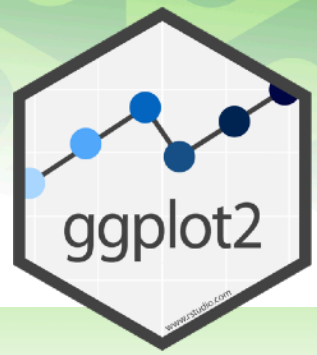


# Data Visualization with ggplot2 : : CHEAT SHEET

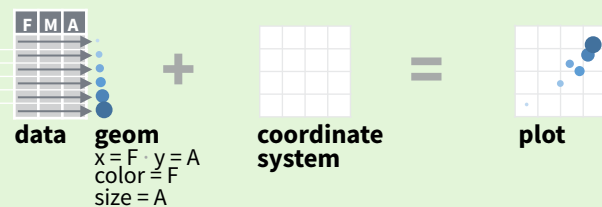


## Basics

**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)) - xmin, xmax, ymin, ymax, alpha, color, fill, linetype, size
- a + geom\_ribbon**(aes(ymin = unemploy - 900, ymax = unemploy + 900)) - x, ymin, ymax, 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 = 1:155, 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

### THREE VARIABLES

- ```
sealsSz <- 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, colour, group, linetype, size, weight
  - 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

#### 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

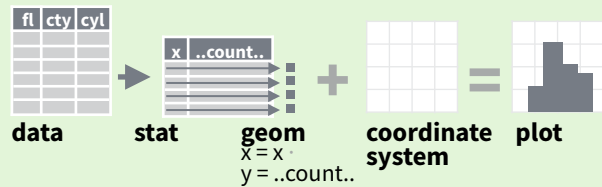
#### maps

- ```
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

# 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, 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..

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() + 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..

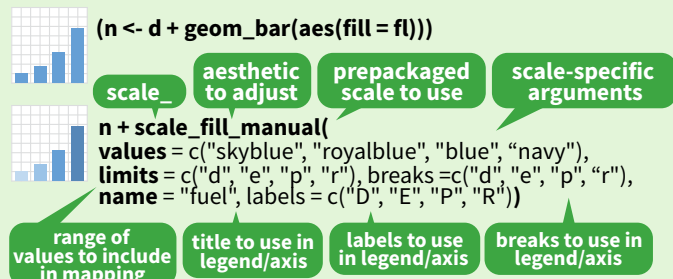
e + stat_summary(fun.data = "mean_cl_boot")

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 & 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))
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(colours=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
r + coord_flip()
xlim, ylim
Flipped Cartesian coordinates
r + coord_polar(theta = "x", direction=1)
theta, start, direction
Polar coordinates
r + coord_trans(ytrans = "sqrt")
xtrans, ytrans, limx, limy
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, orientation,
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_linedraw()
r + theme_minimal()
Minimal themes
r + theme_dark()
dark for contrast
```

# 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 labels

```
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)))
αc αd αe αp αr
```

# Labels

```
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",
<AES> = "New <AES> legend title")
t + annotate(geom = "text", x = 8, y = 9, label = "A")
geom to place manual values for geom's aesthetics
```

# 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

```
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))
```