Package ‘cowplot’

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Title  Streamlined Plot Theme and Plot Annotations for 'ggplot2'

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Description  Provides various features that help with creating publication-quality figures with 'ggplot2', such as a set of themes, functions to align plots and arrange them into complex compound figures, and functions that make it easy to annotate plots and or mix plots with images. The package was originally written for internal use in the Wilke lab, hence the name (Claus O. Wilke’s plot package). It has also been used extensively in the book Fundamentals of Data Visualization.

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BugReports  https://github.com/wilkelab/cowplot/issues

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R topics documented:

- add_sub .................................................. 3
- align_plots ................................................. 5
- as_grob ................................................... 6
- as_gtable .................................................. 7
- axis_canvas ............................................... 7
- background_grid ......................................... 9
- draw_figure_label ....................................... 10
- draw_grob ............................................... 11
- draw_image ............................................... 12
- draw_label ............................................... 14
- draw_line ................................................ 16
- draw_plot ................................................ 17
- draw_plot_label ......................................... 18
- draw_text ................................................ 19
- get_legend ............................................... 20
- get_panel ............................................... 21
- get_plot_component ..................................... 21
- get_title ................................................ 22
- get_y_axis ............................................... 23
- ggdraw .................................................... 24
- ggsave2 .................................................. 24
- gtable_remove_grobs .................................... 25
- gtable_squash_cols ..................................... 26
- gtable_squash_rows ..................................... 26
- insert_xaxis_grob ....................................... 27
- panel_border ............................................. 28
- plot_grid ................................................. 28
- png_null_device ........................................ 32
- rectangle_key_glyph .................................... 32
- save_plot ............................................... 34
- set_null_device .......................................... 36
- stamp ..................................................... 37
- theme_cowplot .......................................... 38
- theme_map ............................................... 39
- theme_minimal_grid ...................................... 40
- theme_nothing .......................................... 42

Index 43
**Description**

This function can add an arbitrary label or mathematical expression underneath the plot, similar to the sub parameter in base R. It is mostly superseded now by the caption argument to `ggplot2::labs()`, and it is recommended to use caption instead of `add_sub()` whenever possible.

**Usage**

```r
add_sub(
  plot, label, x = 0.5, y = 0.5, hjust = 0.5, vjust = 0.5,
  vpadding = grid::unit(1, "lines"),
  fontfamily = "", fontface = "plain", color = "black",
  size = 14, angle = 0, lineheight = 0.9, colour
)
```

**Arguments**

- `plot` A `ggplot` object or `gtable` object derived from a `ggplot` object.
- `label` The label with which the plot should be annotated. Can be a plotmath expression.
- `x` The x position of the label
- `y` The y position of the label
- `hjust` Horizontal justification
- `vjust` Vertical justification
- `vpadding` Vertical padding. The total vertical space added to the label, given in grid units. By default, this is added equally above and below the label. However, by changing the y and vjust parameters, this can be changed.
- `fontfamily` The font family
- `fontface` The font face ("plain", "bold", etc.)
- `color`, `colour` Text color
size  Point size of text
angle Angle at which text is drawn
lineheight Line height of text

Details

The exact location where the label is placed is controlled by the parameters x, y, hjust, and vjust.
By default, all these parameters are set to 0.5, which places the label centered underneath the plot panel. A value of x = 0 indicates the left boundary of the plot panel and a value of x = 1 indicates the right boundary. The parameter hjust works just as elsewhere in ggplot2. Thus, x = 0, hjust = 0 places the label left-justified at the left boundary of the plot panel, x = 0.5, hjust = 0.5 places the label centered underneath the plot panel, and x = 1, hjust = 1 places it right-justified at the right boundary of the plot panel. x-values below 0 or above 1 are allowed, and they move the label beyond the limits of the plot panel.

The y coordinates are relative to the added vertical space that is introduced underneath the x-axis label to place the annotation. A value of y=0 indicates the bottom-most edge of that space and a value of y=1 indicates the top-most edge of that space. The total height of the added space is given by the height needed to draw the label plus the value of vpadding. Thus, if y=0, vjust=0 then the extra padding is added entirely above the label, if y=1, vjust=1 then the extra padding is added entirely below the label, and if y=0.5, vjust=0.5 (the default) then the extra padding is added equally above and below the label. As is the case with x, y-values outside the range 0-1 are allowed. In particular, for sufficiently large values of y, the label will eventually be located inside the plot panel.

Value

A gtable object holding the modified plot.

Examples

```r
library(ggplot2)
theme_set(theme_half_open())
p1 <- ggplot(mtcars, aes(mpg, disp)) + geom_line(colour = "blue") + background_grid(minor="none")
ggdraw(add_sub(p1, "This is an annotation.\nAnnotations can span multiple lines.
"))

# You can also do this repeatedly.
p2 <- add_sub(p1, "This formula has no relevance here:\", y = 0, vjust = 0)
p3 <- add_sub(p2, expression(paste(a^2+b^2, " = ", c^2)))
ggdraw(p3)

#This code also works with faceted plots:
plot.iris <- ggplot(iris, aes(Sepal.Length, Sepal.Width)) +
  geom_point() + facet_grid(. ~ Species) + stat_smooth(method = "lm") +
  background_grid(major = 'y', minor = "none") + # add thin horizontal lines
  panel_border() # and a border around each panel
p2 <- add_sub(plot.iris, "Annotation underneath a faceted plot, left justified. ", x = 0, hjust = 0)
ggdraw(p2)

# Finally, it is possible to move the annotation inside of the plot if desired.
ggdraw(add_sub(p1, "Annotation inside plot", vpadding=grid::unit(0, "lines"),
```
align_plots

Align multiple plots vertically and/or horizontally

Description

Align the plot area of multiple plots. Inputs are a list of plots plus alignment parameters. Horizontal or vertical alignment or both are possible. In the simplest case the function will align all elements of each plot, but it can handle more complex cases as long as the axis parameter is defined. In this case, alignment is done through a call to align_margin(). The function align_plots is called by the plot_grid() function and is usually not called directly, though direct calling of the function is useful if plots with multiple y-axes are desired (see example).

Usage

```r
align_plots(
  ..., plotlist = NULL,
  align = c("none", "h", "v", "hv"),
  axis = c("none", "l", "r", "t", "b", "lr", "tb", "tblr"),
  greedy = TRUE
)
```

Arguments

- ... List of plots to be aligned.
- plotlist (optional) List of plots to display. Alternatively, the plots can be provided individually as the first n arguments of the function align_plots (see plot_grid examples).
- align (optional) Specifies whether graphs in the grid should be horizontally ("h") or vertically ("v") aligned. Options are align="none" (default), "hv" (align in both directions), "h", and "v".
- axis (optional) Specifies whether graphs should be aligned by the left ("l"), right ("r"), top ("t"), or bottom ("b") margins. Options are axis="none" (default), or a string of any combination of "l", "r", "t", and/or "b" in any order (e.g. axis="tblr" or axis="rlbt" for aligning all margins)
- greedy (optional) Defines the alignment policy when alignment axes are specified via the axis option. greedy = TRUE tries to always align by adjusting the outmost margin. greedy = FALSE aligns all columns/rows in the gtable if possible.
Examples

```r
library(ggplot2)

p1 <- ggplot(mpg, aes(manufacturer, hwy)) + stat_summary(fun.y="median", geom = "bar") +
   theme_half_open() +
   theme(axis.text.x = element_text(angle = 45, hjust = 1, vjust= 1))
p2 <- ggplot(mpg, aes(manufacturer, displ)) + geom_point(color="red") +
   scale_y_continuous(position = "right") +
   theme_half_open() + theme(axis.text.x = element_blank())

# manually align and plot on top of each other
aligned_plots <- align_plots(p1, p2, align="hv", axis="tblr")

# Note: In most cases two y-axes should not be used, but this example
# illustrates how one could accomplish it.
ggdraw(aligned_plots[[1]]) + draw_plot(aligned_plots[[2]])
```

as_grob

Convert a base plot or a ggplot2 plot into a grob

Description

This function does its best attempt to take whatever you provide it and turn it into a grob. It is primarily meant to convert ggplot plots into grobs, but it will also take any grid object (grob), a recorded base R plot, a formula specifying a base R plot, a function that generates a base R plot, or a trellis object.

Usage

```r
as_grob(plot, device = NULL)
```

Arguments

- `plot` The plot to convert
- `device` A function that creates an appropriate null device. See `set_null_device()` for details. If set to NULL, will use the cowplot-wide default.

Examples

```r
library(grid)
x <- 1:10
y <- (1:10)^2
p <- ~plot(x, y)
grid.newpage()
grid.draw(as_grob(p))
```
**as_gtable**

Convert plot or other graphics object into a gtable

**Description**

This function does its best attempt to take whatever you provide it and turn it into a gtable. It is primarily meant to convert ggplot plots into gtables, but it will also take any grid object (grob), a recorded R base plot, or a function that generates an R base plot.

**Usage**

```r
as_gtable(plot)
```

```r
plot_to_gtable(plot)
```

**Arguments**

- `plot`  
  The plot or other graphics object to convert into a gtable. Here, `plot` can be any object handled by `as_grob()`.

**Details**

To convert ggplot plots, the function needs to use a null graphics device. This can be set with `set_null_device()`.

**axis_canvas**

Generates a canvas onto which one can draw axis-like objects.

**Description**

This function takes an existing `ggplot2` plot and copies one or both of the axis into a new plot. The main idea is to use this in conjunction with `insert_xaxis_grob()` or `insert_yaxis_grob()` to draw custom axis-like objects or margin annotations. Importantly, while this function works for both continuous and discrete scales, notice that discrete scales are converted into continuous scales in the returned axis canvas. The levels of the discrete scale are placed at continuous values of 1, 2, 3, etc. See Examples for an example of how to convert a discrete scale into a continuous scale.

**Usage**

```r
axis_canvas(
  plot, 
  axis = "y", 
  data = NULL, 
  mapping = aes(), 
  xlim = NULL, 
  ylim = NULL, 
  coord_flip = FALSE 
)
```
Arguments

plot  The plot defining the x and/or y axis range for the axis canvas.
axis  Specifies which axis to copy from plot. Can be "x", "y", or "xy".
data  (optional) Data to be displayed in this layer.
mapping  (optional) Aesthetic mapping to be used in this layer.
xlim  (optional) Vector of two numbers specifying the limits of the x axis. Ignored if the x axis is copied over from plot.
ylim  (optional) Vector of two numbers specifying the limits of the y axis. Ignored if the y axis is copied over from plot.
coord_flip  (optional) If true, flips the coordinate system and applies x limits to the y axis and vice versa. Useful in combination with ggplot2's coord_flip() function.

Examples

# annotate line graphs with labels on the right
library(dplyr)
library(tidyr)
library(ggplot2)
theme_set(theme_half_open())
x <- seq(0, 10, .1)
d <- data.frame(x,
               linear = x,
               squared = x*x/5,
               cubed = x*x*x/25) %>%
gather(fun, y, -x)
pmain <- ggplot(d, aes(x, y, group = fun)) + geom_line() +
scale_x_continuous(expand = c(0, 0))
paxis <- axis_canvas(pmain, axis = "y") +
  geom_text(data = filter(d, x == max(x)), aes(y = y, label = paste0(" ", fun)),
             x = 0, hjust = 0, vjust = 0.5)
ggdraw(insert_yaxis_grob(pmain, paxis, grid::unit(.25, "null")))

# discrete scale with integrated color legend
pmain <- ggplot(iris, aes(x = Species, y = Sepal.Length, fill = Species)) +
  geom_violin(trim = FALSE) + guides(fill = "none") +
  scale_x_discrete(labels = NULL) +
  theme_minimal()
label_data <- data.frame(x = 1:nlevels(iris$Species),
                         Species = levels(iris$Species))
paxis <- axis_canvas(pmain, axis = "x", data = label_data, mapping = aes(x = x)) +
  geom_tile(aes(fill = Species, y = 0.5), width = 0.9, height = 0.3) +
  geom_text(aes(label = Species, y = 0.5), hjust = 0.5, vjust = 0.5, size = 11/.pt)
ggdraw(insert_xaxis_grob(pmain, paxis, grid::unit(.07, "null"),
                         position = "bottom"))

# add marginal density distributions to plot
background_grid

Add/modify/remove the background grid in a ggplot2 plot

Description

This function provides a simple way to set the background grid in ggplot2. It doesn’t do anything that can’t be done just the same with theme(). However, it simplifies creation of the most commonly needed variations.

Usage

background_grid(
  major = c("xy", "x", "y", "only_minor", "none"),
  minor = c("none", "xy", "x", "y"),
  size.major = 0.5,
  size.minor = 0.2,
  color.major = "grey85",
  color.minor = "grey85",
  colour.major, 
  colour.minor
)

Arguments

- **major**: Specifies along which axes you would like to plot major grid lines. Options are "xy", "x", "y", "none".
- **minor**: Specifies along which axes you would like to plot minor grid lines. Options are "xy", "x", "y", "none".
- **size.major**: Size of the major grid lines.
- **size.minor**: Size of the minor grid lines.
- **color.major**, **colour.major**: Color of the major grid lines.
- **color.minor**, **colour.minor**: Color of the minor grid lines.
draw_figure_label

Details

Note: This function completely overwrites all background grid settings of the current theme. If that is not what you want, you may be better off using `theme()` directly.

Examples

```r
library(ggplot2)

ggplot(iris, aes(Sepal.Length, Sepal.Width)) +
  geom_point() +
  theme_half_open() +
  background_grid()
```

---

draw_figure_label  Add a label to a figure

Description

The main purpose of this function is to add labels specifying extra information about the figure, such as "Figure 1", or "A" - often useful in cowplots with more than one pane. The function is similar to `draw_plot_label`.

Usage

```r
draw_figure_label(
  label,
  position = c("top.left", "top", "top.right", "bottom.left", "bottom", "bottom.right"),
  size,
  fontface,
  ...
)
```

Arguments

- `label`: Label to be drawn
- `position`: Position of the label, can be one of "top.left", "top", "top.right", "bottom.left", "bottom", "bottom.right". Default is "top.left"
- `size`: (optional) Size of the label to be drawn. Default is the text size of the current theme
- `fontface`: (optional) Font face of the label to be drawn. Default is the font face of the current theme
- `...`: other arguments passed to `draw_plot_label`

Author(s)

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See Also

draw_plot_label

Examples

library(ggplot2)
df <- data.frame(
  x = 1:10, y1 = 1:10, y2 = (1:10)^2, y3 = (1:10)^3, y4 = (1:10)^4
)
p1 <- ggplot(df, aes(x, y1)) + geom_point()
p2 <- ggplot(df, aes(x, y2)) + geom_point()
p3 <- ggplot(df, aes(x, y3)) + geom_point()
p4 <- ggplot(df, aes(x, y4)) + geom_point()

# Create a simple grid
p <- plot_grid(p1, p2, p3, p4, align = "hv")

# Default font size and position
p + draw_figure_label(label = "Figure 1")

# Different position and font size
p + draw_figure_label(label = "Figure 1", position = "bottom.right", size = 10)

# Using bold font face
p + draw_figure_label(label = "Figure 1", fontface = "bold")

# Making the label red and slanted
p + draw_figure_label(label = "Figure 1", angle = -45, colour = "red")

# Labeling an individual plot
ggdraw(p2) + draw_figure_label(label = "Figure 1", position = "bottom.right", size = 10)

draw_grob  

Draw a grob.

Description

Places an arbitrary grob somewhere onto the drawing canvas. By default, coordinates run from 0 to 1, and the point (0, 0) is in the lower left corner of the canvas.

Usage

draw_grob(
  grob,
  x = 0,
  y = 0,
  width = 1,
)
height = 1,
scale = 1,
clip = "inherit",
hjust = 0,
vjust = 0,
halign = 0.5,
valign = 0.5
)

Arguments

grob The grob to place.
x The x location of the grob. (Left side if hjust = 0.)
y The y location of the grob. (Bottom side if vjust = 0.)
width Width of the grob.
height Height of the grob.
scale Scales the grob relative to the rectangle defined by x, y, width, height. A setting of scale = 1 indicates no scaling.
clip Set to "on" to clip the grob or "inherit" to not clip. Note that clipping doesn’t always work as expected, due to limitations of the grid graphics system.
hjust, vjust Horizontal and vertical justification relative to x.
halign, valign Horizontal and vertical justification of the grob inside the box.

Examples

# A grid grob (here a blue circle)
g <- grid::circleGrob(gp = grid::gpar(fill = "blue"))
# place into the middle of the plotting area, at a scale of 50%
ggdraw() + draw_grob(g, scale = 0.5)

---

draw_image Draw an image

Description

Places an image somewhere onto the drawing canvas. By default, coordinates run from 0 to 1, and the point (0, 0) is in the lower left corner of the canvas. Requires the magick package to work, and fails gracefully if that package is not installed.
Usage

draw_image(
  image,
  x = 0,
  y = 0,
  width = 1,
  height = 1,
  scale = 1,
  clip = "inherit",
  interpolate = TRUE,
  hjust = 0,
  vjust = 0,
  halign = 0.5,
  valign = 0.5
)

Arguments

image        The image to place. Can be a file path, a URL, or a raw vector with image
data, as in magick::image_read(). Can also be an image previously created
by magick::image_read() and related functions.
x            The x location of the image. (Left side if hjust = 0.)
y            The y location of the image. (Bottom side if vjust = 0.)
width       Width of the image.
height      Height of the image.
scale       Scales the image relative to the rectangle defined by x, y, width, height. A
            setting of scale = 1 indicates no scaling.
clip         Set to "on" to clip the image relative to the box into which it is draw (useful
            for scale > 1). Note that clipping doesn't always work as expected, due to
            limitations of the grid graphics system.
interpolate  A logical value indicating whether to linearly interpolate the image (the alterna-
            tive is to use nearest-neighbour interpolation, which gives a more blocky result).
hjust, vjust Horizontal and vertical justification relative to x.
halign, valign Horizontal and vertical justification of the image inside the box.

Examples

library(ggplot2)

# Use image as plot background
p <- ggplot(iris, aes(x = Sepal.Length, fill = Species)) +
  geom_density(alpha = 0.7) +
  scale_y_continuous(expand = expansion(mult = c(0, 0.05))) +
  theme_half_open(12)

logo_file <- system.file("extdata", "logo.png", package = "cowplot")
draw_label

Draw a text label or mathematical expression.

draw_label

draw_label

Description

This function can draw either a character string or mathematical expression at the given coordinates. It works both on top of ggdraw and directly with ggplot, depending on which coordinate system is desired (see examples).
draw_label

Usage

draw_label(
  label,
  x = 0.5,
  y = 0.5,
  hjust = 0.5,
  vjust = 0.5,
  fontfamily = "",
  fontface = "plain",
  color = "black",
  size = 14,
  angle = 0,
  lineheight = 0.9,
  alpha = 1,
  colour
)

Arguments

- **label**: String or plotmath expression to be drawn.
- **x**: The x location (origin) of the label.
- **y**: The y location (origin) of the label.
- **hjust**: Horizontal justification. Default = 0.5 (centered on x). 0 = flush-left at x, 1 = flush-right.
- **vjust**: Vertical justification. Default = 0.5 (centered on y). 0 = baseline at y, 1 = ascender at y.
- **fontfamily**: The font family
- **fontface**: The font face ("plain", "bold", etc.)
- **color, colour**: Text color
- **size**: Point size of text
- **angle**: Angle at which text is drawn
- **lineheight**: Line height of text
- **alpha**: The alpha value of the text

Details

By default, the x and y coordinates specify the center of the text box. Set hjust = 0, vjust = 0 to specify the lower left corner, and other values of hjust and vjust for any other relative location you want to specify.

See Also

- ggdraw
Examples

library(ggplot2)

# setup plot and a label (regression description)
p <- ggplot(mtcars, aes(disp, mpg)) +
  geom_line(color = "blue") +
  theme_half_open() +
  background_grid(minor = 'none')
out <- cor.test(mtcars$disp, mtcars$mpg, method = 'sp', exact = FALSE)
label <- substitute(
  paste("Spearman \( \rho \) = \( \hat{\rho} \), \( P = \), \( p \)-value),
  list(estimate = signif(out$estimate, 2), pvalue = signif(out$p.value, 2))
)

# Add label to plot, centered on \{x,y\} (in data coordinates)
p + draw_label(label, x = 300, y = 32)
# Add label to plot in data coordinates, flush-left at x, baseline at y.
p + draw_label(label, x = 100, y = 30, hjust = 0, vjust = 0)

# Add labels via ggdraw. Uses ggdraw coordinates.
# ggdraw coordinates default to xlim = c(0, 1), ylim = c(0, 1).

ggdraw(p) +
  draw_label("centered on 70% of x range,\n90% of y range", x = 0.7, y = 0.9)


draw_line

---

**Description**

Draw a line from connected points

**Usage**

draw_line(x, y, ...)

**Arguments**

- `x`  Vector of x coordinates.
- `y`  Vector of y coordinates.
- `...`  geom_path parameters such as `colour`, `alpha`, `size`, etc.

**Details**

This is a convenience function, providing a wrapper around ggplot2’s `geom_path`. 
draw_plot

See Also
gem_path, ggdraw

Examples

```r
ggdraw() +
draw_line(
  x = c(0.2, 0.7, 0.7, 0.3),
  y = c(0.1, 0.3, 0.9, 0.8),
  color = "blue", size = 2
)
```

---

draw_plot  

**Draw a (sub)plot.**

Description

Places a plot somewhere onto the drawing canvas. By default, coordinates run from 0 to 1, and the point (0, 0) is in the lower left corner of the canvas.

Usage

```r
draw_plot(
  plot,
  x = 0,
  y = 0,
  width = 1,
  height = 1,
  scale = 1,
  hjust = 0,
  vjust = 0,
  halign = 0.5,
  valign = 0.5
)
```

Arguments

- **plot**: The plot to place. Can be a ggplot2 plot, an arbitrary grob or gtable, or a recorded base-R plot, as in `as_grob()`.
- **x**: The x location of the plot. (Left side if hjust = 0.)
- **y**: The y location of the plot. (Bottom side if vjust = 0.)
- **width**: Width of the plot.
- **height**: Height of the plot.
- **scale**: Scales the grob relative to the rectangle defined by x, y, width, height. A setting of scale = 1 indicates no scaling.
- **hjust, vjust**: Horizontal and vertical justification relative to x.
- **halign, valign**: Horizontal and vertical justification of the plot inside the box.
Examples

```r
library(ggplot2)

# make a plot
p <- ggplot(data.frame(x = 1:3, y = 1:3), aes(x, y)) + geom_point()
# draw into the top-right corner of a larger plot area
ggdraw() + draw_plot(p, .6, .6, .4, .4)
```

---

**draw_plot_label**

*Add a label to a plot*

### Description

This function adds a plot label to the upper left corner of a graph (or an arbitrarily specified position). It takes all the same parameters as `draw_text`, but has defaults that make it convenient to label graphs with letters A, B, C, etc. Just like `draw_text()`, it can handle vectors of labels with associated coordinates.

### Usage

```r
draw_plot_label(
  label,
  x = 0,
  y = 1,
  hjust = -0.5,
  vjust = 1.5,
  size = 16,
  fontface = "bold",
  family = NULL,
  color = NULL,
  colour,
  ...
)
```

### Arguments

- **label**: String (or vector of strings) to be drawn as the label.
- **x**: The x position (or vector thereof) of the label(s).
- **y**: The y position (or vector thereof) of the label(s).
- **hjust**: Horizontal adjustment.
- **vjust**: Vertical adjustment.
- **size**: Font size of the label to be drawn.
- **fontface**: Font face of the label to be drawn.
draw_text

- family (optional) Font family of the plot labels. If not provided, is taken from the current theme.
- color, colour (optional) Color of the plot labels. If not provided, is taken from the current theme.
- ... Other arguments to be handed to draw_text.

draw_text

*Draw multiple text-strings in one go.*

**Description**

This is a convenience function to plot multiple pieces of text at the same time. It cannot handle mathematical expressions, though. For those, use `draw_label`.

**Usage**

```r
draw_text(text, x = 0.5, y = 0.5, size = 14, hjust = 0.5, vjust = 0.5, ...)
```

**Arguments**

- `text` A vector of Character (not expressions) specifying the string(s) to be written.
- `x` Vector of x coordinates.
- `y` Vector of y coordinates.
- `size` Font size of the text to be drawn.
- `hjust` (default = 0.5)
- `vjust` (default = 0.5)
- ... Style parameters, such as `colour`, `alpha`, `angle`, `size`, etc.

**Details**

Note that font sizes are scaled by a factor of 2.85, so sizes agree with those of the theme. This is different from `geom_text` in ggplot2.

By default, the x and y coordinates specify the center of the text box. Set `hjust = 0`, `vjust = 0` to specify the lower left corner, and other values of `hjust` and `vjust` for any other relative location you want to specify.

For a full list of ... options, see `geom_label`.

**See Also**

`draw_label`
Examples

# Draw onto a 1*1 drawing surface
ggdraw() + draw_text("Hello World!", x = 0.5, y = 0.5)

# Adorn a plot from the Anscombe data set of "identical" data.
library(ggplot2)

p <- ggplot(anscombe, aes(x1, y1)) + geom_point() + geom_smooth()
three_strings <- c("Hello World!", "to be or not to be", "over and out")
p + draw_text(three_strings, x = 8:10, y = 5:7, hjust = 0)

---

get_legends

Retrieve the legend of a plot

Description
This function extracts just the legend from a ggplot

Usage
get_legend(plot)

Arguments
plot A ggplot or gtable from which to retrieve the legend

Value
A gtable object holding just the legend or NULL if there is no legend.

Examples

library(ggplot2)
theme_set(theme_half_open())

p1 <- ggplot(mtcars, aes(mpg, disp)) + geom_line()
plot.mpg <- ggplot(mpg, aes(x = cty, y = hwy, colour = factor(cyl))) + geom_point(size=2.5)
# Note that these cannot be aligned vertically due to the legend in the plot.mpg
ggdraw(plot_grid(p1, plot.mpg, ncol=1, align='v'))

legend <- get_legend(plot.mpg)
plot.mpg <- plot.mpg + theme(legend.position='none')
# Now plots are aligned vertically with the legend to the right
ggdraw(plot_grid(plot_grid(p1, plot.mpg, ncol=1, align='v'), plot_grid(NULL, legend, ncol=1), rel_widths=c(1, 0.2)))
get_panel

Retrieve the panel or part of a panel of a plot

Description

get_panel() extracts just the main panel from a ggplot or a specified panel in a faceted plot. get_panel_component() extracts components from the panel, such as geoms.

Usage

get_panel(plot, panel = NULL, return_all = FALSE)
get_panel_component(panel, pattern)

Arguments

plot A ggplot or gtable from which to retrieve the panel
panel An integer indicating which panel to pull. ggplot orders panels column-wise, so this is in order from the top left down.
return_all If there is more than one panel, should all be returned as a list? Default is FALSE.
pattern the name of the component

Value

A gtable object holding the panel(s) or a grob of the component

Examples

library(ggplot2)

p <- ggplot(mpg, aes(displ, cty)) + geom_point()
plot_panel <- get_panel(p)
ggdraw(plot_panel)

ggdraw(get_panel_component(plot_panel, "geom_point"))

get_plot_component

Get plot components

Description

Extract plot components from a ggplot or gtable. get_plot_component() extracts grobs or a list of grobs. plot_component_names() provides the names of the components in the plot. plot_components() returns all components as a list.
Usage

```r
get_plot_component(plot, pattern, return_all = FALSE)
```

```r
plot_component_names(plot)
```

```r
plot_components(plot)
```

Arguments

- **plot**: A ggplot or gtable to extract from.
- **pattern**: The name of the component.
- **return_all**: If there is more than one component, should all be returned as a list? Default is FALSE.

Value

A grob or list of grobs (get_plot_component(), plot_components()) or a character vector (plot_component_names())

Examples

```r
library(ggplot2)

p <- ggplot(mpg, aes(displ, cty)) + geom_point()
ggdraw(get_plot_component(p, "ylab-l"))
```

---

### get_title

*Get plot titles*

Description

These functions extract just the titles from a ggplot. `get_title()` pulls the title, while `get_subtitle()` pulls the subtitle.

Usage

```r
get_title(plot)
```

```r
get_subtitle(plot)
```

Arguments

- **plot**: A ggplot or gtable.
Examples

library(ggplot2)

p <- ggplot(mpg, aes(displ, cty)) +
  geom_point() +
  labs(
    title = "Plot title",
    subtitle = "Plot subtitle"
  )
ggdraw(get_title(p))
ggdraw(get_subtitle(p))

---

get_y_axis  Get plot axes

Description

These functions extract just the axes from a ggplot. get_y_axis() pulls the y-axis, while get_x_axis() pulls the x-axis.

Usage

get_y_axis(plot, position = c("left", "right"))

get_x_axis(plot, position = c("bottom", "top"))

Arguments

plot A ggplot or gtable.

position Which side of the plot is the axis on? For the x-axis, this can be "top" or "bottom", and for the y-axis, it can be "left" or "right".

Examples

library(ggplot2)

p <- ggplot(mpg, aes(displ, cty)) +
  geom_point()

ggdraw(get_y_axis(p))
p <- p + scale_x_continuous(position = "top")
ggdraw(get_x_axis(p, position = "top"))
**ggdraw**

Set up a drawing layer on top of a ggplot

### Description

Set up a drawing layer on top of a ggplot.

### Usage

`ggdraw(plot = NULL, xlim = c(0, 1), ylim = c(0, 1), clip = "off")`

### Arguments

- **plot**: The plot to use as a starting point. Can be a ggplot2 plot, an arbitrary grob or gtable, or a recorded base-R plot, as in `as_grob()`.
- **xlim**: The x-axis limits for the drawing layer.
- **ylim**: The y-axis limits for the drawing layer.
- **clip**: Should drawing be clipped to the set limits? The default is no ("off").

### Examples

```r
library(ggplot2)
p <- ggplot(mpg, aes(displ, cty)) + geom_point() + theme_minimal_grid()
ggdraw(p) + draw_label("Draft", colour = "#80404080", size = 120, angle = 45)
```

---

**ggsave2**

Cowplot reimplementation of `ggsave()`.

### Description

This function behaves just like `ggsave()` from ggplot2. The main difference is that by default it doesn’t use the Dingbats font for pdf output. The Dingbats font causes problems with some pdf readers.

### Usage

```r
ggsave2(
  filename,
  plot = ggplot2::last_plot(),
  device = NULL,
  path = NULL,
  scale = 1,
```
Arguments

filename  Filename of the plot.
plot      Plot to save, defaults to last plot displayed.
device    Device to use, automatically extract from file name extension.
path      Path to save plot to (if you just want to set path and not filename).
scale     Scaling factor.
width     Width (defaults to the width of current plotting window).
height    Height (defaults to the height of current plotting window).
units     Units for width and height when either one is explicitly specified (in, cm, or mm).
dpi       DPI to use for raster graphics.
limitsize When TRUE (the default), ggsave2() will not save images larger than 50x50 inches, to prevent the common error of specifying dimensions in pixels.
...       Other arguments to be handed to the plot device.

gtable_remove_grobs  Remove named elements from gtable

Description

Remove named elements from gtable

Usage

gtable_remove_grobs(table, names, ...)

Arguments

table     The table from which grobs should be removed
names     A character vector of the grob names (as listed in table$layout) that should be removed
...       Other parameters passed through to gtable_filter.
**gtable_squash_cols**  
*Set the width of given columns to 0.*

Description

Set the width of given columns to 0.

Usage

```r
gtable_squash_cols(table, cols)
```

Arguments

- **table**: The gtable on which to operate
- **cols**: Numerical vector indicating the columns whose width should be set to zero.

---

**gtable_squash_rows**  
*Set the height of given rows to 0.*

Description

Set the height of given rows to 0.

Usage

```r
gtable_squash_rows(table, rows)
```

Arguments

- **table**: The gtable on which to operate
- **rows**: Numerical vector indicating the rows whose heights should be set to zero.
**insert_xaxis_grob**  
Insert an axis-like grob on either side of a plot panel in a **ggplot2** plot.

---

### Description

The function `insert_xaxis_grob()` inserts a grob at the top or bottom of the plot panel in a **ggplot2** plot.

### Usage

```r
insert_xaxis_grob(
  plot,
  grob,
  height = grid::unit(0.2, "null"),
  position = c("top", "bottom"),
  clip = "on"
)
```

```r
insert_yaxis_grob(
  plot,
  grob,
  width = grid::unit(0.2, "null"),
  position = c("right", "left"),
  clip = "on"
)
```

### Arguments

- **plot**  
The plot into which the grob will be inserted.

- **grob**  
The grob to insert. This will generally have been obtained via `get_panel()` from a **ggplot2** object, in particular one generated with `axis_canvas()`. If a **ggplot2** plot is provided instead of a grob, then `get_panel()` is called to extract the panel grob.

- **height**  
The height of the grob, in grid units. Used by `insert_xaxis_grob()`.

- **position**  
The position of the grob. Can be "right" or "left" for `insert_yaxis_grob()` and "top" or "bottom" for `insert_xaxis_grob()`.

- **clip**  
Set to "off" to turn off clipping of the inserted grob.

- **width**  
The width of the grob, in grid units. Used by `insert_yaxis_grob()`.

### Details

For usage examples, see `axis_canvas()`.
panel_border

Add/remove the panel border in a ggplot2 plot

Description

This function provides a simple way to modify the panel border in ggplot2. It doesn’t do anything that can’t be done just the same with theme(). However, it saves some typing.

Usage

panel_border(color = "grey85", size = 1, linetype = 1, remove = FALSE, colour)

Arguments

color, colour

The color of the border.

size

Size. Needs to be twice as large as desired outcome when panel clipping is on (the default).

linetype

Line type.

remove

If TRUE, removes the current panel border.

plot_grid

Arrange multiple plots into a grid

Description

Arrange multiple plots into a grid.

Usage

plot_grid(
...,
plotlist = NULL,
align = c("none", "h", "v", "hv"),
axis = c("none", "l", "r", "t", "b", "lr", "tb", "tblr"),
nrow = NULL,
ncol = NULL,
rel_widths = 1,
rel_heights = 1,
lables = NULL,
label_size = 14,
label_fontfamily = NULL,
label_fontface = "bold",
label_colour = NULL,
label_x = 0,
plot_grid

label_y = 1,
hjust = -0.5,
vjust = 1.5,

Arguments

... List of plots to be arranged into the grid. The plots can be any objects that the function as_gtable() can handle (see also examples).

plotlist (optional) List of plots to display. Alternatively, the plots can be provided individually as the first n arguments of the function plot_grid (see examples).

align (optional) Specifies whether graphs in the grid should be horizontally ("h") or vertically ("v") aligned. Options are "none" (default), "hv" (align in both directions), "h", and "v".

axis (optional) Specifies whether graphs should be aligned by the left ("l"), right ("r"), top ("t"), or bottom ("b") margins. Options are "none" (default), or a string of any combination of l, r, t, and b in any order (e.g. "tblr" or "rlbt" for aligning all margins). Must be specified if any of the graphs are complex (e.g. faceted) and alignment is specified and desired. See align_plots() for details.

nrow (optional) Number of rows in the plot grid.

ncol (optional) Number of columns in the plot grid.

rel_widths (optional) Numerical vector of relative columns widths. For example, in a two-column grid, rel_widths = c(2, 1) would make the first column twice as wide as the second column.

rel_heights (optional) Numerical vector of relative rows heights. Works just as rel_widths does, but for rows rather than columns.

labels (optional) List of labels to be added to the plots. You can also set labels="AUTO" to auto-generate upper-case labels or labels="auto" to auto-generate lower-case labels.

label_size (optional) Numerical value indicating the label size. Default is 14.

label_fontfamily (optional) Font family of the plot labels. If not provided, is taken from the current theme.

label_fontface (optional) Font face of the plot labels. Default is "bold".

label_colour (optional) Color of the plot labels. If not provided, is taken from the current theme.

label_x (optional) Single value or vector of x positions for plot labels, relative to each subplot. Defaults to 0 for all labels. (Each label is placed all the way to the left of each plot.)
### Examples

```r
library(ggplot2)

df <- data.frame(
  x = 1:10, y1 = 1:10, y2 = (1:10)^2, y3 = (1:10)^3, y4 = (1:10)^4
)

p1 <- ggplot(df, aes(x, y1)) + geom_point()
p2 <- ggplot(df, aes(x, y2)) + geom_point()
p3 <- ggplot(df, aes(x, y3)) + geom_point()
p4 <- ggplot(df, aes(x, y4)) + geom_point()
p5 <- ggplot(mpg, aes(as.factor(year), hwy)) +
  geom_boxplot() +
  facet_wrap(~class, scales = "free_y")

# simple grid
plot_grid(p1, p2, p3, p4)

# simple grid with labels and aligned plots
plot_grid(
  p1, p2, p3, p4,
  labels = c('A', 'B', 'C', 'D'),
  align="hv"
)

# manually setting the number of rows, auto-generate upper-case labels
plot_grid(p1, p2, p3,
  nrow = 3,
  labels = "AUTO",
  label_size = 12,
)
align = "v"
)

# making rows and columns of different widths/heights
plot_grid(
  p1, p2, p3, p4,
  align = 'hv',
  rel_heights = c(2,1),
  rel_widths = c(1,2)
)

# aligning complex plots in a grid
plot_grid(
  p1, p5,
  align = "h", axis = "b", nrow = 1, rel_widths = c(1, 2)
)

# more examples

#' # missing plots in some grid locations, auto-generate lower-case labels
plot_grid(
  p1, NULL, NULL, p2, p3, NULL,
  ncol = 2,
  labels = "auto",
  label_size = 12,
  align = "v"
)

# can arrange plots on the grid by column as well as by row.
plot_grid(
  p1, NULL, p2, NULL, p3,
  ncol = 2,
  byrow = TRUE
)

# can align top of plotting area as well as bottom
plot_grid(
  p1, p5,
  align = "h", axis = "tb",
  nrow = 1, rel_widths = c(1, 2)
)

# other types of plots not generated with ggplot
p6 <- ~{
  par(
    mar = c(3, 3, 1, 1),
    mgp = c(2, 1, 0)
  )
  plot(sqrt)
}

p7 <- function() {
  par(

```r
mar = c(2, 2, 1, 1),
mgp = c(2, 1, 0)
)
image(volcano)
}
p8 <- grid::circleGrob()

plot_grid(p1, p6, p7, p8, labels = "AUTO", scale = c(1, .9, .9, .7))
```

---

**png_null_device**

*Null devices*

**Description**

Null devices to be used when rendering graphics in the background. See `set_null_device()` for details.

**Usage**

```r
png_null_device(width, height)
pdf_null_device(width, height)
cairo_null_device(width, height)
agg_null_device(width, height)
```

**Arguments**

- `width` Device width in inch
- `height` Device height in inch

---

**rectangle_key_glyph**

*Create customizable legend key glyphs*

**Description**

These functions create customizable legend key glyphs, such as filled rectangles or circles.
Usage

```r
rectangle_key_glyph(
  colour = NA,
  fill = fill,
  alpha = alpha,
  size = size,
  linetype = linetype,
  padding = unit(c(0, 0, 0, 0), "pt"),
  color
)
```

```r
circle_key_glyph(
  colour = NA,
  fill = fill,
  alpha = alpha,
  size = size,
  linetype = linetype,
  padding = unit(c(0, 0, 0, 0), "pt"),
  color
)
```

Arguments

- **colour, color** Unquoted name of the aesthetic to use for the outline color, usually `colour`, `color`, or `fill`. Can also be a color constant, e.g. "red".
- **fill** Unquoted name of the aesthetic to use for the fill color, usually `colour`, `color`, or `fill`. Can also be a color constant, e.g. "red".
- **alpha** Unquoted name of the aesthetic to use for alpha, usually `alpha`. Can also be a numerical constant, e.g. 0.5.
- **size** Unquoted name of the aesthetic to use for the line thickness of the outline, usually `size`. Can also be a numerical constant, e.g. 0.5.
- **linetype** Unquoted name of the aesthetic to use for the line type of the outline, usually `linetype`. Can also be a constant, e.g. 2.
- **padding** Unit vector with four elements specifying the top, right, bottom, and left padding from the edges of the legend key to the edges of the key glyph.

Examples

```r
library(ggplot2)

set.seed(1233)

df <- data.frame(
  x = sample(letters[1:2], 10, TRUE),
  y = rnorm(10)
)

ggplot(df, aes(x, y, color = x)) +
  geom_boxplot(
```
key_glyph = rectangle_key_glyph(fill = color, padding = margin(3, 3, 3, 3))
)

ggplot(df, aes(x, y, color = x)) +
  geom_boxplot(
    key_glyph = circle_key_glyph(
      fill = color,
      color = "black", linetype = 3, size = 0.3,
      padding = margin(2, 2, 2, 2)
    )
  )
)

---

**save_plot**  
*Alternative to ggsave(), with better support for multi-figure plots.*

**Description**

This function replaces the standard `ggsave()` function for saving a plot into a file. It has several advantages over `ggsave()`. First, it uses default sizes that work well with the cowplot theme, so that frequently a plot size does not have to be explicitly specified. Second, it acknowledges that one often first develops individual plots and then combines them into multi-plot figures, and it makes it easy—in combination with `plot_grid()`—to carry out this workflow. Finally, it makes it easy to adjust the aspect ratio of the figure, which is frequently necessary to accommodate plots with or without figure legend.

**Usage**

```r
save_plot(
  filename,  
  plot,  
  ncol = 1,  
  nrow = 1,  
  base_height = 3.71,  
  base_asp = 1.618,  
  base_width = NULL,  
  ...,  
  cols,  
  rows,  
  base_aspect_ratio,  
  width,  
  height
)
```

**Arguments**

- `filename`: Name of the plot file to generate.
- `plot`: Plot to save.
ncol  Number of subplot columns.
nrow  Number of subplot rows.

base_height  The height (in inches) of the plot or of one sub-plot if nrow or ncol > 1. Default is 3.71.

base_asp  The aspect ratio (width/height) of the plot or of one sub-plot if nrow or ncol > 1. This argument is used if base_width = NULL or if base_height = NULL; if both width and height are provided then the aspect ratio is ignored. The default is 1.618 (the golden ratio), which works well for figures with a legend.

base_width  The width (in inches) of the plot or of one sub-plot if nrow or ncol > 1. Default is NULL, which means that the width is calculated from base_height and base_aspect_ratio.

...  Other arguments to be handed to ggsave2().
cols  Deprecated. Use ncol.
rows  Deprecated. Use nrow.

base_aspect_ratio  Deprecated. Use base_asp.

width  Deprecated. Don’t use.
height  Deprecated. Don’t use.

Details

The key idea for this function is that plots are often grids, with sup-plots at the individual grid locations. Therefore, for this function we specify a base width and aspect ratio that apply to one sup-plot, and we then specify how many rows and columns of subplots we have. This means that if we have code that can save a single figure, it is trivial to adapt this code to save a combination of multiple comparable figures. See examples for details.

Examples

library(ggplot2)

# save a single plot with a legend
p1 <- ggplot(mpg, aes(x = cty, y = hwy, color = factor(cyl))) +
  geom_point(size = 2) +
  theme_half_open()

file1 <- tempfile(fileext = ".png")
file2 <- tempfile(fileext = ".png")
save_plot(file1, p1)
# same as file1 but determine base_width given base_height
save_plot(file2, p1, base_height = NULL, base_width = 6)

# save a single plot without legend, adjust aspect ratio
x <- (1:100)/10
p3 <- ggplot(data.frame(x = x, y = x*sin(x)), aes(x, y)) +
  geom_line() +
  theme_minimal_hgrid())
```r
defile3 <- tempfile("file3", fileext = ".pdf")
save_plot(file3, p3, base_asp = 1.1)

# now combine with a second plot and save
p3b <- ggplot(data.frame(x = x, y = cos(x)+x), aes(x, y)) +
  geom_line() +
  theme_minimal_hgrid()
p4 <- plot_grid(p3, p3b, labels = "AUTO")
defile4 <- tempfile("file4", fileext = ".pdf")
save_plot(file4, p4, ncol = 2, base_asp = 1.1)
```

---

**set_null_device**

Sets the null graphics device

---

**Description**

The function `as_grob()` needs to open a graphics device to render ggplot objects into grid graphics objects. Unfortunately, there is no universally reliable graphics device available in R that always works. Therefore, this function allows you to switch out the null device.

**Usage**

`set_null_device(null_device)`

**Arguments**

- `null_device` Either a string that defines the null device ("pdf", "png", "cairo", "agg") or a function that returns a new graphics device.

**Details**

You need to be aware that some graphics devices cause side effects when used as null devices. If you use an interactive device as null device, you may see an empty plot window pop up. Similarly, if you use a graphics device that writes a file, then you may find temporary files associated with the device. The default null device, `pdf(NULL)`, does not cause these side effects. However, it has has other limitations. For example, on OS X, it cannot use all the fonts that are available on the system. The ragg device can use all fonts, but it will create temporary files.

**See Also**

Available null devices are: `pdf_null_device()`, `png_null_device()`, `cairo_null_device()`, `agg_null_device()`
Examples

set_null_device("png") # set the png null device

# create a jpeg null device
jpeg_null_device <- function(width, height) {
  jpeg(
    filename = tempfile(pattern = "jpeg_null_plot", fileext = ".jpg"),
    width = width, height = height, units = "in", res = 96
  )
  dev.control("enable")
}
set_null_device(jpeg_null_device)

---

**stamp**

*Stamp plots with a label, such as good, bad, or ugly.*

Description

Stamp plots with a label, such as good, bad, or ugly.

Usage

```r
stamp(
  p,
  label,
  color = "black",
  alpha = 1,
  vjust = 1.1,
  hjust = 1,
  size = 14,
  family = "",
  fontface = "bold",
  clip = "on",
  colour
)

stamp_good(p, ...)

stamp_bad(p, ...)

stamp_wrong(p, ...)

stamp_ugly(p, ...)
```

Arguments

- **p**  
The plot to stamp
label               The text label used for the stamp
color, colour       The color of the stamp
alpha               Transparency level of the stamp
hjust, vjust        Horizontal and vertical adjustment of the label
size                Font size
family              Font family
fontface            Font face
clip                Should figure be clipped (default is "on")
...                 Arguments handed off to stamp().

Examples

library(ggplot2)

p <- ggplot(iris, aes(x = Sepal.Length, y = Sepal.Width)) +
  geom_point(aes(color = factor(Petal.Width)))

stamp_bad(p + guides(color = "none"))
stamp_ugly(p)

theme_cowplot       Create the default cowplot theme

Description

The default cowplot theme, with a simple half-open frame and no grid. This theme used to be set
by default after loading the cowplot package, but this is no longer the case.

Usage

theme_cowplot(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14
)

theme_half_open(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14
)
theme_map

Arguments

- **font_size**: Overall font size.
- **font_family**: Font family for plot title, axis titles and labels, legend texts, etc.
- **line_size**: Line size for axis lines.
- **rel_small**: Relative size of small text (e.g., axis tick labels)
- **rel_tiny**: Relative size of tiny text (e.g., caption)
- **rel_large**: Relative size of large text (e.g., title)

Details

Both `theme_cowplot()` and `theme_half_open()` provide exactly the same styling.

Value

The theme.

Examples

```r
library(ggplot2)

ggplot(mtcars, aes(disp, mpg)) +
  geom_point() +
  theme_cowplot(font_size = 12)
```

Description

The theme created by this function is useful for plotting maps with cowplot default sizing.

Usage

```r
theme_map(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14
)
```
theme_minimal_grid

Arguments

font_size Overall font size. Default is 14.
font_family Base font family.
line_size Line size for axis lines.
rel_small Relative size of small text (e.g., axis tick labels)
rel_tiny Relative size of tiny text (e.g., caption)
rel_large Relative size of large text (e.g., title)

Value

The theme.

Examples

library(ggplot2)
library(maps)

usa_data = map_data("usa")
ggplot(usa_data, aes(long, lat, fill = region)) +
  geom_polygon() + theme_map()
ggplot(usa_data, aes(long, lat, fill = region)) +
  facet_wrap(~region, scales = "free") +
  geom_polygon() + theme_map()

theme_minimal_grid Minimalistic themes with grids

Description

Three minimalistic themes that provide either a full grid, a horizontal grid, or a vertical grid. Similar to theme_minimal(), but with some stylistic differences. Most importantly, these themes do not draw minor grid lines. Also, font sizes are coordinated with theme_half_open() and with the defaults in the save_plot() function.

Usage

theme_minimal_grid(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14,
  color = "grey85",
  colour
)
theme_minimal_grid

theme_minimal_vgrid(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14,
  color = "grey85",
  colour
)

theme_minimal_hgrid(
  font_size = 14,
  font_family = "",
  line_size = 0.5,
  rel_small = 12/14,
  rel_tiny = 11/14,
  rel_large = 16/14,
  color = "grey85",
  colour
)

Arguments

font_size Overall font size.
font_family Font family for plot title, axis titles and labels, legend texts, etc.
line_size Line size for grid lines.
rel_small Relative size of small text (e.g., axis tick labels)
rel_tiny Relative size of tiny text (e.g., caption)
rel_large Relative size of large text (e.g., title)
color, colour Color of grid lines.

Details

theme_minimal_grid() provides a minimal grid theme. theme_minimal_hgrid() strips down this theme even further and draws only horizontal lines, and theme_minimal_vgrid() does the same for vertical lines.

Examples

library(ggplot2)

# theme_minimal_grid()
ggplot(iris, aes(x = Sepal.Length, y = Sepal.Width, color = Species)) +
  geom_point() + theme_minimal_grid()

# theme_minimal_hgrid()
```r
theme_nothing

Create a completely empty theme

Description
The theme created by this function shows nothing but the plot panel.

Usage

theme_nothing(font_size = 14, font_family = "", rel_small = 12/14)

Arguments

- **font_size**: Overall font size. Default is 14.
- **font_family**: Base font family.
- **rel_small**: Relative size of small text

Value
The theme.

Examples

```r
library(ggplot2)

ggplot(mtcars, aes(disp, mpg, color = cyl)) +
  geom_point() +
  theme_nothing()
```
Index

* datasets
  - draw_grob, 11
  - add_sub, 3
  - agg_null_device (png_null_device), 32
  - agg_null_device(), 36
  - align_margin(), 5
  - align_plots, 5
  - align_plots(), 29, 30
  - as_grob, 6
  - as_grob(), 7, 17, 24, 36
  - as_gtable, 7
  - as_gtable(), 29
  - axis_canvas
  - axis_canvas(), 27
  - background_grid, 9
  - cairo_null_device (png_null_device), 32
  - cairo_null_device(), 36
  - circle_key_glyph (rectangle_key_glymph), 32
  - coord_flip(), 8
  - draw_figure_label, 10
  - draw_grob, 11
  - draw_image, 12
  - draw_label, 14, 19
  - draw_line, 16
  - draw_plot, 17
  - draw_plot_label, 11, 18
  - draw_text, 19
  - geom_label, 19
  - geom_path, 17
  - geomDrawGrob (draw_grob), 11
  - get_legend, 20
  - get_panel, 21
  - get_panel(), 27
  - get_panel_component (get_panel), 21
  - get_plot_component, 21
  - get_subtitle (get_title), 22
  - get_title, 22
  - get_x_axis (get_y_axis), 23
  - get_y_axis, 23
  - ggdraw, 15, 17, 24
  - ggplot2, 7, 8, 27
  - ggplot2::labs(), 3
  - ggsave(), 24, 34
  - ggsave2, 24
  - ggsave2(), 35
  - gtable_remove_grobs, 25
  - gtable_squash_cols, 26
  - gtable_squash_rows, 26
  - insert_xaxis_grob, 27
  - insert_xaxis_grob(), 7
  - insert_xaxis_grob (insert_xaxis_grob), 27
  - insert_xaxis_grob(), 7
  - panel_border, 28
  - pdf_null_device (png_null_device), 32
  - pdf_null_device(), 36
  - plot_component_names
    - (get_plot_component), 21
  - plot_components (get_plot_component), 21
  - plot_grid, 28
  - plot_grid(), 5, 34
  - plot_to_gtable (as_gtable), 7
  - png_null_device, 32
  - png_null_device(), 36
  - rectangle_key_glymph, 32
  - save_plot, 34
  - save_plot(), 40
  - set_null_device, 36
  - set_null_device(), 6, 7, 32
  - stamp, 37
  - stamp_bad (stamp), 37
stamp_good(stamp), 37
stamp_ugly(stamp), 37
stamp_wrong(stamp), 37

theme(), 9, 10
theme_cowplot, 38
theme_half_open(theme_cowplot), 38
theme_half_open(), 40
theme_map, 39
theme_minimal(), 40
theme_minimal_grid, 40
theme_minimal_hgrid
  (theme_minimal_grid), 40
theme_minimal_vgrid
  (theme_minimal_grid), 40
theme_nothing, 42