

# Package ‘grafify’

February 25, 2024

**Type** Package

**Title** Easy Graphs for Data Visualisation and Linear Models for ANOVA

**Date** 2024-02-25

**Version** 4.0.1

**Description** Easily explore data by plotting graphs with a few lines of code. Use these `ggplot()` wrappers to quickly draw graphs of scatter/dots with box-whiskers, violins or SD error bars, data distributions, before-after graphs, factorial ANOVA and more. Customise graphs in many ways, for example, by choosing from colour blind-friendly palettes (12 discreet, 3 continuous and 2 divergent palettes). Use the simple code for ANOVA as ordinary (`lm()`) or mixed-effects linear models (`lmer()`), including randomised-block or repeated-measures designs, and fit non-linear outcomes as a generalised additive model (`gam`) using `mgcv()`. Obtain estimated marginal means and perform post-hoc comparisons on fitted models (via `emmeans()`). Also includes small datasets for practising code and teaching basics before users move on to more complex designs. See vignettes for details on usage <<https://grafify-vignettes.netlify.app/>>. Citation: <[doi:10.5281/zenodo.5136508](https://doi.org/10.5281/zenodo.5136508)>.

**License** GPL (>= 2)

**Imports** car, emmeans, Hmisc, lme4, lmerTest, magrittr, mgcv, patchwork, purrr, stats, tidyr

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**Suggests** dplyr, knitr, Matrix (>= 1.6-5), rlang, rmarkdown, pbkrtest, testthat (>= 3.0.0)

**URL** <https://github.com/ashenoy-cmbi/grafify>

**Config/testthat/edition** 3

**NeedsCompilation** no

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|               |  |
|---------------|--|
| data_1w_death | <i>In vitro experiments measuring percentage cell death in three genotypes of cells.</i> |
|---------------|--|

---

**Description**

These data are from in vitro measurements of death of host cells (measured as percentage of total cells) after infection with three different strains of a pathogenic bacterium, from five independent experiments. The three strains are three levels within the fixed factor Genotype. The five independent experiments are levels within the random variable Experiment. These data can be analysed using linear mixed effects modelling. These data are from [Goddard \*et al\*, Cell Rep, 2019, doi.org/10.1016/j.celrep.2019.03.100](https://doi.org/10.1016/j.celrep.2019.03.100)

**Usage**

data\_1w\_death

**Format**

data.frame: 15 obs. of 3 variables.

**Experiment** Experiment - a random factor with 5 levels "Exp\_1","Exp\_2"...

**Genotype** Genotypes - a fixed factor with 3 levels: "WT","KO\_1","KO\_2".

**Death** Numerical dependent variable indicating percentage cell death.

---

|                 |   |
|-----------------|---|
| data_2w_Festing | <i>Data from two-way ANOVA with randomised block design of treatments of strains of mice.</i> |
|-----------------|---|

---

**Description**

Data from Festing, ILAR Journal (2014) 55, 472–476 <doi: 10.1093/ilar/ilu045>. These data are suitable for two-way linear mixed effects modelling. The activity of GST (numerical dependent variable) was measured in 4 strains of mice (levels with the fixed factor Strain) either treated or controls (levels within the fixed factor Treatment). Once mouse each was used in two randomised blocks, which is the random factor (Block).

**Usage**

data\_2w\_Festing

**Format**

data.frame: 16 obs. of 4 variables:

**Block** A random factor with 2 levels "A" and "B".

**Treatment** A fixed factor with 2 levels: "Control" & "Treated"

**Strain** A fixed factor with 4 levels: "129Ola", "A/J", "NIH" & "BALB/C"

**GST** Numerical dependent variable indicating GST activity measurement

---

|                |  |
|----------------|--|
| data_2w_Tdeath | <i>In vitro measurement of percentage cell death - two-way ANOVA design with repeated measures, and randomised blocks.</i> |
|----------------|--|

---

**Description**

These are measurements of death of infected host cells (as percentage of total cells) upon infection with two strains of bacteria, measured at two time points, in 6 independent experiments. These data repeated-measures data suitable for two-way linear mixed effects modelling with experiment and subjects as random factors.

**Usage**

```
data_2w_Tdeath
```

**Format**

data.frame: 24 obs. of 6 variables:

**Experiment** A random factor with 6 levels "e1", "e2"...

**Time** A fixed factor with 2 levels: "t100" & "t300".

**Time2** A numeric column that allows plotting data on a quantitative "Time" axis. The "Time" column has "factor" type values that should be used for the ANOVA..

**Genotype** A fixed factor with 2 levels that we want to compare "WT" & "KO".

**Subject** A random factor with 12 levels: "s1", "s2"... These are cell culture wells that were measured at two time points, and indicate "subjects" that underwent repeated-measures within each of 6 experiments. Subject IDs for WT and KO are unique and clearly indicate different wells.

**PI** Numerical dependent variable indicating propidium iodide dye uptake as a measure of cell death. These are percentage of dead cells out of total cells plated.

---

|                  |   |
|------------------|---|
| data_cholesterol | <i>Hierarchical data from 25 subjects either treated or not at 5 hospitals - two-way ANOVA design with repeated measures.</i> |
|------------------|---|

---

**Description**

An example dataset on measurements of blood cholesterol levels measured in 5 subjects measured before and after receiving a Drug. Five patients each were recruited at 5 hospitals (a-e), so that there are 25 different subjects (1-25) measured twice. Data are from [Micro/Immuno Stats](#)

**Usage**

```
data_cholesterol
```

**Format**

tibble: 30 obs. of 3 variables:

**Hospital** Factor with 5 levels (a-e), representing different hospitals where subjects were recruited.

**Subject** A factor with 25 levels denoting individuals on whom measurements were made twice.

**Treatment** A factor with 2 levels indicating when measurements were made, i.e. before and after drug.

**Cholesterol** Numerical dependent variable indicating measured doubling time in min.

---

|                    |   |
|--------------------|---|
| data_doubling_time | <i>Doubling time of E.coli measured by 10 students three independent times.</i> |
|--------------------|---|

---

### Description

An example dataset showing measurements of *E. coli* doubling times (in min) measured by 10 different students in 3 independent experiments each. Note that Experiments are just called Exp1-Exp3 even though Exp1 of any of the students are not connected in anyway - this will confuse R! Data are from [Micro/Immuno Stats](#)

### Usage

```
data_doubling_time
```

### Format

tibble: 30 obs. of 3 variables:

**Student** Factor with 10 levels, representing different students.

**Experiment** A factor with 3 levels representing independent experiments.

**Doubling\_time** Numerical dependent variable indicating measured doubling time in min.

---

|              |  |
|--------------|--|
| data_t_pdiff | <i>Matched data from two groups where difference between them is consistent.</i> |
|--------------|--|

---

### Description

An example dataset for paired difference Student's *t* test. These are bodyweight (Mass) in grams of same mice left untreated or treated, which are two groups to be compared. The data are in a longtable format, and the two groups are levels within the factor "Condition". The Subject column lists ID of matched mice that were measured without and with treatment. These data are from [Sanchez-Garrido \*et al\*, Sci Signal, 2018, DOI: 10.1126/scisignal.aat6903.](#)

### Usage

```
data_t_pdiff
```

### Format

data.frame: 20 obs. of 3 variables:

**Subject** Factor with 10 levels, denoted by capital letters, representing individuals or subjects.

**Condition** A fixed factor with 2 levels: "Untreated" & "Treated".

**Mass** Numerical dependent variable indicating body mass of mice

---

data\_t\_pratio                    *Matched data from two groups where ratio between them is consistent.*

---

### Description

An example dataset for paired ratio Student's  $t$  test. These are Cytokine measurements by ELISA (in ng/ml) from 33 independent in vitro experiments performed on two Genotypes that we want to compare. The data are in a longtable format, and the two groups are levels within the factor "Genotype". The Experiment column lists ID of matched experiments.

### Usage

```
data_t_pratio
```

### Format

data.frame: 66 obs. of 3 variables:

**Genotype** Factor with 2 levels, representing genotypes to be compared ("WT" & "KO").

**Experiment** A random factor with 33 levels representing independent experiments, denoted as "Exp\_1", "Exp\_2"...

**Cytokine** Numerical dependent variable indicating cytokine measured by ELISA.

---

data\_zooplankton                *Time-series data on zooplankton in lake Menon.*

---

### Description

A subset of data from (Lathro RC, 2000) ([doi:10.6073/pasta/ec3d0186753985147d4f283252388e05](https://doi.org/10.6073/pasta/ec3d0186753985147d4f283252388e05)) provided by the Wisconsin Department of Natural Resources

### Usage

```
data_zooplankton
```

### Format

tibble: 1127 obs. of 8 variables:

**day** Numeric integer variable.

**year** Numeric integer variable of years during which data were collected.

**lake** This data is for lake Menona; data for other others not included in this subset.

**taxon** Names of zooplankton taxa as factor of 8 levels.

**density** Numeric values of density of measurements.

**density\_adj** Numeric values of adjusted density .  
**min\_density** Numeric values of minimum densities.  
**desnsity\_scaled** Numeric value of scaled density.

---

ga\_anova

*ANOVA table from a generalised additive model (gam)*


---

## Description

One of two functions for fitting generalised additive models (gam) with the [mgcv package](#). It will use the `gam()` function in `mgcv` for ANOVA designs with **up to two categorical fixed factors** (with two or more levels; `Fixed_Factor`), and **exactly one factor is a continuous variable** (e.g. time), which is called `Smooth_Factor`.

1. [ga\\_model](#)
2. [ga\\_anova](#)

## Usage

```
ga_anova(
  data,
  Y_value,
  Fixed_Factor,
  Smooth_Factor,
  Random_Factor = NULL,
  Nodes = NULL,
  ...
)
```

## Arguments

|                            |   |
|----------------------------|---|
| <code>data</code>          | a data frame where categorical independent variables are converted to factors using <code>as.factor()</code> first. The function will throw errors without this.              |
| <code>Y_value</code>       | name of column containing quantitative (dependent) variable, provided within "quotes".  |
| <code>Fixed_Factor</code>  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes". Convert to factors first with <code>as.factor</code> . |
| <code>Smooth_Factor</code> | the continuous variable to fit smoothly with a basis function, provided within "quotes" (only 1 <code>Smooth_Factor</code> allowed).  |
| <code>Random_Factor</code> | name(s) of random factors to be provided in "quotes" (only 1 <code>Random_Factor</code> allowed). Convert to factor with <code>as.factor</code> first.                        |
| <code>Nodes</code>         | number of nodes (the parameter <code>k</code> in <code>gam</code> ).  |
| <code>...</code>           | any additional variables to pass on to <code>gam</code> or <code>anova</code>   |



## Details

A smooth function is fitted with factor-wise smooth basis function (by = ). A default value for number of nodes (the argument k in gam) may work, but a specific number can be provided using the Nodes argument. The model is fit using the REML method. When two categorical fixed factors are provided, an interaction term is included for main effects and smooth basis functions.

If a Random\_Factor is also provided, it is fitted using bs = "re" smooth.

## Value

ANOVA table of class "anova" and "data.frame".

## Examples

```
#with zooplankton data
ga_anova(data = data_zooplankton,
Y_value = "log(density_adj)",
Fixed_Factor = "taxon",
Smooth_Factor = "day")
```

---

ga\_model

*Fit a generalised additive model (gam)*

---

## Description

One of two functions for fitting generalised additive models (gam) with the [mgcv package](#). It will use the gam() function in mgcv for ANOVA designs with **up to two categorical fixed factors** (with two or more levels; Fixed\_Factor), and **exactly one factor is a continuous variable** (e.g. time), which is called Smooth\_Factor.

1. [ga\\_model](#)
2. [ga\\_anova](#)

A smooth function is fitted with factor-wise smooth basis function (by = ). A default value for number of nodes (the argument k in gam) may work, but a specific number can be provided using the Nodes argument. The model is fit using the REML method. When two categorical fixed factors are provided, an interaction term is included for main effects and smooth basis functions.

## Usage

```
ga_model(
  data,
  Y_value,
  Fixed_Factor,
  Smooth_Factor,
  Random_Factor = NULL,
```

```

    Nodes = "NULL",
    ...
  )

```

### Arguments

|               |   |
|---------------|---|
| data          | a data frame where categorical independent variables are converted to factors using <code>as.factor()</code> first. The function will throw errors without this.              |
| Y_value       | name of column containing quantitative (dependent) variable, provided within "quotes".  |
| Fixed_Factor  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes". Convert to factors first with <code>as.factor</code> . |
| Smooth_Factor | the continuous variable to fit smoothly with a basis function, provided within "quotes" (only 1 Smooth_Factor allowed).   |
| Random_Factor | name(s) of random factors to be provided in "quotes" (only 1 Random_Factor allowed). Convert to factor with <code>as.factor</code> first.                                     |
| Nodes         | number of nodes (the parameter <code>k</code> in <code>gam</code> ).  |
| ...           | any additional variables to pass on to <code>gam</code> or <code>anova</code>   |

### Details

If a `Random_Factor` is also provided, it is fitted using `bs = "re"` smooth.

### Value

This function gives a generalised additive model object of class "gam", "lm" and "glm".

### Examples

```

#fit a model with zooplankton data
z1 <- ga_model(data = data_zooplankton,
  Y_value = "log(density_adj)",
  Fixed_Factor = "taxon",
  Smooth_Factor = "day")

```

---

get\_graf\_colours

*Get graf internal*

---

### Description

Function to make grafify colour scheme. **Thank you Dr Simon.**

### Usage

```
get_graf_colours(...)
```

**Arguments**

... internal

**Details**

To visualise grafify colours use `plot_grafify_palette`.

**Value**

This function returns names and hexcodes of colours in grafify as a character vector.

---

|              |  |
|--------------|--|
| graf_colours | <i>List of hexcodes of colours in grafify palettes</i> |
|--------------|--|

---

**Description**

To visualise these colours use `plot_grafify_palette`. `okabe_ito`, `bright`, `contrast`, `dark`, `light`, `muted`, `pale`, `vibrant`, `yello_conti` from Paul Tol's [post](#). `Zesty`, `Pastel`, `Elegant` from this [link](#). Colour hexcodes for `fishy`, `kelly`, `r4`, `safe`, `OrBl_div`, `PrGn_div`, `blue_conti`, `grey_conti` taken from `cols4all:c4a_gui` package. All schemes are colour blind-friendly.

**Usage**

```
graf_colours
```

**Format**

An object of class character of length 154.

**Value**

This is a character vector with names and hexcodes of colours used by palette functions. It is used by `get_graf_colours` to generate palettes.

---

|                  |   |
|------------------|---|
| graf_col_palette | <i>Call grafify palettes for scale &amp; fill functions</i> |
|------------------|---|

---

**Description**

`graf_col_palette` and `graf_col_palette_default` functions generate colours for grafify scale functions. `graf_col_palette` picks sequential colours when the number of discrete colours needed is less than that in the palette. This is the default for grafify with `ColoSeq = TRUE`. If the number of colours required is more than that in the discrete palette, it fills intervening colours using the `colorRampPalette[grDevices]` function.

**Usage**

```
graf_col_palette(palette = "okabe_ito", reverse = FALSE, ...)
```

**Arguments**

|         |                       |
|---------|-----------------------|
| palette | internal              |
| reverse | internal              |
| ...     | additional parameters |

**Details**

graf\_col\_palette\_default picks the most distant colours within the palette, rather than in the sequence they are in the palette, when the number of colours required is less than that in the palette.

Colour order can be reversed in both functions.

When only one colour discreet is required, and you want to reverse the colour palette, ColSeq should be set to FALSE.

**Value**

This generates required number of sequential colours from the chosen grafify palette when called by scale functions of ggplot2.

---

```
graf_col_palette_default
```

*Call grafify palettes for scale & fill functions*

---

**Description**

graf\_col\_palette and graf\_col\_palette\_default functions generate colours for grafify scale functions. graf\_col\_palette picks sequential colours when the number of discrete colours needed is less than that in the palette. This is the default for grafify with ColoSeq = TRUE. If the number of colours required is more than that in the discrete palette, it fills intervening colours using the [colorRampPalette\[grDevices\]](#) function.

**Usage**

```
graf_col_palette_default(palette = "okabe_ito", reverse = FALSE, ...)
```

**Arguments**

|         |                       |
|---------|-----------------------|
| palette | internal              |
| reverse | internal              |
| ...     | additional parameters |

**Details**

graf\_col\_palette\_default picks the most distant colours within the palette, rather than in the sequence they are in the palette, when the number of colours required is less than that in the palette.

Colour order can be reversed in both functions.

When only one colour discreet is required, and you want to reverse the colour palette, ColSeq should be set to FALSE.

**Value**

This generates required number of distant colours from the chosen grafify palette when called by scale functions of ggplot2.

---

|               |  |
|---------------|--|
| graf_palettes | <i>List of palettes available in grafify package</i> |
|---------------|--|

---

**Description**

To visualise these colours use plot\_grafify\_palette.

**Usage**

```
graf_palettes
```

**Format**

An object of class list of length 18.

**Value**

This function returns a list of palettes in grafify with names and hexcodes of colours in those palettes. Names of palettes available are as follows:

Categorical/discreet palettes:

- okabe\_ito
- bright
- contrast
- dark
- kelly
- light
- muted
- pale
- r4
- safe

- vibrant

Sequential quantitative palettes:

- grey\_conti
- blue\_conti
- yellow\_conti

Divergent quantitative palettes:

- OrBl\_div
- PrGn\_div

---

|                |   |
|----------------|---|
| make_1way_data | <i>Make one-way or two-way independent group or randomised block design data.</i> |
|----------------|---|

---

## Description

The [make\\_1way\\_data](#), [make\\_1way\\_rb\\_data](#), [make\\_2way\\_data](#) and [make\\_2way\\_rb\\_data](#) functions generate independent or randomised block (rb) design data of one-way or two-way designs.

## Usage

```
make_1way_data(Group_means, Num_obs, Residual_SD)
```

## Arguments

|             |  |
|-------------|--|
| Group_means | a vector with means of each level of the first fixed factor (FixFac_X1) measured within Group 1.                           |
| Num_obs     | a single numeric value indicating the number of independent measurements, i.e. levels within the random factor Experiment. |
| Residual_SD | a single numeric value indicating residual SD in the model.  |

## Details

Random variates from the normal distribution based on user provided mean and SD provided are generated. For independent designs, the Residual\_SD argument is used to set expected residual SD from the linear model. Exp\_SD is used to set experiment-to-experiment SD, that will be assigned to the random factor for rb designs.

Num\_exp sets the number of independent measurements per group.

For one-way designs, the user provides Group\_means as a vector. Number of levels are recognised based on number of means. For two-way designs, two vectors are to be provided by the user containing means of levels of a second factor. Number of means in both vectors should be the same. These functions can only handle balanced designs, i.e. same number of observations in all groups.

The output is a data frame with one or two columns denoting the fixed factor with levels that match the number of means entered. For rb data, the column for RandFac denotes levels of the blocking factor. The quantitative response variables are in the numeric Values column.

**Value**

This function produces a `data.frame` object containing simulated data.

**Examples**

```
#Basic usage with three levels within Factor_X,
#20 observations in each group, with residual SD 15

one_independent_tab <- make_1way_data(c(350, 250, 100), 15, 20)

str(one_independent_tab)
head(one_independent_tab)
```

---

|                   |   |
|-------------------|---|
| make_1way_rb_data | <i>Make one-way or two-way independent group or randomised block design data.</i> |
|-------------------|---|

---

**Description**

The [make\\_1way\\_data](#), [make\\_1way\\_rb\\_data](#), [make\\_2way\\_data](#) and [make\\_2way\\_rb\\_data](#) functions generate independent or randomised block (rb) design data of one-way or two-way designs.

**Usage**

```
make_1way_rb_data(Group_means, Num_exp, Exp_SD, Residual_SD)
```

**Arguments**

|             |  |
|-------------|--|
| Group_means | a vector with means of each level of the first fixed factor (FixFac_X1) measured within Group 1.                         |
| Num_exp     | a single numeric value. indicating the number of independent measurements, i.e. levels within the random factor RandFac. |
| Exp_SD      | a single numeric value indicating the standard deviation (SD) between experiments, i.e. within RandFac.                  |
| Residual_SD | a single numeric value indicating residual SD in the model.  |

**Details**

Random variates from the normal distribution based on user provided mean and SD provided are generated. For independent designs, the `Residual_SD` argument is used to set expected residual SD from the linear model. `Exp_SD` is used to set experiment-to-experiment SD, that will be assigned to the random factor for rb designs.

`Num_exp` sets the number of independent measurements per group.

For one-way designs, the user provides `Group_means` as a vector. Number of levels are recognised based on number of means. For two-way designs, two vectors are to be provided by the user containing means of levels of a second factor. Number of means in both vectors should be the

same. These functions can only handle balanced designs, i.e. same number of observations in all groups.

The output is a data frame with one or two columns denoting the fixed factor with levels that match the number of means entered. For rb data, the column for RandFac denotes levels of the blocking factor. The quantitative response variables are in the numeric Values column.

## Value

This function produces a `data.frame` object containing simulated data.

## Examples

```
#Basic usage with two levels within FactorX2,
#20 experiments with inter-experiment SD 20, and residual SD 15

two_rb_tab <- make_2way_rb_data(c(100, 20), c(200, 300), 20, 20, 15)

str(two_rb_tab)
head(two_rb_tab)
```

---

|                |   |
|----------------|---|
| make_2way_data | <i>Make one-way or two-way independent group or randomised block design data.</i> |
|----------------|---|

---

## Description

The [make\\_1way\\_data](#), [make\\_1way\\_rb\\_data](#), [make\\_2way\\_data](#) and [make\\_2way\\_rb\\_data](#) functions generate independent or randomised block (rb) design data of one-way or two-way designs.

## Usage

```
make_2way_data(Group_1_means, Group_2_means, Num_obs, Residual_SD)
```

## Arguments

|               |  |
|---------------|--|
| Group_1_means | a vector with means of each level of the first fixed factor (FixFac_X1) measured within Group 1.   |
| Group_2_means | only for <code>make_2way_data</code> and <code>make_2way_rb_data</code> : a vector with mean(s) of each level of FactorX2 measured within Group 2. |
| Num_obs       | a single numeric value indicating the number of independent measurements, i.e. levels within the random factor Experiment.                         |
| Residual_SD   | a single numeric value indicating residual SD in the model.  |



## Details

Random variates from the normal distribution based on user provided mean and SD provided are generated. For independent designs, the `Residual_SD` argument is used to set expected residual SD from the linear model. `Exp_SD` is used to set experiment-to-experiment SD, that will be assigned to the random factor for rb designs.

`Num_obs` sets the number of independent measurements per group.

For one-way designs, the user provides `Group_means` as a vector. Number of levels are recognised based on number of means. For two-way designs, two vectors are to be provided by the user containing means of levels of a second factor. Number of means in both vectors should be the same. These functions can only handle balanced designs, i.e. same number of observations in all groups.

The output is a data frame with one or two columns denoting the fixed factor with levels that match the number of means entered. For rb data, the column for `RandFac` denotes levels of the blocking factor. The quantitative response variables are in the numeric `Values` column.

## Value

This function produces a `data.frame` object containing simulated data.

## Examples

```
#Basic usage with two levels within FactorX2, 20 observations in each group, with residual SD 15
two_independent_tab <- make_2way_data(c(100, 20), c(200, 300), 20, 15)

#Four levels with 5 observations and residual SD 5
two_independent_tab <- make_2way_data(c(100, 20, 1500, 20), c(150, 5, 1450, 25), 5, 5)
```

---

|                                |   |
|--------------------------------|---|
| <code>make_2way_rb_data</code> | <i>Make one-way or two-way independent group or randomised block design data.</i> |
|--------------------------------|---|

---

## Description

The [make\\_1way\\_data](#), [make\\_1way\\_rb\\_data](#), [make\\_2way\\_data](#) and [make\\_2way\\_rb\\_data](#) functions generate independent or randomised block (rb) design data of one-way or two-way designs.

## Usage

```
make_2way_rb_data(Group1_means, Group2_means, Num_exp, Exp_SD, Residual_SD)
```

### Arguments

|              |   |
|--------------|---|
| Group1_means | a vector with means of each level of the first fixed factor (FixFac_X1) measured within Group 1.                        |
| Group2_means | only for make_2way_data and make_2way_rb_data: a vector with mean(s) of each level of FactorX2 measured within Group 2. |
| Num_exp      | a single numeric value indicating the number of independent measurements, i.e. levels within the random factor RandFac. |
| Exp_SD       | a single numeric value indicating the standard deviation (SD) between experiment, i.e. within RandFac.                  |
| Residual_SD  | a single numeric value indicating residual SD in the model.   |

### Details

Random variates from the normal distribution based on user provided mean and SD provided are generated. For independent designs, the Residual\_SD argument is used to set expected residual SD from the linear model. Exp\_SD is used to set experiment-to-experiment SD, that will be assigned to the random factor (RandFac) for rb designs.

Num\_exp sets the number of independent measurements per group.

For one-way designs, the user provides Group\_means as a vector. Number of levels are recognised based on number of means. For two-way designs, two vectors are to be provided by the user containing means of levels of a second factor. Number of means in both vectors should be the same. These functions can only handle balanced designs, i.e. same number of observations in all groups.

The output is a data frame with one or two columns denoting the fixed factor with levels that match the number of means entered. For rb data, the column for RandFac denotes levels of the blocking factor. The quantitative response variables are in the numeric Values column.

### Value

This function produces a data.frame object containing simulated data.

### Examples

```
#Basic usage with two levels within FactorX2,  
#20 experiments with inter-experiment SD 20, and residual SD 15  
  
two_rb_tab <- make_2way_rb_data(c(100, 20), c(200, 300), 20, 20, 15)  
  
str(two_rb_tab)  
head(two_rb_tab)
```

---

|             |  |
|-------------|--|
| mixed_anova | <i>ANOVA table from linear mixed effects analysis.</i> |
|-------------|--|

---

## Description

One of four related functions for mixed effects analyses (based on [lmer](#) and [as\\_lmerModLmerTest](#)) to get a linear model for downstream steps, or an ANOVA table.

1. `mixed_model`
2. `mixed_anova`
3. `mixed_model_slopes`
4. `mixed_anova_slopes`.

## Usage

```
mixed_anova(  
  data,  
  Y_value,  
  Fixed_Factor,  
  Random_Factor,  
  Df_method = "Kenward-Roger",  
  SS_method = "II",  
  ...  
)
```

## Arguments

|                            |   |
|----------------------------|---|
| <code>data</code>          | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .  |
| <code>Y_value</code>       | name of column containing quantitative (dependent) variable, provided within "quotes".                                  |
| <code>Fixed_Factor</code>  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes".  |
| <code>Random_Factor</code> | name(s) of random factors to allow random intercepts; to be provided as a vector when more than one or within "quotes". |
| <code>Df_method</code>     | method for calculating degrees of freedom. Default is Kenward-Roger, can be changed to "Satterthwaite".                 |
| <code>SS_method</code>     | type of sum of square, default is type II, can be changed to "I", "III", "1" or "2", or others.                         |
| <code>...</code>           | any additional arguments to pass on to <a href="#">lmer</a> if required.  |

## Details

These functions require a data table, one dependent variable (`Y_value`), one or more independent variables (`Fixed_Factor`), and at least one random factor (`Random_Factor`). These should match names of variables in the long-format data table exactly.

Outputs of `mixed_model` and `mixed_model_slopes` can be used for post-hoc comparisons with `posthoc_Pairwise`, `posthoc_Levelwise`, `posthoc_vsRef`, `posthoc_Trends_Pairwise`, `posthoc_Trends_Levelwise` and `posthoc_Trends_vsRef` or with `emmeans`.

More than one fixed factors can be provided as a vector (e.g. `c("A", "B")`). A full model with interaction term is fitted. This means when `Y_value = Y`, `Fixed_factor = c("A", "B")`, `Random_factor = "R"` are entered as arguments, these are passed on as  $Y \sim A*B + (1|R)$  (which is equivalent to  $Y \sim A + B + A:B + (1|R)$ ).

In `mixed_model_slopes` and `mixed_anova_slopes`, the following kind of formula is used:  $Y \sim A*B + (S|R)$  (which is equivalent to  $Y \sim A + B + A:B + (S|R)$ ). In this experimental implementation, random slopes and intercepts are fitted (`(Slopes_Factor|Random_Factor)`). Only one term each is allowed for `Slopes_Factor` and `Random_Factor`.

## Value

ANOVA table of class "anova" and "data.frame".

## Examples

```
#Usage with one fixed (Student) and random factor (Experiment)
mixed_anova(data = data_doubling_time,
  Y_value = "Doubling_time",
  Fixed_Factor = "Student",
  Random_Factor = "Experiment")

#two fixed factors provided as a vector
mixed_anova(data = data_cholesterol,
  Y_value = "Cholesterol",
  Fixed_Factor = c("Treatment", "Hospital"),
  Random_Factor = "Subject")
```

---

`mixed_anova_slopes`      *ANOVA table from linear mixed effects analysis.*

---

## Description

One of four related functions for mixed effects analyses (based on `lmer` and `as_lmerModLmerTest`) to get a linear model for downstream steps, or an ANOVA table.

1. `mixed_model`
2. `mixed_anova`
3. `mixed_model_slopes`
4. `mixed_anova_slopes`.

**Usage**

```

mixed_anova_slopes(
  data,
  Y_value,
  Fixed_Factor,
  Slopes_Factor,
  Random_Factor,
  Df_method = "Kenward-Roger",
  SS_method = "II",
  ...
)

```

**Arguments**

|                            |   |
|----------------------------|---|
| <code>data</code>          | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .  |
| <code>Y_value</code>       | name of column containing quantitative (dependent) variable, provided within "quotes".                                  |
| <code>Fixed_Factor</code>  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes".  |
| <code>Slopes_Factor</code> | name of factor to allow varying slopes on.  |
| <code>Random_Factor</code> | name(s) of random factors to allow random intercepts; to be provided as a vector when more than one or within "quotes". |
| <code>Df_method</code>     | method for calculating degrees of freedom. Default is Kenward-Roger, can be changed to "Satterthwaite".                 |
| <code>SS_method</code>     | type of sum of square, default is type II, can be changed to "I", "III", "1" or "2", or others.                         |
| <code>...</code>           | any additional arguments to pass on to <code>lmer</code> if required.   |

**Details**

These functions require a data table, one dependent variable (`Y_value`), one or more independent variables (`Fixed_Factor`), and at least one random factor (`Random_Factor`). These should match names of variables in the long-format data table exactly.

Outputs of `mixed_model` and `mixed_model_slopes` can be used for post-hoc comparisons with [posthoc\\_Pairwise](#), [posthoc\\_Levelwise](#), [posthoc\\_vsRef](#), [posthoc\\_Trends\\_Pairwise](#), [posthoc\\_Trends\\_Levelwise](#) and [posthoc\\_Trends\\_vsRef](#) or with `emmeans`.

More than one fixed factors can be provided as a vector (e.g. `c("A", "B")`). A full model with interaction term is fitted. This means when `Y_value = Y`, `Fixed_factor = c("A", "B")`, `Random_factor = "R"` are entered as arguments, these are passed on as  $Y \sim A*B + (1|R)$  (which is equivalent to  $Y \sim A + B + A:B + (1|R)$ ).

In `mixed_model_slopes` and `mixed_anova_slopes`, the following kind of formula is used:  $Y \sim A*B + (S|R)$  (which is equivalent to  $Y \sim A + B + A:B + (S|R)$ ). In this experimental implementation, random slopes and intercepts are fitted (`(Slopes_Factor|Random_Factor)`). Only one term each is allowed for `Slopes_Factor` and `Random_Factor`.

**Value**

ANOVA table of class "anova" and "data.frame".

**Examples**

```
mixed_anova_slopes(data = data_2w_Tdeath,
  Y_value = "PI",
  Fixed_Factor = c("Genotype", "Time"),
  Slopes_Factor = "Time",
  Random_Factor = "Experiment")
```

---

mixed\_model

*Model from a linear mixed effects model*

---

**Description**

One of four related functions for mixed effects analyses (based on [lmer](#) and [as\\_lmerModLmerTest](#)) to get a linear model for downstream steps, or an ANOVA table.

1. mixed\_model
2. mixed\_anova
3. mixed\_model\_slopes
4. mixed\_anova\_slopes.

**Usage**

```
mixed_model(data, Y_value, Fixed_Factor, Random_Factor, ...)
```

**Arguments**

|               |   |
|---------------|---|
| data          | a data table object, e.g. data.frame or tibble.   |
| Y_value       | name of column containing quantitative (dependent) variable, provided within "quotes".                                  |
| Fixed_Factor  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes".  |
| Random_Factor | name(s) of random factors to allow random intercepts; to be provided as a vector when more than one or within "quotes". |
| ...           | any additional arguments to pass on to <a href="#">lmer</a> if required.  |

## Details

These functions require a data table, one dependent variable (`Y_value`), one or more independent variables (`Fixed_Factor`), and at least one random factor (`Random_Factor`). These should match names of variables in the long-format data table exactly.

Outputs of `mixed_model` and `mixed_model_slopes` can be used for post-hoc comparisons with `posthoc_Pairwise`, `posthoc_Levelwise`, `posthoc_vsRef`, `posthoc_Trends_Pairwise`, `posthoc_Trends_Levelwise` and `posthoc_Trends_vsRef` or with `emmeans`.

More than one fixed factors can be provided as a vector (e.g. `c("A", "B")`). A full model with interaction term is fitted. This means when `Y_value = Y`, `Fixed_factor = c("A", "B")`, `Random_factor = "R"` are entered as arguments, these are passed on as  $Y \sim A*B + (1|R)$  (which is equivalent to  $Y \sim A + B + A:B + (1|R)$ ).

In `mixed_model_slopes` and `mixed_anova_slopes`, the following kind of formula is used:  $Y \sim A*B + (S|R)$  (which is equivalent to  $Y \sim A + B + A:B + (S|R)$ ). In this experimental implementation, random slopes and intercepts are fitted (`(Slopes_Factor|Random_Factor)`). Only one term each is allowed for `Slopes_Factor` and `Random_Factor`.

## Value

This function returns an S4 object of class "lmerModLmerTest".

## Examples

```
#one fixed factor and random factor
mixed_model(data = data_doubling_time,
  Y_value = "Doubling_time",
  Fixed_Factor = "Student",
  Random_Factor = "Experiment")

#two fixed factors as a vector, one random factor
mixed_model(data = data_cholesterol,
  Y_value = "Cholesterol",
  Fixed_Factor = c("Treatment", "Hospital"),
  Random_Factor = "Subject")

#save model
model <- mixed_model(data = data_doubling_time,
  Y_value = "Doubling_time",
  Fixed_Factor = "Student",
  Random_Factor = "Experiment")

#get model summary
summary(model)
```

**Description**

One of four related functions for mixed effects analyses (based on [lmer](#) and [as\\_lmerModLmerTest](#)) to get a linear model for downstream steps, or an ANOVA table.

1. `mixed_model`
2. `mixed_anova`
3. `mixed_model_slopes`
4. `mixed_anova_slopes`.

**Usage**

```
mixed_model_slopes(
  data,
  Y_value,
  Fixed_Factor,
  Slopes_Factor,
  Random_Factor,
  ...
)
```

**Arguments**

|                            |   |
|----------------------------|---|
| <code>data</code>          | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .  |
| <code>Y_value</code>       | name of column containing quantitative (dependent) variable, provided within "quotes".                                  |
| <code>Fixed_Factor</code>  | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes".  |
| <code>Slopes_Factor</code> | name of factor to allow varying slopes on.  |
| <code>Random_Factor</code> | name(s) of random factors to allow random intercepts; to be provided as a vector when more than one or within "quotes". |
| <code>...</code>           | any additional arguments to pass on to <a href="#">lmer</a> if required.  |

**Details**

These functions require a data table, one dependent variable (`Y_value`), one or more independent variables (`Fixed_Factor`), and at least one random factor (`Random_Factor`). These should match names of variables in the long-format data table exactly.

Outputs of `mixed_model` and `mixed_model_slopes` can be used for post-hoc comparisons with [posthoc\\_Pairwise](#), [posthoc\\_Levelwise](#), [posthoc\\_vsRef](#), [posthoc\\_Trends\\_Pairwise](#), [posthoc\\_Trends\\_Levelwise](#) and [posthoc\\_Trends\\_vsRef](#) or with [emmeans](#).

More than one fixed factors can be provided as a vector (e.g. `c("A", "B")`). A full model with interaction term is fitted. This means when `Y_value = Y`, `Fixed_factor = c("A", "B")`, `Random_factor = "R"` are entered as arguments, these are passed on as  $Y \sim A*B + (1|R)$  (which is equivalent to  $Y \sim A + B + A:B + (1|R)$ ).

In `mixed_model_slopes` and `mixed_anova_slopes`, the following kind of formula is used:  $Y \sim A*B + (S|R)$  (which is equivalent to  $Y \sim A + B + A:B + (S|R)$ ). In this experimental implementation,



random slopes and intercepts are fitted ((Slopes\_Factor|Random\_Factor)). Only one term each is allowed for Slopes\_Factor and Random\_Factor.

### Value

This function returns an S4 object of class "lmerModLmerTest".

### Examples

```
#two fixed factors as a vector,
#exactly one slope factor and random factor
mod <- mixed_model_slopes(data = data_2w_Tdeath,
  Y_value = "PI",
  Fixed_Factor = c("Genotype", "Time"),
  Slopes_Factor = "Time",
  Random_Factor = "Experiment")
#get summary
summary(mod)
```

---

|                  |  |
|------------------|--|
| plot_3d_point_sd | <i>Plot of mean &amp; error bars for 1-way ANOVAs with matched shapes mapped to blocking factor.</i> |
|------------------|--|

---

### Description

One of 4 related functions for plotting 1-way ANOVA designs with a blocking factor.

1. [plot\\_3d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_3d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_3d\\_scatterbox](#) (box & whiskers)
4. [plot\\_3d\\_scatterviolin](#) (box & whiskers, violin)

### Usage

```
plot_3d_point_sd(
  data,
  xcol,
  ycol,
  shapes,
  facet,
  ErrorType = "SD",
  symsize = 3.5,
  s_alpha = 1,
  symshape = 22,
  all_alpha = 0.3,
  all_size = 2.5,
  all_shape = 0,
  all_jitter = 0,
```

```

    ewid = 0.2,
    TextXAngle = 0,
    LogYTrans,
    LogYBreaks = waiver(),
    LogYLabels = waiver(),
    LogYLimits = NULL,
    facet_scales = "fixed",
    fontsize = 20,
    symthick,
    ethick,
    ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
              "light", "muted", "pale", "r4", "safe", "vibrant"),
    ColSeq = TRUE,
    ColRev = FALSE,
    SingleColour = "NULL",
    ...
  )

```

### Arguments

|            |   |
|------------|---|
| data       | a data table, e.g. data.frame or tibble.  |
| xcol       | name of the column with the categorical factor to be plotted on X axis.   |
| ycol       | name of the column with quantitative variable to plot on the Y axis.  |
| shapes     | name of the column with the blocking factor or another categorical variable.  |
| facet      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| ErrorType  | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions). |
| symsize    | size of symbols, default set to 3.  |
| s_alpha    | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.  |
| symshape   | The mean is shown with symbol of the shape number 21 (default, filled circle). Pick a number between 0-25 to pick a different type of symbol from <code>ggplot2</code> .                            |
| all_alpha  | fractional opacity of all data points (default = 0.3). Set to non-zero value if you would like all data points plotted in addition to the mean.   |
| all_size   | size of symbols of all data points, if shown (default = 2.5).   |
| all_shape  | all data points are shown with symbols of the shape number 0 (default, open square). Pick a number between 0-25 to pick a different type of symbol from <code>ggplot2</code> .                      |
| all_jitter | reduce overlap of all data points, if shown, by setting a value between 0-1 (default = 0).  |
| ewid       | width of error bars, default set to 0.2.  |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |

|              |  |
|--------------|--|
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).  |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines ( <code>stroke</code> ), default = <code>fontsize/22</code> .  |
| ethick       | thickness of error bar lines; default <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> palettes or base R to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass.  |

## Details

The blocking factor (or any other categorical variable) can be mapped to the `shapes` argument (up to 25 levels allowed). Variables passed to `xcol` and `shapes` are internally converted to factors even if they are numeric or other type of variables.

In `plot_3d_point_sd` and `plot_3d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_3d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses `geom_boxplot` to depict median (thicker line), box (interquartile range (IQR)) and the whiskers ( $1.5 \times \text{IQR}$ ).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

The resulting `ggplot2` graph can take additional geometries or other layers.

## Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

**Examples**

```
#3d version for 1-way data with blocking
#use plot_point_sd when no a blocking factor is not used
plot_3d_point_sd(data = data_1w_death,
xcol = Genotype, ycol = Death,
shapes = Experiment)
```

---

|                    |   |
|--------------------|---|
| plot_3d_scatterbar | <i>Plot a bar graph for 1-way ANOVAs with matched shapes mapped to blocking factor.</i> |
|--------------------|---|

---

**Description**

One of 4 related functions for plotting 1-way ANOVA designs with a blocking factor.

1. [plot\\_3d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_3d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_3d\\_scatterbox](#) (box & whiskers)
4. [plot\\_3d\\_scatterviolin](#) (box & whiskers, violin)

**Usage**

```
plot_3d_scatterbar(
  data,
  xcol,
  ycol,
  shapes,
  facet,
  ErrorType = "SD",
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  jitter = 0.1,
  ewid = 0.2,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
```

```

    ColRev = FALSE,
    SingleColour = "NULL",
    ...
)

```

### Arguments

|              |   |
|--------------|---|
| data         | a data table, e.g. data.frame or tibble.  |
| xcol         | name of the column with the categorical factor to be plotted on X axis.   |
| ycol         | name of the column with quantitative variable to plot on the Y axis.  |
| shapes       | name of the column with the second categorical factor, for example from a two-way ANOVA design.   |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2::facet_wrap</code> .  |
| ErrorType    | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions). |
| symsize      | size of symbols, default set to 3.  |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.  |
| b_alpha      | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.                                 |
| jitter       | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.   |
| ewid         | width of error bars, default set to 0.2.  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| LogYTrans    | transform Y axis into "log10" or "log2"   |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.                                    |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.                                    |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).           |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.  |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = <code>fontsize/22</code> .  |
| bthick       | thickness (in 'pt' units) of lines of boxes; default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .                    |

|              |   |
|--------------|---|
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify palettes or base R to fill along X-axis aesthetic. Accepts any colour other than "black"; use grey_lin11, which is almost black. |
| ...          | any additional arguments to pass.   |

### Details

The blocking factor (or any other categorical variable) can be mapped to the shapes argument (up to 25 levels allowed). Variables passed to xcol and shapes are internally converted to factors even if they are numeric or other type of variables.

In plot\_3d\_point\_sd and plot\_3d\_scatterbar, the default error bar is SD (can be changed to SEM or CI95). In plot\_3d\_point\_sd, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses [geom\\_boxplot](#) to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using ColPal, ColRev or ColSeq arguments. ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

The resulting ggplot2 graph can take additional geometries or other layers.

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```
#3d version for 1-way data with blocking
#use plot_scatterbar_sd without blocking factor
plot_3d_scatterbar(data = data_1w_death,
  xcol = Genotype, ycol = Death,
  shapes = Experiment)
```

---

|                    |  |
|--------------------|--|
| plot_3d_scatterbox | <i>Plot a scatter and box plot for 1-way ANOVAs with matched shapes mapped to blocking factor.</i> |
|--------------------|--|

---

### Description

One of 4 related functions for plotting 1-way ANOVA designs with a blocking factor.

1. [plot\\_3d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_3d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_3d\\_scatterbox](#) (box & whiskers)
4. [plot\\_3d\\_scatterviolin](#) (box & whiskers, violin)

**Usage**

```

plot_3d_scatterbox(
  data,
  xcol,
  ycol,
  shapes,
  facet,
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.5,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)

```

**Arguments**

|                      |   |
|----------------------|---|
| <code>data</code>    | a data table, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>    | name of the column with the categorical factor to be plotted on X axis. If your table has numeric X, enter <code>xcol = factor(name of colum)</code> .              |
| <code>ycol</code>    | name of the column with quantitative variable to plot on the Y axis.  |
| <code>shapes</code>  | name of the column with the second categorical factor in a two-way ANOVA design.  |
| <code>facet</code>   | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| <code>symsize</code> | size of symbols, default set to 3.  |
| <code>s_alpha</code> | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.  |
| <code>b_alpha</code> | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency. |
| <code>bwid</code>    | width of boxes; default 0.5.  |
| <code>jitter</code>  | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.   |

|              |  |
|--------------|--|
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).  |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = <code>fontsize/22</code> .   |
| bthick       | thickness (in 'pt' units) of lines of boxes; default = <code>fontsize/22</code> .  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2geom_boxplot</code> .   |

### Details

The blocking factor (or any other categorical variable) can be mapped to the `shapes` argument (up to 25 levels allowed). Variables passed to `xcol` and `shapes` are internally converted to factors even if they are numeric or other type of variables.

In `plot_3d_point_sd` and `plot_3d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_3d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses `geom_boxplot` to depict median (thicker line), box (interquartile range (IQR)) and the whiskers ( $1.5 \times \text{IQR}$ ).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".



## Examples

```
#3d version for 1-way data with blocking
plot_3d_scatterbox(data = data_1w_death,
  xcol = Genotype, ycol = Death,
  shapes = Experiment)
#use plot_scatterbox without a blocking factor
```

---

`plot_3d_scatterviolin` *Plot a scatter with violin & box plot for 1-way ANOVAs with matched shapes mapped to blocking factor.*

---

## Description

One of 4 related functions for plotting 1-way ANOVA designs with a blocking factor.

1. `plot_3d_point_sd` (mean & SD, SEM or CI95 error bars)
2. `plot_3d_scatterbar` (bar & SD, SEM or CI95 error bars)
3. `plot_3d_scatterbox` (box & whiskers)
4. `plot_3d_scatterviolin` (box & whiskers, violin)

## Usage

```
plot_3d_scatterviolin(
  data,
  xcol,
  ycol,
  shapes,
  facet,
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 0,
  v_alpha = 1,
  bwid = 0.3,
  vadjust = 1,
  jitter = 0.1,
  TextXAngle = 0,
  scale = "width",
  trim = TRUE,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
```

```

    bthick,
    vthick,
    bvthick,
    ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
              "light", "muted", "pale", "r4", "safe", "vibrant"),
    ColSeq = TRUE,
    ColRev = FALSE,
    SingleColour = "NULL",
    ...
)

```

### Arguments

|            |  |
|------------|--|
| data       | a data table, e.g. data.frame or tibble.   |
| xcol       | name of the column with the categorical factor to be plotted on X axis. If your table has numeric X, enter xcol = factor(name of colum).                                 |
| ycol       | name of the column with quantitative variable to plot on the Y axis.   |
| shapes     | name of the column with the second categorical factor in a two-way ANOVA design.   |
| facet      | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .   |
| symsize    | size of symbols, default set to 3.   |
| s_alpha    | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set s_alpha = 0 to not show scatter plot.  |
| b_alpha    | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.      |
| v_alpha    | fractional opacity of violins, default set to 1.   |
| bwid       | width of boxes (default 0.3).  |
| vadjust    | number to adjust the smooth/wigglyness of violin plot (default is 1).  |
| jitter     | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.  |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| scale      | set to "area" by default, can be changed to "count" or "width".  |
| trim       | set whether tips of violin plot should be trimmed at high/low data. Default trim = T, can be changed to F.   |
| LogYTrans  | transform Y axis into "log10" or "log2"  |
| LogYBreaks | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis breaks on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired breaks. |
| LogYLabels | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis labels on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired labels. |
| LogYLimits | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |

|              |   |
|--------------|---|
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.  |
| bthick       | thickness (in 'pt' units) of boxplots; default = fontsize/22.   |
| vthick       | thickness (in 'pt' units) of violins; default = fontsize/22.  |
| bvthick      | thickness (in 'pt' units) of both violins and boxplots; default = fontsize/22.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use grey_lin11, which is almost black. |
| ...          | any additional arguments to pass to ggplot2geom_boxplot or ggplot2geom_violin.  |

### Details

The blocking factor (or any other categorical variable) can be mapped to the shapes argument (up to 25 levels allowed). Variables passed to xcol and shapes are internally converted to factors even if they are numeric or other type of variables.

In plot\_3d\_point\_sd and plot\_3d\_scatterbar, the default error bar is SD (can be changed to SEM or CI95). In plot\_3d\_point\_sd, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses [geom\\_boxplot](#) to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using ColPal, ColRev or ColSeq arguments. ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

The resulting ggplot2 graph can take additional geometries or other layers.

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```
#3d version for 1-way data with blocking
plot_3d_scatterviolin(data = data_1w_death,
  xcol = Genotype, ycol = Death,
  shapes = Experiment)
#use plot_scatterviolin without a blocking factor
```

---

|                  |   |
|------------------|---|
| plot_4d_point_sd | <i>Plot mean &amp; error bars for 2-way ANOVAs with or without a blocking factor.</i> |
|------------------|---|

---

### Description

There are 4 related functions for 2-way ANOVA type plots. In addition to a categorical variable along the X-axis, a grouping factor is passed to either points, bars or boxes argument in these functions. A blocking factor (or any other categorical variable) can be optionally passed to the shapes argument.

1. `plot_4d_point_sd` (mean & SD, SEM or CI95 error bars)
2. `plot_4d_scatterbar` (bar & SD, SEM or CI95 error bars)
3. `plot_4d_scatterbox` (box & whiskers)
4. `plot_4d_scatterviolin` (box & whiskers, violin)

### Usage

```
plot_4d_point_sd(
  data,
  xcol,
  ycol,
  points,
  shapes,
  facet,
  ErrorType = "SD",
  symsize = 3.5,
  s_alpha = 1,
  symshape = 22,
  all_alpha = 0.3,
  all_size = 2.5,
  all_shape = 0,
  all_jitter = 0,
  ewid = 0.2,
  group_wid = 0.8,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  ethick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
```

```

    ColSeq = TRUE,
    ColRev = FALSE,
    ...
)

```

## Arguments

|            |  |
|------------|--|
| data       | a data table, e.g. data.frame or tibble.   |
| xcol       | name of the column with the variable to plot on X axis (will be converted to a factor/categorical variable).   |
| ycol       | name of the column to plot on quantitative variable on the Y axis.   |
| points     | name of the column with grouping within the factor plotted on X-axis (will be converted to a factor/categorical variable).   |
| shapes     | name of the column that contains matched observations (e.g. subject IDs, experiment number) or another variable to pass on to symbol shapes (will be converted to a factor/categorical variable). If not provided, the shapes for all groups is the same, and can be changed with all_shapes, all_alpha, all_size etc. |
| facet      | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .   |
| ErrorType  | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions).  |
| symsize    | size of symbols, default set to 3.5.   |
| s_alpha    | fractional opacity of symbols, default set to 1 (i.e. fully opaque).   |
| symshape   | The mean is shown with symbol of the shape number 21 (default, filled circle). Pick a number between 0-25 to pick a different type of symbol from ggplot2.   |
| all_alpha  | fractional opacity of all data points (default = 0.3).   |
| all_size   | size of symbols of all data points, if shown (default = 2.5).  |
| all_shape  | all data points are shown with symbols of the shape number 0 (default, open square). Pick a number between 0-25 to pick a different type of symbol from ggplot2. This argument only has an effect if shapes argument is used.  |
| all_jitter | reduce overlap of all data points, if shown, by setting a value between 0-1 (default = 0).   |
| ewid       | width of error bars, default set to 0.2.   |
| group_wid  | space between the factors along X-axis, i.e., dodge width. Default group_wid = 0.8 (range 0-1), which can be set to 0 if you'd like the two plotted as position = position_identity().   |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans  | transform Y axis into "log10" or "log2"  |
| LogYBreaks | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |

|              |   |
|--------------|---|
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| facet_scales | whether or not to fix scales on X & Y axes for all facet facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively). |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.  |
| ethick       | thickness of error bar lines; default fontsize/22.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.    |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| ...          | any additional arguments to pass to <a href="#">ggplot2stat_summary</a> or <a href="#">ggplot2geom_point</a> .  |

### Details

These can be especially useful when the fourth variable shapes is a random factor or blocking factor (up to 25 levels are allowed; there will be an error with more levels). The shapes argument can be left blank to plot ordinary 2-way ANOVAs without blocking.

In `plot_4d_point_sd` and `plot_4d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_4d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses [geom\\_boxplot](#) to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
#4d version for 2-way data with blocking
plot_4d_point_sd(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
  points = Time,
  shapes = Experiment)
```

```
#4d version without blocking factor
```

```
#`shapes` can be left blank
plot_4d_point_sd(data = data_2w_Festing,
  xcol = Strain,
  ycol = GST,
  points = Treatment)
```

---

|                    |  |
|--------------------|--|
| plot_4d_scatterbar | <i>Plot scatter plot with bar &amp; error bars for 2-way ANOVAs with or without a blocking factor.</i> |
|--------------------|--|

---

### Description

There are 4 related functions for 2-way ANOVA type plots. In addition to a categorical variable along the X-axis, a grouping factor is passed to either points, bars or boxes argument in these functions. A blocking factor (or any other categorical variable) can be optionally passed to the shapes argument.

1. [plot\\_4d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_4d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_4d\\_scatterbox](#) (box & whiskers)
4. [plot\\_4d\\_scatterviolin](#) (box & whiskers, violin)

### Usage

```
plot_4d_scatterbar(
  data,
  xcol,
  ycol,
  bars,
  shapes,
  facet,
  ErrorType = "SD",
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.7,
  jitter = 0.1,
  ewid = 0.2,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  group_wid = 0.8,
```

```

  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColRev = FALSE,
  ColSeq = TRUE,
  ...
)

```

## Arguments

|                         |   |
|-------------------------|---|
| <code>data</code>       | a data table, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>       | name of the column with the categorical factor to plot on X axis. If column is numeric, enter as <code>factor(col)</code> .   |
| <code>ycol</code>       | name of the column to plot on quantitative variable on the Y axis.  |
| <code>bars</code>       | name of the column containing grouping within the factor plotted on X axis. Can be categorical or numeric X. If your table has numeric X and you want to plot as factor, enter <code>xcol = factor(name of column)</code> . |
| <code>shapes</code>     | name of the column that contains matched observations (e.g. subject IDs, experiment number) or another variable to pass on to symbol shapes. If not provided, the shapes for all groups is the same.                        |
| <code>facet</code>      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| <code>ErrorType</code>  | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions).                         |
| <code>symsize</code>    | size of symbols, default set to 3.  |
| <code>s_alpha</code>    | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.  |
| <code>b_alpha</code>    | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.   |
| <code>bwid</code>       | width of boxes; default 0.7.  |
| <code>jitter</code>     | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.   |
| <code>ewid</code>       | width of error bars, default set to 0.2.  |
| <code>TextXAngle</code> | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| <code>LogYTrans</code>  | transform Y axis into "log10" or "log2"   |
| <code>LogYBreaks</code> | argument for <code>ggplot2</code> [ <code>scale_y_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| <code>LogYLabels</code> | argument for <code>ggplot2</code> [ <code>scale_y_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| <code>LogYLimits</code> | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |



|              |  |
|--------------|--|
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).                        |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| group_wid    | space between the factors along X-axis, i.e., dodge width. Default group_wid = 0.8 (range 0-1), which can be set to 0 if you'd like the two plotted as position = position_identity(). |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.   |
| bthick       | thickness (in 'pt' units) of bar and error bar lines; default = fontsize/22.   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.                     |
| ...          | any additional arguments to pass to <a href="#">ggplot2stat_summary</a> or <a href="#">ggplot2geom_point</a> .   |

### Details

These can be especially useful when the fourth variable shapes is a random factor or blocking factor (up to 25 levels are allowed; there will be an error with more levels). The shapes argument can be left blank to plot ordinary 2-way ANOVAs without blocking.

In `plot_4d_point_sd` and `plot_4d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_4d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses `geom_boxplot` to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
#4d version for 2-way data with blocking
plot_4d_scatterbar(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
  bars = Time,
  shapes = Experiment)
```

```
#4d version without blocking factor
#`shapes` can be left blank
plot_4d_scatterbar(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
  bars = Time)
```

---

plot\_4d\_scatterbox      *Plot scatter, box & whiskers for 2-way ANOVAs with or without a blocking factor.*

---

### Description

There are 4 related functions for 2-way ANOVA type plots. In addition to a categorical variable along the X-axis, a grouping factor is passed to either points, bars or boxes argument in these functions. A blocking factor (or any other categorical variable) can be optionally passed to the shapes argument.

1. [plot\\_4d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_4d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_4d\\_scatterbox](#) (box & whiskers)
4. [plot\\_4d\\_scatterviolin](#) (box & whiskers, violin)

### Usage

```
plot_4d_scatterbox(
  data,
  xcol,
  ycol,
  boxes,
  shapes,
  facet,
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.7,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  group_wid = 0.8,
  symthick,
  bthick,
```

```

  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  ...
)

```

## Arguments

|                           |   |
|---------------------------|---|
| <code>data</code>         | a data table, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>         | name of the column with the categorical factor to plot on X axis. If column is numeric, enter as <code>factor(col)</code> .   |
| <code>ycol</code>         | name of the column to plot on quantitative variable on the Y axis.  |
| <code>boxes</code>        | name of the column containing grouping within the factor plotted on X axis. Can be categorical or numeric X. If your table has numeric X and you want to plot as factor, enter <code>xcol = factor(name of column)</code> .     |
| <code>shapes</code>       | name of the column that contains matched observations (e.g. subject IDs, experiment number) or another variable to pass on to symbol shapes. If not provided, the shapes for all groups is the same.                            |
| <code>facet</code>        | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| <code>symsize</code>      | size of symbols, default set to 3.  |
| <code>s_alpha</code>      | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.  |
| <code>b_alpha</code>      | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.   |
| <code>bwid</code>         | width of boxes; default 0.7.  |
| <code>jitter</code>       | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.   |
| <code>TextXAngle</code>   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| <code>LogYTrans</code>    | transform Y axis into "log10" or "log2"   |
| <code>LogYBreaks</code>   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| <code>LogYLabels</code>   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| <code>LogYLimits</code>   | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| <code>facet_scales</code> | whether or not to fix scales on X & Y axes for all facet graphs. Can be <code>fixed</code> (default), <code>free</code> , <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).            |
| <code>fontsize</code>     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.  |
| <code>group_wid</code>    | space between the factors along X-axis, i.e., <code>dodge width</code> . Default <code>group_wid = 0.8</code> (range 0-1), which can be set to 0 if you'd like the two plotted as <code>position = position_identity()</code> . |

|          |  |
|----------|--|
| symthick | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.   |
| bthick   | thickness (in 'pt' units) of boxplot lines; default = fontsize/22.   |
| ColPal   | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq   | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> . |
| ColRev   | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...      | any additional arguments to pass to <code>ggplot2geom_boxplot</code> .   |

### Details

These can be especially useful when the fourth variable shapes is a random factor or blocking factor (up to 25 levels are allowed; there will be an error with more levels). The shapes argument can be left blank to plot ordinary 2-way ANOVAs without blocking.

In `plot_4d_point_sd` and `plot_4d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_4d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses `geom_boxplot` to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
#4d version for 2-way data with blocking
plot_4d_scatterbox(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
  boxes = Time,
  shapes = Experiment)
```

```
#4d version without blocking factor
#`shapes` can be left blank
plot_4d_scatterbox(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
  boxes = Time)
```

---

plot\_4d\_scatterviolin *Plot scatter, box & violin for 2-way ANOVAs with or without a blocking factor.*

---

## Description

There are 4 related functions for 2-way ANOVA type plots. In addition to a categorical variable along the X-axis, a grouping factor is passed to either points, bars or boxes argument in these functions. A blocking factor (or any other categorical variable) can be optionally passed to the shapes argument.

1. [plot\\_4d\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_4d\\_scatterbar](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_4d\\_scatterbox](#) (box & whiskers)
4. [plot\\_4d\\_scatterviolin](#) (box & whiskers, violin)

## Usage

```
plot_4d_scatterviolin(  
  data,  
  xcol,  
  ycol,  
  boxes,  
  shapes,  
  facet,  
  symsize = 3,  
  s_alpha = 0.8,  
  v_alpha = 1,  
  b_alpha = 0,  
  bwid = 0.3,  
  vadjust = 1,  
  jitter = 0.1,  
  TextXAngle = 0,  
  scale = "width",  
  trim = TRUE,  
  LogYTrans,  
  LogYBreaks = waiver(),  
  LogYLabels = waiver(),  
  LogYLimits = NULL,  
  facet_scales = "fixed",  
  fontsize = 20,  
  group_wid = 0.8,  
  symthick,  
  bthick,  
  vthick,  
  bvthick,
```

```

ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
  "light", "muted", "pale", "r4", "safe", "vibrant"),
ColSeq = TRUE,
ColRev = FALSE,
  ...
)

```

## Arguments

|            |   |
|------------|---|
| data       | a data table, e.g. data.frame or tibble.  |
| xcol       | name of the column with the categorical factor to plot on X axis. If column is numeric, enter as factor(col).   |
| ycol       | name of the column to plot on quantitative variable on the Y axis.  |
| boxes      | name of the column containing grouping within the factor plotted on X axis. Can be categorical or numeric X. If your table has numeric X and you want to plot as factor, enter xcol = factor(name of column). |
| shapes     | name of the column that contains matched observations (e.g. subject IDs, experiment number) or another variable to pass on to symbol shapes. If not provided, the shapes for all groups is the same.          |
| facet      | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .  |
| symsize    | size of symbols, default set to 3.  |
| s_alpha    | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set s_alpha = 0 to not show scatter plot.   |
| v_alpha    | fractional opacity of violins, default set to 1.  |
| b_alpha    | fractional opacity of boxes. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.   |
| bwid       | width of boxes; default 0.3.  |
| vadjust    | number to adjust the smooth/wigglyness of violin plot (default set to 1).   |
| jitter     | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.   |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| scale      | set to "area" by default, can be changed to "count" or "width".   |
| trim       | set whether tips of violin plot should be trimmed at high/low data. Default trim = T, can be changed to F.  |
| LogYTrans  | transform Y axis into "log10" or "log2"   |
| LogYBreaks | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis breaks on log scales, default is waiver(), or provide a vector of desired breaks.   |
| LogYLabels | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis labels on log scales, default is waiver(), or provide a vector of desired labels.   |
| LogYLimits | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |

|              |  |
|--------------|--|
| facet_scales | whether or not to fix scales on X & Y axes for all facet facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).                  |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| group_wid    | space between the factors along X-axis, i.e., dodge width. Default group_wid = 0.8 (range 0-1), which can be set to 0 if you'd like the two plotted as position = position_identity(). |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.   |
| bthick       | thickness (in 'pt' units) of boxplots; default = fontsize/22.  |
| vthick       | thickness (in 'pt' units) of violins; default = fontsize/22.   |
| bvthick      | thickness (in 'pt' units) of both violins and boxplots; default = fontsize/22.   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.                     |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass to <a href="#">ggplot2geom_boxplot</a> or <a href="#">ggplot2geom_violin</a> .  |

### Details

These can be especially useful when the fourth variable shapes is a random factor or blocking factor (up to 25 levels are allowed; there will be an error with more levels). The shapes argument can be left blank to plot ordinary 2-way ANOVAs without blocking.

In `plot_4d_point_sd` and `plot_4d_scatterbar`, the default error bar is SD (can be changed to SEM or CI95). In `plot_4d_point_sd`, a large coloured symbol is plotted at the mean, all other data are shown as smaller symbols. Boxplot uses `geom_boxplot` to depict median (thicker line), box (interquartile range (IQR)) and the whiskers (1.5\*IQR).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
#4d version for 2-way data with blocking
plot_4d_scatterviolin(data = data_2w_Tdeath,
  xcol = Genotype,
  ycol = PI,
```

```
boxes = Time,
shapes = Experiment)

#4d version without blocking factor
#`shapes` can be left blank
plot_4d_scatterviolin(data = data_2w_Tdeath,
xcol = Genotype,
ycol = PI,
boxes = Time)
```

---

plot\_befafter\_box      *Before-after style graph with a boxplot*

---

### Description

One of 3 related functions to plot matching data joined by lines. The variable containing information for matching (e.g. matched subjects or experiments etc.) is passed to the match argument.

1. [plot\\_befafter\\_colours](#) or [plot\\_befafter\\_colors](#),
2. [plot\\_befafter\\_shapes](#)
3. [plot\\_befafter\\_box](#)

### Usage

```
plot_befafter_box(
  data,
  xcol,
  ycol,
  match,
  facet,
  PlotShapes = FALSE,
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.4,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  lthick,
```



```

ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
  "light", "muted", "pale", "r4", "safe", "vibrant"),
ColSeq = TRUE,
ColRev = FALSE,
SingleColour = "NULL",
  ...
)

```

## Arguments

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| xcol         | name of the column containing the categorical variable to be plotted on the X axis.  |
| ycol         | name of the column containing the quantitative Y values.   |
| match        | name of the column with the grouping variable to pass on to geom_line.   |
| facet        | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .   |
| PlotShapes   | logical TRUE or FALSE (default = FALSE) if the shape of the symbol is to be mapped to the match variable. Note that only 25 shapes allowed.                              |
| symsize      | size of symbols, default set to 3.   |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e., 80% opacity).   |
| b_alpha      | fractional opacity of boxes, default set to 1.   |
| bwid         | width of boxplots; default 0.4.  |
| jitter       | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis breaks on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired breaks. |
| LogYLabels   | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis labels on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired labels. |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).          |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.   |
| bthick       | thickness (in 'pt' units) of boxes; default = (fontsize)/22.   |
| lthick       | thickness (in 'pt' units) of lines; default = (fontsize/1.2)/22.   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |

|              |  |
|--------------|--|
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_l1n11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2geom_line</code> , <code>ggplot2geom_point</code> , or <code>ggplot2facet_wrap</code> .   |

### Details

In `plot_befafter_colours/plot_befafter_colors` and `plot_befafter_shapes` setting `Boxplot = TRUE` will also plot a box and whiskers plot.

Note that only 25 shapes are available, and there will be errors with `plot_befafter_shapes` when there are fewer than 25 matched observations; instead use `plot_befafter_colours` instead.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

To plot a graph with a single colour along the X axis variable, use the `SingleColour` argument.

The resulting `ggplot2` graph can take additional geometries or other layers.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
plot_befafter_box(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  match = Subject)
```

```
#with PlotShapes = TRUE
plot_befafter_box(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  match = Subject, PlotShapes = TRUE)
```

---

`plot_befafter_colours` *Plot a before-after plot with lines joining colour-matched symbols.*

---

**Description**

One of 3 related functions to plot matching data joined by lines. The variable containing information for matching (e.g. matched subjects or experiments etc.) is passed to the match argument.

1. [plot\\_befafter\\_colours](#) or [plot\\_befafter\\_colors](#),
2. [plot\\_befafter\\_shapes](#)
3. [plot\\_befafter\\_box](#)

**Usage**

```
plot_befafter_colours(  
  data,  
  xcol,  
  ycol,  
  match,  
  facet,  
  Boxplot = FALSE,  
  symsize = 3,  
  s_alpha = 1,  
  jitter = 0.1,  
  bwid = 0.4,  
  TextXAngle = 0,  
  LogYTrans,  
  LogYBreaks = waiver(),  
  LogYLabels = waiver(),  
  LogYLimits = NULL,  
  facet_scales = "fixed",  
  fontsize = 20,  
  symthick,  
  bthick,  
  lthick,  
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",  
    "light", "muted", "pale", "r4", "safe", "vibrant"),  
  ColSeq = TRUE,  
  ColRev = FALSE,  
  SingleColour = "NULL",  
  ...  
)  
  
plot_befafter_colors(  
  data,  
  xcol,  
  ycol,  
  match,  
  facet,  
  Boxplot = FALSE,  
  symsize = 3,  
  s_alpha = 1,
```

```

  jitter = 0.1,
  bwid = 0.4,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  lthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)

```

### Arguments

|            |  |
|------------|--|
| data       | a data table object, e.g. data.frame or tibble.  |
| xcol       | name of the column containing the categorical variable to be plotted on the X axis.  |
| ycol       | name of the column containing the quantitative Y values.   |
| match      | name of the column with the matching variable to pass on to geom_line.   |
| facet      | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .   |
| Boxplot    | logical TRUE/FALSE, whether to show box and whisker plot or not (default is FALSE)   |
| symsize    | size of symbols, default set to 3.   |
| s_alpha    | fractional opacity of symbols, default set to 1 (i.e. maximum opacity & zero transparency).  |
| jitter     | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.  |
| bwid       | width of boxplots; default 0.4.  |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans  | transform Y axis into "log10" or "log2"  |
| LogYBreaks | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks. |
| LogYLabels | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels. |
| LogYLimits | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |

|              |   |
|--------------|---|
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.  |
| bthick       | thickness (in 'pt' units) of boxes; default = (fontsize)/22.  |
| lthick       | thickness (in 'pt' units) of lines; default = (fontsize/1.2)/22.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use grey_lin11, which is almost black. |
| ...          | any additional arguments to pass to ggplot2geom_line or ggplot2geom_point.  |

### Details

In plot\_befafter\_colours/plot\_befafter\_colors and plot\_befafter\_shapes setting Boxplot = TRUE will also plot a box and whiskers plot.

Note that only 25 shapes are available, and there will be errors with plot\_befafter\_shapes when there are fewer than 25 matched observations; instead use plot\_befafter\_colours instead.

Colours can be changed using ColPal, ColRev or ColSeq arguments. ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

To plot a graph with a single colour along the X axis variable, use the SingleColour argument.

The resulting ggplot2 graph can take additional geometries or other layers.

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```
#plot without legends if necessary
plot_befafter_colours(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  match = Subject, s_alpha = .9, ColSeq = FALSE)+
  guides(fill = "none",
  colour = "none") #remove guides
#plot with boxplot
plot_befafter_colours(data = data_t_pdiff,
```

```
xcol = Condition, ycol = Mass,
match = Subject, s_alpha = .9, ColSeq = FALSE,
Boxplot = TRUE)+
guides(fill = "none",
colour = "none") #remove guides
```

---

plot\_befafter\_shapes *Plot a before-after plot with lines joining shape-matched symbols.*

---

### Description

One of 3 related functions to plot matching data joined by lines. The variable containing information for matching (e.g. matched subjects or experiments etc.) is passed to the match argument.

1. [plot\\_befafter\\_colours](#) or [plot\\_befafter\\_colors](#),
2. [plot\\_befafter\\_shapes](#)
3. [plot\\_befafter\\_box](#)

### Usage

```
plot_befafter_shapes(
  data,
  xcol,
  ycol,
  match,
  facet,
  Boxplot = FALSE,
  symsize = 3,
  s_alpha = 1,
  bwid = 0.4,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  lthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)
```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| xcol         | name of the column containing the categorical variable to be plotted on the X axis.  |
| ycol         | name of the column containing the quantitative Y values.   |
| match        | name of the column with the matching variable to pass on to geom_line.   |
| facet        | add another variable from the data table to create faceted graphs using ggplot2 <a href="#">facet_wrap</a> .   |
| Boxplot      | logical TRUE/FALSE, whether to show box and whisker plot or not (default is FALSE)   |
| symsize      | size of symbols, default set to 3.   |
| s_alpha      | fractional opacity of symbols, default set to 1.   |
| bwid         | width of boxplots; default 0.4.  |
| jitter       | extent of jitter (scatter) of symbols, default is 0.1. Increase to reduce symbol overlap, set to 0 for aligned symbols.  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis breaks on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for ggplot2[ <a href="#">scale_y_continuous</a> ] for Y axis labels on log scales, default is <a href="#">waiver()</a> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, <a href="#">free_y</a> or <a href="#">free_x</a> (for Y and X axis one at a time, respectively).  |
| fontsize     | parameter of <a href="#">base_size</a> of fonts in <a href="#">theme_classic</a> , default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines ( <a href="#">stroke</a> ), default = $\text{fontsize}/22$ .   |
| bthick       | thickness (in 'pt' units) of boxes; default = $(\text{fontsize})/22$ .   |
| lthick       | thickness (in 'pt' units) of lines; default = $(\text{fontsize}/1.2)/22$ .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <a href="#">scale_fill_grafify2</a> .  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <a href="#">grafify</a> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <a href="#">grey_lin11</a> , which is almost black. |
| ...          | any additional arguments to pass to <a href="#">ggplot2geom_line</a> or <a href="#">ggplot2geom_point</a> .  |

## Details

In `plot_befafter_colours/plot_befafter_colors` and `plot_befafter_shapes` setting `Boxplot = TRUE` will also plot a box and whiskers plot.

Note that only 25 shapes are available, and there will be errors with `plot_befafter_shapes` when there are fewer than 25 matched observations; instead use `plot_befafter_colours` instead.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

To plot a graph with a single colour along the X axis variable, use the `SingleColour` argument.

The resulting ggplot2 graph can take additional geometries or other layers.

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
#plot without legends if necessary
plot_befafter_colors(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  match = Subject, s_alpha = .9, ColSeq = FALSE)+
  guides(fill = "none",
  colour = "none") #remove guides
#plot with boxplot
plot_befafter_colors(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  match = Subject, s_alpha = .9, ColSeq = FALSE,
  Boxplot = TRUE)+
  guides(fill = "none",
  colour = "none") #remove guides
```

---

plot\_density

*Plot density distribution of data.*

---

## Description

This function takes a data table, `ycol` of quantitative variable and a categorical grouping variable (`group`), if available, and plots a density graph using `geom_density`). Alternatives are `plot_histogram`, or `plot_qqline`.



**Usage**

```

plot_density(
  data,
  ycol,
  group,
  facet,
  c_alpha = 0.2,
  TextXAngle = 0,
  facet_scales = "fixed",
  fontsize = 20,
  linethick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
             "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  ...
)

```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table e.g. data.frame or tibble.  |
| ycol         | name of the column containing the quantitative variable whose density distribution is to be plotted.   |
| group        | name of the column containing a categorical grouping variable  |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2::facet_wrap</code> .   |
| c_alpha      | fractional opacity of filled colours under the curve, default set to 0.2 (i.e. 20% opacity).   |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).                  |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| linethick    | thickness of symbol border, default set to <code>fontsize/22</code> .  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> . |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass to <code>ggplot2::geom_density</code> .   |

## Details

Note that the function requires the quantitative Y variable first, and groups them based on an X variable. The group variable is mapped to the fill and colour aesthetics in `geom_density`. Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with `plot_grafify_palette`. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
plot_density(data = data_t_pratio,
             ycol = log(Cytokine), group = Genotype)

#with faceting
plot_density(data = data_cholesterol,
             ycol = Cholesterol, group = Treatment,
             facet = Treatment, fontsize = 12)
```

---

|                             |   |
|-----------------------------|---|
| <code>plot_dotbar_sd</code> | <i>Plot a dotplot on a bar graph with SD error bars with two variables.</i> |
|-----------------------------|---|

---

## Description

There are three types of `plot_dot_` functions that plot data as "dots" using the `geom_dotplot` geometry. They all take a data table, a categorical X variable and a numeric Y variable.

1. `plot_dotbar_sd` (bar & SD, SEM or CI95 error bars)
2. `plot_dotbox` (box & whiskers)
3. `plot_dotviolin` (box & whiskers, violin)

## Usage

```
plot_dotbar_sd(
  data,
  xcol,
  ycol,
  facet,
  ErrorType = "SD",
  dotsize = 1.5,
  d_alpha = 0.8,
  b_alpha = 1,
```

```

    bwid = 0.5,
    ewid = 0.2,
    TextXAngle = 0,
    LogYTrans,
    LogYBreaks = waiver(),
    LogYLabels = waiver(),
    LogYLimits = NULL,
    facet_scales = "fixed",
    fontsize = 20,
    dotthick,
    bthick,
    ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
              "light", "muted", "pale", "r4", "safe", "vibrant"),
    ColSeq = TRUE,
    ColRev = FALSE,
    SingleColour = "NULL",
    ...
  )

```

### Arguments

|            |   |
|------------|---|
| data       | a data table object, e.g. data.frame or tibble.   |
| xcol       | name of the column to plot on X axis. This should be a categorical variable.  |
| ycol       | name of the column to plot on quantitative Y axis. This should be a quantitative variable.  |
| facet      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| ErrorType  | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions). |
| dotsize    | size of dots relative to binwidth used by <code>geom_dotplot</code> . Default set to 1.5, increase/decrease as needed.  |
| d_alpha    | fractional opacity of dots, default set to 0.8 (i.e., 80% opacity).   |
| b_alpha    | fractional opacity of bars, default set to 1.   |
| bwid       | width of bars; default 0.5.   |
| ewid       | width of error bars, default set to 0.2.  |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| LogYTrans  | transform Y axis into "log10" or "log2"   |
| LogYBreaks | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.                                    |
| LogYLabels | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.                                    |
| LogYLimits | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |

|              |   |
|--------------|---|
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.   |
| dotthick     | thickness of dot border (stroke parameter of geom_dotplot), default set to fontsize/22.   |
| bthick       | thickness (in 'pt' units) of bar and error bar lines; default = fontsize/22.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using scale_fill_grafify2.  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use grey_lin11, which is almost black. |
| ...          | any additional arguments to pass to ggplot2 <a href="#">geom_dotplot</a> .  |

### Details

Related plot\_scatter\_ variants show data symbols using the [geom\\_point](#) geometry. These are [plot\\_scatterbar\\_sd](#) (or SEM or CI95 error bars), [plot\\_scatterbox](#) and [plot\\_scatterviolin](#). Over plotting in plot\_scatter variants can be reduced with the `jitter` argument.

The X variable is mapped to the fill aesthetic of dots, symbols, bars, boxes and violins.

Colours can be changed using ColPal, ColRev or ColSeq arguments. Colours available can be seen quickly with [plot\\_grafify\\_palette](#). ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

If you prefer a single colour for the graph, use the SingleColour argument.

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```
plot_dotbar_sd(data = data_cholesterol,
              xcol = Treatment,
              ycol = Cholesterol)
```

```
plot_dotbar_sd(data = data_1w_death,
              xcol = Genotype, ycol = Death,
              ColPal = "pale", ColSeq = FALSE, ColRev = TRUE)
```

```
#single colour along X
plot_dotbar_sd(data = data_1w_death,
xcol = Genotype, ycol = Death,
SingleColour = "light_orange")
```

---

plot\_dotbox

---

*Plot a dotplot on a boxplot with two variables.*


---

## Description

There are three types of `plot_dot_` functions that plot data as "dots" using the `geom_dotplot` geometry. They all take a data table, a categorical X variable and a numeric Y variable.

1. `plot_dotbar_sd` (bar & SD, SEM or CI95 error bars)
2. `plot_dotbox` (box & whiskers)
3. `plot_dotviolin` (box & whiskers, violin)

## Usage

```
plot_dotbox(
  data,
  xcol,
  ycol,
  facet,
  dotsize = 1.5,
  d_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.5,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  dotthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)
```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| xcol         | name of the column to plot on X axis. This should be a categorical variable.   |
| ycol         | name of the column to plot on quantitative Y axis. This should be a quantitative variable.   |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| dotsize      | size of dots relative to binwidth used by <code>geom_dotplot</code> . Default set to 1.5, increase/decrease as needed.   |
| d_alpha      | fractional opacity of dots, default set to 0.8 (i.e., 80% opacity).  |
| b_alpha      | fractional opacity of boxes, default set to 1.   |
| bwid         | width of boxplots; default 0.5.  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2</code> [ <code>scale_y_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2</code> [ <code>scale_y_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).  |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| dotthick     | thickness of dot border ( <code>stroke</code> parameter of <code>geom_dotplot</code> ), default set to <code>fontsize/22</code> .  |
| bthick       | thickness (in 'pt' units) of boxplot lines; default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2</code> <a href="#">geom_boxplot</a> or <code>ggplot2</code> <a href="#">geom_dotplot</a> .   |

## Details

Related `plot_scatter_` variants show data symbols using the `geom_point` geometry. These are `plot_scatterbar_sd` (or SEM or CI95 error bars), `plot_scatterbox` and `plot_scatterviolin`. Over plotting in `plot_scatter` variants can be reduced with the `jitter` argument.

The X variable is mapped to the fill aesthetic of dots, symbols, bars, boxes and violins.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with `plot_grafify_palette`. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

If you prefer a single colour for the graph, use the `SingleColour` argument.

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
plot_dotbox(data = data_1w_death,
            xcol = Genotype, ycol = Death)

plot_dotbox(data = data_1w_death,
            xcol = Genotype, ycol = Death,
            ColPal = "vibrant", b_alpha = 0.5)
plot_dotbox(data = data_1w_death,
            xcol = Genotype, ycol = Death,
            SingleColour = "safe_bluegreen", b_alpha = 0.5)
```

---

|                |  |
|----------------|--|
| plot_dotviolin | <i>Plot a dotplot on a violin plot with two variables.</i> |
|----------------|--|

---

## Description

There are three types of `plot_dot_` functions that plot data as "dots" using the `geom_dotplot` geometry. They all take a data table, a categorical X variable and a numeric Y variable.

1. `plot_dotbar_sd` (bar & SD, SEM or CI95 error bars)
2. `plot_dotbox` (box & whiskers)
3. `plot_dotviolin` (box & whiskers, violin)

**Usage**

```

plot_dotviolin(
  data,
  xcol,
  ycol,
  facet,
  dotsize = 1.5,
  d_alpha = 0.8,
  b_alpha = 0,
  v_alpha = 1,
  bwid = 0.3,
  vadjust = 1,
  trim = TRUE,
  scale = "width",
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  dotthick,
  bthick,
  vthick,
  bvthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)

```

**Arguments**

|                      |  |
|----------------------|--|
| <code>data</code>    | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>    | name of the column to plot on X axis. This should be a categorical variable.   |
| <code>ycol</code>    | name of the column to plot on quantitative Y axis. This should be a quantitative variable.   |
| <code>facet</code>   | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| <code>dotsize</code> | size of dots relative to binwidth used by <code>geom_dotplot</code> . Default set to 1.5, increase/decrease as needed.   |
| <code>d_alpha</code> | fractional opacity of dots, default set to 0.8 (i.e., 80% opacity).  |
| <code>b_alpha</code> | fractional opacity of boxplots. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency. |



|              |  |
|--------------|--|
| v_alpha      | fractional opacity of violins, default set to 1.   |
| bwid         | width of boxplots; default 0.3.  |
| vadjust      | number to adjust the smooth/wigglyness of violin plot (default set to 1).  |
| trim         | set whether tips of violin plot should be trimmed at high/low data. Default trim = TRUE, can be changed to FALSE.  |
| scale        | set to "area" by default, can be changed to "count" or "width".  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).  |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| dotthick     | thickness of dot border (stroke parameter of <code>geom_dotplot</code> ), default set to <code>fontsize/22</code> .  |
| bthick       | thickness (in 'pt' units) of boxplots; default = <code>fontsize/22</code> .  |
| vthick       | thickness (in 'pt' units) of violins; default = <code>fontsize/22</code> .   |
| bvthick      | thickness (in 'pt' units) of both violins and boxplots; default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2geom_boxplot</code> , <code>ggplot2geom_dotplot</code> or <code>ggplot2geom_violin</code> .   |

## Details

Related `plot_scatter_` variants show data symbols using the `geom_point` geometry. These are `plot_scatterbar_sd` (or SEM or CI95 error bars), `plot_scatterbox` and `plot_scatterviolin`. Over plotting in `plot_scatter` variants can be reduced with the `jitter` argument.

The X variable is mapped to the fill aesthetic of dots, symbols, bars, boxes and violins.

Colours can be changed using ColPal, ColRev or ColSeq arguments. Colours available can be seen quickly with `plot_grafify_palette`. ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

If you prefer a single colour for the graph, use the SingleColour argument.

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```
#plot with trim = FALSE
plot_dotviolin(data = data_t_pdiff,
xcol = Condition, ycol = Mass,
dotsize = 2, trim = FALSE)

plot_dotviolin(data = data_t_pdiff,
xcol = Condition, ycol = Mass,
trim = FALSE, b_alpha = 0.5,
ColPal = "pale", ColSeq = FALSE)

#single colour along X
plot_dotviolin(data = data_t_pdiff,
xcol = Condition, ycol = Mass,
trim = FALSE, b_alpha = 0.5,
SingleColour = "pale_cyan")
```

---

|                  |                                     |
|------------------|-------------------------------------|
| plot_gam_predict | <i>Plot prediction of gam model</i> |
|------------------|-------------------------------------|

---

### Description

Plot prediction of gam model

### Usage

```
plot_gam_predict(
  Model,
  xcol,
  ycol,
  ByFactor,
  symsize = 1,
  s_alpha = 0.1,
  smooth_alpha = 0.7,
```

```

    linethick,
    fontsize = 20,
    ...
  )

```

### Arguments

|              |   |
|--------------|---|
| Model        | a generalised additive model (gam) fitted with <code>ga_model</code> or <code>mgcv</code> |
| xcol         | the smooth in the gam (should match variable in the model exactly)                        |
| ycol         | the dependent variable in gam (should match variable in the model exactly)                |
| ByFactor     | the by factor used in gam (should match variable in the model exactly)                    |
| symsize      | size of symbols (default = 1)   |
| s_alpha      | opacity of symbols (default = 0.1)  |
| smooth_alpha | opacity of the predicted CI interval (default = 0.7)                                      |
| linethick    | thickness of symbol lines (default = <code>fontsize/22</code> )                           |
| fontsize     | base font size for graph  |
| ...          | additional arguments to pass to <a href="#">plot_xy_CatGroup</a> .                        |

### Value

This function returns a ggplot2 object of class "gg" and "ggplot".

### Examples

```

#fit zooplankton data
z1 <- ga_model(data = data_zooplankton,
Y_value = "log(density_adj)",
Fixed_Factor = "taxon",
Smooth_Factor = "day")

#plot fitted data
plot_gam_predict(Model = z1,
xcol = day,
ycol = `log(density_adj)`,
ByFactor = taxon)

```

---

plot\_grafify\_palette *See grafify colour palettes*

---

### Description

This simple function allows quick visualisation of colours in grafify palettes and their hex codes. It uses `plot_bar_sd` and some arguments are similar and can be adjusted.

**Usage**

```
plot_grafify_palette(
  palette = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant", "OrBl_div", "PrGn_div",
    "blue_conti", "grey_conti", "yellow_conti"),
  fontsize = 14,
  ...
)
```

**Arguments**

|          |  |
|----------|--|
| palette  | name of grafify palettes: "okabe_ito", "vibrant", "bright", "pale", "muted", "dark", "light", "contrast" or "all_grafify". |
| fontsize | font size.   |
| ...      | any additional parameters to pass to plot_bar_sd   |

**Value**

This function returns a ggplot2 object of class "gg" and "ggplot".

**Examples**

```
plot_grafify_palette("pale")
plot_grafify_palette("contrast")
```

---

|                |  |
|----------------|--|
| plot_histogram | <i>Plot data distribution as histograms.</i> |
|----------------|--|

---

**Description**

This function takes a data table, a quantitative variable (ycol) and a grouping variable (group), if available, and plots a histogram graph using [geom\\_histogram](#)). Alternatives are [plot\\_histogram](#), or [plot\\_qqline](#).

**Usage**

```
plot_histogram(
  data,
  ycol,
  group,
  facet,
  BinSize = 30,
  c_alpha = 0.8,
  TextXAngle = 0,
  facet_scales = "fixed",
  fontsize = 20,
```

```

    linethick,
    alpha,
    ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
              "light", "muted", "pale", "r4", "safe", "vibrant"),
    ColSeq = TRUE,
    ColRev = FALSE,
    ...
  )

```

## Arguments

|              |  |
|--------------|--|
| data         | a data table e.g. data.frame or tibble.  |
| ycol         | name of the column containing the quantitative variable whose histogram distribution is to be plotted.   |
| group        | name of the column containing a categorical grouping variable.   |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| BinSize      | number of distinct bins to use on X-axis, default set to 30.   |
| c_alpha      | fractional opacity of colour filled within histograms, default set to 0.8 (i.e. 80% opacity).  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).                  |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| linethick    | thickness of symbol border, default set to <code>fontsize/22</code> .  |
| alpha        | deprecated old argument for c_alpha; retained for backward compatibility.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> . |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass to <code>ggplot2</code> <a href="#">geom_histogram</a> .  |

## Details

Note that the function requires the quantitative Y variable first, and groups them based on a categorical variable passed on via the group argument. The grouping variable is mapped to the fill aesthetics in `geom_histogram`.

`ColPal` & `ColRev` options are applied to both fill and colour scales. Colours available can be seen quickly with [plot\\_grafify\\_palette](#). Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

**Value**

This function returns a ggplot2 object of class "gg" and "ggplot".

**Examples**

```
#Basic usage
plot_histogram(data = data_t_pratio,
  ycol = Cytokine, group = Genotype,
  BinSize = 10)
#with log transformation
plot_histogram(data = data_t_pratio,
  ycol = log(Cytokine), group = Genotype,
  BinSize = 10)
```

---

plot\_lm\_predict

*Plot data and predictions from linear model*

---

**Description**

This function takes a linear model, and up to three variables and plots observe data (circles) and model predictions (squares). If the X-variable is categorical, a box and whiskers plot is overlaid. A variable (ByFactor) can be used for faceting.

**Usage**

```
plot_lm_predict(
  Model,
  xcol,
  ycol,
  ByFactor,
  obs_size = 2,
  obs_alpha = 0.3,
  pred_size = 2,
  pred_alpha = 0.8,
  linethick,
  base_size = 15,
  ...
)
```

**Arguments**

|          |   |
|----------|---|
| Model    | a linear model saved with simple_model, mixed_model or ga_model.                            |
| xcol     | variable along the X axis (should match one of the dependent variables in model exactly).   |
| ycol     | independent variable along the Y axis (should match independent variable in model exactly). |
| ByFactor | optional faceting variable (should match one of the variables in model exactly).            |

|            |  |
|------------|--|
| obs_size   | size of symbols for observed data (default = 2).                           |
| obs_alpha  | opacity of symbols for observed data (default = 0.3).                      |
| pred_size  | size of symbols for predicted data (default = 2).                          |
| pred_alpha | opacity of symbols for predicted data (default = 0.8).                     |
| linethick  | thickness of border lines for boxes and symbols (default is base_size/20). |
| base_size  | base fontsize for theme_grafify  |
| ...        | any other parameters to be passed to theme_grafify                         |

**Value**

This function returns a ggplot2 object of class "gg" and "ggplot".

**Examples**

```
#fit a model
deathm1 <- mixed_model(data_2w_Tdeath,
  "PI", c("Genotype", "Time"),
  "Experiment")
#plot model
plot_lm_predict(deathm1,
  Genotype, PI, Time)
#fit zooplankton data
z1 <- ga_model(data = data_zooplankton,
  Y_value = "log(density_adj)",
  Fixed_Factor = "taxon",
  Smooth_Factor = "day")

#plot fitted data
plot_lm_predict(Model = z1,
  xcol = day,
  ycol = `log(density_adj)`,
  ByFactor = taxon)
```

---

plot\_logscale

*Add log transformations to graphs*


---

**Description**

This function allows "log10" or "log2" transformation of X or Y axes. With "log10" transformation, log10 ticks are also added on the outside.

**Usage**

```
plot_logscale(
  Plot,
  LogYTrans = "log10",
  LogXTrans,
  LogYBreaks = waiver(),
  LogXBreaks = waiver(),
  LogYLimits = NULL,
  LogXLimits = NULL,
  LogYLabels = waiver(),
  LogXLabels = waiver(),
  fontsize = 22,
  ...
)
```

**Arguments**

|            |   |
|------------|---|
| Plot       | a ggplot2 object.   |
| LogYTrans  | transform Y axis into "log10" (default) or "log2"   |
| LogXTrans  | transform X axis into "log10" or "log2"   |
| LogYBreaks | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| LogXBreaks | argument for ggplot2[ <code>scale_x_continuous</code> ] for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| LogYLimits | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| LogXLimits | a vector of length two specifying the range (minimum and maximum) of the X axis.  |
| LogYLabels | argument for ggplot2[ <code>scale_y_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| LogXLabels | argument for ggplot2[ <code>scale_x_continuous</code> ] for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| fontsize   | this parameter sets the linewidth of the log10 tickmarks ( $8 * \text{fontsize} / 22$ for long ticks and $4 * \text{fontsize} / 22$ for middle ticks). It is set to 20 as default to be consistent with rest of <code>grafify</code> . It will need to be changed to 12, which is the default fontsize for graphs produced natively with ggplot2. |
| ...        | any other arguments to pass to <code>scale_y_continuous[ggplot2]</code> or <code>scale_x_continuous[ggplot2]</code>   |

**Details**

Arguments allow for axes limits, breaks and labels to be passed on.

**Value**

This function returns a ggplot2 object of class "gg" and "ggplot".



## Examples

```
#save a ggplot object
P <- ggplot(data_t_pratio,
  aes(Genotype,Cytokine))+
  geom_jitter(shape = 21,
  size = 5, width = .2,
  aes(fill = Genotype),
  alpha = .7)
#transform Y axis
plot_logscale(Plot = P)

#or in one go
plot_logscale(ggplot(data_t_pratio,
  aes(Genotype,Cytokine))+
  geom_jitter(shape = 21,
  size = 5, width = .2,
  aes(fill = Genotype),
  alpha = .7))
```

---

plot\_point\_sd

*Plot a point as mean with SD error bars using two variables.*

---

## Description

There are 4 related functions that use [geom\\_point](#) to plot a categorical variable along the X axis.

1. [plot\\_point\\_sd](#) (mean & SD, SEM or CI95 error bars)
2. [plot\\_scatterbar\\_sd](#) (bar & SD, SEM or CI95 error bars)
3. [plot\\_scatterbox](#) (box & whiskers)
4. [plot\\_scatterviolin](#) (box & whiskers, violin)

## Usage

```
plot_point_sd(
  data,
  xcol,
  ycol,
  facet,
  ErrorType = "SD",
  symsize = 3.5,
  s_alpha = 1,
  symshape = 22,
  all_alpha = 0.3,
  all_size = 2.5,
  all_shape = 1,
  all_jitter = 0,
```

```

ewid = 0.2,
TextXAngle = 0,
LogYTrans,
LogYBreaks = waiver(),
LogYLabels = waiver(),
LogYLimits = NULL,
facet_scales = "fixed",
fontsize = 20,
symthick,
ethick,
ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
  "light", "muted", "pale", "r4", "safe", "vibrant"),
ColSeq = TRUE,
ColRev = FALSE,
SingleColour = "NULL",
...
)

```

### Arguments

|            |   |
|------------|---|
| data       | a data table object, e.g. data.frame or tibble.   |
| xcol       | name of the column with a X variable (will be forced to be a factor/categorical variable).  |
| ycol       | name of the column with quantitative Y variable.  |
| facet      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .   |
| ErrorType  | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions). |
| syzsize    | size of point symbols, default set to 3.5.  |
| s_alpha    | fractional opacity of symbols, default set to 1 (i.e. maximum opacity & zero transparency).   |
| symshape   | The mean is shown with symbol of the shape number 22 (default, filled square). Pick a number between 21-25 to pick a different type of symbol from <code>ggplot2</code> .                           |
| all_alpha  | fractional opacity of all data points (default = 0.3). Set to non-zero value if you would like all data points plotted in addition to the mean.   |
| all_size   | size of symbols of all data points, if shown (default = 2.5).   |
| all_shape  | all data points are shown with symbols of the shape number 1 (default, transparent circle). Pick a number between 0-25 to pick a different type of symbol from <code>ggplot2</code> .               |
| all_jitter | reduce overlap of all data points, if shown, by setting a value between 0-1 (default = 0).  |
| ewid       | width of error bars, default set to 0.2.  |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| LogYTrans  | transform Y axis into "log10" or "log2"   |

|              |   |
|--------------|---|
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.  |
| symthick     | thickness of symbol border, default set to <code>fontsize/22</code> .   |
| ethick       | thickness of error bar lines; default <code>fontsize/22</code> .  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.   |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2stat_summary</code> .  |

## Details

These functions take a data table, categorical X and numeric Y variables, and plot various geometries. The X variable is mapped to the `fill` aesthetic of symbols.

In [plot\\_point\\_sd](#) and [plot\\_scatterbar\\_sd](#), default error bars are SD, which can be changed to SEM or CI95.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with [plot\\_grafify\\_palette](#). `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

If there are many groups along the X axis and you prefer a single colour for the graph, use the `SingleColour` argument.

## Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

**Examples**

```
#Basic usage
plot_point_sd(data = data_doubling_time,
              xcol = Student, ycol = Doubling_time)
```

---

plot\_qqline *Plot quantile-quantile (QQ) graphs from data.*

---

**Description**

This function takes a data table, a quantitative variable (ycol), and a categorical grouping variable (group), if available, and plots a QQ graph using `ggplot2[stat_qq]` and `ggplot2[stat_qq_line]`. Alternatives are `plot_histogram`, or `plot_qqline`.

**Usage**

```
plot_qqline(
  data,
  ycol,
  group,
  facet,
  symsize = 3,
  s_alpha = 0.8,
  TextXAngle = 0,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  linethick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
             "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  ...
)
```

**Arguments**

|         |  |
|---------|--|
| data    | a data table e.g. data.frame or tibble.  |
| ycol    | name of the column containing the quantitative variable whose distribution is to be plotted.               |
| group   | name of the column containing a categorical grouping variable.   |
| facet   | add another variable from the data table to create faceted graphs using <code>ggplot2[facet_wrap]</code> . |
| symsize | size of symbols, default set to 3.   |
| s_alpha | fractional opacity of symbols, default set to 1 (i.e. maximum opacity & zero transparency).                |

|              |  |
|--------------|--|
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).                  |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.  |
| symthick     | thickness of symbol border, default set to fontsize/22.  |
| linethick    | thickness of lines, default set to fontsize/22.  |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> . |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass to <code>ggplot2[geom_qq]</code> or <code>ggplot2[geom_qq_line]</code> .  |

## Details

Note that the function requires the quantitative Y variable first, and a grouping variable as group if required. The graph plots sample quantiles on Y axis & theoretical quantiles on X axis. The X variable is mapped to the fill aesthetic `instat_qq` and colour aesthetic for the `stat_qq_line`.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with `plot_grafify_palette`. When only one level is present within group, symbols will receive "ok\_orange" colour. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

## Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

## Examples

```
plot_qqline(data = data_cholesterol,  
            ycol = Cholesterol, group = Treatment)
```

---

plot\_qqmodel

*Plot quantile-quantile (QQ) graphs from residuals of linear models.*


---

### Description

This function takes a linear model (simple or mixed effects) and plots a QQ graph after running `rstudent` from `rstudent` to generate a table of Studentised model residuals on an ordinary (`simple_model`), mixed model (`mixed_model` or `mixed_model_slopes`). The graph plots studentised residuals from the model (sample) on Y axis & Theoretical quantiles on X axis.

### Usage

```
plot_qqmodel(
  Model,
  symsize = 3,
  s_alpha = 0.8,
  fontsize = 20,
  symthick,
  linethick,
  SingleColour = "#E69F00"
)
```

### Arguments

|              |  |
|--------------|--|
| Model        | name of a saved model generated by <code>simple_model</code> or <code>mixed_model</code> .           |
| symsize      | size of symbols, default set to 3.   |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e., 80% opacity).                               |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20. |
| symthick     | thickness of symbol border, default set to <code>fontsize/22</code> .                                |
| linethick    | thickness of line, default set to <code>fontsize/22</code> .   |
| SingleColour | colour of symbols (default = <code>#E69F00</code> , which is <code>ok_orange</code> )                |

### Details

For generalised additive models fit with `mgcv`, scaled Pearson residuals are plotted.

The function uses `ggplot2[geom_qq]` and `ggplot2[geom_qq_line]` geometries. Symbols receive "`ok_orange`" colour by default.

### Value

This function returns a `ggplot2` object of class "`gg`" and "`ggplot`".

**Examples**

```
#Basic usage
m1 <- simple_model(data = data_2w_Festing,
  Y_value = "GST",
  Fixed_Factor = c("Treatment", "Strain"))
plot_qqmodel(m1)
```

plot\_qq\_gam

*Plot model diagnostics for generalised additive models***Description**

This is a clone of the [appraise](#) function in the `gratia` package (rewritten to avoid depending on `gratia` package for these plots). This function will plot 4 diagnostic plots when given a generalised additive model fitted with `ga_model` or `mgcv`. It creates graphs that use `grafify` colours and `theme_grafify()`.

**Usage**

```
plot_qq_gam(
  Model,
  symsize = 2,
  s_colour = "#E69F00",
  s_alpha = 0.6,
  line_col = "black",
  base_size = 12,
  linethick,
  n_bins = c("sturges", "scott", "fd")
)
```

**Arguments**

|           |   |
|-----------|---|
| Model     | a model of class <code>gam</code> fitted with <code>ga_model</code> or the <code>mgcv</code> package. |
| symsize   | size of symbols (default = 2)   |
| s_colour  | colour of symbols (default = <code>ok_orange</code> )   |
| s_alpha   | opacity of symbols (default = 0.8)  |
| line_col  | colour of lines (default = <code>black</code> )   |
| base_size | font size for theme (default = 12)  |
| linethick | thickness in 'pt' units of lines and symbol orders (default = <code>base_size/22</code> )             |
| n_bins    | one of either <code>"sturges"</code> , <code>"scott"</code> , <code>"fd"</code>                       |

**Value**

This function returns an object of classes `"ggplot"` and `"gg"`.

This function returns a `ggplot2` object of class `"gg"` and `"ggplot"`.

---

plot\_scatterbar\_sd      *Plot scatter dots on a bar graph with SD error bars with two variables.*

---

## Description

There are 4 related functions that use `geom_point` to plot a categorical variable along the X axis.

1. `plot_point_sd` (mean & SD, SEM or CI95 error bars)
2. `plot_scatterbar_sd` (bar & SD, SEM or CI95 error bars)
3. `plot_scatterbox` (box & whiskers)
4. `plot_scatterviolin` (box & whiskers, violin)

## Usage

```
plot_scatterbar_sd(
  data,
  xcol,
  ycol,
  facet,
  ErrorType = "SD",
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.5,
  ewid = 0.3,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  LogYLabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)
```

## Arguments

`data`                    a data table object, e.g. `data.frame` or `tibble`.



|              |   |
|--------------|---|
| xcol         | name of the column to plot on X axis. This should be a categorical variable.  |
| ycol         | name of the column to plot on quantitative Y axis. This should be a quantitative variable.  |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2facet_wrap</code> .  |
| ErrorType    | select the type of error bars to display. Default is "SD" (standard deviation). Other options are "SEM" (standard error of the mean) and "CI95" (95% confidence interval based on t distributions).   |
| symsize      | size of point symbols, default set to 3.  |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e, 80% opacity).   |
| b_alpha      | fractional opacity of boxes, default set to .5 (i.e. 50% transparent).  |
| bwid         | width of bars, default set to 0.5.  |
| ewid         | width of error bars, default set to 0.3.  |
| jitter       | extent of jitter (scatter) of symbols, default is 0.1.  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.  |
| LogYTrans    | transform Y axis into "log10" or "log2"   |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.  |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.  |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.  |
| facet_scales | whether or not to fix scales on X & Y axes for all facet graphs. Can be fixed (default), free, free_y or free_x (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of base_size of fonts in theme_classic, default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = fontsize/22.  |
| bthick       | thickness (in 'pt' units) of both bar and error bar lines; default = fontsize/22.   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">grafify_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify palettes or base R to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2facet_wrap</code> .  |

## Details

These functions take a data table, categorical X and numeric Y variables, and plot various geometries. The X variable is mapped to the fill aesthetic of symbols.

In `plot_point_sd` and `plot_scatterbar_sd`, default error bars are SD, which can be changed to SEM or CI95.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with `plot_grafify_palette`. `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

If you prefer a single colour for the graph, use the `SingleColour` argument.

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
#with jitter
plot_scatterbar_sd(data = data_cholesterol,
  xcol = Treatment, ycol = Cholesterol)

plot_scatterbar_sd(data = data_doubling_time,
  xcol = Student, ycol = Doubling_time,
  SingleColour = "ok_grey")
```

---

plot\_scatterbox

*Plot a scatter plot on a boxplot with two variables.*

---

## Description

There are 4 related functions that use `geom_point` to plot a categorical variable along the X axis.

1. `plot_point_sd` (mean & SD, SEM or CI95 error bars)
2. `plot_scatterbar_sd` (bar & SD, SEM or CI95 error bars)
3. `plot_scatterbox` (box & whiskers)
4. `plot_scatterviolin` (box & whiskers, violin)

**Usage**

```

plot_scatterbox(
  data,
  xcol,
  ycol,
  facet,
  symsize = 3,
  s_alpha = 0.8,
  b_alpha = 1,
  bwid = 0.5,
  jitter = 0.1,
  TextXAngle = 0,
  LogYTrans,
  LogYBreaks = waiver(),
  Ylabels = waiver(),
  LogYLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  SingleColour = "NULL",
  ...
)

```

**Arguments**

|                         |  |
|-------------------------|--|
| <code>data</code>       | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>       | name of the column to plot on X axis. This should be a categorical variable.   |
| <code>ycol</code>       | name of the column to plot on quantitative Y axis. This should be a quantitative variable.   |
| <code>facet</code>      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| <code>symsize</code>    | size of symbols, default set to 3.   |
| <code>s_alpha</code>    | fractional opacity of symbols, default set to 0.8 (i.e, 80% opacity).  |
| <code>b_alpha</code>    | fractional opacity of boxes, default set to 1.   |
| <code>bwid</code>       | width of boxplots; default 0.5.  |
| <code>jitter</code>     | extent of jitter (scatter) of symbols, default is 0.1.   |
| <code>TextXAngle</code> | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| <code>LogYTrans</code>  | transform Y axis into "log10" or "log2"  |
| <code>LogYBreaks</code> | argument for <code>ggplot2</code> <code>[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks. |

|              |  |
|--------------|--|
| Ylabels      | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all graphs. Can be <code>fixed</code> (default), <code>free</code> , <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively).   |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines ( <code>stroke</code> ), default = <code>fontsize/22</code> .  |
| bthick       | thickness (in 'pt' units) of boxplot lines; default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .   |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from <code>grafify</code> or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use <code>grey_lin11</code> , which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2geom_boxplot</code> .   |

### Details

These functions take a data table, categorical X and numeric Y variables, and plot various geometries. The X variable is mapped to the `fill` aesthetic of symbols.

In [plot\\_point\\_sd](#) and [plot\\_scatterbar\\_sd](#), default error bars are SD, which can be changed to SEM or CI95.

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with [plot\\_grafify\\_palette](#). `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

If you prefer a single colour for the graph, use the `SingleColour` argument.

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
plot_scatterbox(data = data_cholesterol,
               xcol = Treatment, ycol = Cholesterol)

plot_scatterbox(data = data_doubling_time,
               xcol = Student, ycol = Doubling_time,
               SingleColour = "ok_grey")
```

---

plot\_scatterviolin      *Plot a scatter plot on a violin plot with two variables.*

---

### Description

There are 4 related functions that use `geom_point` to plot a categorical variable along the X axis.

1. `plot_point_sd` (mean & SD, SEM or CI95 error bars)
2. `plot_scatterbar_sd` (bar & SD, SEM or CI95 error bars)
3. `plot_scatterbox` (box & whiskers)
4. `plot_scatterviolin` (box & whiskers, violin)

### Usage

```
plot_scatterviolin(  
  data,  
  xcol,  
  ycol,  
  facet,  
  symsize = 3,  
  s_alpha = 0.8,  
  b_alpha = 0,  
  v_alpha = 1,  
  bwid = 0.3,  
  vadjust = 1,  
  jitter = 0.1,  
  trim = TRUE,  
  scale = "width",  
  TextXAngle = 0,  
  LogYTrans,  
  LogYBreaks = waiver(),  
  Ylabels = waiver(),  
  LogYLimits = NULL,  
  facet_scales = "fixed",  
  fontsize = 20,  
  symthick,  
  bthick,  
  vthick,  
  bvthick,  
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",  
    "light", "muted", "pale", "r4", "safe", "vibrant"),  
  ColSeq = TRUE,  
  ColRev = FALSE,  
  SingleColour = "NULL",  
  ...  
)
```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| xcol         | name of the column to plot on X axis. This should be a categorical variable.   |
| ycol         | name of the column to plot on quantitative Y axis. This should be a quantitative variable.   |
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| symsize      | size of dots relative to binwidth used by <code>geom_point</code> . Default set to 3.  |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e. 80% opacity). Set <code>s_alpha = 0</code> to not show scatter plot.   |
| b_alpha      | fractional opacity of boxplots. Default is set to 0, which results in white boxes inside violins. Change to any value >0 up to 1 for different levels of transparency.   |
| v_alpha      | fractional opacity of violins, default set to 1.   |
| bwid         | width of boxplots; default 0.3.  |
| vadjust      | number to adjust the smooth/wigglyness of violin plot (default set to 1).  |
| jitter       | extent of jitter (scatter) of symbols, default is 0 (i.e. aligned symbols). To reduce symbol overlap, try 0.1-0.3 or higher.   |
| trim         | set whether tips of violin plot should be trimmed at high/low data. Default <code>trim = T</code> , can be changed to <code>F</code> .   |
| scale        | set to "area" by default, can be changed to "count" or "width".  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| Ylabels      | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all graphs. Can be <code>fixed</code> (default), <code>free</code> , <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively). |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = <code>fontsize/22</code> .   |
| bthick       | thickness (in 'pt' units) of boxplots; default = <code>fontsize/22</code> .  |
| vthick       | thickness (in 'pt' units) of violins; default = <code>fontsize/22</code> .   |
| bvthick      | thickness (in 'pt' units) of both violins and boxplots; default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .                               |

|              |   |
|--------------|---|
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).  |
| SingleColour | a colour hexcode (starting with #), a number between 1-154, or names of colours from grafify or base R palettes to fill along X-axis aesthetic. Accepts any colour other than "black"; use grey_lin11, which is almost black. |
| ...          | any additional arguments to pass to <code>ggplot2geom_boxplot</code> , <code>ggplot2geom_point</code> or <code>ggplot2geom_violin</code> .  |

## Details

These functions take a data table, categorical X and numeric Y variables, and plot various geometries. The X variable is mapped to the fill aesthetic of symbols.

In `plot_point_sd` and `plot_scatterbar_sd`, default error bars are SD, which can be changed to SEM or CI95.

Colours can be changed using ColPal, ColRev or ColSeq arguments. Colours available can be seen quickly with `plot_grafify_palette`. ColPal can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". ColRev (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. ColSeq decides whether colours are picked by respecting the order in the palette or the most distant ones using `colorRampPalette`.

If you prefer a single colour for the graph, use the SingleColour argument.

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
#plot without jitter
plot_scatterviolin(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  symsize = 2, trim = FALSE)

#no symbols
plot_scatterviolin(data = data_t_pdiff,
  xcol = Condition, ycol = Mass,
  s_alpha = 0,
  symsize = 2, trim = FALSE)
```

---

|                  |  |
|------------------|--|
| plot_xy_CatGroup | <i>Plot points on a quantitative X - Y plot &amp; a categorical grouping variable.</i> |
|------------------|--|

---

**Description**

This function takes a data table, quantitative X and Y variables along with a categorical grouping variable, and a and plots a graph with using `geom_point`. The categorical CatGroup variable is mapped to the fill aesthetic of symbols.

**Usage**

```
plot_xy_CatGroup(
  data,
  xcol,
  ycol,
  CatGroup,
  facet,
  Boxplot = FALSE,
  symsize = 3,
  s_alpha = 0.8,
  TextXAngle = 0,
  LogYTrans,
  LogXTrans,
  LogYBreaks = waiver(),
  LogXBreaks = waiver(),
  LogYLabels = waiver(),
  LogXLabels = waiver(),
  LogYLimits = NULL,
  LogXLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  bwid = 0.3,
  b_alpha = 0.3,
  l_alpha = 0.8,
  symthick,
  bthick,
  ColPal = c("okabe_ito", "all_grafify", "bright", "contrast", "dark", "fishy", "kelly",
    "light", "muted", "pale", "r4", "safe", "vibrant"),
  ColSeq = TRUE,
  ColRev = FALSE,
  ...
)
```

**Arguments**

|                       |  |
|-----------------------|--|
| <code>data</code>     | a data table object, e.g. <code>data.frame</code> or <code>tibble</code> .   |
| <code>xcol</code>     | name of the column with quantitative X variable.   |
| <code>ycol</code>     | name of the column with quantitative Y variable.   |
| <code>CatGroup</code> | a categorical variable as grouping factor for colour of data points, should be a categorical variable for default colours to work. Will be converted to factor if your column is numeric |



|              |  |
|--------------|--|
| facet        | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> .  |
| Boxplot      | logical TRUE/FALSE to plot box and whiskers plot (default = FALSE).  |
| symsize      | size of symbols used by <code>geom_point</code> . Default set to 3.  |
| s_alpha      | fractional opacity of symbols, default set to 0.8 (i.e, 80% opacity).  |
| TextXAngle   | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| LogYTrans    | transform Y axis into "log10" or "log2"  |
| LogXTrans    | transform X axis into "log10" or "log2"  |
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogXBreaks   | argument for <code>ggplot2[scale_x_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogXLabels   | argument for <code>ggplot2[scale_x_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| LogXLimits   | a vector of length two specifying the range (minimum and maximum) of the X axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all graphs. Can be <code>fixed</code> (default), <code>free</code> , <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively). |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| bwid         | width of boxplot (default = 0.3).  |
| b_alpha      | fractional opacity of boxes, (default = 0.3).  |
| l_alpha      | fractional opacity of lines joining boxes, (default = 0.8).  |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = <code>fontsize/22</code> .   |
| bthick       | size (in 'pt' units) of outline of boxes, whisker and joining lines (stroke), default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColSeq       | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours, which will be applied using <code>scale_fill_grafify2</code> .                               |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass on.   |

## Details

A box and whisker plot with lines joining the medians can be plotted with `Boxplot = TRUE`. If only box plot is needed without the line, set the opacity of the line to 0 (i.e., `l_alpha = 0`).

Colours can be changed using `ColPal`, `ColRev` or `ColSeq` arguments. Colours available can be seen quickly with [plot\\_grafify\\_palette](#). `ColPal` can be one of the following: "okabe\_ito", "dark", "light", "bright", "pale", "vibrant", "muted" or "contrast". `ColRev` (logical TRUE/FALSE) decides whether colours are chosen from first-to-last or last-to-first from within the chosen palette. `ColSeq` (logical TRUE/FALSE) decides whether colours are picked by respecting the order in the palette or the most distant ones using [colorRampPalette](#).

This plot is related to [plot\\_xy\\_NumGroup](#) which requires a numeric grouping factor. When summary statistics (mean/median) are required, use [plot\\_3d\\_scatterbar](#), [plot\\_3d\\_scatterbox](#) or [plot\\_4d\\_scatterbox](#).

## Value

This function returns a ggplot2 object of class "gg" and "ggplot".

## Examples

```
#The grouping factor cyl is automatically converted to categorical variable
plot_xy_CatGroup(data = mtcars,
  xcol = mpg, ycol = disp, CatGroup = cyl,
  ColPal = "vibrant", ColSeq = FALSE)

#with boxplot
plot_xy_CatGroup(data = mpg,
  xcol = cyl, ycol = cty,
  CatGroup = fl, Boxplot = TRUE)

#add another variable
#with boxplot
plot_xy_CatGroup(data = mpg,
  xcol = cyl, ycol = cty,
  CatGroup = fl, facet = drv,
  Boxplot = TRUE)
```

---

plot\_xy\_NumGroup      *Plot points on a quantitative X - Y plot & a numeric grouping variable.*

---

## Description

This function takes a data table, quantitative X and Y variables, and a numeric grouping variable, and a and plots a graph with using [geom\\_point](#). The numerical NumGroup variable is mapped to the fill aesthetic of symbols, which receives the `scale_fill_grafify` default quantitative palette (blue\_conti). Alternatives are `yellow_conti`, `grey_conti`, `OrBl_div` and `PrGn_div`. Colour order can be reversed with `ColRev = TRUE` (default is FALSE).

**Usage**

```

plot_xy_NumGroup(
  data,
  xcol,
  ycol,
  NumGroup,
  facet,
  Boxplot = FALSE,
  symsize = 3,
  s_alpha = 0.8,
  TextXAngle = 0,
  LogYTrans,
  LogXTrans,
  LogYBreaks = waiver(),
  LogXBreaks = waiver(),
  LogYLabels = waiver(),
  LogXLabels = waiver(),
  LogYLimits = NULL,
  LogXLimits = NULL,
  facet_scales = "fixed",
  fontsize = 20,
  bwid = 0.3,
  b_alpha = 0.3,
  l_alpha = 0.8,
  symthick,
  bthick,
  ColPal = c("blue_conti", "yellow_conti", "grey_conti", "PrGn_div", "OrBl_div"),
  ColRev = FALSE,
  ...
)

```

**Arguments**

|            |   |
|------------|---|
| data       | a data table object, e.g. data.frame or tibble.   |
| xcol       | name of the column with quantitative X variable.  |
| ycol       | name of the column with quantitative Y variable.  |
| NumGroup   | a numeric factor for fill aesthetic of data points.   |
| facet      | add another variable from the data table to create faceted graphs using <code>ggplot2</code> <a href="#">facet_wrap</a> . |
| Boxplot    | logical TRUE/FALSE to plot box and whiskers plot (default = FALSE).   |
| symsize    | size of symbols used by <code>geom_point</code> . Default set to 3.   |
| s_alpha    | fractional opacity of symbols, default set to 0.8 (i.e, 80% opacity).   |
| TextXAngle | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.                          |
| LogYTrans  | transform Y axis into "log10" or "log2"   |
| LogXTrans  | transform X axis into "log10" or "log2"   |

|              |  |
|--------------|--|
| LogYBreaks   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogXBreaks   | argument for <code>ggplot2[scale_x_continuous]</code> for Y axis breaks on log scales, default is <code>waiver()</code> , or provide a vector of desired breaks.   |
| LogYLabels   | argument for <code>ggplot2[scale_y_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogXLabels   | argument for <code>ggplot2[scale_x_continuous]</code> for Y axis labels on log scales, default is <code>waiver()</code> , or provide a vector of desired labels.   |
| LogYLimits   | a vector of length two specifying the range (minimum and maximum) of the Y axis.   |
| LogXLimits   | a vector of length two specifying the range (minimum and maximum) of the X axis.   |
| facet_scales | whether or not to fix scales on X & Y axes for all graphs. Can be <code>fixed</code> (default), <code>free</code> , <code>free_y</code> or <code>free_x</code> (for Y and X axis one at a time, respectively). |
| fontsize     | parameter of <code>base_size</code> of fonts in <code>theme_classic</code> , default set to size 20.   |
| bwid         | width of boxplot (default = 0.3).  |
| b_alpha      | fractional opacity of boxes, (default = 0.3).  |
| l_alpha      | fractional opacity of lines joining boxes, (default = 0.8).  |
| symthick     | size (in 'pt' units) of outline of symbol lines (stroke), default = <code>fontsize/22</code> .   |
| bthick       | size (in 'pt' units) of outline of boxes, whisker and joining lines (stroke), default = <code>fontsize/22</code> .   |
| ColPal       | grafify colour palette to apply, default "okabe_ito"; see <a href="#">graf_palettes</a> for available palettes.  |
| ColRev       | whether to reverse order of colour within the selected palette, default F (FALSE); can be set to T (TRUE).   |
| ...          | any additional arguments to pass on.   |

### Details

This plot is related to [plot\\_xy\\_CatGroup](#) which requires a categorical grouping factor. When summary statistics (mean/median) are required, use [plot\\_3d\\_scatterbar](#), [plot\\_3d\\_scatterbox](#) or [plot\\_4d\\_scatterbox](#).

### Value

This function returns a `ggplot2` object of class "gg" and "ggplot".

### Examples

```
#The grouping factor gear is numeric
plot_xy_NumGroup(data = mtcars,
  xcol = mpg, ycol = disp, NumGroup = cyl,
  s_alpha = 0.8)
#change colour palette
plot_xy_NumGroup(data = mtcars,
```

```
xcol = mpg, ycol = disp, NumGroup = cyl,
s_alpha = 0.8,
ColPal = "grey_conti")
```

---

|                   |   |
|-------------------|---|
| posthoc_Levelwise | <i>Level-wise post-hoc comparisons from a linear or linear mixed effects model.</i> |
|-------------------|---|

---

## Description

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). It also needs to know the fixed factor(s), which should match those in the model and data table.

## Usage

```
posthoc_Levelwise(Model, Fixed_Factor, P_Adj = "fdr", Factor, ...)
```

## Arguments

|              |   |
|--------------|---|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> or related.  |
| Fixed_Factor | one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A B</code> (note the vertical   between the two Fixed_Factor) to <a href="#">emmeans</a> to produce comparisons between each level A with each other listed separately at each level of B. |
| P_Adj        | method for correcting P values for multiple comparisons. Default is set to false discovery rate ("fdr"), can be changed to "none", "tukey", "bonferroni", "sidak". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .  |
| Factor       | old argument name for Fixed_Factor; retained for backward compatibility.  |
| ...          | additional arguments for <a href="#">emmeans</a> such as <code>lmer.df</code> or others. See help for sophisticated models in <a href="#">emmeans</a> .   |

## Details

The function will generate **level-wise comparisons** (as described in Comparisons and contrasts in [emmeans](#)), i.e. comparison between of every level of one factor separately at each level of the other factor. By default, P values are corrected by the FDR method (which can be changed). If the model was fit by transforming the quantitative response variable using "log", "logit", "sqrt" etc., results will still be on the original scale, i.e. `type = "response"` is the default; data will be back-transformed (check results to confirm this), and for log or logit see Transformations and link functions in [emmeans](#), **ratios will be compared**. The first part of the [emmeans](#) results has the estimated marginal means, SE and CI (`$emmeans`), which are generated from the fitted model, and **not** the original data table. The second part has the results of the comparisons (`$contrasts`).

**Value**

returns an "emm\_list" object containing contrasts and emmeans through [emmeans](#).

**Examples**

```
#make a linear model first
CholMod <- mixed_model(data = data_cholesterol,
  Y_value = "Cholesterol",
  Fixed_Factor = c("Hospital", "Treatment"),
  Random_Factor = "Subject")

#note quotes used only for fixed Fixed_Factor
#to get comparisons between different hospitals separately for each level of Treatment
posthoc_Levelwise(Model = CholMod,
  Fixed_Factor = c("Hospital", "Treatment"))

#get comparisons between treatments separately at each hospital
posthoc_Levelwise(Model = CholMod,
  Fixed_Factor = c("Treatment", "Hospital"))
```

---

|                  |   |
|------------------|---|
| posthoc_Pairwise | <i>Pairwise post-hoc comparisons from a linear or linear mixed effects model.</i> |
|------------------|---|

---

**Description**

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). It also needs to know the fixed factor(s), which should match those in the model and data table.

**Usage**

```
posthoc_Pairwise(Model, Fixed_Factor, P_Adj = "fdr", Factor, ...)
```

**Arguments**

|              |   |
|--------------|---|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> or related.  |
| Fixed_Factor | one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A:B</code> (note the colon between the two Fixed_Factor) to <a href="#">emmeans</a> to produce pairwise comparisons. |
| P_Adj        | method for correcting P values for multiple comparisons. Default is set to false discovery rate ("fdr"), can be changed to "none", "tukey", "bonferroni", "sidak". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .  |

Factor            old argument name for Fixed\_Factor; retained for backward compatibility.  
 ...              additional arguments for `emmeans` such as `lmer.df` or others. See help for sophisticated models in `emmeans`.

### Details

The function will generate **pairwise comparisons** of every level of every factor (as described in Comparisons and contrasts in `emmeans`). Too many comparisons will be generated and only use this when necessary. By default, P values are corrected by the FDR method (which can be changed). If the model was fit by transforming the quantitative response variable using "log", "logit", "sqrt" etc., results will still be on the original scale, i.e. `type = "response"` is the default; data will be back-transformed (check results to confirm this), and for log or logit see Transformations and link functions in `emmeans`, **ratios will be compared**. The first part of the `emmeans` results has the estimated marginal means, SE and CI (`$emmeans`), which are generated from the fitted model, and **not** the original data table. The second part has the results of the comparisons (`$contrasts`).

### Value

returns an "emm\_list" object containing contrasts and emmeans through `emmeans`.

### Examples

```
#make linear models first
DoublMod <- simple_model(data = data_doubling_time,
  Y_value = "Doubling_time", Fixed_Factor = "Student")
CholMod <- mixed_model(data = data_cholesterol,
  Y_value = "Cholesterol",
  Fixed_Factor = c("Hospital", "Treatment"),
  Random_Factor = "Subject")

posthoc_Pairwise(Model = DoublMod,
  Fixed_Factor = "Student")

#basic use with two Fixed_Factor provided as a vector
posthoc_Pairwise(Model = CholMod,
  Fixed_Factor = c("Treatment", "Hospital"))

#same call with "tukey" adjustment
posthoc_Pairwise(Model = CholMod,
  Fixed_Factor = c("Treatment", "Hospital"),
  P_adj = "tukey")
```

---

posthoc\_Trends\_Levelwise

*Use `emtrends` to get level-wise comparison of slopes from a linear model.*

---

## Description

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). At least one of the factors should be a numeric covariate whose slopes you wish to find. It also needs to know the fixed factor(s), which should match those in the model and data table.

## Usage

```
posthoc_Trends_Levelwise(
  Model,
  Fixed_Factor,
  Trend_Factor,
  P_Adj = "sidak",
  ...
)
```

## Arguments

|              |   |
|--------------|---|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> (or <code>lm</code> or <code>lmer</code> ).  |
| Fixed_Factor | one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A:B</code> (note the colon between the two Fixed_Factor) to <a href="#">emmeans</a> to produce pairwise comparisons. |
| Trend_Factor | a quantitative variable that interacts with a factor and whose slope (trend) is to be compared  |
| P_Adj        | method for correcting P values for multiple comparisons. Default is "sidak", can be changed to "bonferroni". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .  |
| ...          | additional arguments for <a href="#">emmeans</a> such as <code>lmer.df</code> or others. See help for sophisticated models in <a href="#">emmeans</a> .   |

## Details

Checkout the Interactions with covariates section in the [emmeans](#) vignette for more details. One of the independent variables should be a quantitative (e.g. time points) variable whose slope (trend) you want to find at levels of the other factor.

## Value

returns an "emm\_list" object containing slopes and their contrasts calculated through [emtrends](#).

## Examples

```
#create an lm model
#Time2 is numeric (time points)
```



```
m1 <- simple_model(data = data_2w_Tdeath,
  Y_value = "PI", Fixed_Factor = c("Genotype", "Time2"))
posthoc_Trends_Levelwise(Model = m1,
  Fixed_Factor = "Genotype",
  Trend_Factor = "Time2")
```

---

posthoc\_Trends\_Pairwise

*Use emtrends to get pairwise comparison of slopes from a linear model.*

---

### Description

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). At least one of the factors should be a numeric covariate whose slopes you wish to find. It also needs to know the fixed factor(s), which should match those in the model and data table.

### Usage

```
posthoc_Trends_Pairwise(
  Model,
  Fixed_Factor,
  Trend_Factor,
  P_Adj = "sidak",
  ...
)
```

### Arguments

|              |   |
|--------------|---|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> (or <code>lm</code> or <code>lmer</code> ).  |
| Fixed_Factor | one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A:B</code> (note the colon between the two Fixed_Factor) to <a href="#">emmeans</a> to produce pairwise comparisons. |
| Trend_Factor | a quantitative variable that interacts with a factor and whose slope (trend) is to be compared  |
| P_Adj        | method for correcting P values for multiple comparisons. Default is "sidak", can be changed to "bonferroni". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .  |
| ...          | additional arguments for <a href="#">emmeans</a> such as <code>lmer.df</code> or others. See help for sophisticated models in <a href="#">emmeans</a> .   |

**Details**

Checkout the Interactions with covariates section in the [emmeans](#) vignette for more details. One of the independent variables should be a quantitative (e.g. time points) variable whose slope (trend) you want to find at levels of the other factor.

**Value**

returns an "emm\_list" object containing slopes and their contrasts calculated through [emtrends](#).

**Examples**

```
#create an lm model
#Time2 is numeric (time points)
m1 <- simple_model(data = data_2w_Tdeath,
Y_value = "PI", Fixed_Factor = c("Genotype", "Time2"))
posthoc_Trends_Pairwise(Model = m1,
Fixed_Factor = "Genotype",
Trend_Factor = "Time2")
```

---

posthoc\_Trends\_vsRef *Use emtrends to get level-wise comparison of slopes from a linear model.*

---

**Description**

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). At least one of the factors should be a numeric covariate whose slopes you wish to find. It also needs to know the fixed factor(s), which should match those in the model and data table.

**Usage**

```
posthoc_Trends_vsRef(
  Model,
  Fixed_Factor,
  Trend_Factor,
  Ref_Level = 1,
  P_Adj = "sidak",
  ...
)
```

## Arguments

|              |   |
|--------------|---|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> (or <code>lm</code> or <code>lmer</code> ).  |
| Fixed_Factor | one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A:B</code> (note the colon between the two Fixed_Factor) to <a href="#">emmeans</a> to produce pairwise comparisons. |
| Trend_Factor | a quantitative variable that interacts with a factor and whose slope (trend) is to be compared  |
| Ref_Level    | the level within that factor to be considered the reference or control to compare other levels to (to be provided as a number - by default R orders levels alphabetically); default <code>Ref_Level = 1</code> .  |
| P_Adj        | method for correcting P values for multiple comparisons. Default is "sidak", can be changed to "bonferroni". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .  |
| ...          | additional arguments for <a href="#">emmeans</a> such as <code>lmer.df</code> or others. See help for sophisticated models in <a href="#">emmeans</a> .   |

## Details

Checkout the Interactions with covariates section in the [emmeans](#) vignette for more details. One of the independent variables should be a quantitative (e.g. time points) variable whose slope (trend) you want to find at levels of the other factor.

## Value

returns an "emm\_list" object containing slopes and their contrasts calculated through [emtrends](#).

## Examples

```
#create an lm model
#Time2 is numeric (time points)
m1 <- simple_model(data = data_2w_Tdeath,
  Y_value = "PI", Fixed_Factor = c("Genotype", "Time2"))
posthoc_Trends_vsRef(Model = m1,
  Fixed_Factor = "Genotype",
  Trend_Factor = "Time2",
  Ref_Level = 2)
```

---

 posthoc\_vsRef

*Post-hoc comparisons to a control or reference group.*


---

### Description

This function is a wrapper based on [emmeans](#), and needs a ordinary linear model produced by [simple\\_model](#) or a mixed effects model produced by [mixed\\_model](#) or [mixed\\_model\\_slopes](#) (or generated directly with `lm`, `lme4` or `lmerTest` calls). It also needs to know the fixed factor(s), which should match those in the model and data table.

### Usage

```
posthoc_vsRef(Model, Fixed_Factor, Ref_Level = 1, P_Adj = "fdr", Factor, ...)
```

### Arguments

|              |  |
|--------------|--|
| Model        | a model object fit using <a href="#">simple_model</a> or <a href="#">mixed_model</a> or related.   |
| Fixed_Factor | Fixed_Factor one or more categorical variables, provided as a vector (see Examples), whose levels you wish to compare pairwise. Names of Fixed_Factor should match Fixed_Factor used to fit the model. When more than one factor is provided e.g. <code>Fixed_factor = c("A", "B")</code> , this function passes this on as <code>specs = A B</code> (note the vertical   between the two Fixed_Factor) to <a href="#">emmeans</a> . The specification internally is set to <code>specs = trt.vs.ctrl</code> , <code>Ref_Level = 1</code> to compare each group in A to the reference first group in A, separately at each level of B. |
| Ref_Level    | the level within that factor to be considered the reference or control to compare other levels to (to be provided as a number - by default R orders levels alphabetically); default <code>Ref_Level = 1</code> .   |
| P_Adj        | method for correcting P values for multiple comparisons. Default is set to false discovery rate ("fdr"), can be changed to "none", "tukey", "bonferroni", "sidak". See Interaction analysis in <a href="#">emmeans</a> in the <a href="#">manual</a> for <a href="#">emmeans</a> .   |
| Factor       | old argument name for Fixed_Factor; retained for backward compatibility.   |
| ...          | additional arguments for <a href="#">emmeans</a> such as <code>lmer.df</code> or others. See help for sophisticated models in <a href="#">emmeans</a> .  |

### Details

The function will generate **treatment vs control type of comparisons** (as described in Comparisons and contrasts in [emmeans](#)), i.e. comparison of each level of a factor to a reference level, which is set by default to the first level in the factor (`Ref_Level = 1`). By default, P values are corrected by the FDR method (which can be changed). If the model was fit by transforming the quantitative response variable using "log", "logit", "sqrt" etc., results will still be on the original scale, i.e. `type = "response"` is the default; data will be back-transformed (check results to confirm this), and for log or logit see Transformations and link functions in [emmeans](#), **ratios will be compared**. The first part of the [emmeans](#) results has the estimated marginal means, SE and CI (`$emmeans`), which are generated from the fitted model, and **not** the original data table. The second part has the results of the comparisons (`$contrasts`).

**Value**

returns an "emm\_list" object containing contrasts and emmeans through [emmeans](#).

**Examples**

```
#make linear models first
DoublMod <- simple_model(data = data_doubling_time,
  Y_value = "Doubling_time",
  Fixed_Factor = "Student")

CholMod <- mixed_model(data = data_cholesterol,
  Y_value = "Cholesterol",
  Fixed_Factor = c("Hospital", "Treatment"),
  Random_Factor = "Subject")

#to compare all students with student #9
posthoc_vsRef(Model = DoublMod,
  Fixed_Factor = "Student", Ref_Level = 9)

#for comparison between hospital_a to every other hospital, separately at levels of Treatment
posthoc_vsRef(Model = CholMod,
  Fixed_Factor = c("Hospital", "Treatment"), Ref_Level = 1)
```

---

scale\_colour\_grafify    scale\_colour\_ *and* scale\_fill\_ *functions*

---

**Description**

These let you apply grafify discrete or continuous palettes as fill or colour aesthetics to any ggplot2 (scale\_color\_ spelling is also accepted).

**Usage**

```
scale_colour_grafify(
  palette = "okabe_ito",
  ColSeq = TRUE,
  reverse = FALSE,
  discrete = TRUE,
  ...
)

scale_color_grafify(
  palette = "okabe_ito",
  ColSeq = TRUE,
  reverse = FALSE,
  discrete = TRUE,
  ...
)
```

**Arguments**

|          |   |
|----------|---|
| palette  | Name of the grafify palettes from above, provide within quotes. Default discrete palette is okabe_ito. For quantitative palette, set discrete = FALSE (which will apply blue_conti unless another palette is chosen). |
| ColSeq   | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours.   |
| reverse  | Whether the colour order should be reversed.  |
| discrete | not used.   |
| ...      | Additional parameters for scale_fill or scale_colour.   |

**Details**

The default is palette = "okabe\_ito". The discrete argument is not used at present. The following discrete and quantitative palettes can be used.

Categorical/discreet palettes:

- okabe\_ito (default)
- bright
- contrast
- dark
- kelly
- light
- muted
- pale
- r4
- safe
- vibrant

By default, sequential colours from above palettes will be chosen. To choose the most distant colours set ColSeq = TRUE.

Sequential quantitative palettes:

- grey\_conti
- blue\_conti
- yellow\_conti

Divergent quantitative palettes:

- OrBl\_div
- PrGn\_div

**Value**

ggplot scale\_fill function for discrete colours.

**Examples**

```

#add a grafify fill scheme to ggplot
ggplot(emmeans::neuralgia, aes(x = Treatment,
                               y = Duration))+
  geom_boxplot(aes(fill = Treatment),
              alpha = .6)+
  geom_point(aes(colour = Treatment,
                 shape = Treatment),
            size = 3)+
  scale_fill_grafify(palette = "bright")+
  scale_colour_grafify(palette = "bright")+
  facet_wrap("Sex")+
  theme_classic()
#distant colours `ColSeq = FALSE`
ggplot(emmeans::neuralgia, aes(x = Treatment,
                               y = Duration))+
  geom_boxplot(aes(fill = Treatment),
              alpha = .6)+
  geom_point(aes(colour = Treatment,
                 shape = Treatment),
            size = 3)+
  scale_fill_grafify(palette = "bright",
                    ColSeq = FALSE)+
  scale_colour_grafify(palette = "bright",
                      ColSeq = FALSE)+
  facet_wrap("Sex")+
  theme_classic()
#quantitative colour scheme
ggplot(mtcars, aes(x = disp,
                  y = mpg))+
  geom_point(aes(colour = cyl),
            size = 3)+
  scale_colour_grafify(palette = "blue_conti")

```

---

scale\_fill\_grafify      scale\_colour\_ *and* scale\_fill\_ *functions*

---

**Description**

These let you apply grafify discrete or continuous palettes as fill or colour aesthetics to any ggplot2 (scale\_color\_ spelling is also accepted).

**Usage**

```

scale_fill_grafify(
  palette = "okabe_ito",
  ColSeq = TRUE,
  reverse = FALSE,
  discrete = TRUE,

```

```
    ...  
  )
```

### Arguments

|          |   |
|----------|---|
| palette  | Name of the grafify palettes from above, provide within quotes. Default discrete palette is okabe_ito. For quantitative palette, set discrete = FALSE (which will apply blue_conti unless another palette is chosen). |
| ColSeq   | logical TRUE or FALSE. Default TRUE for sequential colours from chosen palette. Set to FALSE for distant colours.   |
| reverse  | Whether the colour order should be reversed.  |
| discrete | not used.   |
| ...      | Additional parameters for scale_fill or scale_colour.   |

### Details

The default is palette = "okabe\_ito". The discrete argument is not used at present. The following discrete and quantitative palettes can be used.

Categorical/discreet palettes:

- okabe\_ito (default)
- bright
- contrast
- dark
- kelly
- light
- muted
- pale
- r4
- safe
- vibrant

By default, sequential colours from above palettes will be chosen. To choose the most distant colours set ColSeq = TRUE.

Sequential quantitative palettes:

- grey\_conti
- blue\_conti
- yellow\_conti

Divergent quantitative palettes:

- OrBl\_div
- PrGn\_div



**Value**

ggplot scale\_fill function for discrete colours.

**Examples**

```
#add a grafify fill scheme to ggplot
ggplot(emmeans::neuralgia, aes(x = Treatment,
                               y = Duration))+
  geom_boxplot(aes(fill = Treatment),
              alpha = .6)+
  geom_point(aes(colour = Treatment,
                 shape = Treatment),
            size = 3)+
  scale_fill_grafify(palette = "bright")+
  scale_colour_grafify(palette = "bright")+
  facet_wrap("Sex")+
  theme_classic()
#distant colours `ColSeq = FALSE`
ggplot(emmeans::neuralgia, aes(x = Treatment,
                               y = Duration))+
  geom_boxplot(aes(fill = Treatment),
              alpha = .6)+
  geom_point(aes(colour = Treatment,
                 shape = Treatment),
            size = 3)+
  scale_fill_grafify(palette = "bright",
                    ColSeq = FALSE)+
  scale_colour_grafify(palette = "bright",
                      ColSeq = FALSE)+
  facet_wrap("Sex")+
  theme_classic()
#quantitative colour schemes
ggplot(mtcars, aes(x = disp,
                  y = mpg))+
  geom_point(aes(colour = cyl,
                 size = 3))+
  scale_colour_grafify(palette = "blue_conti")
```

---

simple\_anova

*ANOVA table from a linear model fit to data.*

---

**Description**

One of two functions for simple ANOVA tables and linear models without random effects, which use [lm](#) to fit a linear models.

1. `link{simple_anova}`
2. `link{simple_model}`

**Usage**

```
simple_anova(data, Y_value, Fixed_Factor, ...)
```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| Y_value      | name of column containing quantitative (dependent) variable, provided within "quotes".                                 |
| Fixed_Factor | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes". |
| ...          | any additional argument to pass on to <code>lm</code> if required.   |

**Details**

Update in v0.2.1: This function uses `lm` to fit a linear model to data, passes it on to `Anova`, and outputs the ANOVA table with type II sum of squares with F statistics and *P* values. (Previous versions produced type I sum of squares using `anova` call.)

It requires a data table, one quantitative dependent variable and one or more independent variables. If your experiment design has random factors, use the related function `mixed_anova`.

This function is related to `link{simple_model}`.

**Value**

ANOVA table of class "anova" and "data.frame".

**Examples**

```
#Basic usage
simple_anova(data = data_doubling_time,
Y_value = "Doubling_time",
Fixed_Factor = "Student")
```

---

```
simple_model
```

*Model from a linear model fit to data.*

---

**Description**

One of two functions for simple ANOVA tables and linear models without random effects, which use `lm` to fit a linear models.

1. `link{simple_anova}`
2. `link{simple_model}`

**Usage**

```
simple_model(data, Y_value, Fixed_Factor, ...)
```

**Arguments**

|              |  |
|--------------|--|
| data         | a data table object, e.g. data.frame or tibble.  |
| Y_value      | name of column containing quantitative (dependent) variable, provided within "quotes".                                 |
| Fixed_Factor | name(s) of categorical fixed factors (independent variables) provided as a vector if more than one or within "quotes". |
| ...          | any additional arguments to pass on to <a href="#">lm</a> if required.   |

**Details**

Update in v0.2.1: This function uses [lm](#) to fit a linear model to data, passes it on to [Anova](#), and outputs the ANOVA table with type II sum of squares with F statistics and *P* values.

(Previous versions produced type I sum of squares using [anova](#) call.) It requires a data table, one quantitative dependent variable and one or more independent variables.

The model output can be used to extract coefficients and other information, including post-hoc comparisons. If your experiment design has random factors, use the related function [mixed\\_model](#).

This function is related to `link{simple_anova}`. Output of this function can be used with [posthoc\\_Pairwise](#), [posthoc\\_Levelwise](#) and [posthoc\\_vsRef](#), or with [emmeans](#).

**Value**

This function returns an object of class "lm".

**Examples**

```
#fixed factors provided as a vector
Doubmodel <- simple_model(data = data_doubling_time,
  Y_value = "Doubling_time",
  Fixed_Factor = "Student")
#get summary
summary(Doubmodel)
```

---

|               |   |
|---------------|---|
| table_summary | <i>Get numeric summary grouped by factors</i> |
|---------------|---|

---

**Description**

This is a wrapper around [aggregate](#) function in base R to obtain mean, median, standard deviation and count for quantitative variable(s) grouped by one or more factors. More than one column containing of quantitative variables can be passed on, and summaries for each is provided with column names with a ..

**Usage**

```
table_summary(data, Ycol, ByGroup)
```

**Arguments**

|         |  |
|---------|--|
| data    | name of the data table.  |
| Ycol    | name of one column (in quotes) or a vector of column names containing the numerical variable to be summarised. |
| ByGroup | name of one column (in quotes) or a vector of column names containing the grouping factors                     |

**Value**

this function takes in a data.frame or tibble and returns a data.frame or tibble.

**Examples**

```
table_summary(Ycol = "cty",
              ByGroup = c("fl", "drv"),
              data = mpg)
```

---

|                 |                                       |
|-----------------|---------------------------------------|
| table_x_reorder | <i>Reordering groups along X-axis</i> |
|-----------------|---------------------------------------|

---

**Description**

This simple function takes in a data table and reorders groups (categorical variables or factors) to be plotted along the X-axis in a user-defined order.

**Usage**

```
table_x_reorder(data, xcol, OrderX, ...)
```

**Arguments**

|        |  |
|--------|--|
| data   | a data table   |
| xcol   | name of column in above data table (provided within quotes) whose levels are to be reordered |
| OrderX | a vector of group names in the desired order   |
| ...    | any additional arguments for factor call.  |

**Details**

It uses two base R functions: `as.factor` to first force the user-selected column into a factor, and `factor` that reorders levels based on a user-provided vector.

**Value**

This function returns a data frame with a selected column converted into factor with reordered levels.

**Examples**

```

#reorder levels within Genotype
new_data <- table_x_reorder(data_t_pratio,
  xcol = "Genotype",
  OrderX = c("KO", "WT"))
#compare
plot_scatterbox(data_t_pratio,
  Genotype,
  Cytokine)
#with
plot_scatterbox(new_data,
  Genotype,
  Cytokine)
#also works within the plot call
plot_scatterbox(data = table_x_reorder(data_t_pratio,
  xcol = "Genotype",
  OrderX = c("KO", "WT")),
  xcol = Genotype,
  ycol = Cytokine)

```

---

 theme\_grafify

*A modified theme\_classic() for grafify-like graphs.*


---

**Description**

This is a slightly modified `theme_classic[ggplot2]` with two key differences: no border & background for facet panel labels, and font size of text on axes is the same as that of the axes titles (prior to v3.2.0, this was 0.85 times the base font size). The size of text legend title is also same as base font.

**Usage**

```

theme_grafify(
  base_size = 20,
  base_family = "",
  base_line_size = base_size/22,
  base_rect_size = base_size/22,
  TextXAngle = 0,
  vjust = 0,
  hjust = 0,
  ...
)

```

**Arguments**

|                          |  |
|--------------------------|--|
| <code>base_size</code>   | base font size for all text (default is 20). Other text is relative to this. |
| <code>base_family</code> | default font family  |

|                             |  |
|-----------------------------|--|
| <code>base_line_size</code> | default line size (default is base font size/22)   |
| <code>base_rect_size</code> | default size of rectangles (default is base font size/22)  |
| <code>TextXAngle</code>     | orientation of text on X-axis; default 0 degrees. Change to 45 or 90 to remove overlapping text.   |
| <code>vjust</code>          | vertical adjustment of X-axis text alignment (between 0 and 1). Set <code>hjust</code> and <code>vjust</code> to 1 if <code>TextXAngle</code> = 45. Try other options if using other angles.   |
| <code>hjust</code>          | horizontal adjustment of X-axis text alignment (between 0 and 1). Set <code>hjust</code> and <code>vjust</code> to 1 if <code>TextXAngle</code> = 45. Try other options if using other angles. |
| <code>...</code>            | for any other arguments to pass to theme. A useful one is <code>aspect.ratio = 1</code> for square plots.  |

### Details

Since v3.2.0, `theme_grafify` produces transparent backgrounds.

### Value

this returns an output with class "theme" and "gg".

### Examples

```
ggplot(mpg, aes(drv, cty, colour = fl))+  
  geom_jitter(width = 0.2,  
             size = 3, alpha = .7)+  
  theme_grafify()
```

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