

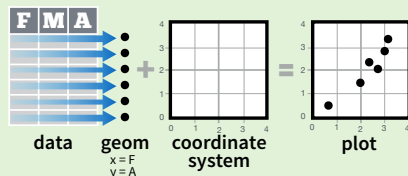
Data Visualization with ggplot2

Cheat Sheet

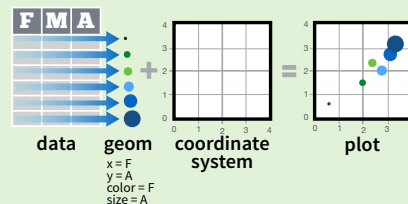


Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and **geoms**—visual marks that represent data points.



To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.



Complete the template below to build a graph.

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION> (
    mapping = aes(<MAPPINGS>),
    stat = <STAT>,
    position = <POSITION>
  ) +
  <COORDINATE_FUNCTION> +
  <FACET_FUNCTION> +
  <SCALE_FUNCTION> +
  <THEME_FUNCTION>
```

Required

Not required, sensible defaults supplied

ggplot(data = mpg, aes(x = cty, y = hwy))

Begins a plot that you finish by adding layers to. Add one geom function per layer.

qplot(x = cty, y = hwy, data = mpg, geom = "point")

Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot()

Returns the last plot

ggsave("plot.png", width = 5, height = 5)

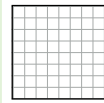
Saves last plot as 5' x 5' file named "plot.png" in working directory. Matches file type to file extension.

Geoms - Use a geom function to represent data points, use the geom's aesthetic properties to represent variables. Each function returns a layer.

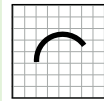
Graphical Primitives

a <- ggplot(economics, aes(date, unemploy))

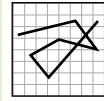
b <- ggplot(seals, aes(x = long, y = lat))



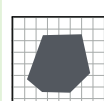
a + geom_blank()
(Useful for expanding limits)



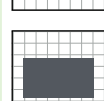
b + geom_curve(aes(yend = lat + 1, xend = long + 1, curvature = z)) - x, xend, y, yend, alpha, angle, color, curvature, linetype, size



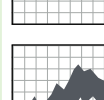
a + geom_path(lineend = "butt", linejoin = "round", linemitre = 1) - x, y, alpha, color, group, linetype, size



a + geom_polygon(aes(group = group)) - x, y, alpha, color, fill, group, linetype, size



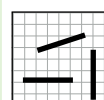
b + geom_rect(aes(xmin = long, ymin = lat, xmax = long + 1, ymax = lat + 1)) - xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size



a + geom_ribbon(aes(ymin = unemploy - 900, ymax = unemploy + 900)) - x, ymax, ymin, alpha, color, fill, group, linetype, size

Line Segments

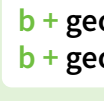
common aesthetics: x, y, alpha, color, linetype, size



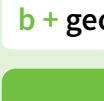
b + geom_abline(aes(intercept = 0, slope = 1))

b + geom_hline(aes(yintercept = lat))

b + geom_vline(aes(xintercept = long))



b + geom_segment(aes(yend = lat + 1, xend = long + 1))

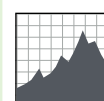


b + geom_spoke(aes(angle = 1:1155, radius = 1))

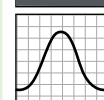
One Variable

Continuous

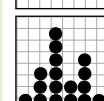
c <- ggplot(mpg, aes(hwy)); **c2** <- ggplot(mpg)



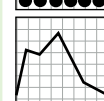
c + geom_area(stat = "bin") - x, y, alpha, color, fill, linetype, size



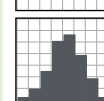
c + geom_density(kernel = "gaussian") - x, y, alpha, color, fill, group, linetype, size, weight



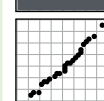
c + geom_dotplot() - x, y, alpha, color, fill



c + geom_freqpoly() - x, y, alpha, color, group, linetype, size



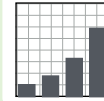
c + geom_histogram(binwidth = 5) - x, y, alpha, color, fill, linetype, size, weight



c2 + geom_qq(aes(sample = hwy)) - x, y, alpha, color, fill, linetype, size, weight

Discrete

d <- ggplot(mpg, aes(fl))

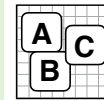


d + geom_bar() - x, alpha, color, fill, linetype, size, weight

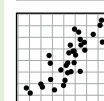
Two Variables

Continuous X, Continuous Y

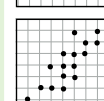
e <- ggplot(mpg, aes(cty, hwy))



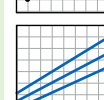
e + geom_label(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE) - x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust



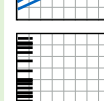
e + geom_jitter(height = 2, width = 2) - x, y, alpha, color, fill, shape, size



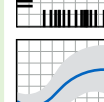
e + geom_point() - x, y, alpha, color, fill, shape, size, stroke



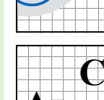
e + geom_quantile() - x, y, alpha, color, group, linetype, size, weight



e + geom_rug(sides = "bl") - x, y, alpha, color, linetype, size



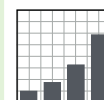
e + geom_smooth(method = lm) - x, y, alpha, color, fill, group, linetype, size, weight



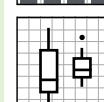
e + geom_text(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE) - x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

Discrete X, Continuous Y

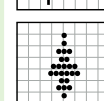
f <- ggplot(mpg, aes(class, hwy))



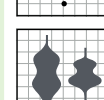
f + geom_col() - x, y, alpha, color, fill, group, linetype, size



f + geom_boxplot() - x, y, lower, middle, upper, ymax, ymin, alpha, color, fill, group, linetype, shape, size, weight



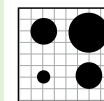
f + geom_dotplot(binaxis = "y", stackdir = "center") - x, y, alpha, color, fill, group



f + geom_violin(scale = "area") - x, y, alpha, color, fill, group, linetype, size, weight

Discrete X, Discrete Y

g <- ggplot(diamonds, aes(cut, color))



g + geom_count() - x, y, alpha, color, fill, shape, size, stroke

Continuous Bivariate Distribution

h <- ggplot(diamonds, aes(carat, price))



h + geom_bin2d(binwidth = c(0.25, 500)) - x, y, alpha, color, fill, linetype, size, weight



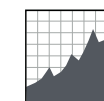
h + geom_density2d() - x, y, alpha, colour, group, linetype, size



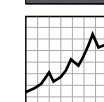
h + geom_hex() - x, y, alpha, colour, fill, size

Continuous Function

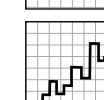
i <- ggplot(economics, aes(date, unemploy))



i + geom_area() - x, y, alpha, color, fill, linetype, size



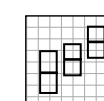
i + geom_line() - x, y, alpha, color, group, linetype, size



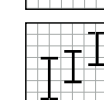
i + geom_step(direction = "hv") - x, y, alpha, color, group, linetype, size

Visualizing error

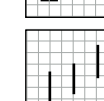
df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
j <- ggplot(df, aes(grp, fit, ymin = fit - se, ymax = fit + se))



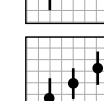
j + geom_crossbar(fatten = 2) - x, y, ymax, ymin, alpha, color, fill, group, linetype, size



j + geom_errorbar() - x, ymax, ymin, alpha, color, group, linetype, size, width (also **geom_errorbarh**())



j + geom_linerange() - x, ymin, ymax, alpha, color, group, linetype, size



j + geom_pointrange() - x, y, ymin, ymax, alpha, color, fill, group, linetype, shape, size

Maps

data <- data.frame(murder = USArrests\$Murder, state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))



k + geom_map(aes(map_id = state), map = map) + **expand_limits**(x = map\$long, y = map\$lat) - map_id, alpha, color, fill, linetype, size

Three Variables

seals\$z <- with(seals, sqrt(delta_long^2 + delta_lat^2))

l <- ggplot(seals, aes(long, lat))



l + geom_raster(aes(fill = z), hjust = 0.5, vjust = 0.5, interpolate = FALSE) - x, y, alpha, fill



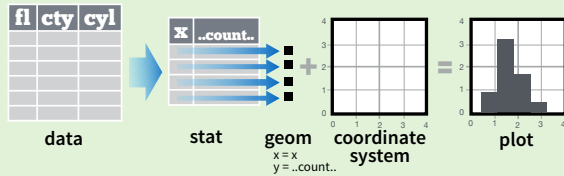
l + geom_contour(aes(z = z)) - x, y, z, alpha, colour, group, linetype, size, weight



l + geom_tile(aes(fill = z)) - x, y, alpha, color, fill, linetype, size, width

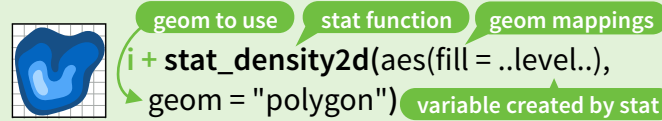
Stats - An alternative way to build a layer

A stat builds new variables to plot (e.g., count, prop).



Visualize a stat by changing the default stat of a geom function, `geom_bar(stat="count")` or by using a stat function, `stat_count(geom="bar")`, which calls a default geom to make a layer (equivalent to a geom function).

Use `..name..` syntax to map stat variables to aesthetics.



1D distributions

- `c + stat_bin(binwidth = 1, origin = 10)`
x, y | ..count.., ..ncount.., ..density.., ..ndensity..
- `c + stat_count(width = 1)` x, y, | ..count.., ..prop..
- `c + stat_density(adjust = 1, kernel = "gaussian")`
x, y, | ..count.., ..density.., ..scaled..

2D distributions

- `e + stat_bin_2d(bins = 30, drop = T)`
x, y, fill | ..count.., ..density..
- `e + stat_bin_hex(bins=30)` x, y, fill | ..count.., ..density..
- `e + stat_density_2d(contour = TRUE, n = 100)`
x, y, color, size | ..level..
- `e + stat_ellipse(level = 0.95, segments = 51, type = "t")`

3 Variables

- `l + stat_contour(aes(z = z))` x, y, z, order | ..level..
- `l + stat_summary_hex(aes(z = z), bins = 30, fun = max)`
x, y, z, fill | ..value..
- `l + stat_summary_2d(aes(z = z), bins = 30, fun = mean)`
x, y, z, fill | ..value..

Comparisons

- `f + stat_boxplot(coef = 1.5)`
x, y | ..lower.., ..middle.., ..upper.., ..width.., ..ymin.., ..ymax..
- `f + stat_ydensity(kernel = "gaussian", scale = "area")`
x, y | ..density.., ..scaled.., ..count.., ..n.., ..violinwidth.., ..width..

Functions

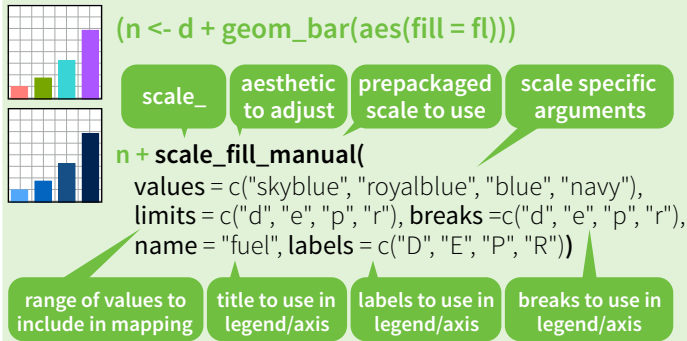
- `e + stat_ecdf(n = 40)` x, y | ..x.., ..y..
- `e + stat_quantile(quantiles = c(0.1, 0.9), formula = y ~ log(x), method = "rq")` x, y | ..quantile..
- `e + stat_smooth(method = "lm", formula = y ~ x, se=T, level=0.95)` x, y | ..se.., ..x.., ..y.., ..ymin.., ..ymax..

General Purpose

- `ggplot() + stat_function(aes(x = -3:3, n = 99, fun = dnorm, args = list(sd=0.5)))` x | ..x.., ..y..
- `e + stat_identity(na.rm = TRUE)`
- `ggplot() + stat_qq(aes(sample=1:100), dist = qt, dparam=list(df=5))` sample, x, y | ..sample.., ..theoretical..
- `e + stat_sum()` x, y, size | ..n.., ..prop..
- `e + stat_summary(fun.data = "mean_cl_boot")`
- `h + stat_summary_bin(fun.y = "mean", geom = "bar")`
- `e + stat_unique()`

Scales

Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.



General Purpose scales

Use with most aesthetics

- `scale_*_continuous()` - map cont' values to visual ones
- `scale_*_discrete()` - map discrete values to visual ones
- `scale_*_identity()` - use data values as visual ones
- `scale_*_manual(values = c())` - map discrete values to manually chosen visual ones
- `scale_*_date(date_labels = "%m/%d")`, `date_breaks = "2 weeks"` - treat data values as dates.
- `scale_*_datetime()` - treat data x values as date times.

Use same arguments as `scale_x_date()`.
See ?strptime for label formats.

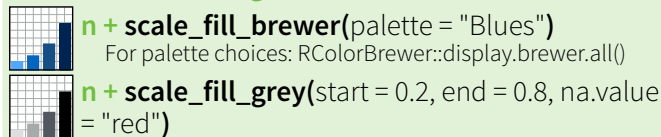
X and Y location scales

Use with x or y aesthetics (x shown here)

- `scale_x_log10()` - Plot x on log10 scale
- `scale_x_reverse()` - Reverse direction of x axis
- `scale_x_sqrt()` - Plot x on square root scale

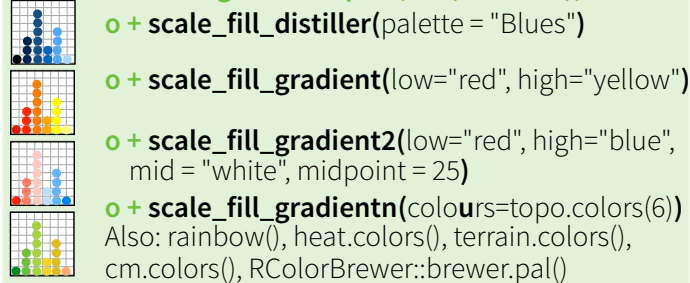
Color and fill scales (Discrete)

`n <- d + geom_bar(aes(fill = fl))`



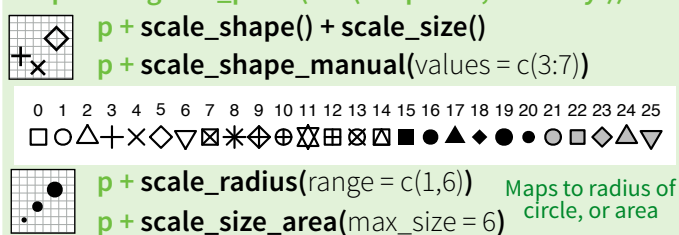
Color and fill scales (Continuous)

`o <- c + geom_dotplot(aes(fill = ..x..))`

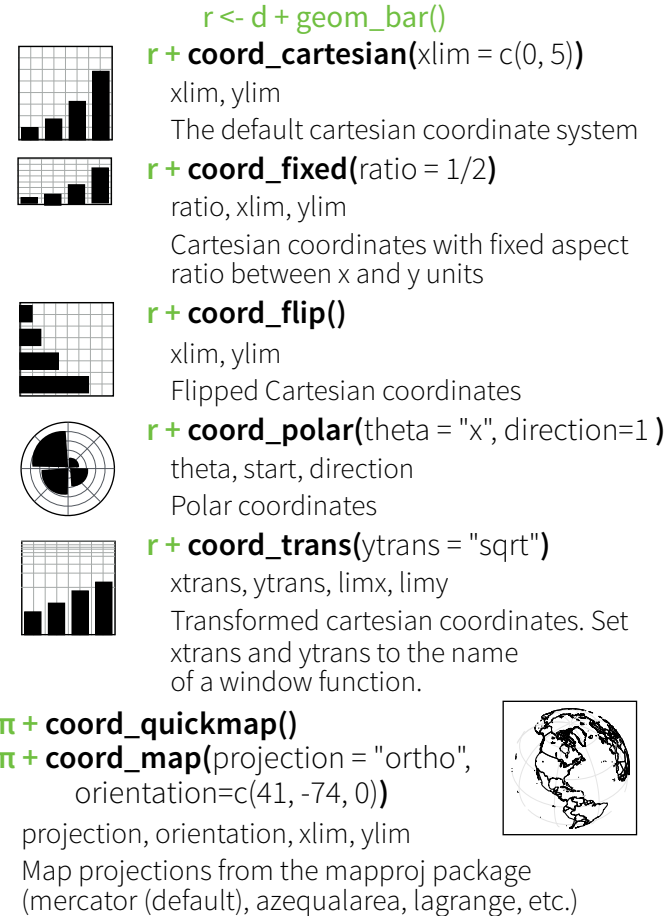


Shape and size scales

`p <- e + geom_point(aes(shape = fl, size = cyl))`

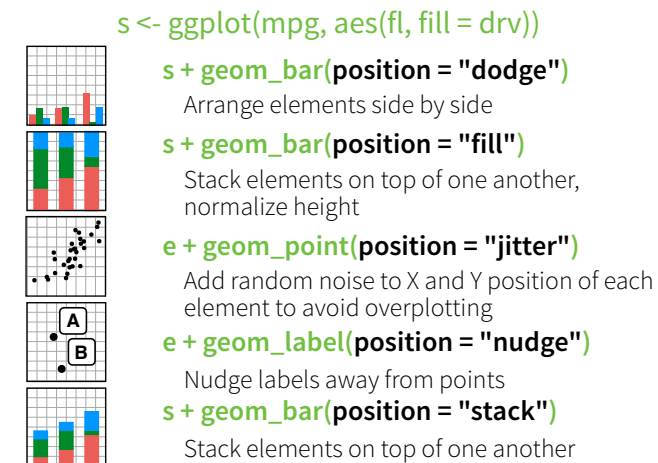


Coordinate Systems



Position Adjustments

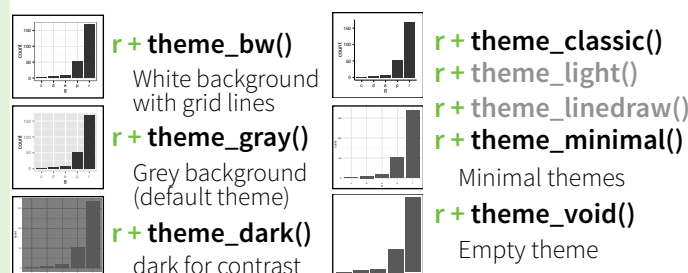
Position adjustments determine how to arrange geoms that would otherwise occupy the same space.



Each position adjustment can be recast as a function with manual **width** and **height** arguments

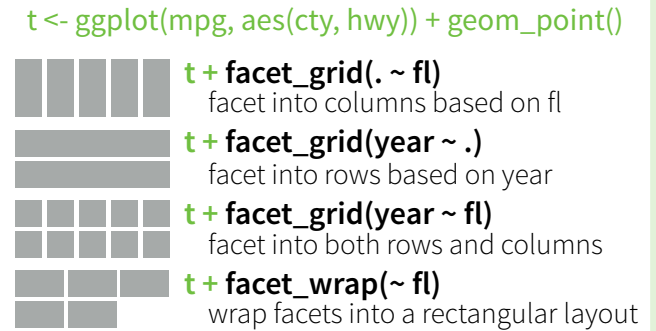
`s + geom_bar(position = position_dodge(width = 1))`

Themes



Faceting

Facets divide a plot into subplots based on the values of one or more discrete variables.

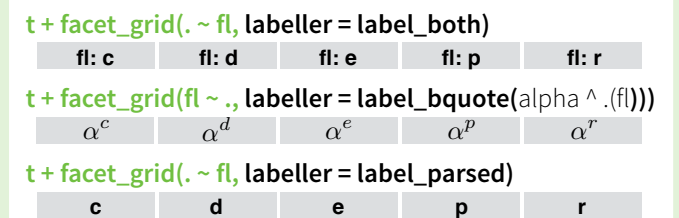


Set **scales** to let axis limits vary across facets

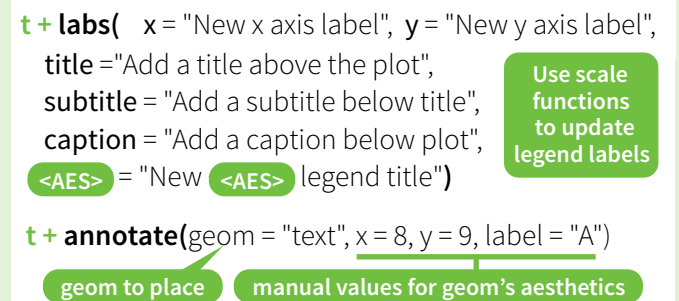
`t + facet_grid(drv ~ fl, scales = "free")`
x and y axis limits adjust to individual facets

- "free_x"** - x axis limits adjust
- "free_y"** - y axis limits adjust

Set **labeller** to adjust facet labels



Labels



Use scale functions to update legend labels

Legends

`n + theme(legend.position = "bottom")`
Place legend at "bottom", "top", "left", or "right"

`n + guides(fill = "none")`
Set legend type for each aesthetic: colorbar, legend, or none (no legend)

`n + scale_fill_discrete(name = "Title", labels = c("A", "B", "C", "D", "E"))`
Set legend title and labels with a scale function.

Zooming

