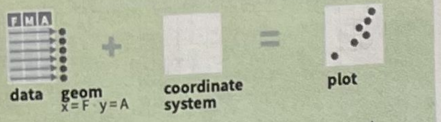
Data visualization with ggplot2 : : CHEAT SHEET

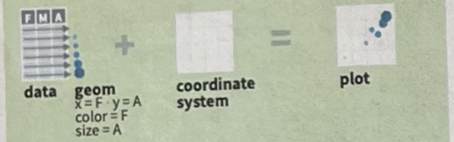
ggplot2

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>) +                                  required
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
stat = <STAT>, position = <POSITION>) +                   Not
<COORDINATE_FUNCTION> +                                   required,
<FACET_FUNCTION> +                                        sensible
<SCALE_FUNCTION> +                                        defaults
<THEME_FUNCTION>                                          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")

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
⊗	⊠	■	●	▲	◆	●	•	●	■	◆	▲	▼

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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(fl))

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

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

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

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

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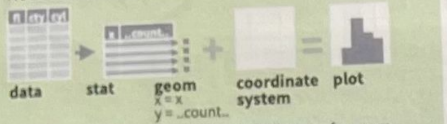
Stats An alternative way to build a layer.

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.

geom to use · stat function · geommappings

`i + stat_density_2d(aes(fill = ..level..), geom = "polygon")`

variable created by stat

`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.

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

scale_ · aesthetic to adjust · prepackaged scale to use · scale-specific arguments

```
n + scale_fill_manual(
  values = c("skyblue", "royalblue", "blue", "navy"),
  limits = c("d", "e", "p", "r"), breaks =c("d", "e", "p", "r"),
  name = "fuel", labels = c("D", "E", "P", "R"))
```

range of values to include in mapping · title to use in legend/axis · labels to use in legend/axis · breaks to use in legend/axis

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")`

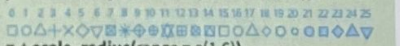
`o + scale_fill_gradient2(low = "red", high = "blue", mid = "white", midpoint = 25)`

`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))`



`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_gray()`
Grey background (default theme).

`r + theme_dark()`
Dark for contrast.

`r + theme_classic()`

`r + theme_light()`

`r + theme_linedraw()`

`r + theme_minimal()`
Minimal theme.

`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.postion = "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

`t + facet_grid(rows = vars(fl), labeller = label_bquote(alpha ^ .(fl)))`

α^c α^d α^e α^p α^r

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))`

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