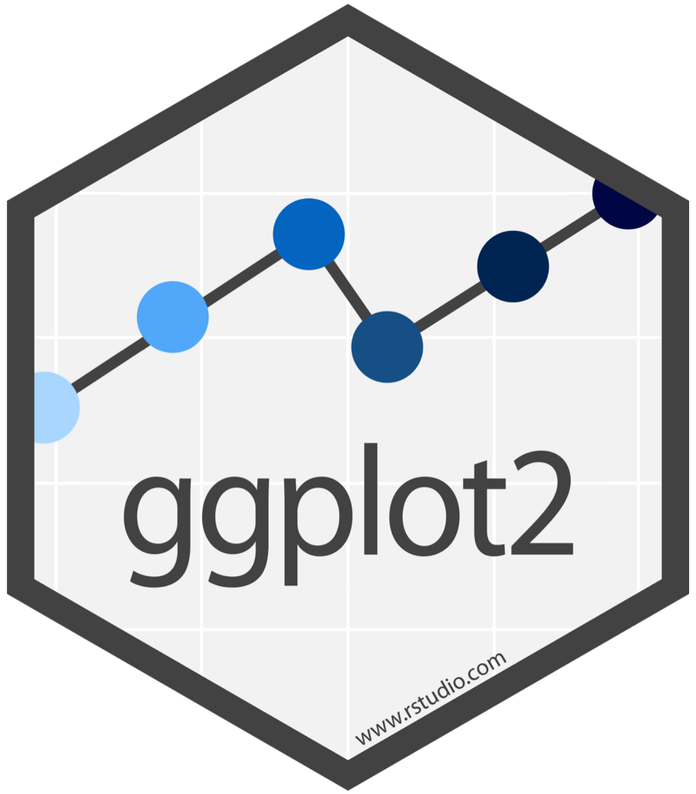
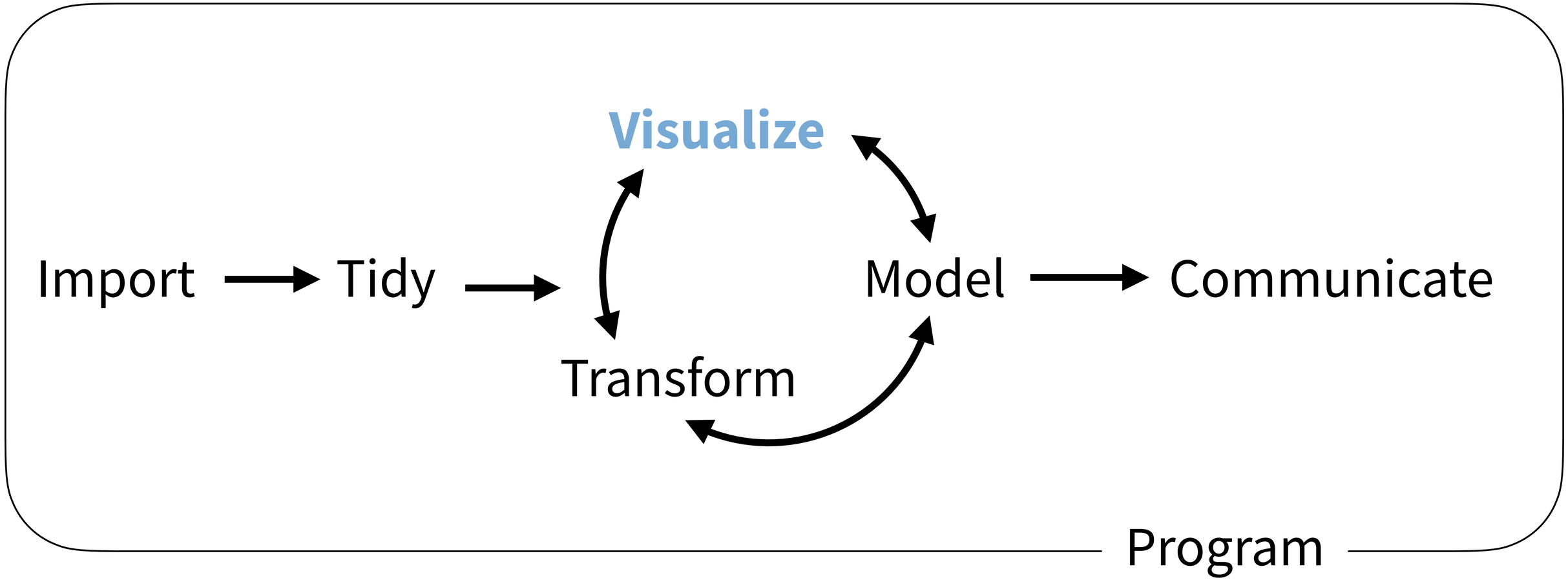
Visualize Data with



(Applied) **Data Science**



"The simple graph has brought more information to the data analyst’s mind than any other device. "

- John Tukey

mpg

Fuel economy data for 38 models of car.

```
mpg
```

manufacturer <chr>	displ <dbl>	year <int>	cyl <int>	trans <chr>	drv <chr>	cty <int>	hwy <int>	fl <chr>	class <chr>
audi	1.8	1999	4	auto(l5)	f	18	29	p	compact
audi	1.8	1999	4	manual(m5)	f	21	29	p	compact
audi	2.0	2008	4	manual(m6)	f	20	31	p	compact
audi	2.0	2008	4	auto(av)	f	21	30	p	compact
audi	2.8	1999	6	auto(l5)	f	16	26	p	compact
audi	2.8	1999	6	manual(m5)	f	18	26	p	compact
audi	3.1	2008	6	auto(av)	f	18	27	p	compact

Quiz

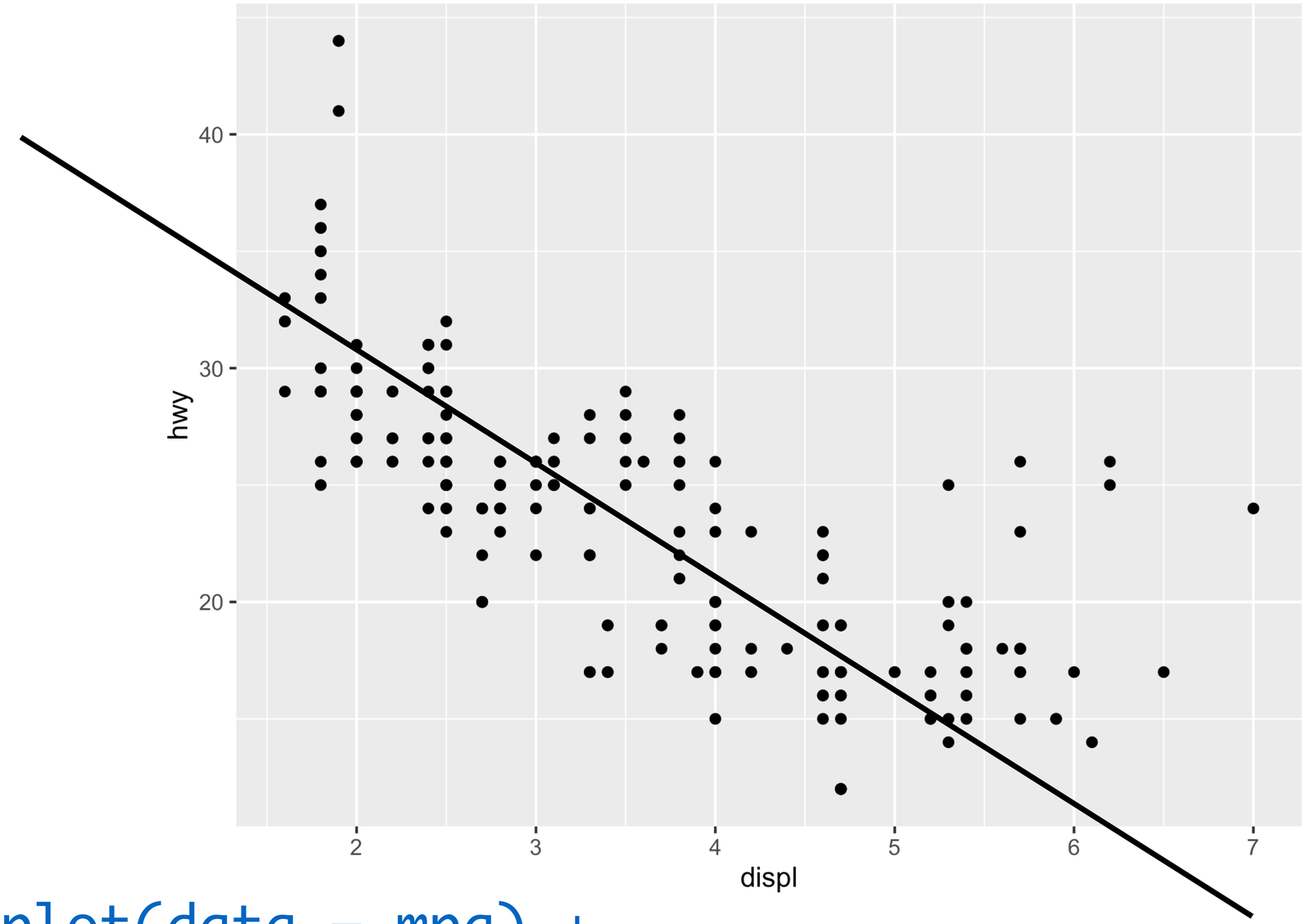
What relationship do you expect to see between engine size (displ) and mileage (hwy)?

No peeking ahead!

Your Turn 1

Run this code in **02-Visualize-Exercises.qmd** to make a graph. Pay strict attention to spelling, capitalization, and parentheses!

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```




```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

1. "Initialize" a plot with ggplot()

2. Add layers with geom_ functions

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

Pro tip: Always put the + at the end of a line, Never at the start

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

data

+ before new line

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

type of layer

aes()

x variable

y variable

A template

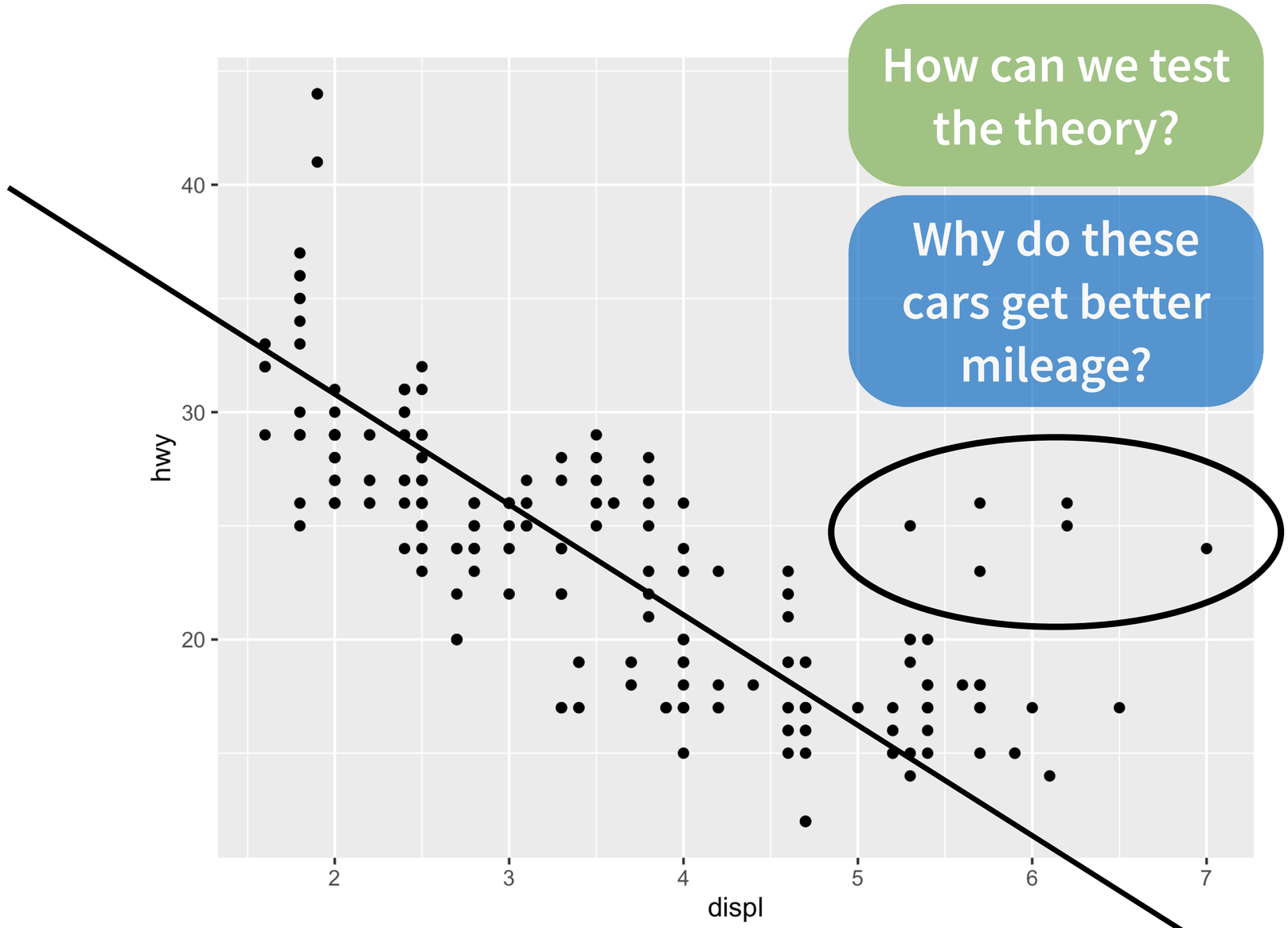
```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

```
  geom_point(mapping = aes(x = displ, y = hwy))
```

Mappings

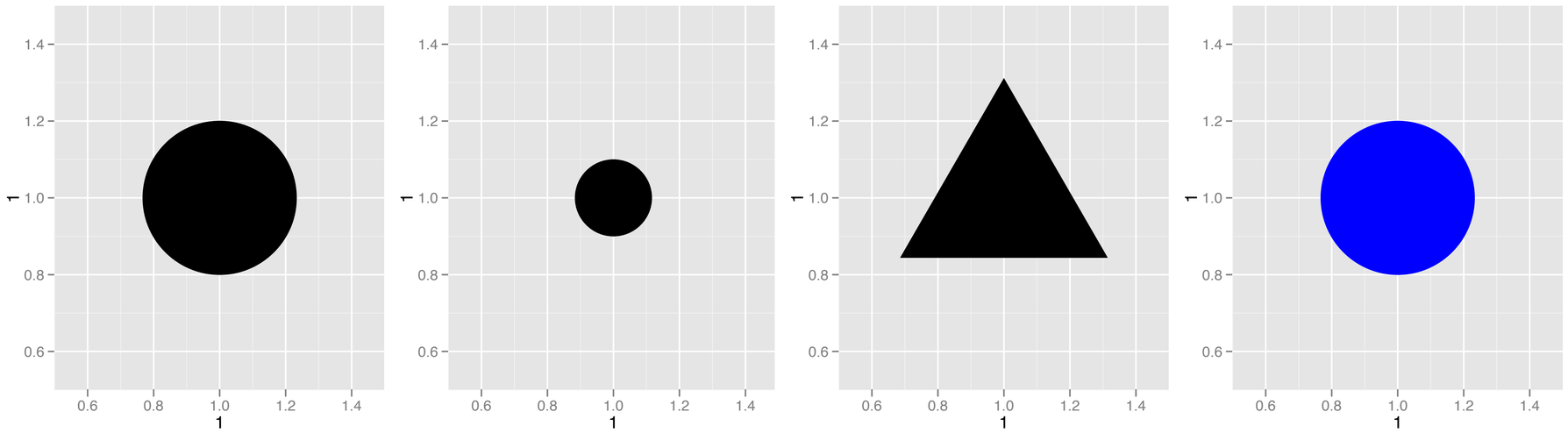
"The greatest value of a picture is when it forces us to notice what we never expected to see."

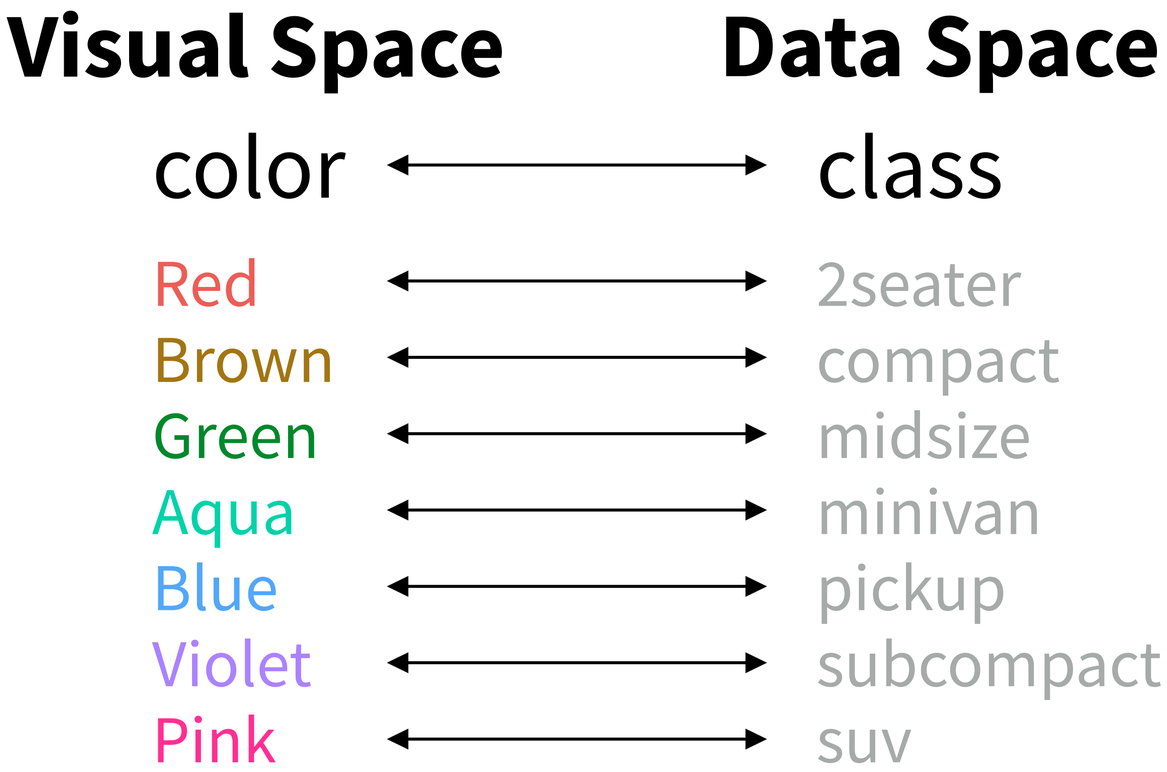
- John Tukey




```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

Aesthetics




Visual Space
Data Space
color
class
Red
2seater
Brown
compact
Green
midsize
Aqua
minivan
Blue
pickup
Violet
subcompact
Pink
suv

Aesthetics

aesthetic property

Variable to map it to

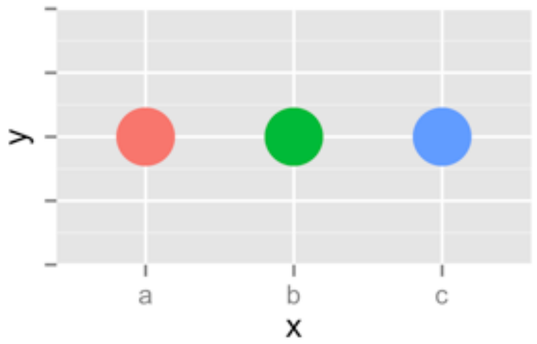
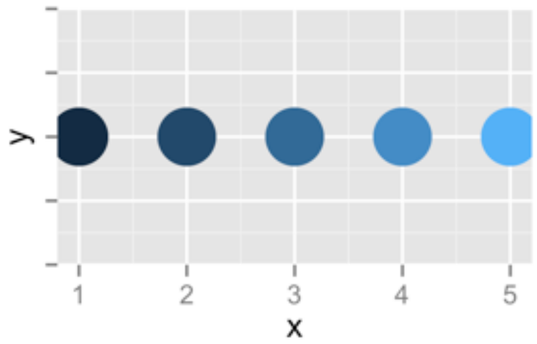
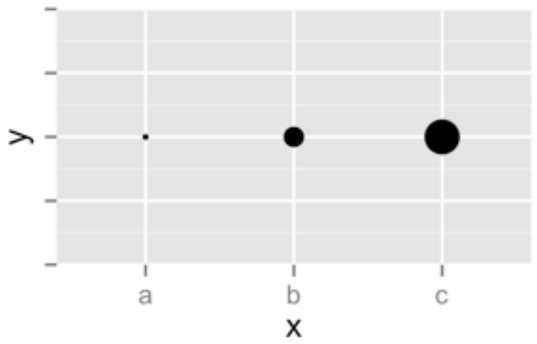
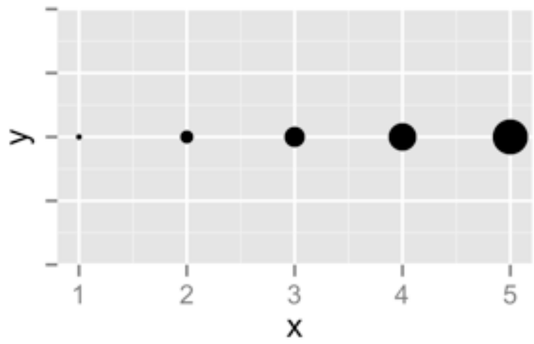
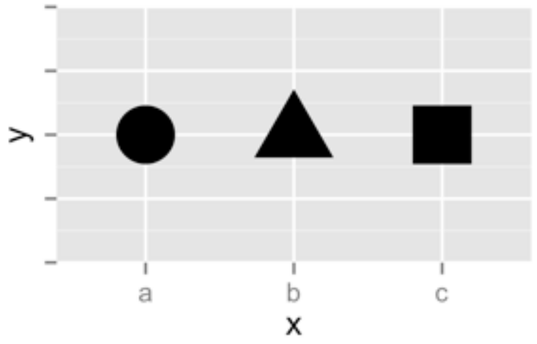
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = class))
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, size = class))
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, shape = class))
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, alpha = class))
```

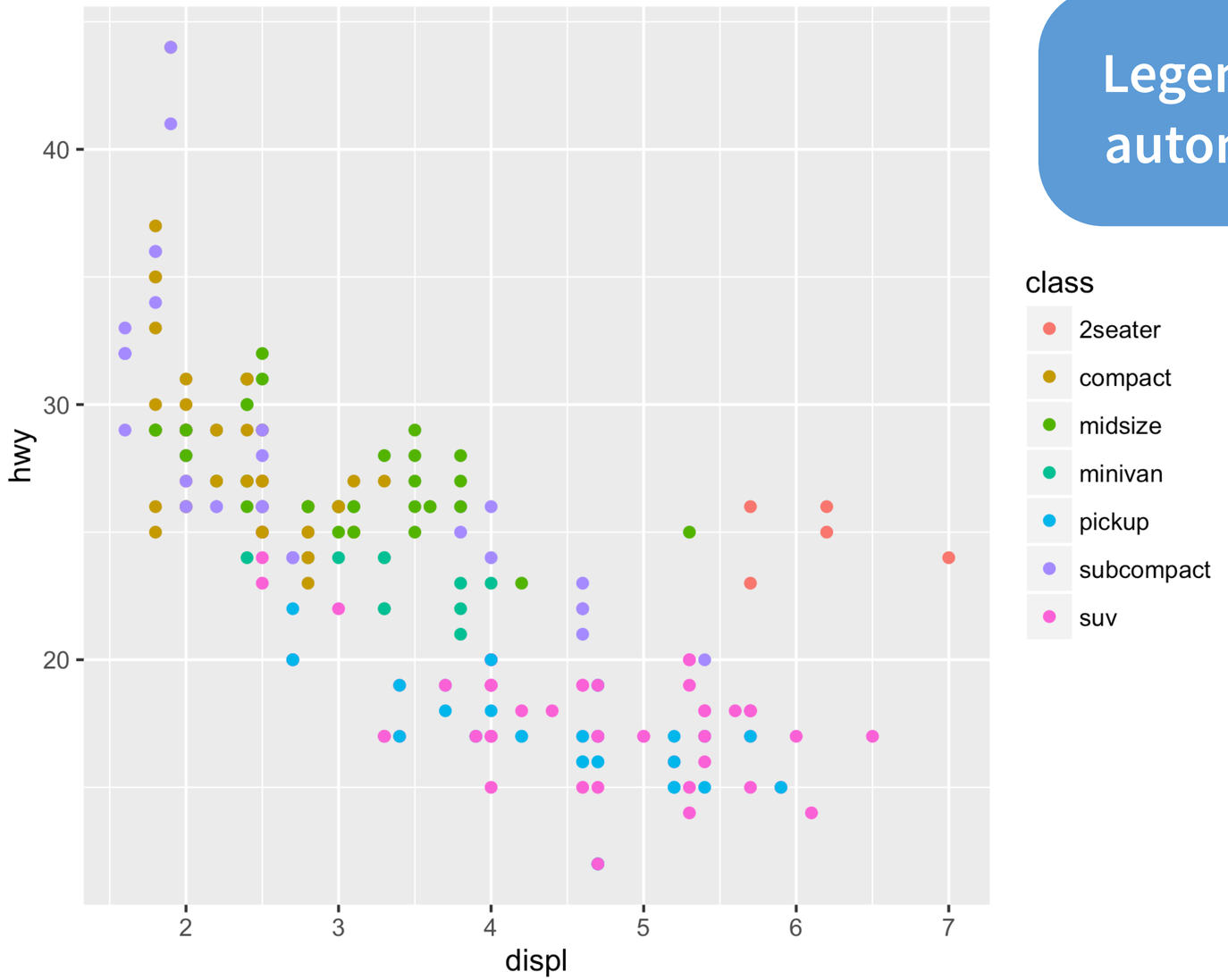
Your Turn 2

In the next chunk, add color, size, alpha, and shape aesthetics to your graph. Experiment.

Do different things happen when you map aesthetics to discrete and continuous variables?

What happens when you use more than one aesthetic?

	Discrete	Continuous
Color		
Size		
Shape		



Legend added automatically

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy, color = class))
```

ERROR!

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy), color = class)
```

Facets

Facets

Subplots that display subsets of the data.

Help me

What do **facet_grid** and **facet_wrap** do?

```
q <- ggplot(mpg) + geom_point(aes(x = displ, y = hwy))
q + facet_grid(cols = vars(cyl))
q + facet_grid(rows = vars(drv))
q + facet_grid(rows = vars(drv), cols = vars(cyl))
q + facet_wrap(facets = vars(class))
```

summary

facet_grid() - 2D grid, one variable in rows, one variable in columns

facet_wrap() - 1D ribbon wrapped into 2D

A ggplot2 template

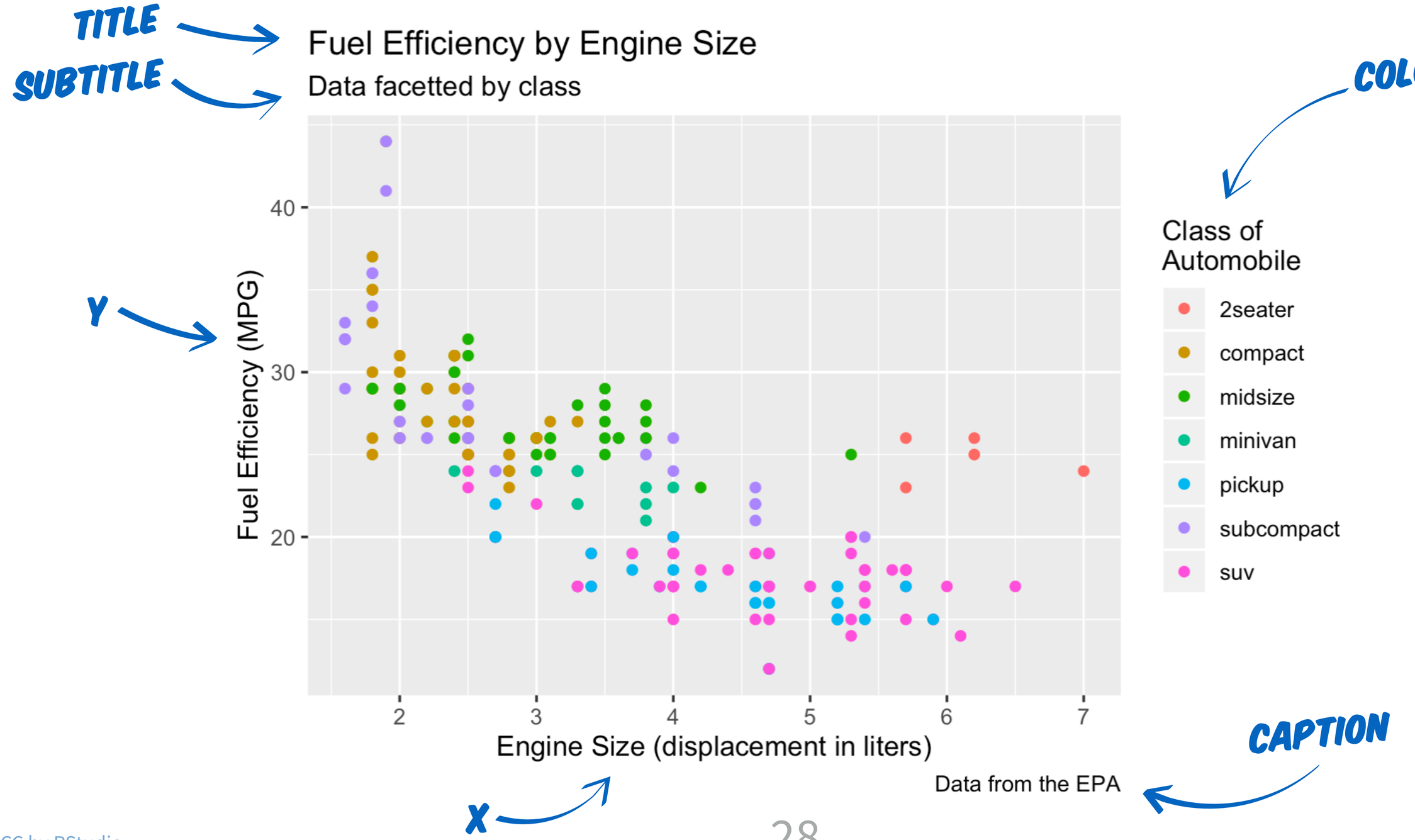
Make any plot by filling in the parameters of this template

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>)) +
  <FACET_FUNCTION>
```

Your Turn 3

Add the black code to your graph. What does it do?

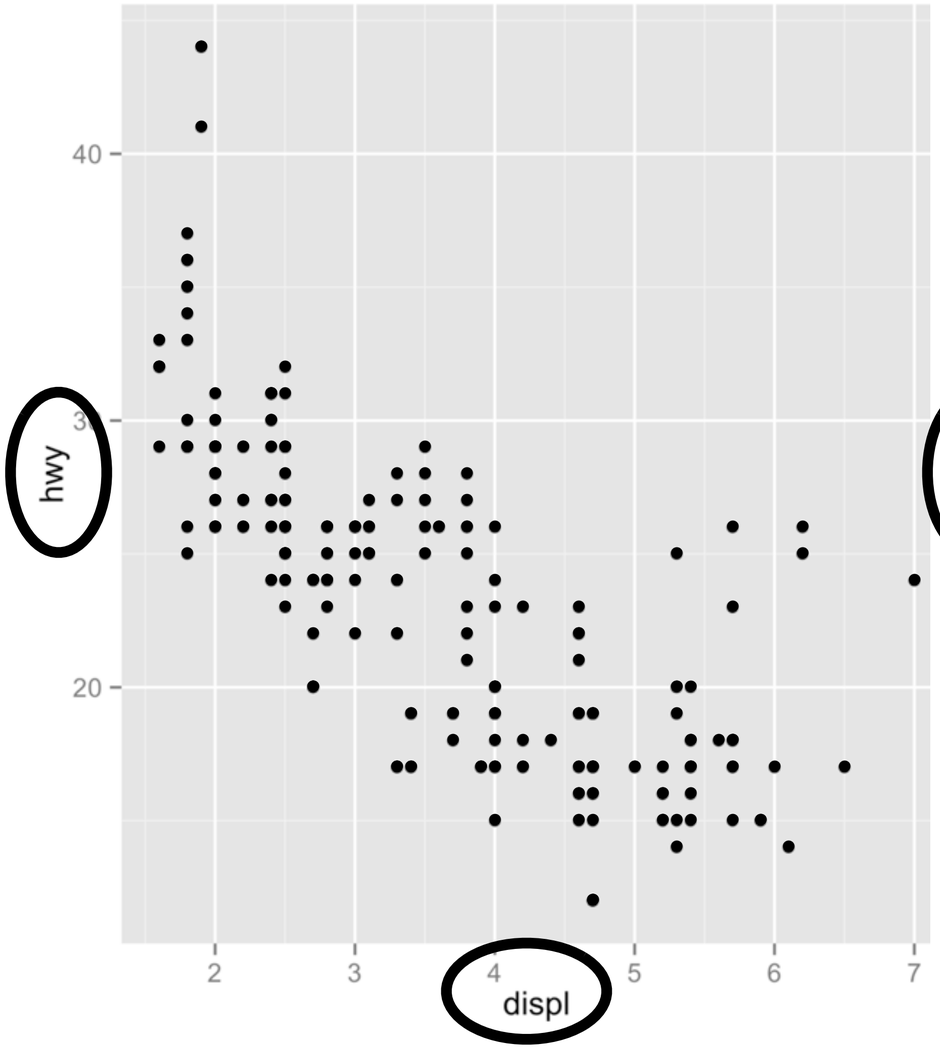
```
ggplot(data = mpg) +
  geom_point(mapping = aes(displ, hwy, color = class)) +
  labs(title = "Fuel Efficiency by Engine Size",
       subtitle = "Data facetted by class",
       x = "Engine Size (displacement in liters)",
       y = "Fuel Efficiency (MPG)",
       color = "Class of\nAutomobile",
       caption = "Data from the EPA")
```

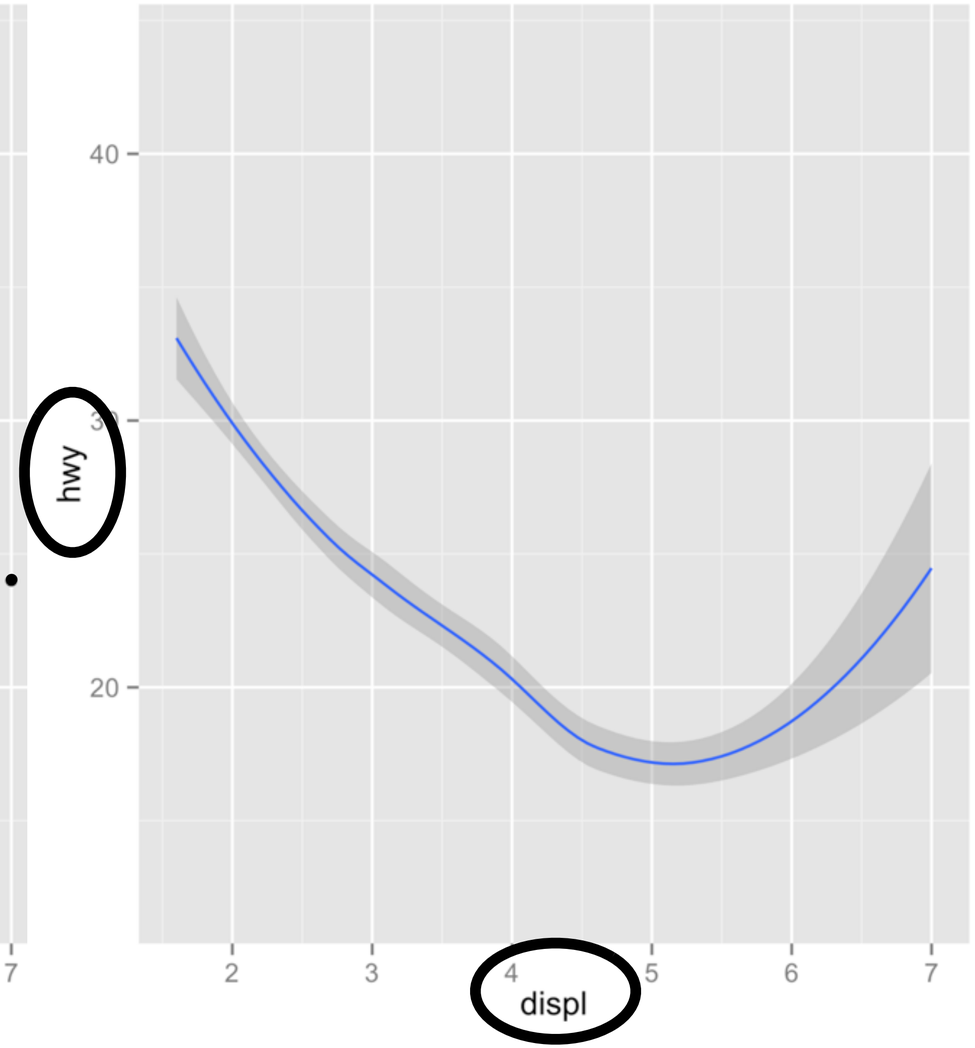


Geoms

How are these plots similar?

Same: x var , y var , data



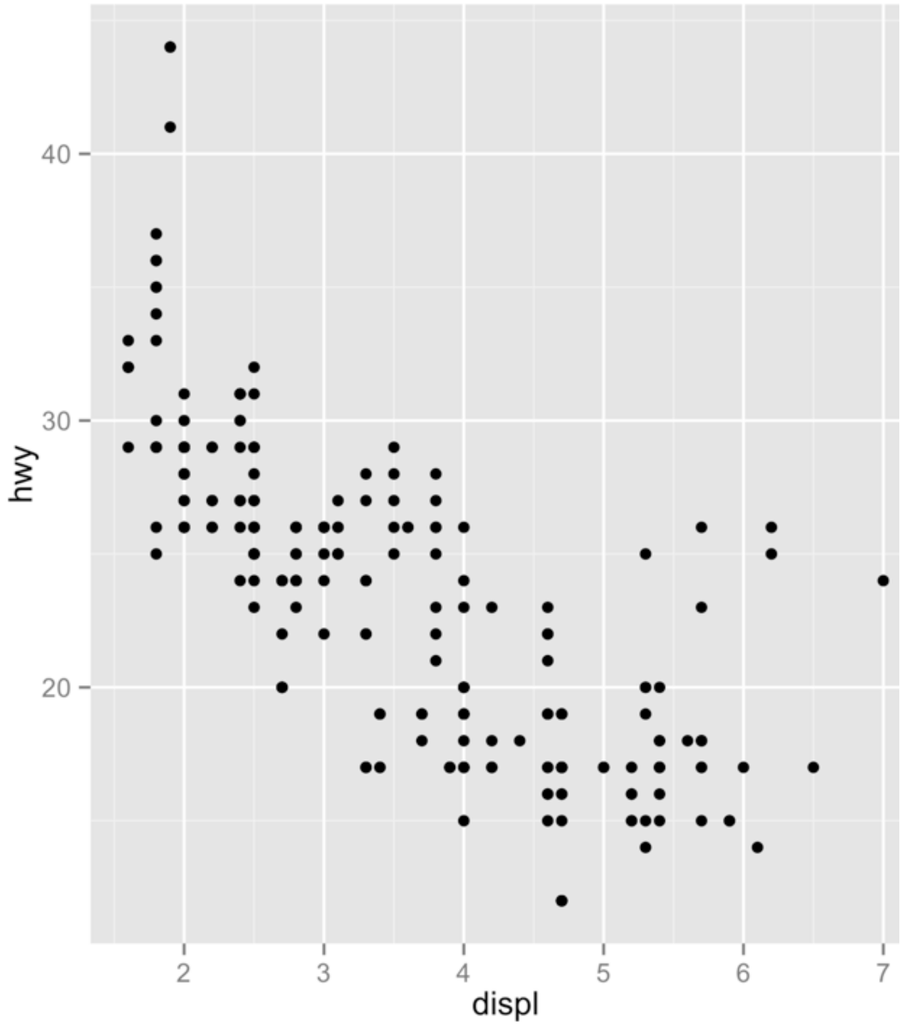


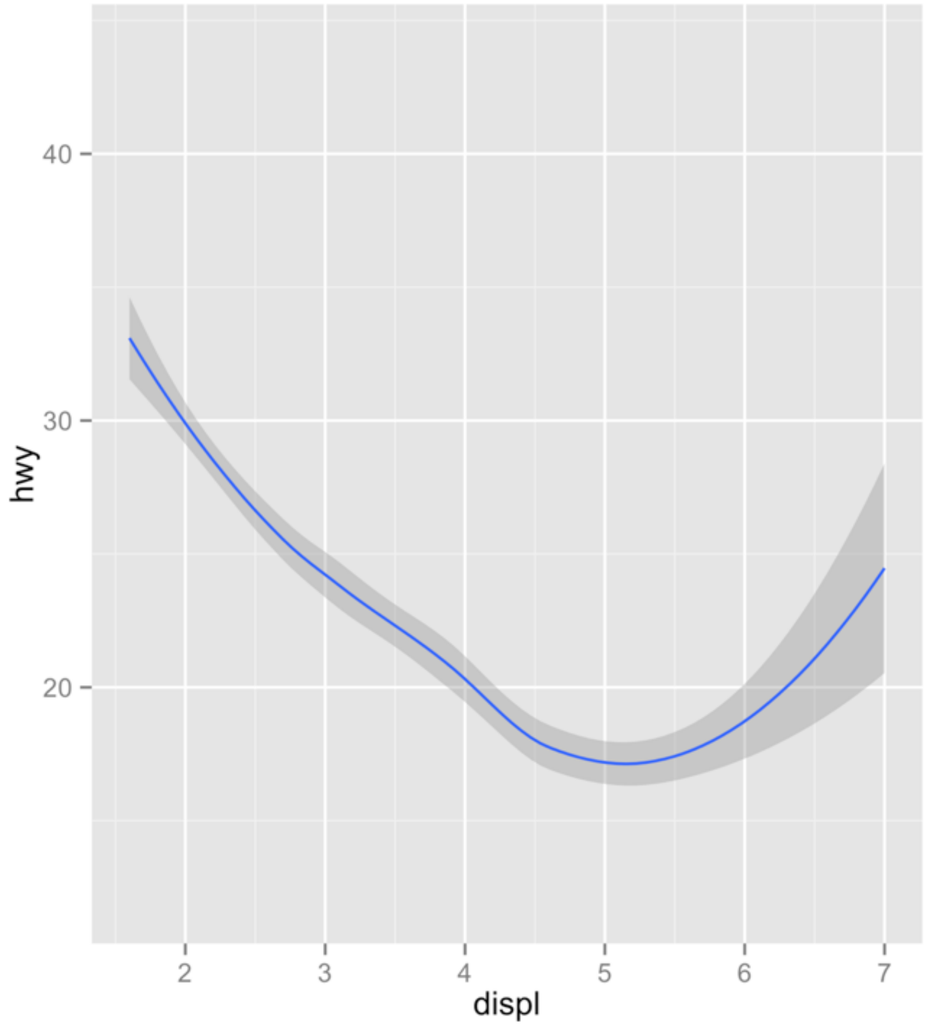
ggplot2

How are these plots different?

Different: geometric object (geom),

e.g. the visual object used to represent the data





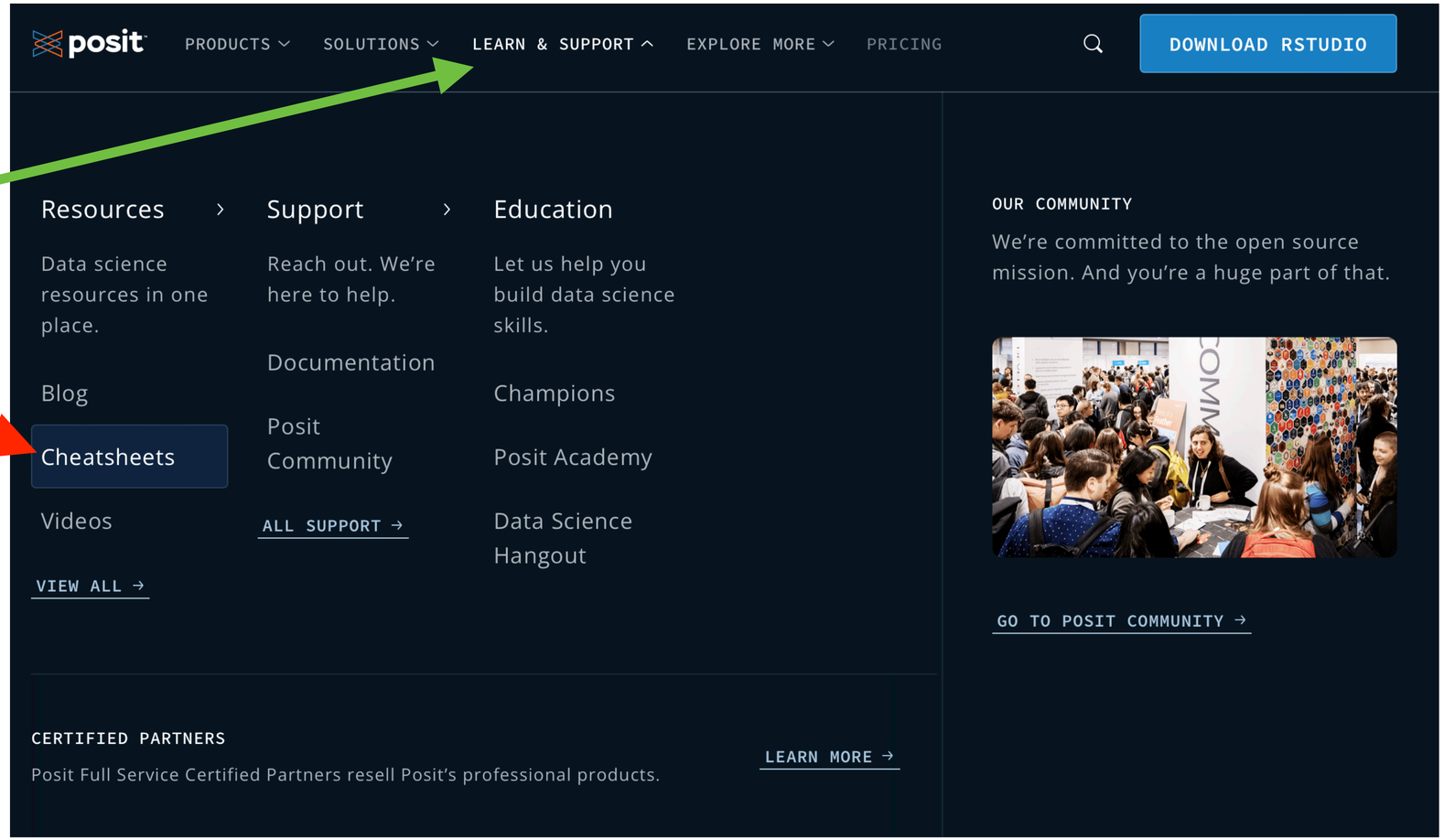
ggplot2

geoms

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

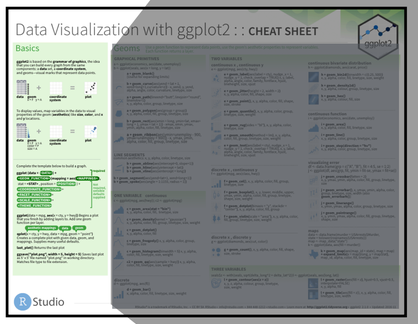
https://posit.co/resources/cheatsheets/

CLICK CHEATSHEETS IN THE LEARN & SUPPORT TAB



geom_ functions

Each requires a mapping argument.



Geoms

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

ggplot2

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_contour(aes(z = z))
x, y, z, alpha, colour, group, linetype, size, weight

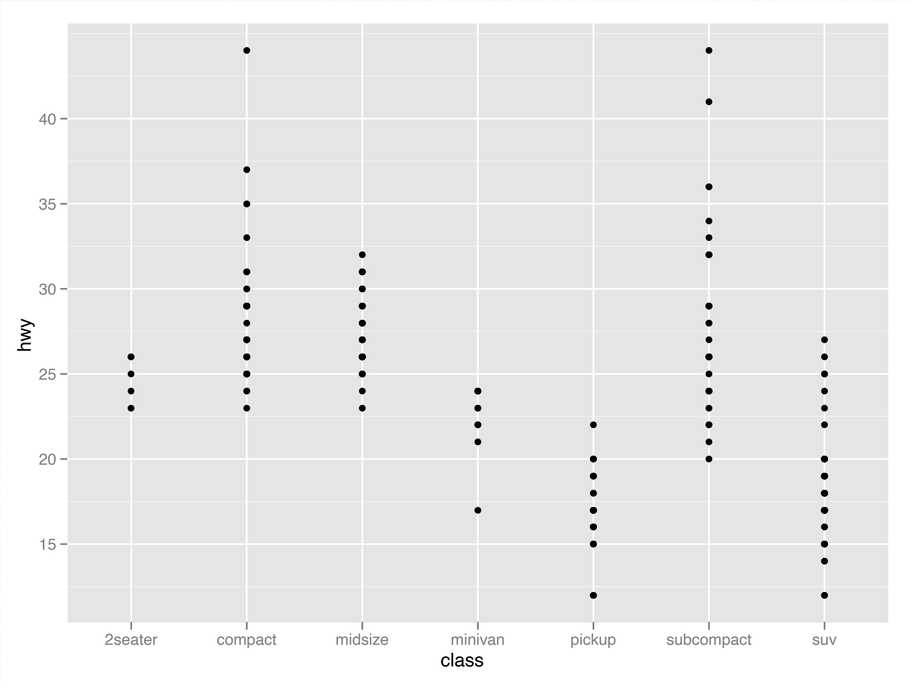
l + geom_raster(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE**)**
x, y, alpha, fill

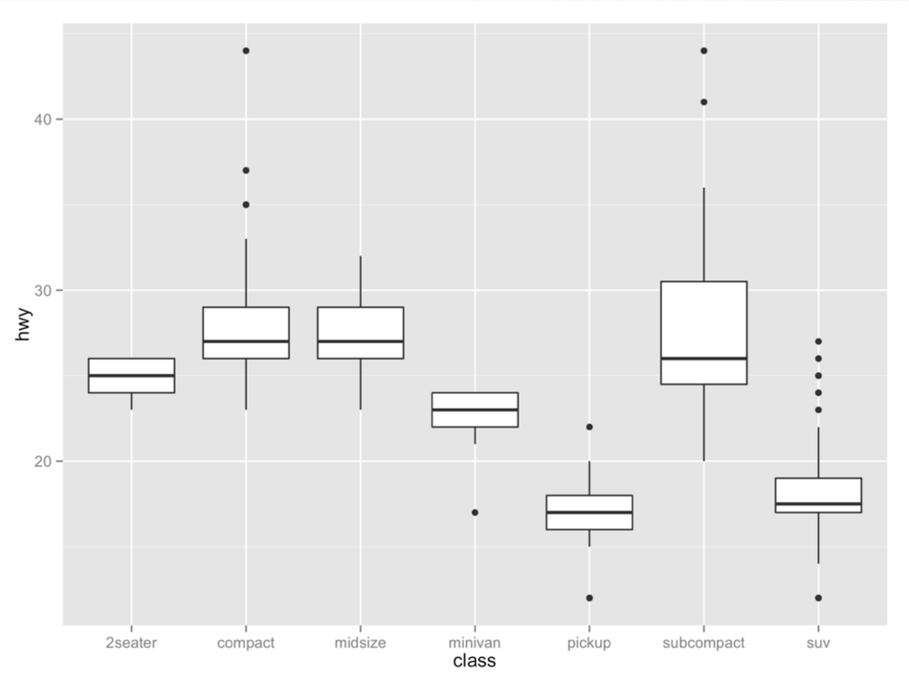
l + geom_tile(aes(fill = z)**)**, x, y, alpha, color, fill, linetype, size, width

ggplot2

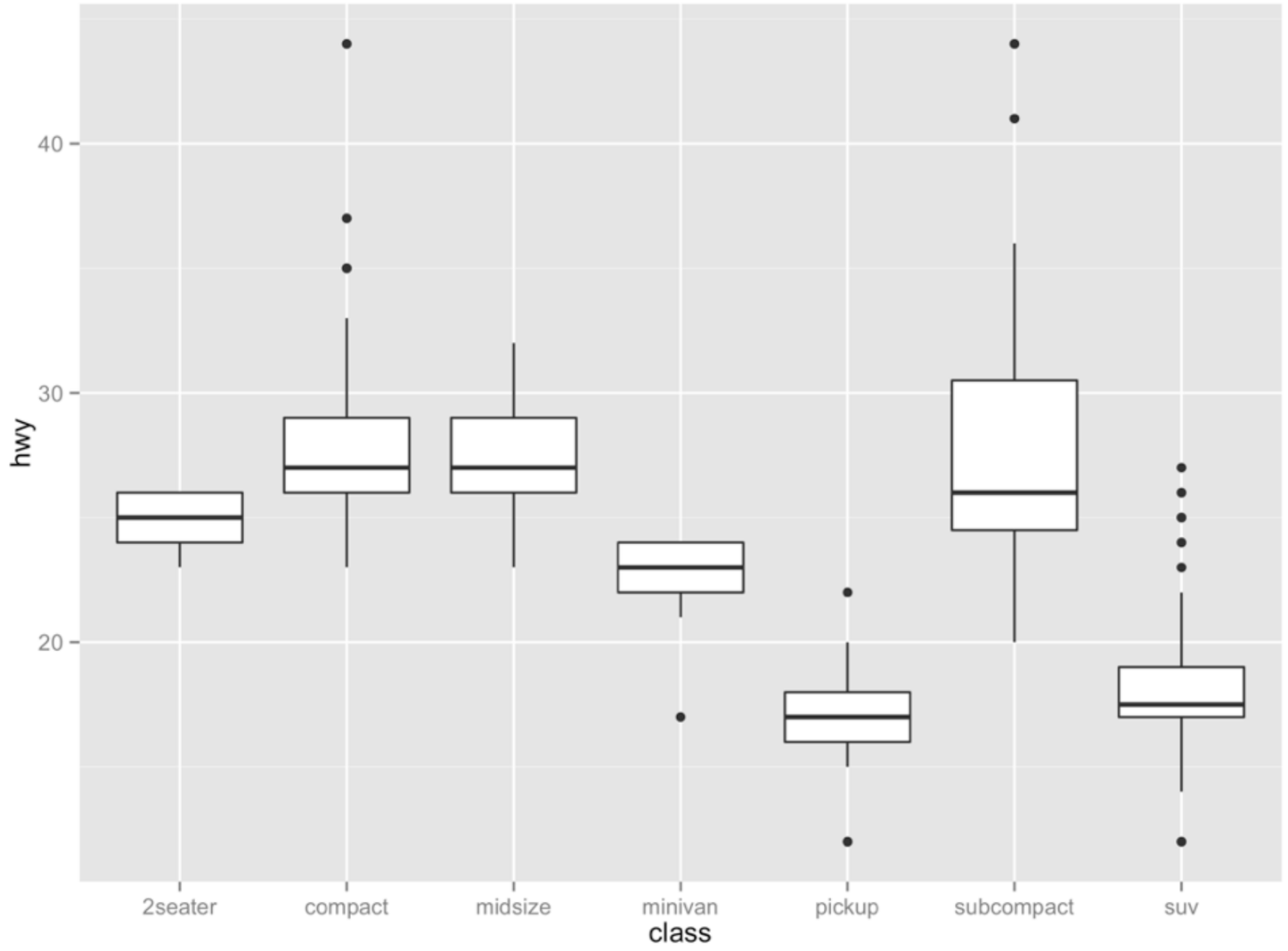
Your Turn 4

Decide how to replace this scatterplot with one that draws boxplots. Use the cheatsheet. Try your best guess.






```
ggplot(mpg) + geom_point(aes(class, hwy))
```

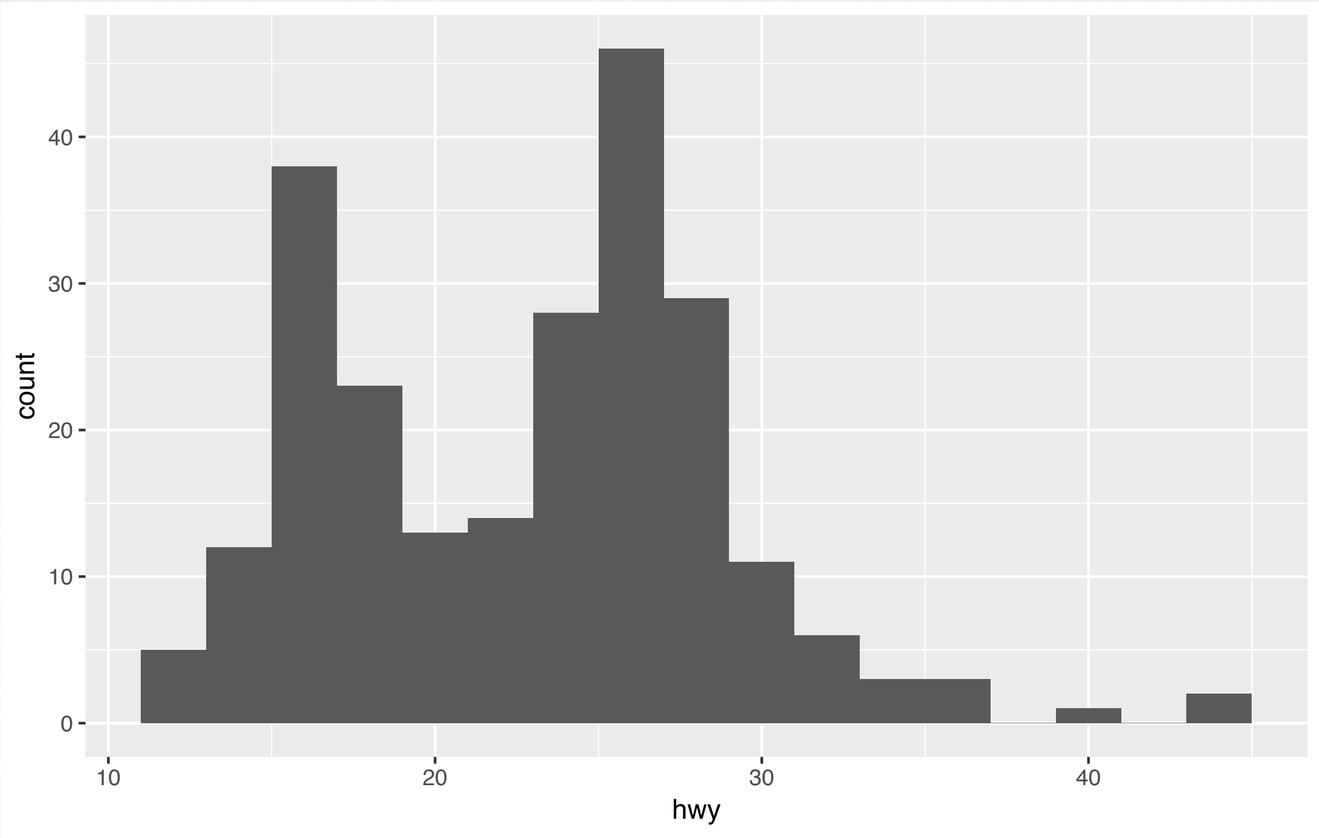


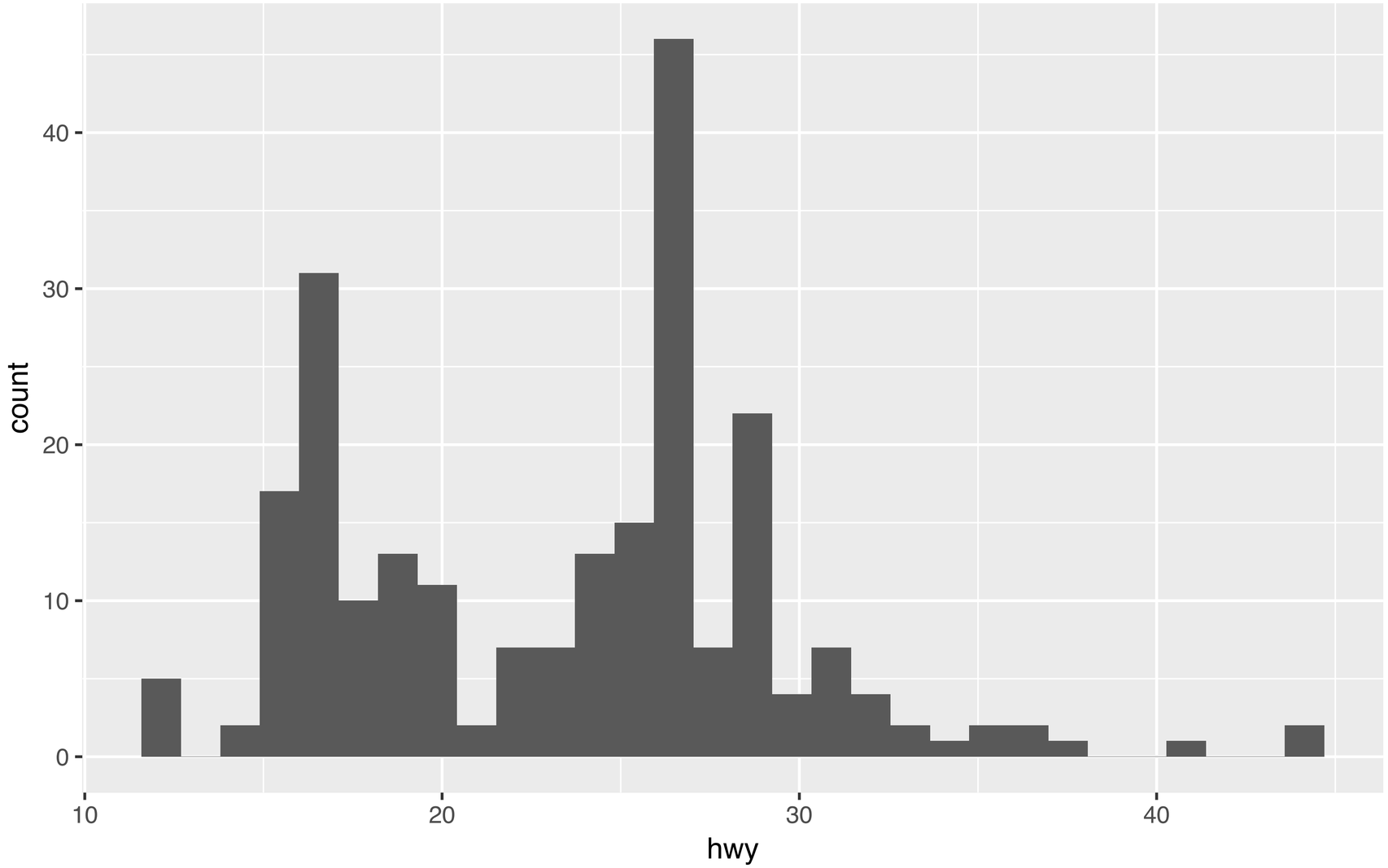

```
ggplot(data = mpg) +
  geom_boxplot(mapping = aes(x = class, y = hwy))
```

ggplot2

Your Turn 5

Make the histogram of **hwy** below. Use the cheatsheet. Hint: do not supply a **y** variable.

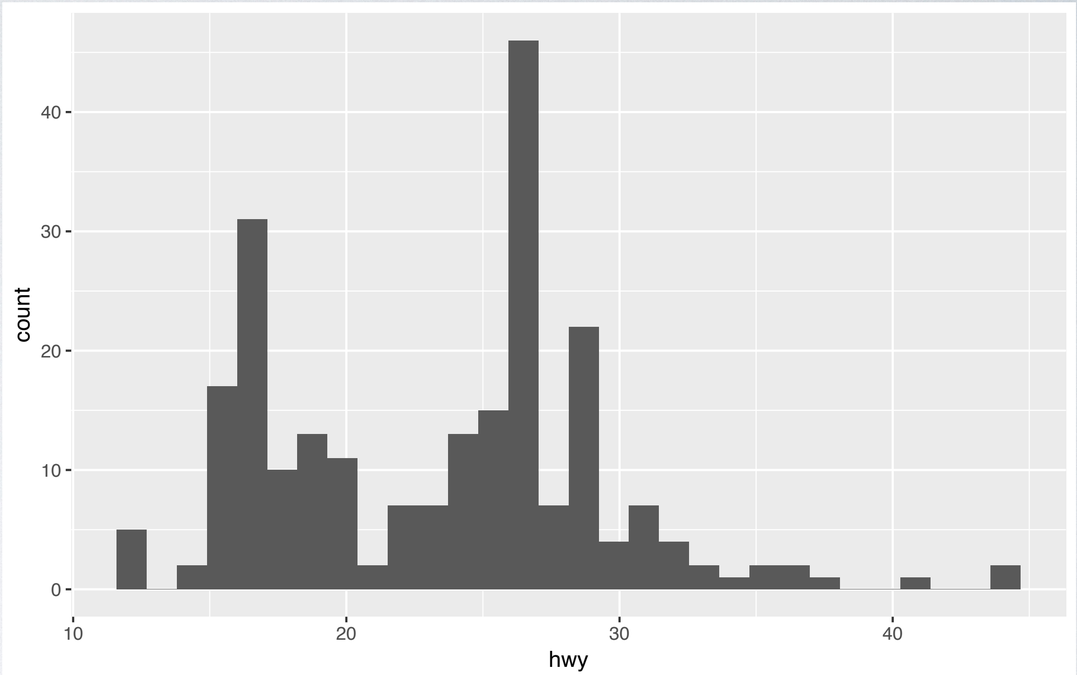


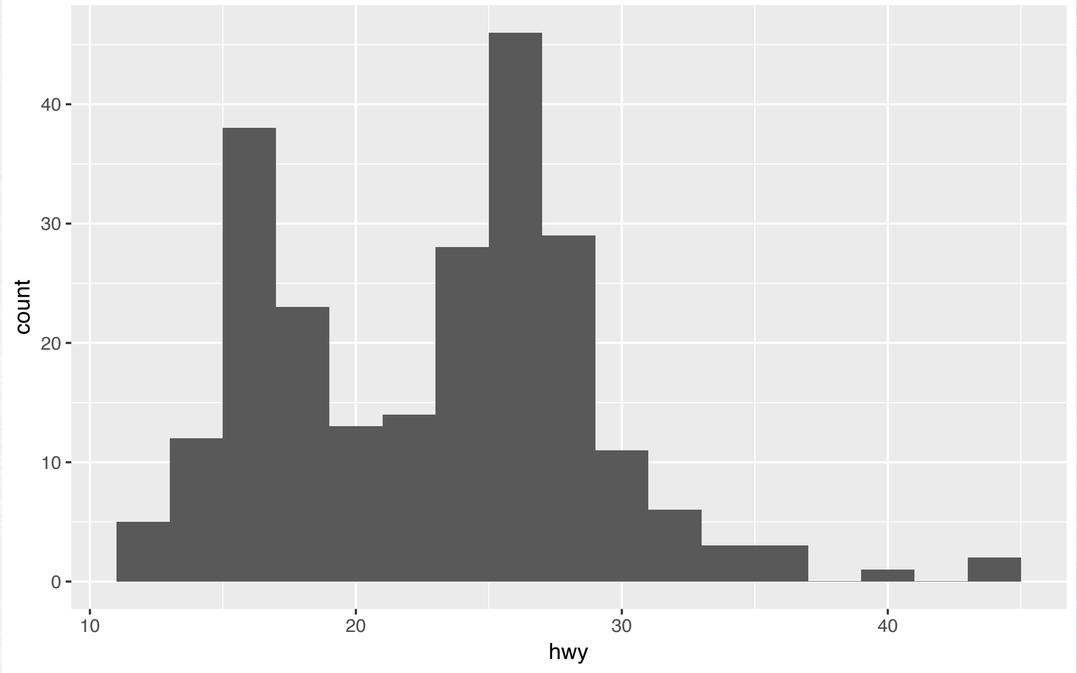



```
ggplot(data = mpg) +
  geom_histogram(mapping = aes(x = hwy))
```

Quiz

What is the difference?





"Help" pages

To open the documentation for a function, type

```
?geom_histogram
```

? — **function name** (no parentheses)

geom_freqpoly {ggplot2} R Documentation

Histograms and frequency polygons

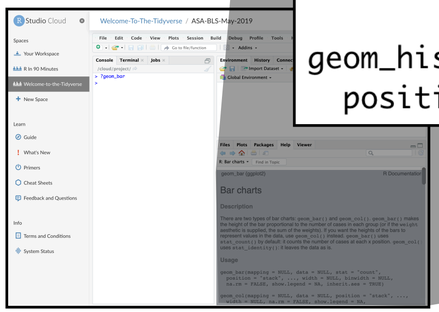
Description

Visualise the distribution of a single continuous variable by dividing the x axis into bins and counting the number of observations in each bin. Histograms (`geom_histogram()`) display the counts with bars; frequency polygons (`geom_freqpoly()`) display the counts with lines. Frequency polygons are more suitable when you want to compare the distribution across the levels of a categorical variable.

Usage

```
geom_freqpoly(mapping = NULL, data = NULL, stat = "bin",
  position = "identity", ..., na.rm = FALSE, show.legend = NA,
  inherit.aes = TRUE)

geom_histogram(mapping = NULL, data = NULL, stat = "bin",
  position = "stack", ..., binwidth = NULL, bins = NULL,
```



ggplot2

Tips

- **scan** page for relevant info
- **ignore** things that don't make sense
- **try** out the examples

geom_freqpoly {ggplot2} R Documentation

Histograms and frequency polygons

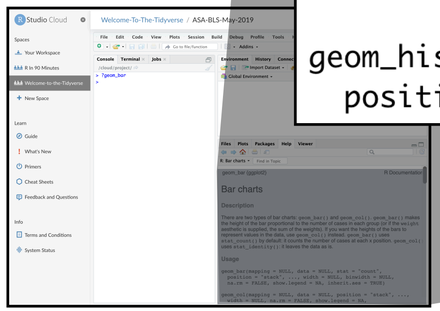
Description

Visualise the distribution of a single continuous variable by dividing the x axis into bins and counting the number of observations in each bin. Histograms (`geom_histogram()`) display the counts with bars; frequency polygons (`geom_freqpoly()`) display the counts with lines. Frequency polygons are more suitable when you want to compare the distribution across the levels of a categorical variable.

Usage

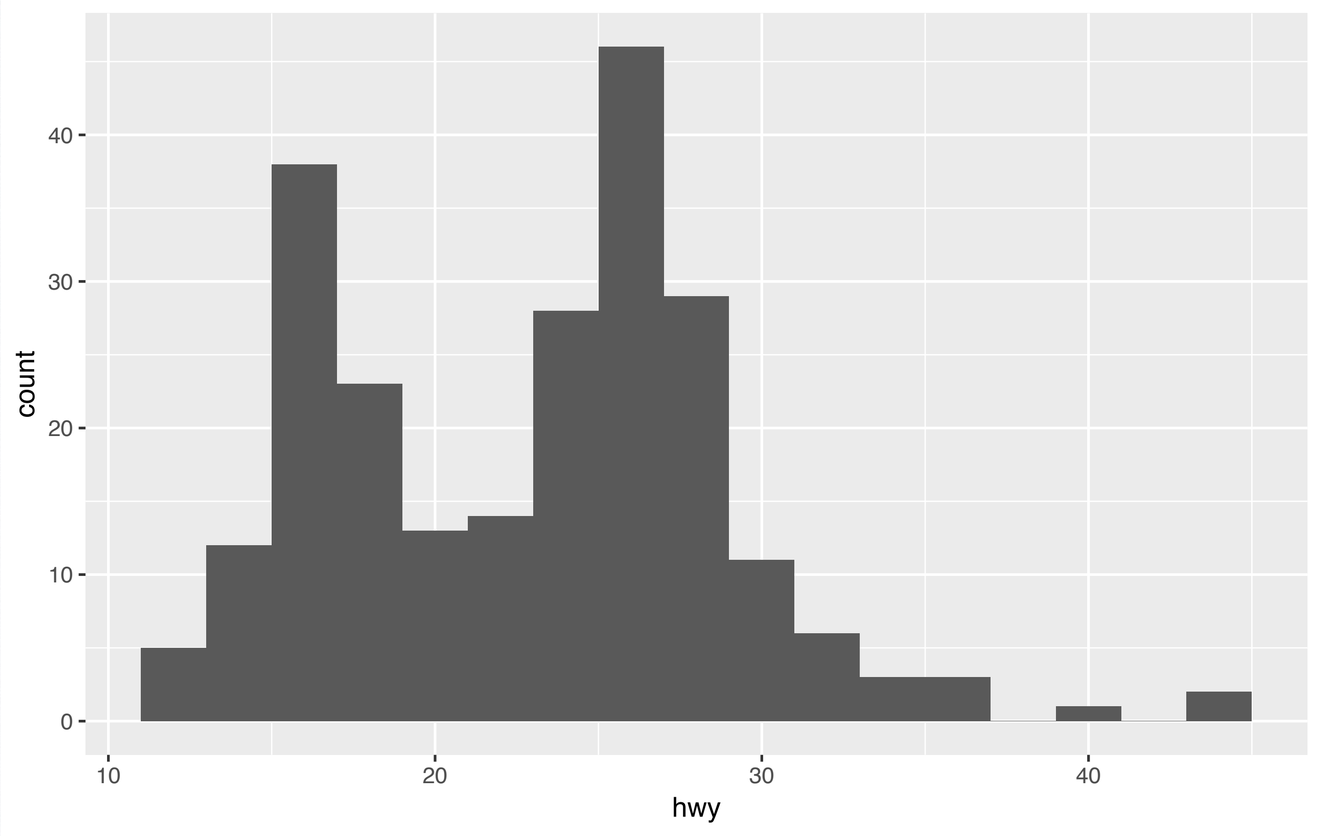
```
geom_freqpoly(mapping = NULL, data = NULL, stat = "bin",
  position = "identity", ..., na.rm = FALSE, show.legend = NA,
  inherit.aes = TRUE)

geom_histogram(mapping = NULL, data = NULL, stat = "bin",
  position = "stack", ..., binwidth = NULL, bins = NULL,
```

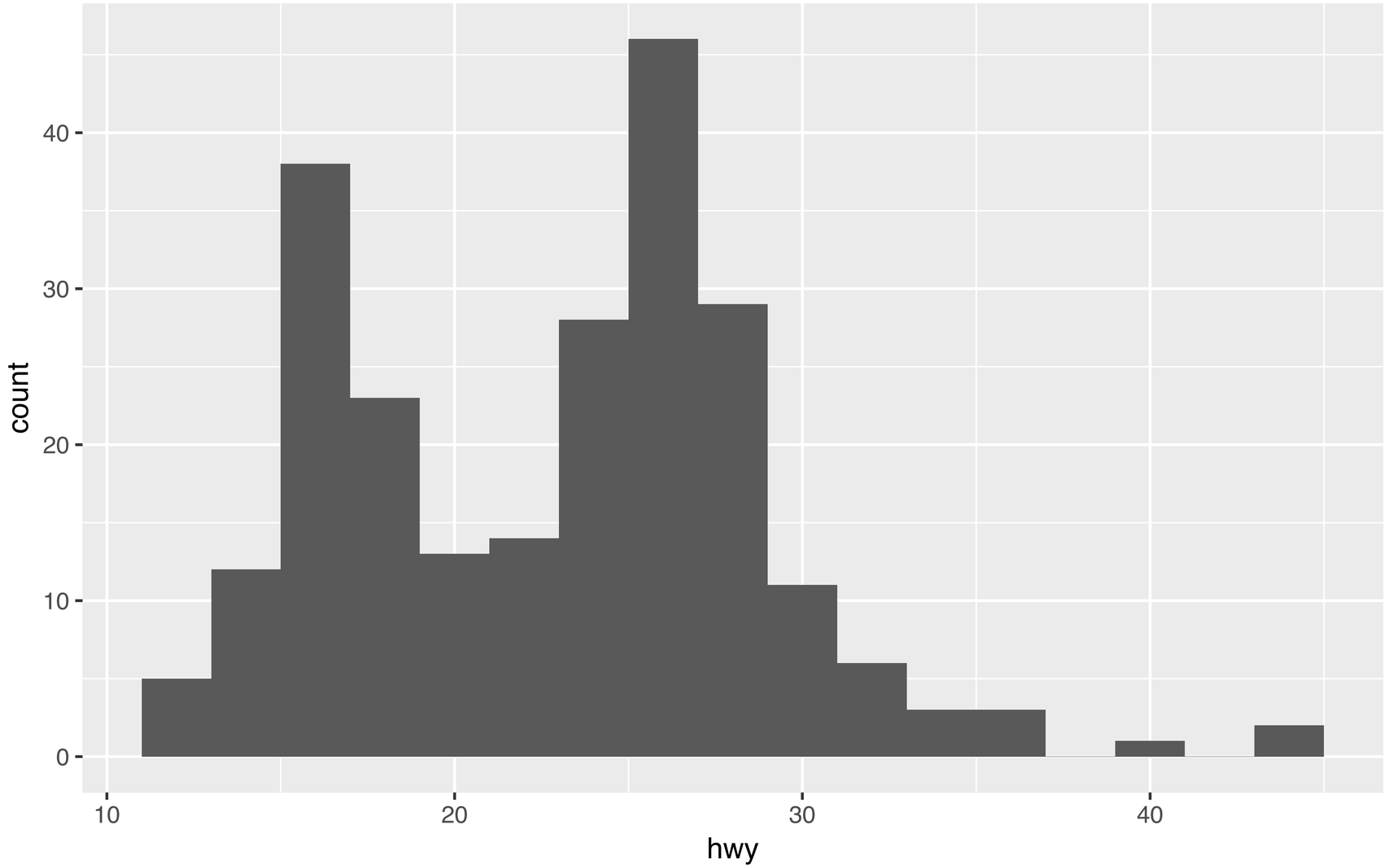


Your Turn 6

Use the help page for **geom_histogram** to make the bins **2** mpg wide.



02:00




```
ggplot(data = mpg) +
  geom_histogram(mapping = aes(x = hwy), binwidth = 2)
```

ggplot2.tidyverse.org

ggplot2

Overview

ggplot2 is a system for declaratively creating graphics, based on The Grammar of Graphics. You provide the data, tell ggplot2 how to map variables to aesthetics, what graphical primitives to use, and it takes care of the details.

Installation

```
# The easiest way to get ggplot2 is to install the whole tidyverse:
install.packages("tidyverse")
```

LINKS

View on CRAN

Browse source code

Report a bug

Learn more

Extensions

COMMUNITY

Contributing guide

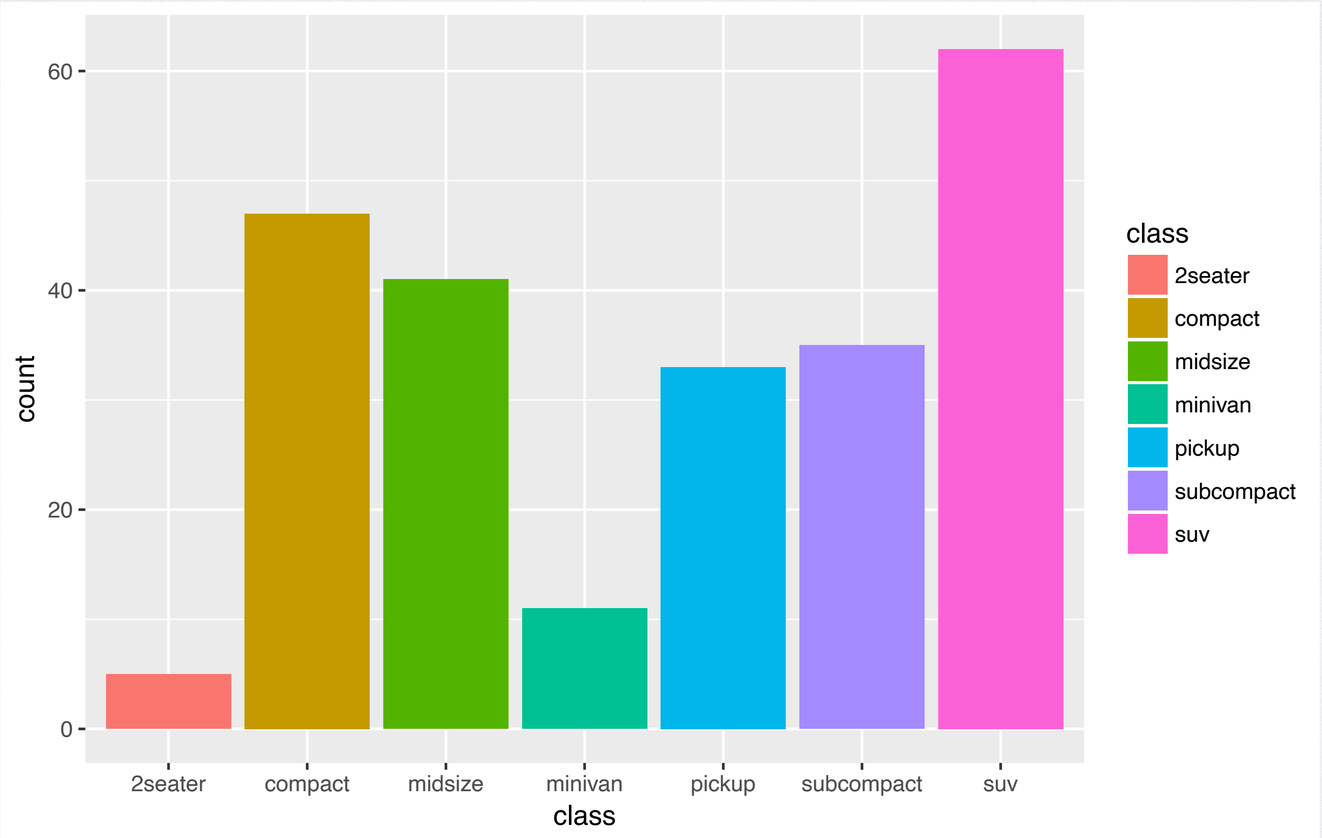
Code of conduct

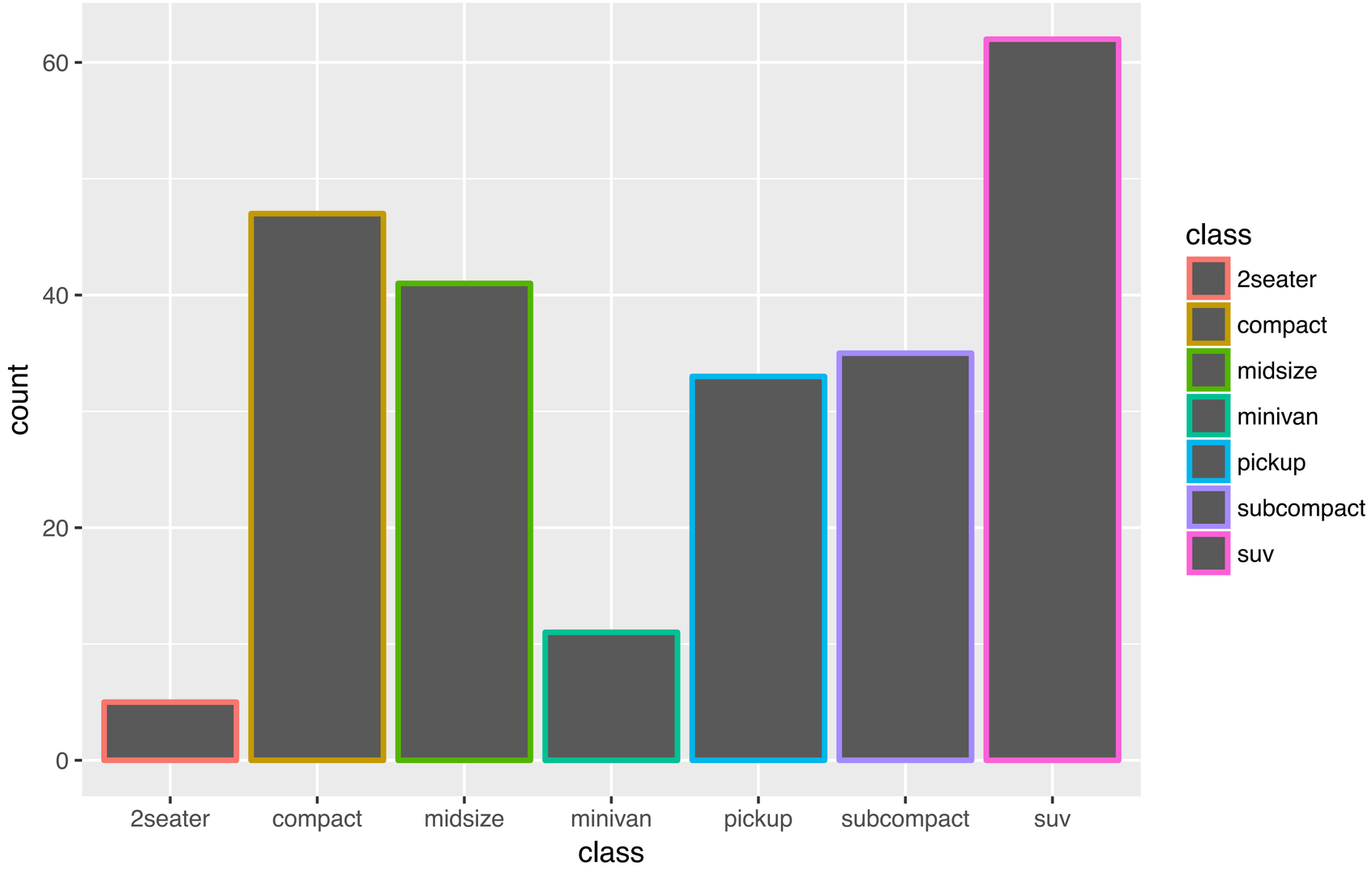
CITATION

Citing ggplot2

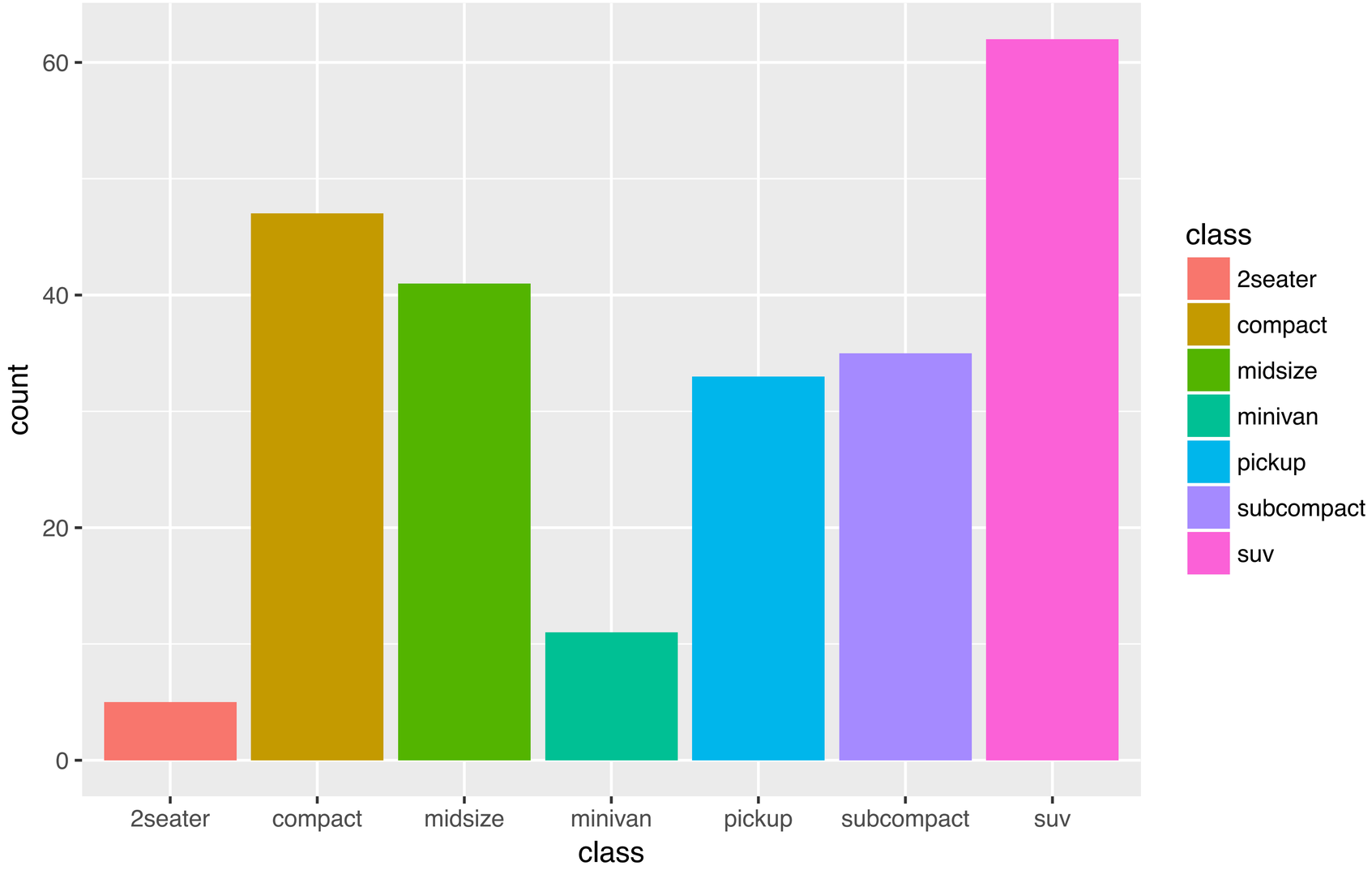
Your Turn 7

Make the bar chart of **class** below. Use the cheatsheet. Hint: do not supply a **y** variable.

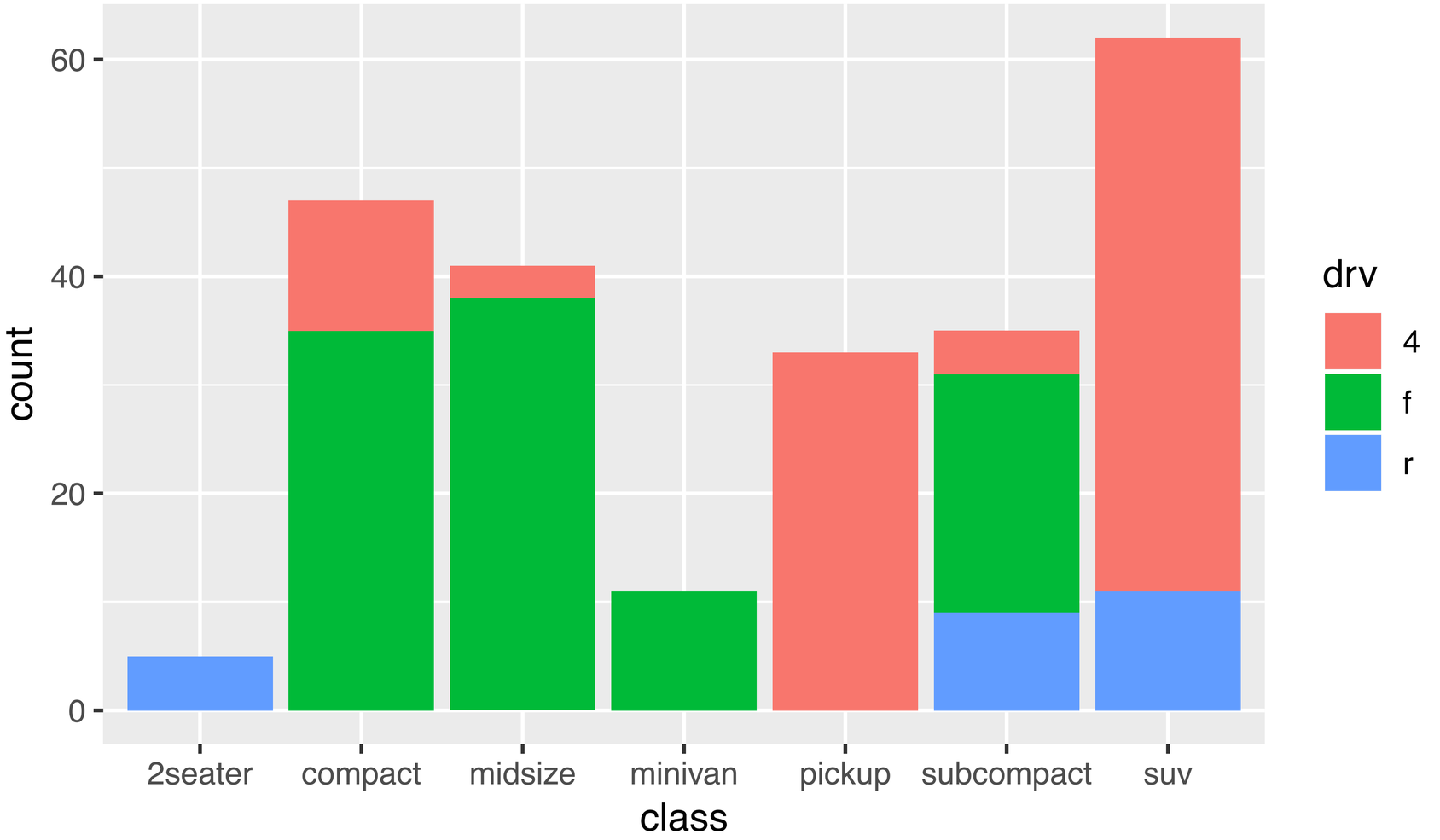





```
ggplot(data = mpg) +
  geom_bar(mapping = aes(x = class, color = class))
```




```
ggplot(data = mpg) +
  geom_bar(mapping = aes(x = class, fill = class))
```

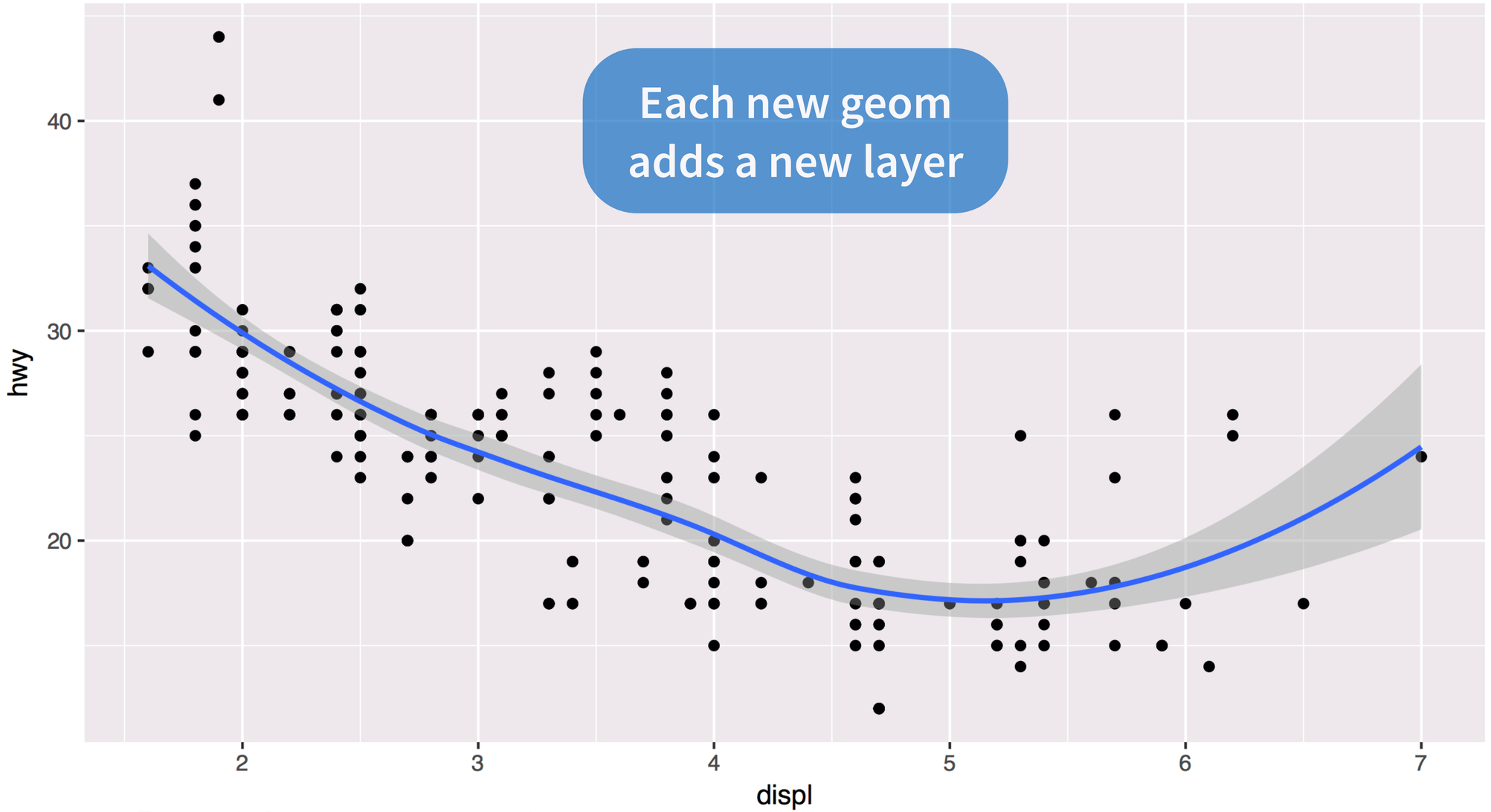



```
ggplot(data = mpg) +
  geom_bar(mapping = aes(x = class, fill = drv))
```

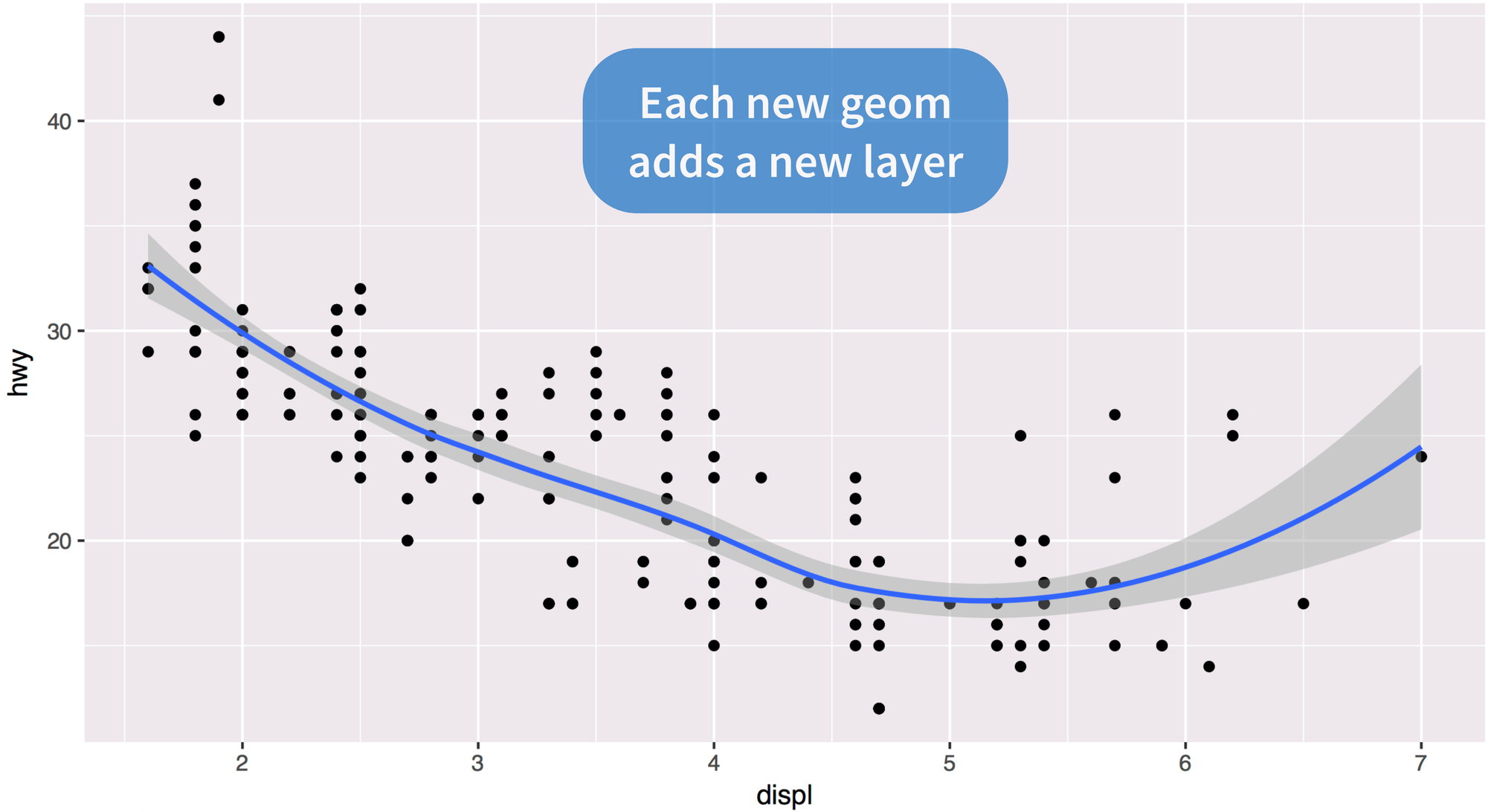
Quiz

What will this code do?

```
ggplot(mpg) +
  geom_point(aes(displ, hwy)) +
  geom_smooth(aes(displ, hwy))
```



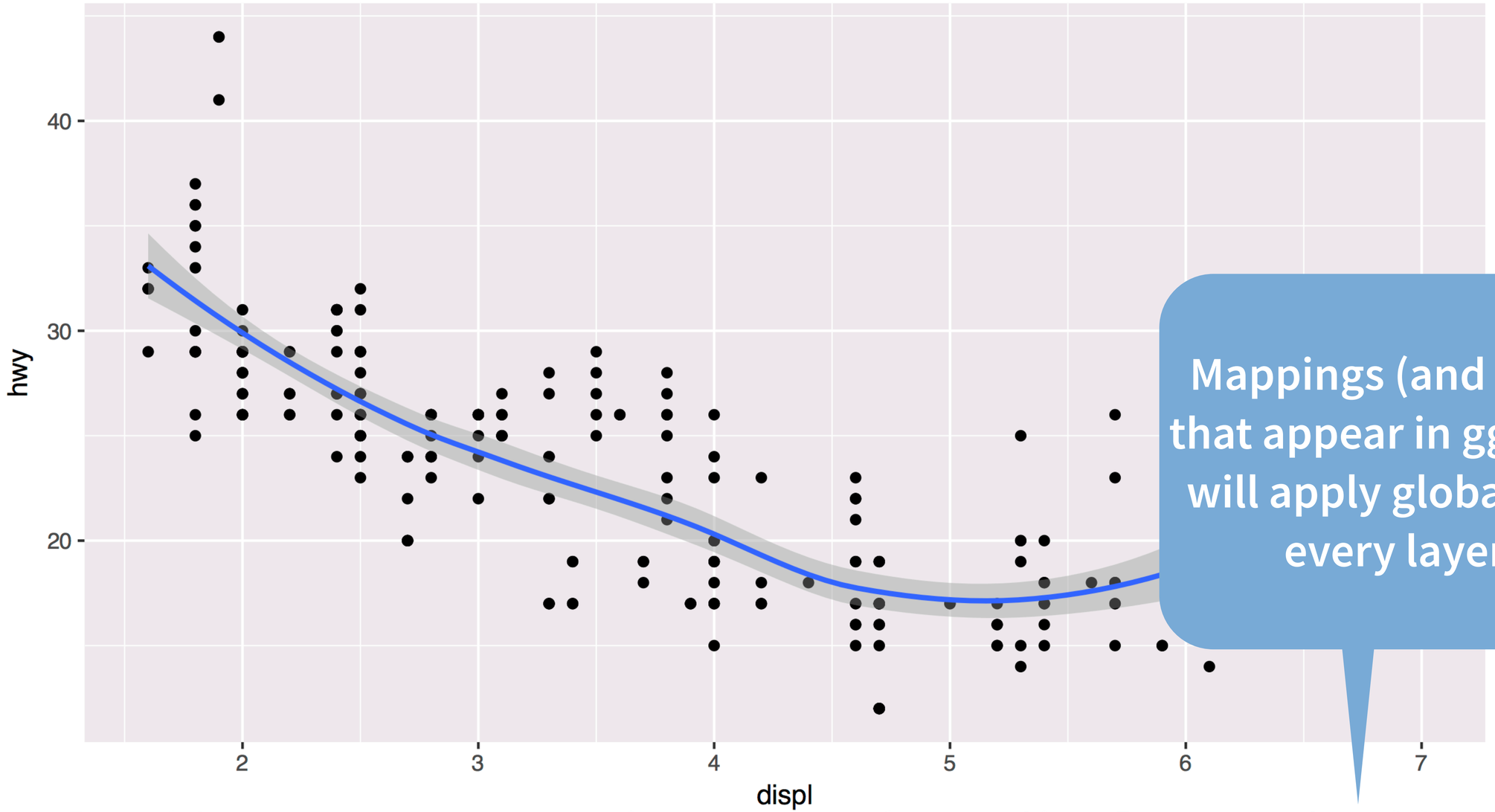

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy)) +
  geom_smooth(mapping = aes(x = displ, y = hwy))
```




```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy)) +
  geom_smooth(mapping = aes(x = displ, y = hwy))
```

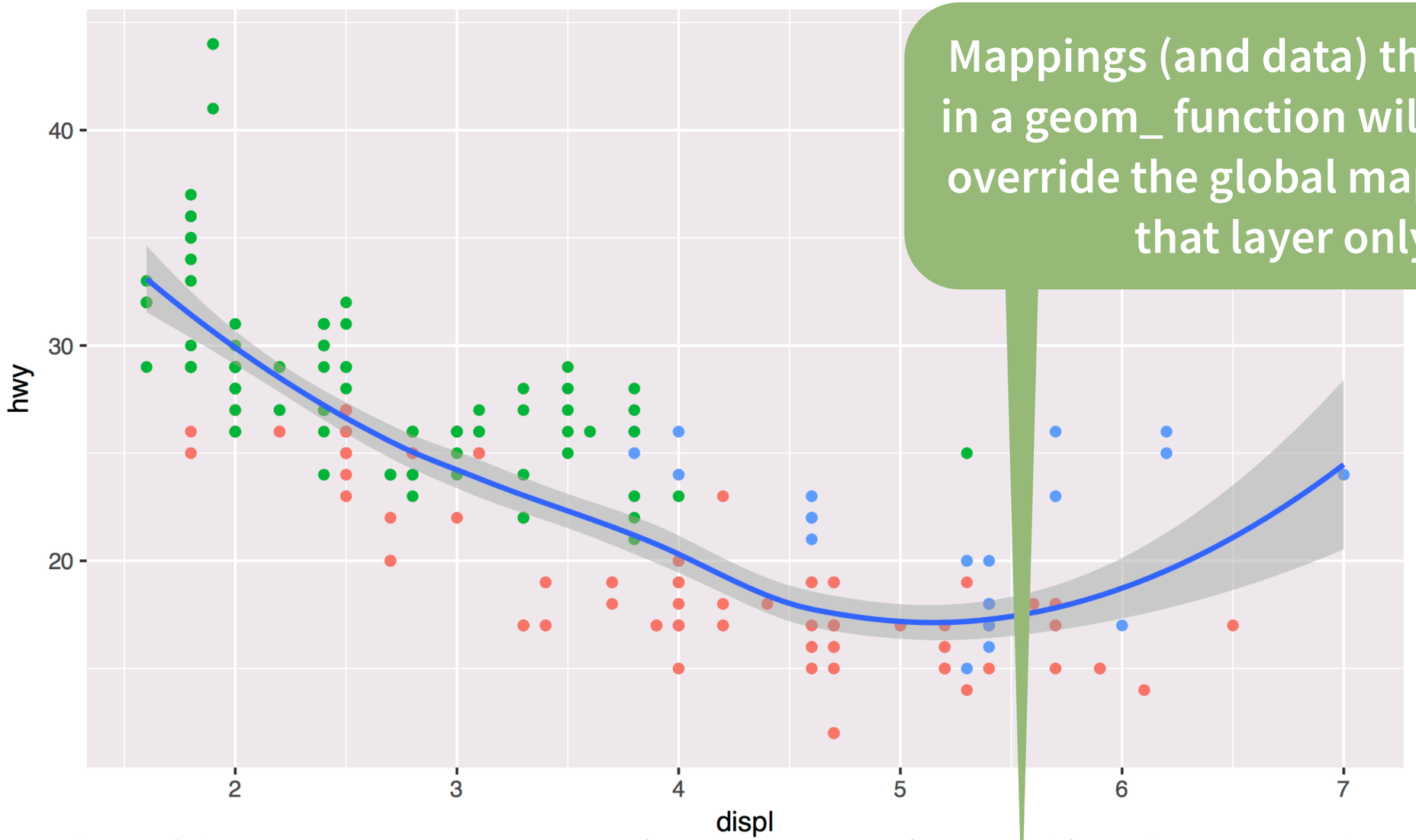
ggplot2

global vs. local



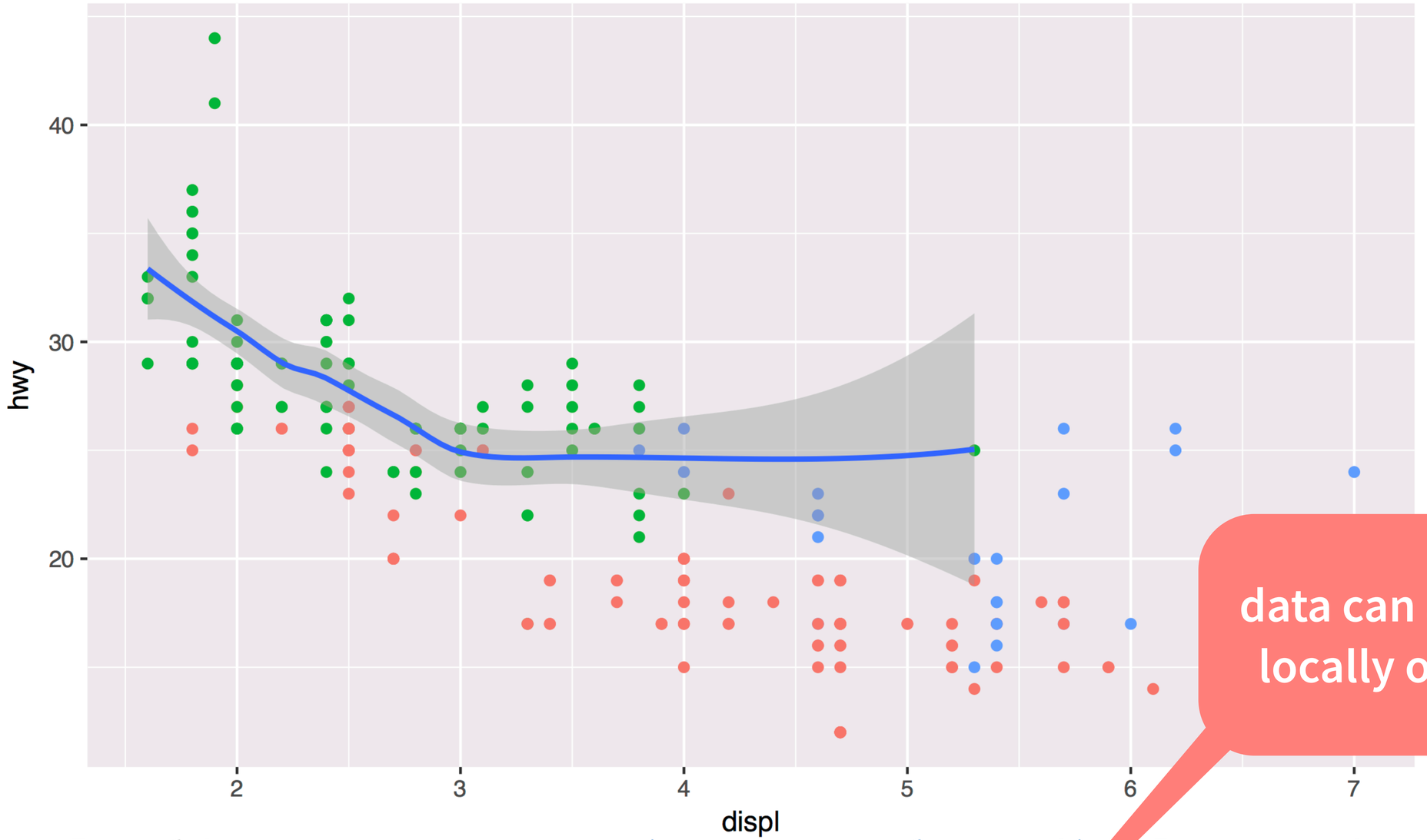
Mappings (and data) that appear in ggplot() will apply globally to every layer

```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +
  geom_point() +
  geom_smooth()
```



Mappings (and data) that appear in a geom_ function will add to or override the global mappings for that layer only

```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +
  geom_point(mapping = aes(color = drv)) +
  geom_smooth()
```



data can also be set locally or globally

```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +
  geom_point(mapping = aes(color = drv)) +
  geom_smooth(data = filter(mpg, drv == "f"))
```

Quiz

What is different about this plot? Run the code!

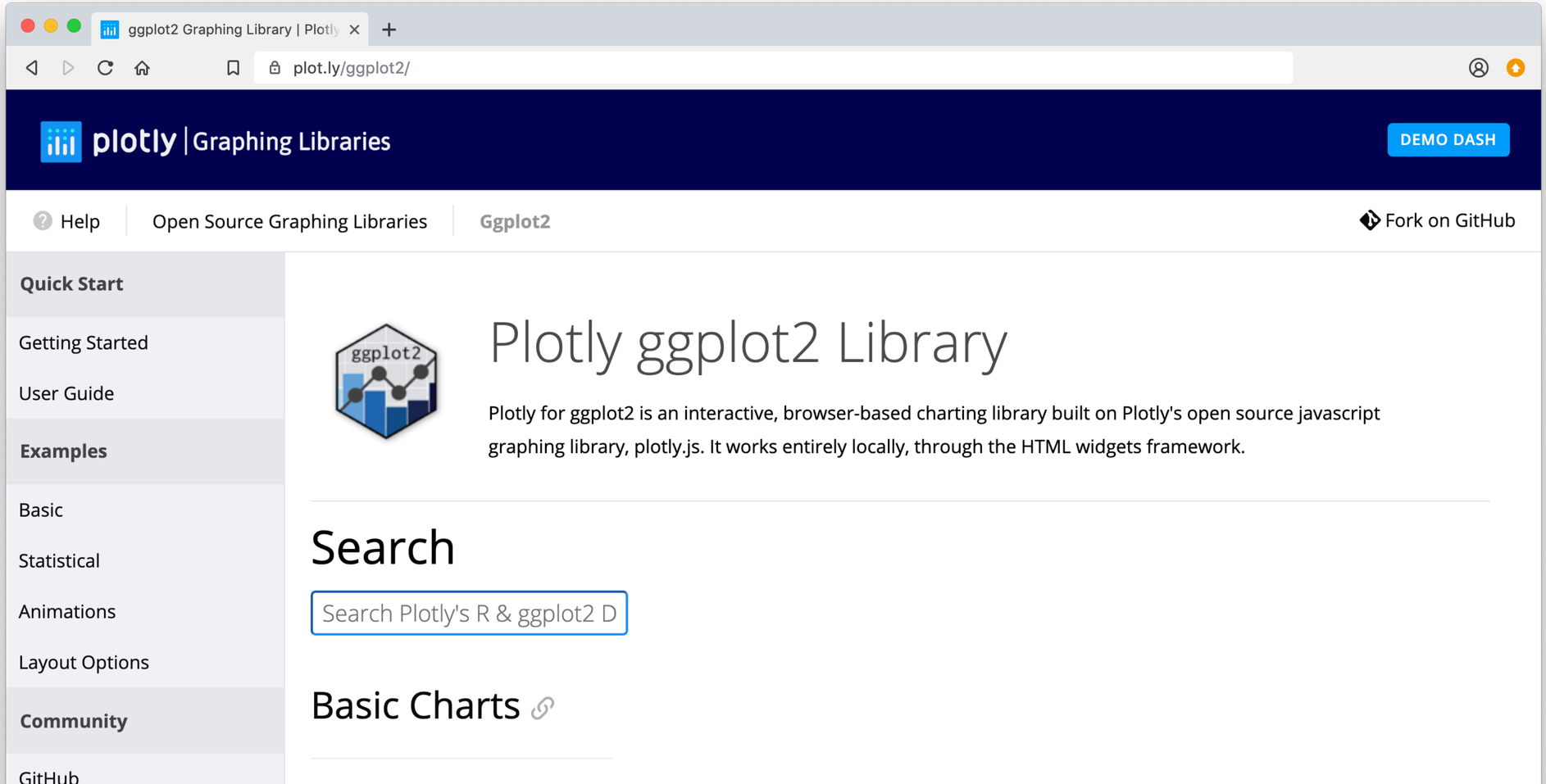
```
p <- ggplot(mpg) +
  geom_point(aes(displ, hwy)) +
  geom_smooth(aes(displ, hwy))

library(plotly)
ggplotly(p)
```

interactivity

Plotly

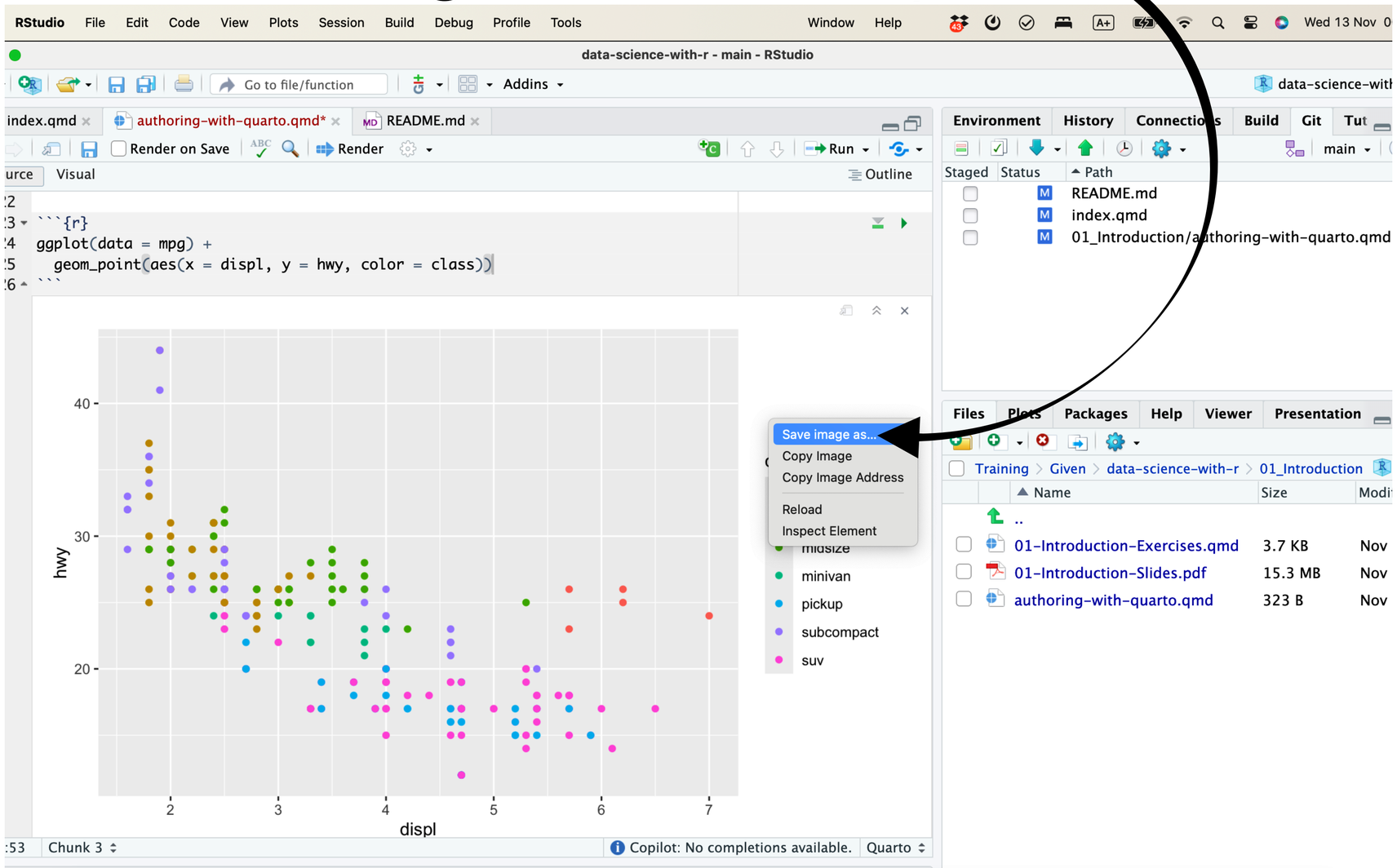
Tools for making interactive plots. plot.ly/ggplot2/



Saving graphs

GUI method

Right click on the plot



Code method

ggsave() saves the last plot.

Uses size on screen:

```
ggsave("my-plot.pdf")
ggsave("my-plot.png")
```

Specify size in inches

```
ggsave("my-plot.pdf", width =
```

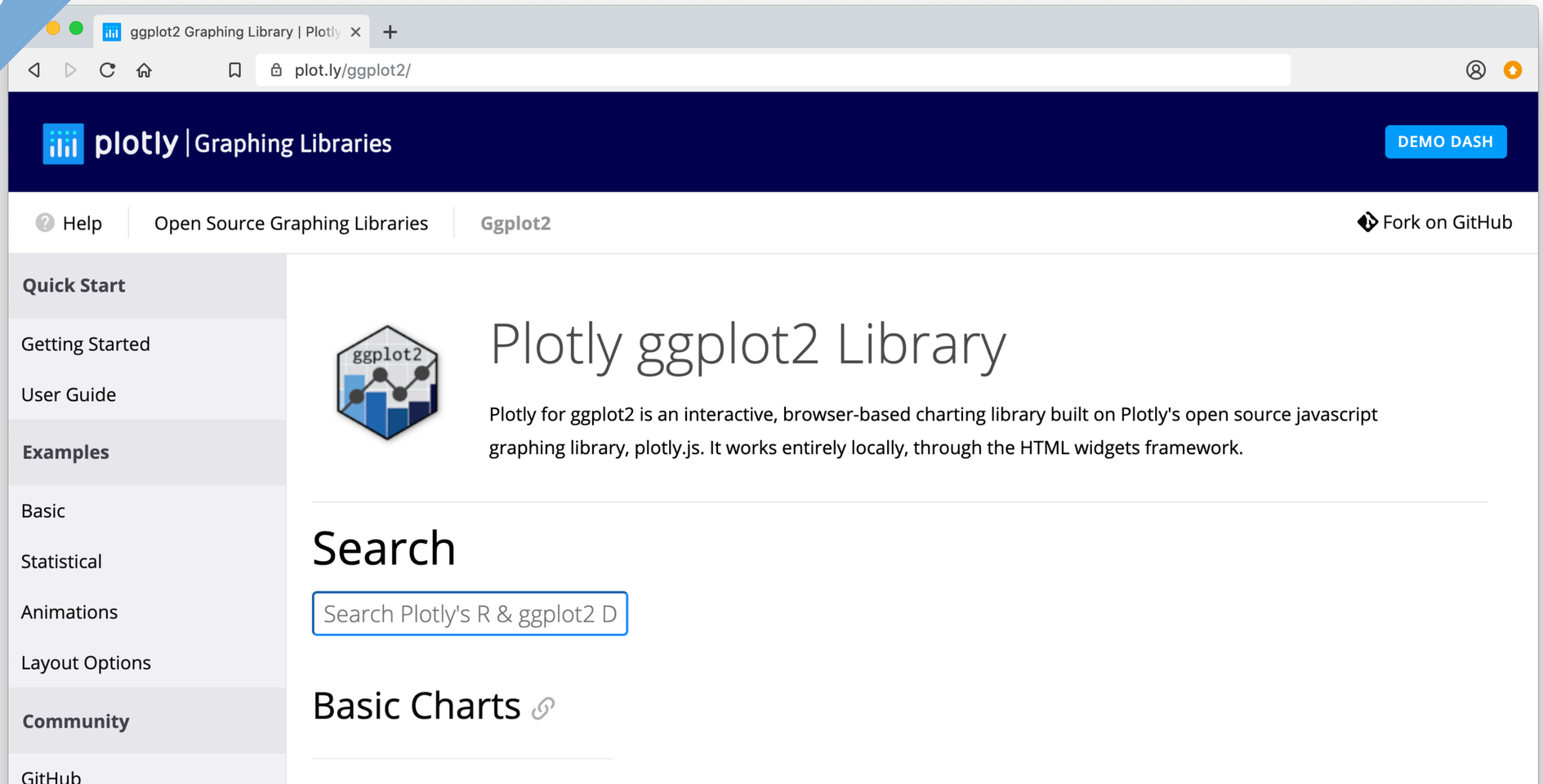
Q: But where will it save it?

A: Alongside your .qmd

Save with htmlwidgets::saveWidget()

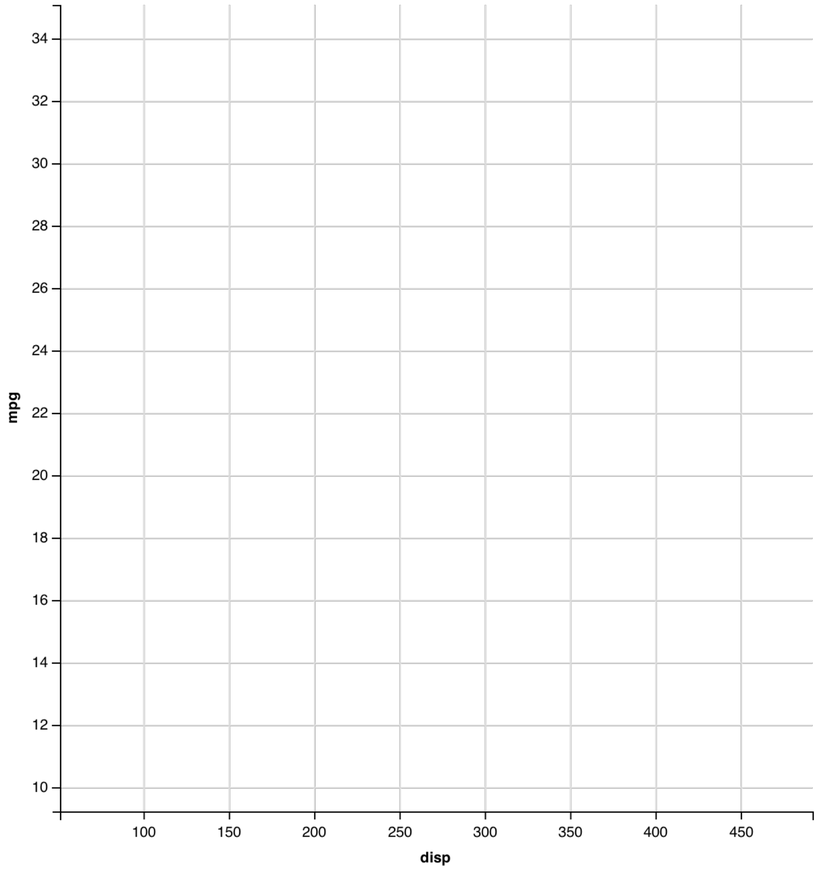
Plotly

s for making interactive plots. plot.ly/ggplot2/



Grammar of Graphics

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



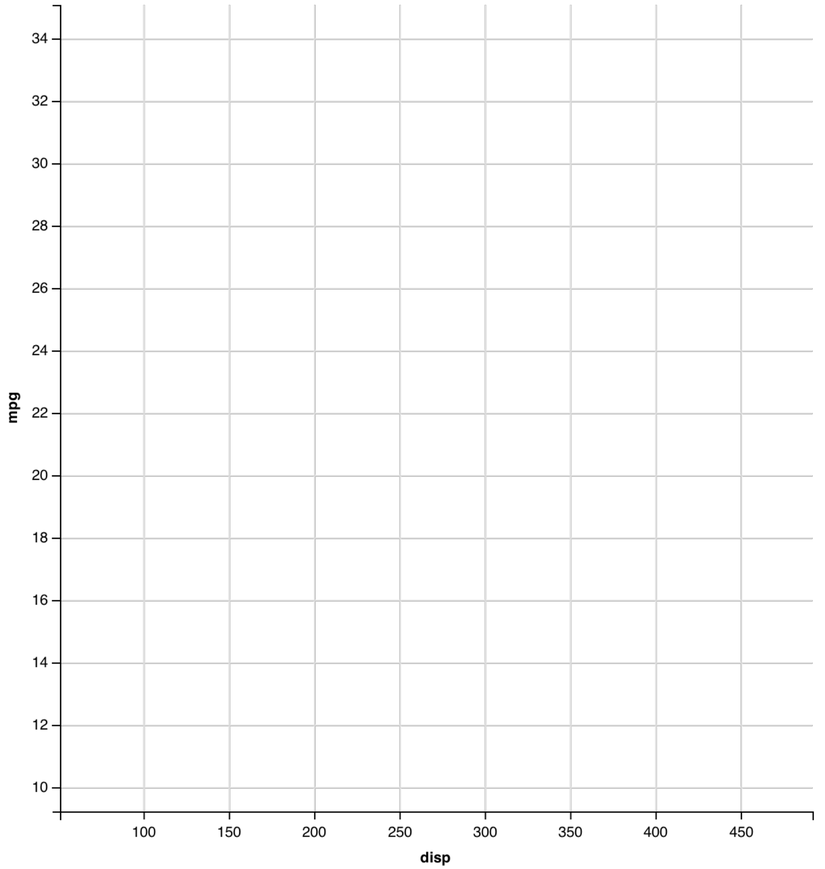
data geom

ggplot2

mappings

fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



data geom

ggplot2

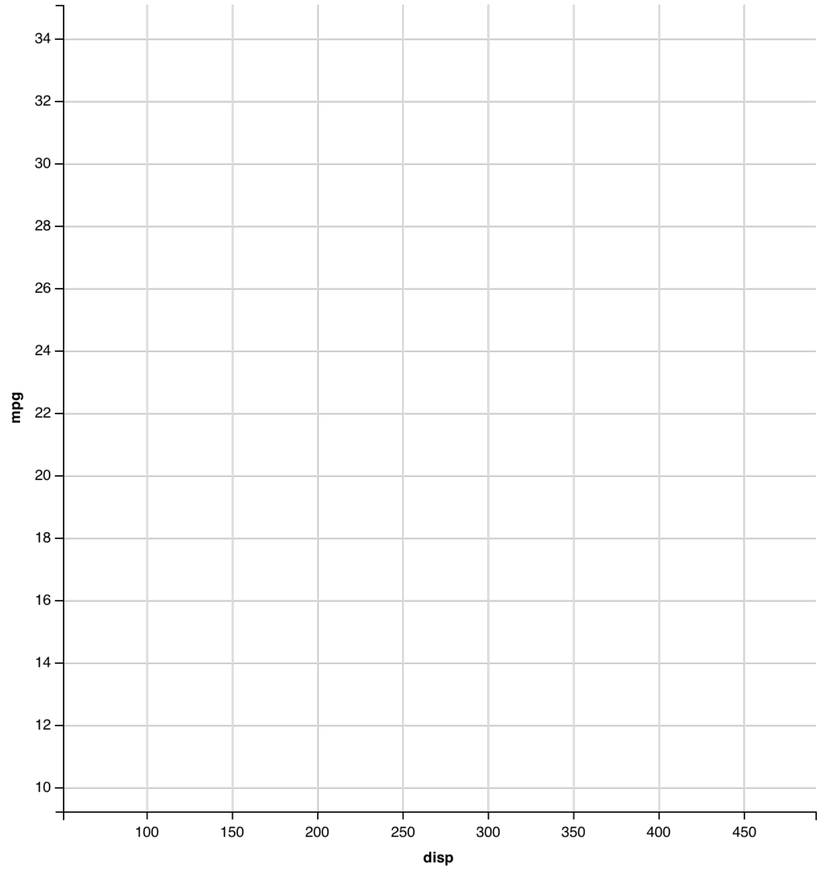
mappings

shape

fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1

data



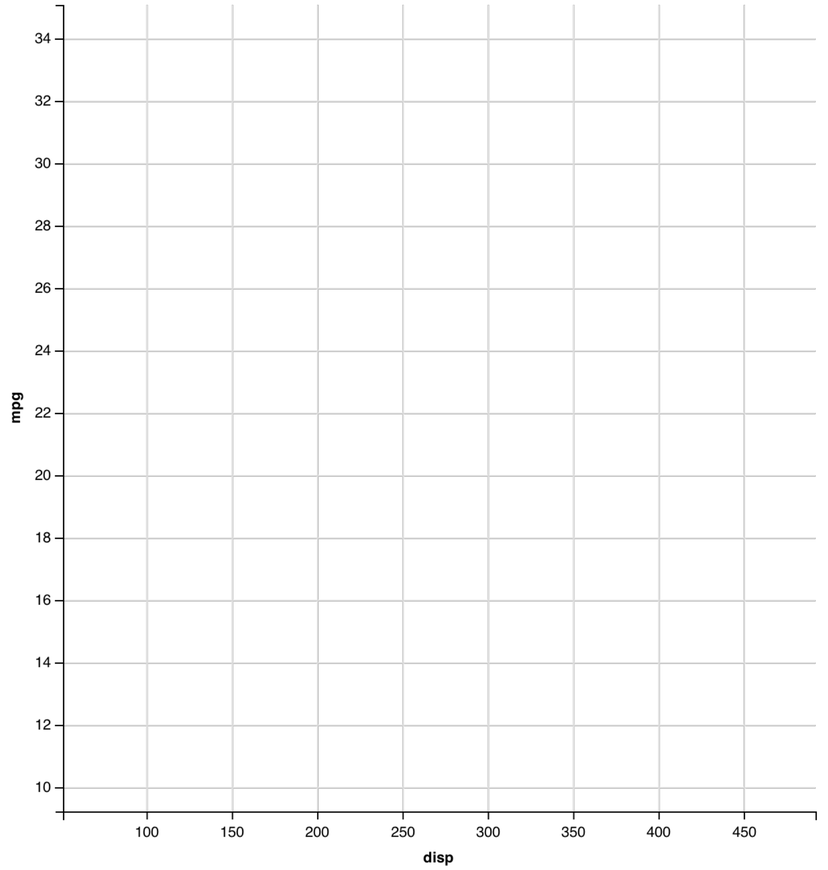
geom

ggplot2

mappings

shape x fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



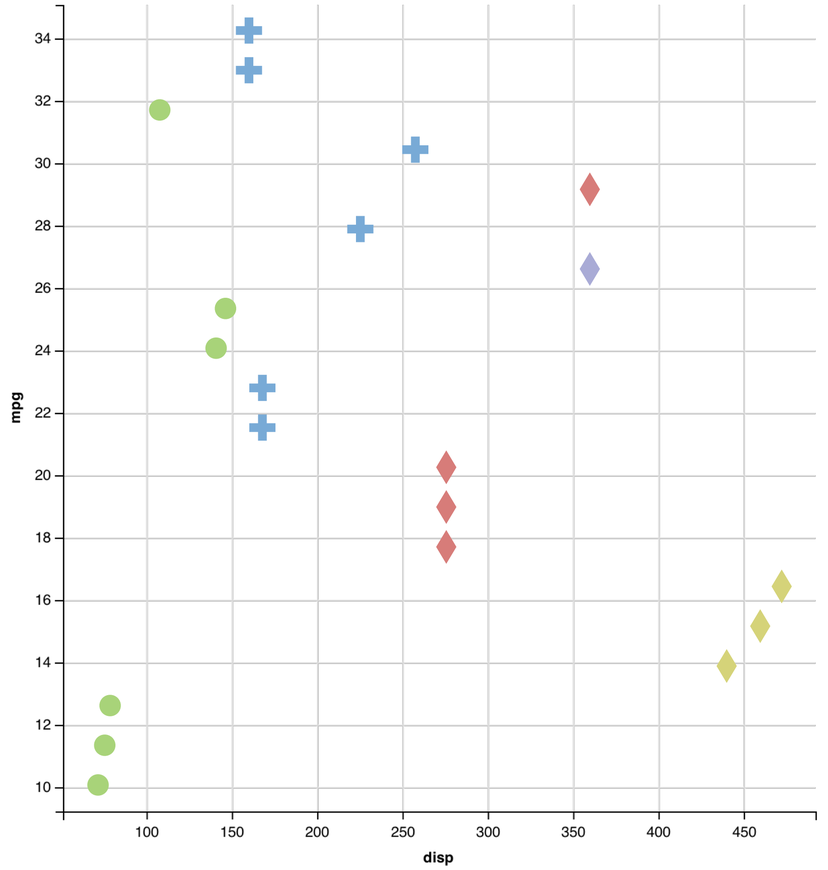
data geom

ggplot2

mappings

y shape x fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



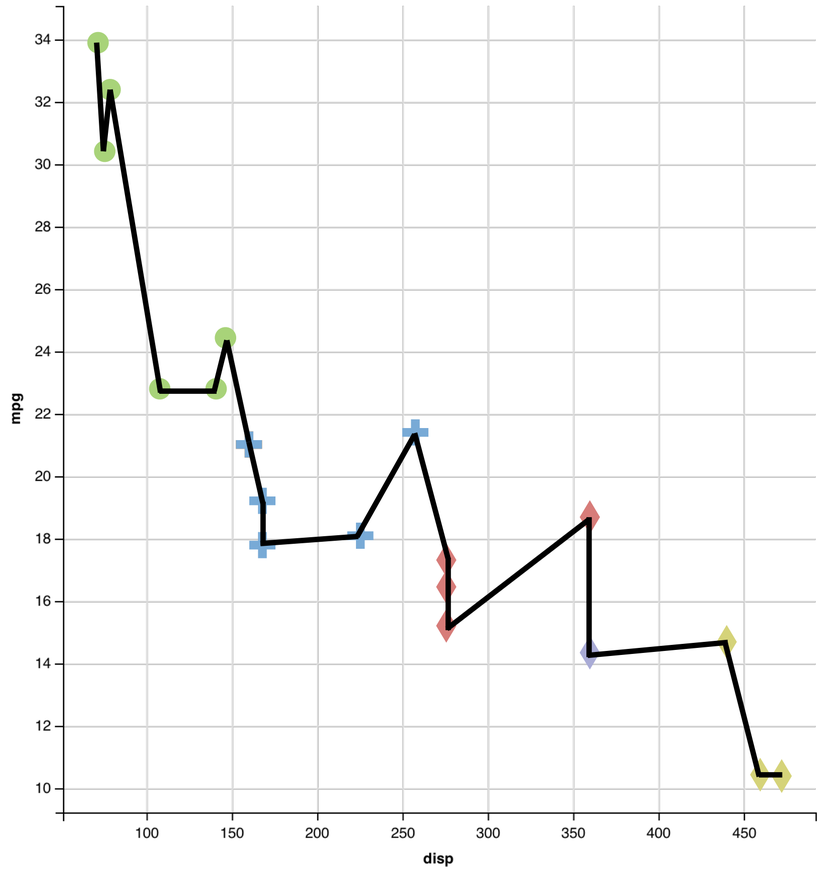
data geom

ggplot2

mappings

y shape x fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



data

geom

points

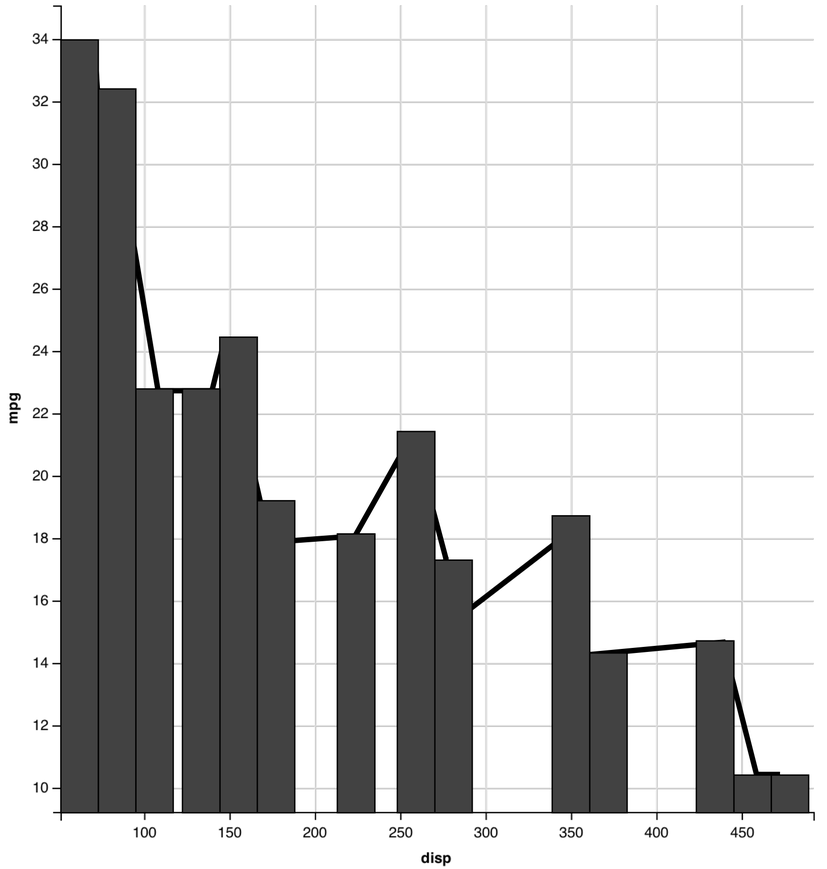
lines

ggplot2

mappings

y x

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



data **geom**

points

lines

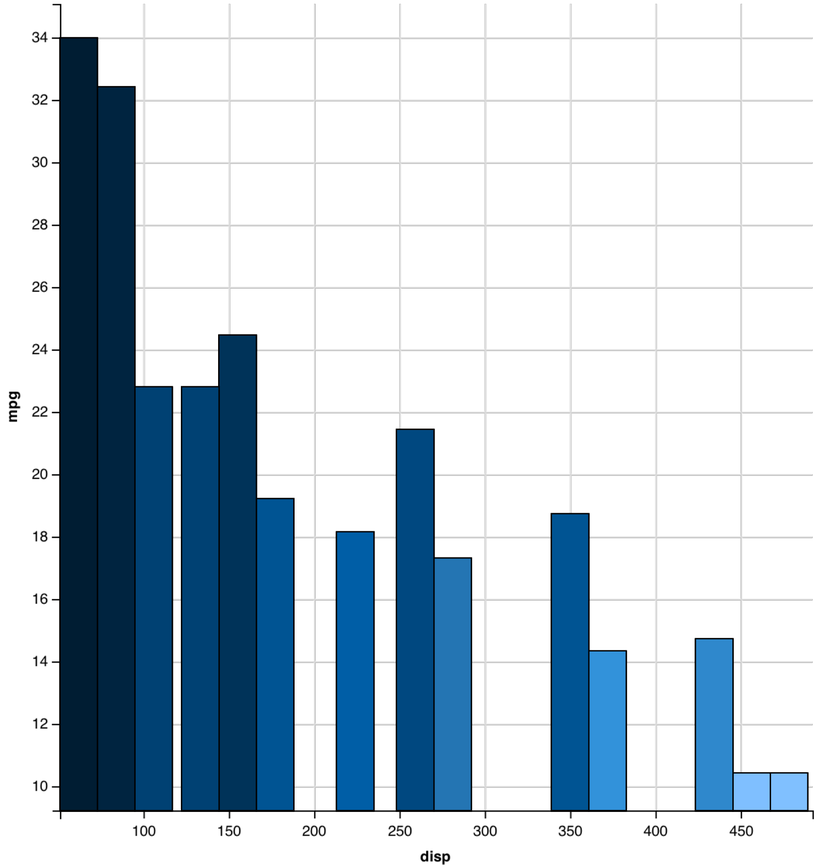
bars

ggplot2

mappings

y fill

mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1



data

geom

points

lines

bars

To make a graph

[template]

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

To make a graph

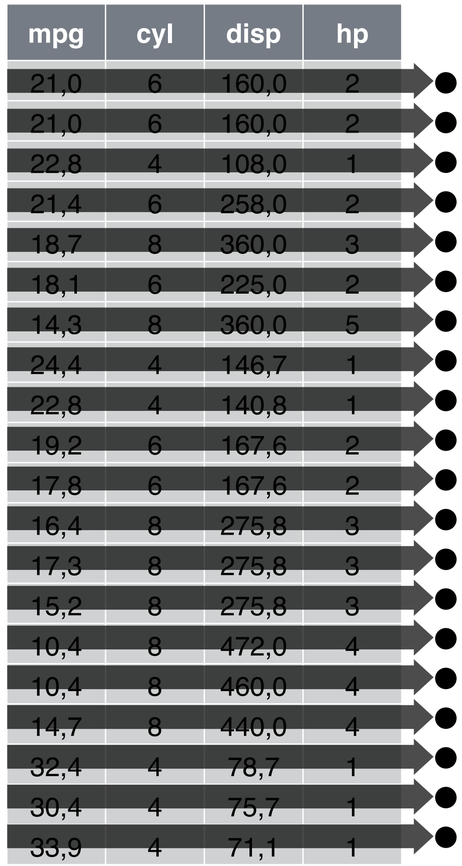
mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1

data

1. Pick a **data** set

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

To make a graph



mpg	cyl	disp	hp
21,0	6	160,0	2
21,0	6	160,0	2
22,8	4	108,0	1
21,4	6	258,0	2
18,7	8	360,0	3
18,1	6	225,0	2
14,3	8	360,0	5
24,4	4	146,7	1
22,8	4	140,8	1
19,2	6	167,6	2
17,8	6	167,6	2
16,4	8	275,8	3
17,3	8	275,8	3
15,2	8	275,8	3
10,4	8	472,0	4
10,4	8	460,0	4
14,7	8	440,0	4
32,4	4	78,7	1
30,4	4	75,7	1
33,9	4	71,1	1

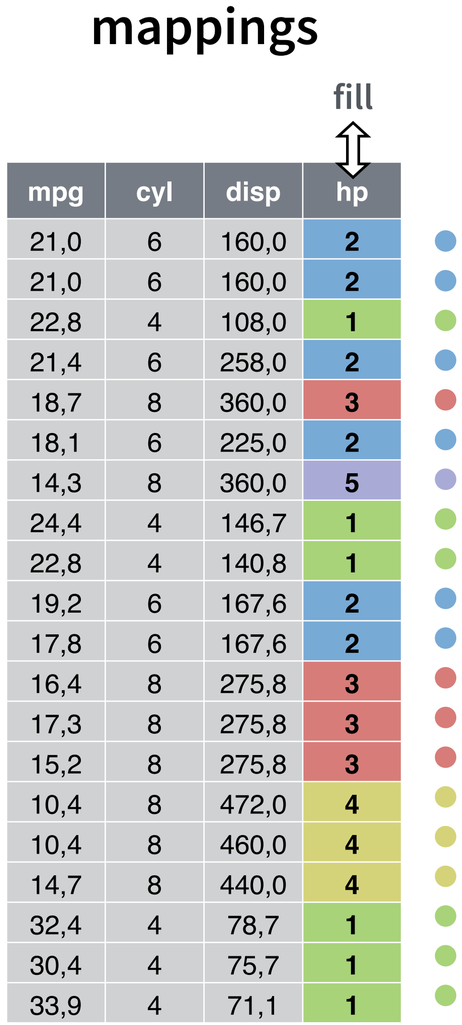
data **geom**

1. Pick a **data** set

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

2. Choose a **geom** to display cases

To make a graph



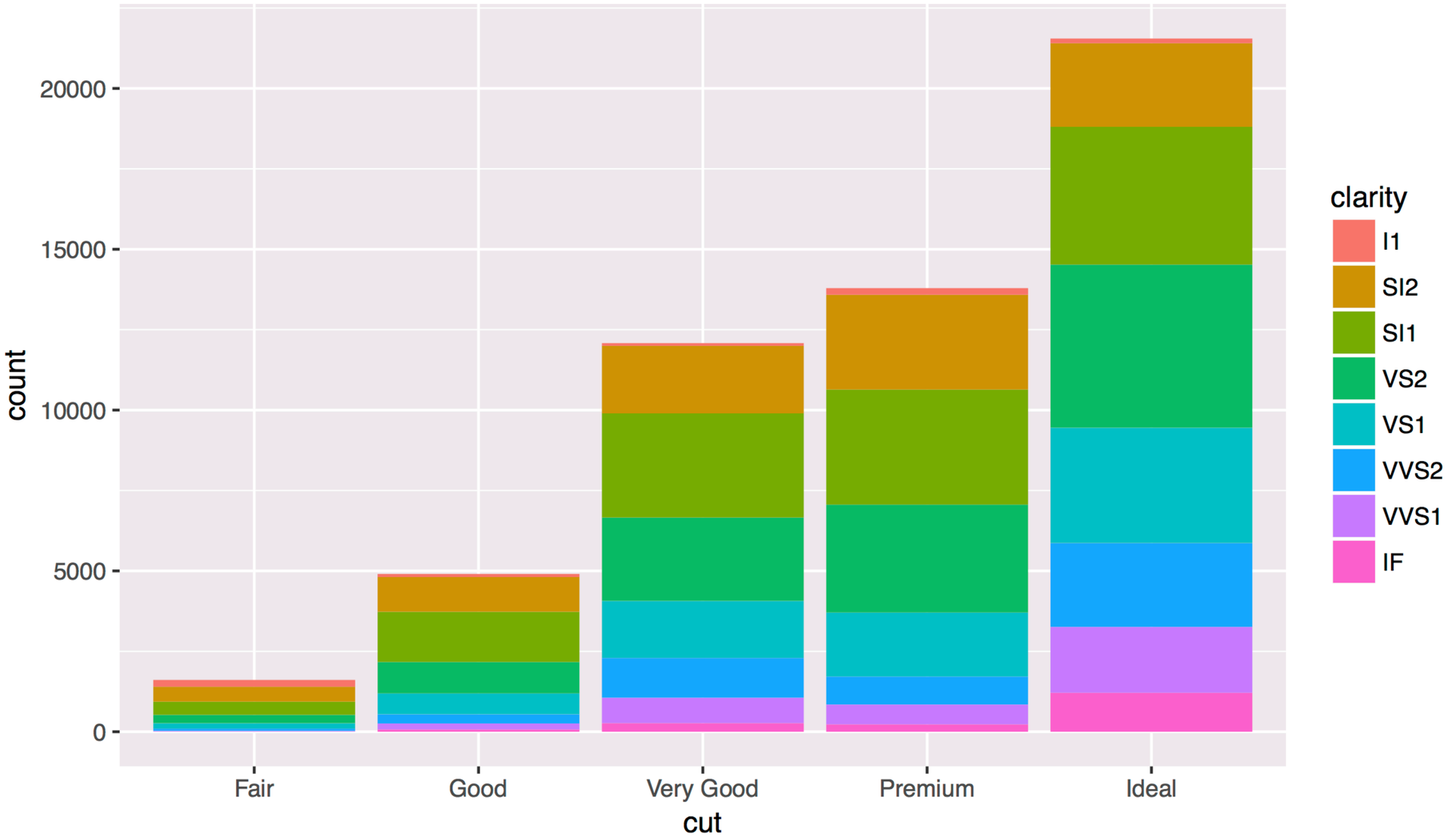
1. Pick a **data** set

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

2. Choose a **geom** to display cases

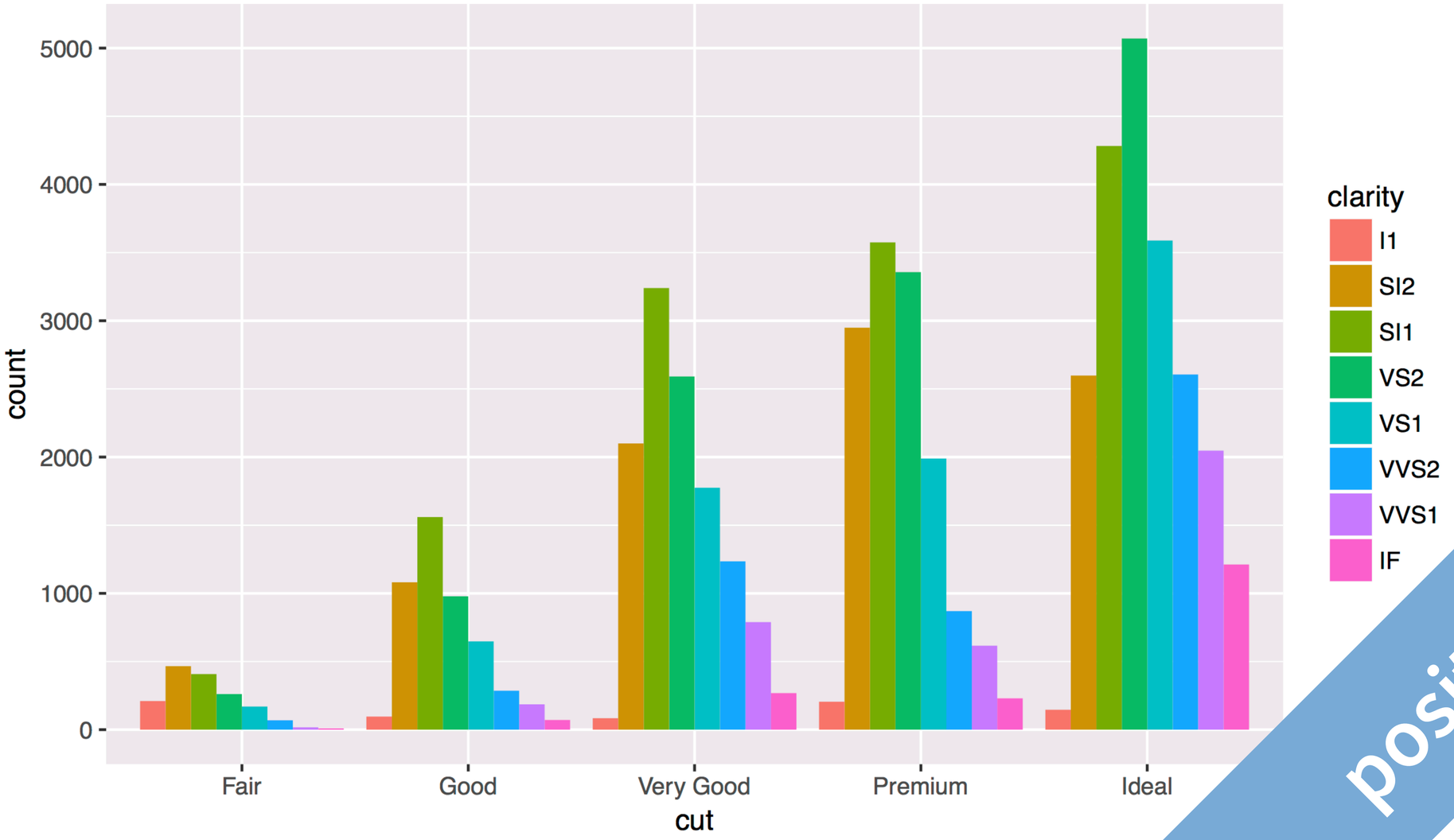
3. **Map** aesthetic properties to variables

What else?


20000
15000
10000
5000
0
count
Fair
Good
Very Good
Premium
Ideal
cut
clarity
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF

Position Adjustments

How overlapping objects are arranged

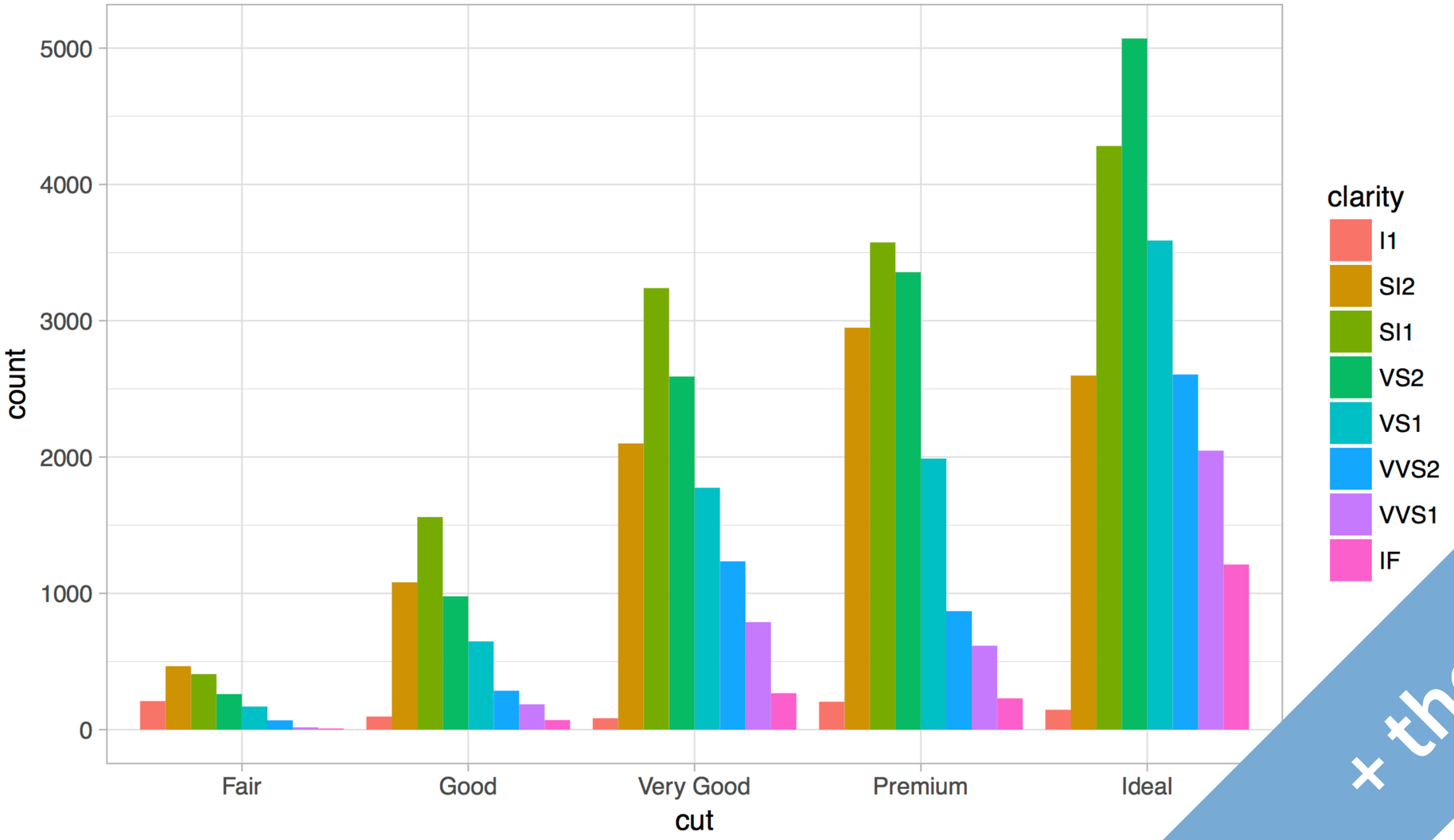


position_*()

ggplot2

Themes

Visual appearance of non-data elements

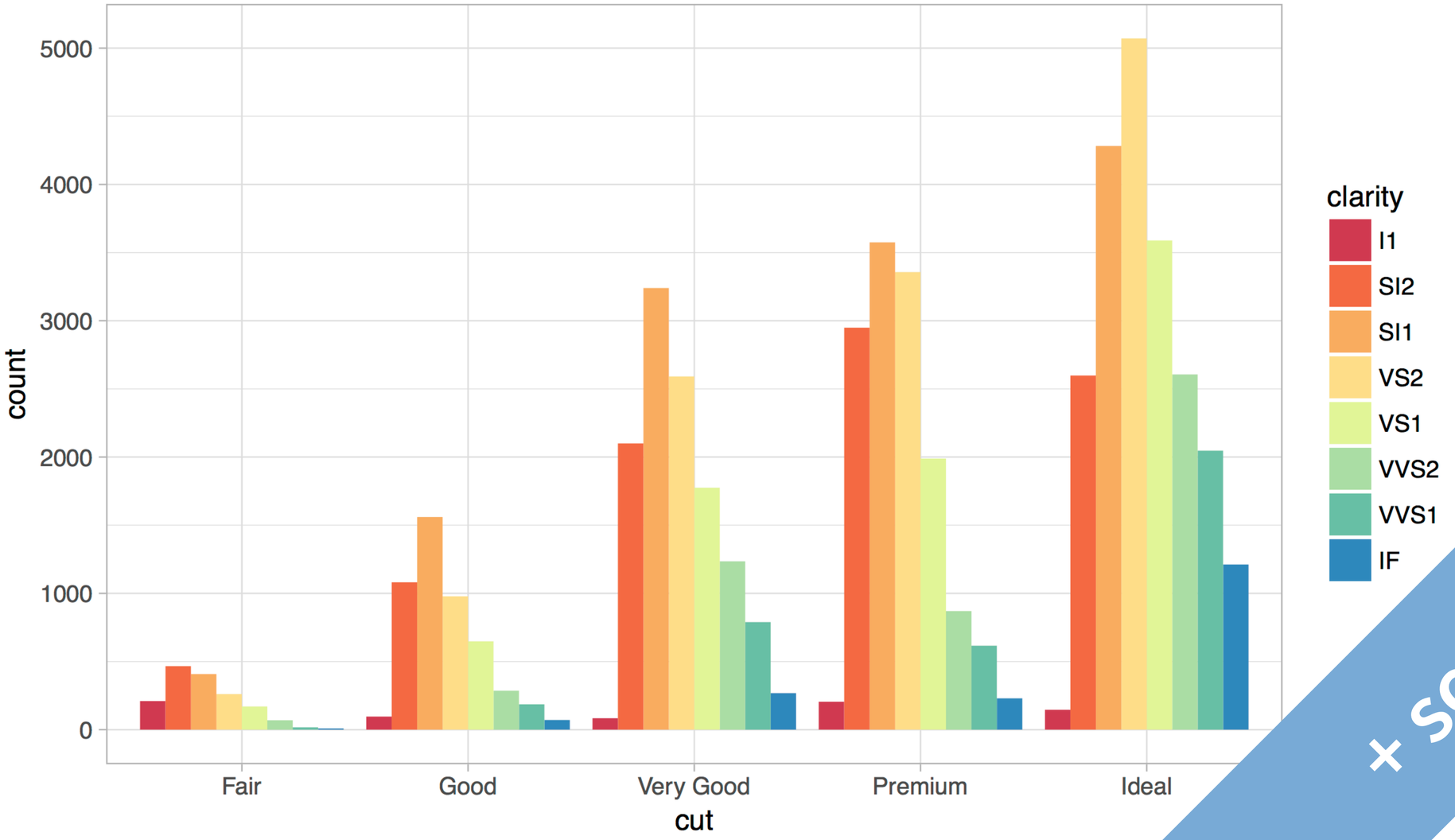


+ theme_*()

ggplot2

Scales

Customize color scales, other mappings

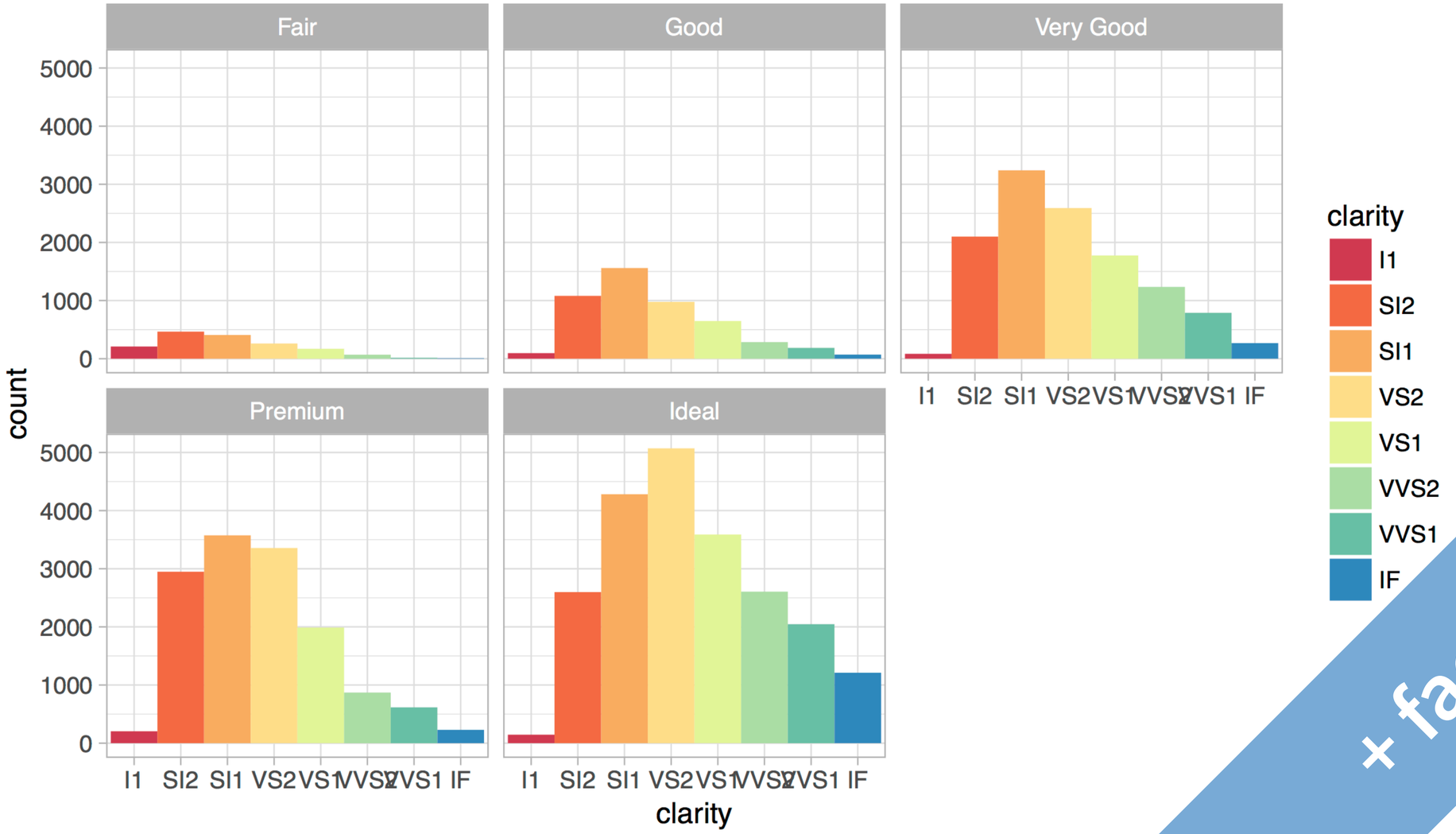


+ scale_*()

ggplot2

Facets

Subplots that display subsets of the data.

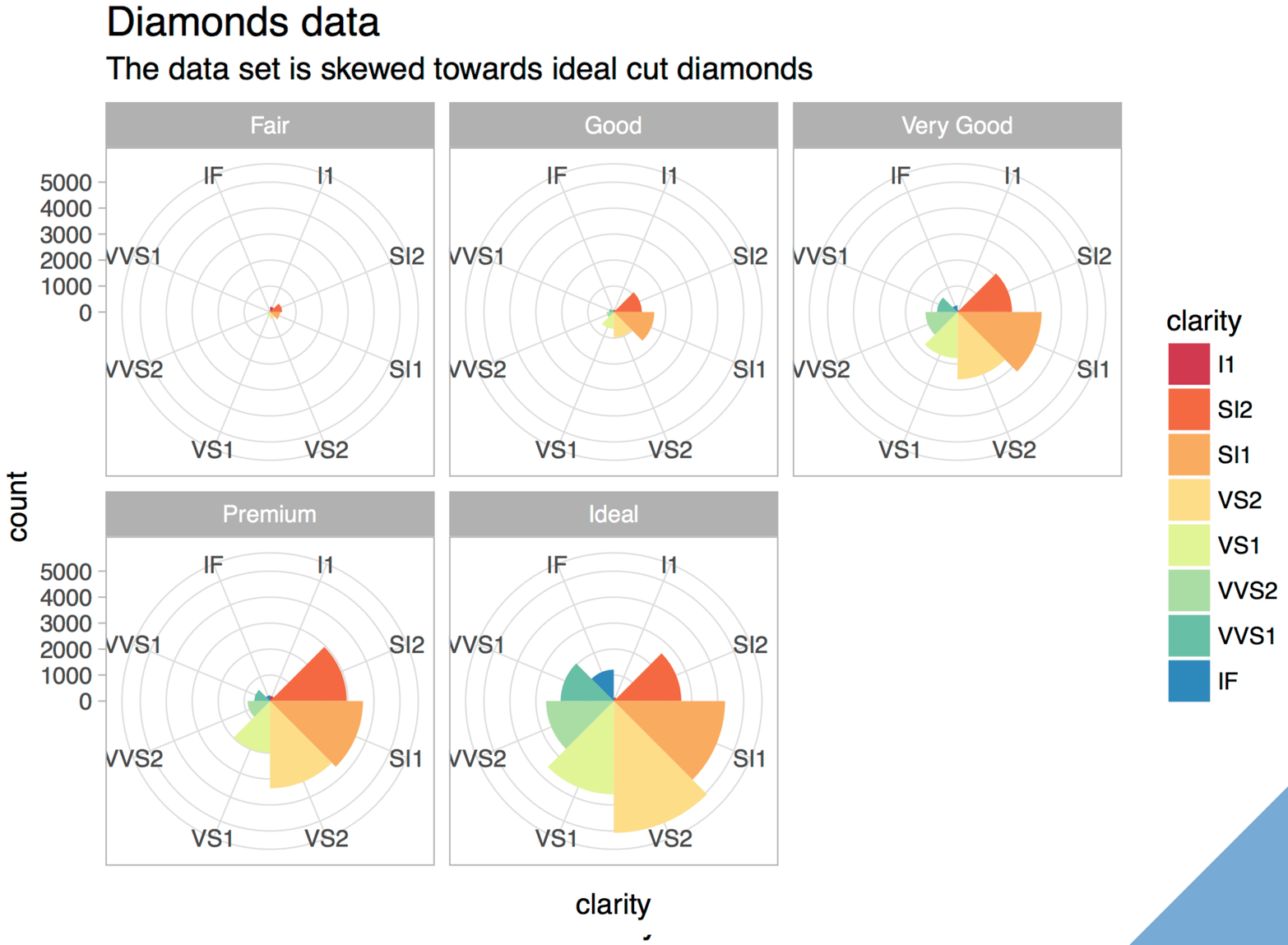


+ facet_*()

ggplot2

Coordinate systems

Titles and captions



+ labs()

ggplot2

A ggplot2 template

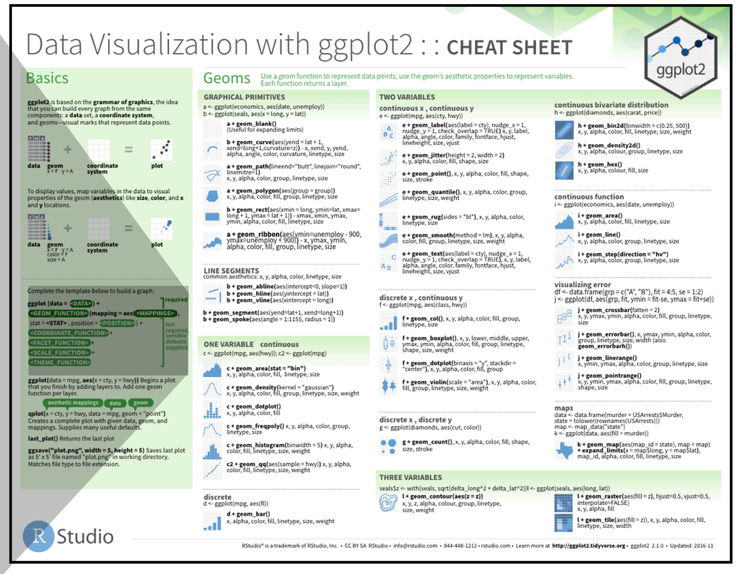
Make any plot by filling in the parameters of this template

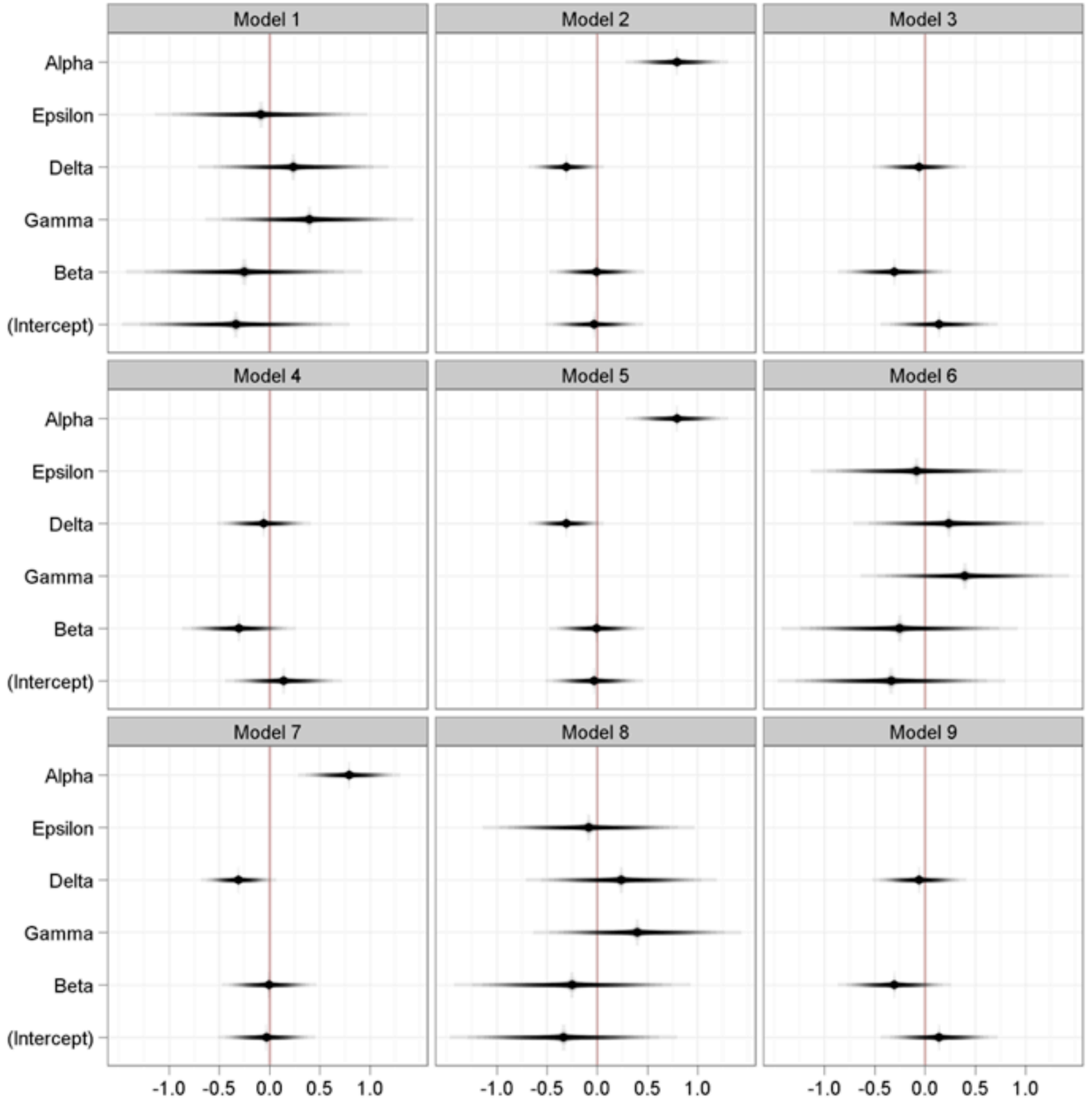
Complete the template below to build a graph.

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

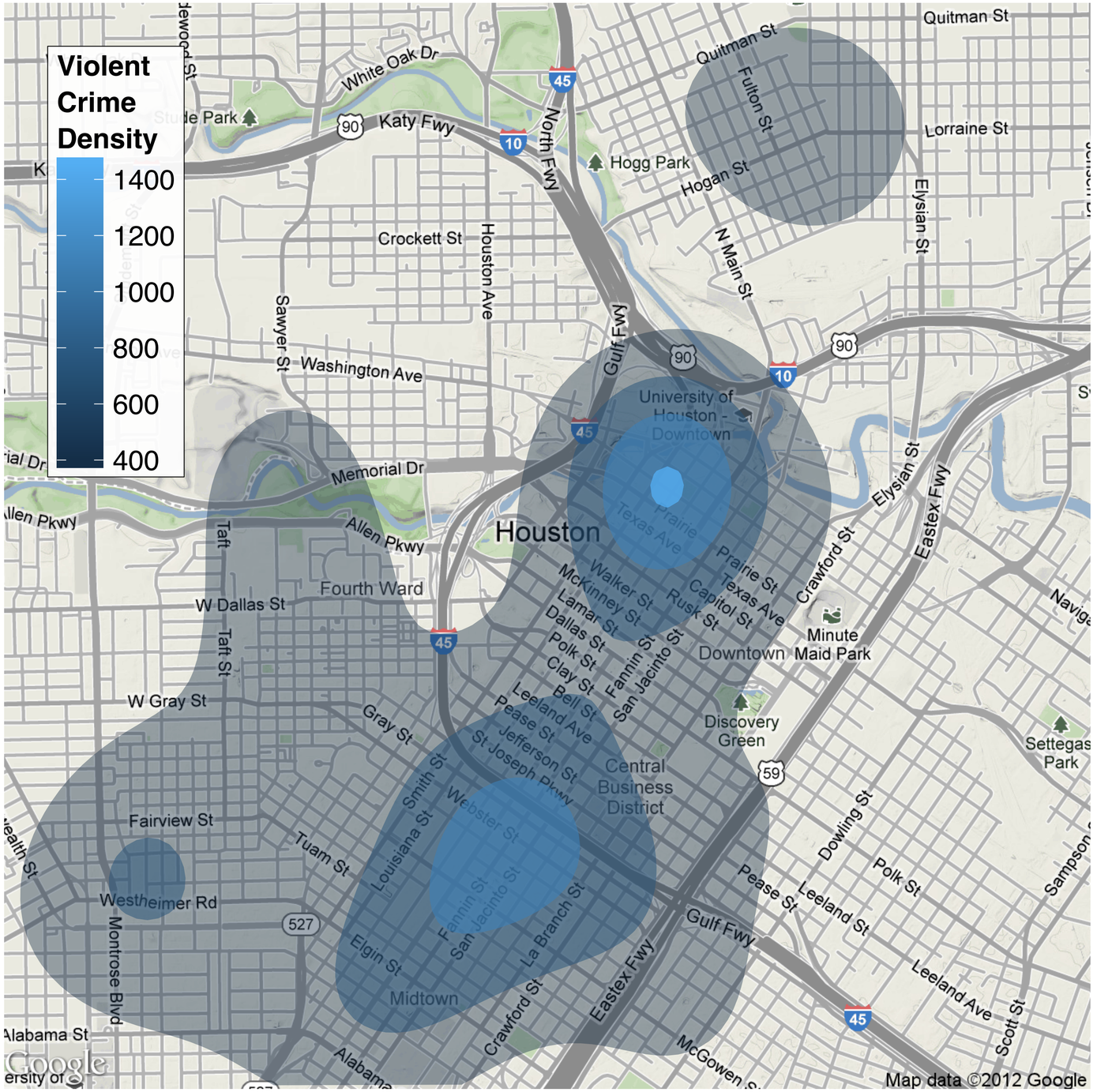
required

Not required, sensible defaults supplied

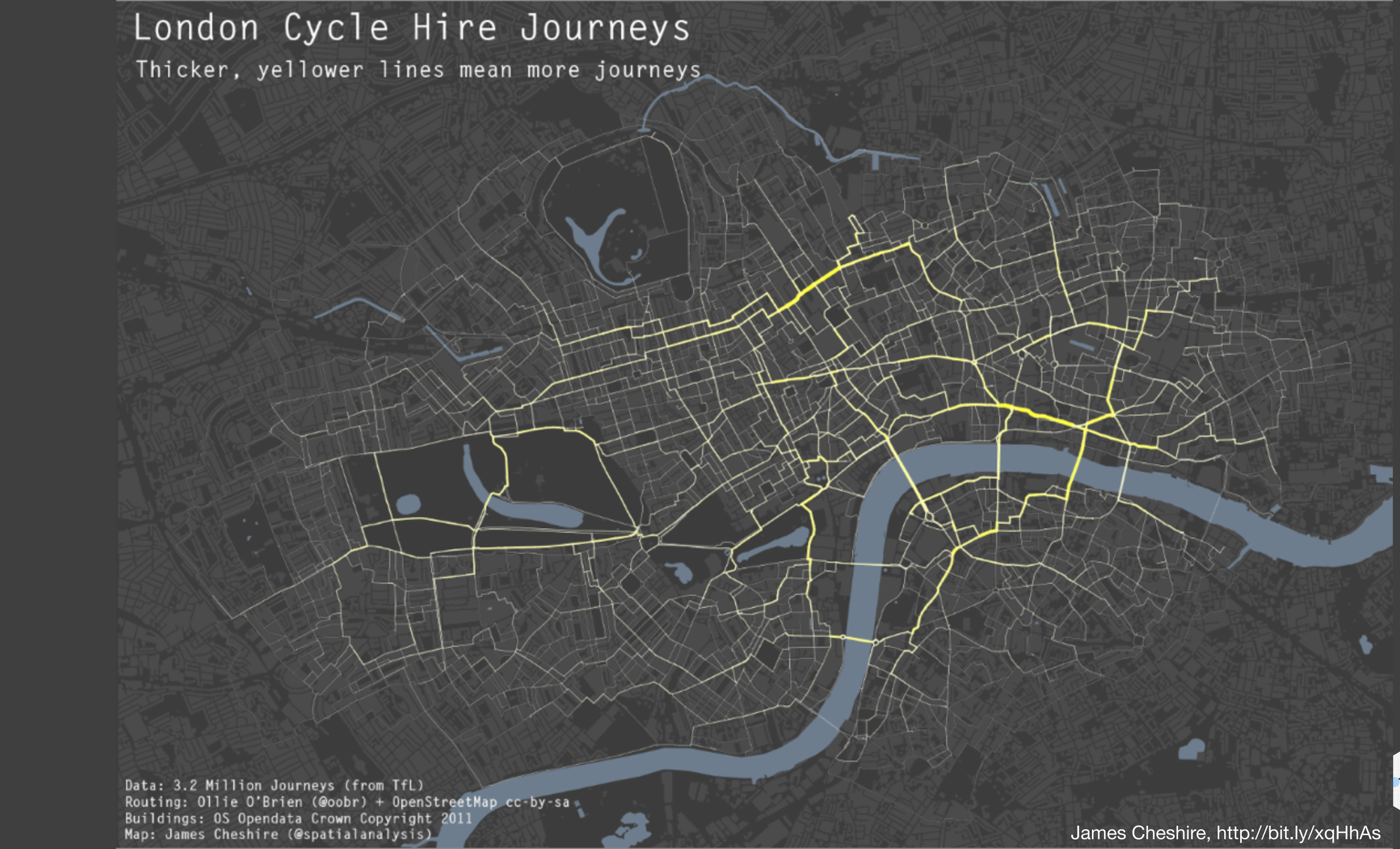




David B Sparks, http://bit.ly/hn54NW



David Kahle, https://dl.dropbox.com/u/24648660/ggmap%20useR%202012.pdf



ggplot2

James Cheshire, http://bit.ly/xqHhAs

Useful resources

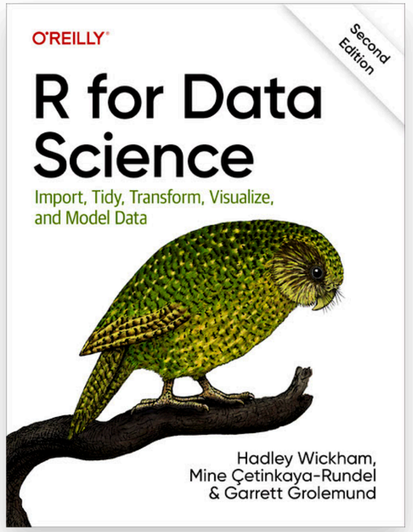
https://exts.ggplot2.tidyverse.org/gallery/
https://ggforce.data-imaginist.com
https://github.com/dkahle/ggmap
https://eliocamp.github.io/ggnewscale/
https://www.rayshader.com/

https://ggplot2-book.org

https://r4ds.hadley.nz

R for Data Science (2e)

Welcome



This is the website for the 2nd edition of **"R for Data Science"**. This book will teach you how to do data science with R: You'll learn how to get your data into R, get it into the most useful structure, transform it and visualize.

In this book, you will find a practicum of skills for data science. Just as a chemist learns how to clean test tubes and stock a lab, you'll learn how to clean data and draw plots—and many other things besides. These are the skills that allow data science to happen, and here you will find the best practices for doing each of these things with R. You'll learn how to use the grammar of graphics, literate programming, and reproducible research to save time. You'll also learn how to manage cognitive resources to facilitate discoveries when wrangling, visualizing, and exploring data.

Your Turn

Navigate to the main page of the class: **https://astamm.github.io/data-science-with-r/**.

Download **03-Transform-Exercises.qmd** from the outline table and open it.

Visualize Data with