Package ‘insight’

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Type Package

Title Easy Access to Model Information for Various Model Objects

Version 0.18.8

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Description A tool to provide an easy, intuitive and consistent access to information contained in various R models, like model formulas, model terms, information about random effects, data that was used to fit the model or data from response variables. ‘insight’ mainly revolves around two types of functions: Functions that find (the names of) information, starting with 'find_', and functions that get the underlying data, starting with 'get_'. The package has a consistent syntax and works with many different model objects, where otherwise functions to access these information are missing.

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URL https://easystats.github.io/insight/

BugReports https://github.com/easystats/insight/issues

Depends R (>= 3.5)

Imports methods, stats, utils

Suggests AER, afex, aod, BayesFactor, bayestestR, bbmle, bdsmatrix, betareg, bife, biglm, blavaan, blme, boot, brms, censReg, cgam, clubSandwich, coxme, cplm, crch, datawizard, effectsize, emmeans, epiR, estimatr, feisr, fixest, fungible, gam, gamlss, gamm4, gbm, gee, geepack, GLMMadaptive, glmmTMB, gnmnl, gt, htr, ivreg, JM, knitr, lavaan, lavaSearch2, lfe, lme4, lmerTest, lme4test, logistf, logitr, MASS, marginaleffects, Matrix, mclogit, mclust, MCMCglmm, merTools, metaBMA, mgcv, mice, mlogit, mhurdle, multgee, nlme, nnet, nonnest2, ordinal, panelr, parameters, parsnip, pbkrtest, performance, plm, poorman, pscl, psych, quantreg, rmarkdown, rms, robustbase, robustlmm, rstanarm (>= 2.21.1), rstantoools, rstudioapi, sandwich, speedglm, splines, statmod, survey, survival, testthat, truncreg, tweedie, VGAM
R topics documented:

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all_models_equal  Checks if all objects are models of same class

Description

Small helper that checks if all objects are supported (regression) model objects and of same class.

Usage

all_models_equal(..., verbose = FALSE)

all_models_same_class(..., verbose = FALSE)

Arguments

...  A list of objects.

verbose  Toggle off warnings.

Value

A logical, TRUE if x are all supported model objects of same class.

Examples

if (require("lme4")) {
  data(mtcars)
  data(sleepstudy)

  m1 <- lm(mpg ~ wt + cyl + vs, data = mtcars)
  m2 <- lm(mpg ~ wt + cyl, data = mtcars)
  m3 <- lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
  m4 <- glm(formula = vs ~ wt, family = binomial(), data = mtcars)

  all_models_same_class(m1, m2)
  all_models_same_class(m1, m2, m3)
  all_models_same_class(m1, m4, m2, m3, verbose = TRUE)
  all_models_same_class(m1, m4, mtcars, m2, m3, verbose = TRUE)
}

check_if_installed  

Checking if needed package is installed

Description

Checking if needed package is installed

Usage

check_if_installed(
  package,
  reason = "for this function to work",
  stop = TRUE,
  minimum_version = NULL,
  quietly = FALSE,
  prompt = interactive(),
  ...
)

Arguments

package
A character vector naming the package(s), whose installation needs to be checked in any of the libraries.

reason
A phrase describing why the package is needed. The default is a generic description.

stop
Logical that decides whether the function should stop if the needed package is not installed.

minimum_version
A character vector, representing the minimum package version that is required for each package. Should be of same length as package. If NULL, no check for minimum version is done.

quietly
Logical, if TRUE, invisibly returns a vector of logicals (TRUE for each installed package, FALSE otherwise), and does not stop or throw a warning. If quietly = TRUE, arguments stop and prompt are ignored. Use this argument to internally check for package dependencies without stopping or warnings.

prompt
If TRUE, will prompt the user to install needed package(s). Ignored if quietly = TRUE.

Value

If stop = TRUE, and package is not yet installed, the function stops and throws an error. Else, a named logical vector is returned, indicating which of the packages are installed, and which not.
clean_names

Examples

```r
## Not run:
check_if_installed("insight")
try(check_if_installed("nonexistent_package"))
try(check_if_installed("insight", minimum_version = "99.8.7"))
try(check_if_installed(c("nonexistent", "also_not_here"), stop = FALSE))
## End(Not run)
```

clean_names

Get clean names of model terms

description

This function "cleans" names of model terms (or a character vector with such names) by removing patterns like \texttt{log()} or \texttt{as.factor()} etc.

Usage

```r
clean_names(x, ...)
## S3 method for class 'character'
clean_names(x, include_names = FALSE, ...)
```

Arguments

- `x`: A fitted model, or a character vector.
- `...`: Currently not used.
- `include_names`: Logical, if \texttt{TRUE}, returns a named vector where names are the original values of \texttt{x}.

Value

The "cleaned" variable names as character vector, i.e. pattern like \texttt{s()} for splines or \texttt{log()} are removed from the model terms.

Note

Typically, this method is intended to work on character vectors, in order to remove patterns that obscure the variable names. For convenience reasons it is also possible to call \texttt{clean_names()} also on a model object. If \texttt{x} is a regression model, this function is (almost) equal to calling \texttt{find_variables()}. The main difference is that \texttt{clean_names()} always returns a character vector, while \texttt{find_variables()} returns a list of character vectors, unless \texttt{flatten = TRUE}. See 'Examples'.

Examples

```r
# example from ?stats::glm
counts <- c(18, 17, 15, 20, 10, 20, 25, 13, 12)
outcome <- as.numeric(gl(3, 1, 9))
treatment <- gl(3, 3)
m <- glm(counts ~ log(outcome) + as.factor(treatment), family = poisson())
clean_names(m)

# difference "clean_names()" and "find_variables()"
if (require("lme4")) {
  m <- glmer(
    cbind(incidence, size - incidence) ~ period + (1 | herd),
    data = cbpp,
    family = binomial
  )
  clean_names(m)
  find_variables(m)
  find_variables(m, flatten = TRUE)
}
```

---

**clean_parameters**  
*Get clean names of model parameters*

**Description**

This function "cleans" names of model parameters by removing patterns like "r_" or "b[]" (mostly applicable to Stan models) and adding columns with information to which group or component parameters belong (i.e. fixed or random, count or zero-inflated...)

The main purpose of this function is to easily filter and select model parameters, in particular of - but not limited to - posterior samples from Stan models, depending on certain characteristics. This might be useful when only selective results should be reported or results from all parameters should be filtered to return only certain results (see `print_parameters()`).

**Usage**

```r
clean_parameters(x, ...)
```

**Arguments**

- `x`    A fitted model.
- `...`  Currently not used.
Details

The Effects column indicate if a parameter is a fixed or random effect. The Component can either be conditional or zero_inflated. For models with random effects, the Group column indicates the grouping factor of the random effects. For multivariate response models from brms or rstanarm, an additional Response column is included, to indicate which parameters belong to which response formula. Furthermore, Cleaned_Parameter column is returned that contains “human readable” parameter names (which are mostly identical to Parameter, except for for models from brms or rstanarm, or for specific terms like smooth- or spline-terms).

Value

A data frame with "cleaned" parameter names and information on effects, component and group where parameters belong to. To be consistent across different models, the returned data frame always has at least four columns Parameter, Effects, Component and Cleaned_Parameter. See 'Details'.

Examples

## Not run:
library(brms)
model <- download_model("brms_zi_2")
clean_parameters(model)
## End(Not run)

---

color_if  

Color-formatting for data columns based on condition

Description

Convenient function that formats columns in data frames with color codes, where the color is chosen based on certain conditions. Columns are then printed in color in the console.

Usage

color_if(
  x,
  columns,
  predicate = `>`,
  value = 0,
  color_if = "green",
  color_else = "red",
  digits = 2
)

colour_if(  
x,
```r
color_if =
  columns,
predicate = '>',
value = 0,
colour_if = "green",
colour_else = "red",
digits = 2
)

Arguments

x A data frame
columns Character vector with column names of x that should be formatted.
predicate A function that takes columns and value as input and which should return TRUE or FALSE, based on if the condition (in comparison with value) is met.
value The comparator. May be used in conjunction with predicate to quickly set up a function which compares elements in columns to value. May be ignored when predicate is a function that internally computes other comparisons. See 'Examples'.
color_if, colour_if Character vector, indicating the color code used to format values in x that meet the condition of predicate and value. May be one of "red", "yellow", "green", "blue", "violet", "cyan" or "grey". Formatting is also possible with "bold" or "italic".
color_else, colour_else See color_if, but only for conditions that are not met.
digits Digits for rounded values.

Details

The predicate-function simply works like this: which(predicate(x[, columns], value))

Value

The .

Examples

# all values in Sepal.Length larger than 5 in green, all remaining in red
x <- color_if(iris[1:10, ], columns = "Sepal.Length", predicate = '>', value = 5)
x
cat(x$Sepal.Length)

# all levels "setosa" in Species in green, all remaining in red
x <- color_if(iris, columns = "Species", predicate = '==', value = "setosa")
cat(x$Species)

# own function, argument "value" not needed here
p <- function(x, y) {
x >= 4.9 & x <= 5.1
```
```r
# all values in Sepal.Length between 4.9 and 5.1 in green, all remaining in red
x <- color_if(iris[1:10, ], columns = "Sepal.Length", predicate = p)
cat(x$Sepal.Length)
```

### compact_character

**Description**

Remove empty strings from character

**Usage**

```r
compact_character(x)
```

**Arguments**

- `x` A single character or a vector of characters.

**Value**

A character or a character vector with empty strings removed.

**Examples**

```r
compact_character(c("x", "y", NA))
compact_character(c("x", "NULL", ",", "y"))
```

### compact_list

**Description**

Remove empty elements from lists

**Usage**

```r
compact_list(x, remove_na = FALSE)
```

**Arguments**

- `x` A list or vector.
- `remove_na` Logical to decide if NAs should be removed.
### Examples

```r
compact_list(list(NULL, 1, c(NA, NA)))
compact_list(c(1, NA, NA))
compact_list(c(1, NA, NA), remove_na = TRUE)
```

---

### Description

`display()` is a generic function to export data frames into various table formats (like plain text, markdown, ...). `print_md()` usually is a convenient wrapper for `display(format = "markdown")`. Similar, `print_html()` is a shortcut for `display(format = "html")`. See the documentation for the specific objects' classes.

### Usage

```r
display(object, ...)

print_md(x, ...)

print_html(x, ...)

# S3 method for class 'data.frame'
display(object, format = "markdown", ...)

# S3 method for class 'data.frame'
print_md(x, ...)

# S3 method for class 'data.frame'
print_html(x, ...)
```

### Arguments

- `object`, `x` A data frame.
- `...` Arguments passed to other methods.
- `format` String, indicating the output format. Can be "markdown" or "html".

### Value

Depending on `format`, either an object of class `gt_tbl` or a character vector of class `knitr_kable`.

### Examples

```r
display(iris[1:5, ])
```
**download_model**

### Description

Downloads pre-compiled models from the *circus*-repository. The *circus*-repository contains a variety of fitted models to help the systematic testing of other packages.

### Usage

```r
download_model(name, url = NULL)
```

### Arguments

- **name**
  - Model name.
- **url**
  - String with the URL from where to download the model data. Optional, and should only be used in case the repository-URL is changing. By default, models are downloaded from [https://raw.github.com/easystats/circus/master/data/](https://raw.github.com/easystats/circus/master/data/).

### Details

The code that generated the model is available at the [https://easystats.github.io/circus/reference/index.html](https://easystats.github.io/circus/reference/index.html).

### Value

A model from the *circus*-repository.

### References

[https://easystats.github.io/circus/](https://easystats.github.io/circus/)

---

**ellipsis_info**

### Description

Provides information regarding the models entered in an ellipsis. It detects whether all are models, regressions, nested regressions etc., assigning different classes to the list of objects.

### Usage

```r
ellipsis_info(objects, ...)
```

---

## Default S3 method:

```r
e llipsis_info(..., only_models = TRUE, verbose = TRUE)
```
Arguments

- `objects, ...`: Arbitrary number of objects. May also be a list of model objects.
- `only_models`: Only keep supported models (default to `TRUE`).
- `verbose`: Toggle warnings.

Value

The list with objects that were passed to the function, including additional information as attributes (e.g. if models have same response or are nested).

Examples

```r
m1 <- lm(Sepal.Length ~ Petal.Width + Species, data = iris)
m2 <- lm(Sepal.Length ~ Species, data = iris)
m3 <- lm(Sepal.Length ~ Petal.Width, data = iris)
m4 <- lm(Sepal.Length ~ 1, data = iris)
m5 <- lm(Petal.Width ~ 1, data = iris)

objects <- ellipsis_info(m1, m2, m3, m4)
class(objects)

objects <- ellipsis_info(m1, m2, m4)
attributes(objects)$is_nested

objects <- ellipsis_info(m1, m2, m5)
attributes(objects)$same_response
```

Description

Data frame and Tables Pretty Formatting

Usage

```r
export_table(
  x,
  sep = " | ",
  header = "-",
  cross = NULL,
  empty_line = NULL,
  digits = 2,
  protect_integers = TRUE,
  missing = "",
  width = NULL,
  format = NULL,
```
title = NULL, 
caption = title, 
subtitle = NULL, 
footer = NULL, 
align = NULL, 
group_by = NULL, 
zap_small = FALSE, 
table_width = NULL, 
verbose = TRUE, 
... 
)

Arguments

x A data frame. May also be a list of data frames, to export multiple data frames into multiple tables.

sep Column separator.

header Header separator. Can be NULL.

cross Character that is used where separator and header lines cross.

empty_line Separator used for empty lines. If NULL, line remains empty (i.e. filled with whitespaces).

digits Number of digits for rounding or significant figures. May also be "signif" to return significant figures or "scientific" to return scientific notation. Control the number of digits by adding the value as suffix, e.g. digits = "scientific4" to have scientific notation with 4 decimal places, or digits = "signif5" for 5 significant figures (see also signif()).

protect_integers Should integers be kept as integers (i.e., without decimals)?

missing Value by which NA values are replaced. By default, an empty string (i.e. "") is returned for NA.

width Refers to the width of columns (with numeric values). Can be either NULL, a number or a named numeric vector. If NULL, the width for each column is adjusted to the minimum required width. If a number, columns with numeric values will have the minimum width specified in width. If a named numeric vector, value names are matched against column names, and for each match, the specified width is used (see 'Examples'). Only applies to text-format (see format).

format Name of output-format, as string. If NULL (or "text"), returned output is used for basic printing. Can be one of NULL (the default) resp. "text" for plain text, "markdown" (or "md") for markdown and "html" for HTML output.

title, caption, subtitle Table title (same as caption) and subtitle, as strings. If NULL, no title or subtitle is printed, unless it is stored as attributes (table_title, or its alias table_caption, and table_subtitle). If x is a list of data frames, caption may be a list of table captions, one for each table.
footer

Table footer, as string. For markdown-formatted tables, table footers, due to the limitation in markdown rendering, are actually just a new text line under the table. If x is a list of data frames, footer may be a list of table captions, one for each table.

align

Column alignment. For markdown-formatted tables, the default align = NULL will right-align numeric columns, while all other columns will be left-aligned. If format = "html", the default is left-align first column and center all remaining. May be a string to indicate alignment rules for the complete table, like "left", "right", "center" or "firstleft" (to left-align first column, center remaining); or maybe a string with abbreviated alignment characters, where the length of the string must equal the number of columns, for instance, align = "lccrl" would left-align the first column, center the second and third, right-align column four and left-align the fifth column. For HTML-tables, may be one of "center", "left" or "right".

group_by

Name of column in x that indicates grouping for tables. Only applies when format = "html". group_by is passed down to gt::gt(groupname_col = group_by).

zap_small

Logical, if TRUE, small values are rounded after digits decimal places. If FALSE, values with more decimal places than digits are printed in scientific notation.

table_width

Numeric, or "auto", indicating the width of the complete table. If table_width = "auto" and the table is wider than the current width (i.e. line length) of the console (or any other source for textual output, like markdown files), the table is split into two parts. Else, if table_width is numeric and table rows are larger than table_width, the table is split into two parts.

verbose

Toggle messages and warnings.

... Currently not used.

Value

A data frame in character format.

Note

The values for caption, subtitle and footer can also be provided as attributes of x, e.g. if caption = NULL and x has attribute table_caption, the value for this attribute will be used as table caption. table_subtitle is the attribute for subtitle, and table_footer for footer.

See Also

Vignettes Formatting, printing and exporting tables and Formatting model parameters.

Examples

```r
export_table(head(iris))
export_table(head(iris), cross = "*")
export_table(head(iris), sep = " ", header = "*", digits = 1)
```

# split longer tables
export_table(head(iris), table_width = 30)

## Not run:
# colored footers
data(iris)
x <- as.data.frame(iris[1:5,])
atr(x, "table_footer") <- c("This is a yellow footer line.", "yellow")

export_table(x)

attr(x, "table_footer") <- list(
  c("\nA yellow line", "yellow"),
  c("\nAnd a red line", "red"),
  c("\nAnd a blue line", "blue")
)

export_table(x)

attr(x, "table_footer") <- list(
  c("Without the ", "yellow"),
  c("new-line character ", "red"),
  c("we can have multiple colors per line.", "blue")
)

export_table(x)

## End(Not run)

# column-width
d <- data.frame(
  x = c(1, 2, 3),
  y = c(100, 200, 300),
  z = c(10000, 20000, 30000)
)

export_table(d)
export_table(d, width = 8)
export_table(d, width = c(x = 5, z = 10))
export_table(d, width = c(x = 5, y = 5, z = 10), align = "lcr")

---

find_algorithm | Find sampling algorithm and optimizers

## Description

Returns information on the sampling or estimation algorithm as well as optimization functions, or for Bayesian model information on chains, iterations and warmup-samples.

## Usage

find_algorithm(x, ...)
find_formula

Arguments

x  A fitted model.
...
Currently not used.

Value

A list with elements depending on the model.
For frequentist models:
• algorithm, for instance "OLS" or "ML"
• optimizer, name of optimizing function, only applies to specific models (like gam)
For frequentist mixed models:
• algorithm, for instance "REML" or "ML"
• optimizer, name of optimizing function
For Bayesian models:
• algorithm, the algorithm
• chains, number of chains
• iterations, number of iterations per chain
• warmup, number of warmups per chain

Examples

```r
if (require("lme4")) {
  data(sleepstudy)
  m <- lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
  find_algorithm(m)
}
## Not run:
library(rstanarm)
m <- stan_lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
find_algorithm(m)
## End(Not run)
```

find_formula  Find model formula

Description

Returns the formula(s) for the different parts of a model (like fixed or random effects, zero-inflated component, ...). formula_ok() checks if a model formula has valid syntax regarding writing TRUE instead of T inside poly() and that no data names are used (i.e. no data$variable, but rather variable).
find_formula

Usage

find_formula(x, verbose = TRUE, ...)

formula_ok(x, verbose = TRUE, ...)

Arguments

x
A fitted model.

verbose
Toggle warnings.

... Currently not used.

Value

A list of formulas that describe the model. For simple models, only one list-element, conditional, is returned. For more complex models, the returned list may have following elements:

• conditional, the "fixed effects" part from the model (in the context of fixed-effects or instrumental variable regression, also called regressors). One exception are DirichletRegModel models from DirichletReg, which has two or three components, depending on model.

• random, the "random effects" part from the model (or the id for gee-models and similar)

• zero_inflated, the "fixed effects" part from the zero-inflation component of the model

• zero_inflated_random, the "random effects" part from the zero-inflation component of the model

• dispersion, the dispersion formula

• instruments, for fixed-effects or instrumental variable regressions like ivreg::ivreg(), lfe::felm() or plm::plm(), the instrumental variables

• cluster, for fixed-effects regressions like lfe::felm(), the cluster specification

• correlation, for models with correlation-component like nlme::gls(), the formula that describes the correlation structure

• slopes, for fixed-effects individual-slope models like feisr::feis(), the formula for the slope parameters

• precision, for DirichletRegModel models from DirichletReg, when parametrization (i.e. model) is "alternative".

Note

For models of class lme or gls the correlation-component is only returned, when it is explicitly defined as named argument (form), e.g. corAR1(form = ~1 | Mare)

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_formula(m)

if (require("lme4")) {

m <- lmer(Sepal.Length ~ Sepal.Width + (1 | Species), data = iris)
f <- find_formula(m)
f
format(f)
}

---

## find_interactions

**Find interaction terms from models**

### Description

Returns all lowest to highest order interaction terms from a model.

### Usage

```r
find_interactions(
  x, 
  component = c("all", "conditional", "zi", "zero_inflated", "dispersion", "instruments"),
  flatten = FALSE
)
```

### Arguments

- `x` A fitted model.
- `component` Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the *conditional* component is also called *count* or *mean* component, depending on the model.
- `flatten` Logical, if *TRUE*, the values are returned as character vector, not as list. Duplicated values are removed.

### Value

A list of character vectors that represent the interaction terms. Depending on component, the returned list has following elements (or *NULL*, if model has no interaction term):

- **conditional**, interaction terms that belong to the "fixed effects" terms from the model
- **zero_inflated**, interaction terms that belong to the "fixed effects" terms from the zero-inflation component of the model
- **instruments**, for fixed-effects regressions like *ivreg*, *felm* or *plm*, interaction terms that belong to the instrumental variables
find_offset

Examples

```r
data(mtcars)

m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_interactions(m)

m <- lm(mpg ~ wt * cyl + vs * hp * gear + carb, data = mtcars)
find_interactions(m)
```

---

find_offset  

Find possible offset terms in a model

Description

Returns a character vector with the name(s) of offset terms.

Usage

```r
find_offset(x)
```

Arguments

- `x`: A fitted model.

Value

A character vector with the name(s) of offset terms.

Examples

```r
# Generate some zero-inflated data
set.seed(123)
N <- 100 # Samples
x <- runif(N, 0, 10) # Predictor
off <- rgamma(N, 3, 2) # Offset variable
yhat <- -1 + x * 0.5 + log(off) # Prediction on log scale
dat <- data.frame(y = NA, x, logOff = log(off))
dat$y <- rpois(N, exp(yhat)) # Poisson process
dat$y <- ifelse(rbinom(N, 1, 0.3), 0, dat$y) # Zero-inflation process

if (require("pscl")) {
  m1 <- zeroinfl(y ~ offset(logOff) + x | 1, data = dat, dist = "poisson")
  find_offset(m1)

  m2 <- zeroinfl(y ~ x | 1, data = dat, offset = logOff, dist = "poisson")
  find_offset(m2)
}
**find_parameters**

Find names of model parameters

---

**Description**

Returns the names of model parameters, like they typically appear in the `summary()` output. For Bayesian models, the parameter names equal the column names of the posterior samples after coercion from `as.data.frame()`. See the documentation for your object's class:

- **Bayesian models** (`rstanarm`, `brms`, `MCMCglmm`, ...)
- **Generalized additive models** (`mgcv`, `VGAM`, ...)
- **Marginal effects models** (`mfx`)
- **Estimated marginal means** (`emmeans`)
- **Mixed models** (`lme4`, `glmmTMB`, `GLMMadaptive`, ...)
- **Zero-inflated and hurdle models** (`pscl`, ...)
- **Models with special components** (`betareg`, `MuMIn`, ...)

**Usage**

```r
find_parameters(x, ...) 
```

---

**Arguments**

- `x` - A fitted model.
- `...` - Currently not used.
- `flatten` - Logical, if `TRUE`, the values are returned as character vector, not as list. Duplicated values are removed.
- `verbose` - Toggle messages and warnings.

**Value**

A list of parameter names. For simple models, only one list-element, `conditional`, is returned.

---

**Model components**

Possible values for the `component` argument depend on the model class. Following are valid options:

- "all": returns all model components, applies to all models, but will only have an effect for models with more than just the conditional model component.
- "conditional": only returns the conditional component, i.e. "fixed effects" terms from the model. Will only have an effect for models with more than just the conditional model component.
• "smooth_terms": returns smooth terms, only applies to GAMs (or similar models that may contain smooth terms).
• "zero_inflated" (or "zi"): returns the zero-inflation component.
• "dispersion": returns the dispersion model component. This is common for models with zero-inflation or that can model the dispersion parameter.
• "instruments": for instrumental-variable or some fixed effects regression, returns the instruments.
• "location": returns location parameters such as conditional, zero_inflated, smooth_terms, or instruments (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters).
• "distributional" (or "auxiliary"): components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)

Description

Returns the names of model parameters, like they typically appear in the summary() output.

Usage

## S3 method for class 'averaging'
find_parameters(x, component = c("conditional", "full"), flatten = FALSE, ...)

## S3 method for class 'betareg'
find_parameters(
x,
component = c("all", "conditional", "precision", "location", "distributional", "auxiliary"),
flatten = FALSE,
...
)

## S3 method for class 'DirichletRegModel'
find_parameters(
x,
component = c("all", "conditional", "precision", "location", "distributional", "auxiliary"),

find_parameters.averaging

Find model parameters from models with special components
find_parameters(averaging

flatten = FALSE,
...)

## S3 method for class 'mjoint'
find_parameters(
x,
  component = c("all", "conditional", "survival"),
  flatten = FALSE,
...)

## S3 method for class 'glmx'
find_parameters(
x,
  component = c("all", "conditional", "extra"),
  flatten = FALSE,
...)

Arguments

x A fitted model.

component Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model, the dispersion term, the instrumental variables or marginal effects be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variables (so called fixed-effects regressions), or models with marginal effects from mfx. May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model. There are three convenient shortcuts: component = "all" returns all possible parameters. If component = "location", location parameters such as conditional, zero_inflated, smooth_terms, or instruments are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For component = "distributional" (or "auxiliary"), components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

flatten Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

... Currently not used.

Value

A list of parameter names. The returned list may have following elements:

• conditional, the "fixed effects" part from the model.

• full, parameters from the full model.
Examples

```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)
```

Description

Returns the names of model parameters, like they typically appear in the `summary()` output.

Usage

```r
## S3 method for class 'betamfx'
find_parameters(
  x,
  component = c("all", "conditional", "precision", "marginal", "location",
                 "distributional", "auxiliary"),
  flatten = FALSE,
  ...
)

## S3 method for class 'logitmfx'
find_parameters(
  x,
  component = c("all", "conditional", "marginal", "location"),
  flatten = FALSE,
  ...
)
```

Arguments

- `x` A fitted model.
- `component` Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model, the dispersion term, the instrumental variables or marginal effects be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variables (so called fixed-effects regressions), or models with marginal effects from `mfx`. May be abbreviated. Note that the `conditional` component is also called `count` or `mean` component, depending on the model. There are three convenient shortcuts: `component = "all"` returns all possible parameters. If `component = "location"`, location parameters such as conditional, zero_inflated, smooth_terms, or instruments are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For `component = "distributional"` (or "auxiliary"), components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.
find_parameters.BGGM

flatten Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

... Currently not used.

Value

A list of parameter names. The returned list may have following elements:

- conditional, the "fixed effects" part from the model.
- marginal, the marginal effects.
- precision, the precision parameter.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)

find_parameters.BGGM  Find names of model parameters from Bayesian models

Description

Returns the names of model parameters, like they typically appear in the summary() output. For Bayesian models, the parameter names equal the column names of the posterior samples after coercion from as.data.frame().

Usage

## S3 method for class 'BGGM'
find_parameters(
  x,
  component = c("correlation", "conditional", "intercept", "all"),
  flatten = FALSE,
  ...)

## S3 method for class 'BFBayesFactor'
find_parameters(
  x,
  effects = c("all", "fixed", "random"),
  component = c("all", "extra"),
  flatten = FALSE,
  ...)

## S3 method for class 'MCMCglmm'

find_parameters(x, effects = c("all", "fixed", "random"), flatten = FALSE, ...)

## S3 method for class 'bamlss'
find_parameters(
  x,
  flatten = FALSE,
  component = c("all", "conditional", "location", "distributional", "auxiliary"),
  parameters = NULL,
  ...
)

## S3 method for class 'brmsfit'
find_parameters(
  x,
  effects = "all",
  component = "all",
  flatten = FALSE,
  parameters = NULL,
  ...
)

## S3 method for class 'bayesx'
find_parameters(
  x,
  component = c("all", "conditional", "smooth_terms"),
  flatten = FALSE,
  parameters = NULL,
  ...
)

## S3 method for class 'stanreg'
find_parameters(
  x,
  effects = c("all", "fixed", "random"),
  component = c("location", "all", "conditional", "smooth_terms", "sigma",
               "distributional", "auxiliary"),
  flatten = FALSE,
  parameters = NULL,
  ...
)

## S3 method for class 'sim.merMod'
find_parameters(
  x,
  effects = c("all", "fixed", "random"),
  flatten = FALSE,
  parameters = NULL,
  ...
Arguments

x A fitted model.

component Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model, the dispersion term, the instrumental variables or marginal effects be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variables (so called fixed-effects regressions), or models with marginal effects from mfx. May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model. There are three convenient shortcuts: component = "all" returns all possible parameters. If component = "location", location parameters such as conditional, zero_inflated, smooth_terms, or instruments are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For component = "distributional" (or "auxiliary"), components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

flatten Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

... Currently not used.

effects Should parameters for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.

parameters Regular expression pattern that describes the parameters that should be returned.

Value

A list of parameter names. For simple models, only one list-element, conditional, is returned. For more complex models, the returned list may have following elements:

- conditional, the "fixed effects" part from the model
- random, the "random effects" part from the model
- zero_inflated, the "fixed effects" part from the zero-inflation component of the model
- zero_inflated_random, the "random effects" part from the zero-inflation component of the model
- smooth_terms, the smooth parameters

Furthermore, some models, especially from brms, can also return auxiliary parameters. These may be one of the following:

- sigma, the residual standard deviation (auxiliary parameter)
- dispersion, the dispersion parameters (auxiliary parameter)
- beta, the beta parameter (auxiliary parameter)
- simplex, simplex parameters of monotonic effects (brms only)
- mix, mixture parameters (brms only)
- shiftprop, shifted proportion parameters (brms only)
Examples

```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)
```

---

**find_parameters.emmGrid**

*Find model parameters from estimated marginal means objects*

---

**Description**

Returns the parameter names from a model.

**Usage**

```r
## S3 method for class 'emmGrid'
find_parameters(x, flatten = FALSE, merge_parameters = FALSE, ...)
```

**Arguments**

- `x` A fitted model.
- `flatten` Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.
- `merge_parameters` Logical, if TRUE and x has multiple columns for parameter names (like emmGrid objects may have), these are merged into a single parameter column, with parameters names and values as values.
- `...` Currently not used.

**Value**

A list of parameter names. For simple models, only one list-element, conditional, is returned.

**Examples**

```r
data(mtcars)
model <- lm(mpg ~ wt * factor(cyl), data = mtcars)
if (require("emmeans", quietly = TRUE)) {
  emm <- emmeans(model, c("wt", "cyl"))
  find_parameters(emm)
}
```
**find_parameters.gamlss**

*Find names of model parameters from generalized additive models*

**Description**

Returns the names of model parameters, like they typically appear in the summary() output.

**Usage**

```r
## S3 method for class 'gamlss'
find_parameters(x, flatten = FALSE, ...)
```

```r
## S3 method for class 'gam'
find_parameters(
  x,
  component = c("all", "conditional", "smooth_terms", "location"),
  flatten = FALSE,
  ...
)
```

**Arguments**

- `x` A fitted model.
- `flatten` Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.
- `...` Currently not used.
- `component` Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model, the dispersion term, the instrumental variables or marginal effects be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variables (so called fixed-effects regressions), or models with marginal effects from mfx. May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model. There are three convenient shortcuts: component = "all" returns all possible parameters. If component = "location", location parameters such as conditional, zero_inflated, smooth_terms, or instruments are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For component = "distributional" (or "auxiliary"), components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

**Value**

A list of parameter names. The returned list may have following elements:

- `conditional`, the "fixed effects" part from the model.
- `smooth_terms`, the smooth parameters.
find_parameters.glmmTMB

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)

find_parameters.glmmTMB

Find names of model parameters from mixed models

Description

Returns the names of model parameters, like they typically appear in the summary() output.

Usage

## S3 method for class 'glmmTMB'
find_parameters(
  x,
  effects = c("all", "fixed", "random"),
  component = c("all", "conditional", "zi", "zero_inflated", "dispersion"),
  flatten = FALSE,
  ...
)

## S3 method for class 'nlmerMod'
find_parameters(
  x,
  effects = c("all", "fixed", "random"),
  component = c("all", "conditional", "nonlinear"),
  flatten = FALSE,
  ...
)

## S3 method for class 'merMod'
find_parameters(x, effects = c("all", "fixed", "random"), flatten = FALSE, ...)

Arguments

x A fitted model.
effects Should parameters for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.
component Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model or the dispersion term? Applies to models with zero-inflated and/or dispersion formula. Note that the conditional component is also called count or mean component, depending on the model. There are three convenient shortcuts: component = "all" returns all
possible parameters. If component = "location", location parameters such as conditional or zero_inflated are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For component = "distributional" (or "auxiliary"), components like sigma or dispersion (and other auxiliary parameters) are returned.

flatten Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

... Currently not used.

Value
A list of parameter names. The returned list may have following elements:

- conditional, the "fixed effects" part from the model.
- random, the "random effects" part from the model.
- zero_inflated, the "fixed effects" part from the zero-inflation component of the model.
- zero_inflated_random, the "random effects" part from the zero-inflation component of the model.
- dispersion, the dispersion parameters (auxiliary parameter)
- nonlinear, the parameters from the nonlinear formula.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)

find_parameters.zeroinfl

Find names of model parameters from zero-inflated models

Description

Returns the names of model parameters, like they typically appear in the summary() output.

Usage

## S3 method for class 'zeroinfl'
find_parameters(
  x,
  component = c("all", "conditional", "zi", "zero_inflated"),
  flatten = FALSE,
  ...
)

## S3 method for class 'mhurdle'
find_parameters.zeroinfl

find_parameters(
  x,
  component = c("all", "conditional", "zi", "zero_inflated", "infrequent_purchase", "ip",
                "auxiliary"),
  flatten = FALSE,
  ...
)

Arguments

x A fitted model.

component Which type of parameters to return, such as parameters for the conditional
model, the zero-inflated part of the model, the dispersion term, the instrumental
variables or marginal effects be returned? Applies to models with zero-inflated
and/or dispersion formula, or to models with instrumental variables (so called
fixed-effects regressions), or models with marginal effects from mfx. May be
abbreviated. Note that the conditional component is also called count or mean
component, depending on the model. There are three convenient shortcuts:
component = "all" returns all possible parameters. If component = "location",
location parameters such as conditional, zero_inflated, smooth_terms, or
instruments are returned (everything that are fixed or random effects - depend-
ing on the effects argument - but no auxiliary parameters). For component =
"distributional" (or "auxiliary"), components like sigma, dispersion,
beta or precision (and other auxiliary parameters) are returned.

flatten Logical, if TRUE, the values are returned as character vector, not as list. Dupli-
cated values are removed.

... Currently not used.

Value

A list of parameter names. The returned list may have following elements:

- conditional, the "fixed effects" part from the model.
- zero_inflated, the "fixed effects" part from the zero-inflation component of the model.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_parameters(m)
Description

Returns the names of the predictor variables for the different parts of a model (like fixed or random effects, zero-inflated component,...). Unlike find_parameters(), the names from find_predictors() match the original variable names from the data that was used to fit the model.

Usage

find_predictors(x, ...)

## Default S3 method:
find_predictors(
  x,
  effects = c("fixed", "random", "all"),
  component = c("all", "conditional", "zi", "zero_inflated", "dispersion", "instruments", "correlation", "smooth_terms"),
  flatten = FALSE,
  verbose = TRUE,
  ...
)

Arguments

x A fitted model.

... Currently not used.

effects Should variables for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.

column Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model.

flatten Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

verbose Toggle warnings.

Value

A list of character vectors that represent the name(s) of the predictor variables. Depending on the combination of the arguments effects and component, the returned list has following elements:

- conditional, the "fixed effects" terms from the model
• random, the "random effects" terms from the model
• zero_inflated, the "fixed effects" terms from the zero-inflation component of the model
• zero_inflated_random, the "random effects" terms from the zero-inflation component of the model
• dispersion, the dispersion terms
• instruments, for fixed-effects regressions like ivreg, felm or plm, the instrumental variables
• correlation, for models with correlation-component like gls, the variables used to describe the correlation structure

Model components

Possible values for the component argument depend on the model class. Following are valid options:

• "all": returns all model components, applies to all models, but will only have an effect for models with more than just the conditional model component.
• "conditional": only returns the conditional component, i.e. "fixed effects" terms from the model. Will only have an effect for models with more than just the conditional model component.
• "smooth_terms": returns smooth terms, only applies to GAMs (or similar models that may contain smooth terms).
• "zero_inflated" (or "zi"): returns the zero-inflation component.
• "dispersion": returns the dispersion model component. This is common for models with zero-inflation or that can model the dispersion parameter.
• "instruments": for instrumental-variable or some fixed effects regression, returns the instruments.
• "location": returns location parameters such as conditional, zero_inflated, smooth_terms, or instruments (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters).
• "distributional" (or "auxiliary"): components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_predictors(m)
find_random

Description

Return the name of the grouping factors from mixed effects models.

Usage

find_random(x, split_nested = FALSE, flatten = FALSE)

Arguments

x
A fitted mixed model.

split_nested
Logical, if TRUE, terms from nested random effects will be returned as separated elements, not as single string with colon. See 'Examples'.

flatten
Logical, if TRUE, the values are returned as character vector, not as list. Duplicate values are removed.

Value

A list of character vectors that represent the name(s) of the random effects (grouping factors). Depending on the model, the returned list has following elements:

- random, the "random effects" terms from the conditional part of model
- zero_inflated_random, the "random effects" terms from the zero-inflation component of the model

Examples

if (require("lme4")) {
  data(sleepstudy)
  sleepstudy$mygrp <- sample(1:5, size = 180, replace = TRUE)
  sleepstudy$mysubgrp <- NA
  for (i in 1:5) {
    filter_group <- sleepstudy$mygrp == i
    sleepstudy$mysubgrp[filter_group] <-
      sample(1:30, size = sum(filter_group), replace = TRUE)
  }
  m <- lmer(
    Reaction ~ Days + (1 | mygrp / mysubgrp) + (1 | Subject),
    data = sleepstudy
  )

  find_random(m)
  find_random(m, split_nested = TRUE)
}
find_random_slopes  Find names of random slopes

Description
Return the name of the random slopes from mixed effects models.

Usage
find_random_slopes(x)

Arguments
x A fitted mixed model.

Value
A list of character vectors with the name(s) of the random slopes, or NULL if model has no random slopes. Depending on the model, the returned list has following elements:

- random, the random slopes from the conditional part of model
- zero_inflated_random, the random slopes from the zero-inflation component of the model

Examples
if (require("lme4")) {
  data(sleepstudy)
  m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
  find_random_slopes(m)
}

find_response  Find name of the response variable

Description
Returns the name(s) of the response variable(s) from a model object.

Usage
find_response(x, combine = TRUE, ...)

Examples
if (require("lme4")) {
  data(sleepstudy)
  m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
  find_response(m)
}
**find_smooth**

---

**Arguments**

- **x**: A fitted model.
- **combine**: Logical, if TRUE and the response is a matrix-column, the name of the response matches the notation in formula, and would for instance also contain patterns like "cbind(...)". Else, the original variable names from the matrix-column are returned. See 'Examples'.
- **...**: Currently not used.

**Value**

The name(s) of the response variable(s) from x as character vector, or NULL if response variable could not be found.

**Examples**

```r
if (require("lme4")) {
  data(cbpp)
  cbpp$trials <- cbpp$size - cbpp$incidence
  m <- glm(cbind(incidence, trials) ~ period, data = cbpp, family = binomial)

  find_response(m, combine = TRUE)
  find_response(m, combine = FALSE)
}
```

---

**find_smooth**

Find smooth terms from a model object

---

**Description**

Return the names of smooth terms from a model object.

**Usage**

```r
find_smooth(x, flatten = FALSE)
```

**Arguments**

- **x**: A (gam) model.
- **flatten**: Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.

**Value**

A character vector with the name(s) of the smooth terms.
find_statistic

Examples

```r
if (require("mgcv")) {
    data(iris)
    model <- gam(Petal.Length ~ Petal.Width + s(Sepal.Length), data = iris)
    find_smooth(model)
}
```

find_statistic Find statistic for model

Description

Returns the statistic for a regression model (t-statistic, z-statistic, etc.).

Small helper that checks if a model is a regression model object and return the statistic used.

Usage

```r
find_statistic(x, ...)
```

Arguments

- `x` An object.
- `...` Currently not used.

Value

A character describing the type of statistic. If there is no statistic available with a distribution, **NULL** will be returned.

Examples

```r
# regression model object
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
find_statistic(m)
```
find_terms

Find all model terms

Description

Returns a list with the names of all terms, including response value and random effects, "as is". This means, on-the-fly tranformations or arithmetic expressions like log(), I(), as.factor() etc. are preserved.

Usage

find_terms(x, flatten = FALSE, verbose = TRUE, ...)

Arguments

- **x**: A fitted model.
- **flatten**: Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.
- **verbose**: Toggle warnings.
- **...**: Currently not used.

Value

A list with (depending on the model) following elements (character vectors):

- **response**: the name of the response variable
- **conditional**: the names of the predictor variables from the conditional model (as opposed to the zero-inflated part of a model)
- **random**: the names of the random effects (grouping factors)
- **zero_inflated**: the names of the predictor variables from the zero-inflated part of the model
- **zero_inflated_random**: the names of the random effects (grouping factors)
- **dispersion**: the name of the dispersion terms
- **instruments**: the names of instrumental variables

Returns NULL if no terms could be found (for instance, due to problems in accessing the formula).

Note

The difference to find_variables() is that find_terms() may return a variable multiple times in case of multiple transformations (see examples below), while find_variables() returns each variable name only once.
Examples

if (require("lme4")) {
  data(sleepstudy)
  m <- lmer(
    log(Reaction) ~ Days + I(Days^2) + (1 + Days + exp(Days) | Subject),
    data = sleepstudy
  )

  find_terms(m)
}

find_transformation(data)

find_transformation
Find possible transformation of response variables

Description
This function checks whether any transformation, such as log- or exp-transforming, was applied to the response variable (dependent variable) in a regression formula. Currently, following patterns are detected: log, log1p, log2, log10, exp, expm1, sqrt, log(x+<number>), log-log and power (to 2nd power, like I(x^2)).

Usage
find_transformation(x)

Arguments

x A regression model.

Value
A string, with the name of the function of the applied transformation. Returns "identity" for no transformation, and e.g. "log(x+3)" when a specific values was added to the response variables before log-transforming. For unknown transformations, returns NULL.

Examples

# identity, no transformation
model <- lm(Sepal.Length ~ Species, data = iris)
find_transformation(model)

# log-transformation
model <- lm(log(Sepal.Length) ~ Species, data = iris)
find_transformation(model)

# log+2
model <- lm(log(Sepal.Length + 2) ~ Species, data = iris)
find_transformation(model)
find_variables

Find names of all variables

Description

Returns a list with the names of all variables, including response value and random effects.

Usage

```r
find_variables(
  x,
  effects = "all",
  component = "all",
  flatten = FALSE,
  verbose = TRUE
)
```

Arguments

- **x**: A fitted model.
- **effects**: Should variables for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.
- **component**: Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model.
- **flatten**: Logical, if TRUE, the values are returned as character vector, not as list. Duplicated values are removed.
- **verbose**: Toggle warnings.

Value

A list with (depending on the model) following elements (character vectors):

- **response**: the name of the response variable
- **conditional**: the names of the predictor variables from the conditional model (as opposed to the zero-inflated part of a model)
- **cluster**: the names of cluster or grouping variables
- **dispersion**: the name of the dispersion terms
- **instruments**: the names of instrumental variables
- **random**: the names of the random effects (grouping factors)
- **zero_inflated**: the names of the predictor variables from the zero-inflated part of the model
- **zero_inflated_random**: the names of the random effects (grouping factors)
Model components

Possible values for the component argument depend on the model class. Following are valid options:

- "all": returns all model components, applies to all models, but will only have an effect for models with more than just the conditional model component.
- "conditional": only returns the conditional component, i.e. "fixed effects" terms from the model. Will only have an effect for models with more than just the conditional model component.
- "smooth_terms": returns smooth terms, only applies to GAMs (or similar models that may contain smooth terms).
- "zero_inflated" (or "zi"): returns the zero-inflation component.
- "dispersion": returns the dispersion model component. This is common for models with zero-inflation or that can model the dispersion parameter.
- "instruments": for instrumental-variable or some fixed effects regression, returns the instruments.
- "location": returns location parameters such as conditional, zero_inflated, smooth_terms, or instruments (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters).
- "distributional" (or "auxiliary"): components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

Note

The difference to `find_terms()` is that `find_variables()` returns each variable name only once, while `find_terms()` may return a variable multiple times in case of transformations or when arithmetic expressions were used in the formula.

Examples

```r
if (require("lme4")) {
  data(cbpp)
  data(sleepstudy)
  # some data preparation...
  cbpp$trials <- cbpp$size - cbpp$incidence
  sleepstudy$mygrp <- sample(1:5, size = 100, replace = TRUE)
  sleepstudy$mysubgrp <- NA
  for (i in 1:5) {
    filter_group <- sleepstudy$mygrp == i
    sleepstudy$mysubgrp[filter_group] <-
      sample(1:30, size = sum(filter_group), replace = TRUE)
  }
  m1 <- glmer(
    cbind(incidence, size - incidence) ~ period + (1 | herd),
    data = cbpp,
    family = binomial
  )
}
```
find_variables(m1)

m2 <- lmer(
  Reaction ~ Days + (1 | mygrp/mysubgrp) + (1 | Subject),
  data = sleepstudy
)
find_variables(m2)
find_variables(m2, flatten = TRUE)

find_weights

Find names of model weights

Description
Returns the name of the variable that describes the weights of a model.

Usage
find_weights(x, ...)

Arguments
x A fitted model.
...
Currently not used.

Value
The name of the weighting variable as character vector, or NULL if no weights were specified.

Examples
data(mtcars)
mtcars$weight <- rnorm(nrow(mtcars), 1, .3)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars, weights = weight)
find_weights(m)

fish
Sample data set

Description
A sample data set, used in tests and some examples.
format_bf

Bayes Factor formatting

Description
Bayes Factor formatting

Usage

format_bf(
  bf,
  stars = FALSE,
  stars_only = FALSE,
  name = "BF",
  protect_ratio = FALSE,
  na_reference = NA,
  exact = FALSE
)

Arguments

bf
  Bayes Factor.

stars
  Add significance stars (e.g., p < .001***).

stars_only
  Return only significance stars.

name
  Name prefixing the text. Can be NULL.

protect_ratio
  Should values smaller than 1 be represented as ratios?

na_reference
  How to format missing values (NA).

exact
  Should very large or very small values be reported with a scientific format (e.g., 4.24e5), or as truncated values (as "> 1000" and "< 1/1000")?

Value

A formatted string.

Examples

format_bf(bfs <- c(0.000045, 0.033, NA, 1557, 3.54))
format_bf(bfs, exact = TRUE, name = NULL)
format_bf(bfs, stars = TRUE)
format_bf(bfs, protect_ratio = TRUE)
format_bf(bfs, protect_ratio = TRUE, exact = TRUE)
format_bf(bfs, na_reference = 1)
format_capitalize  

*Capitalizes the first letter in a string*

**Description**

This function converts the first letter in a string into upper case.

**Usage**

```r
format_capitalize(x, verbose = TRUE)
```

**Arguments**

- `x`  
  A character vector or a factor. The latter is coerced to character. All other objects are returned unchanged.

- `verbose`  
  Toggle warnings.

**Value**

`x`, with first letter capitalized.

**Examples**

```r
format_capitalize("hello")
format_capitalize(c("hello", "world"))
unique(format_capitalize(iris$Species))
```

format_ci  

*Confidence/Credible Interval (CI) Formatting*

**Description**

Confidence/Credible Interval (CI) Formatting

**Usage**

```r
format_ci(
  CI_low,
  CI_high,
  ci = 0.95,
  digits = 2,
  brackets = TRUE,
  width = NULL,
  width_low = width,
  width_high = width,
  missing = "",
  zap_small = FALSE
)
```
**Arguments**

- **CI_low**  
  Lower CI bound.

- **CI_high**  
  Upper CI bound.

- **ci**  
  CI level in percentage.

- **digits**  
  Number of digits for rounding or significant figures. May also be "signif" to return significant figures or "scientific" to return scientific notation. Control the number of digits by adding the value as suffix, e.g. `digits = "scientific4"` to have scientific notation with 4 decimal places, or `digits = "signif5"` for 5 significant figures (see also `signif()`).

- **brackets**  
  Either a logical, and if TRUE (default), values are encompassed in square brackets. If FALSE or NULL, no brackets are used. Else, a character vector of length two, indicating the opening and closing brackets.

- **width**  
  Minimum width of the returned string. If not NULL and width is larger than the string’s length, leading whitespaces are added to the string. If `width="auto"`, width will be set to the length of the longest string.

- **width_low**, **width_high**  
  Like `width`, but only applies to the lower or higher confidence interval value. This can be used when the values for the lower and upper CI are of very different length.

- **missing**  
  Value by which NA values are replaced. By default, an empty string (i.e. "") is returned for NA.

- **zap_small**  
  Logical, if TRUE, small values are rounded after digits decimal places. If FALSE, values with more decimal places than digits are printed in scientific notation.

**Value**

A formatted string.

**Examples**

```r
format_ci(1.20, 3.57, ci = 0.90)
format_ci(1.20, 3.57, ci = NULL)
format_ci(1.20, 3.57, ci = NULL, brackets = FALSE)
format_ci(1.20, 3.57, ci = NULL, brackets = c("\\), "))
format_ci(c(1.205645, 23.4), c(3.57, -1.35), ci = 0.90)
format_ci(c(1.20, NA, NA), c(3.57, -1.35, NA), ci = 0.90)

# automatic alignment of width, useful for printing multiple CIs in columns
x <- format_ci(c(1.205, 23.4, 100.43), c(3.57, -13.35, 9.4))
cat(x, sep = "\n")

x <- format_ci(c(1.205, 23.4, 100.43), c(3.57, -13.35, 9.4), width = "auto")
cat(x, sep = "\n")
```
Format messages and warnings

Description

Inserts line breaks into a longer message or warning string. Line length is adjusted to maximum
length of the console, if the width can be accessed. By default, new lines are indented by two
spaces.

format_alert() is a wrapper that combines formatting a string with a call to message(), warning() or stop(). By default, format_alert() creates a message(). format_warning() and format_error() change the default type of exception to warning() and stop(), respectively.

Usage

format_message(
  string,
  ..., 
  line_length = 0.9 * getOption("width", 80),
  indent = " ",&
)

format_alert(
  string,
  ..., 
  line_length = 0.9 * getOption("width", 80),
  indent = " ",
  type = "message",
  call. = FALSE
)

format_warning(...)

format_error(...)

Arguments

string A string.

... Further strings that will be concatenated as indented new lines.

line_length Numeric, the maximum length of a line. The default is 90% of the width of the
console window.

indent Character vector. If further lines are specified in . . . , a user-defined string can be
specified to indent subsequent lines. Defaults to " " (two white spaces), hence for each start of the line after the first line, two white space characters are in-
serted.

type Type of exception alert to raise. Can be "message" for message(), "warning" for warning(), or "error" for stop().
call. Logical. Indicating if the call should be included in the error message. This is usually confusing for users when the function producing the warning or error is deep within another function, so the default is FALSE.

Details

There is an experimental formatting feature implemented in this function. You can use following tags:

- {.b text} for bold formatting
- {.i text} to use italic font style
- {.url www.url.com} formats the string as URL (i.e., enclosing URL in < and >, blue color and italic font style)
- {.pkg packagename} formats the text in blue color.

This feature has some limitations: it's hard to detect the exact length for each line when the string has multiple lines (after line breaks) and the string contains formatting tags. Thus, it can happen that lines are wrapped at an earlier length than expected. Furthermore, if you have multiple words in a format tag ( {.b one two three} ), a line break might occur inside this tag, and the formatting no longer works (messing up the message-string).

Value

For format_message(), a formatted string. For format_alert() and related functions, the requested exception, with the exception formatted using format_message().

Examples

```r
msg <- format_message("Much too long string for just one line, I guess!",
         line_length = 15
)
message(msg)

msg <- format_message("Much too long string for just one line, I guess!",
        "First new line",
        "Second new line",
        "(both indented)",
        line_length = 30
)
message(msg)

msg <- format_message("Much too long string for just one line, I guess!",
        "First new line",
        "Second new line",
        "(not indented)",
        line_length = 30,
        indent = ""
)
message(msg)

# Caution, experimental! See 'Details'
msg <- format_message(
```

"This is *italic*, visit [easystats.github.io/easystats](https://easystats.github.io/easystats)",
line_length = 30
)
message(msg)

```r
## Not run:
format_alert("This is a message.")
format_alert("This is a warning.", type = "warning")
format_warning("This is a warning.")
try(format_error("This is an error."))

## End(Not run)
```

---

**format_number**

*Convert number to words*

**Description**

Convert number to words

**Usage**

```r
format_number(x, textual = TRUE, ...)
```

**Arguments**

- **x**: Number.
- **textual**: Return words. If FALSE, will run `format_value()`.
- **...**: Arguments to be passed to `format_value()` if textual is FALSE.

**Value**

A formatted string.

**Note**

The code has been adapted from here [https://github.com/ateucher/useful_code/blob/master/R/numbers2words.r](https://github.com/ateucher/useful_code/blob/master/R/numbers2words.r)

**Examples**

```r
format_number(2)
format_number(45)
format_number(324.68765)
```
**Description**

Format p-values.

**Usage**

```r
format_p(
p,
stars = FALSE,
stars_only = FALSE,
whitespace = TRUE,
name = "p",
missing = "",
digits = 3,
...
)
```

**Arguments**

- `p` value or vector of p-values.
- `stars` Add significance stars (e.g., p < .001***).
- `stars_only` Return only significance stars.
- `whitespace` Logical; if `TRUE` (default), preserves whitespaces. Else, all whitespace characters are removed from the returned string.
- `name` Name prefixing the text. Can be `NULL`.
- `missing` Value by which `NA` values are replaced. By default, an empty string (i.e., "") is returned for `NA`.
- `decimal_separator` Character, if not `NULL`, will be used as decimal separator.
- `digits` Number of significant digits. May also be "scientific" to return exact p-values in scientific notation, or "apa" to use an APA 7th edition-style for p-values (equivalent to `digits = 3`). If "scientific", control the number of digits by adding the value as a suffix, e.g., `digits = "scientific4"` to have scientific notation with 4 decimal places.
- `...` Arguments from other methods.

**Value**

A formatted string.
Examples

```r
format.p(c(.02, .065, 0, .23))
format.p(c(.02, .065, 0, .23), name = NULL)
format.p(c(.02, .065, 0, .23), stars_only = TRUE)

model <- lm(mpg ~ wt + cyl, data = mtcars)
p <- coef(summary(model))[, 4]
format.p(p, digits = "apa")
format.p(p, digits = "scientific")
format.p(p, digits = "scientific2")
```

---

### format_pd

**Probability of direction (pd) formatting**

#### Description

Probability of direction (pd) formatting

#### Usage

```r
format_pd(pd, stars = FALSE, stars_only = FALSE, name = "pd")
```

#### Arguments

- `pd` Probability of direction (pd).
- `stars` Add significance stars (e.g., `p < .001***`).
- `stars_only` Return only significance stars.
- `name` Name prefixing the text. Can be `NULL`.

#### Value

A formatted string.

#### Examples

```r
format_pd(0.12)
format_pd(c(0.12, 1, 0.9999, 0.98, 0.995, 0.96), name = NULL)
format_pd(c(0.12, 1, 0.9999, 0.98, 0.995, 0.96), stars = TRUE)
```
### format_rope

**Percentage in ROPE formatting**

**Description**

Percentage in ROPE formatting

**Usage**

```r
format_rope(rope_percentage, name = "in ROPE", digits = 2)
```

**Arguments**

- **rope_percentage**: Value or vector of percentages in ROPE.
- **name**: Name prefixing the text. Can be `NULL`.
- **digits**: Number of significant digits. May also be "scientific" to return exact p-values in scientific notation, or "apa" to use an APA 7th edition-style for p-values (equivalent to `digits = 3`). If "scientific", control the number of digits by adding the value as a suffix, e.g., `digits = "scientific4"` to have scientific notation with 4 decimal places.

**Value**

A formatted string.

**Examples**

```r
format_rope(c(0.02, 0.12, 0.357, 0))
format_rope(c(0.02, 0.12, 0.357, 0), name = NULL)
```

### format_string

**String Values Formatting**

**Description**

String Values Formatting

**Usage**

```r
format_string(x, 
## S3 method for class 'character'
format_string(x, length = NULL, abbreviate = "...", ...)```
Arguments

x  String value.
...  Arguments passed to or from other methods.
length  Numeric, maximum length of the returned string. If not NULL, will shorten the string to a maximum length, however, it will not truncate inside words. I.e. if the string length happens to be inside a word, this word is removed from the returned string, so the returned string has a maximum length of length, but might be shorter.
abbreviate  String that will be used as suffix, if x was shortened.

Value

A formatted string.

Examples

```r
s <- "This can be considered as very long string!"
# string is shorter than max.length, so returned as is
format_string(s, 60)

# string is shortened to as many words that result in
# a string of maximum 20 chars
format_string(s, 20)
```

Description

This function takes a data frame with model parameters as input and formats certain columns into a more readable layout (like collapsing separate columns for lower and upper confidence interval values). Furthermore, column names are formatted as well. Note that `format_table()` converts all columns into character vectors!

Usage

```r
format_table(
  x,
  pretty_names = TRUE,
  stars = FALSE,
  digits = 2,
  ci_width = "auto",
  ci_brackets = TRUE,
  ci_digits = 2,
  p_digits = 3,
  rope_digits = 2,
)```
ic_digits = 1,
zap_small = FALSE,
preserve_attributes = FALSE,
exact = TRUE,
use_symbols = getOption("insight_use_symbols", FALSE),
verbose = TRUE,
...
)

Arguments

x         A data frame of model's parameters, as returned by various functions of the easystats-packages. May also be a result from broom::tidy().
pretty_names Return "pretty" (i.e. more human readable) parameter names.
stars     If TRUE, add significance stars (e.g., p < .001***). Can also be a character vector, naming the columns that should include stars for significant values. This is especially useful for Bayesian models, where we might have multiple columns with significant values, e.g. BF for the Bayes factor or pd for the probability of direction. In such cases, use stars = c("pd", "BF") to add stars to both columns, or stars = "BF" to only add stars to the Bayes factor and exclude the pd column. Currently, following columns are recognized: "BF", "pd" and "p".
digits, ci_digits, p_digits, rope_digits, ic_digits
Number of digits for rounding or significant figures. May also be "signif" to return significant figures or "scientific" to return scientific notation. Control the number of digits by adding the value as suffix, e.g. digits = "scientific4" to have scientific notation with 4 decimal places, or digits = "signif5" for 5 significant figures (see also signif()).
ci_width  Minimum width of the returned string for confidence intervals. If not NULL and width is larger than the string's length, leading whitespaces are added to the string. If width="auto", width will be set to the length of the longest string.
ci_brackets Logical, if TRUE (default), CI-values are encompassed in square brackets (else in parentheses).
zap_small Logical, if TRUE, small values are rounded after digits decimal places. If FALSE, values with more decimal places than digits are printed in scientific notation.
preserve_attributes Logical, if TRUE, preserves all attributes from the input data frame.
exact     Formatting for Bayes factor columns, in case the provided data frame contains such a column (i.e. columns named "BF" or "log_BF"). For exact = TRUE, very large or very small values are then either reported with a scientific format (e.g., 4.24e5), else as truncated values (as "> 1000" and "< 1/1000").
use_symbols Logical, if TRUE, column names that refer to particular effect sizes (like Phi, Omega or Epsilon) include the related unicode-character instead of the written name. This only works on Windows for R >= 4.2, and on OS X or Linux for R >= 4.0. It is possible to define a global option for this setting, see 'Note'.
verbose   Toggle messages and warnings.
...     Arguments passed to or from other methods.
**Value**

A data frame. Note that `format_table()` converts all columns into character vectors!

**Note**

`options(insight_use_symbols = TRUE)` override the `use_symbols` argument and always displays symbols, if possible.

**See Also**

Vignettes Formatting, printing and exporting tables and Formatting model parameters.

**Examples**

```r
cat <- model_parameters(lm(Sepal.Length ~ Species * Sepal.Width, data = iris))
cat <- model_parameters(x, p_digits = "scientific")
```

```r
if (require("rstanarm", warn.conflicts = FALSE) && require("parameters", , warn.conflicts = FALSE)) {
  model <- stan_glm(Sepal.Length ~ Species, data = iris, refresh = 0, seed = 123)
  x <- model_parameters(model, ci = c(0.69, 0.89, 0.95))
  as.data.frame(format_table(x))
}
```

---

### format_value

**Numeric Values Formatting**

**Description**

`format_value()` converts numeric values into formatted string values, where formatting can be something like rounding digits, scientific notation etc. `format_percent()` is a short-cut for `format_value(as_percent = TRUE).

**Usage**

```r
format_value(x, 
```

```r
## S3 method for class 'data.frame'
format_value( 
  x,
  digits = 2,
  protect_integers = FALSE,
```
format_value

missing = "", 
width = NULL, 
as_percent = FALSE, 
zap_small = FALSE, 
...
)

## S3 method for class 'numeric'
format_value(
  x,
  digits = 2,
  protect_integers = FALSE,
  missing = "",
  width = NULL,
  as_percent = FALSE,
  zap_small = FALSE,
  ...
)

format_percent(x, ...)

Arguments

x               Numeric value.
...
Arguments passed to or from other methods.
digits          Number of digits for rounding or significant figures. May also be "signif" to return significant figures or "scientific" to return scientific notation. Control the number of digits by adding the value as suffix, e.g. digits = "scientific4" to have scientific notation with 4 decimal places, or digits = "signif5" for 5 significant figures (see also signif()).

protect_integers Should integers be kept as integers (i.e., without decimals)?

missing         Value by which NA values are replaced. By default, an empty string (i.e. "") is returned for NA.

width           Minimum width of the returned string. If not NULL and width is larger than the string’s length, leading whitespaces are added to the string.

as_percent      Logical, if TRUE, value is formatted as percentage value.

zap_small       Logical, if TRUE, small values are rounded after digits decimal places. If FALSE, values with more decimal places than digits are printed in scientific notation.

Value

A formatted string.
get_auxiliary

Get auxiliary parameters from models

Description

Returns the requested auxiliary parameters from models, like dispersion, sigma, or beta...

Usage

get_auxiliary(
  x,
  type = "sigma",
  summary = TRUE,
  centrality = "mean",
  verbose = TRUE,
  ...
)

Arguments

x

A model.

type

The name of the auxiliary parameter that should be retrieved. "sigma" is available for most models, "dispersion" for models of class glm, glmerMod or glmmTMB as well as brmsfit. "beta" and other parameters are currently only returned for brmsfit models. See ’Details’.

Examples

format_value(1.20)
format_value(1.2)
format_value(1.201313)
format_value(c(0.0045, 234, -23))
format_value(c(0.0045, .12, .34))
format_value(c(0.0045, .12, .34), as_percent = TRUE)
format_value(c(0.0045, .12, .34), digits = "scientific")
format_value(c(0.0045, .12, .34), digits = "scientific2")

# default
format_value(c(0.0045, .123, .345))
# significant figures
format_value(c(0.0045, .123, .345), digits = "signif")

format_value(as.factor(c("A", "B", "A")))
format_value(iris$Species)

format_value(3)
format_value(3, protect_integers = TRUE)

format_value(head(iris))
get_auxiliary

summary Logical, indicates whether the full posterior samples (summary = FALSE)) or the summarized centrality indices of the posterior samples (summary = TRUE)) should be returned as estimates.

centrality Only for models with posterior samples, and when summary = TRUE. In this case, centrality = "mean" would calculate means of posterior samples for each parameter, while centrality = "median" would use the more robust median value as measure of central tendency.

verbose Toggle warnings.

Details

Currently, only sigma and the dispersion parameter are returned, and only for a limited set of models.

Sigma Parameter: See get_sigma().

Dispersion Parameter: There are many different definitions of "dispersion", depending on the context. get_auxiliary() returns the dispersion parameters that usually can be considered as variance-to-mean ratio for generalized (linear) mixed models. Exceptions are models of class glmmTMB, where the dispersion equals $\sigma^2$. In detail, the computation of the dispersion parameter for generalized linear models is the ratio of the sum of the squared working-residuals and the residual degrees of freedom. For mixed models of class glmer, the dispersion parameter is also called $\phi$ and is the ratio of the sum of the squared Pearson-residuals and the residual degrees of freedom. For models of class glmmTMB, dispersion is $\sigma^2$.

brms models: For models of class brmsfit, there are different options for the type argument. See a list of supported auxiliary parameters here: find_parameters.BGGM().

Value

The requested auxiliary parameter, or NULL if this information could not be accessed.

Examples

# from ?glm
clotting <- data.frame(  
u = c(5, 10, 15, 20, 30, 40, 60, 80, 100),  
lot1 = c(118, 58, 42, 35, 27, 25, 21, 19, 18),  
lot2 = c(69, 35, 26, 21, 18, 16, 13, 12, 12)  
)
model <- glm(lot1 ~ log(u), data = clotting, family = Gamma())
geat_auxiliary(model, type = "dispersion") # same as summary(model)$dispersion
get_call

Get the model’s function call

Description
Returns the model’s function call when available.

Usage
get_call(x)

Arguments
x
A fitted mixed model.

Value
A function call.

Examples
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_call(m)

if (require("lme4")) {
  m <- lmer(Sepal.Length ~ Sepal.Width + (1 | Species), data = iris)
  get_call(m)
}

get_data

Get the data that was used to fit the model

Description
This function tries to get the data that was used to fit the model and returns it as data frame.

Usage
get_data(x, ...)

## Default S3 method:
get_data(x, verbose = TRUE, ...)

## S3 method for class 'glmmTMB'
get_data(x, effects = "all", component = "all", verbose = TRUE, ...)

## S3 method for class 'afex_aov'
get_data(x, shape = c("long", "wide"), ...)
**Arguments**

- **x**: A fitted model.
- **...**: Currently not used.
- **verbose**: Toggle messages and warnings.
- **effects**: Should model data for fixed effects ("fixed"), random effects ("random") or both ("all") be returned? Only applies to mixed or gee models.
- **component**: Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the *conditional* component is also called *count* or *mean* component, depending on the model.
- **shape**: Return long or wide data? Only applicable in repeated measures designs.

**Value**

The data that was used to fit the model.

**Model components**

Possible values for the component argument depend on the model class. Following are valid options:

- "all": returns all model components, applies to all models, but will only have an effect for models with more than just the conditional model component.
- "conditional": only returns the conditional component, i.e. "fixed effects" terms from the model. Will only have an effect for models with more than just the conditional model component.
- "smooth_terms": returns smooth terms, only applies to GAMs (or similar models that may contain smooth terms).
- "zero_inflated" (or "zi"): returns the zero-inflation component.
- "dispersion": returns the dispersion model component. This is common for models with zero-inflation or that can model the dispersion parameter.
- "instruments": for instrumental-variable or some fixed effects regression, returns the instruments.
- "location": returns location parameters such as conditional, zero_inflated, smooth_terms, or instruments (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters).
- "distributional" (or "auxiliary"): components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

**Note**

Unlike `model.frame()`, which may contain transformed variables (e.g. if `poly()` or `scale()` was used inside the formula to specify the model), `get_data()` aims at returning the "original", untransformed data (if possible). Consequently, column names are changed accordingly, i.e. "log(x)" will become "x" etc. for all data columns with transformed values.
Examples

```r
if (require("lme4")) {
  data(cbpp, package = "lme4")
  cbpp$trials <- cbpp$size - cbpp$incidence
  m <- glm(cbind(incidence, trials) ~ period, data = cbpp, family = binomial)
  head(get_data(m))
}
```

---

**get_datagrid**  
*Create a reference grid*

---

**Description**

Create a reference matrix, useful for visualisation, with evenly spread and combined values. Usually used to make generate predictions using `get_predicted()`. See this vignette for a tutorial on how to create a visualisation matrix using this function.

**Usage**

```r
get_datagrid(x, ...)
```

## S3 method for class 'data.frame'

```r
get_datagrid(
  x,
  at = "all",
  factors = "reference",
  numerics = "mean",
  preserve_range = FALSE,
  reference = x,
  length = 10,
  range = "range",
  ...
)
```

## S3 method for class 'numeric'

```r
get_datagrid(x, length = 10, range = "range", ...)
```

## S3 method for class 'factor'

```r
get_datagrid(x, ...)
```

## Default S3 method:

```r
get_datagrid(
  x,
  at = "all",
  factors = "reference",
  numerics = "mean",
  preserve_range = TRUE,
  ...)
```
get_datagrid

```r
reference = x,
include_smooth = TRUE,
include_random = FALSE,
include_response = FALSE,
data = NULL,
verbose = TRUE,
...
)
```

**Arguments**

- **x**  
  An object from which to construct the reference grid.

- **at**  
  Indicates the focal predictors (variables) for the reference grid and at which values focal predictors should be represented. If not specified otherwise, representative values for numeric variables or predictors are evenly distributed from the minimum to the maximum, with a total number of length values covering that range (see 'Examples'). Possible options for at are:
  - "all", which will include all variables or predictors.
  - a character vector of one or more variable or predictor names, like `c("Species", "Sepal.Width")`, which will create a grid of all combinations of unique values. For factors, will use all levels, for numeric variables, will use a range of length `length` (evenly spread from minimum to maximum) and for character vectors, will use all unique values.
  - a list of named elements, indicating focal predictors and their representative values, e.g. `at = list(Sepal.Length = c(2, 4), Species = "setosa")`.
  - a string with assignments, e.g. `at = "Sepal.Length = 2"` or `at = c("Sepal.Length = 2", "Species = 'setosa'")` - note the usage of single and double quotes to assign strings within strings.

There is a special handling of assignments with brackets, i.e. values defined inside `[` and `]`. For numeric variables, the value(s) inside the brackets should either be
  - two values, indicating minimum and maximum (e.g. `at = "Sepal.Length = [0, 5]"`), for which a range of length `length` (evenly spread from given minimum to maximum) is created.
  - more than two numeric values `at = "Sepal.Length = [2,3,4,5]"`, in which case these values are used as representative values.
  - a "token" that creates pre-defined representative values:
    - for mean and +/- 1 SD around the mean: "x = [sd]"
    - for median and +/- 1 MAD around the median: "x = [mad]"
    - for Tukey's five number summary (minimum, lower-hinge, median, upper-hinge, maximum): "x = [fivenum]"
    - for terciles, including minimum and maximum: "x = [terciles]"
    - for terciles, excluding minimum and maximum: "x = [terciles2]"
    - for quartiles, including minimum and maximum: "x = [quartiles]"
get_datagrid

- for quartiles, excluding minimum and maximum: "x = [quartiles2]"
- for minimum and maximum value: "x = [minmax]"
- for 0 and the maximum value: "x = [zeromax]"

For factor variables, the value(s) inside the brackets should indicate one or more factor levels, like at = "Species = [setosa, versicolor]". Note: the length argument will be ignored when using brackets-tokens.

The remaining variables not specified in at will be fixed (see also arguments factors and numerics).

factors Type of summary for factors. Can be "reference" (set at the reference level), "mode" (set at the most common level) or "all" to keep all levels.

numerics Type of summary for numeric values. Can be "all" (will duplicate the grid for all unique values), any function ("mean", "median", ...) or a value (e.g., numerics = 0).

preserve_range In the case of combinations between numeric variables and factors, setting preserve_range = TRUE will drop the observations where the value of the numeric variable is originally not present in the range of its factor level. This leads to an unbalanced grid. Also, if you want the minimum and the maximum to closely match the actual ranges, you should increase the length argument.

reference The reference vector from which to compute the mean and SD. Used when standardizing or unstandardizing the grid using effectsize::standardize.

length Length of numeric target variables selected in "at". This arguments controls the number of (equally spread) values that will be taken to represent the continuous variables. A longer length will increase precision, but can also substantially increase the size of the datagrid (especially in case of interactions). If NA, will return all the unique values. In case of multiple continuous target variables, length can also be a vector of different values (see examples).

range Option to control the representative values given in at, if no specific values were provided. range can be one of the following:

- "range" (default), will use the minimum and maximum of the original data vector as end-points (min and max).
- if an interval type is specified, such as "iqr", "ci", "hdi" or "eti", it will spread the values within that range (the default CI width is 95% but this can be changed by adding for instance ci = 0.90.) See IQR() and bayestestR::ci(). This can be useful to have more robust change and skipping extreme values.
- if "sd" or "mad", it will spread by this dispersion index around the mean or the median, respectively. If the length argument is an even number (e.g., 4), it will have one more step on the positive side (i.e., -1, 0, +1, +2). The result is a named vector. See 'Examples.'
- "grid" will create a reference grid that is useful when plotting predictions, by choosing representative values for numeric variables based on their position in the reference grid. If a numeric variable is the first predictor in at, values from minimum to maximum of the same length as indicated in length are generated. For numeric predictors not specified at first in at, mean and -1/+1 SD around the mean are returned. For factors, all levels are returned.
include_smooth  If \( x \) is a model object, decide whether smooth terms should be included in the data grid or not.

include_random  If \( x \) is a mixed model object, decide whether random effect terms should be included in the data grid or not. If \( \text{include\_random} \) is FALSE, but \( x \) is a mixed model with random effects, these will still be included in the returned grid, but set to their "population level" value (e.g., NA for \textit{glmmTMB} or 0 for \textit{merMod}). This ensures that common \texttt{predict()} methods work properly, as these usually need data with all variables in the model included.

include_response  If \( x \) is a model object, decide whether the response variable should be included in the data grid or not.

data  Optional, the data frame that was used to fit the model. Usually, the data is retrieved via \texttt{get\_data()}.  

verbose  Toggle warnings.

\section*{Value}

Reference grid data frame.

\section*{See Also}

\texttt{get\_predicted()} 

\section*{Examples}

\footnotesize

```r
# Datagrids of variables and dataframes

if (require("bayestestR", quietly = TRUE) & require("datawizard", quietly = TRUE)) {
  # Single variable is of interest; all others are "fixed"  
  # Factors
  get_datagrid(iris, at = "Species")  # Returns all the levels
  get_datagrid(iris, at = "Species = c('setosa', 'versicolor')")  # Specify an expression

  # Numeric variables
  get_datagrid(iris, at = "Sepal.Length")  # default spread length = 10
  get_datagrid(iris, at = "Sepal.Length", length = 3)  # change length
  get_datagrid(iris[2:150, ],
    at = "Sepal.Length",
    factors = "mode",
    numerics = "median"
  )  # change non-targets fixing

  get_datagrid(iris, at = "Sepal.Length", range = "ci", ci = 0.90)  # change min/max of target
  get_datagrid(iris, at = "Sepal.Length = [0, 1]")  # manually change min/max
  get_datagrid(iris, at = "Sepal.Length = [sd]")  # -1 SD, mean and +1 SD
  get_datagrid(iris, at = "Sepal.Length = [quartiles]")  # quartiles

  # Numeric and categorical variables, generating a grid for plots
  get_datagrid(iris, at = c("Sepal.Length", "Species"), range = "grid")
  get_datagrid(iris, at = c("Species", "Sepal.Length"), range = "grid")
```

\normalsize
# Standardization and unstandardization

data <- get_datagrid(iris, at = "Sepal.Length", range = "sd", length = 3)
data$Sepal.Length # It is a named vector (extract names with `names(out$Sepal.Length)`) datawizard::standardize(data, select = "Sepal.Length")
data <- get_datagrid(iris, at = "Sepal.Length = c(-2, 0, 2)") # Manually specify values data datawizard::unstandardize(data, select = "Sepal.Length")

# Multiple variables are of interest, creating a combination ---------------
get_datagrid(iris, at = c("Sepal.Length", "Species"), length = 3)
get_datagrid(iris, at = c("Sepal.Length", "Petal.Length"), length = c(3, 2))
get_datagrid(iris, at = c(1, 3), length = 3)
get_datagrid(iris, at = c("Sepal.Length", "Species"), preserve_range = TRUE)
get_datagrid(iris, at = c("Sepal.Length", "Species"), numerics = 0)
get_datagrid(iris, at = c("Sepal.Length = 3", "Species"))
get_datagrid(iris, at = c("Sepal.Length = c(3, 1)", "Species = 'setosa'"))

# With list-style at-argument
get_datagrid(iris, at = list(Sepal.Length = c(1, 3), Species = "setosa"))

# With models ===============================================================
# Fit a linear regression
model <- lm(Sepal.Length ~ Sepal.Width * Petal.Length, data = iris)
# Get datagrid of predictors
data <- get_datagrid(model, length = c(20, 3), range = c("range", "sd"))
# same as: get_datagrid(model, range = "grid", length = 20)
# Add predictions
data$Sepal.Length <- get_predicted(model, data = data)
# Visualize relationships (each color is at -1 SD, Mean, and +1 SD of Petal.Length)
plot(data$Sepal.Width, data$Sepal.Length, col = data$Petal.Length, 
     main = "Relationship at -1 SD, Mean, and +1 SD of Petal.Length")

---

**get_deviance**

**Model Deviance**

### Description

Returns model deviance (see `stats::deviance()`).

### Usage

```r
get_deviance(x, ...)  
```

```
## Default S3 method:  
get_deviance(x, verbose = TRUE, ...)
```
get_df

Arguments

x  A model.
... Not used.
verbose Toggle warnings and messages.

Details

For GLMMs of class glmerMod, glmmTMB or MixMod, the absolute unconditional deviance is returned (see 'Details' in ?lme4::merMod-class), i.e. minus twice the log-likelihood. To get the relative conditional deviance (relative to a saturated model, conditioned on the conditional modes of random effects), use deviance(). The value returned get_deviance() usually equals the deviance-value from the summary().

Value

The model deviance.

Examples

data(mtcars)
x <- lm(mpg ~ cyl, data = mtcars)
get_deviance(x)

get_df

Extract degrees of freedom

Description

Estimate or extract residual or model-based degrees of freedom from regression models.

Usage

get_df(x, ...)

## Default S3 method:
get_df(x, type = "residual", verbose = TRUE, ...)

Arguments

x  A statistical model.
... Currently not used.
type Can be "residual", "wald", "normal", or "model". "analytical" is an alias for "residual".
• "residual" (aka "analytical") returns the residual degrees of freedom, which usually is what stats::df.residual() returns. If a model object has no method to extract residual degrees of freedom, these are calculated as n-p, i.e. the number of observations minus the number of estimated parameters. If residual degrees of freedom cannot be extracted by either approach, returns Inf.

• "wald" returns residual (aka analytical) degrees of freedom for models with t-statistic, 1 for models with Chi-squared statistic, and Inf for all other models. Also returns Inf if residual degrees of freedom cannot be extracted.

• "normal" always returns Inf.

• "model" returns model-based degrees of freedom, i.e. the number of (estimated) parameters.

• For mixed models, can also be "ml1" (approximation of degrees of freedom based on a "m-l-1" heuristic as suggested by Elff et al. 2019) or "betwithin", and for models of class merMod, type can also be "satterthwaite" or "kenward-roger". See 'Details'.

Usually, when degrees of freedom are required to calculate p-values or confidence intervals, type = "wald" is likely to be the best choice in most cases.

verbose Toggle warnings.

details

Details

Degrees of freedom for mixed models
Inferential statistics (like p-values, confidence intervals and standard errors) may be biased in mixed models when the number of clusters is small (even if the sample size of level-1 units is high). In such cases it is recommended to approximate a more accurate number of degrees of freedom for such inferential statistics (see Li and Redden 2015).

m-l-1 degrees of freedom

The m-l-1 heuristic is an approach that uses a t-distribution with fewer degrees of freedom. In particular for repeated measure designs (longitudinal data analysis), the m-l-1 heuristic is likely to be more accurate than simply using the residual or infinite degrees of freedom, because get_df(type = "ml1") returns different degrees of freedom for within-cluster and between-cluster effects. Note that the "m-l-1" heuristic is not applicable (or at least less accurate) for complex multilevel designs, e.g. with cross-classified clusters. In such cases, more accurate approaches like the Kenward-Roger approximation is recommended. However, the "m-l-1" heuristic also applies to generalized mixed models, while approaches like Kenward-Roger or Satterthwaite are limited to linear mixed models only.

Between-within degrees of freedom

The Between-within denominator degrees of freedom approximation is, similar to the "m-l-1" heuristic, recommended in particular for (generalized) linear mixed models with repeated measurements (longitudinal design). get_df(type = "betwithin") implements a heuristic based on the between-within approach, i.e. this type returns different degrees of freedom for within-cluster and between-cluster effects. Note that this implementation does not return exactly the same results as shown in Li and Redden 2015, but similar.

Satterthwaite and Kenward-Rogers degrees of freedom
Unlike simpler approximation heuristics like the "m-l-1" rule (type = "ml1"), the Satterthwaite or Kenward-Rogers approximation is also applicable in more complex multilevel designs. However, the "m-l-1" or "between-within" heuristics also apply to generalized mixed models, while approaches like Kenward-Roger or Satterthwaite are limited to linear mixed models only.

References


Examples

```r
model <- lm(Sepal.Length ~ Petal.Length * Species, data = iris)
get_df(model) # same as df.residual(model)
get_df(model, type = "model") # same as attr(logLik(model), "df")
```

Description

A robust alternative to stats::family

Usage

```r
get_family(x, ...)```

Arguments

- `x` A statistical model.
- `...` Further arguments passed to methods.
Examples

data(mtcars)
x <- glm(vs ~ wt, data = mtcars, family = "binomial")
get_family(x)

if (require("mgcv")) {
  x <- mgcv::gamm(
    vs ~ am + s(wt),
    random = list(cyl = ~1),
    data = mtcars,
    family = "binomial"
  )
  get_family(x)
}

---

**get_intercept**

*Get the value at the intercept*

Description

Returns the value at the intercept (i.e., the intercept parameter), and NA if there isn’t one.

Usage

get_intercept(x, ...)

Arguments

x A model.

... Not used.

Value

The value of the intercept.

Examples

get_intercept(lm(Sepal.Length ~ Petal.Width, data = iris))
get_intercept(lm(Sepal.Length ~ 0 + Petal.Width, data = iris))

if (require("lme4")) {
  get_intercept(lme4::lmer(Sepal.Length ~ Sepal.Width + (1 | Species), data = iris))
}

if (require("gamm4")) {
  get_intercept(gamm4::gamm4(Sepal.Length ~ s(Petal.Width), data = iris))
}
**get_loglikelihood**  

**Log-Likelihood**

**Description**

A robust function to compute the log-likelihood of a model, as well as individual log-likelihoods (for each observation) whenever possible. Can be used as a replacement for `stats::logLik()` out of the box, as the returned object is of the same class (and it gives the same results by default).

**Usage**

```r
get_loglikelihood(x, ...)  
loglikelihood(x, ...)  
## S3 method for class 'lm'
get_loglikelihood(
  x,  
estimator = "ML",  
REML = FALSE,  
check_response = FALSE,  
verbose = TRUE,  
...  
)
```

**Arguments**

- **x**: A model.
- **...**: Passed down to `logLik()`, if possible.
- **estimator**: Corresponds to the different estimators for the standard deviation of the errors. If `estimator="ML"` (default), the scaling is done by `n` (the biased ML estimator), which is then equivalent to using `stats::logLik()`. If `estimator="OLS"`, it returns the unbiased OLS estimator. `estimator="REML"` will give same results as `stats::logLik(..., REML=TRUE)`. Note that individual log-likelihoods are not available under REML.
- **REML**: Only for linear models. This argument is present for compatibility with `stats::logLik()`. Setting it to `TRUE` will overwrite the `estimator` argument and is thus equivalent to setting `estimator="REML"`. It will give the same results as `stats::logLik(..., REML=TRUE)`. Note that individual log-likelihoods are not available under REML.
- **check_response**: Logical, if `TRUE`, checks if the response variable is transformed (like `log()` or `sqrt()`), and if so, returns a corrected log-likelihood. To get back to the original scale, the likelihood of the model is multiplied by the Jacobian/derivative of the transformation.
- **verbose**: Toggle warnings and messages.
Value

An object of class "logLik", also containing the log-likelihoods for each observation as a per_observation attribute (attributes(get_loglikelihood(x))$per_observation) when possible. The code was partly inspired from the nonnest2 package.

Examples

```r
x <- lm(Sepal.Length ~ Petal.Width + Species, data = iris)
get_loglikelihood(x, estimator = "ML")  # Equivalent to stats::logLik(x)
get_loglikelihood(x, estimator = "REML")  # Equivalent to stats::logLik(x, REML=TRUE)
get_loglikelihood(x, estimator = "OLS")
```

get_modelmatrix

Model Matrix

Description

Creates a design matrix from the description. Any character variables are coerced to factors.

Usage

```r
get_modelmatrix(x, ...)
```

Arguments

- `x`: An object.
- `...`: Passed down to other methods (mainly model.matrix()).

Examples

```r
data(mtcars)
model <- lm(am ~ vs, data = mtcars)
get_modelmatrix(model)
```
get_parameters

**Get model parameters**

**Description**

Returns the coefficients (or posterior samples for Bayesian models) from a model. See the documentation for your object’s class:

- **Bayesian models** (rstanarm, brms, MCMCglmm, ...)
- **Estimated marginal means** (emmeans)
- **Generalized additive models** (mgcv, VGAM, ...)
- **Marginal effects models** (mfx)
- **Mixed models** (lme4, glmmTMB, GLMMadaptive, ...)
- **Zero-inflated and hurdle models** (pscl, ...)
- **Models with special components** (betareg, MuMIn, ...)
- **Hypothesis tests** (htest)

**Usage**

```r
get_parameters(x, ...) 
## Default S3 method:
get_parameters(x, verbose = TRUE, ...)
```

**Arguments**

- `x` A fitted model.
- `...` Currently not used.
- `verbose` Toggle messages and warnings.

**Details**

In most cases when models either return different "effects" (fixed, random) or "components" (conditional, zero-inflated, ...), the arguments `effects` and `component` can be used.

`get_parameters()` is comparable to `coef()`, however, the coefficients are returned as data frame (with columns for names and point estimates of coefficients). For Bayesian models, the posterior samples of parameters are returned.

**Value**

- for non-Bayesian models, a data frame with two columns: the parameter names and the related point estimates.
- for Anova (aov()) with error term, a list of parameters for the conditional and the random effects parameters
Model components

Possible values for the component argument depend on the model class. Following are valid options:

- "all": returns all model components, applies to all models, but will only have an effect for models with more than just the conditional model component.
- "conditional": only returns the conditional component, i.e. "fixed effects" terms from the model. Will only have an effect for models with more than just the conditional model component.
- "smooth_terms": returns smooth terms, only applies to GAMs (or similar models that may contain smooth terms).
- "zero_inflated" (or "zi"): returns the zero-inflation component.
- "dispersion": returns the dispersion model component. This is common for models with zero-inflation or that can model the dispersion parameter.
- "instruments": for instrumental-variable or some fixed effects regression, returns the instruments.
- "location": returns location parameters such as conditional, zero_inflated, smooth_terms, or instruments (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters).
- "distributional" (or "auxiliary"): components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)

---

get_parameters.betamfx

*Get model parameters from marginal effects models*

Description

Returns the coefficients from a model.

Usage

```r
## S3 method for class 'betamfx'
get_parameters(x, component = c("all", "conditional", "precision", "marginal"), ...)
```

```r
## S3 method for class 'logitmfx'
get_parameters(x, component = c("all", "conditional", "marginal"), ...)
```
get_parameters.betareg

Arguments

x
A fitted model.

component
Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model.

... Currently not used.

Value

A data frame with three columns: the parameter names, the related point estimates and the component.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)

get_parameters.betareg

Get model parameters from models with special components

Description

Returns the coefficients from a model.

Usage

## S3 method for class 'betareg'
get_parameters(
x,
component = c("all", "conditional", "precision", "location", "distributional", "auxiliary"),
...
)

## S3 method for class 'DirichletRegModel'
get_parameters(
x,
component = c("all", "conditional", "precision", "location", "distributional", "auxiliary"),
...
)
## S3 method for class 'averaging'
get_parameters(x, component = c("conditional", "full"), ...)

## S3 method for class 'glmx'
get_parameters(
  x,
  component = c("all", "conditional", "extra", "location", "distributional", "auxiliary"),
  ...
)

## S3 method for class 'clm2'
get_parameters(x, component = c("all", "conditional", "scale"), ...)

## S3 method for class 'mvord'
get_parameters(
  x,
  component = c("all", "conditional", "thresholds", "correlation"),
  ...
)

## S3 method for class 'mjoint'
get_parameters(x, component = c("all", "conditional", "survival"), ...)

### Arguments

- **x**: A fitted model.
- **component**: Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the **conditional** component is also called **count** or **mean** component, depending on the model.

- **...**: Currently not used.

### Value

A data frame with three columns: the parameter names, the related point estimates and the component.

### Examples

```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)
```
get_parameters.BGGM

Get model parameters from Bayesian models

Description

Returns the coefficients (or posterior samples for Bayesian models) from a model.

Usage

## S3 method for class 'BGGM'
get_parameters(
  x,
  component = c("correlation", "conditional", "intercept", "all"),
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'MCMCglmm'
get_parameters(
  x,
  effects = c("fixed", "random", "all"),
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'BFBayesFactor'
get_parameters(
  x,
  effects = c("all", "fixed", "random"),
  component = c("all", "extra"),
  iterations = 4000,
  progress = FALSE,
  verbose = TRUE,
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'stanmvreg'
get_parameters(
  x,
  effects = c("fixed", "random", "all"),
  parameters = NULL,
  summary = FALSE,
  centrality = "mean",
  ...


```r
## S3 method for class 'brmsfit'
get_parameters(
  x,
  effects = "fixed",
  component = "all",
  parameters = NULL,
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'stanreg'
get_parameters(
  x,
  effects = c("fixed", "random", "all"),
  component = c("location", "all", "conditional", "smooth_terms", "sigma",
                "distributional", "auxiliary"),
  parameters = NULL,
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'bayesx'
get_parameters(
  x,
  component = c("conditional", "smooth_terms", "all"),
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'bamlss'
get_parameters(
  x,
  component = c("all", "conditional", "smooth_terms", "location", "distributional",
                "auxiliary"),
  parameters = NULL,
  summary = FALSE,
  centrality = "mean",
  ...
)

## S3 method for class 'sim.merMod'
get_parameters(

```
get_parameters.BGGM

x,
effects = c("fixed", "random", "all"),
parameters = NULL,
summary = FALSE,
centrality = "mean",
...
)

## S3 method for class 'sim'
get_parameters(x, parameters = NULL, summary = FALSE, centrality = "mean", ...)

Arguments

x A fitted model.

component Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model, the dispersion term, the instrumental variables or marginal effects be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variables (so called fixed-effects regressions), or models with marginal effects from mfx. May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model. There are three convenient shortcuts: component = "all" returns all possible parameters. If component = "location", location parameters such as conditional, zero_inflated, smooth_terms, or instruments are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For component = "distributional" (or "auxiliary"), components like sigma, dispersion, beta or precision (and other auxiliary parameters) are returned.

summary Logical, indicates whether the full posterior samples (summary = FALSE)) or the summarized centrality indices of the posterior samples (summary = TRUE)) should be returned as estimates.

centrality Only for models with posterior samples, and when summary = TRUE. In this case, centrality = "mean" would calculate means of posterior samples for each parameter, while centrality = "median" would use the more robust median value as measure of central tendency.

... Currently not used.

effects Should parameters for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.

iterations Number of posterior draws.

progress Display progress.

verbose Toggle messages and warnings.

parameters Regular expression pattern that describes the parameters that should be returned.

Details

In most cases when models either return different "effects" (fixed, random) or "components" (conditional, zero-inflated, ...), the arguments effects and component can be used.
get_parameters.emmGrid

Value
The posterior samples from the requested parameters as data frame. If summary = TRUE, returns a data frame with two columns: the parameter names and the related point estimates (based on centrality).

BFBayesFactor Models
Note that for BFBayesFactor models (from the BayesFactor package), posteriors are only extracted from the first numerator model (i.e., model[1]). If you want to apply some function foo() to another model stored in the BFBayesFactor object, index it directly, e.g. foo(model[2]), foo(1/model[5]), etc. See also bayestestR::weighted_posteriors().

Examples
```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)
```

get_parameters.emmGrid

Get model parameters from estimated marginal means objects

Description
Returns the coefficients from a model.

Usage
```r
## S3 method for class 'emmGrid'
get_parameters(x, summary = FALSE, merge_parameters = FALSE, ...)

## S3 method for class 'emm_list'
get_parameters(x, summary = FALSE, ...)
```

Arguments
- **x**: A fitted model.
- **summary**: Logical, indicates whether the full posterior samples (summary = FALSE)) or the summarized centrality indices of the posterior samples (summary = TRUE) should be returned as estimates.
- **merge_parameters**: Logical, if TRUE and x has multiple columns for parameter names (like emmGrid objects may have), these are merged into a single parameter column, with parameters names and values as values.
- **...**: Currently not used.
Value

A data frame with two columns: the parameter names and the related point estimates.

Note

Note that emmGrid or emm_list objects returned by functions from emmeans have a different structure compared to usual regression models. Hence, the Parameter column does not always contain names of variables, but may rather contain values, e.g. for contrasts. See an example for pairwise comparisons below.

Examples

```r
data(mtcars)
model <- lm(mpg ~ wt * factor(cyl), data = mtcars)
if (require("emmeans", quietly = TRUE)) {
  emm <- emmeans(model, "cyl")
  get_parameters(emm)
  emm <- emmeans(model, pairwise ~ cyl)
  get_parameters(emm)
}
```

---

get_parameters.gamm Get model parameters from generalized additive models

Description

Returns the coefficients from a model.

Usage

```r
## S3 method for class 'gamm'
get_parameters(
  x,
  component = c("all", "conditional", "smooth_terms", "location"),
  ...
)

## S3 method for class 'gam'
get_parameters(
  x,
  component = c("all", "conditional", "smooth_terms", "location"),
  ...
)

## S3 method for class 'rqss'
get_parameters(x, component = c("all", "conditional", "smooth_terms"), ...)
```
get_parameters.glmm

get_parameters.glmm

Get model parameters from mixed models

Description

Returns the coefficients from a model.

Usage

## S3 method for class 'glmm'
get_parameters(x, effects = c("all", "fixed", "random"), ...)

## S3 method for class 'coxme'
get_parameters(x, effects = c("fixed", "random"), ...)

## S3 method for class 'nlmerMod'
get_parameters(
  x,
  effects = c("fixed", "random"),
  component = c("all", "conditional", "nonlinear"),
  ...
)

## S3 method for class 'merMod'
get_parameters(x, effects = c("fixed", "random"), ...)
## S3 method for class 'glmmTMB'
get_parameters(
  x,
  effects = c("fixed", "random"),
  component = c("all", "conditional", "zi", "zero_inflated", "dispersion"),
  ...
)

## S3 method for class 'glimML'
get_parameters(x, effects = c("fixed", "random", "all"), ...)

### Arguments

- **x**
  A fitted model.

- **effects**
  Should parameters for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.

- **...**
  Currently not used.

- **component**
  Which type of parameters to return, such as parameters for the conditional model, the zero-inflated part of the model or the dispersion term? Applies to models with zero-inflated and/or dispersion formula. Note that the *conditional* component is also called *count* or *mean* component, depending on the model. There are three convenient shortcuts: *component = "all"* returns all possible parameters. If *component = "location"*, location parameters such as conditional or zero_inflated are returned (everything that are fixed or random effects - depending on the effects argument - but no auxiliary parameters). For *component = "distributional"* (or "auxiliary"), components like sigma or dispersion (and other auxiliary parameters) are returned.

### Details

In most cases when models either return different "effects" (fixed, random) or "components" (conditional, zero-inflated, ...), the arguments effects and component can be used.

### Value

If *effects = "fixed"*, a data frame with two columns: the parameter names and the related point estimates. If *effects = "random"*, a list of data frames with the random effects (as returned by ranef()), unless the random effects have the same simplified structure as fixed effects (e.g. for models from MCMCglmm).

### Examples

```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)
```
get_parameters.htest  Get model parameters from htest-objects

Description

Returns the parameters from a hypothesis test.

Usage

```r
## S3 method for class 'htest'
get_parameters(x, ...)
```

Arguments

- `x`  A fitted model.
- `...`  Currently not used.

Value

A data frame with two columns: the parameter names and the related point estimates.

Examples

```r
get_parameters(t.test(1:10, y = c(7:20)))
```

get_parameters.zeroinfl  Get model parameters from zero-inflated and hurdle models

Description

Returns the coefficients from a model.

Usage

```r
## S3 method for class 'zeroinfl'
get_parameters(
  x,
  component = c("all", "conditional", "zi", "zero_inflated"),
  ...
)
```

```r
## S3 method for class 'zcpglm'
get_parameters(
  x,
```
Arguments

x A fitted model.

component Should all predictor variables, predictor variables for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model.

... Currently not used.

Value

For models with smooth terms or zero-inflation component, a data frame with three columns: the parameter names, the related point estimates and the component.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_parameters(m)

get_predicted Model predictions (robust) and their confidence intervals

Description

The get_predicted() function is a robust, flexible and user-friendly alternative to base R predict() function. Additional features and advantages include availability of uncertainty intervals (CI), bootstrapping, a more intuitive API and the support of more models than base R’s predict() function. However, although the interface are simplified, it is still very important to read the documentation of the arguments. This is because making "predictions" (a lose term for a variety of things) is a non-trivial process, with lots of caveats and complications. Read the 'Details' section for more information.
get_predicted_ci() returns the confidence (or prediction) interval (CI) associated with predictions made by a model. This function can be called separately on a vector of predicted values. get_predicted() usually returns confidence intervals (included as attribute, and accessible via the as.data.frame() method) by default.

Usage

get_predicted(x, ...)

## Default S3 method:
get_predicted(
  x,
  data = NULL,
  predict = "expectation",
  ci = NULL,
  ci_type = "confidence",
  ci_method = NULL,
  dispersion_method = "sd",
  vcov = NULL,
  vcov_args = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'lm'
get_predicted(
  x,
  data = NULL,
  predict = "expectation",
  ci = NULL,
  iterations = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'stanreg'
get_predicted(
  x,
  data = NULL,
  predict = "expectation",
  iterations = NULL,
  ci = NULL,
  ci_method = NULL,
  include_random = "default",
  include_smooth = TRUE,
  verbose = TRUE,
  ...
)
## S3 method for class 'gam'
get_predicted(
  x,
  data = NULL,
  predict = "expectation",
  ci = NULL,
  include_random = TRUE,
  include_smooth = TRUE,
  iterations = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'lmerMod'
get_predicted(
  x,
  data = NULL,
  predict = "expectation",
  ci = NULL,
  ci_method = NULL,
  include_random = "default",
  iterations = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'principal'
get_predicted(x, data = NULL, ...)

### Arguments

- **x**: A statistical model (can also be a data.frame, in which case the second argument has to be a model).
- **...**: Other argument to be passed, for instance to `get_predicted_ci()`.
- **data**: An optional data frame in which to look for variables with which to predict. If omitted, the data used to fit the model is used. Visualization matrices can be generated using `get_datagrid()`.
- **predict**: string or NULL
  - "link" returns predictions on the model’s link-scale (for logistic models, that means the log-odds scale) with a confidence interval (CI).
  - "expectation" (default) also returns confidence intervals, but this time the output is on the response scale (for logistic models, that means probabilities).
  - "prediction" also gives an output on the response scale, but this time associated with a prediction interval (PI), which is larger than a confidence interval (though it mostly make sense for linear models).
• "classification" only differs from "prediction" for binomial models where it additionally transforms the predictions into the original response's type (for instance, to a factor).

• Other strings are passed directly to the type argument of the `predict()` method supplied by the modelling package.

• When `predict = NULL`, alternative arguments such as type will be captured by the `...` ellipsis and passed directly to the `predict()` method supplied by the modelling package. Note that this might result in conflicts with multiple matching type arguments - thus, the recommendation is to use the `predict` argument for those values.

• Notes: You can see the 4 options for predictions as on a gradient from "close to the model" to "close to the response data": "link", "expectation", "prediction", "classification". The `predict` argument modulates two things: the scale of the output and the type of certainty interval. Read more about in the Details section below.

`ci` The interval level. Default is `NULL`, to be fast even for larger models. Set the interval level to an explicit value, e.g. 0.95, for 95% CI).

`ci_type` Can be "prediction" or "confidence". Prediction intervals show the range that likely contains the value of a new observation (in what range it would fall), whereas confidence intervals reflect the uncertainty around the estimated parameters (and gives the range of the link; for instance of the regression line in a linear regressions). Prediction intervals account for both the uncertainty in the model’s parameters, plus the random variation of the individual values. Thus, prediction intervals are always wider than confidence intervals. Moreover, prediction intervals will not necessarily become narrower as the sample size increases (as they do not reflect only the quality of the fit). This applies mostly for "simple" linear models (like `lm`), as for other models (e.g., `glm`), prediction intervals are somewhat useless (for instance, for a binomial model for which the dependent variable is a vector of 1s and 0s, the prediction interval is... [0, 1]).

`ci_method` The method for computing p values and confidence intervals. Possible values depend on model type.

• `NULL` uses the default method, which varies based on the model type.

• Most frequentist models: "wald" (default), "residual" or "normal".

• Bayesian models: "quantile" (default), "hdi", "eti", and "spi".

• Mixed effects `lme4` models: "wald" (default), "residual", "normal", "satterthwaite", and "kenward-roger".

See `get_df()` for details.

`dispersion_method` Bootstrap dispersion and Bayesian posterior summary: "sd" or "mad".

`vcov` Variance-covariance matrix used to compute uncertainty estimates (e.g., for robust standard errors). This argument accepts a covariance matrix, a function which returns a covariance matrix, or a string which identifies the function to be used to compute the covariance matrix.

• A covariance matrix

• A function which returns a covariance matrix (e.g., `stats::vcov()`)

...
• A string which indicates the kind of uncertainty estimates to return.
  - Heteroskedasticity-consistent: "vcovHC", "HC", "HC0", "HC1", "HC2", "HC3", "HC4", "HC4m", "HC5". See ?sandwich::vcovHC
  - Bootstrap: "vcovBS", "xy", "residual", "wild", "mammen", "webb". See ?sandwich::vcovBS
  - Other sandwich package functions: "vcovHAC", "vcovPC", "vcovCL", "vcovPL".

vcov_args List of arguments to be passed to the function identified by the vcov argument.
This function is typically supplied by the sandwich or clubSandwich packages. Please refer to their documentation (e.g., ?sandwich::vcovHAC) to see the list of available arguments. If no estimation type (argument type) is given, the default type for "HC" (or "vcovHC") equals the default from the sandwich package; for type "CR" (or "vcovCR"), the default is set to "CR3".

verbose Toggle warnings.
iterations For Bayesian models, this corresponds to the number of posterior draws. If NULL, will return all the draws (one for each iteration of the model). For frequentist models, if not NULL, will generate bootstrapped draws, from which bootstrapped CIs will be computed. Iterations can be accessed by running as.data.frame(..., keep_iterations = TRUE) on the output.

include_random If "default", include all random effects in the prediction, unless random effect variables are not in the data. If TRUE, include all random effects in the prediction (in this case, it will be checked if actually all random effect variables are in data). If FALSE, don’t take them into account. Can also be a formula to specify which random effects to condition on when predicting (passed to the re.form argument). If include_random = TRUE and data is provided, make sure to include the random effect variables in data as well.

include_smooth For General Additive Models (GAMs). If FALSE, will fix the value of the smooth to its average, so that the predictions are not depending on it. (default), mean(), or bayestestR::map_estimate().

Details

In insight::get_predicted(), the predict argument jointly modulates two separate concepts, the scale and the uncertainty interval.

Confidence Interval (CI) vs. Prediction Interval (PI):

• Linear models - lm(): For linear models, Prediction intervals (predict="prediction") show the range that likely contains the value of a new observation (in what range it is likely to fall), whereas confidence intervals (predict="expectation" or predict="link") reflect the uncertainty around the estimated parameters (and gives the range of uncertainty of the regression line). In general, Prediction Intervals (PIs) account for both the uncertainty in the model’s parameters, plus the random variation of the individual values. Thus, prediction intervals are always wider than confidence intervals. Moreover, prediction intervals will not necessarily become narrower as the sample size increases (as they do not reflect only the quality of the fit, but also the variability within the data).
**Generalized Linear models** - `glm()`: For binomial models, prediction intervals are somewhat useless (for instance, for a binomial (Bernoulli) model for which the dependent variable is a vector of 1s and 0s, the prediction interval is... `[0, 1]`).

**Link scale vs. Response scale:** When users set the `predict` argument to "expectation", the predictions are returned on the response scale, which is arguably the most convenient way to understand and visualize relationships of interest. When users set the `predict` argument to "link", predictions are returned on the link scale, and no transformation is applied. For instance, for a logistic regression model, the response scale corresponds to the predicted probabilities, whereas the link-scale makes predictions of log-odds (probabilities on the logit scale). Note that when users select `predict="classification"` in binomial models, the `get_predicted()` function will first calculate predictions as if the user had selected `predict="expectation"`. Then, it will round the responses in order to return the most likely outcome.

**Heteroscedasticity consistent standard errors:** The arguments `vcov` and `vcov_args` can be used to calculate robust standard errors for confidence intervals of predictions. These arguments, when provided in `get_predicted()`, are passed down to `get_predicted_ci()`, thus, see the related documentation there for more details.

**Bayesian and Bootstrapped models and iterations:** For predictions based on multiple iterations, for instance in the case of Bayesian models and bootstrapped predictions, the function used to compute the centrality (point-estimate predictions) can be modified via the `centrality_function` argument. For instance, `get_predicted(model, centrality_function = stats::median)`. The default is `mean`. Individual draws can be accessed by running `iter <- as.data.frame(get_predicted(model))`, and their iterations can be reshaped into a long format by `bayestestR::reshape_iterations(iter)`.

**Value**

The fitted values (i.e. predictions for the response). For Bayesian or bootstrapped models (when `iterations != NULL`), iterations (as columns and observations are rows) can be accessed via `as.data.frame()`.

**See Also**

`get_datagrid()`

**Examples**

data(mtcars)
x <- lm(mpg ~ cyl + hp, data = mtcars)
predictions <- get_predicted(x, ci = 0.95)
predictions

# Options and methods -------------------------
get_predicted(x, predict = "prediction")

# Get CI
as.data.frame(predictions)

if (require("boot")) {
  # Bootstrapped
**get_predicted_ci**

Confidence intervals around predicted values

**Usage**

get_predicted_ci(x, ...)

## Default S3 method:
get_predicted_ci(
x,
predictions = NULL,
data = NULL,
se = NULL,
CI = 0.95,
ci_type = "confidence",
ci_method = NULL,)
Arguments

x
  A statistical model (can also be a data.frame, in which case the second argument
  has to be a model).

... Other argument to be passed, for instance to get_predicted_ci().
predictions A vector of predicted values (as obtained by stats::fitted(), stats::predict() or
  get_predicted()).
data An optional data frame in which to look for variables with which to predict. If
  omitted, the data used to fit the model is used. Visualization matrices can be
  generated using get_datagrid().
se Numeric vector of standard error of predicted values. If NULL, standard errors
  are calculated based on the variance-covariance matrix.

... The interval level. Default is NULL, to be fast even for larger models. Set the
  interval level to an explicit value, e.g. 0.95, for 95% CI).

... Can be "prediction" or "confidence". Prediction intervals show the range
  that likely contains the value of a new observation (in what range it would fall),
  whereas confidence intervals reflect the uncertainty around the estimated param-
  eters (and gives the range of the link; for instance of the regression line in a linear
  regressions). Prediction intervals account for both the uncertainty in the model’s
  parameters, plus the random variation of the individual values. Thus, prediction
  intervals are always wider than confidence intervals. Moreover, prediction in-
  tervals will not necessarily become narrower as the sample size increases (as
  they do not reflect only the quality of the fit). This applies mostly for "simple"
  linear models (like lm), as for other models (e.g., glm), prediction intervals are
  somewhat useless (for instance, for a binomial model for which the dependent
  variable is a vector of 1s and 0s, the prediction interval is... [0, 1]).

... The method for computing p values and confidence intervals. Possible values
  depend on model type.
  • NULL uses the default method, which varies based on the model type.
  • Most frequentist models: "wald" (default), "residual" or "normal".
  • Bayesian models: "quantile" (default), "hdi", "eti", and "spi".
  • Mixed effects lme4 models: "wald" (default), "residual", "normal", "satterthwaite",
  and "kenward-roger".

See get_df() for details.

dispersion_method Bootstrap dispersion and Bayesian posterior summary: "sd" or "mad".

vcov Variance-covariance matrix used to compute uncertainty estimates (e.g., for ro-
  bust standard errors). This argument accepts a covariance matrix, a function
which returns a covariance matrix, or a string which identifies the function to be used to compute the covariance matrix.

- A covariance matrix
- A function which returns a covariance matrix (e.g., `stats::vcov()`)
- A string which indicates the kind of uncertainty estimates to return.
  - Heteroskedasticity-consistent: "vcovHC", "HC", "HC0", "HC1", "HC2", "HC3", "HC4", "HC4m", "HC5". See `?sandwich::vcovHC`
  - Bootstrap: "vcovBS", "xy", "residual", "wild", "mammen", "webb". See `?sandwich::vcovBS`
  - Other sandwich package functions: "vcovHAC", "vcovPC", "vcovCL", "vcovPL".

vcov_args List of arguments to be passed to the function identified by the vcov argument. This function is typically supplied by the sandwich or clubSandwich packages. Please refer to their documentation (e.g., `?sandwich::vcovHAC`) to see the list of available arguments. If no estimation type (argument type) is given, the default type for "HC" (or "vcovHC") equals the default from the sandwich package; for type "CR" (or "vcovCR"), the default is set to "CR3".

verbose Toggle warnings.

Examples

```r
# Confidence Intervals for Model Predictions
# ------------------------------------------
data(mtcars)

# Linear model
# ------------
x <- lm(mpg ~ cyl + hp, data = mtcars)
predictions <- predict(x)

# Confidence intervals
ci_vals <- get_predicted_ci(x, predictions, ci_type = "prediction")
head(ci_vals)

# Prediction intervals
ci_vals <- get_predicted_ci(x, predictions, ci_type = "confidence")
head(ci_vals)

# Prediction intervals with custom confidence levels
ci_vals <- get_predicted_ci(x, predictions, ci = c(0.8, 0.9, 0.95))
head(ci_vals)

# Bootstrapped
# -----------
if (require("boot")) {
  predictions <- get_predicted(x, iterations = 500)
  get_predicted_ci(x, predictions)
}

if (require("datawizard") && require("bayestestR")) {
  ci_vals <- get_predicted_ci(x, predictions, ci = c(0.80, 0.95))
  head(ci_vals)
}
```
get_predictors

Get the data from model predictors

Description

Returns the data from all predictor variables (fixed effects).

Usage

get_predictors(x, verbose = TRUE)

Arguments

x
A fitted model.

verbose
Toggle messages and warnings.

Value

The data from all predictor variables, as data frame.

Examples

m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
head(get_predictors(m))
get_priors

Get summary of priors used for a model

Description

Provides a summary of the prior distributions used for the parameters in a given model.

Usage

get_priors(x, ...)

## S3 method for class 'brmsfit'
get_priors(x, verbose = TRUE, ...)

Arguments

x A Bayesian model.
...
verbose Toggle warnings and messages.

Value

A data frame with a summary of the prior distributions used for the parameters in a given model.

Examples

## Not run:
library(rstanarm)
model <- stan_glm(Sepal.Width ~ Species * Petal.Length, data = iris)
get_priors(model)
## End(Not run)

get_random

Get the data from random effects

Description

Returns the data from all random effects terms.

Usage

get_random(x)
get_residuals

Arguments

x A fitted mixed model.

Value

The data from all random effects terms, as data frame. Or NULL if model has no random effects.

Examples

if (require("lme4")) {
  data(sleepstudy)
  # prepare some data...
  sleepstudy$mygrp <- sample(1:5, size = 180, replace = TRUE)
  sleepstudy$mysubgrp <- NA
  for (i in 1:5) {
    filter_group <- sleepstudy$mygrp == i
    sleepstudy$mysubgrp[filter_group] <-
    sample(1:30, size = sum(filter_group), replace = TRUE)
  }
  m <- lmer(
    Reaction ~ Days + (1 | mygrp / mysubgrp) + (1 | Subject),
    data = sleepstudy
  )
  head(get_random(m))
}

get_residuals Extract model residuals

Description

Returns the residuals from regression models.

Usage

get_residuals(x, ...)

## Default S3 method:
get_residuals(x, weighted = FALSE, verbose = TRUE, ...)

Arguments

x A model.

... Passed down to residuals(), if possible.

weighted Logical, if TRUE, returns weighted residuals.

verbose Toggle warnings and messages.
Value

The residuals, or NULL if this information could not be accessed.

Note

This function returns the default type of residuals, i.e. for the response from linear models, the deviance residuals for models of class glm etc. To access different types, pass down the type argument (see 'Examples').

This function is a robust alternative to residuals(), as it works for some special model objects that otherwise do not respond properly to calling residuals().

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_residuals(m)

m <- glm(vs ~ wt + cyl + mpg, data = mtcars, family = binomial())
get_residuals(m) # type = "deviance" by default
get_residuals(m, type = "response")

describe

Description

Returns the values the response variable(s) from a model object. If the model is a multivariate response model, a data frame with values from all response variables is returned.

Usage

general_response(x, select = NULL, verbose = TRUE)

Arguments

x A fitted model.
select Optional name(s) of response variables for which to extract values. Can be used in case of regression models with multiple response variables.
verbose Toggle warnings.

Value

The values of the response variable, as vector, or a data frame if x has more than one defined response variable.
get_sigma

Examples

```r
if (require("lme4")) {
  data(cbpp)
  cbpp$trials <- cbpp=size - cbpp$incidence

  m <- glm(cbind(incidence, trials) ~ period, data = cbpp, family = binomial)
  head(get_response(m))
  get_response(m, select = "incidence")
}

data(mtcars)
  m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
  get_response(m)
```

get_sigma

Get residual standard deviation from models

Description

Returns `sigma`, which corresponds the estimated standard deviation of the residuals. This function extends the `sigma()` base R generic for models that don’t have implemented it. It also computes the confidence interval (CI), which is stored as an attribute.

Sigma is a key-component of regression models, and part of the so-called auxiliary parameters that are estimated. Indeed, linear models for instance assume that the residuals comes from a normal distribution with mean 0 and standard deviation `sigma`. See the details section below for more information about its interpretation and calculation.

Usage

```r
get_sigma(x, ci = NULL, verbose = TRUE)
```

Arguments

- **x** A model.
- **ci** Scalar, the CI level. The default (NULL) returns no CI.
- **verbose** Toggle messages and warnings.

Details

**Interpretation of Sigma:** The residual standard deviation, σ, indicates that the predicted outcome will be within +/- σ units of the linear predictor for approximately 68% of the data points (Gelman, Hill & Vehtari 2020, p.84). In other words, the residual standard deviation indicates the accuracy for a model to predict scores, thus it can be thought of as “a measure of the average distance each observation falls from its prediction from the model” (Gelman, Hill & Vehtari 2020, p.168). σ can be considered as a measure of the unexplained variation in the data, or of the precision of inferences about regression coefficients.
Calculation of Sigma: By default, `get_sigma()` tries to extract sigma by calling `stats::sigma()`. If the model-object has no `sigma()` method, the next step is calculating sigma as square-root of the model-deviance divided by the residual degrees of freedom. Finally, if even this approach fails, and `x` is a mixed model, the residual standard deviation is accessed using the square-root from `get_variance_residual()`.

Value

The residual standard deviation (sigma), or NULL if this information could not be accessed.

References


Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
get_sigma(m)

get_statistic

Get statistic associated with estimates

Description

Returns the statistic (t, z, ...) for model estimates. In most cases, this is the related column from `coef(summary())`.

Usage

gfget_statistic(x, ...)

## Default S3 method:
get_statistic(x, column_index = 3, verbose = TRUE, ...)

## S3 method for class 'glmTMB'
get_statistic(g, component = c("all", "conditional", "zi", "zero_inflated", "dispersion"), ...)

## S3 method for class 'clm2'
get_statistic(x, component = c("all", "conditional", "scale"), ...)

## S3 method for class 'betamfx'
get_statistic(}
Arguments

x
A model.

... currently not used.

column_index For model objects that have no defined get_statistic() method yet, the
default method is called. This method tries to extract the statistic column from
coef(summary()), where the index of the column that is being pulled is column_index.
Defaults to 3, which is the default statistic column for most models' summary-output.

verbose Toggle messages and warnings.

component Should all parameters, parameters for the conditional model, or for the zero-
inflated part of the model be returned? Applies to models with zero-inflated
component. component may be one of "conditional", "zi", "zero-inflated" or "all" (default). For models with smooth terms, component = "smooth_terms"
is also possible. May be abbreviated. Note that the conditional component is
also called count or mean component, depending on the model.

ci Confidence Interval (CI) level. Default to 0.95 (95%). Currently only applies to
objects of class emmGrid.

adjust Character value naming the method used to adjust p-values or confidence inter-
vals. See ?emmeans::summary.emmGrid for details.

merge_parameters Logical, if TRUE and x has multiple columns for parameter names (like emmGrid
objects may have), these are merged into a single parameter column, with pa-
rameters names and values as values.

robust Logical, if TRUE, test statistic based on robust standard errors is returned.
**get_transformation**

Return function of transformed response variables

**Description**

This function checks whether any transformation, such as log- or exp-transforming, was applied to the response variable (dependent variable) in a regression formula, and returns the related function that was used for transformation.

**Usage**

get_transformation(x)

**Arguments**

- x: A regression model.

**Value**

A list of two functions: $transformation$, the function that was used to transform the response variable; $inverse$, the inverse-function of $transformation$ (can be used for "back-transformation"). If no transformation was applied, both list-elements $transformation$ and $inverse$ just return function(x) x. If transformation is unknown, NULL is returned.

**Examples**

```r
# identity, no transformation
model <- lm(Sepal.Length ~ Species, data = iris)
get_transformation(model)

# log-transformation
model <- lm(log(Sepal.Length) ~ Species, data = iris)
get_transformation(model)

# log-function
get_transformation(model)$transformation(.3)
log(.3)

# inverse function is exp()
get_transformation(model)$inverse(.3)
exp(.3)
```
get_varcov

Get variance-covariance matrix from models

Description
Returns the variance-covariance, as retrieved by stats::vcov(), but works for more model objects that probably don’t provide a vcov()-method.

Usage
get_varcov(x, ...)

## Default S3 method:
get_varcov(x, verbose = TRUE, vcov = NULL, vcov_args = NULL, ...)

## S3 method for class 'betareg'
get_varcov(
  x,
  component = c("conditional", "precision", "all"),
  verbose = TRUE,
  ...
)

## S3 method for class 'clm2'
get_varcov(x, component = c("all", "conditional", "scale"), ...)

## S3 method for class 'truncreg'
get_varcov(x, component = c("conditional", "all"), verbose = TRUE, ...)

## S3 method for class 'hurdle'
get_varcov(
  x,
  component = c("conditional", "zero_inflated", "zi", "all"),
  vcov = NULL,
  vcov_args = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'glmmTMB'
get_varcov(
  x,
  component = c("conditional", "zero_inflated", "zi", "dispersion", "all"),
  verbose = TRUE,
  ...
)
get_varcov

## S3 method for class 'MixMod'
get_varcov(
  x,
  effects = c("fixed", "random"),
  component = c("conditional", "zero_inflated", "zi", "dispersion", "auxiliary", "all"),
  verbose = TRUE,
  ...
)

## S3 method for class 'brmsfit'
get_varcov(x, component = "conditional", verbose = TRUE, ...)

## S3 method for class 'betamfx'
get_varcov(
  x,
  component = c("conditional", "precision", "all"),
  verbose = TRUE,
  ...
)

## S3 method for class 'aov'
get_varcov(x, complete = FALSE, verbose = TRUE, ...)

## S3 method for class 'mixor'
get_varcov(x, effects = c("all", "fixed", "random"), verbose = TRUE, ...)

Arguments

x          A model.
...        Currently not used.
verbose    Toggle warnings.
vcov       Variance-covariance matrix used to compute uncertainty estimates (e.g., for robust standard errors). This argument accepts a covariance matrix, a function which returns a covariance matrix, or a string which identifies the function to be used to compute the covariance matrix.

- A covariance matrix
- A function which returns a covariance matrix (e.g., stats::vcov())
- A string which indicates the kind of uncertainty estimates to return.
  - Heteroskedasticity-consistent: "vcovHC", "HC", "HC0", "HC1", "HC2", "HC3", "HC4", "HC4m", "HC5". See ?sandwich::vcovHC
  - Bootstrap: "vcovBS", "xy", "residual", "wild", "mammen", "webb". See ?sandwich::vcovBS
  - Other sandwich package functions: "vcovHAC", "vcovPC", "vcovCL", "vcovPL".

get_varcov

vcov_args List of arguments to be passed to the function identified by the vcov argument. This function is typically supplied by the sandwich or clubSandwich packages. Please refer to their documentation (e.g., ?sandwich::vcovHAC) to see the list of available arguments. If no estimation type (argument type) is given, the default type for "HC" (or "vcovHC") equals the default from the sandwich package; for type "CR" (or "vcovCR"), the default is set to "CR3".

component Should the complete variance-covariance matrix of the model be returned, or only for specific model components only (like count or zero-inflated model parts)? Applies to models with zero-inflated component, or models with precision (e.g. betareg) component. component may be one of "conditional", "zi", "zero-inflated", "dispersion", "precision", or "all". May be abbreviated. Note that the conditional component is also called count or mean component, depending on the model.

effects Should the complete variance-covariance matrix of the model be returned, or only for specific model parameters only? Currently only applies to models of class mixor.

complete Logical, if TRUE, for aov, returns the full variance-covariance matrix.

Value

The variance-covariance matrix, as matrix-object.

Note

get_varcov() tries to return the nearest positive definite matrix in case of negative eigenvalues of the variance-covariance matrix. This ensures that it is still possible, for instance, to calculate standard errors of model parameters. A message is shown when the matrix is negative definite and a corrected matrix is returned.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
ge_varcov(m)

# vcov of zero-inflation component from hurdle-model
if (require("pscl")) {
  data("bioChemists", package = "pscl")
  mod <- hurdle(art ~ phd + fem | ment, data = bioChemists, dist = "negbin")
ge_varcov(mod, component = "zero_inflated")
} 

# robust vcov of, count component from hurdle-model
if (require("pscl") & require("sandwich")) {
  data("bioChemists", package = "pscl")
  mod <- hurdle(art ~ phd + fem | ment, data = bioChemists, dist = "negbin")
ge_varcov(
    mod,
    component = "conditional",
    vcov = "BS",
    ...)
get_variance

vcov_args = list(R = 50)
}
}

get_variance (x = get_variance(x), component = c("all", "fixed", "random", "residual", "distribution", "dispersion", "intercept", "slope", "rho01", "rho00"), verbose = TRUE, 
... )

get_variance_residual(x, verbose = TRUE, ...)  
get_variance_fixed(x, verbose = TRUE, ...)  
get_variance_random(x, verbose = TRUE, tolerance = 1e-05, ...)  
get_variance_distribution(x, verbose = TRUE, ...)  
get_variance_dispersion(x, verbose = TRUE, ...)  
get_variance_intercept(x, verbose = TRUE, ...)  
get_variance_slope(x, verbose = TRUE, ...)  
get_correlation_slope_intercept(x, verbose = TRUE, ...)  
get_correlation_slopes(x, verbose = TRUE, ...)

Arguments

x A mixed effects model.
component Character value, indicating the variance component that should be returned. By default, all variance components are returned. The distribution-specific ("distribution") and residual ("residual") variance are the most computational intensive components, and hence may take a few seconds to calculate.

Description

This function extracts the different variance components of a mixed model and returns the result as list. Functions like get_variance_residual(x) or get_variance_fixed(x) are shortcuts for get_variance(x, component = "residual") etc.
**get_variance**

**verbose**
Toggle off warnings.

... Currently not used.

**tolerance**
Tolerance for singularity check of random effects, to decide whether to compute random effect variances or not. Indicates up to which value the convergence result is accepted. The larger tolerance is, the stricter the test will be. See `performance::check_singularity()`.

**Details**

This function returns different variance components from mixed models, which are needed, for instance, to calculate r-squared measures or the intraclass-correlation coefficient (ICC).

**Fixed effects variance:** The fixed effects variance, $\sigma_f^2$, is the variance of the matrix-multiplication $\beta \ast X$ (parameter vector by model matrix).

**Random effects variance:** The random effect variance, $\sigma_i^2$, represents the mean random effect variance of the model. Since this variance reflect the "average" random effects variance for mixed models, it is also appropriate for models with more complex random effects structures, like random slopes or nested random effects. Details can be found in Johnson 2014, in particular equation 10. For simple random-intercept models, the random effects variance equals the random-intercept variance.

**Distribution-specific variance:** The distribution-specific variance, $\sigma_d^2$, depends on the model family. For Gaussian models, it is $\sigma^2$ (i.e. $\sigma\text{model}^2$). For models with binary outcome, it is $\pi^2/3$ for logit-link, 1 for probit-link, and $\pi^2/6$ for cloglog-links. Models from Gamma-families use $\mu^2$ (as obtained from `family$variance()`). For all other models, the distribution-specific variance is based on lognormal approximation, $\log(1 + \text{var}(x)/\mu^2)$ (see Nakagawa et al. 2017). The expected variance of a zero-inflated model is computed according to Zuur et al. 2012, p277.

**Variance for the additive overdispersion term:** The variance for the additive overdispersion term, $\sigma_e^2$, represents "the excess variation relative to what is expected from a certain distribution" (Nakagawa et al. 2017). In (most? many?) cases, this will be $\theta$.

**Residual variance:** The residual variance, $\sigma_\epsilon^2$, is simply $\sigma_d^2 + \sigma_e^2$.

**Random intercept variance:** The random intercept variance, or between-subject variance ($\tau_{00}$), is obtained from `VarCorr()`.

**Random slope variance:** The random slope variance ($\tau_{11}$) is obtained from `VarCorr()`.

**Random slope-intercept correlation:** The random slope-intercept correlation ($\rho_{01}$) is obtained from `VarCorr()`.
get_variance

Value

A list with following elements:

• `var.fixed`, variance attributable to the fixed effects
• `var.random`, (mean) variance of random effects
• `var.residual`, residual variance (sum of dispersion and distribution)
• `var.distribution`, distribution-specific variance
• `var.dispersion`, variance due to additive dispersion
• `var.intercept`, the random-intercept-variance, or between-subject-variance ($\tau_{00}$)
• `var.slope`, the random-slope-variance ($\tau_{11}$)
• `cor.slope_intercept`, the random-slope-intercept-correlation ($\rho_{01}$)
• `cor.slopes`, the correlation between random slopes ($\rho_{00}$)

Note

This function supports models of class `merMod` (including models from `blme`, `clmm`, `cpglmm`, `glmmadmb`, `glmmTMB`, `MixMod`, `lme`, `mixed`, `rlmerMod`, `stanreg`, `brmsfit` or `wbm`). Support for objects of class `MixMod` (`GLMMadaptive`), `lme` (`nlme`) or `brmsfit` (`brms`) is experimental and may not work for all models.

References


Examples

```r
## Not run:
library(lme4)
data(sleepstudy)
m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
get_variance(m)
get_variance_fixed(m)
get_variance_residual(m)
## End(Not run)
```
get_weights

Get the values from model weights

Description

Returns weighting variable of a model.

Usage

get_weights(x, ...)

## Default S3 method:
get_weights(x, na_rm = FALSE, null_as_ones = FALSE, ...)

Arguments

x A fitted model.

... Currently not used.

na_rm Logical, if TRUE, removes possible missing values.

null_as_ones Logical, if TRUE, will return a vector of 1 if no weights were specified in the model (as if the weights were all set to 1).

Value

The weighting variable, or NULL if no weights were specified. If the weighting variable should also be returned (instead of NULL) when all weights are set to 1 (i.e. no weighting), set null_as_ones = TRUE.

Examples

data(mtcars)
set.seed(123)
mtcars$weight <- rnorm(nrow(mtcars), 1, .3)

# LMs
m <- lm(mpg ~ wt + cyl + vs, data = mtcars, weights = weight)
get_weights(m)

get_weights(lm(mpg ~ wt, data = mtcars), null_as_ones = TRUE)

# GLMs
m <- glm(vs ~ disp + mpg, data = mtcars, weights = weight, family = quasibinomial)
get_weights(m)
m <- glm(cbind(cyl, gear) ~ mpg, data = mtcars, weights = weight, family = binomial)
get_weights(m)
**Description**

Checks if model has an intercept.

**Usage**

```r
has_intercept(x, verbose = TRUE)
```

**Arguments**

- `x`: A model object.
- `verbose`: Toggle warnings.

**Value**

`TRUE` if `x` has an intercept, `FALSE` otherwise.

**Examples**

```r
model <- lm(mpg ~ 0 + gear, data = mtcars)
has_intercept(model)

model <- lm(mpg ~ gear, data = mtcars)
has_intercept(model)

if (require("lme4")) {
  model <- lmer(Reaction ~ 0 + Days + (Days | Subject), data = sleepstudy)
  has_intercept(model)

  model <- lmer(Reaction ~ Days + (Days | Subject), data = sleepstudy)
  has_intercept(model)
}
```

---

**is_converged**

*Convergence test for mixed effects models*

**Description**

`is_converged()` provides an alternative convergence test for merMod-objects.

**Usage**

```r
is_converged(x, tolerance = 0.001, ...)
```
Arguments

- **x**: `merMod` or `glmmTMB-object`.
- **tolerance**: Indicates up to which value the convergence result is accepted. The smaller tolerance is, the stricter the test will be.
- **...**: Currently not used.

Details

**Convergence and log-likelihood**: Convergence problems typically arise when the model hasn’t converged to a solution where the log-likelihood has a true maximum. This may result in unreliable and overly complex (or non-estimable) estimates and standard errors.

**Inspect model convergence**: `lme4` performs a convergence-check (see `?lme4::convergence`), however, as as discussed here and suggested by one of the lme4-authors in this comment, this check can be too strict. `is_converged()` thus provides an alternative convergence test for `merMod`-objects.

**Resolving convergence issues**: Convergence issues are not easy to diagnose. The help page on `?lme4::convergence` provides most of the current advice about how to resolve convergence issues. Another clue might be large parameter values, e.g. estimates (on the scale of the linear predictor) larger than 10 in (non-identity link) generalized linear model might indicate complete separation. Complete separation can be addressed by regularization, e.g. penalized regression or Bayesian regression with appropriate priors on the fixed effects.

**Convergence versus Singularity**: Note the different meaning between singularity and convergence: singularity indicates an issue with the “true” best estimate, i.e. whether the maximum likelihood estimation for the variance-covariance matrix of the random effects is positive definite or only semi-definite. Convergence is a question of whether we can assume that the numerical optimization has worked correctly or not.

Value

- `TRUE` if convergence is fine and `FALSE` if convergence is suspicious. Additionally, the convergence value is returned as attribute.

Examples

```r
if (require("lme4")) {
  data(cbpp)
  set.seed(1)
  cbpp$x <- rnorm(nrow(cbpp))
  cbpp$x2 <- runif(nrow(cbpp))

  model <- glmer(
    cbind(incidence, size - incidence) ~ period + x + x2 + (1 + x | herd),
    data = cbpp,
    family = binomial()
  )

  is_converged(model)
}
## Not run:
if (require("glmmTMB")) {
    model <- glmmTMB(Sepal.Length - poly(Petal.Width, 4) * poly(Petal.Length, 4) +
                     (1 + poly(Petal.Width, 4) | Species), data = iris)
    is_converged(model)
}
## End(Not run)

---

### is_empty_object

**Check if object is empty**

**Description**
Check if object is empty

**Usage**

```r
is_empty_object(x)
```

**Arguments**

- `x`: A list, a vector, or a dataframe.

**Value**
A logical indicating whether the entered object is empty.

**Examples**

```r
is_empty_object(c(1, 2, 3, NA))
is_empty_object(list(NULL, c(NA, NA)))
is_empty_object(list(NULL, NA))
```

---

### is_gam_model

**Checks if a model is a generalized additive model**

**Description**
Small helper that checks if a model is a generalized additive model.

**Usage**

```r
is_gam_model(x)
```
is_mixed_model

Checks if a model is a mixed effects model

Description
Small helper that checks if a model is a mixed effects model, i.e. if it the model has random effects.

Usage
is_mixed_model(x)

Arguments
x A model object.

Value
A logical, TRUE if x is a mixed model.
is_model

Checks if an object is a regression model or statistical test object

Description
Small helper that checks if a model is a regression model or a statistical object. is_regression_model() is stricter and only returns TRUE for regression models, but not for, e.g., htest objects.

Usage
is_model(x)

is_regression_model(x)

Arguments
x An object.

Details
This function returns TRUE if x is a model object.

Value
A logical, TRUE if x is a (supported) model object.

Examples
data(mtcars)
model <- lm(mpg ~ wt + cyl + vs, data = mtcars)
is_mixed_model(model)

if (require("lme4")) {
data(sleepstudy)
model <- lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
is_mixed_model(model)
}

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
is_model(m)
is_model(mtcars)

test <- t.test(1:10, y = c(7:20))
is_model(test)
is_regression_model(test)
Description

Small helper that checks if a model is a supported (regression) model object. supported_models() prints a list of currently supported model classes.

Usage

is_model_supported(x)
supported_models()

Arguments

x
An object.

Details

This function returns TRUE if x is a model object that works with the package’s functions. A list of supported models can also be found here: https://github.com/easystats/insight.

Value

A logical, TRUE if x is a (supported) model object.

Examples

data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
is_model_supported(m)
is_model_supported(mtcars)

# to see all supported models
supported_models()
is_multivariate  Checks if an object stems from a multivariate response model

Description

Small helper that checks if a model is a multivariate response model, i.e. a model with multiple outcomes.

Usage

is_multivariate(x)

Arguments

x  A model object, or an object returned by a function from this package.

Value

A logical, TRUE if either x is a model object and is a multivariate response model, or TRUE if a return value from a function of insight is from a multivariate response model.

Examples

## Not run:
library(rstanarm)
data("pbcLong")
model <- stan_mvmer(
  formula = list(
    logBili ~ year + (1 | id),
    albumin ~ sex + year + (year | id)
  ),
data = pbcLong,
  chains = 1, cores = 1, seed = 12345, iter = 1000
)
f <- find_formula(model)
is_multivariate(model)
is_multivariate(f)
## End(Not run)
is_nested_models  
Checks whether a list of models are nested models

Description
Checks whether a list of models are nested models, strictly following the order they were passed to the function.

Usage
is_nested_models(...)

Arguments
...  
Multiple regression model objects.

Value
TRUE if models are nested, FALSE otherwise. If models are nested, also returns two attributes that indicate whether nesting of models is in decreasing or increasing order.

Examples
m1 <- lm(Sepal.Length ~ Petal.Width + Species, data = iris)
m2 <- lm(Sepal.Length ~ Species, data = iris)
m3 <- lm(Sepal.Length ~ Petal.Width, data = iris)
m4 <- lm(Sepal.Length ~ 1, data = iris)

is_nested_models(m1, m2, m4)
is_nested_models(m4, m2, m1)
is_nested_models(m1, m2, m3)

is_nullmodel  
Checks if model is a null-model (intercept-only)

Description
Checks if model is a null-model (intercept-only), i.e. if the conditional part of the model has no predictors.

Usage
is_nullmodel(x)

Arguments
x  
A model object.
Value

TRUE if \( x \) is a null-model, FALSE otherwise.

Examples

```r
model <- lm(mpg ~ 1, data = mtcars)
is_nullmodel(model)

model <- lm(mpg ~ gear, data = mtcars)
is_nullmodel(model)

if (require("lme4")) {
  model <- lmer(Reaction ~ 1 + (Days | Subject), data = sleepstudy)
  is_nullmodel(model)

  model <- lmer(Reaction ~ Days + (Days | Subject), data = sleepstudy)
  is_nullmodel(model)
}
```

link_function

Get link-function from model object

Description

Returns the link-function from a model object.

Usage

```r
link_function(x, ...)
```

Arguments

- **x**: A fitted model.
- **...**: Currently not used.
- **what**: For `gamlss` models, indicates for which distribution parameter the link (inverse) function should be returned; for `betareg` or `DirichletRegModel`, can be "mean" or "precision".
Value

A function, describing the link-function from a model-object. For multivariate-response models, a list of functions is returned.

Examples

# example from ?stats::glm
counts <- c(18, 17, 15, 20, 10, 20, 25, 13, 12)
outcome <- gl(3, 1, 9)
treatment <- gl(3, 3)
m <- glm(counts ~ outcome + treatment, family = poisson())

link_function(m)(.3)
# same as
log(.3)

### link_inverse

*Get link-inverse function from model object*

Description

Returns the link-inverse function from a model object.

Usage

link_inverse(x, ...)

## S3 method for class 'betareg'
link_inverse(x, what = c("mean", "precision"), ...)

## S3 method for class 'DirichletRegModel'
link_inverse(x, what = c("mean", "precision"), ...)

## S3 method for class 'betamfx'
link_inverse(x, what = c("mean", "precision"), ...)

## S3 method for class 'gamlss'
link_inverse(x, what = c("mu", "sigma", "nu", "tau"), ...)

Arguments

- `x` A fitted model.
- `...` Currently not used.
- `what` For gamlss models, indicates for which distribution parameter the link (inverse) function should be returned; for betareg or DirichletRegModel, can be "mean" or "precision".
Value

A function, describing the inverse-link function from a model-object. For multivariate-response models, a list of functions is returned.

Examples

```r
# example from ?stats::glm
counts <- c(18, 17, 15, 20, 10, 20, 25, 13, 12)
outcome <- gl(3, 1, 9)
treatment <- gl(3, 3)
m <- glm(counts ~ outcome + treatment, family = poisson())

link_inverse(m)(.3)
# same as
exp(.3)
```

model_info

Access information from model objects

Description

Retrieve information from model objects.

Usage

```r
model_info(x, ...)

## Default S3 method:
model_info(x, verbose = TRUE, ...)
```

Arguments

- `x` A fitted model.
- `...` Currently not used.
- `verbose` Toggle off warnings.

Details

`model_info()` returns a list with information about the model for many different model objects. Following information is returned, where all values starting with `is_` are logicals.

- `is_binomial`: family is binomial (but not negative binomial)
- `is_bernoulli`: special case of binomial models: family is Bernoulli
- `is_poisson`: family is poisson
- `is_negbin`: family is negative binomial
- `is_count`: model is a count model (i.e. family is either poisson or negative binomial)
• is_beta: family is beta
• is_betabinomial: family is beta-binomial
• is_dirichlet: family is dirichlet
• is_exponential: family is exponential (e.g. Gamma or Weibull)
• is_logit: model has logit link
• is_probit: model has probit link
• is_linear: family is gaussian
• is_tweedie: family is tweedie
• is_ordinal: family is ordinal or cumulative link
• is_cumulative: family is ordinal or cumulative link
• is_multinomial: family is multinomial or categorical link
• is_categorical: family is categorical link
• is_censored: model is a censored model (has a censored response, including survival models)
• is_truncated: model is a truncated model (has a truncated response)
• is_survival: model is a survival model
• is_zero_inflated: model has zero-inflation component
• is_hurdle: model has zero-inflation component and is a hurdle-model (truncated family distribution)
• is_dispersion: model has dispersion component (not only dispersion parameter)
• is_mixed: model is a mixed effects model (with random effects)
• is_multivariate: model is a multivariate response model (currently only works for brmsfit objects)
• is_trial: model response contains additional information about the trials
• is_bayesian: model is a Bayesian model
• is_gam: model is a generalized additive model
• is_anova: model is an Anova object
• is_ttest: model is an an object of class htest, returned by t.test()
• is_correlation: model is an an object of class htest, returned by cor.test()
• is_ranktest: model is an an object of class htest, returned by cor.test() (if Spearman’s rank correlation), wilcox.text() or kruskal.test().
• is_variancetest: model is an an object of class htest, returned by bartlett.test(), shapiro.test() or car::leveneTest().
• is_levenetest: model is an an object of class anova, returned by car::leveneTest().
• is_onewaytest: model is an an object of class htest, returned by oneway.test()
• is_propertest: model is an an object of class htest, returned by prop.test()
• is_binomtest: model is an an object of class htest, returned by binom.test()
• is_chi2test: model is an an object of class htest, returned by chisq.test()
- **is_xtab**: model is an an object of class htest or BFBayesFactor, and test-statistic stems from a contingency table (i.e. chisq.test() or BayesFactor::contingencyTableBF()

- **link_function**: the link-function

- **family**: name of the distributional family of the model. For some exceptions (like some htest objects), can also be the name of the test.

- **n_obs**: number of observations

### Value

A list with information about the model, like family, link-function etc. (see 'Details').

### Examples

```r
ldose <- rep(0:5, 2)
numdead <- c(1, 4, 9, 13, 18, 20, 0, 2, 6, 10, 12, 16)
sex <- factor(rep(c("M", "F"), c(6, 6)))
SF <- cbind(numdead, numalive = 20 - numdead)
dat <- data.frame(ldose, sex, SF, stringsAsFactors = FALSE)
m <- glm(SF ~ sex * ldose, family = binomial)
model_info(m)
```

## Not run:
```r
library(glmmTMB)
data("Salamanders")
m <- glmmTMB(
  count ~ spp + cover + mined + (1 | site),
  ziformula = ~ spp + mined,
  dispformula = ~DOY,
  data = Salamanders,
  family = nbinom2
)
## End(Not run)
```

```r
model_info(m)
```

---

**model_name**

*Name the model*

### Description

Returns the "name" (class attribute) of a model, possibly including further information.

### Usage

```r
model_name(x, ...)  
```

## Default S3 method:
```r
model_name(x, include_formula = FALSE, include_call = FALSE, ...)
```
null_model

Arguments

x A model.

... Currently not used.

include_formula Should the name include the model’s formula.

include_call If TRUE, will return the function call as a name.

Value

A character string of a name (which usually equals the model’s class attribute).

Examples

m <- lm(Sepal.Length ~ Petal.Width, data = iris)
model_name(m)
model_name(m, include_formula = TRUE)
model_name(m, include_call = TRUE)

if (require("lme4")) {
  model_name(lmer(Sepal.Length ~ Sepal.Width + (1 | Species), data = iris))
}

null_model

Compute intercept-only model for regression models

Description

This function computes the null-model (i.e. (y ~ 1)) of a model. For mixed models, the null-model takes random effects into account.

Usage

null_model(model, verbose = TRUE, ...)

Arguments

model A (mixed effects) model.

verbose Toggle off warnings.

... Arguments passed to or from other methods.

Value

The null-model of x
\textbf{Examples}

```r
if (require("lme4")) {
  data(sleepstudy)
  m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
  summary(m)
  summary(null_model(m))
}
```

\textbf{n\_obs} \hspace{1cm} \textit{Get number of observations from a model}

\textbf{Description}

This method returns the number of observation that were used to fit the model, as numeric value.

\textbf{Usage}

```r
n\_obs(x, ...)
```

\textbf{Arguments}

\begin{itemize}
  \item \texttt{x} \hspace{1cm} A fitted model.
  \item \texttt{...} \hspace{1cm} Currently not used.
  \item \texttt{disaggregate} \hspace{1cm} For binomial models with aggregated data, \texttt{n\_obs()} returns the number of data rows by default. If \texttt{disaggregate = TRUE}, the total number of trials is returned instead (determined by summing the results of \texttt{weights()} for aggregated data, which will be either the weights input for proportion success response or the row sums of the response matrix if matrix response, see 'Examples').
  \item \texttt{weighted} \hspace{1cm} For survey designs, returns the weighted sample size.
  \item \texttt{shape} \hspace{1cm} Return long or wide data? Only applicable in repeated measures designs.
  \item \texttt{select} \hspace{1cm} Optional name(s) of response variables for which to extract values. Can be used in case of regression models with multiple response variables.
\end{itemize}
**n_parameters**

**Value**

The number of observations used to fit the model, or NULL if this information is not available.

**Examples**

```r
data(mtcars)
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)
n_obs(m)

if (require("lme4")) {
  data(cbpp, package = "lme4")
m <- glm(
    cbind(incidence, size - incidence) ~ period,
data = cbpp,
family = binomial(link = "logit")
  )
n_obs(m)
n_obs(m, disaggregate = TRUE)
}
```

**Description**

Returns the number of parameters (coefficients) of a model.

**Usage**

```r
n_parameters(x, ...)

## Default S3 method:
n_parameters(x, remove_nonestimable = FALSE, ...)

## S3 method for class 'merMod'
n_parameters(
x,
effects = c("fixed", "random"),
remove_nonestimable = FALSE,
...
)

## S3 method for class 'glmmTMB'
n_parameters(
x,
effects = c("fixed", "random"),
component = c("all", "conditional", "zi", "zero_inflated"),
remove_nonestimable = FALSE,
```
## S3 method for class 'zeroinfl'

```r
n_parameters(
x,  
component = c("all", "conditional", "zi", "zero_inflated"),  
remove_nonestimable = FALSE,  
...)
```

## S3 method for class 'gam'

```r
n_parameters(
x,  
component = c("all", "conditional", "smooth_terms"),  
remove_nonestimable = FALSE,  
...)
```

## S3 method for class 'brmsfit'

```r
n_parameters(x, effects = "all", component = "all", ...)
```

### Arguments

- `x` A statistical model.
- `...` Arguments passed to or from other methods.
- `remove_nonestimable` Logical, if TRUE, removes (i.e. does not count) non-estimable parameters (which may occur for models with rank-deficient model matrix).
- `effects` Should number of parameters for fixed effects, random effects or both be returned? Only applies to mixed models. May be abbreviated.
- `component` Should total number of parameters, number parameters for the conditional model, the zero-inflated part of the model, the dispersion term or the instrumental variables be returned? Applies to models with zero-inflated and/or dispersion formula, or to models with instrumental variable (so called fixed-effects regressions). May be abbreviated.

### Value

The number of parameters in the model.

### Note

This function returns the number of parameters for the fixed effects by default, as returned by `find_parameters(x, effects = "fixed")`. It does not include all estimated model parameters, i.e. auxiliary parameters like sigma or dispersion are not counted. To get the number of all estimated parameters, use `get_df(x, type = "model")`. 

...
Examples

```r
data(iris)
model <- lm(Sepal.Length ~ Sepal.Width * Species, data = iris)
n_parameters(model)
```

---

**object_has_names**

Check names and rownames

---

Description

`object_has_names()` checks if specified names are present in the given object. `object_has_rownames()` checks if rownames are present in a dataframe.

Usage

```r
object_has_names(x, names)
object_has_rownames(x)
```

Arguments

- `x` A named object (an atomic vector, a list, a dataframe, etc.).
- `names` A single character or a vector of characters.

Value

A logical or a vector of logicals.

Examples

```r
# check if specified names are present in the given object
object_has_names(mtcars, "am")
object_has_names(anscombe, c("x1", "z1", "y1"))
object_has_names(list("x" = 1, "y" = 2), c("x", "a"))

# check if a dataframe has rownames
object_has_rownames(mtcars)
```
print_color

Description

Convenient function that allows coloured output in the console. Mainly implemented to reduce package dependencies.

Usage

```r
print_color(text, color)
print_colour(text, colour)
color_text(text, color)
colour_text(text, colour)
color_theme()
```

Arguments

text

color, colour

Character vector, indicating the colour for printing. May be one of "white", "black", "red", "yellow", "green", "blue", "violet", "cyan" or "grey". Bright variants of colors are available by adding the prefix "b" (or "br_" or "bright_"), e.g. "bred" (or "br_red" resp. "bright_red"). Background colors can be set by adding the prefix "bg_" (e.g. "bg_red"). Formatting is also possible with "bold" or "italic".

Details

This function prints `text` directly to the console using `cat()`, so no string is returned. `color_text()` however, returns only the formatted string, without using `cat()`. `color_theme()` either returns "dark" when RStudio is used with dark color scheme, "light" when it's used with light theme, and NULL if the theme could not be detected.

Value

Nothing.

Examples

```r
print_color("I'm blue dabeidi dabe dei", "blue")
```
print_parameters

Prepare summary statistics of model parameters for printing

Description

This function takes a data frame, typically a data frame with information on summaries of model parameters like \texttt{bayestestR::describe_posterior()}, \texttt{bayestestR::hdi()} or \texttt{parameters::model_parameters()}, as input and splits this information into several parts, depending on the model. See details below.

Usage

\begin{verbatim}
print_parameters(
  x,
  ..., 
  split_by = c("Effects", "Component", "Group", "Response"),
  format = "text",
  parameter_column = "Parameter",
  keep_parameter_column = TRUE,
  remove_empty_column = FALSE,
  titles = NULL,
  subtitles = NULL
)
\end{verbatim}

Arguments

\begin{verbatim}
x
...
split_by
format
parameter_column
keep_parameter_column
\end{verbatim}

x A fitted model, or a data frame returned by \texttt{clean_parameters()}.  
... One or more objects (data frames), which contain information about the model parameters and related statistics (like confidence intervals, HDI, ROPE, ...).  
split_by split_by should be a character vector with one or more of the following elements: "Effects", "Component", "Response" and "Group". These are the column names returned by \texttt{clean_parameters()}, which is used to extract the information from which the group or component model parameters belong. If NULL, the merged data frame is returned. Else, the data frame is split into a list, split by the values from those columns defined in split_by.  
format Name of output-format, as string. If NULL (or "text"), assumed use for output is basic printing. If "markdown", markdown-format is assumed. This only affects the style of title- and table-caption attributes, which are used in \texttt{export_table()}.  
parameter_column String, name of the column that contains the parameter names. Usually, for data frames returned by functions the easystats-packages, this will be "Parameter".  
keep_parameter_column Logical, if TRUE, the data frames in the returned list have both a "Cleaned_Parameter" and "Parameter" column. If FALSE, the (unformatted) "Parameter" is removed, and the column with cleaned parameter names ("Cleaned_Parameter") is renamed into "Parameter".
remove_empty_column
Logical, if TRUE, columns with completely empty character values will be removed.

titles, subtitles
By default, the names of the model components (like fixed or random effects, count or zero-inflated model part) are added as attributes "table_title" and "table_subtitle" to each list element returned by print_parameters(). These attributes are then extracted and used as table (sub) titles in export_table(). Use titles and subtitles to override the default attribute values for "table_title" and "table_subtitle". titles and subtitles may be any length from 1 to same length as returned list elements. If titles and subtitles are shorter than existing elements, only the first default attributes are overwritten.

Details
This function prepares data frames that contain information about model parameters for clear printing.

First, x is required, which should either be a model object or a prepared data frame as returned by clean_parameters(). If x is a model, clean_parameters() is called on that model object to get information with which model components the parameters are associated.

Then, ... take one or more data frames that also contain information about parameters from the same model, but also have additional information provided by other methods. For instance, a data frame in ... might be the result of, for instance, bayestestR::describe_posterior(), or parameters::model_parameters(), where we have a) a Parameter column and b) columns with other parameter values (like CI, HDI, test statistic, etc.).

Now we have a data frame with model parameters and information about the association to the different model components, a data frame with model parameters, and some summary statistics. print_parameters() then merges these data frames, so the parameters or statistics of interest are also associated with the different model components. The data frame is split into a list, so for a clear printing. Users can loop over this list and print each component for a better overview. Further, parameter names are "cleaned", if necessary, also for a cleaner print. See also 'Examples'.

Value
A data frame or a list of data frames (if split_by is not NULL). If a list is returned, the element names reflect the model components where the extracted information in the data frames belong to, e.g. random.zero_inflated.Intercept: persons. This is the data frame that contains the parameters for the random effects from group-level "persons" from the zero-inflated model component.

Examples
## Not run:
library(bayestestR)
model <- download_model("brms_zi_2")
x <- hdi(model, effects = "all", component = "all")

# hdi() returns a data frame; here we use only the
standardize_column_order

Standardize column order

Description

Standardizes order of columns for dataframes and other objects from easystats and broom ecosystem packages.

Usage

standardize_column_order(data, ...)

## S3 method for class 'parameters_model'
standardize_column_order(data, style = c("easystats", "broom"), ...)

Arguments

data A data frame. In particular, objects from easystats package functions like parameters::model_parameters or effectsize::effectsize() are accepted, but also data frames returned by broom::tidy() are valid objects.

... Currently not used.

style Standardization can either be based on the naming conventions from the easystats-project, or on broom's naming scheme.

Value

A data frame, with standardized column order.
**standardize_names**

**Examples**

```r
# easystats conventions
df1 <- cbind.data.frame(
  CI_low = -2.873,
  t = 5.494,
  CI_high = -1.088,
  p = 0.00001,
  Parameter = -1.980,
  CI = 0.95,
  df = 29.234,
  Method = "Student's t-test"
)

standardize_column_order(df1, style = "easystats")

# broom conventions
df2 <- cbind.data.frame(
  conf.low = -2.873,
  statistic = 5.494,
  conf.high = -1.088,
  p.value = 0.00001,
  estimate = -1.980,
  conf.level = 0.95,
  df = 29.234,
  method = "Student's t-test"
)

standardize_column_order(df2, style = "broom")
```

---

**standardize_names**  
*Standardize column names*

**Description**

Standardize column names from data frames, in particular objects returned from `parameters::model_parameters()`, so column names are consistent and the same for any model object.

**Usage**

```r
standardize_names(data, ...)

## S3 method for class 'parameters_model'
standardize_names(
  data,
  style = c("easystats", "broom"),
  ignore_estimate = FALSE,
  ...)
```
Arguments

- data: A data frame. In particular, objects from easystats package functions like parameters::model_parameters() or effectsize::effectsize() are accepted, but also data frames returned by broom::tidy() are valid objects.
- ...: Currently not used.
- style: Standardization can either be based on the naming conventions from the easystats-project, or on broom's naming scheme.
- ignore_estimate: Logical, if TRUE, column names like "mean" or "median" will not be converted to "Coefficient" resp. "estimate".

Details

This method is in particular useful for package developers or users who use, e.g., parameters::model_parameters() in their own code or functions to retrieve model parameters for further processing. As model_parameters() returns a data frame with varying column names (depending on the input), accessing the required information is probably not quite straightforward. In such cases, standardize_names() can be used to get consistent, i.e. always the same column names, no matter what kind of model was used in model_parameters().

For style = "broom", column names are renamed to match broom's naming scheme, i.e. Parameter is renamed to term, Coefficient becomes estimate and so on.

For style = "easystats", when data is an object from broom::tidy(), column names are converted from "broom"-style into "easystats"-style.

Value

A data frame, with standardized column names.

Examples

```r
if (require("parameters")) {
  model <- lm(mpg ~ wt + cyl, data = mtcars)
  mp <- model_parameters(model)
  as.data.frame(mp)
  standardize_names(mp)
  standardize_names(mp, style = "broom")
}
```

---

text_remove_backticks  Remove backticks from a string

Description

This function removes backticks from a string.
Usage

text_remove_backticks(x, ...)

## S3 method for class 'data.frame'
text_remove_backticks(x, column = "Parameter", verbose = FALSE, ...)

Arguments

x A character vector, a data frame or a matrix. If a matrix, backticks are removed from the column and row names, not from values of a character vector.

... Currently not used.

column If x is a data frame, specify the column of character vectors, where backticks should be removed. If NULL, all character vectors are processed.

verbose Toggle warnings.

Value

x, where all backticks are removed.

Note

If x is a character vector or data frame, backticks are removed from the elements of that character vector (or character vectors from the data frame.) If x is a matrix, the behaviour slightly differs: in this case, backticks are removed from the column and row names. The reason for this behaviour is that this function mainly serves formatting coefficient names. For vcov() (a matrix), row and column names equal the coefficient names and therefore are manipulated then.

Examples

# example model
data(iris)
iris$'a m' <- iris$Species
iris$'Sepal Width' <- iris$Sepal.Width
model <- lm('Sepal Width' ~ Petal.Length + 'a m', data = iris)

# remove backticks from string
names(coef(model))
text_remove_backticks(names(coef(model)))

# remove backticks from character variable in a data frame
# column defaults to "Parameter".
d <- data.frame(
  Parameter = names(coef(model)),
  Estimate = unname(coef(model))
)
d
text_remove_backticks(d)
Small helper functions

Description

Collection of small helper functions. `trim_ws()` is an efficient function to trim leading and trailing whitespaces from character vectors or strings. `n_unique()` returns the number of unique values in a vector. `has_single_value()` is equivalent to `n_unique() == 1` but is faster. `safe_deparse()` is comparable to `deparse1()`, i.e. it can safely deparse very long expressions into a single string. `safe_deparse_symbol()` only deparses a substituted expressions when possible, which can be much faster than `deparse(substitute())` for those cases where `substitute()` returns no valid object name.

Usage

```r
trim_ws(x, ...)
## S3 method for class 'data.frame'
trim_ws(x, character_only = TRUE, ...)

n_unique(x, ...)
## Default S3 method:
n_unique(x, na.rm = TRUE, ...)

safe_deparse(x, ...)

safe_deparse_symbol(x)

has_single_value(x, na.rm = FALSE)
```

Arguments

- **x** A (character) vector, or for some functions may also be a data frame.
- **...** Currently not used.
- **character_only** Logical, if `TRUE` and `x` is a data frame or list, only processes character vectors.
- **na.rm** Logical, if missing values should be removed from the input.

Value

- `n_unique()`: For a vector, `n_unique` always returns an integer value, even if the input is `NULL` (the return value will be 0 then). For data frames or lists, `n_unique()` returns a named numeric vector, with the number of unique values for each element.
- `has_single_value()`: `TRUE` if `x` has only one unique value, `FALSE` otherwise.
- `trim_ws()`: A character vector, where trailing and leading white spaces are removed.
- safe_deparse(): A character string of the unevaluated expression or symbol.
- safe_deparse_symbol(): A character string of the unevaluated expression or symbol, if x was a symbol. If x is no symbol (i.e. if is.name(x) would return FALSE), NULL is returned.

Examples

trim_ws(" no space! ")
n_unique(iris$Species)
has_single_value(c(1, 1, 2))

# safe_deparse_symbol() compared to deparse(substitute())
safe_deparse_symbol(as.name("test"))
deparse(substitute(as.name("test")))
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