

# Data Visualization with ggplot2 : : CHEAT SHEET

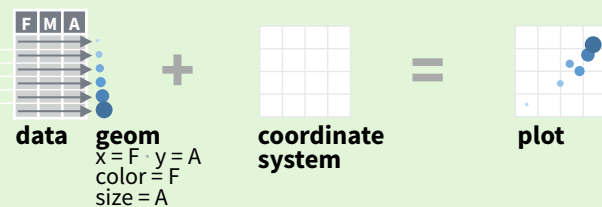


## Basics

**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 = 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(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

### 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

#### 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

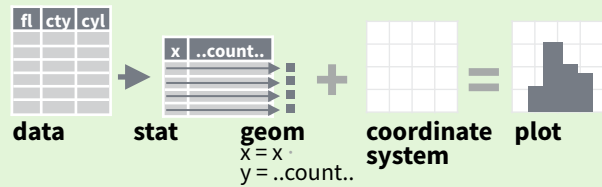
#### maps

- ```
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

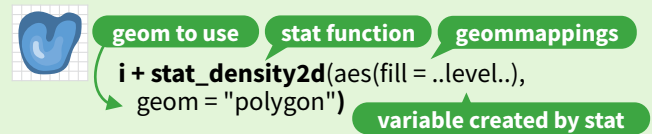
# Stats

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 =  $y \sim \log(x)$ , method = "rq") **x, y** | ..quantile..

**e + stat\_smooth**(method = "lm", formula =  $y \sim x$ , 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..

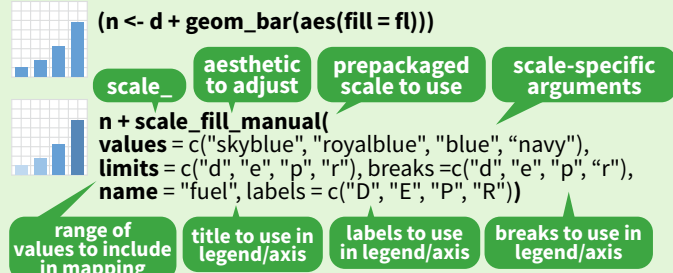
**e + stat\_summary**(fun.data = "mean\_cl\_boot")

**h + stat\_summary\_bin**(fun = "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()**

**o + scale\_fill\_gradientn**(colours=topo.colors(6))

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

Also: **rainbow()**, **heat.colors()**, **terrain.colors()**, **cm.colors()**, **RColorBrewer::brewer.pal()**

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

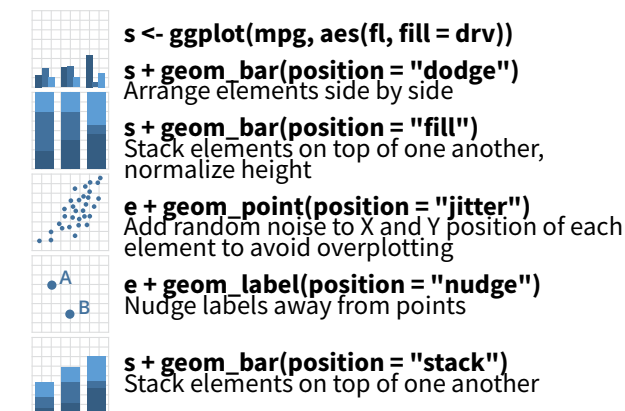
**r + coord\_polar**(theta = "x", direction=1)  
theta, start, direction  
Polar coordinates

**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, xlim, ylim  
Map projections from the mapproj package (mercator (default), azequalarea, lagrange, etc.)

# Position Adjustments

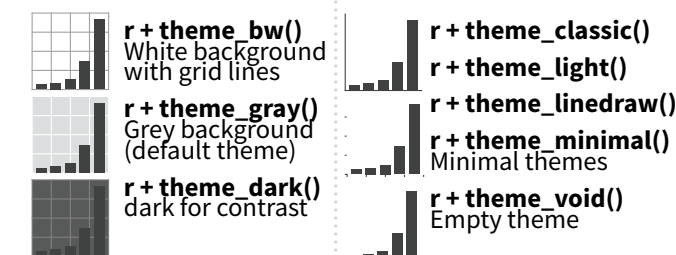
Position adjustments determine how to arrange geoms that would otherwise occupy the same space.



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.

**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)))

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

**α<sup>c</sup>** **α<sup>d</sup>** **α<sup>e</sup>** **α<sup>p</sup>** **α<sup>r</sup>**

# 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))