Package 'LinRegInteractive'

February 8, 2020

Type Package

Title Interactive Interpretation of Linear Regression Models

Version 0.3-3

Date 2020-02-08

Author Martin Meermeyer

Maintainer Martin Meermeyer <m.meermeyer@gmail.com>

Description Interactive visualization of effects, response functions
and marginal effects for different kinds of regression models. In this version
linear regression models, generalized linear models, generalized additive
models and linear mixed-effects models are supported.
Major features are the interactive approach and the handling of the effects of categorical covariates:
if two or more factors are used as covariates every combination of the levels of each
factor is treated separately. The automatic calculation of
marginal effects and a number of possibilities to customize the graphical output
are useful features as well.

License GPL-2

Depends R (>= 3.0.0), rpanel (>= 1.1-4), xtable

Suggests AER, gam, mgcv, nlme

NeedsCompilation no

Repository CRAN

Date/Publication 2020-02-08 17:00:02 UTC

R topics documented:

LinRegInteractive-package

Interactive Interpretation of Linear Regression Models

Description

The implementation is based on the package **rpanel** and provides an interactive visualization of effects, response functions and marginal effects for different kinds of regression models. Major features are the interactive approach and the handling of the effects of categorical covariates: if two or more factors are used as covariates every combination of the levels of each factor (referred to as *groups*) is treated separately. The automatic calculation of marginal effects and a number of possibilities to customize the graphical output are useful features as well. In the accompanying vignette the usage is described in detail. Please refer to the documentation of the generic function fxInteractive for available methods.

Details

Package:	LinRegInteractive
Type:	Package
Version:	0.3-3
Date:	2020-02-08
License:	GPL-2

Author(s)

Martin Meermeyer <m.meermeyer@gmail.com>

References

Bowman, A., Crawford, E., Alexander, G., and Bowman, R. (2007). rpanel: Simple interactive controls for R functions using the tcltk package. *Journal of Statistical Software*, 17(9), 1-18.

See Also

The noninteractive visualization of the results for various types of regression models can be achieved with the package **effects**.

Examples

```
## Not run:
### Metric dependent variable ###
data("munichrent03")
model.rent <- lm(rent ~ yearc + I(yearc^2) + rooms + area*location + upkitchen,
```

```
      data=munichrent03)
fxInteractive(model.rent)

### Binary dependent variable ###
data("creditdata")
model.cd <- glm(credit ~ amount + I(amount^2) + age + duration*teleph + housing,
     family=binomial, data=creditdata)
fxInteractive(model.cd)

## End(Not run)
```

---

creditdata   *Credit Default Data*

Description

Stratified sample of 1,000 credit receivers (in the following *cr*) from a private bank in southern
Germany. The data were sampled at the end of the 1970s, therefore the credit amount is given in
DEM (1.95583 DEM = 1 EUR).

Usage

```
data("creditdata")
```

Format

A data frame with 1,000 observations on the following 21 variables.

credit Factor with levels "good" (no problems occur in redemption) and "bad" (problems occur
    in redemption).

amount Credit amount in DEM (numeric).

duration Duration of lent term in months (numeric).

age Age of the cr in years (numeric).

addcredit Has the cr additional credits at other vendors? Ordered factor with levels "none" (no
    additional credits), "bank" (at other banks) and "bargain" (at other vendors than banks).

asset Most valuable asset of the cr. Ordered factor with levels "none" (no valuable assets), "car"
    (car), "savings" (savings) and "prop" (freehold property).

bail Bailsman available? Ordered factor with levels "none" (no bailsmen), "applicant" (bails-
    man is additional applicant for the credit) and "yes" (external bailsman).

curacc Current account of the cr. Ordered factor with levels "none" (no account), "debit" (ac-
    count with dedit balance), "credit" (account with credit balance) and "wage" (account with
    periodical income).

empldur Duration of employment of the cr at the current employer. Ordered factor with levels
    "none" (unemployed), "max1y" (less than 1 year), "max4y" (between 1 and 4 years), "max7y"
    (between 4 and 7 years) and "min7y" (more than 7 years).

housdur For which period does the cr lives in current housing? Ordered factor with levels `"max1y"` (less than 1 year), `"max4y"` (between 1 and 4 years), `"max7y"` (between 4 and 7 years) and `"min7y"` (more than 7 years).

housing Accommodation of the cr. Ordered factor with levels `"social"` (social accommodation), `"rent"` (rented accommodation) and `"freehold"` (freehold accommodation).

immigrant Factor: Is the cr an immigrant?

installment Monthly installment in % of disposable income. Ordered factor with levels `"max20"` (installment is less than 20% of disposable income), `"max25"` (installment is more than 20% and less than 25% of disposable income), `"max35"` (installment is more than 25% and less than 35% of disposable income) and `"min35"` (installment is more than 35% of disposable income).

intuse Intended usage for the credit. Factor with levels `"car-new"` (buy a new car), `"car-old"` (buy an used car), `"fittings"` (buy fittings), `"hifi"` (buy radio or TV), `"holiday"` (pay a holiday), `"househ"` (buy new household items), `"misc"` (miscellaneous activities), `"qualif"` (pay a new qualification), `"repair"` (repair something) and `"retrain"` (pay a retrain).

job Employment status of the cr. Ordered factor with levels `"none"` (unemployed), `"unskilled"` (unskilled worker), `"medium"` (intermediate position) and `"higher"` (leading position).

martsex Martial status and sex of the cr. Factor with levels `"f-div-m-sing"` (female-divorced and male-single), `"f-sing"` (female-single), `"m-div"` (male-divorced) and `"m-mar"` (male-married).

moral Payment moral of the cr. Factor with levels `"alright"` (no problems with credits in the past at the bank), `"critical"` (further credits at other banks or problems with account management), `"none"` (no credits previously or fully paid back), `"yetalright"` (no problems with current credits at the bank so far) and `"problems"` (problems with credits in the past).

pers Number of persons who are entitled to maintenance from cr. Ordered factor with levels `"max2"` (up to 2) and `"min3"` (more than 2).

prevcred Number of previous credits of the cr at the bank (including the actual). Ordered factor with levels `"max1"` (1 credit), `"max3"` (between 2 and 3), `"max5"` (between 4 and 5) and `"min6"` (6 or more).

savacc Savings account of the cr. Ordered factor with levels `"none"` (no savings account), `"max1h"` (savings account with a balance up to 100 DEM), `"max5h"` (savings account with a balance between 100 DEM and 500 DEM), `"max1t"` (savings account with a balance between 500 DEM and 1.000 DEM) and `"min1t"` (savings account with a balance greater than 1,000 DEM).

teleph Factor: Has the cr a landline?

Source

References

Fahrmeir, L., Hamerle, A., Tutz, G. (1996): *Multivariate statistische Verfahren*, 2nd edition. Berlin: de Gruyter. 390 ff.

Fahrmeir, L., Kneib, T., Lang, S., Marx, B. (2013): *Regression: Models, Methods and Applications*. Berlin: Springer.

Open Data LMU (2010): *Kreditscoring zur Klassifikation von Kreditnehmern*.

Examples

```
data("creditdata")
print(summary(creditdata))

par(ask=TRUE)
plot(credit ~ amount, data=creditdata)
plot(credit ~ duration, data=creditdata)
plot(credit ~ age, data=creditdata)
plot(credit ~ housing, data=creditdata)
plot(credit ~ intuse, data=creditdata)
plot(credit ~ teleph, data=creditdata)
par(ask=FALSE)
```

---

factorCombinations   *Combine Levels of Different Factors to Groups*

Description

All levels of the factors from a [`data.frame`](data.frame) provided are combined, each combination of factor levels is referred to as *group*.

Usage

```
factorCombinations(X, factor.sep = "|", level.sep = ".", count=TRUE)
```

Arguments

X	A [`data.frame`](data.frame) containing at least one factor.
factor.sep	Character by which the factor-factor level combinations are separated in the group names.
level.sep	Character by which the level names are separated from the corresponding factor names in the group names.
count	Should the occurences of the different groups in the data.frame provided be counted? Default to TRUE.

Value

A list with the following components:

combinations	A data frame containing every combination of factor levels (groups) for the factors provided.
names	A character vector with the names of the groups. Factor-factor level combinations are separated by factor.sep and level names from the corresponding factor names by level.sep.
counts	If count is TRUE a vector indicating the number of occurences of the different groups within the data.frame provided to the function. NULL if count is set to FALSE.

Note

Function is mainly for internal use in **LinRegInteractive** but may be useful for other purposes as well.

Examples

```
# multiple factors
data("CO2")
print(factorCombinations(CO2))

# single factor
data("chickwts")
print(factorCombinations(chickwts))
```

---

fxInteractive   *Interactive Interpretation of Linear Regression Models*

Description

fxInteractive is a generic function for the interactive visualization of the results of various types of regression models. Originally the function was developed to translate proposals for the interpretation of models for binary outcomes made by Hoetker (2007) into practice. The function invokes particular methods for different kinds of fitted-model objects, see the list of available methods in the details. The implementation is based on the package **rpanel**. Major features are the interactive approach and the handling of the effects of categorical covariates: if two or more factors are used as covariates every combination of the levels of each factor (referred to as *groups*) is treated separately. The automatic calculation of marginal effects and a number of possibilities to customize the graphical output are useful features as well. In the accompanying vignette the usage is described in detail.

Usage

```
fxInteractive(model, ...)
```

Arguments

model	An appropriate fitted-model object (mandatory), see details.
...	Additional arguments for different aspects of usage, visualization and output. See the documentation of the corresponding methods for details.

Details

The only mandatory argument of the function is an appropriate fitted-model object. In this package version methods for the following regression models are available:

- Generalized linear models fitted with glm. The glm-method also works for generalized additive models fitted with gam (package **gam** and **mgcv**).

- Multiple linear regression models fitted with lm.
- Linear mixed-effects models fitted with lme (package **nlme**).

For the fitted-model objects the following prerequisites must be met:

- The model must contain at least one metric covariate.
- The model must be specified with the formula interface and the data frame containing the variables must be passed with the data argument.
- The categorical variables must be factors (ordered or unordered).

The basic idea of the function is the interactive usage. It is nevertheless easy to reproduce the plots for publication purposes, refer to section 5 of the vignette for this.

Users of the IDE **RStudio** may need to change the graphic device with options(device = "x11") before calling the function because in current versions of RStudio multiple graphic devices occasionally do not work.

Value

The default method just returns a notice. For supported fitted-model objects no object is returned. By calling the function usually a menu appears from which a metric covariate employed in the model must be selected. After choosing the covariate a graphic device which contains a termplot of the selected metric covariate and a GUI-panel to manipulate the plot will be opened. The GUI-panel has the following elements:

- A slider for each metric covariate.
- A radiobox to select the type of the current display (effect, response (if appropriate) and marginal effect).
- A checkbox to select the factor combinations (groups) to be displayed.
- A button to print tables of output to the console, see below.

The appearance of the panel can be controlled by a number of arguments, see section 6.4 of the vignette for details.

When the button is clicked four tables are printed to the console:

1. Table of coefficients obtained by the summary-method.
2. Table of the chosen values of the metric covariates and their ECDF-values in the dataset.
3. Table of the link and response function at the chosen values of the metric covariates for each group.
4. Table of marginal effects for each metric covariate at the chosen values of the metric covariates for each group.

By setting the argument latex2console to TRUE (see the documentation of the methods) the latter three tables are printed as LaTeX-code using functions provided by the package **xtable** (Dahl, 2012), see section 4 of the vignette for details.

The format of the text output and the layout of the plots can be controlled to a large extent, see section 6.1, 6.2 and 6.3 of the vignette for details.

The code to save plots in a platform independent way is adopted from the program archive accompanying Kruschke (2014) (URL: http://rpubs.com/NMA/9704).

Author(s)

Martin Meermeyer <m.meermeyer@gmail.com>

References

Bowman, A., Crawford, E., Alexander, G., and Bowman, R. (2007). rpanel: Simple interactive controls for R functions using the tcltk package. *Journal of Statistical Software*, 17(9), 1-18.

Dahl, D. B. (2014). xtable: Export tables to LaTeX or HTML. R package version 1.7-4.

Hoetker, G. (2007). The use of logit and probit models in strategic management research: Critical issues. *Strategic Management Journal*, 28(4), 331-343.

Kruschke, J. K. (2014). *Doing Bayesian Data Analysis: A Tutorial with R, JAGS, and Stan*, 2nd edition. Waltham (MA): Elsevier (Academic Press).

See Also

fxInteractive.glm is the corresponding method for generalized linear models fitted with glm.

fxInteractive.lm is the corresponding method for multiple linear regression models fitted with lm.

fxInteractive.lme is the corresponding method for linear mixed-effects models fitted with lme (package **nlme**).

The noninteractive visualization of the results for various types of regression models can be achieved with the package **effects**.

---

fxInteractive.glm   *Interactive Interpretation of Generalized Linear Models*

Description

This method implements proposals for the interpretation of models for binary outcomes made by Hoetker (2007) but works for other types of generalized linear models as well. The method is also suitable for generalized additive models fitted with gam (package **gam** and **mgcv**).

Usage

```
## S3 method for class 'glm'
fxInteractive(model, initial.values = as.list(NULL),
    preselect.var = NA, preselect.type = "link", preselect.groups = NULL,
    dev.height = 18, dev.width = 18, dev.width.legend = 8, dev.pointsize = 10,
    dev.defined = FALSE, ylim = NA, col = NA, lty = 1, lwd = 1,
    main = NA, main.line = 1.5, xlab = NA, ylab = NA,
    legend.add = TRUE, legend.space = legend.add, legend.only = FALSE,
    legend.pos = "center", legend.cex = 1, legend.width.factor = 1,
    rug.ticksize = 0.02, rug.col = "black", vline.actual = TRUE,
    pos.hlines = c(0, 0.5, 0), n.effects = 100,
    autosave.plot = FALSE, snapshot.plot = FALSE,
```

```
graphics.filename = "LinRegIntPlot", graphics.numbering = !autosave.plot,
graphics.type = "pdf", factor.sep = "|", level.sep = ".",
latex2console = FALSE, xtable.big.mark = ".", xtable.decimal.mark = ",",
xtable.digits = NULL, xtable.display = NULL, xtable.booktabs = FALSE,
panel.title = "Generalized Linear Model", label.button = "Snapshot",
label.slider.act = "Variable displayed: ", label.box.type = "Type",
label.types = c("linear predictor", "response", "marginal effect"),
label.box.groups = "Groups",
slider.width = 200, slider.height = 60, button.height = 30,
box.type.height = 100, box.group.character.width = 7,
box.group.line.height = 28, dist.obj.width = 20,
dist.obj.height = 10, ...)
```

Arguments

`model`	Object of class `glm` (mandatory).
`initial.values`	Initial values for the metric covariates in a named list, default to the means. See section 4 of the vignette and examples below.
`preselect.var`	Name of continuous variable to be displayed as character or `NA` (default) for menu selection.
`preselect.type`	The type of the initial plot to be displayed. Must be one of the values `"link"` (default), `"response"` or `"marginal"`.
`preselect.groups`	Numeric vector with the index of the groups which are displayed in the initial plot. If `NULL` (the default) all groups are displayed.
`dev.height`	Height of graphic device in cm, default to 18.
`dev.width`	Width of plot area in graphic device in cm, default to 18.
`dev.width.legend`	Width of legend area in graphic device in cm, default to 8.
`dev.pointsize`	Character pointsize of graphic device, default to `10`.
`dev.defined`	Graphic device predefined? Default to `FALSE`, see section 6.3 of the vignette for usage.
`ylim`	With a numeric vector of length 2 the plot limits in y-direction can be set. If `NA` (the default) these are determined automatically.
`col`	Vector of color specifications to represent different groups. Passed to the line commands and the legend. Actual palette and consecutive sequence if `NA` (default).
`lty`	Vector of line type specifications to represent different groups. Passed to the line commands and the legend, default to solid lines.
`lwd`	Vector of line width specifications to represent different groups. Passed to the line commands and the legend, default to 1.
`main`	Title for the plot, default to `NA`.
`main.line`	Height for plot title in lines which is passed to title(), default to 1.5.
`xlab`	Label for the x-axis. Name of the selected covariate, if `NA` (the default).

ylab	Label for the y-axis. Name of the selected plot type (see argument `label.types`), if `NA` (the default).
legend.add	Should a legend be added to the plot? Default to `TRUE`.
legend.space	Should the space for the legend be reserved? Default to the value of `legend.add`. Setting `legend.add` to `FALSE` and `legend.space` to `TRUE` plots white space instead of the legend. This can be useful when different plots are arranged in a document to ensure exact alignments and sizes, see section 6.2 of the vignette for details.
legend.only	Should just the legend be plotted? Default to `FALSE`. A plot with the legend alone can be useful when different plots are arranged in a document, see section 6.2 of the vignette for details.
legend.pos	Position of the legend as character, see [legend](#) for details. Default to `"center"`.
legend.cex	Relative size of legend text. Can be reduced if the model contains many groups. Default to `1`.
legend.width.factor	
	Factor by which the width of the legend is increased. Default to `1`. Increasing this can solve the problem that the legend annotations do not fit in the surrounding box when the plots are saved as PDF or EPS files, see section 5 of the vignette for details.
rug.ticksize	Length of rugplot tickmarks, dafault to `0.02`. Set to `0` or `NA`, if no rugplot should be drawn. For many observations the rug considerably slows down the rebuild of the plot.
rug.col	Color of rugplot tickmarks, default to `"black"`.
vline.actual	Add vertical line at actual position of selected metric covariate? Default to `TRUE`.
pos.hlines	Positions of the horizontal lines for [1] the plot of the link function, [2] the plot of the response and [3] the plot of marginal effects. `NA` for no lines, default to `c(0,0.5,0)`.
n.effects	Number of equally spaced points over the span of the selected metric covariate to calculate the effects for plotting, default to `100`. Increase, if lines are not smooth.
autosave.plot	Directly save the initial plot? Default to `FALSE`. If set to `TRUE` the GUI-panel is immediately closed after initialization.
snapshot.plot	Save plot when snapshot button is pressed? Default to `FALSE`, see section 5 of the vignette for details.
graphics.filename	
	Filename (optionally including a path) as character for graphic file.
graphics.numbering	
	If `TRUE` (the default) a 3 digits number is automatically appended to the filenname to avoid that existing graphic files are overwritten.
graphics.type	Graphics file type argument, default to `"pdf"`. On Windows systems all file types accepted by [savePlot](#) work. Under non Windows systems allowed values are `"pdf"`, `"eps"`, `"png"`, `"jpeg"`, `"jpg"`, `"tiff"` and `"bmp"`.
factor.sep	Character separating the factor-factor level combinations in the group names (default to `"|"`).

level.sep	Character separating the factor name and the corresponding factor levels in the group names (default to `"."`).
latex2console	Should the textoutput triggered by the snapshot button be printed as LaTeX-code? Default to `FALSE`.
xtable.big.mark	
	Bigmark character for LaTeX output passed to `print.xtable`, default to `","`.
xtable.decimal.mark	
	Decimal character for LaTeX output passed to `print.xtable`, default to `"."`.
xtable.digits	Number of digits for LaTeX output passed to `xtable`, default to `NULL`.
xtable.display	Display style for LaTeX output passed to `xtable`, default to `NULL`.
xtable.booktabs	
	Use the LaTeX package `booktabs` for horizontal lines in LaTeX tables, default to `FALSE`. Passed to `print.xtable`.
panel.title	Title used in the title bar of the GUI-panel of type `character`.
label.button	Label for the snapshot-button of type `character`.
label.slider.act	
	Additional label for the slider of the selected metric covariate of type `character`.
label.box.type	Title for the radiogroup box of type `character`.
label.types	Labels for radiogroup buttons (`character` vector of length 3). By default these are also used as corresponding annotations for the y-axis.
label.box.groups	
	Title for the checkbox of type `character`.
slider.width	Width of each slider in points (default to `200`).
slider.height	Height of each slider in points (default to `60`).
button.height	Height of snapshot button in points (default to `30`).
box.type.height	
	Height of radiobox for type selection in points (default to `90`).
box.group.character.width	
	The width of the boxes is basically a this value times the number of characters in points (default to `7`).
box.group.line.height	
	The height of the checkbox is this value times the number of groups in points (default to `28`).
dist.obj.width	Vertical distance between sliders and boxes and vertical margins in points (default to `20`).
dist.obj.height	
	Horizontal distance between panel objects in points (default to `10`).
...	Other graphical parameters passed to `par`.

Details

The only mandatory argument of the function is a fitted-model object of class `glm`. For this object the following prerequisites must be met:

- The model must contain at least one metric covariate.
- The model must be specified with the formula interface and the data frame containing the variables must be passed with the data argument.
- The categorical variables must be factors (ordered or unordered).

Please refer to the documentation of fxInteractive or the vignette for more details.

Value

No object is returned, please refer to the documentation of fxInteractive or the vignette for more details.

Author(s)

Martin Meermeyer <m.meermeyer@gmail.com>

References

Hoetker, G. (2007). The use of logit and probit models in strategic management research: Critical issues. *Strategic Management Journal*, 28(4), 331-343.

Kleiber, C., Zeileis, A. (2008). *Applied Econometrics with R*. New York: Springer.

Examples

```
### Model specification ###
data("creditdata")

## Treat ordered factors as unordered factors.
options(contrasts=c("contr.treatment","contr.treatment"))

model.cd <- glm(credit ~ amount + I(amount^2) + age + duration*teleph + housing,
    family=binomial, data=creditdata)

## Not run:

### Basic usage ###

## RStudio users may need to change the graphic device, see details.
options(device = "x11")

## Using defaults
fxInteractive(model.cd)

## Switch text output to LaTeX
fxInteractive(model.cd, latex2console = TRUE)

## Continental European number format in LaTeX output
fxInteractive(model.cd, latex2console = TRUE, decimal.mark = ",", big.mark = ".")

## Save plot as PDF to current working directory when 'Snapshot' is clicked
fxInteractive(model.cd, snapshot.plot = TRUE)
```

```
## Change color scheme and line types
fxInteractive(model.cd, col = rep(c(2,4),each = 3), lty = c(1,3,5))

## Change separation characters
fxInteractive(model.cd, factor.sep = "-", level.sep = ">")

## Suppress legend
fxInteractive(model.cd, legend.add = FALSE)

## Suppress rug plot
fxInteractive(model.cd, rug.ticksize = NA)

## Set initial values of metric covatiates
fxInteractive(model.cd, initial.values = list(amount=5000, age=30, duration=24))

## Preselect covariate, plot type and groups
fxInteractive(model.cd, preselect.var = "duration", preselect.type = "response",
    preselect.groups = c(2,5))

## Preselect covariate and plot type and change axis annotations
fxInteractive(model.cd, preselect.var = "duration", preselect.type = "response",
    xlab = "duration (months)", ylab = "probability of credit default")


### Visualization of statistical concepts ###

## Nonparametric effect
require("splines")
model.cd.bs <- glm(credit ~ bs(amount) + age + duration*teleph + housing,
    family = binomial, data = creditdata)
fxInteractive(model.cd.bs, preselect.var = "amount")

## Generalized additive model
require("mgcv")
model.cd.mgcv <- gam(credit ~ s(amount) + age + duration*teleph + housing,
family = binomial, data = creditdata)
fxInteractive(model.cd.mgcv)

## Interaction effect (directly)
fxInteractive(model.cd, preselect.var = "duration")

## Interaction effect (indirectly)
fxInteractive(model.cd, preselect.var = "age")
# manipulate slider for 'duration'

## Quasi-complete separation
# example from Kleiber, Zeileis (2008), p. 130ff
require("AER")
data("MurderRates")
model.mr <- glm(I(executions > 0) ~ time + income + noncauc + lfp + southern,
    family = binomial, data = MurderRates)
fxInteractive(model.mr, preselect.var = "income", preselect.type = "response")
```

```
### Additional examples ###

## Customize device for printing
fxInteractive(model.cd,
    dev.width = 6,
    dev.width.legend = 4,
    dev.height = 6,
    dev.pointsize = 6,
    col = c("darkred","red","salmon","darkblue","blue","lightblue"),
    legend.width.factor = 1.1,
    vline.actual = FALSE,
    snapshot.plot = TRUE,
    graphics.filename = "creddefault-termplot",
    mar = c(2.5,2.5,1,1)+0.1,
    mgp = c(1.5,0.5,0),
    tcl = -0.3)

## Save predefined plot automatically
fxInteractive(model.cd,
    initial.values = list(amount=5000, duration=24, age=30),
    preselect.var = "duration",
    preselect.type = "link",
    autosave.plot = TRUE,
    graphics.filename = "fig-creddefault-duration-link",
    legend.width.factor = 1.05)

## Modifications for models with many groups
# Increase space for legend and squeeze panel controls
model.cd.moregroups <- glm(credit ~ amount + I(amount^2) + age
    + duration*teleph + housing + job, family = binomial, data = creditdata)
fxInteractive(model.cd.moregroups,
    dev.width.legend = 9,
    legend.cex = 1,
    box.type.height = 90,
    box.group.character.width = 6,
    box.group.line.height = 25,
    dist.obj.height = 2)

# Squeeze legend and  panel controls
model.cd.manygroups <- glm(credit ~ amount + I(amount^2) + age
    + duration*teleph + housing + intuse, family = binomial, data = creditdata)
fxInteractive(model.cd.manygroups,
    dev.width.legend = 6,
    legend.cex = 0.54,
    box.type.height = 90,
    box.group.character.width = 6,
    box.group.line.height = 25,
    dist.obj.height = 2)
# Note that checkbox for groups grows beyond screen

# Preselect groups and specifiy color and line types directly
```

```
model.cd.manygroups <- glm(credit ~ amount + I(amount^2) + age
    + duration*teleph + housing + intuse, family = binomial, data = creditdata)
index.groups <- c(1,11,21,31,41,51)
vec.col <- NULL
vec.col[index.groups] <- c(1:6)
vec.lty <- NULL
vec.lty[index.groups] <- rep(c(1,2), each = 3)
fxInteractive(model.cd.manygroups,
preselect.var = "amount",
preselect.groups = index.groups,
col = vec.col,
lty = vec.lty)

## End(Not run)
```

---

fxInteractive.lm   *Interactive Interpretation of Multiple Linear Regression Models*

Description

This method facilitates the interpretation of multiple linear regression models and is a byproduct of
the method fxInteractive.glm for generalized linear models.

Usage

```
## S3 method for class 'lm'
 fxInteractive(model, initial.values = as.list(NULL),
    preselect.var = NA, preselect.type = "effect", preselect.groups = NULL,
    dev.height = 18, dev.width = 18, dev.width.legend = 8, dev.pointsize = 10,
    dev.defined = FALSE, ylim = NA, col = NA, lty = 1, lwd = 1,
    main = NA, main.line = 1.5, xlab = NA, ylab = NA,
    legend.add = TRUE, legend.space = legend.add, legend.only = FALSE,
    legend.pos = "center", legend.cex = 1, legend.width.factor = 1,
    rug.ticksize = 0.02, rug.col = "black", vline.actual = TRUE,
    pos.hlines = c(0, 0), n.effects = 100,
    autosave.plot = FALSE, snapshot.plot = FALSE,
    graphics.filename = "LinRegIntPlot", graphics.numbering = !autosave.plot,
    graphics.type = "pdf", factor.sep = "|", level.sep = ".",
    latex2console = FALSE, xtable.big.mark = ".", xtable.decimal.mark = ",",
    xtable.digits = NULL, xtable.display = NULL, xtable.booktabs = FALSE,
    panel.title = "Linear Model", label.button = "Snapshot",
    label.slider.act = "Variable displayed: ", label.box.type = "Type",
    label.types = c("effect", "marginal effect"),
    label.box.groups = "Groups",
    slider.width = 200, slider.height = 60, button.height = 30,
    box.type.height = 75, box.group.character.width = 7,
    box.group.line.height = 28, dist.obj.width = 20,
    dist.obj.height = 10, ...)
```

Arguments

`model`	Object of class [`lm`](mandatory).
`initial.values`	Initial values for the metric covariates in a named list, default to the means. See section 4 of the vignette and examples below.
`preselect.var`	Name of continuous variable to be displayed as character or `NA` (default) for menu selection.
`preselect.type`	The type of the initial plot to be displayed. Must be one of the values `"effect"` (default) or `"marginal"`.
`preselect.groups`	
	Numeric vector with the index of the groups which are displayed in the initial plot. If `NULL` (the default) all groups are displayed.
`dev.height`	Height of graphic device in cm, default to `18`.
`dev.width`	Width of plot area in graphic device in cm, default to `18`.
`dev.width.legend`	
	Width of legend area in graphic device in cm, default to `8`.
`dev.pointsize`	Character pointsize of graphic device, default to `10`.
`dev.defined`	Graphic device predefined? Default to `FALSE`, see section 6.3 of the vignette for usage.
`ylim`	With a numeric vector of length 2 the plot limits in y-direction can be set. If `NA` (the default) these are determined automatically.
`col`	Vector of color specifications to represent different groups. Passed to the line commands and the legend. Actual palette and consecutive sequence if `NA` (default).
`lty`	Vector of line type specifications to represent different groups. Passed to the line commands and the legend, default to solid lines.
`lwd`	Vector of line width specifications to represent different groups. Passed to the line commands and the legend, default to `1`.
`main`	Title for the plot, default to `NA`.
`main.line`	Height for plot title in lines which is passed to title(), default to `1.5`.
`xlab`	Label for the x-axis. Name of the selected covariate, if `NA` (the default).
`ylab`	Label for the y-axis. Name of the selected plot type (see argument `label.types`), if `NA` (the default).
`legend.add`	Should a legend be added to the plot? Default to `TRUE`.
`legend.space`	Should the space for the legend be reserved? Default to the value of `legend.add`. Setting `legend.add` to `FALSE` and `legend.space` to `TRUE` plots white space instead of the legend. This can be useful when different plots are arranged in a document to ensure exact alignments and sizes, see section 6.2 of the vignette for details.
`legend.only`	Should just the legend be plotted? Default to `FALSE`. A plot with the legend alone can be useful when different plots are arranged in a document, see section 6.2 of the vignette for details.
`legend.pos`	Position of the legend as character, see [`legend`](legend) for details. Default to `"center"`.

legend.cex Relative size of legend text. Can be reduced if the model contains many groups. Default to 1.

legend.width.factor

 Factor by which the width of the legend is increased. Default to 1. Increasing this can solve the problem that the legend annotations do not fit in the surrounding box when the plots are saved as PDF or EPS files, see section 5 of the vignette for details.

rug.ticksize Length of rugplot tickmarks, dafault to 0.02. Set to 0 or NA, if no rugplot should be drawn. For many observations the rug considerably slows down the rebuild of the plot.

rug.col Color of rugplot tickmarks, default to "black".

vline.actual Add vertical line at actual position of selected metric covariate? Default to TRUE.

pos.hlines Positions of the horizontal lines for [1] the plot of the effects and [2] the plot of marginal effects. NA for no lines, default to c(0,0).

n.effects Number of equally spaced points over the span of the selected metric covariate to calculate the effects for plotting, default to 100. Increase, if lines are not smooth.

autosave.plot Directly save the initial plot? Default to FALSE. If set to TRUE the GUI-panel is immediately closed after initialization.

snapshot.plot Save plot when snapshot button is pressed? Default to FALSE, see section 5 of the vignette for details.

graphics.filename

 Filename (optionally including a path) as character for graphic file.

graphics.numbering

 If TRUE (the default) a 3 digits number is automatically appended to the filenname to avoid that existing graphic files are overwritten.

graphics.type Graphics file type argument, default to "pdf". On Windows systems all file types accepted by [savePlot](#) work. Under non Windows systems allowed values are "pdf", "eps", "png", "jpeg", "jpg", "tiff" and "bmp".

factor.sep Character separating the factor-factor level combinations in the group names (default to "|").

level.sep Character separating the factor name and the corresponding factor levels in the group names (default to ".").

latex2console Should the textoutput triggered by the snapshot button be printed as LaTeX-code? Default to FALSE.

xtable.big.mark

 Bigmark character for LaTeX output passed to [print.xtable](#), default to ",".

xtable.decimal.mark

 Decimal character for LaTeX output passed to [print.xtable](#), default to ".".

xtable.digits Number of digits for LaTeX output passed to [xtable](#), default to NULL.

xtable.display Display style for LaTeX output passed to [xtable](#), default to NULL.

xtable.booktabs

 Use the LaTeX package booktabs for horizontal lines in LaTeX tables, default to FALSE. Passed to [print.xtable](#).

panel.title   Title used in the title bar of the GUI-panel of type character.

label.button   Label for the snapshot-button of type character.

label.slider.act

                  Additional label for the slider of the selected metric covariate of type character.

label.box.type   Title for the radiogroup box of type character.

label.types   Labels for radiogroup buttons (character vector of length 2). By default these
                  are also used as corresponding annotations for the y-axis.

label.box.groups

                  Title for the checkbox of type character.

slider.width   Width of each slider in points (default to 200).

slider.height   Height of each slider in points (default to 60).

button.height   Height of snapshot button in points (default to 30).

box.type.height

                  Height of radiobox for type selection in points (default to 90).

box.group.character.width

                  The width of the boxes is basically a this value times the number of characters
                  in points (default to 7).

box.group.line.height

                  The height of the checkbox is this value times the number of groups in points
                  (default to 28).

dist.obj.width   Vertical distance between sliders and boxes and vertical margins in points (de-
                  fault to 20).

dist.obj.height

                  Horizontal distance between panel objects in points (default to 10).

...   Other graphical parameters passed to par.

Details

The only mandatory argument of the function is a fitted-model object of class lm. For this object
the following prerequisites must be met:

- The model must contain at least one metric covariate.

- The model must be specified with the formula interface and the data frame containing the
  variables must be passed with the data argument.

- The categorical variables must be factors (ordered or unordered).

Please refer to the documentation of fxInteractive or the vignette for more details.

Value

No object is returned, please refer to the documentation of fxInteractive or the vignette for more
details.

Author(s)

Martin Meermeyer <m.meermeyer@gmail.com>

Examples

```
### Model specification ###
data("munichrent03")

## Treat ordered factors as unordered factors.
options(contrasts=c("contr.treatment","contr.treatment"))

model.rent <- lm(rent ~ yearc + I(yearc^2) + rooms + area*location + upkitchen,
    data=munichrent03)

## Not run:

### Basic usage ###

## RStudio users may need to change the graphic device, see details.
options(device = "x11")

## Using defaults
fxInteractive(model.rent)

## Switch text output to LaTeX
fxInteractive(model.rent, latex2console = TRUE)

## Continental European number format in LaTeX output
fxInteractive(model.rent, latex2console = TRUE, xtable.decimal.mark = ",", xtable.big.mark = ".")

## Save plot as PDF to current working directory when 'Snapshot' is clicked
fxInteractive(model.rent, snapshot.plot = TRUE)

## Change color scheme and line types
fxInteractive(model.rent, col = rep(c(1,2,4),each = 2), lty = c(1,5))

## Change separation characters
fxInteractive(model.rent, factor.sep = "-", level.sep = ">")

## Suppress legend
fxInteractive(model.rent, legend.add = FALSE)

## Suppress rug plot
fxInteractive(model.rent, rug.ticksize = NA)

## Set initial values of metric covatiates
fxInteractive(model.rent, initial.values = list(yearc=1990, rooms=3, area=80))

## Preselect covariate, plot type and groups
fxInteractive(model.rent, preselect.var = "yearc", preselect.type = "marginal",
    preselect.groups = c(2,4,6))

## Preselect covariate and plot type and change axis annotations
fxInteractive(model.rent, preselect.var = "yearc", preselect.type = "effect",
    xlab = "year of construction", ylab = "net rent (EUR)")
```

```
### Visualization of statistical concepts ###

## Nonlinear effect
fxInteractive(model.rent, preselect.var = "yearc")

## Nonparametric effect
require("splines")
model.rent.bs <- lm(rent ~ bs(yearc) + rooms + area*location + upkitchen,
    data = munichrent03)
model.rent.bs$data <- munichrent03
fxInteractive(model.rent.bs, preselect.var = "yearc")
# Note that the data must be attached to the fitted-model object
# afterwards, see section 7 of the vignette for details.

## Interaction effect (directly)
fxInteractive(model.rent, preselect.var = "area")

## Interaction effect (indirectly)
fxInteractive(model.rent, preselect.var = "yearc")
# manipulate slider for 'area'


### Additional examples ###

## Customize device for printing
fxInteractive(model.rent,
    dev.width = 6,
    dev.width.legend = 4,
    dev.height = 6,
    dev.pointsize = 6,
    col = c("red","darkred","blue","darkblue","green","darkgreen"),
    legend.width.factor = 1.1,
    vline.actual = FALSE,
    snapshot.plot = TRUE,
    graphics.filename = "munichrent-termplot",
    mar = c(2.5,2.5,1,1)+0.1,
    mgp = c(1.5,0.5,0),
    tcl =  -0.3)

## Save predefined plot automatically
fxInteractive(model.rent,
    initial.values = list(yearc=1990, rooms=3, area=80),
    preselect.var = "area",
    preselect.type = "marginal",
    autosave.plot = TRUE,
    graphics.filename = "fig-rent-area-marg",
    legend.width.factor = 1.05)

## Modifications for models with many groups
# Increase space for legend and squeeze panel controls
model.rent.moregroups <- lm(rent ~ yearc + I(yearc^2) + rooms + area*location
    + upkitchen + bathtile, data = munichrent03)
```

```
fxInteractive(model.rent.moregroups,
    dev.width.legend = 9,
    legend.cex = 1,
    box.type.height = 65,
    box.group.character.width = 6,
    box.group.line.height = 28,
    dist.obj.height = 2)

# Squeeze legend and  panel controls
model.rent.manygroups <- lm(rent ~ yearc + I(yearc^2) + rooms + area
    + district + upkitchen, data = munichrent03)
fxInteractive(model.rent.manygroups,
    dev.width.legend = 6,
    legend.cex = 0.65,
    box.type.height = 90,
    box.group.character.width = 6,
    box.group.line.height = 25,
    dist.obj.height=2)
# Note that checkbox for groups grows beyond screen

# Preselect groups and specifiy color and line types directly
model.rent.manygroups <- lm(rent ~ yearc + I(yearc^2) + rooms + area
    + district + upkitchen, data = munichrent03)
index.groups <- c(3,4,17,18,49,50)
vec.col <- NULL
vec.col[index.groups] <- c(1:6)
vec.lty <- NULL
vec.lty[index.groups] <- rep(c(1,2), each = 3)
fxInteractive(model.rent.manygroups,
preselect.var = "area",
preselect.groups = index.groups,
col = vec.col,
lty = vec.lty)

## End(Not run)
```

---

fxInteractive.lme   *Interactive Interpretation of Linear Mixed-Effects Models*

Description

This method facilitates the interpretation of linear mixed-effects models and is a byproduct of the
method `fxInteractive.glm` for generalized linear models.

Usage

```
## S3 method for class 'lme'
 fxInteractive(model, predict.lme.level = 0, initial.values = as.list(NULL),
    preselect.var = NA, preselect.type = "effect", preselect.groups = NULL,
    dev.height = 18, dev.width = 18, dev.width.legend = 8, dev.pointsize = 10,
```

```
dev.defined = FALSE, ylim = NA, col = NA, lty = 1, lwd = 1,
main = NA, main.line = 1.5, xlab = NA, ylab = NA,
legend.add = TRUE, legend.space = legend.add, legend.only = FALSE,
legend.pos = "center", legend.cex = 1, legend.width.factor = 1,
rug.ticksize = 0.02, rug.col = "black", vline.actual = TRUE,
pos.hlines = c(0, 0), n.effects = 100,
autosave.plot = FALSE, snapshot.plot = FALSE,
graphics.filename = "LinRegIntPlot", graphics.numbering = !autosave.plot,
graphics.type = "pdf", factor.sep = "|", level.sep = ".",
latex2console = FALSE, xtable.big.mark = ".", xtable.decimal.mark = ",",
xtable.digits = NULL, xtable.display = NULL, xtable.booktabs = FALSE,
panel.title = "Linear Mixed-Effects Model", label.button = "Snapshot",
label.slider.act = "Variable displayed: ", label.box.type = "Type",
label.types = c("effect", "marginal effect"),
label.box.groups = "Groups",
slider.width = 200, slider.height = 60, button.height = 30,
box.type.height = 75, box.group.character.width = 7,
box.group.line.height = 28, dist.obj.width = 20,
dist.obj.height = 10, ...)
```

Arguments

`model`	Object of class [lme](#) (package **nlme**) (mandatory).
`predict.lme.level`	
	Level of grouping to be displayed, passed to [predict.lme](#). Only one level can be displayed, default to 0.
`initial.values`	Initial values for the metric covariates in a named list, default to the means. See section 4 of the vignette and examples below.
`preselect.var`	Name of continuous variable to be displayed as character or NA (default) for menu selection.
`preselect.type`	The type of the initial plot to be displayed. Must be one of the values `"effect"` (default) or `"marginal"`.
`preselect.groups`	
	Numeric vector with the index of the groups which are displayed in the initial plot. If NULL (the default) all groups are displayed.
`dev.height`	Height of graphic device in cm, default to 18.
`dev.width`	Width of plot area in graphic device in cm, default to 18.
`dev.width.legend`	
	Width of legend area in graphic device in cm, default to 8.
`dev.pointsize`	Character pointsize of graphic device, default to 10.
`dev.defined`	Graphic device predefined? Default to FALSE, see section 6.3 of the vignette for usage.
`ylim`	With a numeric vector of length 2 the plot limits in y-direction can be set. If NA (the default) these are determined automatically.

col	Vector of color specifications to represent different groups. Passed to the line commands and the legend. Actual palette and consecutive sequence if NA (default).
lty	Vector of line type specifications to represent different groups. Passed to the line commands and the legend, default to solid lines.
lwd	Vector of line width specifications to represent different groups. Passed to the line commands and the legend, default to 1.
main	Title for the plot, default to NA.
main.line	Height for plot title in lines which is passed to title(), default to 1.5.
xlab	Label for the x-axis. Name of the selected covariate, if NA (the default).
ylab	Label for the y-axis. Name of the selected plot type (see argument label.types), if NA (the default).
legend.add	Should a legend be added to the plot? Default to TRUE.
legend.space	Should the space for the legend be reserved? Default to the value of legend.add. Setting legend.add to FALSE and legend.space to TRUE plots white space instead of the legend. This can be useful when different plots are arranged in a document to ensure exact alignments and sizes, see section 6.2 of the vignette for details.
legend.only	Should just the legend be plotted? Default to FALSE. A plot with the legend alone can be useful when different plots are arranged in a document, see section 6.2 of the vignette for details.
legend.pos	Position of the legend as character, see [legend](#) for details. Default to "center".
legend.cex	Relative size of legend text. Can be reduced if the model contains many groups. Default to 1.
legend.width.factor	
	Factor by which the width of the legend is increased. Default to 1. Increasing this can solve the problem that the legend annotations do not fit in the surrounding box when the plots are saved as PDF or EPS files, see section 5 of the vignette for details.
rug.ticksize	Length of rugplot tickmarks, dafault to 0.02. Set to 0 or NA, if no rugplot should be drawn. For many observations the rug considerably slows down the rebuild of the plot.
rug.col	Color of rugplot tickmarks, default to "black".
vline.actual	Add vertical line at actual position of selected metric covariate? Default to TRUE.
pos.hlines	Positions of the horizontal lines for [1] the plot of the effects and [2] the plot of marginal effects. NA for no lines, default to c(0,0).
n.effects	Number of equally spaced points over the span of the selected metric covariate to calculate the effects for plotting, default to 100. Increase, if lines are not smooth.
autosave.plot	Directly save the initial plot? Default to FALSE. If set to TRUE the GUI-panel is immediately closed after initialization.
snapshot.plot	Save plot when snapshot button is pressed? Default to FALSE, see section 5 of the vignette for details.

graphics.filename

 Filename (optionally including a path) as character for graphic file.

graphics.numbering

 If `TRUE` (the default) a 3 digits number is automatically appended to the filen-name to avoid that existing graphic files are overwritten.

graphics.type Graphics file type argument, default to `"pdf"`. On Windows systems all file types accepted by [savePlot](#) work. Under non Windows systems allowed values are `"pdf"`, `"eps"`, `"png"`, `"jpeg"`, `"jpg"`, `"tiff"` and `"bmp"`.

factor.sep Character separating the factor-factor level combinations in the group names (default to `"|"`).

level.sep Character separating the factor name and the corresponding factor levels in the group names (default to `"."`).

latex2console Should the textoutput triggered by the snapshot button be printed as LaTeX-code? Default to `FALSE`.

xtable.big.mark

 Bigmark character for LaTeX output passed to [print.xtable](#), default to `","`.

xtable.decimal.mark

 Decimal character for LaTeX output passed to [print.xtable](#), default to `"."`.

xtable.digits Number of digits for LaTeX output passed to [xtable](#), default to `NULL`.

xtable.display Display style for LaTeX output passed to [xtable](#), default to `NULL`.

xtable.booktabs

 Use the LaTeX package booktabs for horizontal lines in LaTeX tables, default to `FALSE`. Passed to [print.xtable](#).

panel.title Title used in the title bar of the GUI-panel of type `character`.

label.button Label for the snapshot-button of type `character`.

label.slider.act

 Additional label for the slider of the selected metric covariate of type `character`.

label.box.type Title for the radiogroup box of type `character`.

label.types Labels for radiogroup buttons (`character` vector of length 2). By default these are also used as corresponding annotations for the y-axis.

label.box.groups

 Title for the checkbox of type `character`.

slider.width Width of each slider in points (default to `200`).

slider.height Height of each slider in points (default to `60`).

button.height Height of snapshot button in points (default to `30`).

box.type.height

 Height of radiobox for type selection in points (default to `90`).

box.group.character.width

 The width of the boxes is basically a this value times the number of characters in points (default to `7`).

box.group.line.height

 The height of the checkbox is this value times the number of groups in points (default to `28`).

dist.obj.width   Vertical distance between sliders and boxes and vertical margins in points (default to `20`).

dist.obj.height

               Horizontal distance between panel objects in points (default to `10`).

...   Other graphical parameters passed to [par](par).

Details

The only mandatory argument of the function is a fitted-model object of class [lme](lme) (package **nlme**). For this object the following prerequisites must be met:

- The model must contain at least one metric covariate.
- The model must be specified with the formula interface and the data frame containing the variables must be passed with the `data` argument.
- The categorical variables must be factors (ordered or unordered).

In this method the additional argument `predict.lme.level` is responsible for the level of grouping to be displayed, see the documentation of predict.lme.

Please refer to the documentation of fxInteractive or the vignette for more details.

Value

No object is returned, please refer to the documentation of fxInteractive or the vignette for more details.

Author(s)

Martin Meermeyer <m.meermeyer@gmail.com>

See Also

The examples in fxInteractive.glm and fxInteractive.lm are more elaborated and show different aspects of usage and customization which are valid for this method, too.

Examples

```
require("nlme")
data("Orthodont")
LMEmod <- lme(distance ~ age + Sex, data = Orthodont, random = ~ age | Subject)

## Not run:
## RStudio users may need to change the graphic device, see details.
options(device = "x11")

## Grouping level 0 is used by default.
fxInteractive(LMEmod, legend.cex=0.6)

## Display grouping level 1
fxInteractive(LMEmod, predict.lme.level=1, legend.cex=0.6)
```

```
## For individual specific factors only observable factor combinations are meaningful
# the grouping variable must be the last column
combs.count    <- factorCombinations(Orthodont[,c(4,3)])$counts
combs.observed <- combs.count > 0
fxInteractive(LMEmod, predict.lme.level=1, preselect.groups=combs.observed)

## End(Not run)
```

---

munichrent03   *Data for the Rent Index 2003 in Munich, Germany*

Description

Sample of 2,053 appartments from the data collected for the preparation of the Munich rent index
2003.

Usage

```
data("munichrent03")
```

Format

A data frame with 2,053 observations on the following 12 variables.

rent Net rent in EUR (numeric).

rentsqm Net rent per square meter in EUR (numeric).

area Floor area in square meters (numeric).

rooms Number of rooms (numeric).

yearc Year of construction (numeric).

bathextra Factor: High quality equipment in the bathroom?

bathtile Factor: Bathroom tiled?

cheating Factor: Central heating available?

district Urban district where the apartment is located. Factor with 25 levels: "All-Umenz" (Al-
    lach - Untermenzing), "Alt-Le" (Altstadt - Lehel), "Au-Haid" (Au - Haidhausen), "Au-Lo-La"
    (Aubing - Lochhausen - Langwied), "BamLaim" (Berg am Laim), "Bogenh" (Bogenhausen),
    "Feld-Has" (Feldmoching - Hasenbergl), "Had" (Hadern), "Laim" (Laim), "Lud-Isar"(Ludwigsvorstadt
    - Isarvorstadt), "Maxvor" (Maxvorstadt), "Mil-AmH" (Milbertshofen - Am Hart), "Moos" (Moosach),
    "Neuh-Nymp" (Neuhausen - Nymphenburg), "Obgies" (Obergiesing), "Pas-Obmenz" (Pasing -
    Obermenzing), "Ram-Per" (Ramersdorf - Perlach), "SchwWest" (Schwabing West), "Schwab-Frei"
    (Schwabing - Freimann), "Schwanth" (Schwanthalerhoehe), "Send" (Sendling), "Send-West"
    (Sendling - Westpark), "Th-Ob-Fo-Fu-So" (Thalkirchen - Obersendling - Forstenried - Fuer-
    stenried - Solln), "Trud-Riem" (Trudering - Riem) and "Ugies-Har" (Untergiesing - Harlach-
    ing).

location Quality of location. Ordered factor with levels "normal", "good" and "top".

upkitchen Factor: Upscale equipment in kitchen?

wwater Factor: Hot water supply available?

Source

References

Fahrmeir, L., Kneib, T., Lang, S., Marx, B. (2013): *Regression: Models, Methods and Applications*. Berlin: Springer.

Fahrmeir, L., Kuenstler, R., Pigeot, I., Tutz, G. (2004): *Statistik: der Weg zur Datenanalyse*, 5th edition. Berlin: Springer.

Open Data LMU (2003): *Muenchner Mietspiegel 2003*.

Examples

```
data("munichrent03")
print(summary(munichrent03))

par(ask=TRUE)
plot(munichrent03[,1:5])
plot(rentsqm ~ bathextra, data=munichrent03)
plot(rentsqm ~ bathtile, data=munichrent03)
plot(rentsqm ~ cheating, data=munichrent03)
plot(rentsqm ~ location, data=munichrent03)
plot(rentsqm ~ upkitchen, data=munichrent03)
plot(rentsqm ~ wwater, data=munichrent03)

oldpar <- par(no.readonly = TRUE)
par(las=3, mar=c(8,4,4,2)+0.1)
plot(rentsqm ~ district, xlab=NA, data=munichrent03)
par(oldpar)

par(ask=FALSE)
```

Index