Package ‘insight’

August 16, 2024

Type Package

Title Easy Access to Model Information for Various Model Objects

Version 0.20.3

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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 (>= 3.6)

Imports methods, stats, utils

Suggests AER, afex, aod, BayesFactor, bayestestR, bbmle, bdsmatrix, betareg, bife, biglm, BH, blavaan (>= 0.5-5), blme, boot, brms, broom, car, carData, censReg, cgam, clubSandwich, coxme, cplm, crch, curl, datawizard, effectsize, emmeans, epiR, estimatr, feisr, fixest (>= 0.11.2), fungible, gam, gamlss, gamlss.data, gamm4, gbm, gee, geepack, geoR, ggeffects, GLMMadaptive, glmTMB, glmtoolbox, gml, grDevices, gt, httpstest2, httr, htr2, interp, ivreg, JM, knitr, lavaan, lavaSearch2, lfe, lme4, lmerTest, lmtest, logistf, logitr, marginaleffects, MASS, Matrix, mclogit, mclust, MCMCglmm, merTools, metaBMA, metadat, metafor, metaplus, mgcv, mice, mlogit, mmmr, modelbased, multgee, MuMIn, nestedLogit, nlme, nnet, nonnest2, ordinal, panelr, parameters, parsnip, pbkrtest, performance, plm, poorman, PROreg (>= 1.3.0), pscl, psych, quantreg, Rcpp,
RcppEigen, rmarkdown, rms, robustbase, robustlmm, rpart, rstanarm (>= 2.21.1), rstansamplingtools (>= 2.1.0), rstudioapi, sandwich, serp, speedglm, splines, statmod, survey, survival, svyglm, testthat, tinytable (>= 0.1.0), TMB, truncreg, tweedie, VGAM, withr

VignetteBuilder knitr

Encoding UTF-8

Language en-US

RoxygenNote 7.3.2

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Config/Needs/check stan-dev/cmdstanr

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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

data(mtcars)
data(sleepstudy, package = "lme4")

m1 <- lm(mpg ~ wt + cyl + vs, data = mtcars)
m2 <- lm(mpg ~ wt + cyl, data = mtcars)
m3 <- lme4::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)
**apply_table_theme**  

*Data frame and Tables Pretty Formatting*

**Description**

Data frame and Tables Pretty Formatting

**Usage**

```r
apply_table_theme(out, x, theme = "default", sub_header_positions = NULL)
```

```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,
  by = NULL,
  group_by = NULL,
  zap_small = FALSE,
  table_width = NULL,
  verbose = TRUE,
  ...
)
```

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>out</td>
<td>A tinytable object.</td>
</tr>
<tr>
<td>x</td>
<td>A data frame. May also be a list of data frames, to export multiple data frames into multiple tables.</td>
</tr>
<tr>
<td>theme</td>
<td>The theme to apply to the table. One of &quot;default&quot;, &quot;grid&quot;, &quot;striped&quot;, &quot;bootstrap&quot;, &quot;void&quot;, &quot;tabular&quot;, or &quot;darklines&quot;.</td>
</tr>
<tr>
<td>sub_header_positions</td>
<td>A vector of row positions to apply a border to. Currently particular for internal use of other easystats packages.</td>
</tr>
<tr>
<td>sep</td>
<td>Column separator.</td>
</tr>
</tbody>
</table>
apply_table_theme

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 = "1cclr1" 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".
by      Name of column in x that indicates grouping for tables. Only applies when format = "html". by is passed down to gt::gt(groupname_col = by).
group_by Deprecated, please use by instead.
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.

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

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)

# colored footers
data(iris)
x <- as.data.frame(iris[1:5, ])
attr(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("Without the ", "red"),
  c("Without the ", "blue")
)
check_if_installed

```r
check_if_installed(TRUE)
```

### Description

Checking if needed package is installed

### Usage

```r
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`, will automatically check the DESCRIPTION file for the correct minimum version. If using
minimum_version with more than one package, NA should be used instead of NULL for packages where a specific version is not necessary.

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.

... Currently ignored

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.

Examples

check_if_installed("insight")
try(check_if_installed("datawizard", stop = FALSE))
try(check_if_installed("rstanarm", stop = FALSE))
try(check_if_installed("nonexistent_package", stop = FALSE))
try(check_if_installed("insight", minimum_version = "99.8.7"))
try(check_if_installed(c("nonexistent", "also_not_here"), stop = FALSE))
try(check_if_installed(c("datawizard", "rstanarm"), stop = FALSE))
try(check_if_installed(c("datawizard", "rstanarm"),
    minimum_version = c(NA, "2.21.1"), stop = FALSE ))

---------
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 log() or as.factor() etc.

Usage

    clean_names(x, ...)

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

- **x**: A fitted model, or a character vector.
- **include_names**: Logical, if TRUE, returns a named vector where names are the original values of `x`.

Value

The "cleaned" variable names as character vector, i.e. pattern like `s()` for splines or `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 `clean_names()` also on a model object. If `x` is a regression model, this function is (almost) equal to calling `find_variables()`. The main difference is that `clean_names()` always returns a character vector, while `find_variables()` returns a list of character vectors, unless `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()"
data(cbpp, package = "lme4")
m <- lme4::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**

```r
model <- download_model("brms_zi_2")
clean_parameters(model)
```
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

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

colour_if(
  x, 
  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".
compact_character

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
x, where columns matched by predicate are wrapped into color codes.

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
}
# 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
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

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

compact_list(x, remove_na = FALSE)

Arguments

x A list or vector.
remove_na Logical to decide if NAs should be removed.

Examples

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

display

Generic export of data frames into formatted tables

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

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  Download circus models

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 = "https://raw.github.com/easystats/circus/master/data/",
    extension = ".rda",
    verbose = TRUE
)
```
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.githubusercontent.com/easystats/circus/master/data/.
extension  File extension. Default is .rda.
verbose  Toggle messages and warnings.

Details

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

Value

A model from the circus-repository, or NULL if model could not be downloaded (e.g., due to server problems).

References

https://easystats.github.io/circus/

Examples

download_model("aov_1")
try(download_model("non_existent_model"))
Argument

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
```

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

```r
find_algorithm(x, ...)
```

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
data(sleepstudy, package = "lme4")
m <- lme4::lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
find_algorithm(m)
```

```r
data(sleepstudy, package = "lme4")
m <- suppressWarnings(rstanarm::stan_lmer(
  Reaction ~ Days + (1 | Subject),
data = sleepstudy,
  refresh = 0
))
find_algorithm(m)
```

---

**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, ...)

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

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

## S3 method for class 'nestedLogit'
find_formula(x, dichotomies = FALSE, verbose = TRUE, ...)

Arguments

x A fitted model.
...
Currently not used.
verbose Toggle warnings.
dichotomies Logical, if model is a nestedLogit objects, returns the formulas for the
dichotomies.

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 instru-
  mental 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
- scale, for distributional models such as mgcv::gaulss() family fitted with mgcv::gam(),
  the formula that describes the scale parameter
- 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)

m <- lme4::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

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

Examples

data(mtcars)

```r
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

# 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
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, ...)
```

## Default S3 method:

```r
find_parameters(x, flatten = FALSE, verbose = TRUE, ...)
```

## S3 method for class 'pgmm'

```r
find_parameters(x, component = c("conditional", "all"), flatten = FALSE, ...)
```

## S3 method for class 'nls'

```r
find_parameters(
x,
   component = c("all", "conditional", "nonlinear"),
   flatten = FALSE,
   ...
)
```
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.

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.

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)
find_parameters.averaging

Find model parameters from models with special components

Description

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

Usage

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

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

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

Find names of model parameters from marginal effects models

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.

... 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

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

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

```r
## 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.
- `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

```r
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

```r
## 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(
```


```r

## 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 'stanmvreg'
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 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.

... 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

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

## 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.
...

Value

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

Examples

data(mtcars)
model <- lm(mpg ~ wt * factor(cyl), data = mtcars)
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, ...)

## 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. Duplicate values are removed.
- `...` Currently not used.
- `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.

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.

Examples

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

Description

`find_parameters` finds names of model parameters from mixed models.

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

```r
## 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 'hglm'
find_parameters(
x,  
effects = c("all", "fixed", "random"),
component = c("all", "conditional", "dispersion"),
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.
find_parameters.zeroinfl

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

...  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)

find_predictors  Find names of model predictors

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,
## S3 method for class 'afex_aov'

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.
- **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 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
find_random

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

Find names of random effects

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. Duplicated values are removed.
find_random_slopes

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

data(sleepstudy, package = "lme4")
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 <- lme4::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
find_response

Examples

```r
data(sleepstudy, package = "lme4")
m <- lme4::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

```r
find_response(x, combine = TRUE, ...)
```

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

## S3 method for class 'joint'
find_response(
  x,
  combine = TRUE,
  component = c("conditional", "survival", "all"),
  ...
)
```

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.

- **component**  
  Character, if x is a joint model, this argument can be used to specify which component to return. Possible values are "conditional", "survival" or "all".
find_smooth

Value

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

Examples

data(cbpp, package = "lme4")
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

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.

Examples

data(iris)
model <- mgcv::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

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

# 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 transformations or arithmetic expressions like log(), I(), as.factor() etc. are preserved.

Usage

find_terms(x, ...)

## Default S3 method:
find_terms(x, flatten = FALSE, as_term_labels = FALSE, verbose = TRUE, ...)
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.
- **as_term_labels**: Logical, if TRUE, extracts model formula and tries to access the "term.labels" attribute. This should better mimic the `terms()` behaviour even for those models that do not have such a method, but may be insufficient, e.g. for mixed models.
- **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)
- `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

```r
# data(sleepstudy, package = "lme4")
m <- suppressWarnings(lme4::lmer(
  log(Reaction) ~ Days + I(Days^2) + (1 + Days + exp(Days) | Subject),
  data = sleepstudy
))
find_terms(m)

# sometimes, it is necessary to retrieve terms from "term.labels" attribute
m <- lm(mpg ~ hp * (am + cyl), data = mtcars)
find_terms(m, as_term_labels = TRUE)
```
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, power (to 2nd power, like I(x^2)), and inverse (like 1/y).

Usage

find_transformation(x, ...)

Arguments

x A regression model or a character string of the response value.

... Currently not used.

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)

# inverse, response provided as character string
find_transformation("1 / y")
**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

data(cbpp, package = "lme4")
data(sleepstudy, package = "lme4")
# some data preparation...
cbpp$trials <- cbpp$size - cbpp$incidence
sleepstudy$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)
}
m1 <- lme4::glmer(
  cbind(incidence, size - incidence) ~ period + (1 | herd),
  data = cbpp,
  family = binomial
)
find_variables(m1)
m2 <- lme4::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**

```r
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**

```r
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**

```r
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**

```r
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, ...)
```

```r
# S3 method for class 'numeric'
format_ci(
  CI_low,
  CI_high,
  ci = 0.95,
  digits = 2,
  brackets = TRUE,
  width = NULL,
)```
\begin{verbatim}
width_low = width,
width_high = width,
missing = "",
zap_small = FALSE,
ci_string = "CI",
... )

Arguments

CI_low  Lower CI bound. Usually a numeric value, but can also be a CI output returned by \texttt{bayestestR}, in which case the remaining arguments are unnecessary.
...
Arguments passed to or from other methods.
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 \texttt{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 \texttt{NA} values are replaced. By default, an empty string (i.e. "") is returned for \texttt{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.
ci_string  String to be used in the output to indicate the type of interval. Default is "CI", but can be changed to "HDI" or anything else, if necessary.

Value

A formatted string.

Examples

format_ci(1.20, 3.57, ci = 0.90)
format_ci(1.20, 3.57, ci = NULL)
\end{verbatim}
format_message

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

```r
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,
  immediate = FALSE
)

format_warning(..., immediate = FALSE)

format_error(...)```
Arguments

string  A string.

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 inserted.

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 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 features 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)
```

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

---

**format_message**  

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 inserted.

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 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.

immediate Logical. Indicating if the warning should be printed immediately. Only applies to format_warning() or format_alert() with type = "warning". 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 features 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)
```

```r
msg <- format_message("Much too long string for just one line, I guess!",
```
format_number

Convert number to words

Description

Convert number to words

Usage

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

Arguments

x

Number.
format_p

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

Examples

format_number(2)
format_number(45)
format_number(324.68765)

format_p(p, stars = FALSE, stars_only = FALSE, whitespace = TRUE, name = "p", missing = "", decimal_separator = NULL, 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
format_p(c(0.02, 0.065, 0, .23))
format_p(c(0.02, 0.065, 0, .23), name = NULL)
format_p(c(0.02, 0.065, 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
format_pd(pd, stars = FALSE, stars_only = FALSE, name = "pd")

Arguments

<table>
<thead>
<tr>
<th>pd</th>
<th>Probability of direction (pd).</th>
</tr>
</thead>
<tbody>
<tr>
<td>stars</td>
<td>Add significance stars (e.g., p &lt; .001***).</td>
</tr>
<tr>
<td>stars_only</td>
<td>Return only significance stars.</td>
</tr>
<tr>
<td>name</td>
<td>Name prefixing the text. Can be NULL.</td>
</tr>
</tbody>
</table>

Value
A formatted string.
format_rope

Examples

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

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

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

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

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)
format_table

Parameter table formatting

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

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)` overrides the `use_symbols` argument and always displays symbols, if possible.

**See Also**
Vignettes Formatting, printing and exporting tables and Formatting model parameters.

**Examples**

```r
format_table(head(iris), digits = 1)

m <- lm(Sepal.Length ~ Species * Sepal.Width, data = iris)
x <- parameters::model_parameters(m)
as.data.frame(format_table(x))
as.data.frame(format_table(x, p_digits = "scientific"))
```

```r
model <- rstanarm::stan_glm(
```
format_value

Sepal.Length ~ Species,
data = iris,
refresh = 0,
seed = 123
)
x <- parameters::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

format_value(x, ...)

## S3 method for class 'data.frame'
format_value(x,
digits = 2,
protect_integers = FALSE,
missing = "",
width = NULL,
as_percent = FALSE,
zap_small = FALSE,
lead_zero = TRUE,
style_positive = "none",
style_negative = "hyphen",
...
)

## S3 method for class 'numeric'
format_value(x,
digits = 2,
protect_integers = FALSE,
missing = "",
width = NULL,
as_percent = FALSE,
zap_small = FALSE,
lead_zero = TRUE,
...
style_positive = "none",
style_negative = "hyphen",
...
)

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.

lead_zero Logical, if TRUE (default), includes leading zeros, else leading zeros are dropped.

style_positive A string that determines the style of positive numbers. May be "none" (default), "plus" to add a plus-sign or "space" to precede the string by a Unicode "figure space", i.e., a space equally as wide as a number or +.

style_negative A string that determines the style of negative numbers. May be "hyphen" (default), "minus" for a proper Unicode minus symbol or "parens" to wrap the number in parentheses.

Value

A formatted string.

Examples

format_value(1.20)
format_value(1.2)
format_value(1.2012313)
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, 0.12, 0.34), digits = "scientific2")
format_value(c(0.045, 0.12, 0.34), lead_zero = FALSE)

# default
format_value(c(0.0045, 0.123, 0.345))
# significant figures
format_value(c(0.0045, 0.123, 0.345), 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

*Get auxiliary parameters from models*

**Description**

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

**Usage**

```r
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 glmTMB as well as brmsfit. "beta" and other parameters are currently only returned for brmsfit models. See `Details`
- **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.
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

```r
# 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())
get_auxiliary(model, type = "dispersion") # same as summary(model)$dispersion
```
Arguments

x  A fitted mixed model.

Value

A function call.

Examples

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

```r
m <- lme4::lmer(Sepal.Length ~ Sepal.Width + (1 | Species), data = iris)
get_call(m)
```

### Description

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

Usage

```r
get_data(x, ...)
```

```r
## Default S3 method:
get_data(x, source = "environment", verbose = TRUE, ...)
```

```r
## S3 method for class 'glmmTMB'
get_data(
x,
extffects = "all",
component = "all",
source = "environment",
verbose = TRUE,
...
)
```

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

```r
## S3 method for class 'rma'
get_data(
x,
```
source = "environment",
   verbose = TRUE,
   include_interval = FALSE,
   transf = NULL,
   transf_args = NULL,
   ci = 0.95,
   ...
)

Arguments

x A fitted model.

source String, indicating from where data should be recovered. If source = "environment" (default), data is recovered from the environment (e.g. if the data is in the workspace). This option is usually the fastest way of getting data and ensures that the original variables used for model fitting are returned. Note that always the current data is recovered from the environment. Hence, if the data was modified after model fitting (e.g., variables were recoded or rows filtered), the returned data may no longer equal the model data. If source = "frame" (or "mf"), the data is taken from the model frame. Any transformed variables are back-transformed, if possible. This option returns the data even if it is not available in the environment, however, in certain edge cases back-transforming to the original data may fail. If source = "environment" fails to recover the data, it tries to extract the data from the model frame; if source = "frame" and data cannot be extracted from the model frame, data will be recovered from the environment. Both ways only returns observations that have no missing data in the variables used for model fitting.

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.

include_interval For meta-analysis models, should normal-approximation confidence intervals be added for each response effect size?

transf For meta-analysis models, if intervals are included, a function applied to each response effect size and its interval.

transf_args For meta-analysis models, an optional list of arguments passed to the transf function.

CI For meta-analysis models, the Confidence Interval (CI) level if include_interval = TRUE. Default to 0.95 (95%).
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.

Examples

data(cbpp, package = "lme4")
cbpp$trials <- cbpp$size - cbpp$incidence
m <- glm(cbind(incidence, trials) ~ period, data = cbpp, family = binomial)
head(get_data(m))
Usage

get_datagrid(x, ...)

## S3 method for class 'data.frame'
get_datagrid(
  x,
  by = "all",
  factors = "reference",
  numerics = "mean",
  preserve_range = FALSE,
  reference = x,
  length = 10,
  range = "range",
  at,
  ...
)

## S3 method for class 'numeric'
get_datagrid(x, length = 10, range = "range", ...)

## S3 method for class 'factor'
get_datagrid(x, ...)

## Default S3 method:
get_datagrid(
  x,
  by = "all",
  factors = "reference",
  numerics = "mean",
  preserve_range = TRUE,
  reference = x,
  include_smooth = TRUE,
  include_random = FALSE,
  include_response = FALSE,
  data = NULL,
  verbose = TRUE,
  at,
  ...
)

Arguments

x An object from which to construct the reference grid.

... Arguments passed to or from other methods (for instance, length or range to control the spread of numeric variables.).

by 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 by 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. by = list(Sepal.Length = c(2, 4), Species = "setosa").
- a string with assignments, e.g. by = "Sepal.Length = 2" or by = 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. by = "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 by = "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]"
  - 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 by = "Species = [setosa, versicolor]". Note: the length argument will be ignored when using brackets-tokens.

The remaining variables not specified in by 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
get_datagrid

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 by. 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 by, if no specific values were provided. Use in combination with the length argument to control the number of values within the specified range. 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 by, values from minimum to maximum of the same length as indicated in length are generated. For numeric predictors not specified at first in by, mean and -1/+1 SD around the mean are returned. For factors, all levels are returned.

at
Deprecated. Use by instead.

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 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 glmmTMB or 0 for merMod). This ensures that common 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 get_data().

verbose
Toggle warnings.
Reference grid data frame.

See Also

get_predicted()

Examples

# Datagrids of variables and dataframes --------------------------------------

# Single variable is of interest; all others are "fixed" -------------------

# Factors
get_datagrid(iris, by = "Species") # Returns all the levels
get_datagrid(iris, by = "Species = c('setosa', 'versicolor')") # Specify an expression

# Numeric variables
get_datagrid(iris, by = "Sepal.Length") # default spread length = 10
get_datagrid(iris, by = "Sepal.Length", length = 3) # change length
get_datagrid(iris[2:150, ],
        by = "Sepal.Length",
        factors = "mode", numerics = "median"
) # change non-targets fixing
get_datagrid(iris, by = "Sepal.Length", range = "ci", ci = 0.90) # change min/max of target
get_datagrid(iris, by = "Sepal.Length = [0, 1]"") # Manually change min/max
# identical to previous line: -1 SD, mean and +1 SD
get_datagrid(iris, by = "Sepal.Length", range = "sd", length = 3)

# Numeric and categorical variables, generating a grid for plots
# default spread length = 10
get_datagrid(iris, by = c("Sepal.Length", "Species"), range = "grid")
# default spread length = 3 (-1 SD, mean and +1 SD)
get_datagrid(iris, by = c("Species", "Sepal.Length"), range = "grid")

# Standardization and unstandardization
data <- get_datagrid(iris, by = "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, by = "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, by = c("Sepal.Length", "Species"), length = 3)
get_datagrid(iris, by = c("Sepal.Length", "Petal.Length"), length = c(3, 2))
get_datagrid(iris, by = c(1, 3), length = 3)
get_datagrid(iris, by = c("Sepal.Length", "Species"), preserve_range = TRUE)
get_datagrid(iris, by = c("Sepal.Length", "Species"), numerics = 0)
get_datagrid(iris, by = c("Sepal.Length = 3", "Species"))
get_datagrid(iris, by = c("Sepal.Length = c(3, 1)"", "Species = 'setosa'"))
# With list-style by-argument

```r
get_datagrid(iris, by = list(Sepal.Length = c(1, 3), Species = "setosa"))
```

# With models

```r
# 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, ...)
```

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

**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

general(x, ...)

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

Arguments

x
A statistical model.

... Currently not used.

type Type of approximation for the degrees of freedom. Can be one of the following:

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


get_df

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

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")
```

get_family

A robust alternative to stats::family

Description

A robust and resilient alternative to stats::family. To avoid issues with models like gamm4.

Usage

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

Arguments

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

Examples

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

```
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

```r
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))

gamma4::gamm4(Sepal.Length ~ s(Petal.Width), data = iris)

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

get_loglikelihood(x, ...)

class_loglikelihood(x, ...)

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

get_loglikelihood Intercept
get_modelmatrix

**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 `logLik(..., REML = TRUE)`.
- **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, ...)  
```

```r
## 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

```r
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.
get_parameters.betareg

Usage

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

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

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)

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 'glmgee'
get_parameters(x, component = c("all", "conditional", "dispersion"), ...)

## 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

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,
...
get_parameters.BGGM

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",
...
)

## 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,
get_parameters(BGGM

```r
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(
  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**: 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.
- **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.
get_parameters.emmGrid

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.

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

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

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

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

---

get_parameters.emmGrid

Get model parameters from estimated marginal means objects

Description

Returns the coefficients from a model.

Usage

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

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

---
get_parameters.gamm

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.

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 enmeans 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

data(mtcars)
model <- lm(mpg ~ wt * factor(cyl), data = mtcars)
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

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

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

---

**get_parameters.glmm**: Get model parameters from mixed models

**Description**

Returns the coefficients from a model.
Usage

```r
## 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"), ...)

## 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", "nonlinear"), ...)

## 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.
get_parameters.htest

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

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

## 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

gt.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

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

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

## S3 method for class 'mhurdle'
get_parameters(
  x,
  component = c("all", "conditional", "zi", "zero_inflated", "infrequent_purchase", "ip", "auxiliary"),
  ...)

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.
get_predicted is a robust, flexible and user-friendly alternative to base R \texttt{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 \texttt{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.

\texttt{get_predicted()} usually returns confidence intervals (included as attribute, and accessible via the \texttt{as.data.frame()} method) by default. It is preferred to rely on the \texttt{get_predicted()} function for standard errors and confidence intervals - use \texttt{get_predicted_ci()} only if standard errors and confidence intervals are not available otherwise.

**Usage**

\begin{verbatim}
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,  
          ci_type = "confidence",  
          ci_method = NULL,  
          dispersion_method = "sd",  
          vcov = NULL,  
          vcov_args = NULL,  
          verbose = TRUE,  
          ...)  
\end{verbatim}

**Examples**

\begin{verbatim}
data(mtcars)  
m <- lm(mpg ~ wt + cyl + vs, data = mtcars)  
get_parameters(m)  
\end{verbatim}

\begin{verbatim}
# Model predictions (robust) and their confidence intervals  
get_predicted(mtcars)  
\end{verbatim}
get_predicted

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",
iterations = NULL,
  ci = NULL,
  include_random = TRUE,
  include_smooth = TRUE,
  iterations = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'lmerMod'
get_predicted(
  x,
  data = NULL,
predict = "expectation",
iterations = NULL,
  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 \texttt{re.form} argument). If \texttt{include_random = TRUE} and \texttt{data} is provided, make sure to include the random effect variables in \texttt{data} as well.

\textbf{include_smooth}

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

\section*{Details}

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

\section*{Value}

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

\subsection*{Confidence Interval (CI) vs. Prediction Interval (PI)}

- **Linear models** - \texttt{lm}(): For linear models, prediction intervals (\texttt{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 (\texttt{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** - \texttt{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... \([0, 1]\)).

\section*{Link scale vs. Response scale}

When users set the \texttt{predict} argument to "\texttt{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 \texttt{predict} argument to "\texttt{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 \texttt{predict="classification"} in binomial models, the \texttt{get_predicted()} function will first calculate predictions as if the user had selected \texttt{predict="expectation"}. Then, it will round the responses in order to return the most likely outcome.

\section*{Heteroscedasticity consistent standard errors}

The arguments \texttt{vcov} and \texttt{vcov_args} can be used to calculate robust standard errors for confidence intervals of predictions. These arguments, when provided in \texttt{get_predicted()}, are passed down to \texttt{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)`.

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)

# Bootstrapped
as.data.frame(get_predicted(x, iterations = 4))
# Same as as.data.frame(..., keep_iterations = FALSE)
summary(get_predicted(x, iterations = 4))

# Different prediction types ------------------------
data(iris)
data <- droplevels(iris[1:100, ])

# Fit a logistic model
x <- glm(Species ~ Sepal.Length, data = data, family = "binomial")

# Expectation (default): response scale + CI
pred <- get_predicted(x, predict = "expectation", ci = 0.95)
head(as.data.frame(pred))

# Prediction: response scale + PI
pred <- get_predicted(x, predict = "prediction", ci = 0.95)
head(as.data.frame(pred))

# Link: link scale + CI
pred <- get_predicted(x, predict = "link", ci = 0.95)
head(as.data.frame(pred))

# Classification: classification "type" + PI
```r
pred <- get_predicted(x, predict = "classification", ci = 0.95)
head(as.data.frame(pred))
```

---

### get_predicted_ci

**Confidence intervals around predicted values**

#### Description

Confidence intervals around predicted values

#### Usage

```r
get_predicted_ci(x, ...)
```

```r
## Default S3 method:
get_predicted_ci(
  x,
  predictions = NULL,
  data = NULL,
  se = NULL,
  ci = 0.95,
  ci_type = "confidence",
  ci_method = NULL,
  dispersion_method = "sd",
  vcov = NULL,
  vcov_args = NULL,
  verbose = TRUE,
  ...
)
```

#### 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.

- `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.
Details

Typically, get_predicted() returns confidence intervals based on the standard errors as returned by the predict()-function, assuming normal distribution (+/- 1.96 * SE) resp. a Student’s t-distribution (if degrees of freedom are available). If predict() for a certain class does not return standard errors (for example, merMod-objects), these are calculated manually, based on following steps: matrix-multiply \( X \) by the parameter vector \( \beta \) to get the predictions, then extract the variance-covariance matrix \( V \) of the parameters and compute \( XVX^T \) to get the variance-covariance matrix of the predictions. The square-root of the diagonal of this matrix represent the standard errors of the predictions, which are then multiplied by the critical test-statistic value (e.g., ~1.96 for normal distribution) for the confidence intervals.

If \( \text{ci_type} = "prediction" \), prediction intervals are calculated. These are wider than confidence intervals, because they also take into account the uncertainty of the model itself. Before taking the square-root of the diagonal of the variance-covariance matrix, get_predicted_ci() adds the residual variance to these values. For mixed models, get_variance_residual() is used, while get_sigma()^2 is used for non-mixed models.

It is preferred to rely on standard errors returned by get_predicted() (i.e. returned by the predict()-function), because these are more accurate than manually calculated standard errors. Use get_predicted_ci() only if standard errors are not available otherwise. An exception are Bayesian models or bootstrapped predictions, where get_predicted_ci() returns quantiles of the posterior distribution or bootstrapped samples of the predictions. These are actually accurate standard errors resp. confidence (or uncertainty) intervals.

Examples

```
# Confidence Intervals for Model Predictions
# ------------------------------------------

data(mtcars)

data(mtcars)

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

# get_predicted_ci(x, predictions, ci_type = "prediction")
# head(ci_vals)

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

# Bootstrapped
# -----------
predictions <- get_predicted(x, iterations = 500)

# get_predicted_ci(x, predictions)

ci_vals <- get_predicted_ci(x, predictions, ci = c(0.80, 0.95))
# head(ci_vals)
datawizard::reshape_ci(ci_vals)

```

get_predicted_ci
predictions,  
dispersion_method = "MAD",  
  ci_method = "HDI"
)
head(ci_vals)

# Logistic model
# --------------
x <- glm(vs ~ wt, data = mtcars, family = "binomial")
predictions <- predict(x, type = "link")
  ci_vals <- get_predicted_ci(x, predictions, ci_type = "prediction")
head(ci_vals)
  ci_vals <- get_predicted_ci(x, predictions, ci_type = "confidence")
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.

...
Currently not used.

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

library(rstanarm)
model <- stan_glm(Sepal.Width ~ Species * Petal.Length, data = iris)
get_priors(model)

get_random

Get the data from random effects

Description

Returns the data from all random effects terms.

Usage

get_random(x)

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

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

```r
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")
```

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

```r
get_response(x, ...)
```

Arguments

- `x`    A fitted model.
- `...`  Currently not used.
select       Optional name(s) of response variables for which to extract values. Can be used in case of regression models with multiple response variables.

as_proportion Logical, if TRUE and the response value is a proportion (e.g. y1 / y2), then the returned response value will be a vector with the result of this proportion. Else, always a data frame is returned.

source       String, indicating from where data should be recovered. If source = "environment" (default), data is recovered from the environment (e.g. if the data is in the workspace). This option is usually the fastest way of getting data and ensures that the original variables used for model fitting are returned. Note that always the current data is recovered from the environment. Hence, if the data was modified after model fitting (e.g., variables were recoded or rows filtered), the returned data may no longer equal the model data. If source = "frame" (or "mf"), the data is taken from the model frame. Any transformed variables are back-transformed, if possible. This option returns the data even if it is not available in the environment, however, in certain edge cases back-transforming to the original data may fail. If source = "environment" fails to recover the data, it tries to extract the data from the model frame; if source = "frame" and data cannot be extracted from the model frame, data will be recovered from the environment. Both ways only returns observations that have no missing data in the variables used for model fitting.

verbose      Toggle warnings.

dichotomies  Logical, if model is a nestedLogit objects, returns the response values for the dichotomies.

Value

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

Examples

data(cbpp)
cbpp$trials <- cbpp$size - cbpp$incidence
dat <- cbpp

m <- glm(cbind(incidence, trials) ~ period, data = dat, 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

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

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.

Value

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

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().

References

Examples

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

Description

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

Usage

```r
get_statistic(x, ...)
```

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

## S3 method for class 'glmmTMB'
```r
get_statistic(x, component = "all", ...)```

## S3 method for class 'emmGrid'
```r
get_statistic(x, ci = 0.95, adjust = "none", merge_parameters = FALSE, ...)```

## S3 method for class 'gee'
```r
get_statistic(x, robust = FALSE, ...)```

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` String, indicating the model component for which parameters should be returned. The default for all models is "all", which returns the requested information for all available model components. Furthermore, there are specific options depending on the model class. component then may be one of:
get_transformation

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.

Examples

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

Value

A data frame with the model’s parameter names and the related test statistic.

Adjust

Character value naming the method used to adjust p-values or confidence intervals. 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 parameters names and values as values.

Robust

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

ci

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

Examples

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

get_transformation(x, verbose = TRUE)

Arguments

x A regression model.
verbose Logical, if TRUE, prints a warning if the transformation could not be determined.

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

# 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(0.3)
log(0.3)

# inverse function is exp()
get_transformation(model)$inverse(0.3)
exp(0.3)

---

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 'glmgee'
get_varcov(
  x,
  verbose = TRUE,
  vcov = c("robust", "df-adjusted", "model", "bias-corrected", "jackknife"),
  ...
)

## S3 method for class 'nestedLogit'
get_varcov(
  x,
  component = "all",
  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
get_varcov

- 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 "vcoCR"), 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)
get_varcov(m)

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

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

vcov_args = list(R = 50)

---

get_variance

Get variance components from random effects models

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.

Usage

get_variance(x, ...)

## S3 method for class 'merMod'
get_variance(
  x,
  component = c("all", "fixed", "random", "residual", "distribution", "dispersion", "intercept", "slope", "rho01", "rho00"),
  tolerance = 1e-08,
  null_model = NULL,
  approximation = "lognormal",
  verbose = TRUE,
  ...
)

## S3 method for class 'glmmTMB'
get_variance(
  x,
  component = c("all", "fixed", "random", "residual", "distribution", "dispersion", "intercept", "slope", "rho01", "rho00"),
  model_component = NULL,
  tolerance = 1e-08,
  null_model = NULL,
  approximation = "lognormal",
  verbose = TRUE,
  ...
)

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

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

get_variance_random(x, verbose = TRUE, tolerance = 1e-08, ...)
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.
...
Currently not used.
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.
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().
null_model Optional, a null-model to be used for the calculation of random effect variances. If NULL, the null-model is computed internally.
approximation Character string, indicating the approximation method for the distribution-specific (observation level, or residual) variance. Only applies to non-Gaussian models. Can be "lognormal" (default), "delta" or "trigamma". For binomial models, the default is the theoretical distribution specific variance, however, it can also be "observation_level". See Nakagawa et al. 2017, in particular supplement 2, for details.
verbose Toggle off warnings.
model_component For models that can have a zero-inflation component, specify for which component variances should be returned. If NULL or "full" (the default), both the conditional and the zero-inflation component are taken into account. If "conditional", only the conditional component is considered.

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).
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-specific/observation level variance)
- `var.distribution`, distribution-specific (or observation level) 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 ($\rho_{00}$)

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 reflects the "average" random effects variance for fixed 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 (observation level) variance

The distribution-specific variance, $\sigma_d^2$, is the conditional variance of the response given the predictors $\text{Var}\{y|x\}$, which depends on the model family.

- **Gaussian**: For Gaussian models, it is $\sigma^2$ (i.e. $\text{sigma(model)}^2$).
- **Bernoulli**: For models with binary outcome, it is $\pi^2/3$ for logit-link, 1 for probit-link, and $\pi^2/6$ for cloglog-links.
- **Binomial**: For other binomial models, the distribution-specific variance for Bernoulli models is used, divided by a weighting factor based on the number of trials and successes.
- **Gamma**: Models from Gamma-families use $\mu^2$ (as obtained from `family$\text{variance}()$).
- For all other models, the distribution-specific variance is by default based on lognormal approximation, $\log(1 + \text{var}(x)/\mu^2)$ (see Nakagawa et al. 2017). Other approximation methods can be specified with the `approximation` argument.
- **Zero-inflation models**: 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, $\sigma^2_e$, represents "the excess variation relative to what is expected from a certain distribution" (Nakagawa et al. 2017). In (most? many?) cases, this will be $0$.

Residual variance

The residual variance, $\sigma^2_\epsilon$, is simply $\sigma^2_d + \sigma^2_e$.

Random intercept variance

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

It indicates how much groups or subjects differ from each other, while the residual variance $\sigma^2_\epsilon$ indicates the *within-subject variance*.

Random slope variance

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

This measure is only available for mixed models with random slopes.

Random slope-intercept correlation

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

This measure is only available for mixed models with random intercepts and slopes.

Supported models and model families

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 not fully implemented or tested, and therefore may not work for all models of the aforementioned classes.

The results are validated against the solutions provided by Nakagawa et al. (2017), in particular examples shown in the Supplement 2 of the paper. Other model families are validated against results from the `MuMIn` package. This means that the returned variance components should be accurate and reliable for following mixed models or model families:

- Bernoulli (logistic) regression
- Binomial regression (with other than binary outcomes)
- Poisson and Quasi-Poisson regression
- Negative binomial regression (including nbinom1 and nbinom2 families)
- Gaussian regression (linear models)
- Gamma regression
- Tweedie regression
- Beta regression
- Ordered beta regression

Following model families are not yet validated, but should work:
• Zero-inflated and hurdle models
• Beta-binomial regression
• Compound Poisson regression
• Generalized Poisson regression
• Log-normal regression

Extracting variance components for models with zero-inflation part is not straightforward, because it is not definitely clear how the distribution-specific variance should be calculated. Therefore, it is recommended to carefully inspect the results, and probably validate against other models, e.g. Bayesian models (although results may be only roughly comparable).

Log-normal regressions (e.g. lognormal() family in glmmTMB or gaussian(“log”)) often have a very low fixed effects variance (if they were calculated as suggested by Nakagawa et al. 2017). This results in very low ICC or r-squared values, which may not be meaningful (see performance::icc() or performance::r2_nakagawa()).

References


Examples

```r
library(lme4)
data(sleepstudy)
m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
get_variance(m)
get_variance_fixed(m)
get_variance_residual(m)
```

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.
...
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)

has_intercept Checks if model has an intercept

Description

Checks if model has an intercept.

Usage

has_intercept(x, verbose = TRUE)
Arguments

x  A model object.
verbose  Toggle warnings.

Value

TRUE if x has an intercept, FALSE otherwise.

Examples

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

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

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

is_converged(x, tolerance = 0.001, ...)

Arguments

x  A 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.

Value

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

Examples

```r
data(chpp)
set.seed(1)
chpp$x <- rnorm(nrow(chpp))
chpp$x2 <- runif(nrow(chpp))

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

model <- glmmTMB(
  Sepal.Length ~ poly(Petal.Width, 4) * poly(Petal.Length, 4) +
  (1 + poly(Petal.Width, 4) | Species),
  data = iris
)
is_converged(model)
```
is_empty_object  
Check if object is empty

Description
Check if object is empty

Usage
is_empty_object(x)

Arguments
x  A list, a vector, or a dataframe.

Value
A logical indicating whether the entered object is empty.

Examples
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
is_gam_model(x)

Arguments
x  A model object.

Value
A logical, TRUE if x is a generalized additive model and has smooth-terms
is_mixed_model

Note

This function only returns TRUE when the model inherits from a typical GAM model class and when smooth terms are present in the model formula. If model has no smooth terms or is not from a typical gam class, FALSE is returned.

Examples

data(iris)
model1 <- lm(Petal.Length ~ Petal.Width + Sepal.Length, data = iris)
model2 <- mgcv::gam(Petal.Length ~ Petal.Width + s(Sepal.Length), data = iris)
is_gam_model(model1)
is_gam_model(model2)

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.

Examples

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

data(sleepstudy, package = "lme4")
model <- lme4::lmer(Reaction ~ Days + (1 | Subject), data = sleepstudy)
is_mixed_model(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)
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)

is_model_supported

Checks if a regression model object is supported by the insight package

Description

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

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_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.

Details

The term "nested" here means that all the fixed predictors of a model are contained within the fixed predictors of a larger model (sometimes referred to as the encompassing model). Currently, is_nested_models() ignores random effects parameters.
is_nullmodel

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

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

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

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

model <- lme4::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

link_function(x, ...)

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

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

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

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

Arguments

x       A fitted model.
...
what    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)(0.3)
# same as
log(0.3)
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

# 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)(0.3)
# same as
exp(0.3)
Description

Retrieve information from model objects.

Usage

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

## Default S3 method:
```r
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_orderedbeta`: family is ordered beta
- `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 and vglm/vgam 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.test() 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_proptest**: 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
- **n_grouplevels**: for mixed models, returns names and numbers of random effect groups

**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)

# logistic regression
model_info(m)

# t-test
m <- t.test(1:10, y = c(7:20))
model_info(m)
```

---

### 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, ...)
```

### 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

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

Compute intercept-only model for regression models

Description

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

Usage

```r
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`

Examples

```r
data(sleepstudy)
m <- lmer(Reaction ~ Days + (1 + Days | Subject), data = sleepstudy)
summary(m)
summary(null_model(m))
```

n_grouplevels

Count number of random effect levels in a mixed model

Description

Returns the number of group levels of random effects from mixed models.

Usage

```r
n_grouplevels(x, ...)
```
 Arguments

    x  A mixed model.
    ... Additional arguments that can be passed to the function. Currently, you can
        use data to provide the model data, if available, to avoid retrieving model data
        multiple times.

 Value

    The number of group levels in the model.

 Examples

    data(sleepstudy, package = "lme4")
    set.seed(12345)
    sleepstudy$grp <- sample(1:5, size = 180, replace = TRUE)
    sleepstudy$subgrp <- NA
    for (i in 1:5) {
      filter_group <- sleepstudy$grp == i
      sleepstudy$subgrp[filter_group] <-
        sample(1:30, size = sum(filter_group), replace = TRUE)
    }
    model <- lme4::lmer(Reaction ~ Days + (1 | grp / subgrp) + (1 | Subject),
                         data = sleepstudy)
    n_grouplevels(model)

 n_obs

    Get number of observations from a model

 Description

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

 Usage

    n_obs(x, ...)

    ## S3 method for class 'glm'
    n_obs(x, disaggregate = FALSE, ...)

    ## S3 method for class 'svyolr'
    n_obs(x, weighted = FALSE, ...)

    ## S3 method for class 'afex_aov'
    n_obs(x, shape = c("long", "wide"), ...)
n_parameters  

## S3 method for class 'stanmvreg'

n_obs(x, select = NULL, ...)

### Arguments

- **x**: A fitted model.
- **...**: Currently not used.
- **disaggregate**: For binomial models with aggregated data, `n_obs()` returns the number of data rows by default. If `disaggregate = TRUE`, the total number of trials is returned instead (determined by summing the results of `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').
- **weighted**: For survey designs, returns the weighted sample size.
- **shape**: Return long or wide data? Only applicable in repeated measures designs.
- **select**: Optional name(s) of response variables for which to extract values. Can be used in case of regression models with multiple response variables.

### 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)

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)
```

---

### n_parameters  

**Count number of parameters in a model**

### Description

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

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

## S3 method for class 'gam'
n_parameters(
  x,
  component = c("all", "conditional", "smooth_terms"),
  remove_nonestimable = FALSE,
  ...
)

## S3 method for class 'brmsfit'
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

    # 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  Coloured console output

Description

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

Usage

print_color(text, color)

print_colour(text, colour)

color_text(text, color)

colour_text(text, colour)

color_theme()

Arguments

text The text to print.

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 dabedi dabedei", "blue")
```

---

**Description**

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

**Usage**

```r
print_parameters(
  x,
  ..., 
  by = c("Effects", "Component", "Group", "Response"),
  format = "text",
  parameter_column = "Parameter",
  keep_parameter_column = TRUE,
  remove_empty_column = FALSE,
  titles = NULL,
  subtitles = NULL,
  split_by = NULL
)
```

**Arguments**

- `x` A fitted model, or a data frame returned by `clean_parameters()`.
- `...` One or more objects (data frames), which contain information about the model parameters and related statistics (like confidence intervals, HDI, ROPE, ...).
- `by` 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 `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 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 `export_table()`.
print_parameters

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 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.

split_by
Deprecated, please use by instead.

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 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

```r
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
# information on parameter names and HDI values
tmp <- as.data.frame(x)[, 1:4]
tmp

# Based on the "by" argument, we get a list of data frames that
# is split into several parts that reflect the model components.
print_parameters(model, tmp)

# This is the standard print()-method for "bayestestR::hdi"-objects.
# For printing methods, it is easy to print complex summary statistics
# in a clean way to the console by splitting the information into
# different model components.
x
```

---

**standardize_column_order**

*Standardize column order*

**Description**

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

**Usage**

```r
standardize_column_order(data, ...)
```

```r
## 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.
**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, ...)```

```r
# S3 method for class 'parameters_model'
standardize_names(
    data,
    style = c("easystats", "broom"),
)```

**Value**

A data frame, with standardized column order.

**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 = 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
model <- lm(mpg ~ wt + cyl, data = mtcars)
mp <- model_parameters(model)

as.data.frame(mp)
standardize_names(mp)
standardize_names(mp, style = "broom")
```
**Description**

This function removes backticks from a string.

**Usage**

```r
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**

```r
# 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)

---

**trim_ws**  
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, ...)
```

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

```r
n_unique(x, ...)
```

```r
## Default S3 method:
n_unique(x, na.rm = TRUE, ...)
```

```r
safe_deparse(x, ...)
```

```r
safe_deparse_symbol(x)
```

```r
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

```r
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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