

Package ‘LinRegInteractive’

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Type Package

Title Interactive Interpretation of Linear Regression Models

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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

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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)

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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 Bailman available? Ordered factor with levels "none" (no bailsmen), "applicant" (bailman is additional applicant for the credit) and "yes" (external bailman).

curacc Current account of the cr. Ordered factor with levels "none" (no account), "debit" (account with debit 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).

- houstdur 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

<https://doi.org/10.5282/ubm/data.23>

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` provided are combined, each combination of factor levels is referred to as *group*.

Usage

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

Arguments

<code>X</code>	A <code>data.frame</code> containing at least one factor.
<code>factor.sep</code>	Character by which the factor-factor level combinations are separated in the group names.
<code>level.sep</code>	Character by which the level names are separated from the corresponding factor names in the group names.
<code>count</code>	Should the occurrences of the different groups in the <code>data.frame</code> provided be counted? Default to TRUE.

Value

A list with the following components:

<code>combinations</code>	A data frame containing every combination of factor levels (groups) for the factors provided.
<code>names</code>	A character vector with the names of the groups. Factor-factor level combinations are separated by <code>factor.sep</code> and level names from the corresponding factor names by <code>level.sep</code> .
<code>counts</code>	If <code>count</code> is TRUE a vector indicating the number of occurrences of the different groups within the <code>data.frame</code> provided to the function. NULL if <code>count</code> 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 <code>glm</code> (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 <code>title()</code> , default to 1.5.
xlab	Label for the x-axis. Name of the selected covariate, if NA (the default).

<code>ylab</code>	Label for the y-axis. Name of the selected plot type (see argument <code>label.types</code>), if NA (the default).
<code>legend.add</code>	Should a legend be added to the plot? Default to TRUE.
<code>legend.space</code>	Should the space for the legend be reserved? Default to the value of <code>legend.add</code> . Setting <code>legend.add</code> to FALSE and <code>legend.space</code> 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.
<code>legend.only</code>	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.
<code>legend.pos</code>	Position of the legend as character, see legend for details. Default to "center".
<code>legend.cex</code>	Relative size of legend text. Can be reduced if the model contains many groups. Default to 1.
<code>legend.width.factor</code>	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.
<code>rug.ticksize</code>	Length of rugplot tickmarks, default 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.
<code>rug.col</code>	Color of rugplot tickmarks, default to "black".
<code>vline.actual</code>	Add vertical line at actual position of selected metric covariate? Default to TRUE.
<code>pos.hlines</code>	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 <code>c(0, 0.5, 0)</code> .
<code>n.effects</code>	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.
<code>autosave.plot</code>	Directly save the initial plot? Default to FALSE. If set to TRUE the GUI-panel is immediately closed after initialization.
<code>snapshot.plot</code>	Save plot when snapshot button is pressed? Default to FALSE, see section 5 of the vignette for details.
<code>graphics.filename</code>	Filename (optionally including a path) as character for graphic file.
<code>graphics.numbering</code>	If TRUE (the default) a 3 digits number is automatically appended to the filename to avoid that existing graphic files are overwritten.
<code>graphics.type</code>	Graphics file type argument, default to "pdf". On Windows systems all file types accepted by <code>savePlot</code> work. Under non Windows systems allowed values are "pdf", "eps", "png", "jpeg", "jpg", "tiff" and "bmp".
<code>factor.sep</code>	Character separating the factor-factor level combinations in the group names (default to " ").

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

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)

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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.ticksiz = NA)

## Set initial values of metric covariates
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 specify 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.ticksiz = 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

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

<code>panel.title</code>	Title used in the title bar of the GUI-panel of type character.
<code>label.button</code>	Label for the snapshot-button of type character.
<code>label.slider.act</code>	Additional label for the slider of the selected metric covariate of type character.
<code>label.box.type</code>	Title for the radiogroup box of type character.
<code>label.types</code>	Labels for radiogroup buttons (character vector of length 2). By default these are also used as corresponding annotations for the y-axis.
<code>label.box.groups</code>	Title for the checkbox of type character.
<code>slider.width</code>	Width of each slider in points (default to 200).
<code>slider.height</code>	Height of each slider in points (default to 60).
<code>button.height</code>	Height of snapshot button in points (default to 30).
<code>box.type.height</code>	Height of radiobox for type selection in points (default to 90).
<code>box.group.character.width</code>	The width of the boxes is basically a this value times the number of characters in points (default to 7).
<code>box.group.line.height</code>	The height of the checkbox is this value times the number of groups in points (default to 28).
<code>dist.obj.width</code>	Vertical distance between sliders and boxes and vertical margins in points (default to 20).
<code>dist.obj.height</code>	Horizontal distance between panel objects in points (default to 10).
<code>...</code>	Other graphical parameters passed to <code>par</code> .

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.ticksiz = NA)

## Set initial values of metric covariates
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 specify 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

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

<code>col</code>	Vector of color specifications to represent different groups. Passed to the line commands and the legend. Actual palette and consecutive sequence if NA (default).
<code>lty</code>	Vector of line type specifications to represent different groups. Passed to the line commands and the legend, default to solid lines.
<code>lwd</code>	Vector of line width specifications to represent different groups. Passed to the line commands and the legend, default to 1.
<code>main</code>	Title for the plot, default to NA.
<code>main.line</code>	Height for plot title in lines which is passed to <code>title()</code> , default to 1.5.
<code>xlab</code>	Label for the x-axis. Name of the selected covariate, if NA (the default).
<code>ylab</code>	Label for the y-axis. Name of the selected plot type (see argument <code>label.types</code>), if NA (the default).
<code>legend.add</code>	Should a legend be added to the plot? Default to TRUE.
<code>legend.space</code>	Should the space for the legend be reserved? Default to the value of <code>legend.add</code> . Setting <code>legend.add</code> to FALSE and <code>legend.space</code> 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.
<code>legend.only</code>	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.
<code>legend.pos</code>	Position of the legend as character, see legend for details. Default to "center".
<code>legend.cex</code>	Relative size of legend text. Can be reduced if the model contains many groups. Default to 1.
<code>legend.width.factor</code>	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.
<code>rug.ticksize</code>	Length of rugplot tickmarks, default 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.
<code>rug.col</code>	Color of rugplot tickmarks, default to "black".
<code>vline.actual</code>	Add vertical line at actual position of selected metric covariate? Default to TRUE.
<code>pos.hlines</code>	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 <code>c(0, 0)</code> .
<code>n.effects</code>	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.
<code>autosave.plot</code>	Directly save the initial plot? Default to FALSE. If set to TRUE the GUI-panel is immediately closed after initialization.
<code>snapshot.plot</code>	Save plot when snapshot button is pressed? Default to FALSE, see section 5 of the vignette for details.

<code>graphics.filename</code>	Filename (optionally including a path) as character for graphic file.
<code>graphics.numbering</code>	If TRUE (the default) a 3 digits number is automatically appended to the filename to avoid that existing graphic files are overwritten.
<code>graphics.type</code>	Graphics file type argument, default to "pdf". On Windows systems all file types accepted by <code>savePlot</code> work. Under non Windows systems allowed values are "pdf", "eps", "png", "jpeg", "jpg", "tiff" and "bmp".
<code>factor.sep</code>	Character separating the factor-factor level combinations in the group names (default to " ").
<code>level.sep</code>	Character separating the factor name and the corresponding factor levels in the group names (default to ".").
<code>latex2console</code>	Should the textoutput triggered by the snapshot button be printed as LaTeX-code? Default to FALSE.
<code>xtable.big.mark</code>	Bigmark character for LaTeX output passed to <code>print.xtable</code> , default to ",".
<code>xtable.decimal.mark</code>	Decimal character for LaTeX output passed to <code>print.xtable</code> , default to ".".
<code>xtable.digits</code>	Number of digits for LaTeX output passed to <code>xtable</code> , default to NULL.
<code>xtable.display</code>	Display style for LaTeX output passed to <code>xtable</code> , default to NULL.
<code>xtable.booktabs</code>	Use the LaTeX package <code>booktabs</code> for horizontal lines in LaTeX tables, default to FALSE. Passed to <code>print.xtable</code> .
<code>panel.title</code>	Title used in the title bar of the GUI-panel of type character.
<code>label.button</code>	Label for the snapshot-button of type character.
<code>label.slider.act</code>	Additional label for the slider of the selected metric covariate of type character.
<code>label.box.type</code>	Title for the radiogroup box of type character.
<code>label.types</code>	Labels for radiogroup buttons (character vector of length 2). By default these are also used as corresponding annotations for the y-axis.
<code>label.box.groups</code>	Title for the checkbox of type character.
<code>slider.width</code>	Width of each slider in points (default to 200).
<code>slider.height</code>	Height of each slider in points (default to 60).
<code>button.height</code>	Height of snapshot button in points (default to 30).
<code>box.type.height</code>	Height of radiobox for type selection in points (default to 90).
<code>box.group.character.width</code>	The width of the boxes is basically a this value times the number of characters in points (default to 7).
<code>box.group.line.height</code>	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 `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 apartments 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" (Allach - Untermenzing), "Alt-Le" (Altstadt - Lehel), "Au-Haid" (Au - Haidhausen), "Au-Lo-La" (Aubing - Lochhausen - Langwied), "BamLaim" (Berg am Laim), "Bogenh" (Bogenhausen), "Feld-Has" (Feldmoching - Hasenberg), "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 - Fuerstenried - Solln), "Trud-Riem" (Trudering - Riem) and "Ugies-Har" (Untergiesing - Harlaching).

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

<https://doi.org/10.5282/ubm/data.2>

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)
```

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