** for polytomous logit models, this element can take on the value "lines" (the default) or "stacked" for line plots or stacked-area plots, respectively.

Other elements:

- **alternating** if TRUE (the default), the tick labels alternate by panels in multi-panel displays from left to right and top to bottom; if FALSE, tick labels appear at the bottom and on the left.

- **grid** if TRUE (the default is FALSE), add grid lines to the plot.

- **confint** specifications to add/remove confidence intervals or regions from a plot, and to set the nominal confidence level.

- **style** one of "auto", "bars", "lines", "bands", and "none"; the default is "bars" for factors, "bands" for numeric predictors, and "none" for multiline plots; "auto" also produces "bars" for factors and "bands" for numeric predictors, even in multiline plots.

- **alpha** transparency of confidence bands; the default is 0.15.

- **col** colors; the default is taken from the line colors.

- **partial.residuals** specifications concerning the addition of partial residuals to the plot.

- **plot** display the partial residuals; the default is TRUE if residuals are present in the "eff" object, FALSE otherwise.

- **fitted** show fitted values as well as residuals; the default is FALSE.

- **col** color for partial residuals; the default is the second line color.

- **pch** plotting symbols for partial residuals; the default is 1, a circle.

- **cex** size of symbols for partial residuals; the default is 1.

- **smooth** draw a loess smooth of the partial residuals; the default is TRUE.
span  span for the loess smooth; the default is 2/3.
smooth.col  color for the loess smooth; the default is the second line color.
lty  line type for the loess smooth; the default is the first line type, normally 1 (a solid line).
lwd  line width for the loess smooth; the default is the first line width, normally 2.

id  specifications for optional point identification when partial residuals are plotted.

n  number of points to identify; default is 2 if id=TRUE and 0 if id=FALSE. Points are selected based on the Mahalanobis distances of the pairs of x-values and partial residuals from their centroid.
col  color for the point labels; default is the same as the color of the partial residuals.
cex  relative size of text for point labels; default is 0.75.
labels  vector of point labels; the default is the names of the residual vector, which is typically the row names of the data frame to which the model is fit.
lattice  the plots are drawn with the lattice package, generally by the xyplot function. These specifications are passed as arguments to the functions that actually draw the plots.
layout  the layout argument to the lattice function xyplot (or, in some cases densityplot), which is used to draw the effect display; if not specified, the plot will be formatted so that it appears on a single page.
key.args  a key, or legend, is added to the plot if multiline=TRUE. This argument is a list with components that determine the the placement and other characteristics of the key. The default if not set by the user is key.args = list(space="top",columns=2,border=FALSE,fontfamily="serif",cex.title=.80,cex=0.75).
  If there are more than 6 groups in the plot, columns is set to 3. For stacked-area plots, the default is a one-column key. In addition to the arguments shown explicitly below, any of the arguments listed in the xyplot documentation in the key section can be used.
  space  determines the placement of the key outside the plotting area, with default space="above" for above the plot and below its title. Setting space="right" uses space to the right of the plot for the key.
x, y, corner  used to put the key on the graph itself. For example, x=.05,y=.95,corner=c(0,1)
  will locate the upper-left corner of the key at (.05, .95), thinking of the graph as a unit square.
columns  number of columns in the key. If space="top", columns should be 2, 3 or 4; if space="right", set columns=1.
border  if TRUE draw a border around the key; omit the border if FALSE.
fontfamily  the default is "sans" for the sans-serif font used in the rest of the plot; the alternative is "serif" for a serif font.
cex, cex.title  the default relative size of the font for labels and the title, respectively.
  To save space set these to be smaller than 1.
strip  a list with three elements: factor.names, which if TRUE, the default, shows conditioning variable names in the panel headers; values, which if TRUE, the default unless partial residuals are plotted, displays conditioning variable values in the panel headers, and cex, the relative size of the text displayed in the strip.
array  a list with elements row, col, nrow, ncol, and more, used to graph an effect as part of an array of plots; row, col, nrow, and ncol are used to compose the split argument and more the more argument to print.trellis. The array argument is automatically set by plot.efflist and will be ignored if used with that function.
Value

The summary method for "eff" objects returns a "summary.eff" object with the following components (those pertaining to confidence limits need not be present):

- **header**: a character string to label the effect.
- **effect**: an array containing the estimated effect.
- **lower.header**: a character string to label the lower confidence limits.
- **lower**: an array containing the lower confidence limits.
- **upper.header**: a character string to label the upper confidence limits.
- **upper**: an array containing the upper confidence limits.

The plot method for "eff" objects returns a "plot.eff" object (an enhanced "trellis" object); the provided print method plots the object.

The [] method for "efflist" objects is used to subset an "efflist" object and returns an object of the same class.

Author(s)

John Fox <jfox@mcmaster.ca> and Jangman Hong.

See Also

LegacyArguments, effect, allEffects, effectsTheme, xyplot, densityplot, print.trellis, loess, sequential_hcl, and the Predictor Effects Graphics Gallery and Effect Displays with Partial Residuals vignettes.

Examples

# also see examples in ?effect

```r
# plot predictorEffects
mod <- lm(prestige ~ education + log(income)*type + women, Prestige)
plot(predictorEffects(mod, ~ income), axes=list(grid=TRUE))
plot(predictorEffects(mod, ~ income), lines=list(multiline=TRUE),
     axes=list(grid=TRUE))
plot(predictorEffects(mod, ~ type), lines=list(multiline=TRUE),
     axes=list(grid=TRUE),
     confint=list(style="bars"))

mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion,
                   data=Cowles, family=binomial)
eff.cowles <- allEffects(mod.cowles, xlevels=list(extraversion=seq(0, 24, 6)))
eff.cowles
as.data.frame(eff.cowles[[2]])  # neuroticism*extraversion interaction

plot(eff.cowles, 'sex', axes=list(grid=TRUE,
    y=list(lab="Prob(Volunteer)")),
    x=list(rotate=90),
    lines=list(lty=0))
```
plot(eff.cowles, 'neuroticism:extraversion', axes=list(y=list(lab="Prob(Volunteer)", ticks=list(at=c(.1,.25,.5,.75,.9))))

plot(Effect(c("neuroticism", "extraversion"), mod.cowles, se=list(type="Scheffe"), xlevels=list(extraversion=seq(0, 24, 6))), axes=list(y=list(lab="Prob(Volunteer)", ticks=list(at=c(.1,.25,.5,.75,.9))))

# change color of the confidence bands to 'black' with .15 transparency
plot(eff.cowles, 'neuroticism:extraversion', axes=list(y=list(lab="Prob(Volunteer)", ticks=list(at=c(.1,.25,.5,.75,.9)))), confint=list(col="red", alpha=.3))

plot(eff.cowles, 'neuroticism:extraversion', lines=list(multiline=TRUE), axes=list(y=list(lab="Prob(Volunteer)")), lattice=list(key.args = list(x = 0.65, y = 0.99, corner = c(0, 1))))

# use probability scale in place of logit scale, all lines are black.
plot(eff.cowles, 'neuroticism:extraversion', lines=list(multiline=TRUE, lty=1:8, col="black"), axes=list(y=list(lab="Prob(Volunteer)")), lattice=list(key.args = list(x = 0.65, y = 0.99, corner = c(0, 1)))))

plot(effect('sex:neuroticism:extraversion', mod.cowles, xlevels=list(extraversion=seq(0, 24, 6))), lines=list(multiline=TRUE))

plot(effect('sex:neuroticism:extraversion', mod.cowles, xlevels=list(extraversion=seq(0, 24, 6))), lines=list(multiline=TRUE), confint=list(style="bands"), lattice=list(key.args = list(x=0.75, y=0.75, corner=c(0, 0))))

if (require(nnet)){
  mod.beps <- multinom(vote ~ age + gender + economic.cond.national + economic.cond.household + Blair + Hague + Kennedy + Europe*political.knowledge, data=BEPS)
  plot(effect("Europe*political.knowledge", mod.beps, xlevels=list(political.knowledge=0:3)))
}

plot(effect("Europe*political.knowledge", mod.beps, xlevels=list(political.knowledge=0:3),
predictorEffects

```r
if (require(MASS)){
  mod.wvs <- polr(poverty ~ gender + religion + degree + country*poly(age, 3),
                  data=WVS)
  plot(effect("country*poly(age, 3)", mod.wvs))

  plot(effect("country*poly(age, 3)", mod.wvs), lines=list(multiline=TRUE))
  plot(effect("country*poly(age, 3)", mod.wvs),
       axes=list(y=list(style="stacked")),
       lines=list(col=c("gray75", "gray50", "gray25")))
  plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs))
}

mod.pres <- lm(prestige ~ log(income, 10) + poly(education, 3) + poly(women, 2),
                 data=Prestige)
eff.pres <- allEffects(mod.pres)
plot(eff.pres)
plot(eff.pres[1:2])

plot(eff.pres[1],
     axes=list(x=list(transform=list(trans=log10, inverse=function(x) 10^x),
                 ticks=list(at=c(1000, 2000, 5000, 10000, 20000))))

mod <- lm(log(prestige) ~ income:type + education, data=Prestige)
p1 <- predictorEffects(mod, ~ income)
# log-scale for response
plot(p1, lines=list(multiline=TRUE))
# log-scale, with arithmetic tick marks
plot(p1, lines=list(multiline=TRUE),
     axes=list(y=list(transform=list(trans=log, inverse = exp),
                      lab="prestige", type="rescale")))
# arithmetic scale and tick marks, with other arguments
plot(p1, lines=list(multiline=TRUE), grid=TRUE,
     lattice=list(key.args=list(space="right", border=TRUE)),
     axes=list(y=list(transform=exp, lab="prestige")))
```

---

**predictorEffects**

*Functions For Computing Predictor Effects*
**predictorEffects**

**Description**

Alternatives to the Effect and allEffects functions that use a different paradigm for conditioning in an effect display. The user specifies one predictor, either continuous or a factor, for the horizontal axis of a plot, and the function determines the appropriate plot to display (which is drawn by plot). See the vignette Predictor Effects Graphics Gallery for details and examples.

**Usage**

```r
predictorEffect(predictor, mod, focal.levels=50, xlevels=5, ...)
```

```r
## S3 method for class 'poLCA'
predictorEffect(predictor, mod, focal.levels=50, xlevels=5, ...)
```

```r
## S3 method for class 'svyglm'
predictorEffect(predictor, mod, focal.levels=50, xlevels=5, ...)
```

```r
## Default S3 method:
predictorEffect(predictor, mod, focal.levels=50, xlevels=5, ...)
```

```r
predictorEffects(mod, predictors, focal.levels=50, xlevels=5, ...)
```

```r
## S3 method for class 'poLCA'
predictorEffects(mod, predictors = ~ ., focal.levels=50, xlevels=5, ...)
```

```r
## Default S3 method:
predictorEffects(mod, predictors = ~ ., focal.levels=50, xlevels=5, ...)
```

**Arguments**

- **mod**: A model object. Supported models include all those described on the help page for `Effect`.
- **predictor**: quoted name of the focal predictor.
- **predictors**: If the default ~ ., a predictor effect plot is drawn for each predictor (not regressor) in a model. Otherwise, this should be a one-sided formula listing the first-order predictors for which predictor effect plots should be drawn.
- **focal.levels**: for `predictorEffect`, the number of evenly-spaced values (the default is 50) for the focal predictor or a vector of values for the focal predictor. For `predictorEffects`, the number of evenly-spaced values (default 50) to use for each focal predictor in turn or a named list, similar to `xlevels`, giving the number of values or the values themselves for each predictor individually, to be used when that predictor is the focal predictor; if a focal predictor doesn’t appear in the list, the default of 50 values is used.
this argument is used to set the levels of conditioning predictors; it may either
be a single number specifying the number of evenly-spaced values (the default
is 5) to which each conditioning predictor is to be set, or it may be a list with
elements named for the predictors giving the number of values or a vector of val-
ues to which each conditioning predictor is to be set, as explained in the help for
\texttt{Effect}. If the focal predictor is included in the \texttt{xlevels} list, it is disregarded; if
any conditioning predictor is omitted from the list, its number of values is set to
5. The default behavior of \texttt{xlevels} is different when \texttt{residuals=TRUE}; in that
case, it behaves as in \texttt{Effect.lm}, and is effectively set by default to the 0.2, 0.4,
0.6, and 0.8 quantiles of conditioning predictors.

The \texttt{xlevels} argument works similarly for \texttt{predictorEffect} and \texttt{predictorEffects}.

Additional arguments passed to \texttt{Effect}.

\textbf{Details}

Effect plots view a fitted regression function $E(Y|X)$ in (sequences of) two-dimensional plots using
conditioning and slicing. The functions described here use a different method of determining the
conditioning and slicing than \texttt{allEffects} uses. The predictor effect of a focal predictor, say $x_1$, is
the usual effect for the generalized interaction of $x_1$ with all the other predictors in a model. When
a predictor effect object is plotted, the focal predictor is by default plotted on the horizontal axis.

For example, in the model \texttt{mod} with formula $y \sim x_1 + x_2 + x_3$, the predictor effect $p_1 \leftarrow \text{predictorEffects}(\texttt{mod}, \sim x_1)$ is essentially equivalent to $p_2 \leftarrow \text{Effect}("x_1", \texttt{mod})$. When plotted, these objects may produce
different graphs because plot($p_1$) will always put $x_1$ on the horizontal axis while plot($p_2$) uses a
rule to determine the horizontal axis based on the characteristics of all the predictors, e.g., preferring
continuous predictors over factors.

If \texttt{mod} has the formula $y \sim x_1 + x_2 + x_3 + x_1:x_2$, then $p_1 \leftarrow \text{predictorEffects}(\texttt{mod}, \sim x_1)$ is essen-
tially equivalent to $p_2 \leftarrow \text{Effect}(c("x_1","x_2"), \texttt{mod})$. As in the last example, the plotted ver-
sions of these objects may differ because of different rules used to determine the predictor on the
horizontal axis.

If \texttt{mod} has the formula $y \sim x_1 + x_2 + x_3 + x_1:x_2 + x_1:x_3$, then $p_1 \leftarrow \text{predictorEffects}(\texttt{mod}, \sim x_1)$ is essen-
tially equivalent to $p_2 \leftarrow \text{Effect}(c("x_1","x_2","x_3"), \texttt{mod})$. Again, the plotted ver-
sions of these objects may differ because of the rules used to determine the horizontal axis.

\textbf{Value}

\texttt{predictorEffect} returns an object of class c("predictoreff","eff"). The components of
the object are described in the help for \texttt{Effect}; \texttt{predictorEffects} returns an object of class
"predictorefflist", which is a list whose elements are of class c("predictoreff","eff").

\textbf{Author(s)}

S. Weisberg <sandy@umn.edu> and J. Fox

\textbf{References}

See \texttt{Effect}. 

See Also

Effect, plot.predictoreff, the Predictor Effects Graphics Gallery vignette, and the Effect Displays with Partial Residuals vignette.

Examples

mod <- lm(prestige ~ type*(education + income) + women, Prestige)
plot(predictorEffect("income", mod))
plot(predictorEffects(mod, - education + income + women))

mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion, data=Cowles, family=binomial)
plot(predictorEffects(mod.cowles, xlevels=4))
plot(predictorEffect("neuroticism", mod.cowles, xlevels=list(extraversion=seq(5, 20, by=5))),
    axes=list(grid=TRUE,
            x=list(rug=FALSE),
            y=list(lab="Probability of Vounteering"),
            lines=list(multiline=TRUE),
            type="response")
predictorEffects(mod.cowles, focal.levels=4, xlevels=4)

# svyglm() example (adapting an example from the survey package)

if (require(survey)){
  data(api)
  dstrat<-svydesign(id=~1, strata=~stype, weights=~pw, data=apistrat, fpc=~fpc)
  mod <- svyglm(sch.wide ~ ell + meals + mobility, design=dstrat, family=quasibinomial())
  plot(predictorEffects(mod),
    axes=list(y=list(lim=log(c(0.4, 0.99)/c(0.6, 0.01)),
                ticks=list(at=c(0.4, 0.75, 0.9, 0.95, 0.99))))
  }

summary.eff

Summarizing and Printing Effects

Description

summary, print, and as.data.frame methods for objects created using the effects package.

Usage

## S3 method for class 'eff'
print(x, type=c("response", "link"), ...)
## S3 method for class 'effpoly'
print(x, type=c("probability", "logits"), ...)
## S3 method for class 'efflatent'
print(x, ...)
## S3 method for class 'efflist'
print(x, ...)
## S3 method for class 'mlm.efflist'
print(x, ...)
## S3 method for class 'summary.eff'
print(x, ...)
## S3 method for class 'eff'
summary(object, type=c("response", "link"), ...)
## S3 method for class 'effpoly'
summary(object, type=c("probability", "logits"), ...)
## S3 method for class 'efflatent'
summary(object, ...)
## S3 method for class 'efflist'
summary(object, ...)
## S3 method for class 'mlm.efflist'
summary(object, ...)
## S3 method for class 'eff'
as.data.frame(x, row.names=NULL, optional=TRUE, type=c("response", "link"), ...)
## S3 method for class 'efflist'
as.data.frame(x, row.names=NULL, optional=TRUE, type, ...)## S3 method for class 'effpoly'
as.data.frame(x, row.names=NULL, optional=TRUE, ...)## S3 method for class 'efflatent'
as.data.frame(x, row.names=NULL, optional=TRUE, ...)## S3 method for class 'eff'
vcov(object, ...)

### Arguments

- **x, object**: an object consisting of fitted values and other information needed to draw effects plots that is produced by functions in the effects package.

- **type**: fitted values are by default printed by these functions in the "response" scale. For models with a link function like a GLM, fitted values in the linear predictor scale are obtained by setting type="link". For polytomous response models setting type="logits" returns fitted values in the logit scale.

- **row.names, optional**: arguments to as.data.frame not used by these methods.

- **...**: other arguments passed on

### Value

The print methods return the fitted values in tables. The summary methods return the fitted values and 95 percent confidence intervals, also in tables. The as.data.frame method returns fitted values, standard errors, and 95 percent confidence intervals as a data frame, or as a list of data frames for the efflist method. The vcov method returns the covariance matrix of the fitted values.
**Author(s)**

John Fox <jfox@mcmaster.ca> and Jangman Hong.

**Examples**

```r
mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion, 
                   data=Cowles, family=binomial)
eff.cowles <- predictorEffects(mod.cowles)
print(eff.cowles)
print(eff.cowles["neuroticism"], type="link")
summary(eff.cowles["neuroticism"], type="link")
as.data.frame(eff.cowles)
# covariance matrix of fitted values in linear predictor scale
vcov(eff.cowles[[1]])
```
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