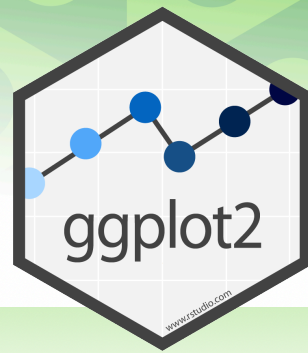


Data visualization with ggplot2 : : CHEAT SHEET

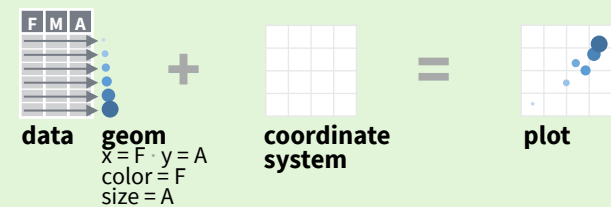


Basics

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.

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.

Aes Common aesthetic values.

color and **fill** - string ("red", "#RRGGBB")

linetype - integer or string (0 = "blank", 1 = "solid", 2 = "dashed", 3 = "dotted", 4 = "dotdash", 5 = "longdash", 6 = "twodash")

lineend - string ("round", "butt", or "square")

linejoin - string ("round", "mitre", or "bevel")

size - integer (line width in mm)

shape - integer/shape name or a single character ("a")



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() and **a + expand_limits()**
Ensure limits include values across all plots.

b + geom_curve(aes(yend = lat + 1, xend = long + 1, curvature = 1) - 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(alpha = 50)) - x, y, alpha, color, fill, group, subgroup, 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(f))
```

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

TWO VARIABLES

both continuous

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

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

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) - x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

one discrete, one continuous

```
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

both discrete

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

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

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

THREE VARIABLES

```
seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2)); l <- ggplot(seals, aes(long, lat))
```

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

l + geom_contour_filled(aes(fill = z))
x, y, alpha, color, fill, group, linetype, size, subgroup

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_density_2d()
x, y, alpha, color, group, linetype, size

h + geom_hex()
x, y, alpha, color, 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

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

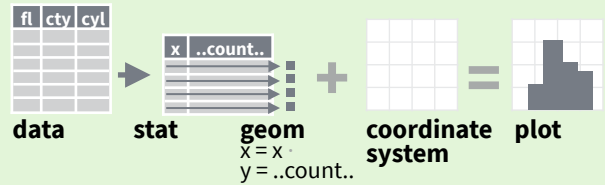
l + geom_tile(aes(fill = z))
x, y, alpha, color, fill, linetype, size, width



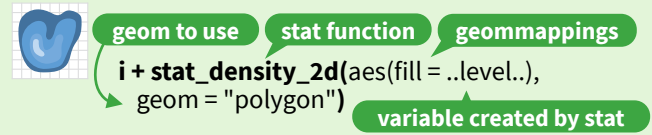
Stats

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.

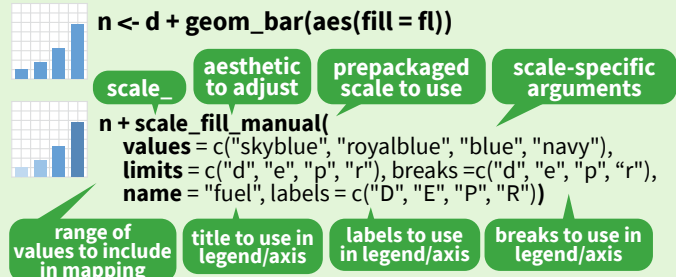


- `c + stat_bin(binwidth = 1, boundary = 10)`
`x, y | ..count.., ..ncount.., ..density.., ..ndensity..`
- `c + stat_count(width = 1) x, y | ..count.., ..prop..`
- `c + stat_density(adjust = 1, kernel = "gaussian")`
`x, y | ..count.., ..density.., ..scaled..`
- `e + stat_bin_2d(bins = 30, drop = T)`
`x, 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")`
- `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..`
- `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..`
- `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..`
- `ggplot() + xlim(-5, 5) + stat_function(fun = dnorm, n = 20, geom = "point") x | ..x.., ..y..`
- `ggplot() + stat_qq(aes(sample = 1:100))`
`x, y, sample | ..sample.., ..theoretical..`
- `e + stat_sum() x, y, size | ..n.., ..prop..`
- `e + stat_summary(fun.data = "mean_cl_boot")`
- `h + stat_summary_bin(fun = "mean", geom = "bar")`
- `e + stat_identity()`
- `e + stat_unique()`

Scales

Override defaults with `scales` package.

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_*_binned()` - Map continuous values to discrete bins.
- `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 values as date times. Same as `scale_*_date()`. See `?strptime` for label formats.

X & Y LOCATION SCALES

- Use with x or y aesthetics (x shown here)
- `scale_x_log10()` - Plot x on log10 scale.
- `scale_x_reverse()` - Reverse the direction of the x axis.
- `scale_x_sqrt()` - Plot x on square root scale.

COLOR AND FILL SCALES (DISCRETE)

- `n + scale_fill_brewer(palette = "Blues")`
For palette choices:
`RColorBrewer::display.brewer.all()`
- `n + scale_fill_grey(start = 0.2, end = 0.8, na.value = "red")`

COLOR AND FILL SCALES (CONTINUOUS)

- `o <- c + geom_dotplot(aes(fill = ..x..))`
- `o + scale_fill_distiller(palette = "Blues")`
- `o + scale_fill_gradient(low="red", high="yellow")`
- `o + scale_fill_gradient2(low="red", high="blue", mid="white", midpoint = 25)`
- `o + scale_fill_gradientn(colors = topo.colors(6))`
Also: `rainbow()`, `heat.colors()`, `terrain.colors()`, `cm.colors()`, `RColorBrewer::brewer.pal()`

SHAPE AND SIZE SCALES

- `p <- e + geom_point(aes(shape = fl, size = cyl))`
- `p + scale_shape() + scale_size()`
- `p + scale_shape_manual(values = c(3:7))`
`0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25`
`□ ○ △ + × ◇ ▼ ☆ ✖ ⊗ ⊕ ⊗ ⊕ ⊗ ⊕ □ ○ △ ◇ ○ ○ ○ □ ◇ △ ▼`
- `p + scale_radius(range = c(1,6))`
- `p + scale_size_area(max_size = 6)`

Coordinate Systems

- `r <- d + geom_bar()`
- `r + coord_cartesian(xlim = c(0, 5))` - xlim, ylim
The default cartesian coordinate system.
- `r + coord_fixed(ratio = 1/2)`
ratio, xlim, ylim - Cartesian coordinates with fixed aspect ratio between x and y units.
- `ggplot(mpg, aes(y = fl)) + geom_bar()`
Flip cartesian coordinates by switching x and y aesthetic mappings.
- `r + coord_polar(theta = "x", direction=1)`
theta, start, direction - Polar coordinates.
- `r + coord_trans(y = "sqrt")` - x, y, xlim, ylim
Transformed cartesian coordinates. Set `xtrans` and `ytrans` to the name of a window function.
- `π + coord_quickmap()`
- `π + coord_map(projection = "ortho", orientation = c(41, -74, 0))` - projection, xlim, ylim
Map projections from the `mapproj` package (mercator (default), `azequalarea`, `lagrange`, etc.).

Position Adjustments

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

- `s <- ggplot(mpg, aes(fl, fill = drv))`
- `s + geom_bar(position = "dodge")`
Arrange elements side by side.
- `s + geom_bar(position = "fill")`
Stack elements on top of one another, normalize height.
- `e + geom_point(position = "jitter")`
Add random noise to X and Y position of each element to avoid overplotting.
- `e + geom_label(position = "nudge")`
Nudge labels away from points.
- `s + geom_bar(position = "stack")`
Stack elements on top of one another.

Each position adjustment can be recast as a function with manual **width** and **height** arguments:
`s + geom_bar(position = position_dodge(width = 1))`

Themes

- `r + theme_bw()`
White background with grid lines.
- `r + theme_classic()`
- `r + theme_light()`
- `r + theme_gray()`
Grey background (default theme).
- `r + theme_linedraw()`
Minimal theme.
- `r + theme_dark()`
Dark for contrast.
- `r + theme_void()`
Empty theme.
- `r + theme()` Customize aspects of the theme such as axis, legend, panel, and facet properties.
`r + ggtitle("Title") + theme(plot.title.position = "plot")`
`r + theme(panel.background = element_rect(fill = "blue"))`

Faceting

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

- `t <- ggplot(mpg, aes(cty, hwy)) + geom_point()`
- `t + facet_grid(cols = vars(fl))`
Facet into columns based on fl.
- `t + facet_grid(rows = vars(year))`
Facet into rows based on year.
- `t + facet_grid(rows = vars(year), cols = vars(fl))`
Facet into both rows and columns.
- `t + facet_wrap(vars(fl))`
Wrap facets into a rectangular layout.
- Set `scales` to let axis limits vary across facets.
- `t + facet_grid(rows = vars(drv), cols = vars(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 label:

- `t + facet_grid(cols = vars(fl), labeller = label_both)`
- | fl: c | fl: d | fl: e | fl: p | fl: r |
|------------|------------|------------|------------|------------|
| α^c | α^d | α^e | α^p | α^r |
- `t + facet_grid(rows = vars(fl), labeller = label_bquote(alpha ^ .(fl)))`

Labels and Legends

- Use `labs()` to label the elements of your plot.
- `t + labs(x = "New x axis label", y = "New y axis label", title = "Add a title above the plot", subtitle = "Add a subtitle below title", caption = "Add a caption below plot", alt = "Add alt text to the plot", <AES> = "New <AES> legend title")`
- `t + annotate(geom = "text", x = 8, y = 9, label = "A")`
Places a geom with manually selected aesthetics.
- `p + guides(x = guide_axis(n.dodge = 2))` Avoid crowded or overlapping labels with `guide_axis(n.dodge or angle)`.
- `n + guides(fill = "none")` Set legend type for each aesthetic: `colorbar`, `legend`, or `none` (no legend).
- `n + theme(legend.position = "bottom")`
Place legend at "bottom", "top", "left", or "right".
- `n + scale_fill_discrete(name = "Title", labels = c("A", "B", "C", "D", "E"))`
Set legend title and labels with a scale function.

Zooming

- Without clipping (preferred):
`t + coord_cartesian(xlim = c(0, 100), ylim = c(10, 20))`
- With clipping (removes unseen data points):
`t + xlim(0, 100) + ylim(10, 20)`
`t + scale_x_continuous(limits = c(0, 100)) + scale_y_continuous(limits = c(0, 100))`

