Package ‘boxcoxmix’

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Type Package

Title Box-Cox-Type Transformations for Linear and Logistic Models with Random Effects

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Author Amani Almohaimeed and Jochen Einbeck

Maintainer Amani Almohaimeed <amani.almohaimeed@gmail.com>

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Box-Cox-type transformations for linear and logistic models with random effects using non-parametric profile maximum likelihood estimation. The main functions are `optim.boxcox()` and `boxcoxttype()`.

Details

- Package: boxcoxmix
- Type: Package
- Version: 0.21
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- License: GPL (>=3)

Author(s)

Amani Almohaimed and Jochen Einbeck

References


Maintainer: Amani Almohaimed <amani.almohaimed@gmail.com>
boxcoxtype

Box-Cox-type link function for logistic mixed-effects Models

Description

The boxcoxtype() performs a grid search over the parameter Lambda for logistic mixed-effects models and then optimizes over this grid, to calculate the maximum likelihood estimator of the transformation.

Usage

boxcoxtype(formula, random = ~1, k = 3, trials = 1, data,
find.in.range = c(-2, 2), s = 20, plot.opt = 1,
random.distribution = "np", ...)

boxcoxpower(Lambda = 0)

binomial(link = boxcoxpower(0))

Arguments

formula a formula describing the transformed response and the fixed effect model (e.g. y ~ x).
random a formula defining the random model. Set random= ~1 to model logistic-type overdispersion model. For a two-level logistic-type model, set random= ~1|groups, where groups are at the upper level.
k the number of mass points.
trials optional prior weights for the data. For Bernoulli distribution, set trials=1.
data a data frame containing variables used in the fixed and random effect models.
find.in.range search in a range of Lambda, with default (-2,2) in step of 0.1.
s number of points in the grid search of Lambda.
plot.opt Set plot.opt=1, to plot the profile log-likelihood against Lambda. if plot.opt=0, no plot is printed.
random.distribution the mixing distribution, Gaussian Quadrature (gq) or NPML (np) can be set.
... extra arguments will be ignored.
Lambda the power of the transformation
link the link function to be used.
The Box-Cox transformation (Box & Cox, 1964) is applied to the logistic mixed-effects models with an unspecified mixing distribution. The NPML estimate of the mixing distribution is known to be a discrete distribution involving a finite number of mass-points and corresponding masses (Aitkin et al., 2009). An Expectation-Maximization (EM) algorithm is used for fitting the finite mixture distribution, one needs to specify the number of components \( k \) of the finite mixture in advance. This algorithm can be implemented using the npmlreg function \code{alldist} for the logistic-type overdispersion model and the npmlreg function \code{allvc} for the two-level logistic-type model, setting family = binomial(link = boxcoxpower(Lambda)) where Lambda is the value of the power transformation. When \( k=1 \), the npmlreg function \code{alldist()} fits the logistic regression model without random effects.

\code{boxcoxtype()} performs a grid search over the parameter Lambda and then optimizes over this grid, to calculate the maximum likelihood estimator of the transformation. It produces a plot of the profile likelihood function that summarises information concerning Lambda, including a vertical line indicating the best value of Lambda that maximizes the profile log-likelihood.

### Value
- **Maximum**  
  the best estimate of Lambda found.
- **objective**  
  the value of the profile log-likelihood corresponding to Maximum.
- **coef**  
  the vector of coefficients.
- **profile.loglik**  
  the profile log-likelihood of the fitted regression model.
- **fit**  
  the fitted alldist object from the last EM iteration.
- **aic**  
  the Akaike information criterion of the fitted regression model.
- **bic**  
  the Bayesian information criterion of the fitted regression model.

The other outcomes are not relevant to users and they are intended for internal use only.

### Author(s)
Amani Almohaimeed and Jochen Einbeck

### References


### See Also
\code{np.boxcoxmix, optim.boxcox, tolfind.boxcox, Kfind.boxcox}. 

Examples

# Beta blockers data
data("beta blocker", package = "flexmix")
library(npmlreg)
betavc <- allvc(cbind(Deaths, Total - Deaths) ~ Treatment, data = betablocker, random=-1|Center, 
k=3, random.distribution='np', family = binomial(link = boxcoxpower(0)))
betavc$disparity
# [1] 318.7211
betavc3 <- boxcoxtype(cbind(Deaths, Total - Deaths) ~ Treatment, random=-1|Center, 
data = betablocker, find.in.range = c(-2,0.4), s=40,k=3,random.distribution='np')
# Maximum Profile Log-likelihood: -158.6025 at lambda = -0.56
betavc3$fit$disparity
# [1] 317.2049
betavc3$aic
# [1] 331.2049
betavc3$bic
# [1] 343.6942

Kfind.boxcox

*Grid search over K for NPML estimation of random effect and variance component models*

Description

A grid search over the parameter K, to set the best number of mass-points.

Usage

`Kfind.boxcox(formula, groups = 1, data, lambda = 1, EMdev.change = 1e-04, 
steps = 500, find.k = c(2,10), model.selection = "aic", start = "gq", 
find.tol = c(0,1.5), steps.tol = 15, ...)`

Arguments

- `formula`: a formula describing the transformed response and the fixed effect model (e.g. `y ~ x`).
- `groups`: the random effects. To fit overdispersion models, set `groups = 1`.
- `data`: a data frame containing variables used in the fixed and random effect models.
- `lambda`: a transformation parameter, setting `lambda=1` means 'no transformation'.
- `EMdev.change`: a small scalar, with default 0.0001, used to determine when to stop EM algorithm.
- `steps`: maximum number of iterations for the EM algorithm.
- `find.k`: search in a range of K, with default (2,10) in step of 1.
model.selection
Set model.selection="aic", to use Akaike information criterion as model selection criterion or model.selection="bic", to use Bayesian information criterion as model selection criterion.

start
A description of the initial values to be used in the fitted model, Quantile-based version "quantile" or Gaussian Quadrature "gq" can be set.

find.tol
Search in a range of tol, with default (0,1.5) in step of 1.

steps.tol
Number of points in the grid search of tol.

... extra arguments will be ignored.

Details
Not only the shape of the distribution causes the skewness it may due to the use of an insufficient number of classes, K. For this, the Kfind.boxcox() function was created to search over a selected range of K and find the best. For each number of classes, a grid search over tol is performed and the tol with the lowest aic or bic value is considered as the optimal. Having the minimal aic or bic values for a whole range of K that have been specified beforehand, the Kfind.boxcox() function can find the best number of the component as the one with the smallest value. It also plots the aic or bic values against the selected range of K, including a vertical line indicating the best value of K that minimizes the model selection criteria. The full range of classes and their corresponding optimal tol can be printed off from the Kfind.boxcox()’s output and used with other boxcoxmix functions as starting points.

Value
MinDisparity the minimum disparity found.
Best.K the value of K corresponding to MinDisparity.
AllMinDisparities a vector containing all minimum disparities calculated on the grid.
AllMintol list of tol values used in the grid.
All.K list of K values used in the grid.
All.aic the Akaike information criterion of all fitted regression models.
All.bic the Bayesian information criterion of all fitted regression models.

Author(s)
Amani Almohameed and Jochen Einbeck

See Also
tolfind.boxcox.
Examples

```r
# Fabric data
data(fabric, package = "npmlreg")
teststr <- Kfind.boxcox(y ~ x, data = fabric, start = "gq", groups = 1,
    find.k = c(2, 3), model.selection = "aic", steps.tol = 5)
# Minimal AIC: 202.2114 at K = 2
```

np.boxcoxmix

Response Transformations for Random Effect and Variance Component Models

Description

The function `np.boxcoxmix()` fits an overdispersed generalized linear model and variance component models using nonparametric profile maximum likelihood.

Usage

```r
np.boxcoxmix(formula, groups = 1, data, K = 3, tol = 0.5, lambda = 1,
    steps = 500, EMdev.change = 1e-04, plot.opt = 1, verbose = TRUE,
    start = "gq", ...)
```

Arguments

- `formula` a formula describing the transformed response and the fixed effect model (e.g. `y ~ x`).
- `groups` the random effects. To fit overdispersion models, set `groups = 1`.
- `data` a data frame containing variables used in the fixed and random effect models.
- `K` the number of mass points.
- `tol` a positive scalar (usually, `0 < tol <= 2`).
- `lambda` a transformation parameter, setting `lambda = 1` means ‘no transformation’.
- `steps` maximum number of iterations for the EM algorithm.
- `EMdev.change` a small scalar, with default `0.0001`, used to determine when to stop EM algorithm.
- `plot.opt` Set `plot.opt = 1`, to plot the disparity against iteration number. Use `plot.opt = 2` for `tolfind.boxcox()` and `plot.opt = 3` for `optim.boxcox()`.
np.boxcoxmix

verbosed: If set to FALSE, no printed output on progress.

start: a description of the initial values to be used in the fitted model. Quantile-based version "quantile" or Gaussian Quadrature "gq" can be set.

... extra arguments will be ignored.

Details

The Box-Cox transformation (Box & Cox, 1964) is applied to the overdispersed generalized linear models and variance component models with an unspecified mixing distribution. The NPML estimate of the mixing distribution is known to be a discrete distribution involving a finite number of mass-points and corresponding masses (Aitkin et al., 2009). An Expectation-Maximization (EM) algorithm is used for fitting the finite mixture distribution, one needs to specify the number of components \( k \) of the finite mixture in advance. To stop the EM-algorithm when it reached its convergence point, we need to define the convergence criteria that is the absolute change in the successive log-likelihood function values being less than an arbitrary parameter such as \( \text{EMdev} \cdot \text{change} = 0.0001 \) (Einbeck et al., 2014). This algorithm can be implemented using the function \( \text{np.boxcoxmix()} \), which is designed to account for overdispersed generalized linear models and variance component models using the non-parametric profile maximum likelihood (NPPML) estimation.

The ability of the EM algorithm to locate the global maximum in fewer iterations can be affected by the choice of initial values, the function \( \text{np.boxcoxmix}() \) allows us to choose from two different methods to set the initial value of the mass points. When option "gq" is set, then Gauss-Hermite masses and mass points are used as starting points in the EM algorithm, while setting start= "quantile" uses the Quantile-based version to select the starting points.

Value

- **mass.point**: the fitted mass points.
- **p**: the masses corresponding to the mixing proportions.
- **beta**: the vector of coefficients.
- **sigma**: the standard deviation of the mixing distribution (the square root of the variance).
- **se**: the standard error of the estimate.
- **w**: a matrix of posterior probabilities that element i comes from cluster k.
- **loglik**: the log-likelihood of the fitted regression model.
- **complete.loglik**: the complete log-likelihood of the fitted regression model.
- **disparity**: the disparity of the fitted regression model.
- **EMiteration**: provides the number of iterations of the EM algorithm.
- **EMconverged**: TRUE means the EM algorithm converged.
- **call**: the matched call.
- **formula**: the formula provided.
- **data**: the data argument.
- **aic**: the Akaike information criterion of the fitted regression model.
bic the Bayesian information criterion of the fitted regression model.
fitted the fitted values for the individual observations.
fitted.transformed the fitted values for the individual transformed observations.
residuals the difference between the observed values and the fitted values.
residuals.transformed the difference between the transformed observed values and the transformed fitted values.
predicted.re a vector of predicted residuals.
The other outcomes are not relevant to users and they are intended for internal use only.

Author(s)
Amani Almohaimeed and Jochen Einbeck

References

See Also
optim.boxcox, tolfind.boxcox.

Examples
# Pennsylvanian Hospital Stay Data
data(hosp, package = "npmlreg")
test1 <- np.boxcoxmix(duration ~ age + wbc1, data = hosp, K = 2, tol = 1,
                      start = "quantile", lambda = 1)
round(summary(test1)$w, digits = 3)
# [1,] 1.000 0.000

# Refinery yield of gasoline Data
data(Gasoline, package = "nlme")
test2.vc <- np.boxcoxmix(yield ~ endpoint + vapor, groups = Gasoline$Sample,
data = Gasoline, K = 3, tol = 1.7, start = "quantile", lambda = 0)
test2.vc$disparity
# [1] 176.9827
np.estep  

*Internal boxcoxmix functions*

**Description**

 auxiliary functions are not intended to be directly called from the user.

**Usage**

```r
np.estep(y, x, lambda, p, beta, z, sigma)
np.zk(y, x, w, beta, lambda)
fik(y, x, lambda, beta, z, sigma)
np.theta(y, x, lambda, beta, z)
yhat(v, lambda = 1)
ytrans(y, lambda = 1)
np.bhat(y, x, w, z, lambda)
np.mstep(y, x, beta, lambda, w)
np.em(y, x, K, lambda = 1, steps = 500, tol = 0.5, start = "gq",
    EMdev.change = 1e-04, plot.opt = 1, verbose = TRUE, ...)
np.boxcox(formula, groups = 1, data, K = 3, tol = 0.5, lambda = 1,
    steps = 500, EMdev.change = 1e-04, plot.opt = 1, verbose = TRUE,
    start = "gq", ...)
vc.estep(Y, X, sizes = 1, lambda, p, beta, z, sigma)
zk(Y, X, sizes, w, beta, lambda)
bhat(Y, X, sizes, w, z, lambda)
mik(Y, X, sizes, lambda, beta, z, sigma)
vc.theta(Y, X, sizes, lambda, beta, z)
vc.mstep(Y, X, sizes = 1, beta, lambda, w)
```
vc.em(y, x, sizes = 1, K, lambda, steps = 500, tol = 0.5, start = "gq",
EMdev.change = 1e-04, plot.opt = 1, verbose = TRUE, ...)

vc.boxcox(formula, groups = 1, data, K = 3, tol = 0.5, lambda = 1,
steps = 500, EMdev.change = 1e-04, plot.opt = 1, verbose = TRUE,
start = "gq", ...)

gqz(numnodes = 20, minweight = 1e-06)

masspoint.class(object)

Arguments

y .......... x .......... lambda .......... a transformation parameter, setting lambda=1 means 'no transformation'.
K .......... the number of mass points.
steps .......... maximum number of iterations for the EM algorithm.
tol .......... a positive scalar (usually, 0< tol <= 2)
start .......... a description of the initial values to be used in the fitted model, Quantile-based
version "quantile" or Gaussian Quadrature "gq" can be set.
EMdev.change .......... a small scalar, with default 0.0001, used to determine when to stop EM algo-
thesis.
plot.opt .......... Set plot.opt=1, to plot the disparity against iteration number. Use plot.opt=2
for tolfind.boxcox and plot.opt=3 for optim.boxcox.
verbose .......... If set to FALSE, no printed output on progress.
... .......... extra arguments will be ignored.
formula .......... a formula describing the transformed response and the fixed effect model (e.g.
y ~ x).
groups .......... the random effects. To fit overdispersion models, set groups = 1.
data .......... a data frame containing variables used in the fixed and random effect models.

Details

Internal boxcoxmix functions

Author(s)

Amani Almohaimeed and Jochen Einbeck

```
optim.boxcox

Response Transformations for Random Effect and Variance Component Models
```

Description

The \texttt{optim.boxcox()} performs a grid search over the parameter \( \lambda \) for overdispersed generalized linear models and variance component models and then optimizes over this grid, to calculate the maximum likelihood estimator of the transformation.

Usage

```
optim.boxcox(formula, groups = 1, data, K = 3, steps = 500, tol = 0.5,
start = "gq", EMdev.change = 1e-04, find.in.range = c(-3, 3), s = 60,
plot.opt = 3, verbose = FALSE, noformat = FALSE, ...)
```

Arguments

- **formula**: a formula describing the transformed response and the fixed effect model (e.g. \( y \sim x \)).
- **groups**: the random effects. To fit overdispersion models, set groups = 1.
- **data**: a data frame containing variables used in the fixed and random effect models.
- **K**: the number of mass points.
- **steps**: maximum number of iterations for the EM algorithm.
- **tol**: a positive scalar (usually, \( 0 < \text{tol} \leq 2 \))
- **start**: a description of the initial values to be used in the fitted model, Quantile-based version "quantile" or Gaussian Quadrature "gq" can be set.
- **EMdev.change**: a small scalar, with default 0.0001, used to determine when to stop EM algorithm.
- **find.in.range**: search in a range of \( \lambda \), with default (-3,3) in step of 0.1.
- **s**: number of points in the grid search of \( \lambda \).
- **plot.opt**: Set plot.opt=3, to plot the disparity against iteration number and the profile log-likelihood against \( \lambda \). Use plot.opt=0, to only plot the profile log-likelihood against \( \lambda \).
- **verbose**: If set to FALSE, no printed output on progress.
- **noformat**: Set noformat = TRUE, to change the formatting of the plots.
- **...**: extra arguments will be ignored.
Details

The Box-Cox transformation (Box & Cox, 1964) is applied to the overdispersed generalized linear models and variance component models with an unspecified mixing distribution. The NPML estimate of the mixing distribution is known to be a discrete distribution involving a finite number of mass-points and corresponding masses (Aitkin et al., 2009). An Expectation-Maximization (EM) algorithm is used for fitting the finite mixture distribution, one needs to specify the number of components $K$ of the finite mixture in advance. To stop the EM-algorithm when it reached its convergence point, we need to defined the convergence criteria that is the absolute change in the successive log-likelihood function values being less than an arbitrary parameter such as \texttt{EMdev.change} = 0.0001 (Einbeck et al., 2014). This algorithm can be implemented using the function \texttt{np.boxcoxmix()}, which is designed to account for overdispersed generalized linear models and variance component models using the non-parametric profile maximum likelihood (NPPML) estimation.

The ability of the EM algorithm to locate the global maximum in fewer iterations can be affected by the choice of initial values, the function \texttt{optim.boxcox()} allows us to choose from two different methods to set the initial value of the mass points. When option "gq" is set, then Gauss-Hermite masses and mass points are used as starting points in the EM algorithm, while setting start= "quantile" uses the Quantile-based version to select the starting points.

\texttt{optim.boxcox()} performs a grid search over the parameter $\lambda$ and then optimizes over this grid, to calculate the maximum likelihood estimator of the transformation. It produces a plot of the non-parametric profile likelihood function that summarises information concerning $\lambda$, including a vertical line indicating the best value of $\lambda$ that maximizes the non-parametric profile log-likelihood.

Value

\begin{itemize}
  \item \texttt{all.lambda} list of $\lambda$ values used in the grid.
  \item \texttt{Maximum} the best estimate of $\lambda$ found.
  \item \texttt{objective} the value of the profile log-likelihood corresponding to Maximum.
  \item \texttt{EMconverged} 1 is TRUE, means the EM algorithm converged.
  \item \texttt{EMiteration} provides the number of iterations of the EM algorithm.
  \item \texttt{mass.point} the fitted mass points.
  \item \texttt{p} the masses corresponding to the mixing proportions.
  \item \texttt{beta} the vector of coefficients.
  \item \texttt{sigma} the standard deviation of the mixing distribution (the square root of the variance).
  \item \texttt{se} the standard error of the estimate.
  \item \texttt{w} a matrix of posterior probabilities that element i comes from cluster k.
  \item \texttt{loglik} the profile log-likelihood of the fitted regression model.
  \item \texttt{profile.loglik} the profile complete log-likelihood of the fitted regression model.
  \item \texttt{disparity} the disparity of the fitted regression model.
  \item \texttt{call} the matched call.
  \item \texttt{formula} the formula provided.
\end{itemize}
the data argument.

aic      the Akaike information criterion of the fitted regression model.

fitted   the fitted values for the individual observations.

fitted.transformed the fitted values for the individual transformed observations.

residuals the difference between the observed values and the fitted values.

residuals.transformed the difference between the transformed observed values and the transformed fitted values.

predicted.re a vector of predicted residuals.

The other outcomes are not relevant to users and they are intended for internal use only.

Author(s)

Amani Almohameed and Jochen Einbeck

References


See Also

np.boxcoxmix, tolfind.boxcox.

Examples

# The strength Data
data(mdscore)
maxlam <- optim.boxcox(y ~ cut*lot, data = mdscore, K = 3,
                        start = "gq", find.in.range = c(-2, 2), s = 5)

# Maximum profile log-likelihood: 33.6795 at lambda= -0.4

data(nls)

oxboys$boy <- gl(26,9)

maxlamvc <- optim.boxcox(height ~ age, groups = oxboys$boy,
                          data = oxboys, K = 2, start = "gq",
                          find.in.range=c(-1.2,1), s=6, plot.opt = 0)

maxlamvc$Maximum

#[1] -0.8333333

plot(maxlamvc,8)
Description

plot() is a generic function used to produce some useful diagnostic plotting of the functions:
np.boxcoxmix(), optim.boxcox() and tolfind.boxcox().

Usage

## S3 method for class 'boxcoxmix'
plot(x, plot.opt = 1, ...)

Arguments

x an object for which a plot is desired.

plot.opt an integer value between 1 and 8.

... additional arguments.

Details

Plot diagnostics for boxcoxmix functions

Value

The plots to be printed depend on the number given in plot.opt, for the np.boxcoxmix(), optim.boxcox() and tolfind.boxcox() functions:

1 the disparities with the iteration number against the mass points
2 the fitted value against the response of the original and the transformed Data.
3 probability plot of residuals of the original against the transformed data.
4 individual posterior probabilities.
5 control charts of residuals of the original against the transformed data.
6 The histograms of residuals of the original against the transformed data.
7 works only for the tolfind.boxcox() function and plots the specified range of tol against the disparities
8 works only for the optim.boxcox() function and gives the profile likelihood function that summarises information concerning lambda.
9 works only for the Kfind.boxcox() function and plots the specified range of K against the AIC or BIC information criteria
10 works only for the boxcoxtype() function and gives the profile likelihood function that summarises information concerning lambda for generalized linear Mixed-effects Models.
Description

summary() and print() are generic functions used to produce the results of the functions: np.boxcoxmix(), optim.boxco() and tolfind.boxco().

Usage

## S3 method for class 'boxcoxmix'
print(x, digits = max(3, getOption("digits") - 3),
       na.print = "", ...)

## S3 method for class 'boxcoxmixpure'
print(x, digits = max(3, getOption("digits") - 3),
       na.print = "", ...)

## S3 method for class 'boxcoxmix'
summary(object, digits = max(3, getOption("digits") - 3),
         ...)  

## S3 method for class 'boxcoxmixpure'
summary(object, digits = max(3, getOption("digits") -
         3), ...)

Arguments

x an object for which a summary is desired.

digits an integer number format.

na.print a character string which is used to indicate NA values output format.

... additional arguments.

object an object for which a summary is desired.

Details

Summary of boxcoxmix functions
tolfind.boxcox

Grid search over tol for NPPML estimation of random effect and variance component models

Description

A grid search over the parameter tol, to set the initial values of the EM algorithm.

Usage

```r
tolfind.boxcox(formula, groups = 1, data, K = 3, lambda = 1, EMdev.change = 1e-04, plot.opt = 2, s = 15, steps = 500, find.in.range = c(0, 1.5), start = "gq", verbose = FALSE, noformat = FALSE, ...)
```

Arguments

- `formula`: a formula describing the transformed response and the fixed effect model (e.g. `y ~ x`).
- `groups`: the random effects. To fit overdispersion models, set `groups = 1`.
- `data`: a data frame containing variables used in the fixed and random effect models.
- `K`: the number of mass points.
- `lambda`: a transformation parameter, setting `lambda=1` means 'no transformation'.
- `EMdev.change`: a small scalar, with default 0.0001, used to determine when to stop EM algorithm.
- `plot.opt`: Set `plot.opt=2`, to plot the EM trajectories and the development of the disparity over iteration number. And `plot.opt=0`, for none of them.
- `s`: number of points in the grid search of tol.
- `steps`: maximum number of iterations for the EM algorithm.
- `find.in.range`: search in a range of tol, with default (0,1.5) in step of 0.1.
- `start`: a description of the initial values to be used in the fitted model, Quantile-based version "quantile" or Gaussian Quadrature "gq" can be set.
- `verbose`: If set to FALSE, no printed output on progress.
- `noformat`: Set `noformat = TRUE`, to change the formatting of the plots.
- `...`: extra arguments will be ignored.

Details

A grid search over tol can be performed using `tolfind.boxcox()` function, which works for `np.boxcoxmix()` to find the optimal solution.
Value

MinDisparity  the minimum disparity found.
Mintol       the value of tol corresponding to MinDisparity.
AllDisparities a vector containing all disparities calculated on the grid.
Alltol       list of tol values used in the grid.
AllEMconverged 1 is TRUE, means the EM algorithm converged.
aic           the Akaike information criterion of the fitted regression model.
bic           the Bayesian information criterion of the fitted regression model.

Author(s)

Amani Almohaimeed and Jochen Einbeck

See Also

np.boxcoxmix.

Examples

# The Pennsylvanian Hospital Stay Data
data(hosp, package = "npmlreg")
test1 <- tolfind.boxcox(duration ~ age, data = hosp, K = 2, lambda = 0,
                         find.in.range = c(0, 2), s = 10, start = "gq")
# Minimal Disparity: 137.8368 at toll= 2
# Minimal Disparity with EM converged: 137.8368 at tol= 2

# Effect of Phenylbiguanide on Blood Pressure
data(PBG, package = "nlme")
test2 <- tolfind.boxcox(deltaBP ~ dose, groups = PBG$Rabbit, find.in.range = c(0, 2),
                         data = PBG, K = 2, lambda = -1, s = 15, start = "quantile", plot.opt = 0)
test2$mintol
# [1] 1.6

test2$minDisparity
# [1] 449.5876
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