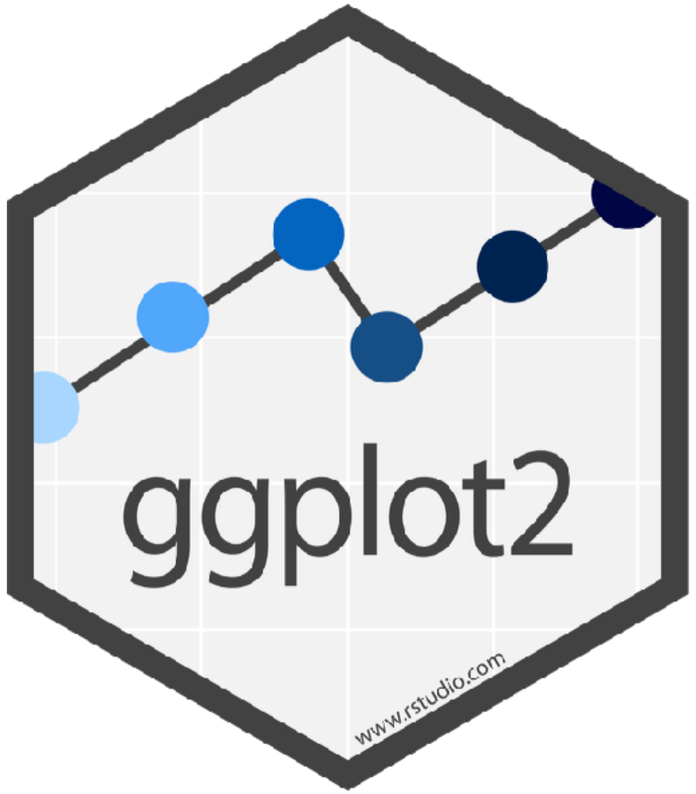
Visualize Data with



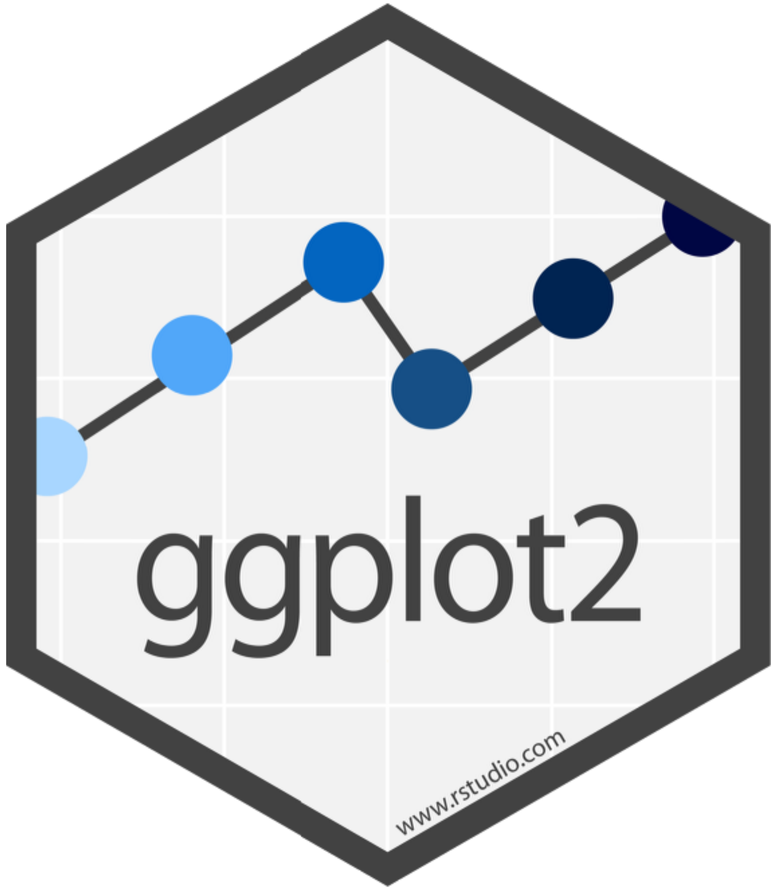
In R4DS

Visualizing Data

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

- John Tukey

ggplot2

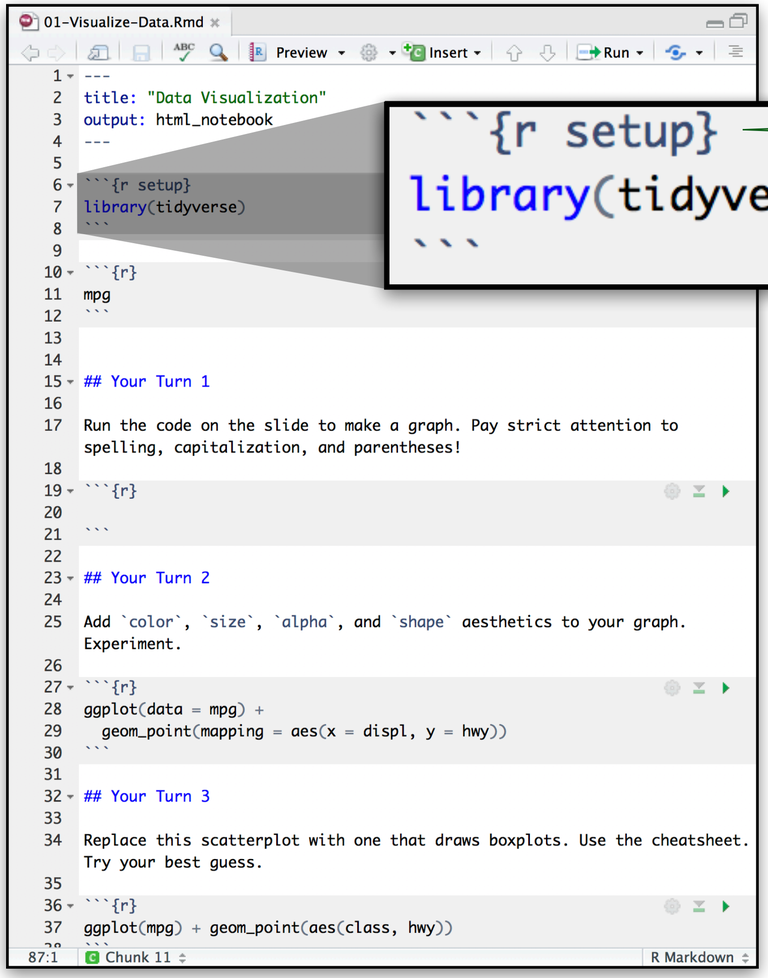


One of the earliest members of the tidyverse.

Complicated plots, come from combining simple components.

Setup

The setup chunk is always run once before anything else



mpg

Fuel economy data for 38 models of car.

```
mpg
?mpg
```

Quiz

Confer with your neighbours.

What relationship do you expect to see between engine size (`displ`) and highway fuel efficiency (`hwy`)?

No peeking ahead!

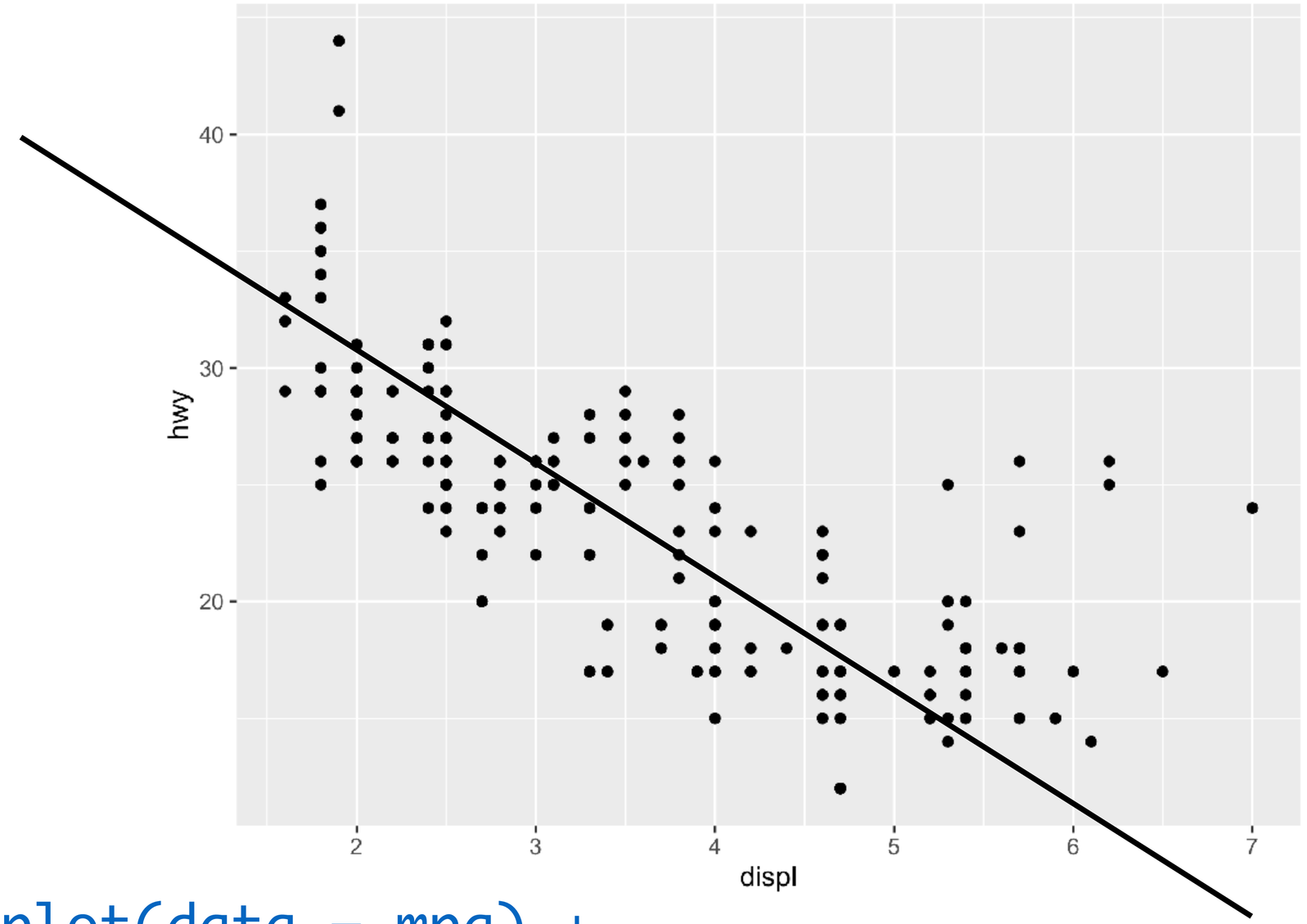
Your Turn 1

Run this code in your notebook to make a graph.

Pay strict attention to spelling, capitalization, and parentheses!

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

I'm working on it **I'm stuck!** **I'm done!**



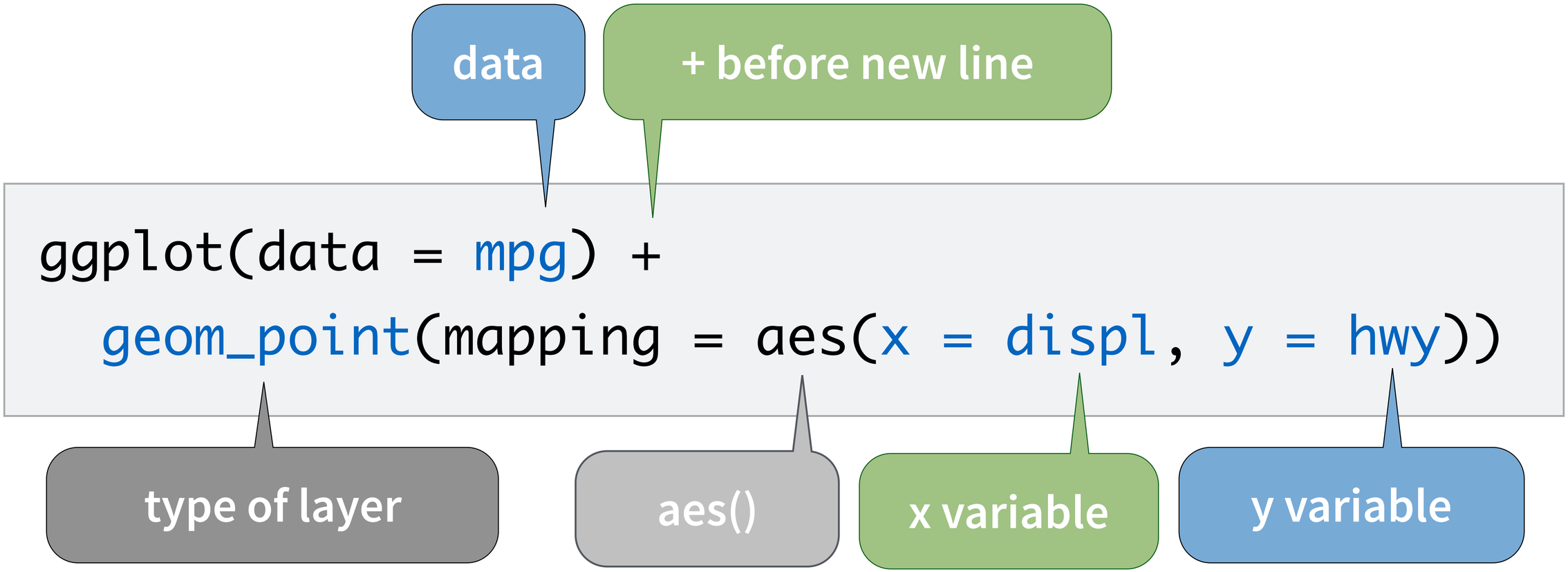

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy))
```

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))
```



A Template

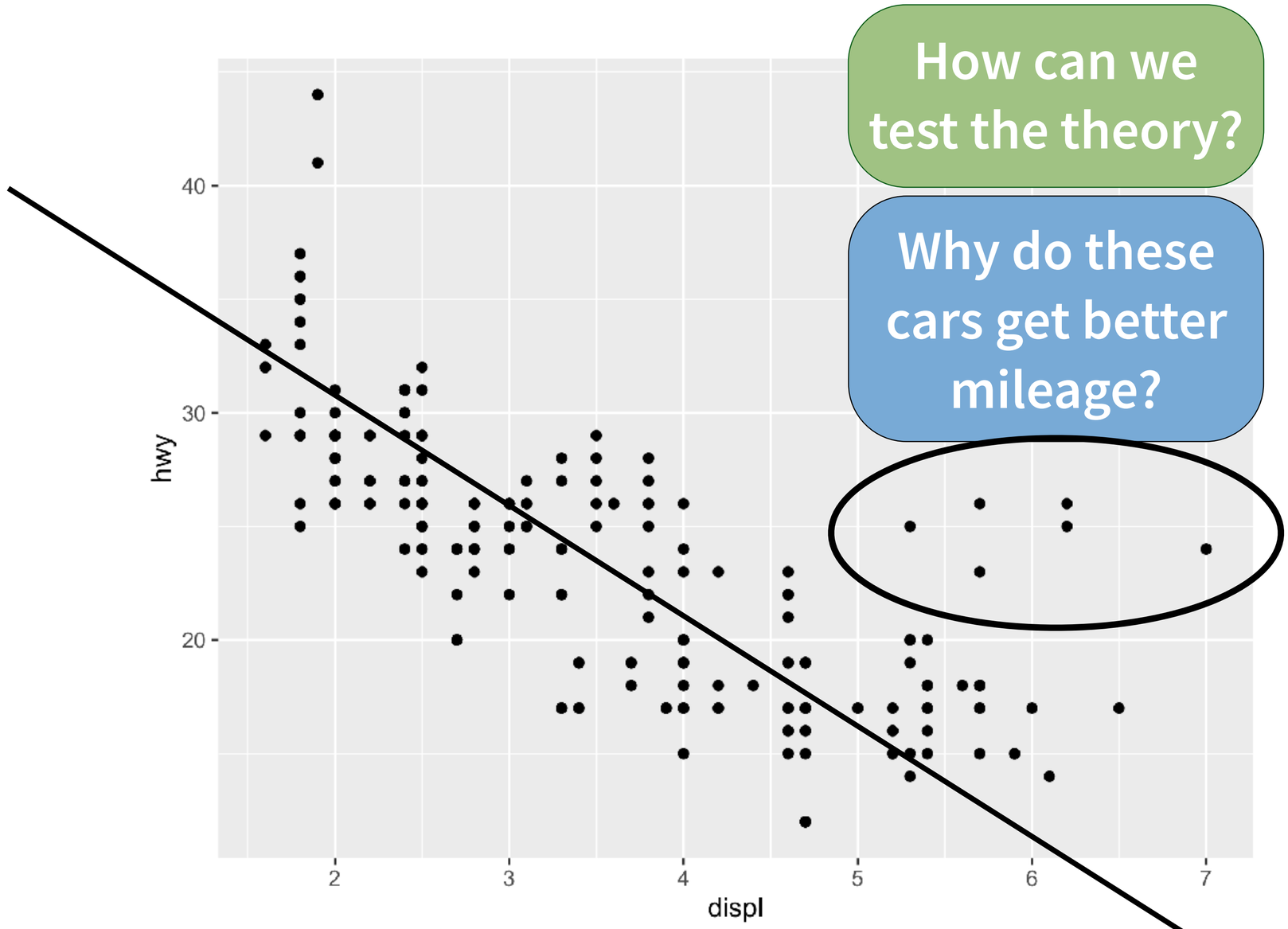
```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))
```

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

A Template

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

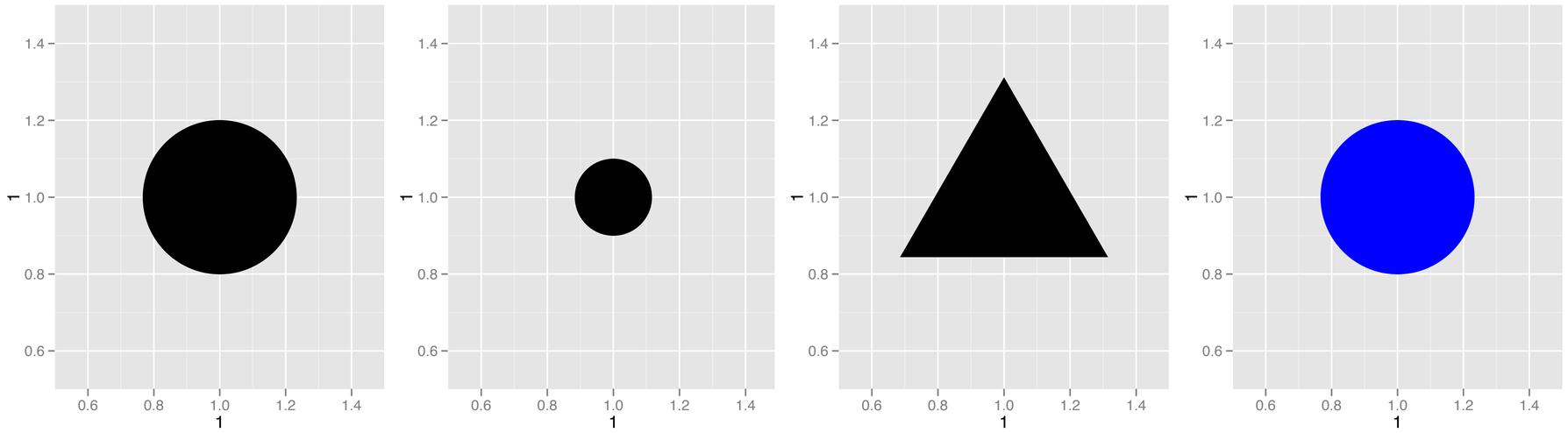
Mappings




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

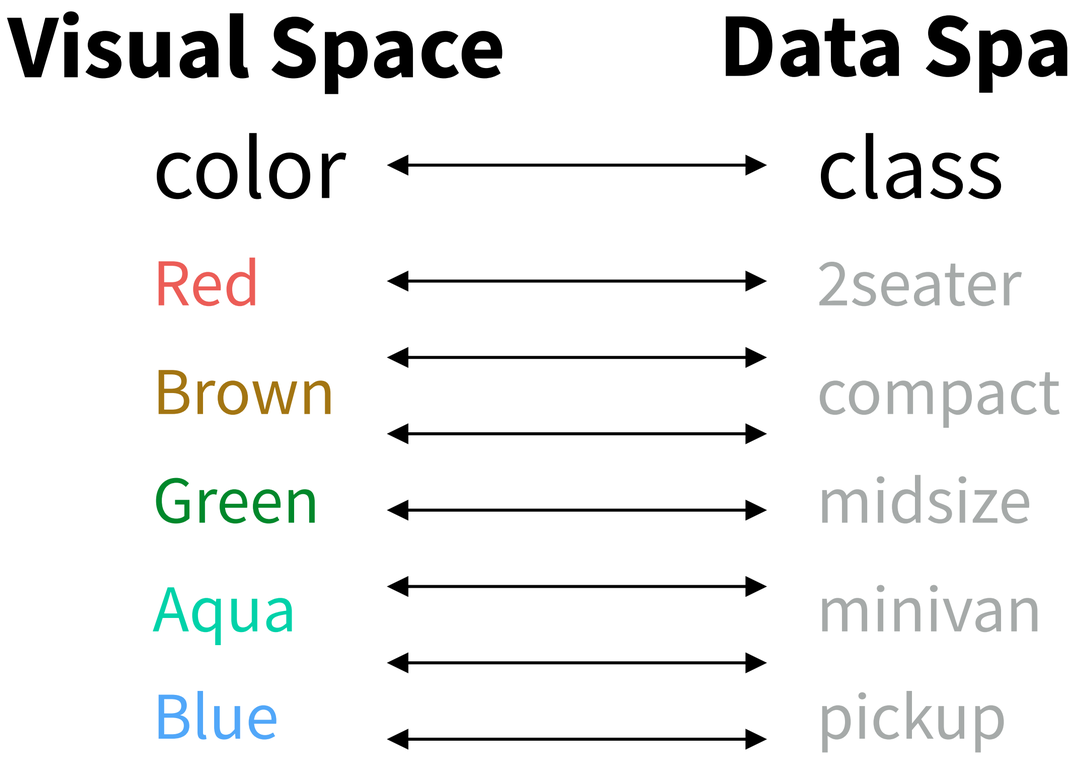
Aesthetics

Visual properties of a geometric object



How do the appearance of these points vary?

Mappings describe how aesthetics should relate to variables in the data.



Aesthetics

aesthetic property

Variable to map it to

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

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

Aesthetics

aesthetic property

Variable to map it to

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

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

Aesthetics

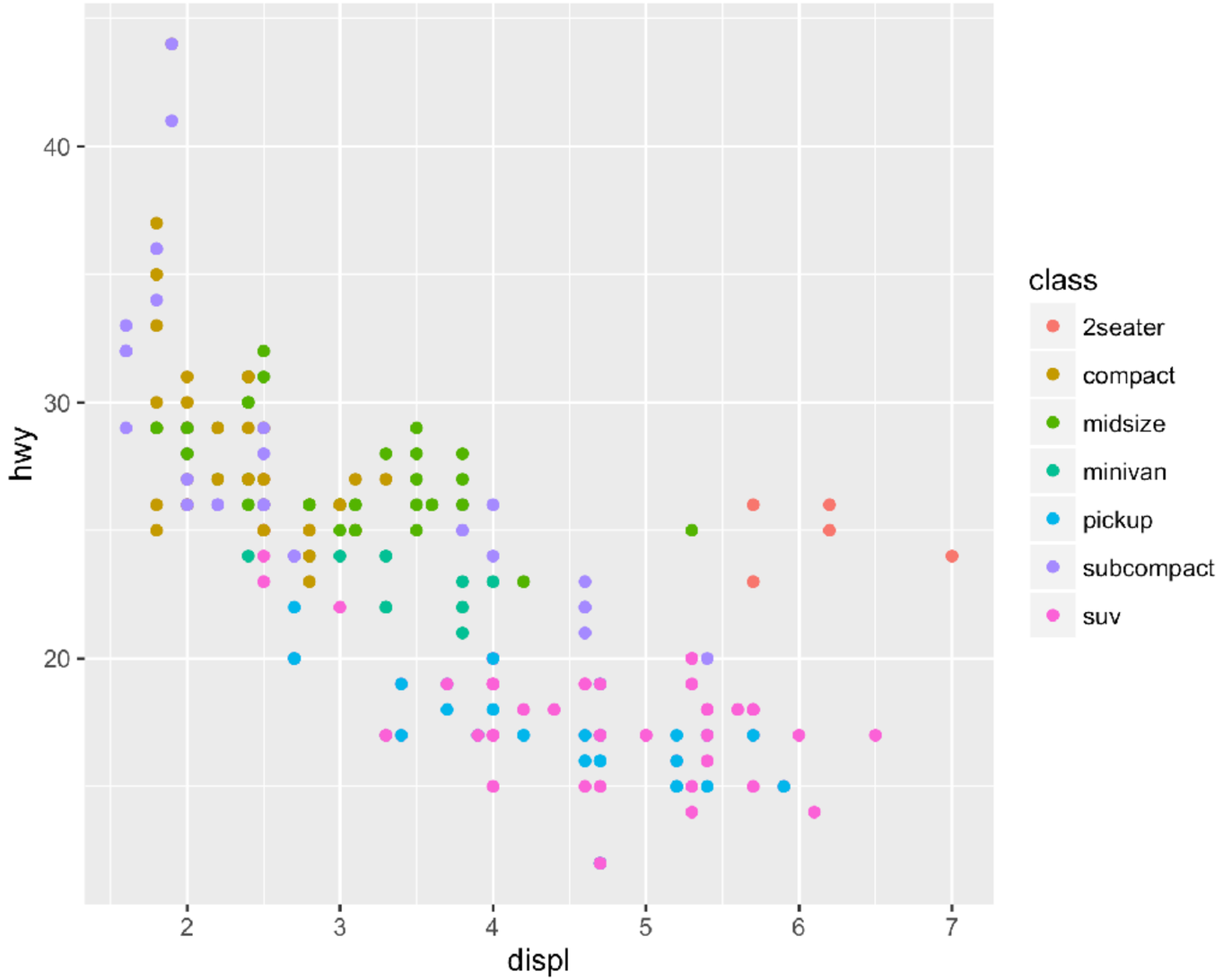
aesthetic property

Variable to map it to

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

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

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

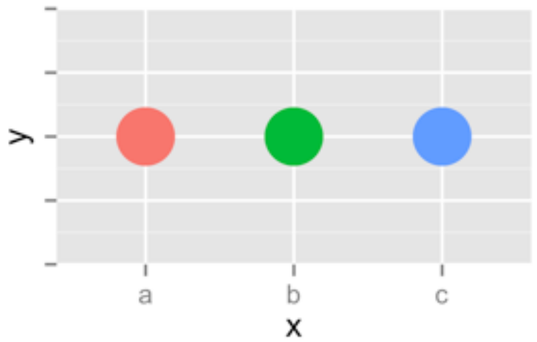
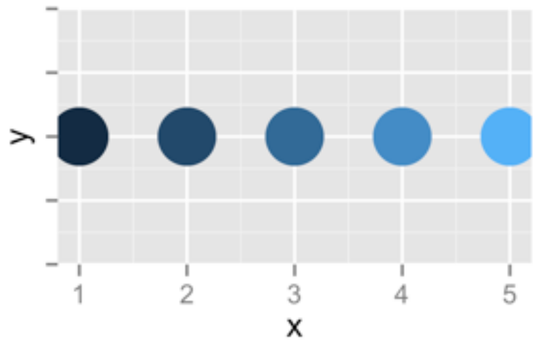
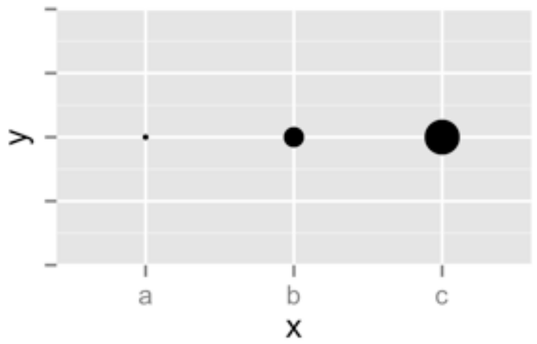
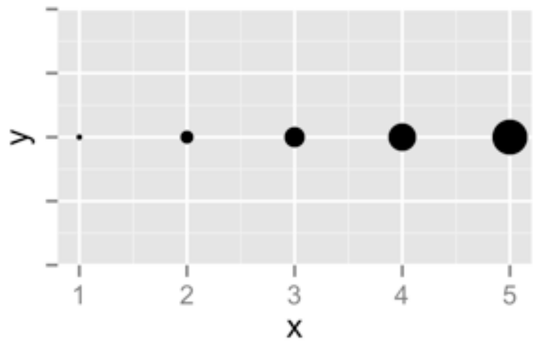
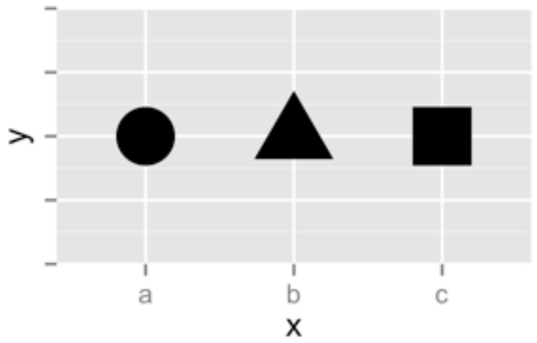


Legend added automatically

Your Turn 2

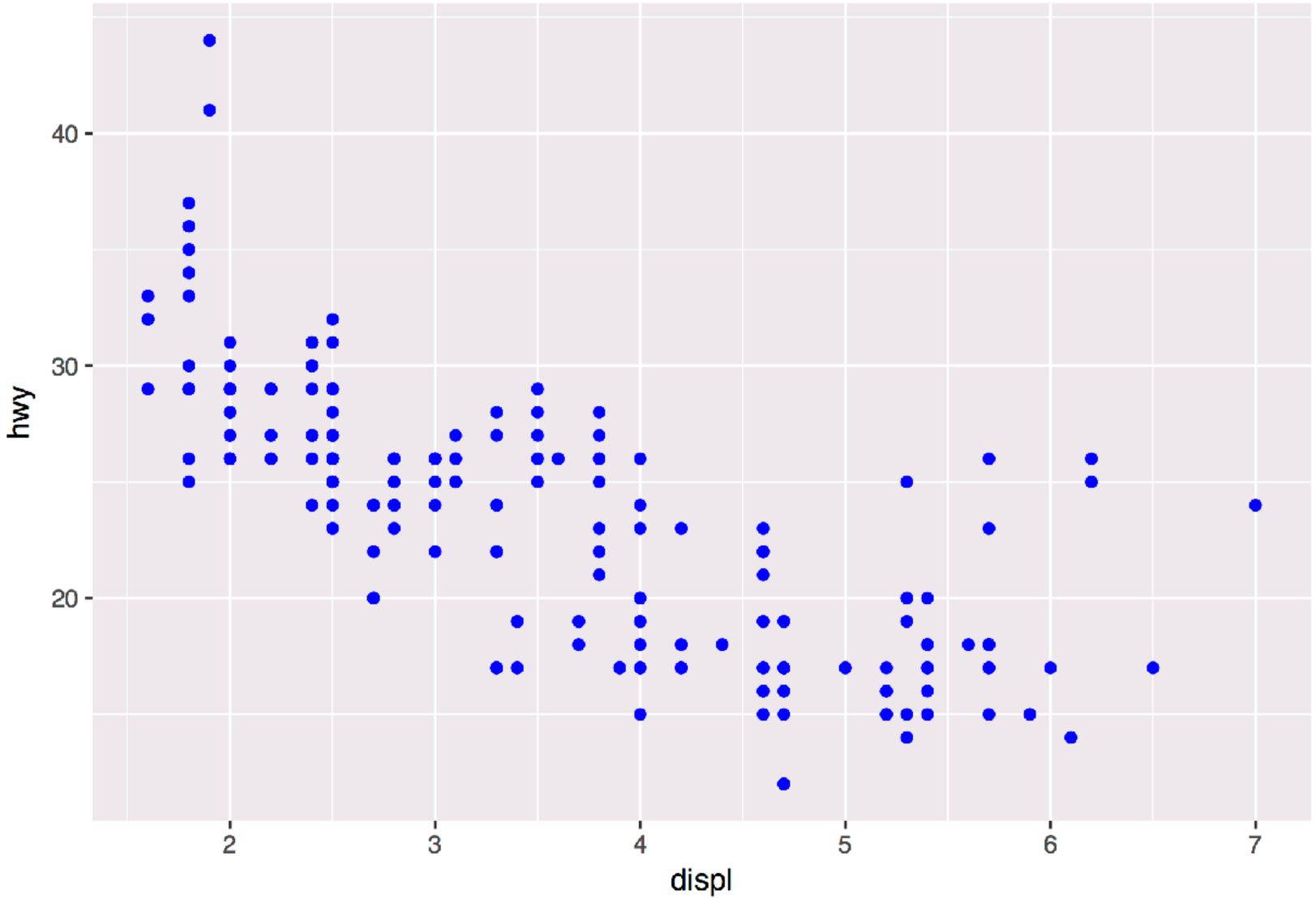
In the next chunk, add color, size, alpha, and shape aesthetics to your graph. Experiment.

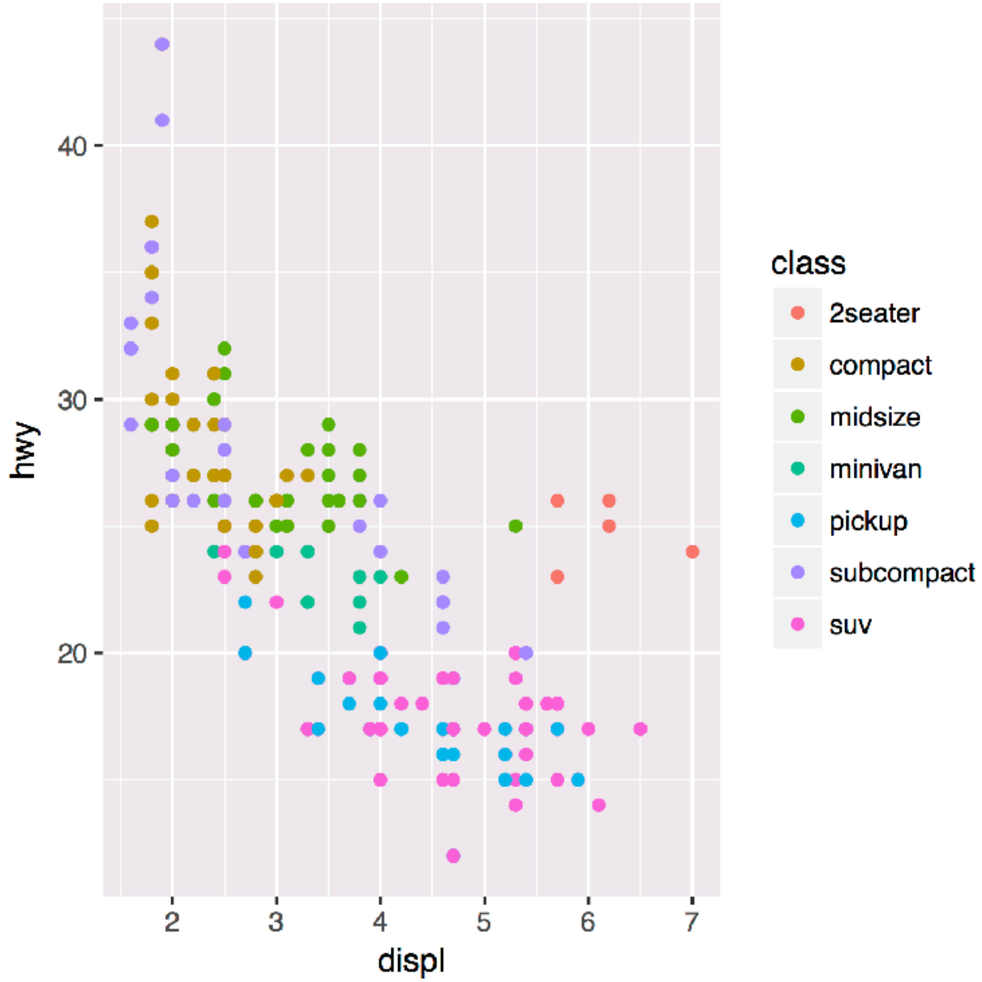
- Do different things happen when you map aesthetics to discrete and continuous variables?
- What happens when you use more than one aesthetic?

	Discrete	Continuous
Color		
Size		
Shape		

Set vs. Map

How would you make this plot?

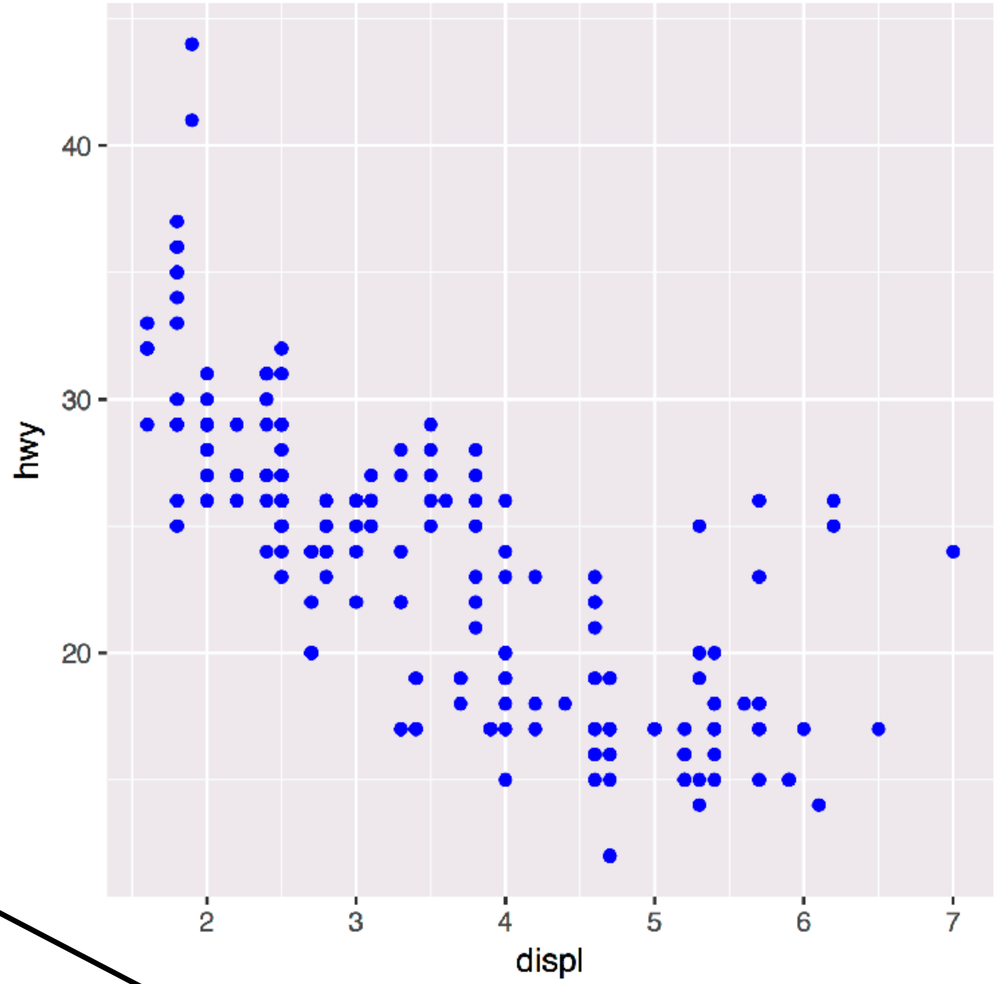




Inside of aes(): maps an aesthetic to a variable

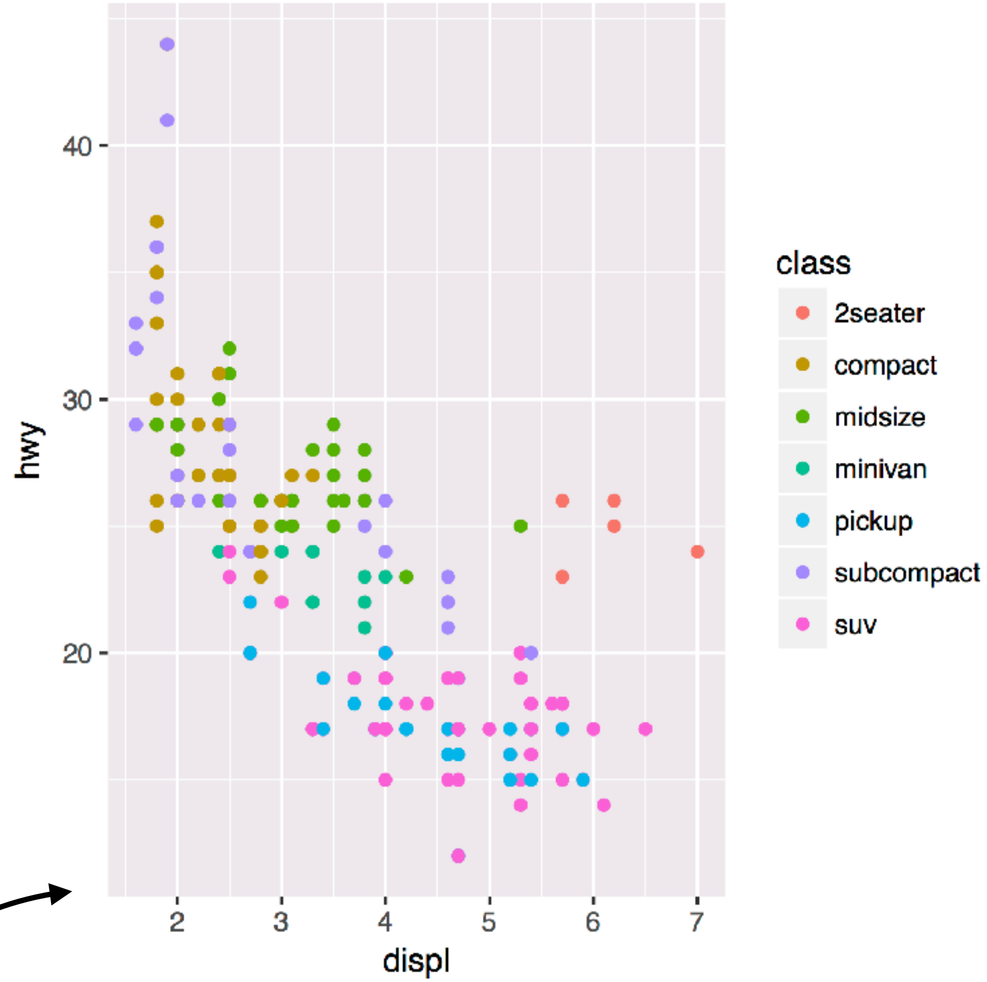
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = class))
```

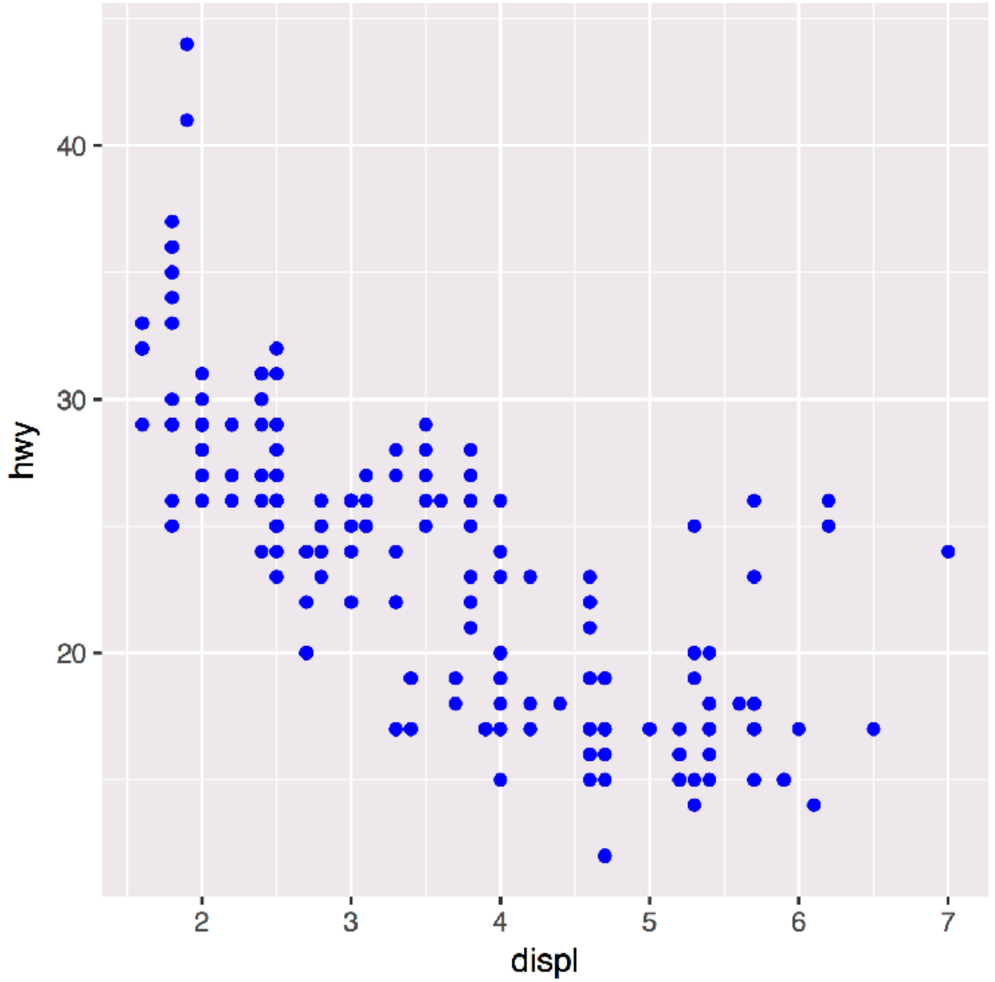
Outside of aes(): sets an aesthetic to a value




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

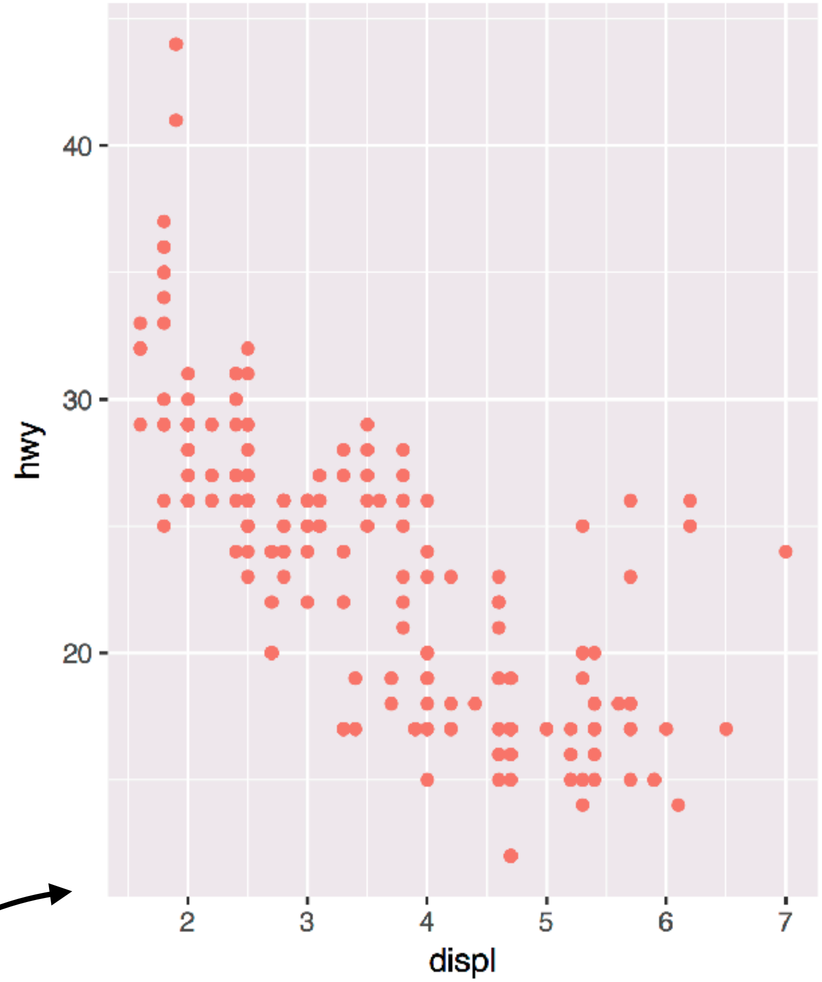
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy), color = "blue")
```

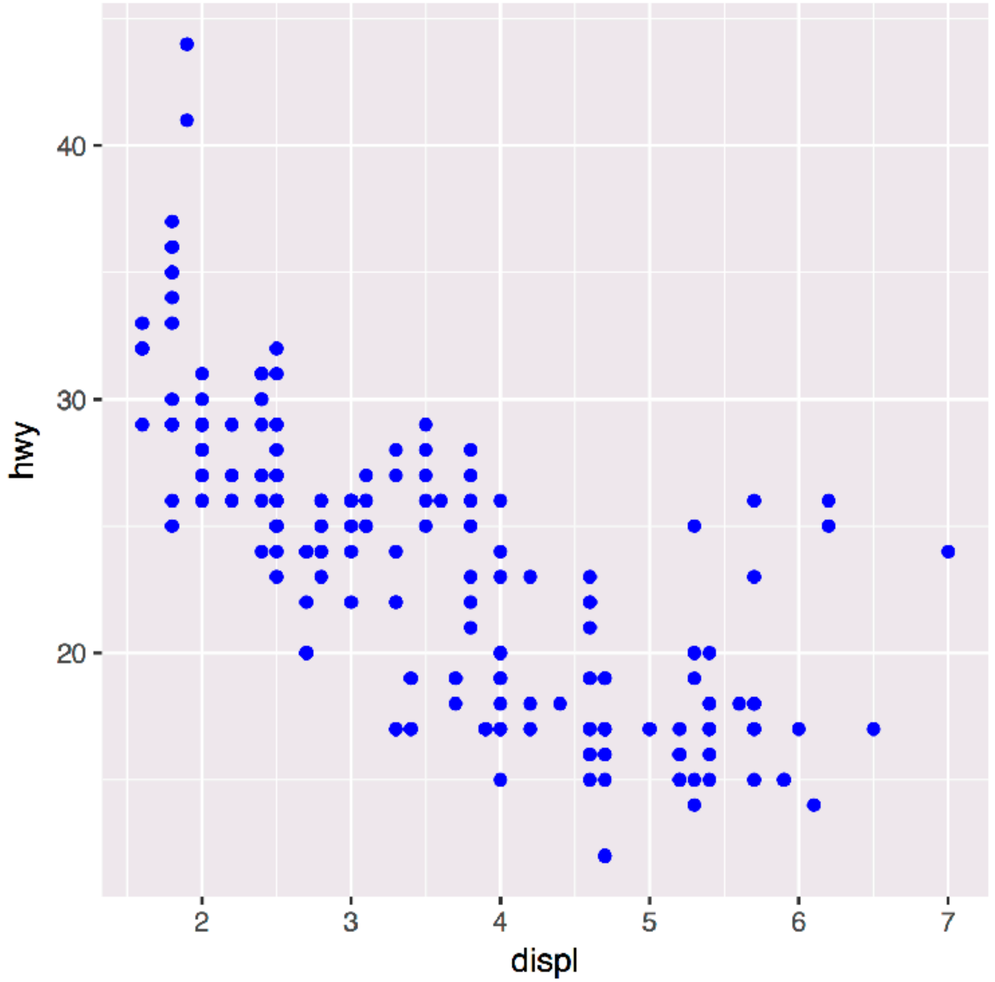





```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = class))
```

```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy), color = "blue")
```





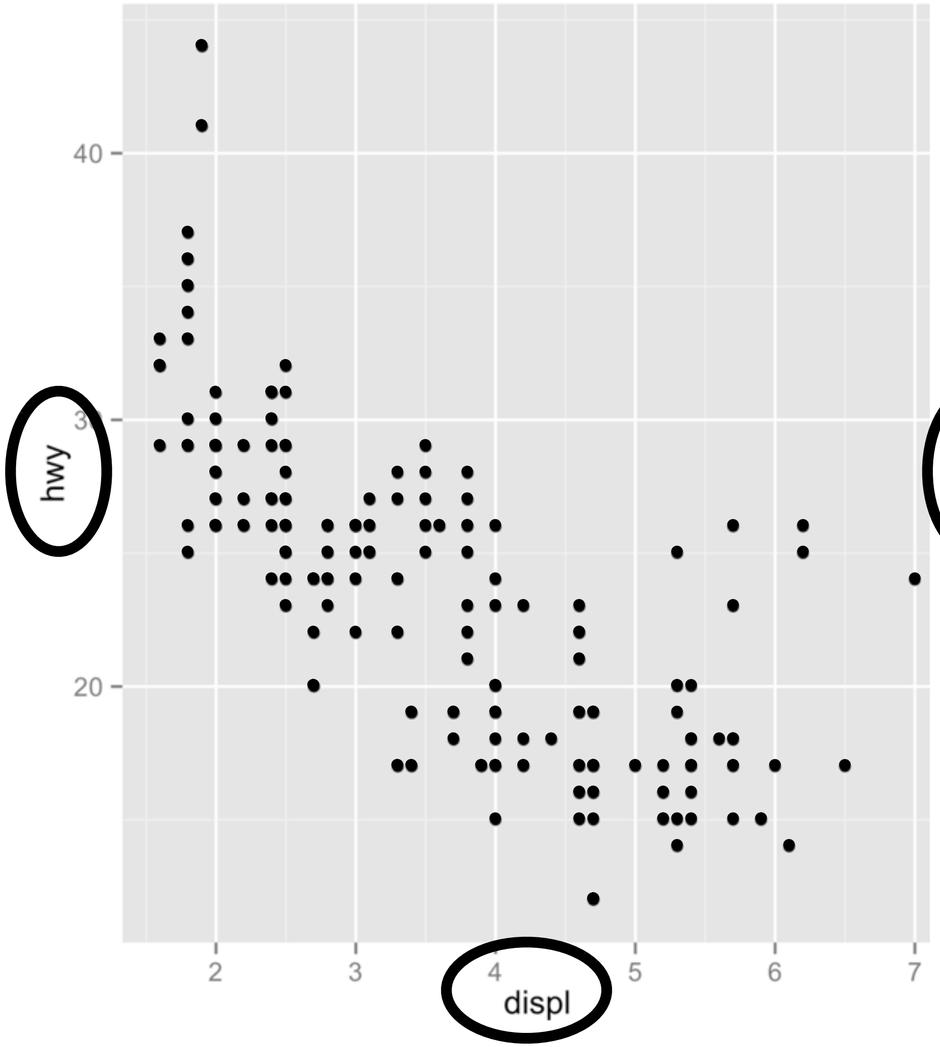

```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = "blue"))
```

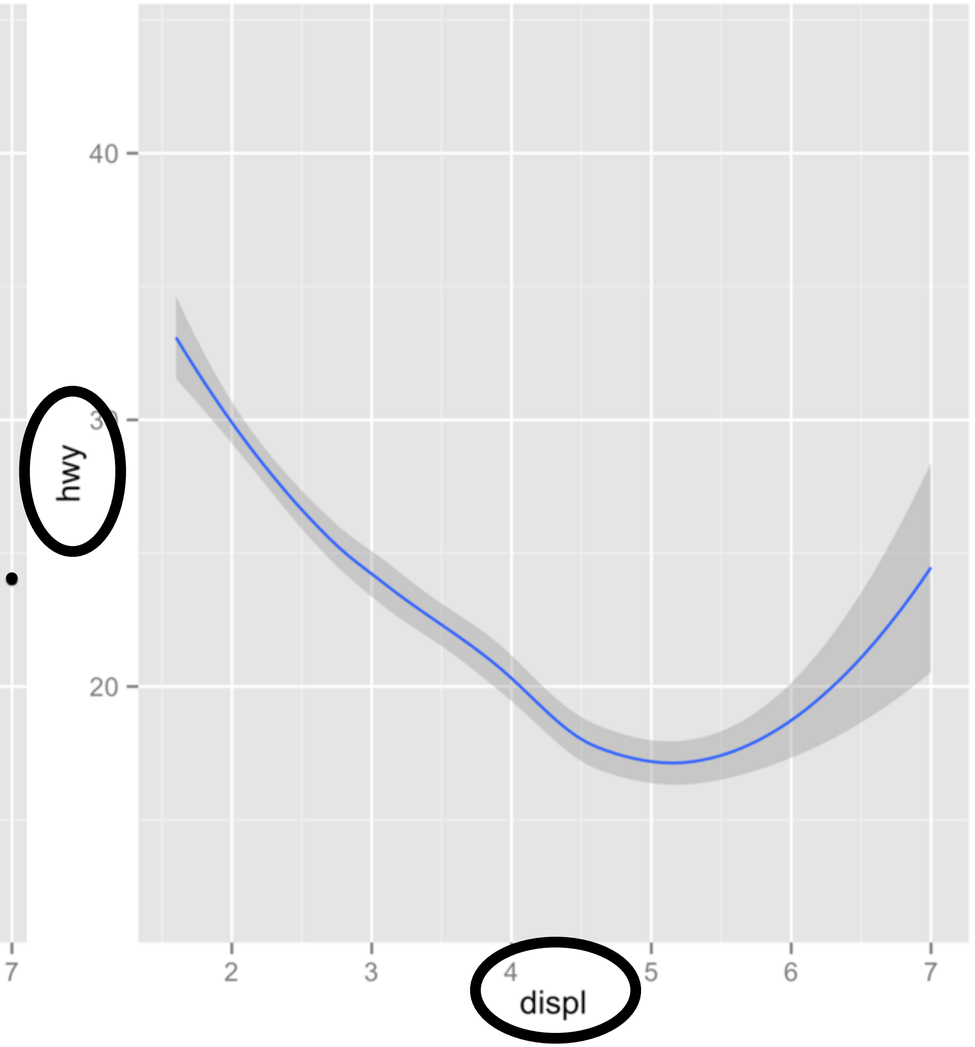
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy), color = "blue")
```

Geoms

How are these plots similar?

Same: x var , y var , data

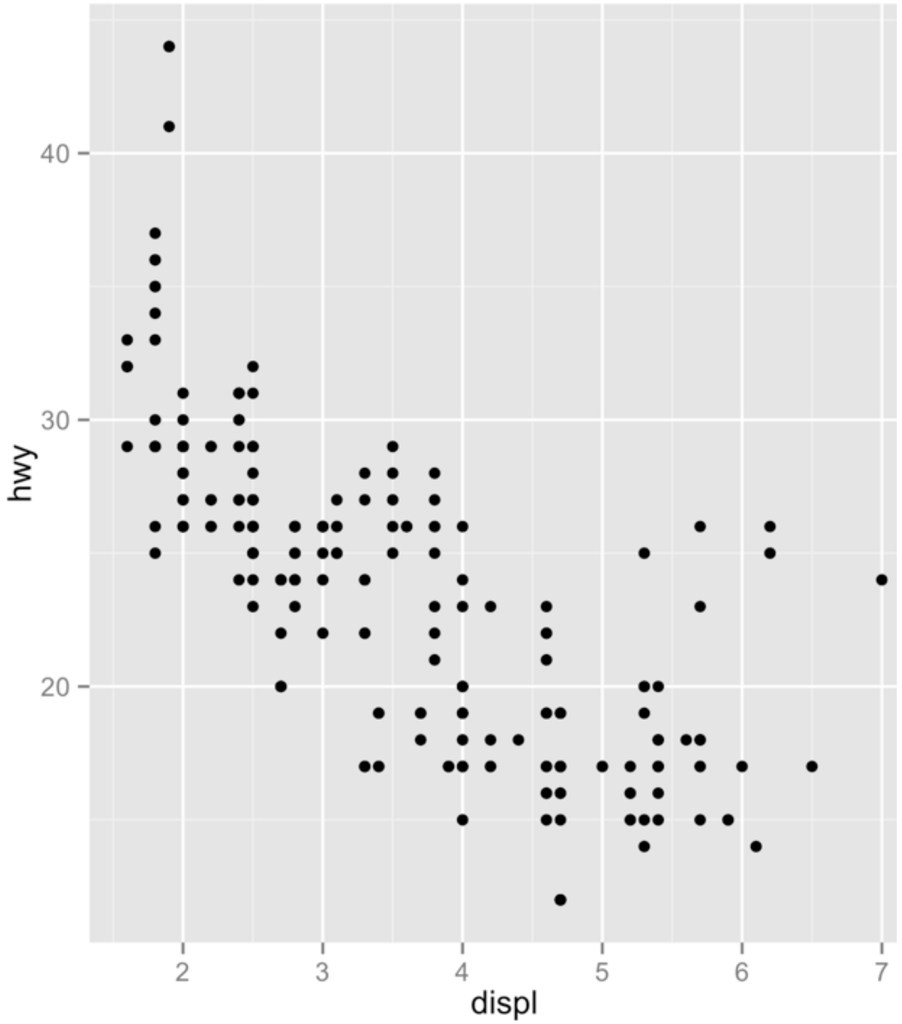


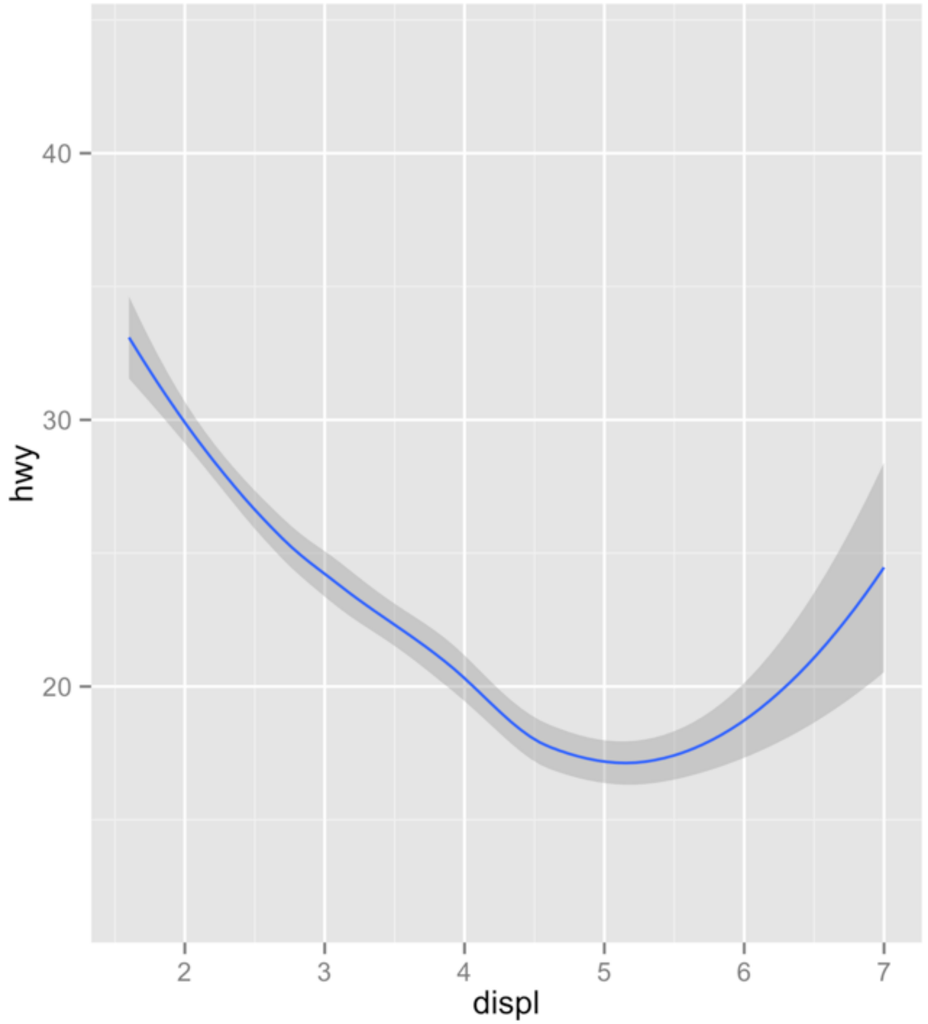


How are these plots different?

Different: geometric object (geom),

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



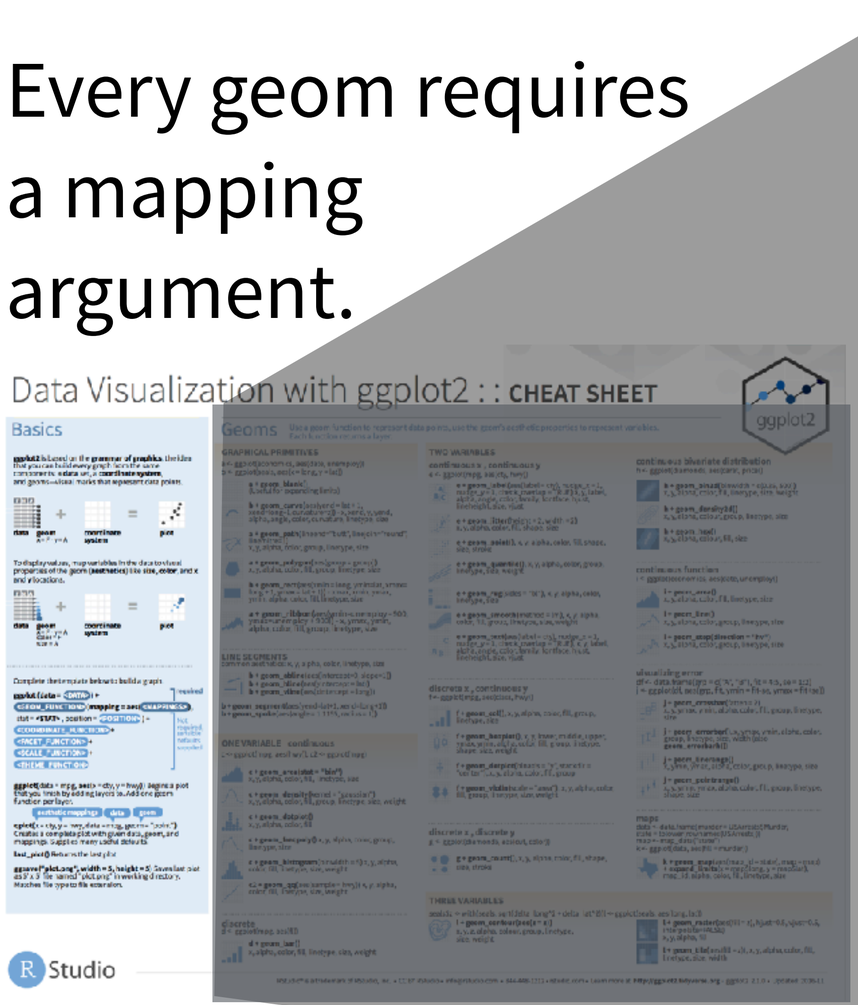


geoms

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

geom_functions

Every geom requires a mapping argument.

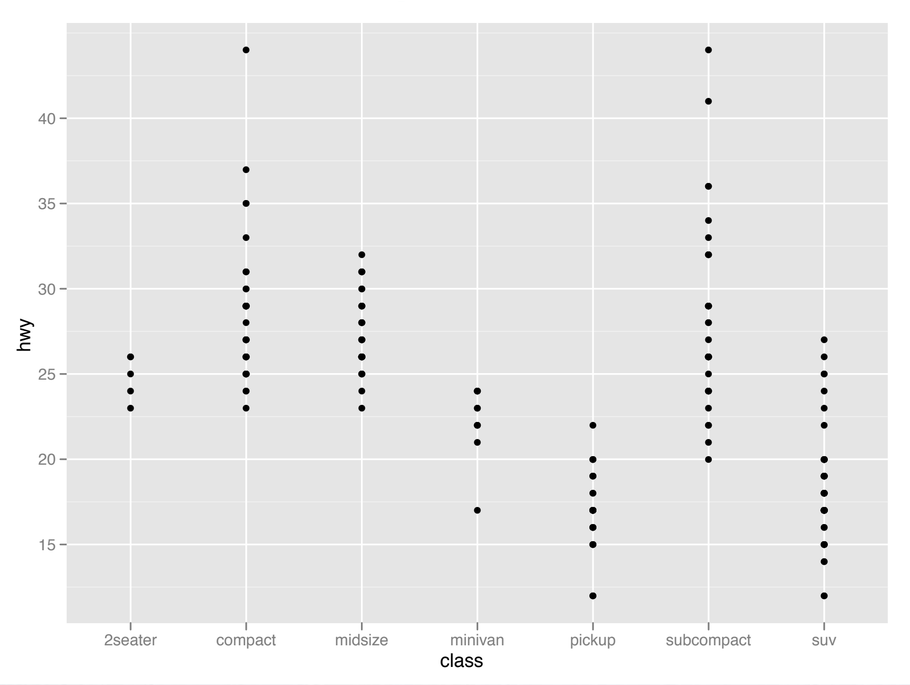


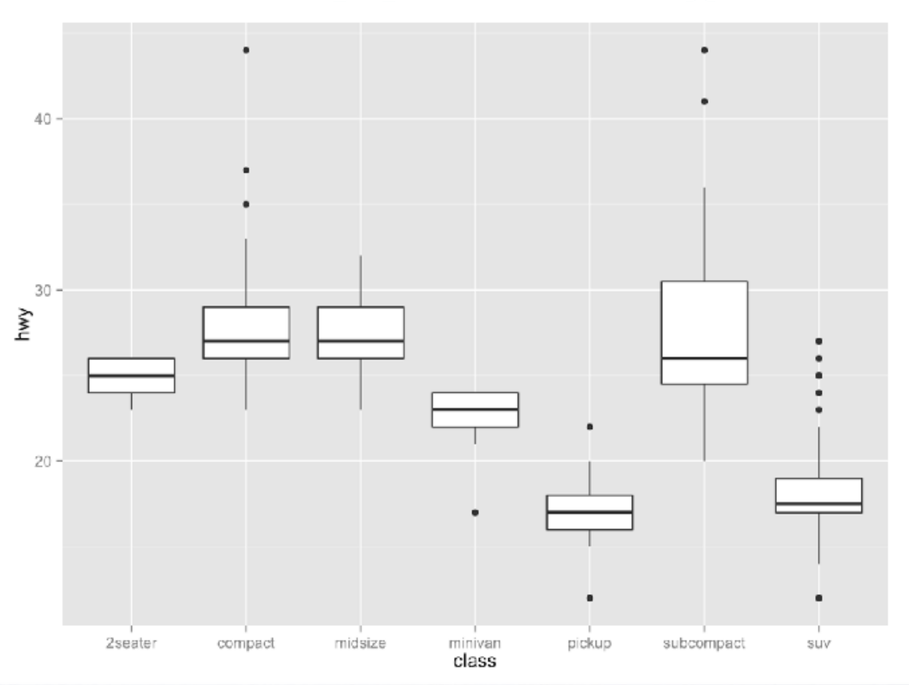
Your Turn

Pair up.

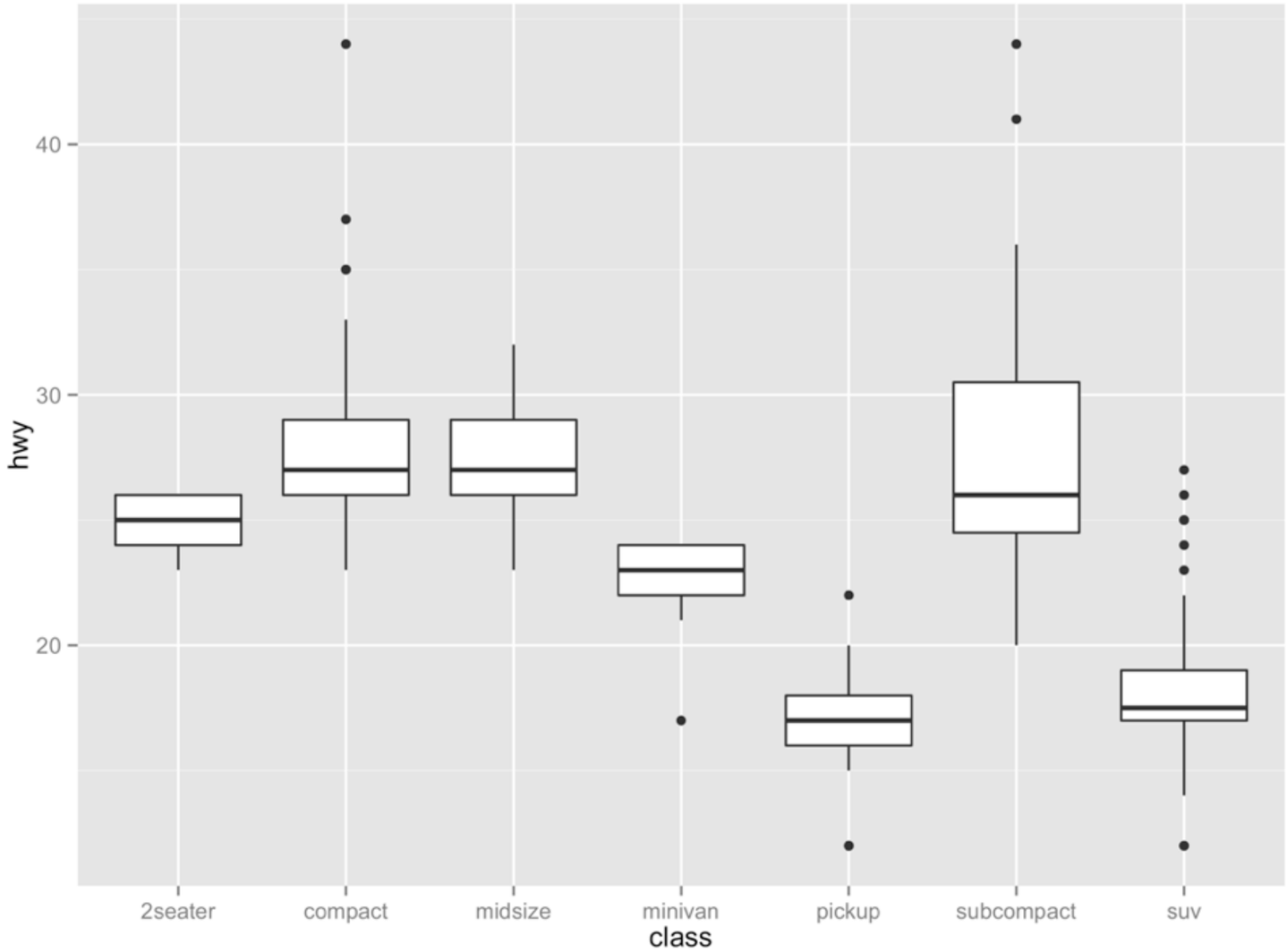
Your Turn 3

With your partner, decide how to replace this scatterplot with one that draws boxplots? Use the cheatsheet. Try your best guess.





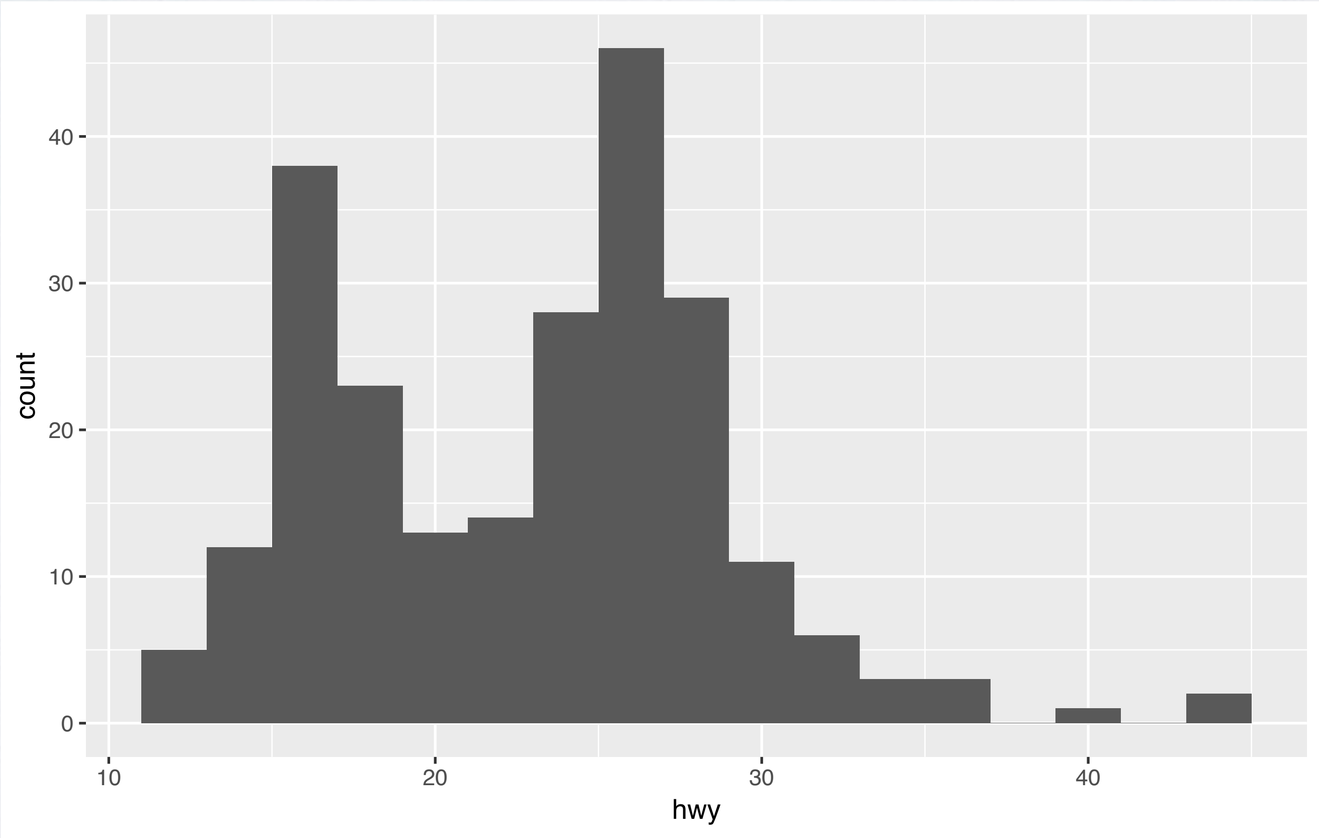

```
ggplot(mpg) + geom_point(aes(class, hwy))
```



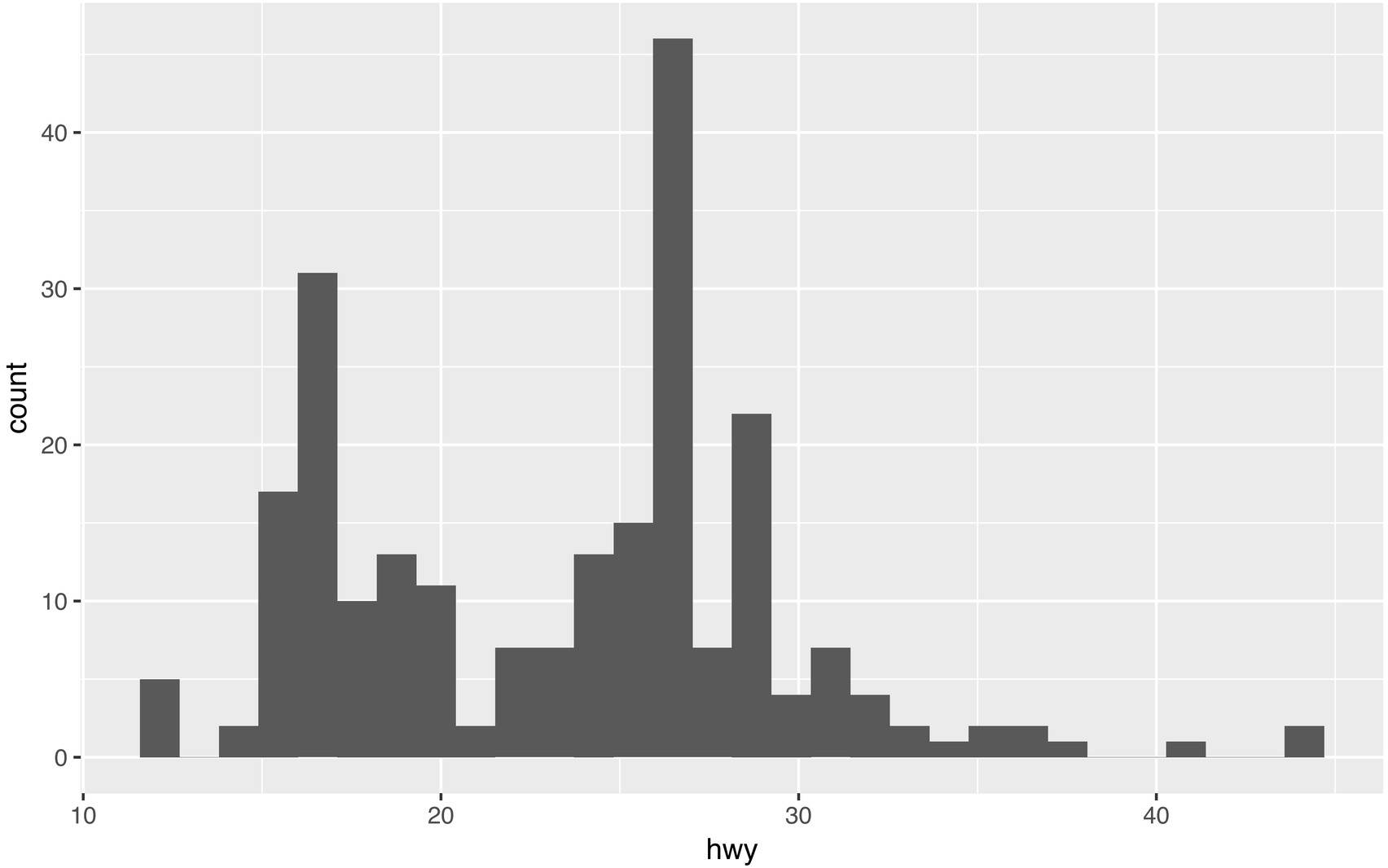

```
ggplot(data = mpg) +
  geom_boxplot(mapping = aes(x = class, y = hwy))
```

Your Turn 4

With your partner, make the **histogram** of hwy below. Use the cheatsheet. **Hint:** do not supply a y variable.

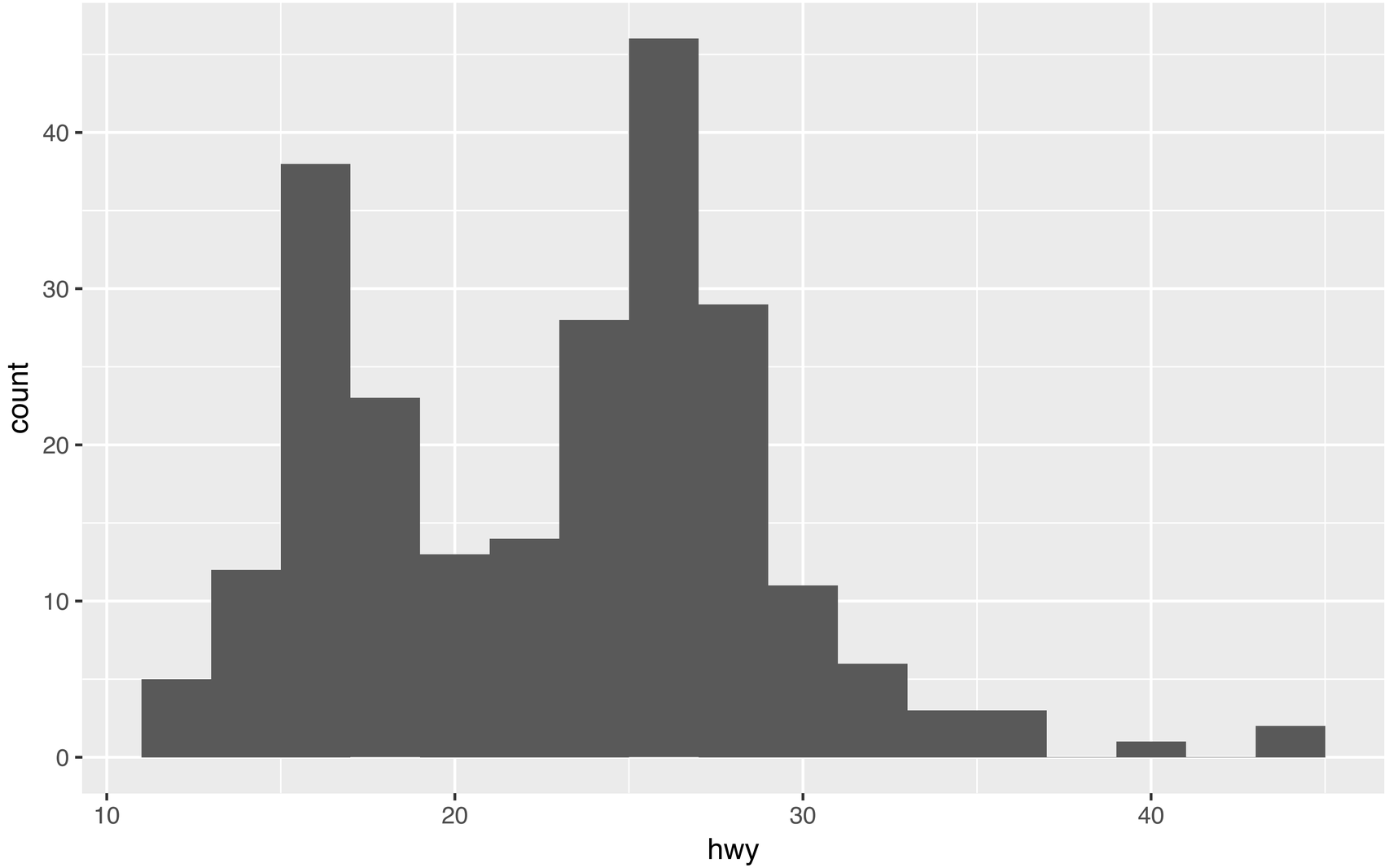


?



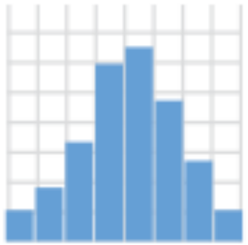

```
ggplot(data = mpg) +
  geom_histogram(mapping = aes(x = hwy))
```

No y aesthetic




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

Arguments inside (), are geom specific options

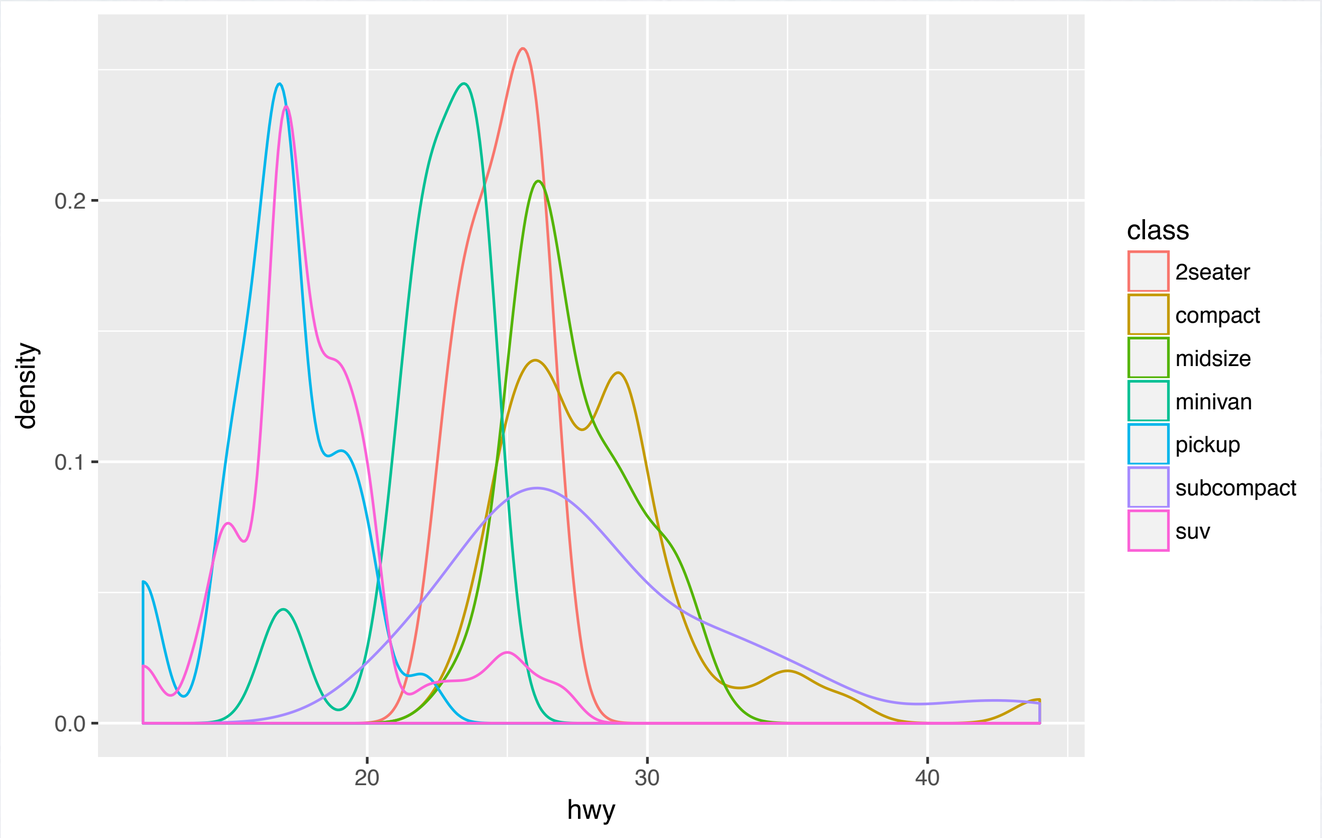


c + geom_histogram(binwidth = 5**)** x, y, alpha, color, fill, linetype, size, weight

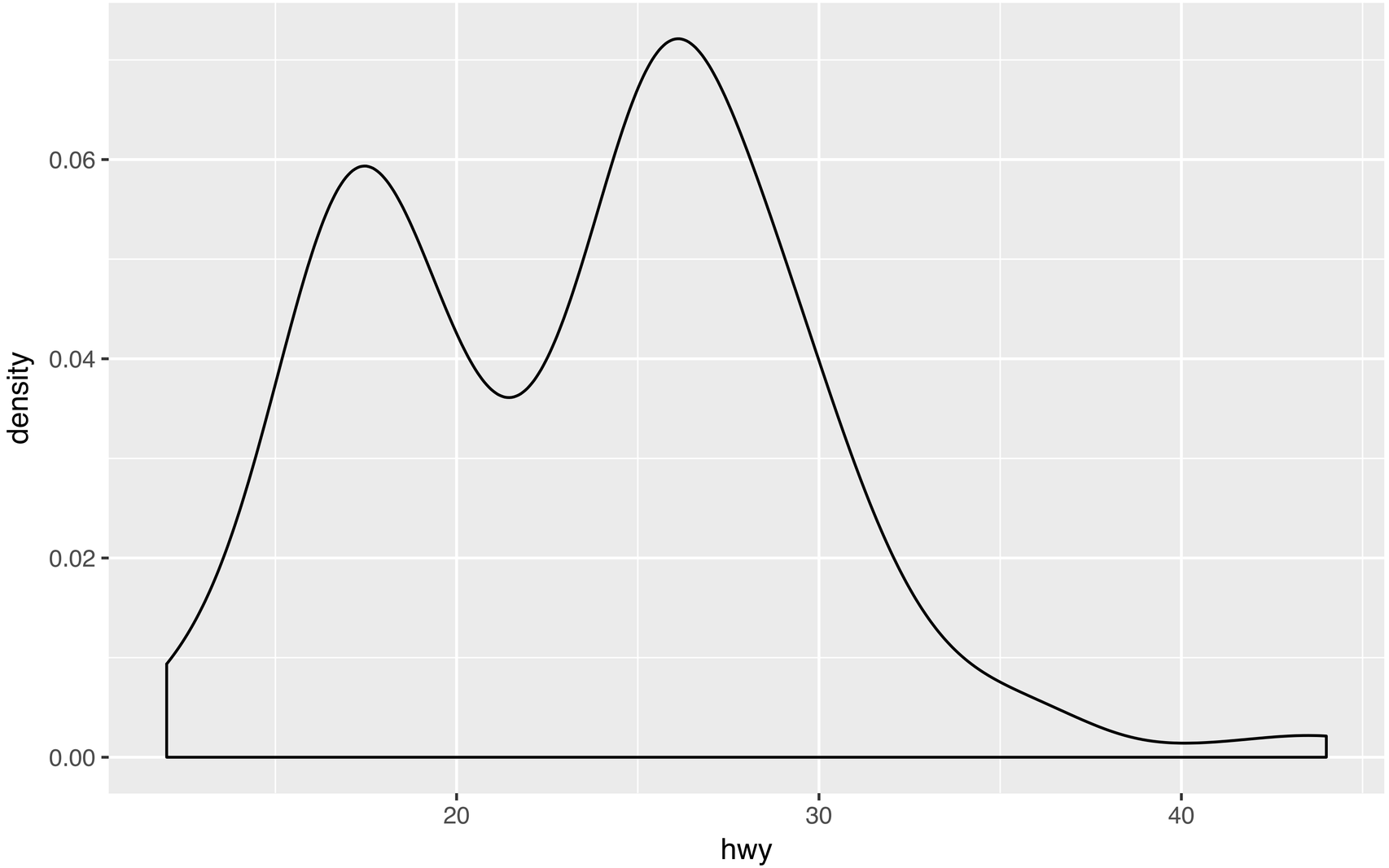
Outside the (), are aesthetics that can be mapped or set.

Your Turn 5

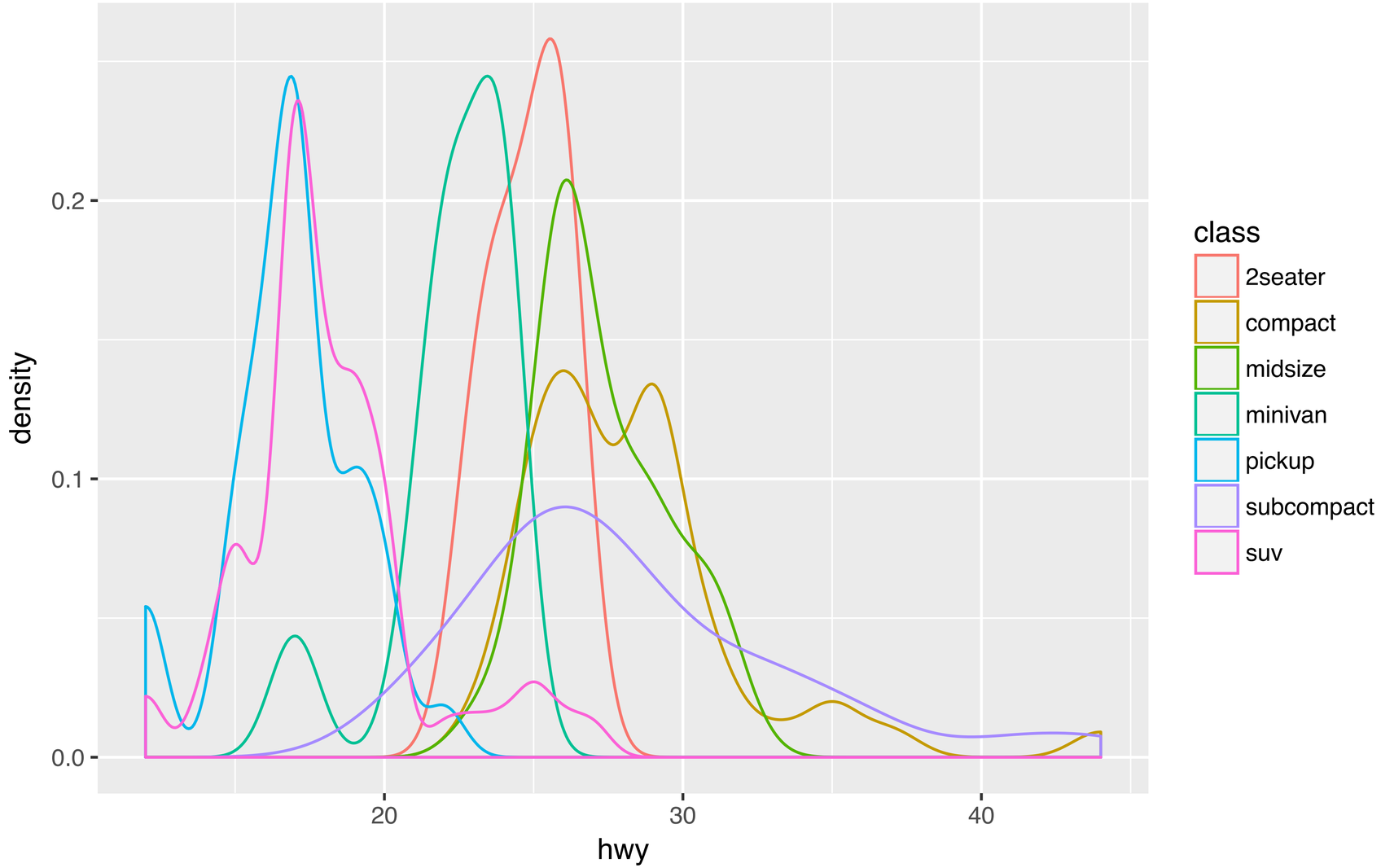
With your partner, make the density plot of hwy colored by `class` below. Use the cheatsheet. Try your best guess.



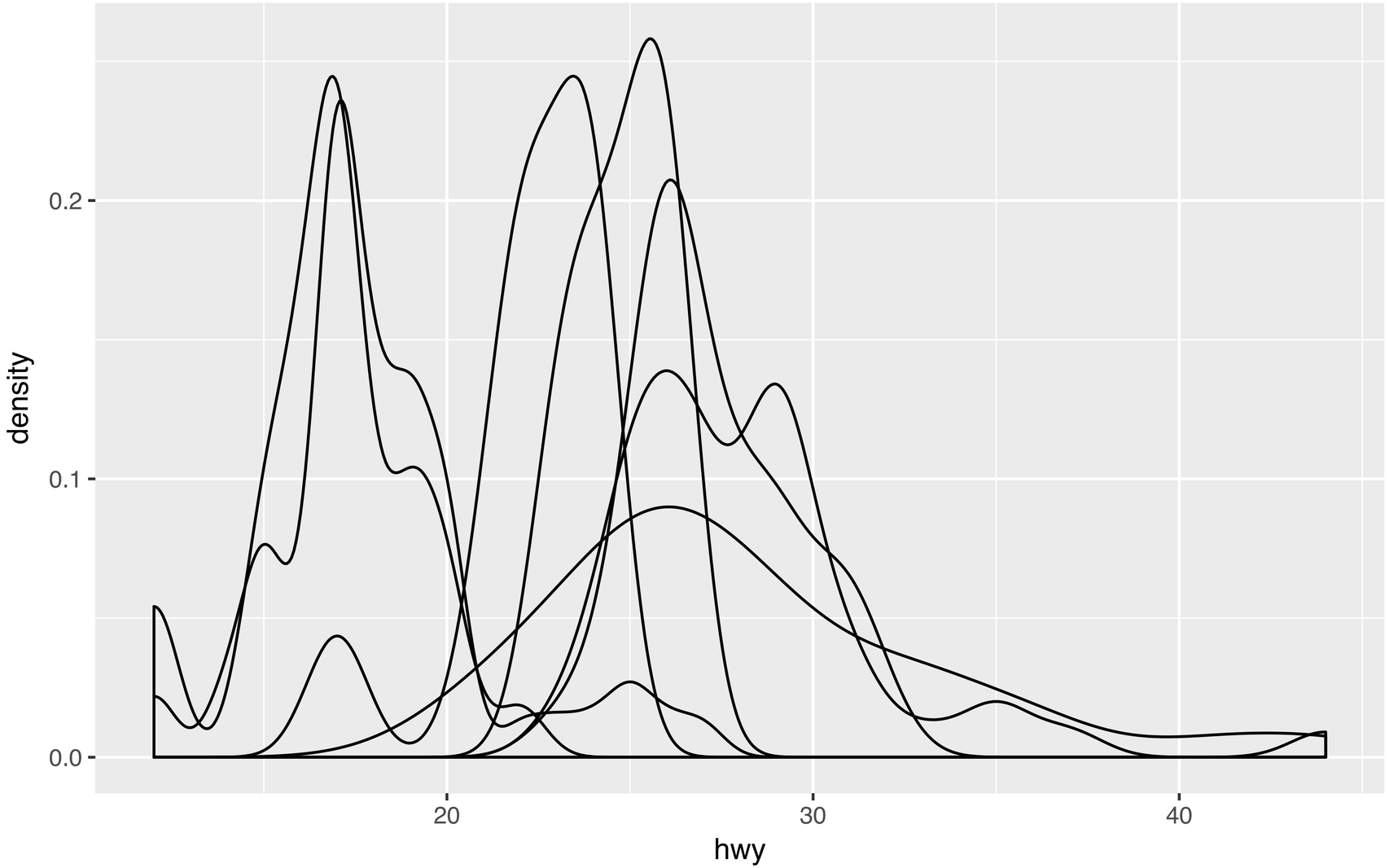
02:00




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



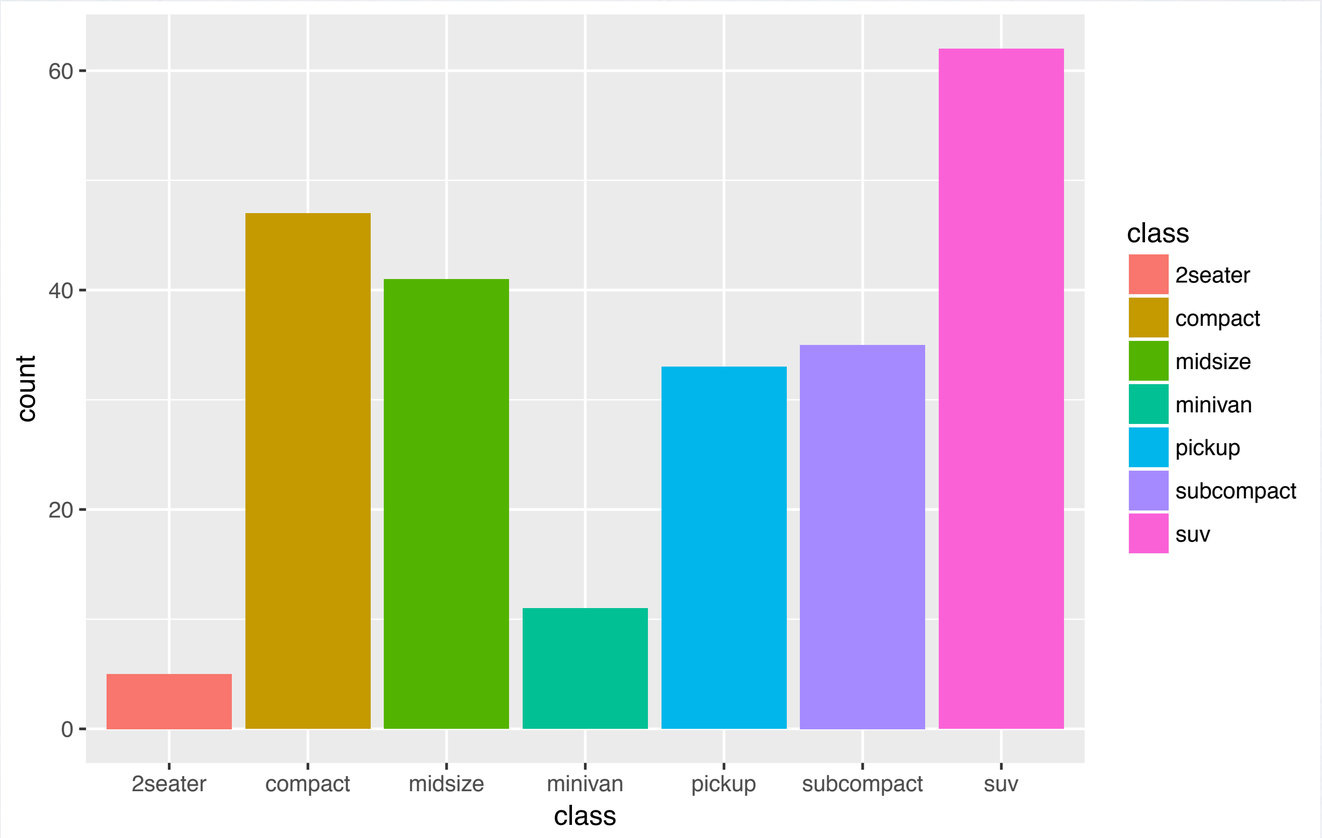

```
ggplot(data = mpg) +
  geom_density(mapping = aes(x = hwy, color = class))
```



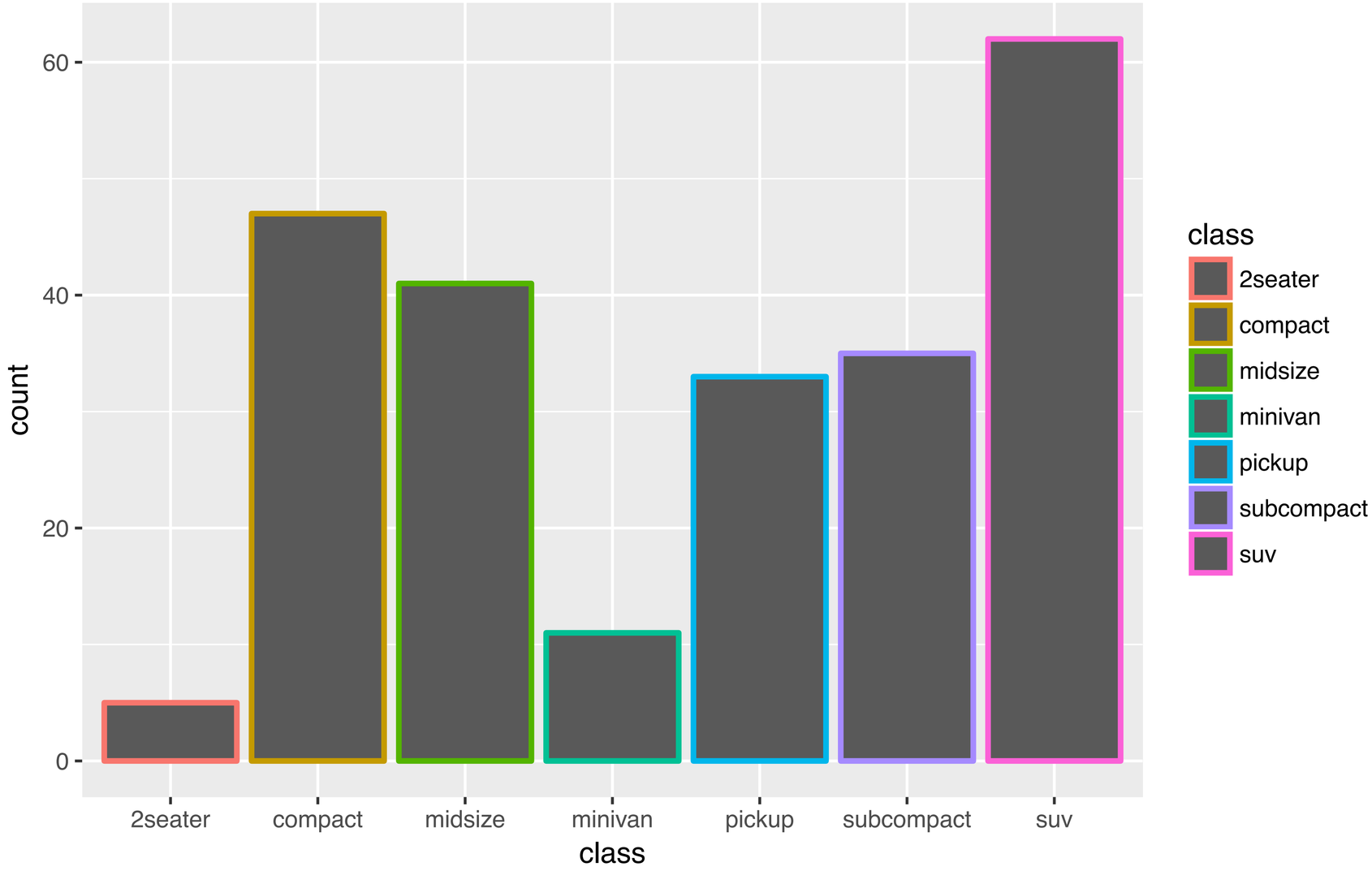

```
ggplot(data = mpg) +
  geom_density(mapping = aes(x = hwy, group = class))
```

Your Turn 6

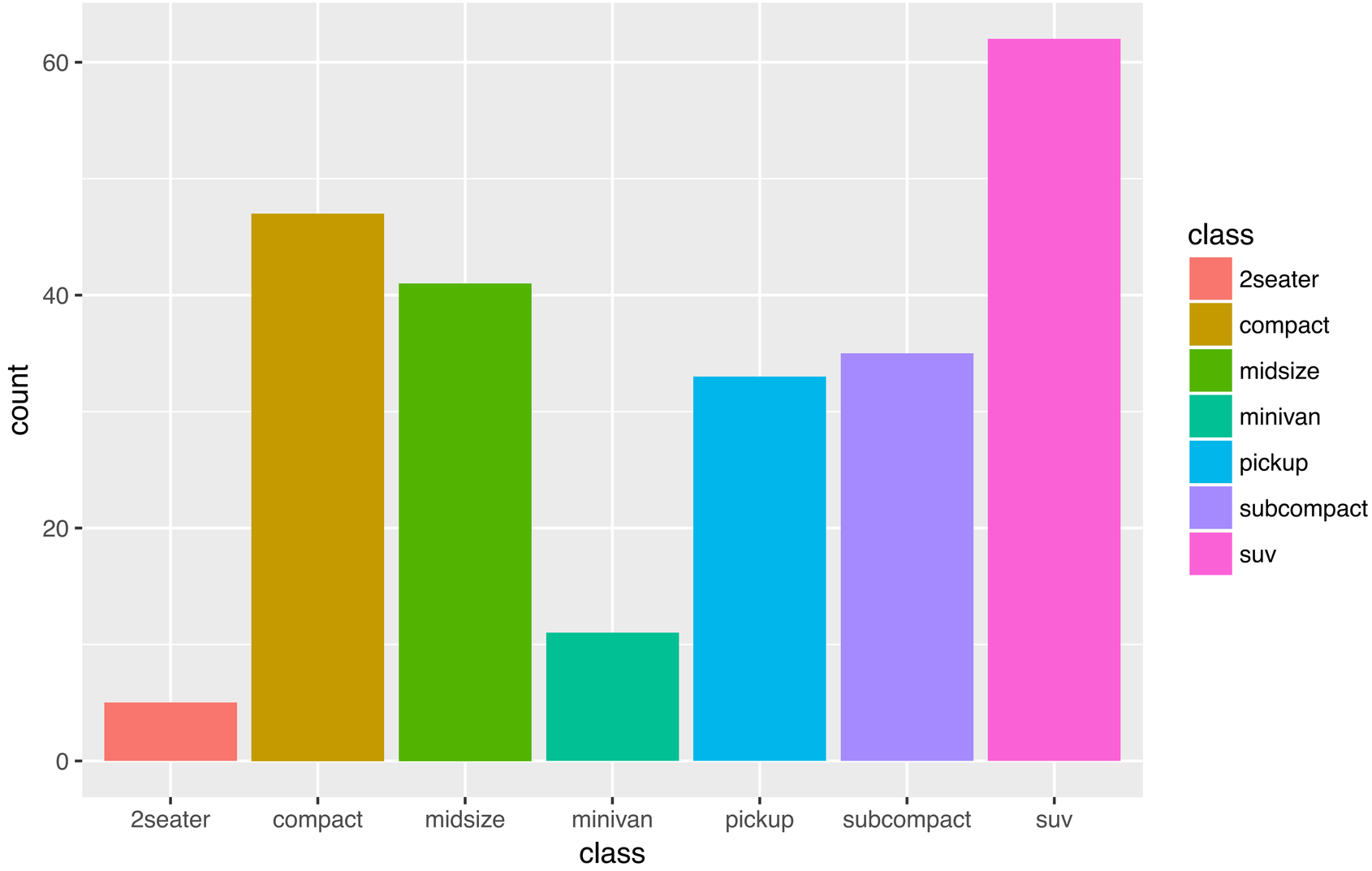
With your partner, make the **bar** chart of `class` colored by `class` below. Use the cheatsheet. Try your best guess.



02:00




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



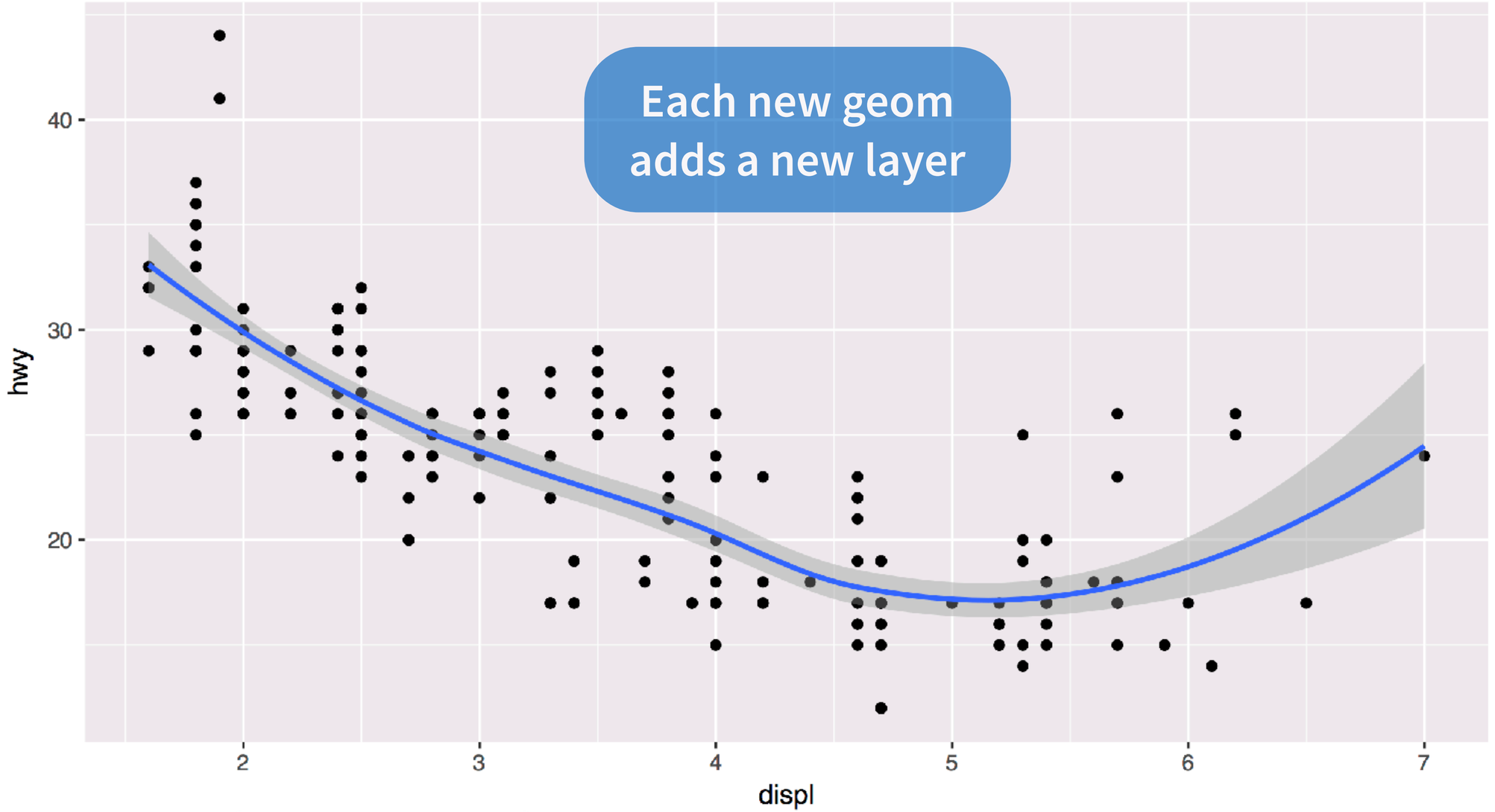

```
ggplot(data = mpg) +
  geom_bar(mapping = aes(x = class, fill = class))
```

Your Turn 7

With your partner, predict what this code will do.

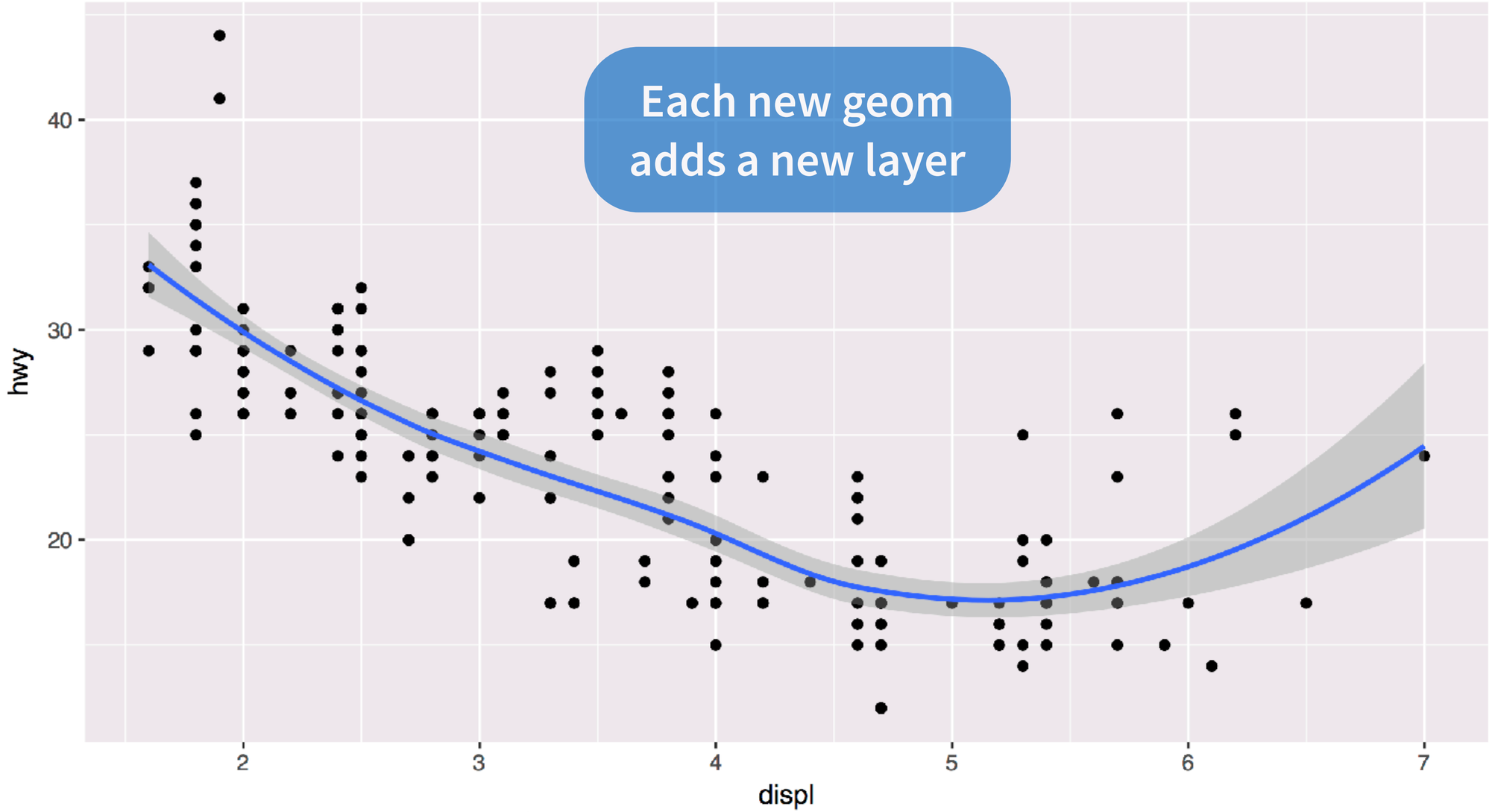
Then run it.

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



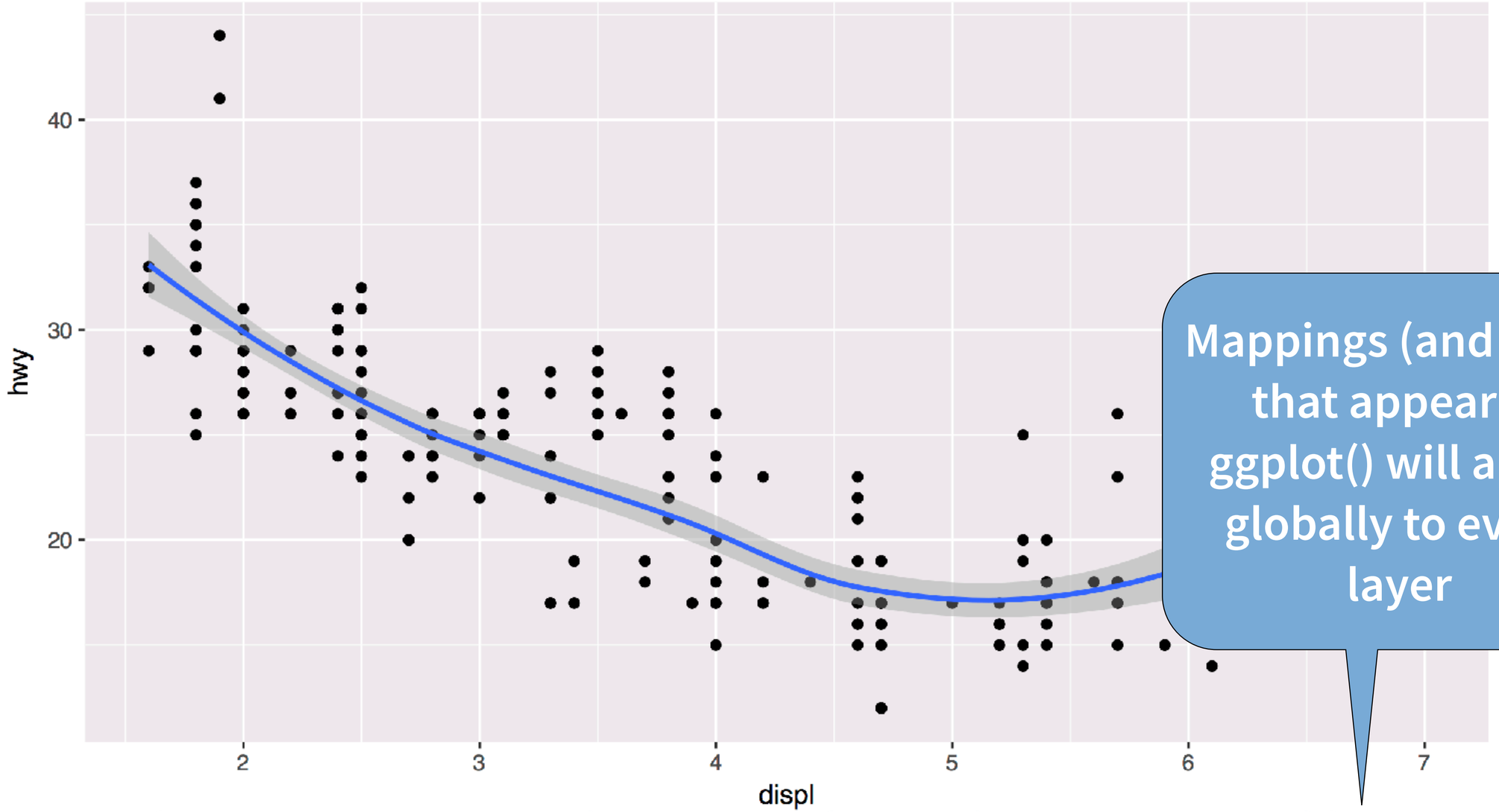

```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy)) +
  geom_smooth(mapping = aes(x = displ, y = hwy))
```


ggplot2




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

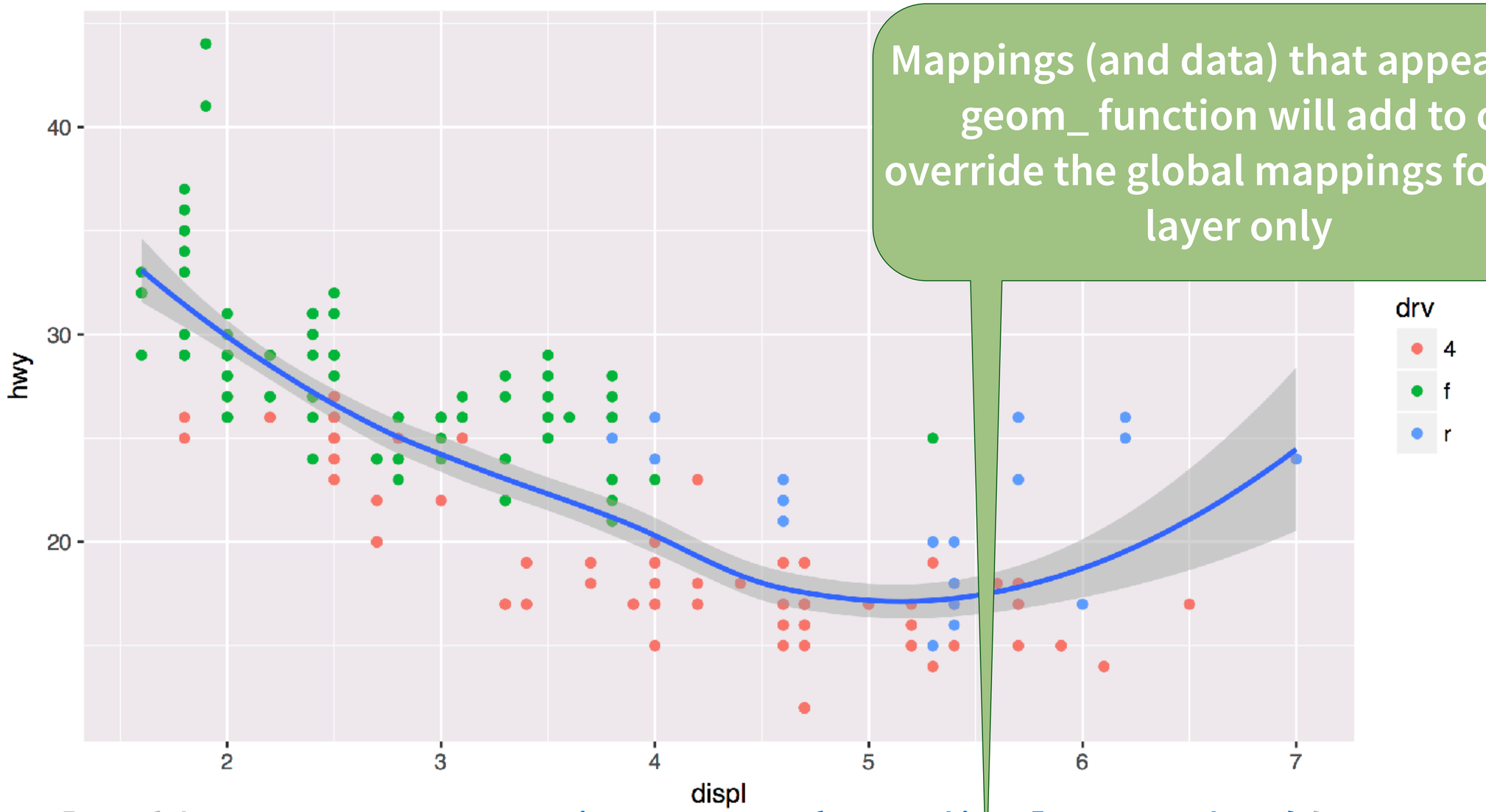
Global vs. Local



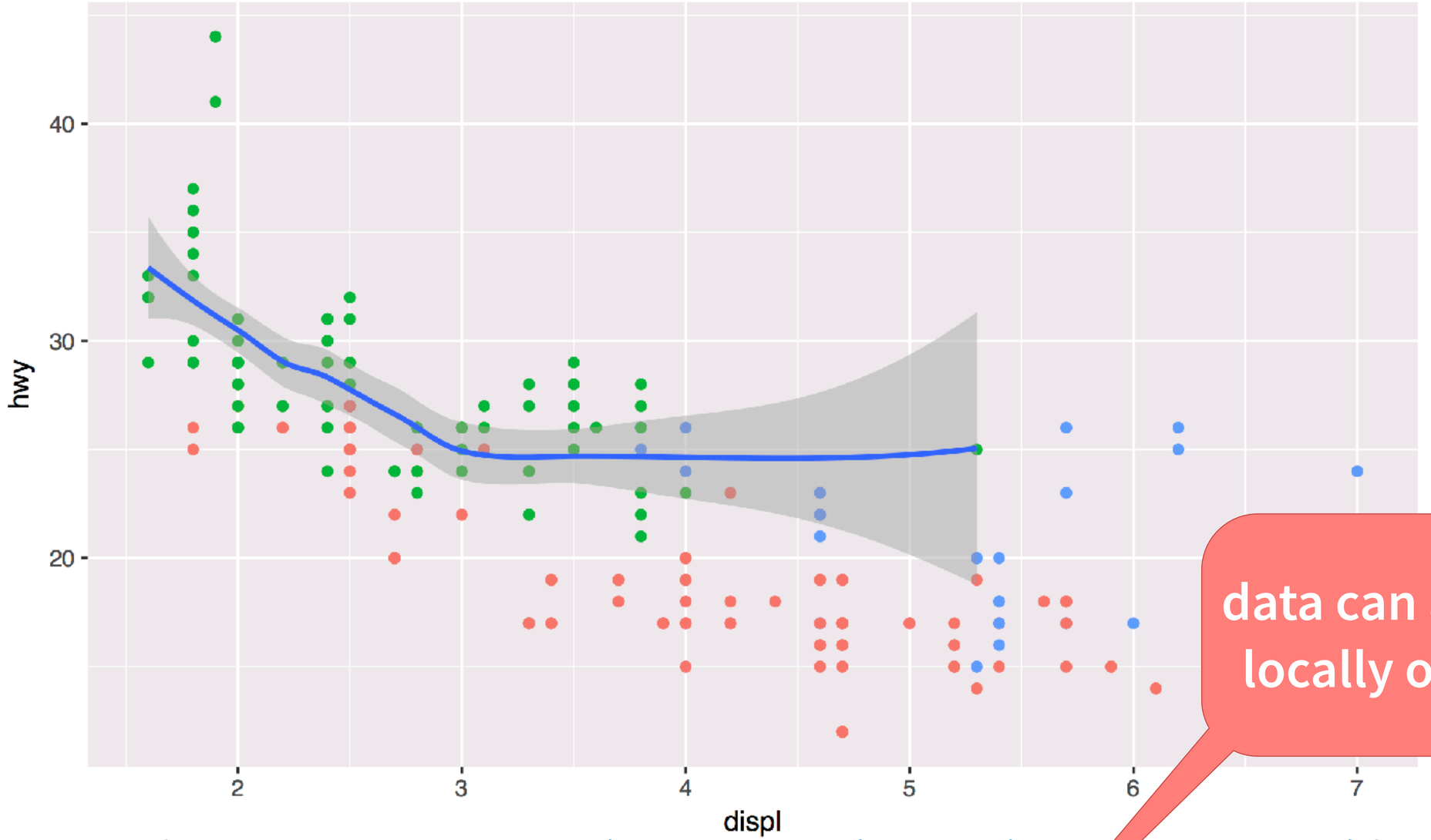
Mappings (and data) that appear in ggplot() will apply globally to every layer

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


ggplot2




```
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"))
```


ggplot2

Saving graphs

Your Turn 8

What does this command return?

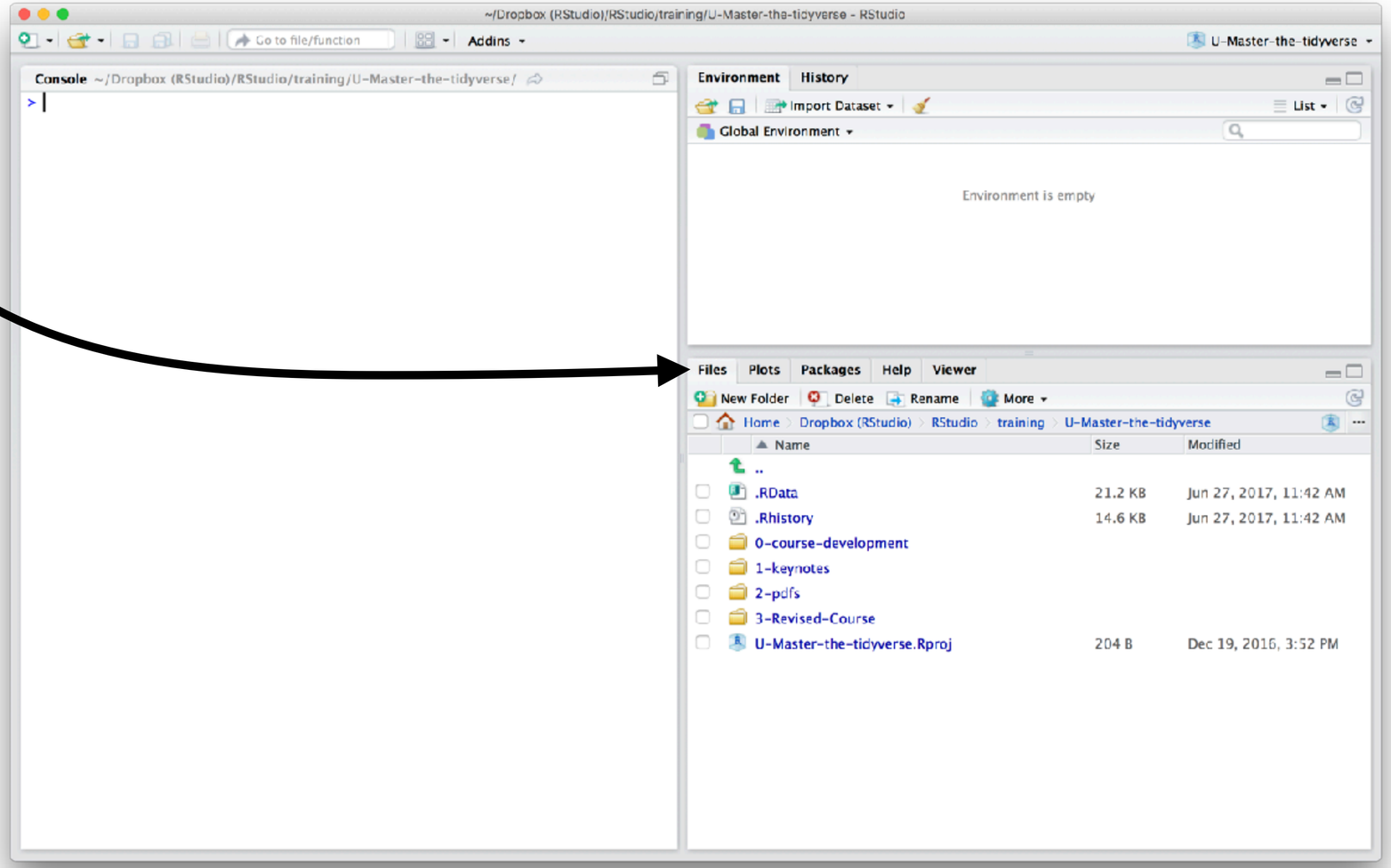
```
getwd()
```

Working Directory

R associates itself with a folder (i.e. directory) on your computer.

- This folder is known as your "working directory"
- When you save files, R will save them here
- When you load files, R will look for them here

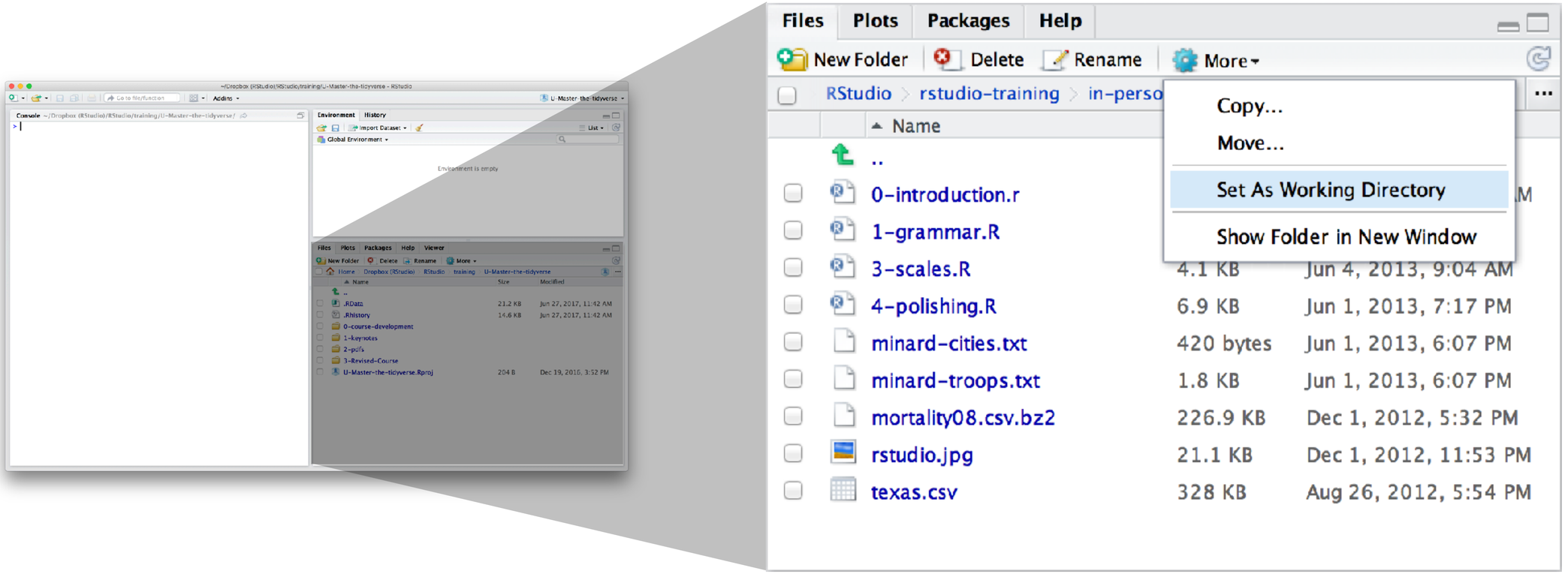
The files pane of the IDE displays the contents of your working directory



ggplot2

Changing the Working directory

Navigate in the files pane to a new directory. Click More > Set As Working Directory



Saving plots

ggsave() saves the last plot.
Uses size on screen:

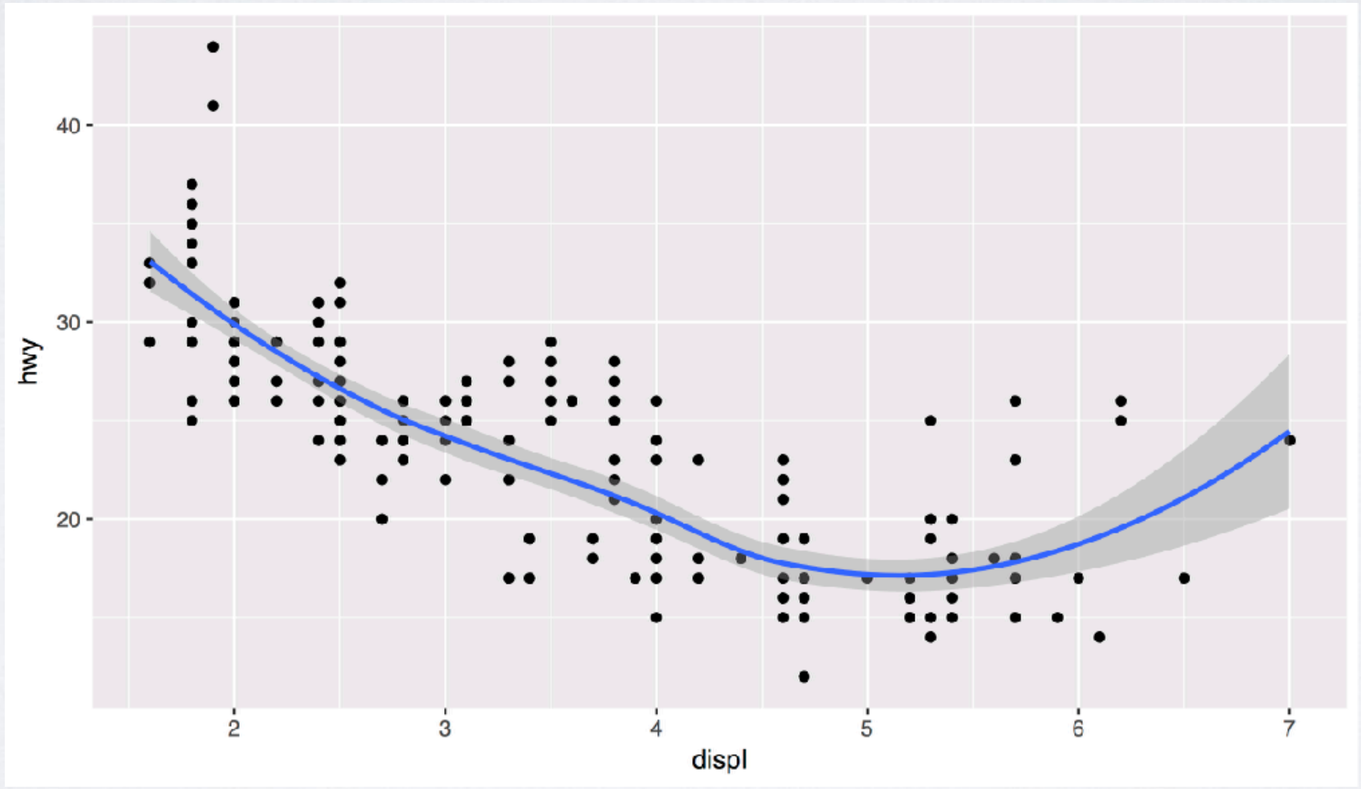
```
ggsave("my-plot.pdf")
ggsave("my-plot.png")
```

Specify size in inches

```
ggsave("my-plot.pdf", width = 6, height = 6)
```

Your Turn 9

Save your last plot and then locate it in your files pane. (You may have to refresh the files list).



Grammar of Graphics

To make a graph

[template]

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

To make a graph

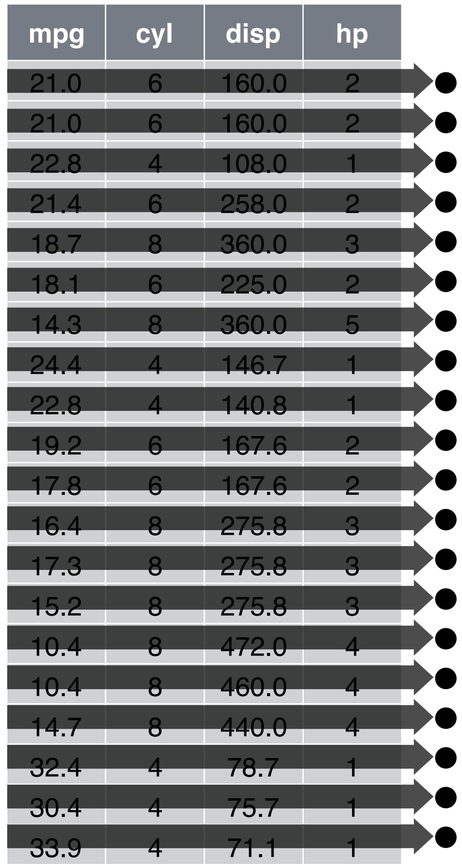
mpg	cyl	disp	hp
21.0	6	160.0	2
21.0	6	160.0	2
22.8	4	108.0	1
21.4	6	258.0	2
18.7	8	360.0	3
18.1	6	225.0	2
14.3	8	360.0	5
24.4	4	146.7	1
22.8	4	140.8	1
19.2	6	167.6	2
17.8	6	167.6	2
16.4	8	275.8	3
17.3	8	275.8	3
15.2	8	275.8	3
10.4	8	472.0	4
10.4	8	460.0	4
14.7	8	440.0	4
32.4	4	78.7	1
30.4	4	75.7	1
33.9	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

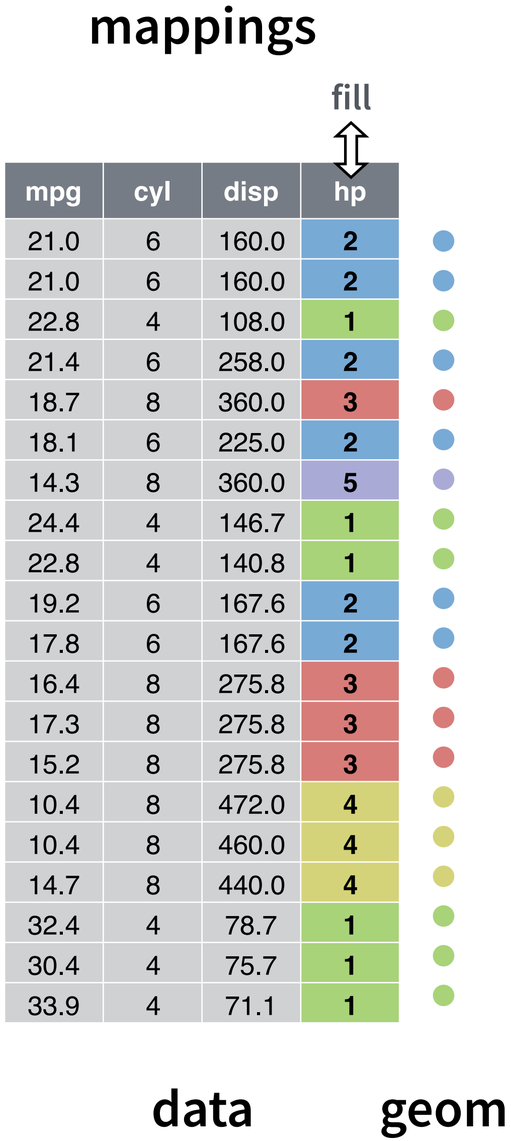
data **geom**

1. Pick a **data** set

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

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

To make a graph



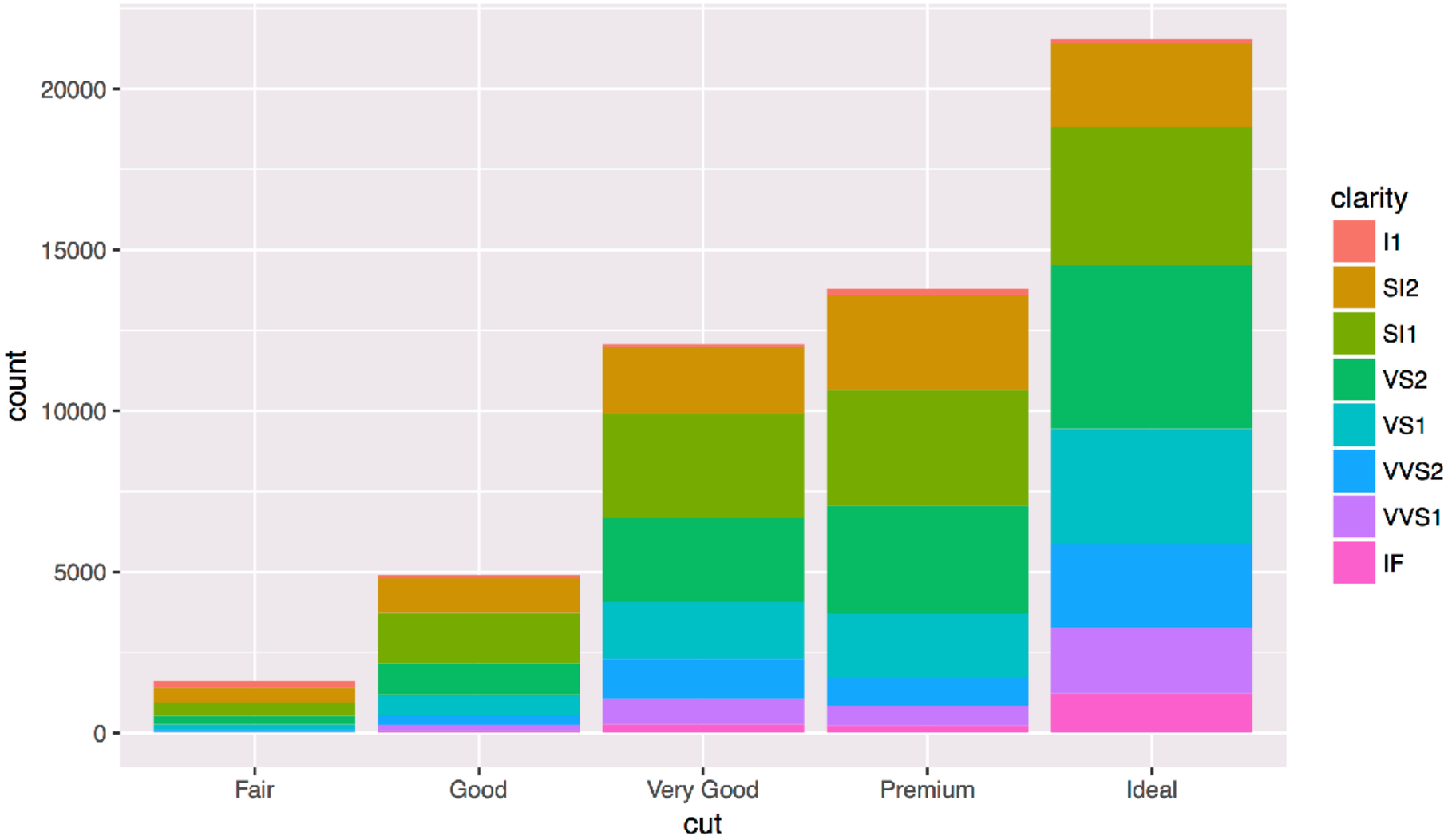
1. Pick a **data** set

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

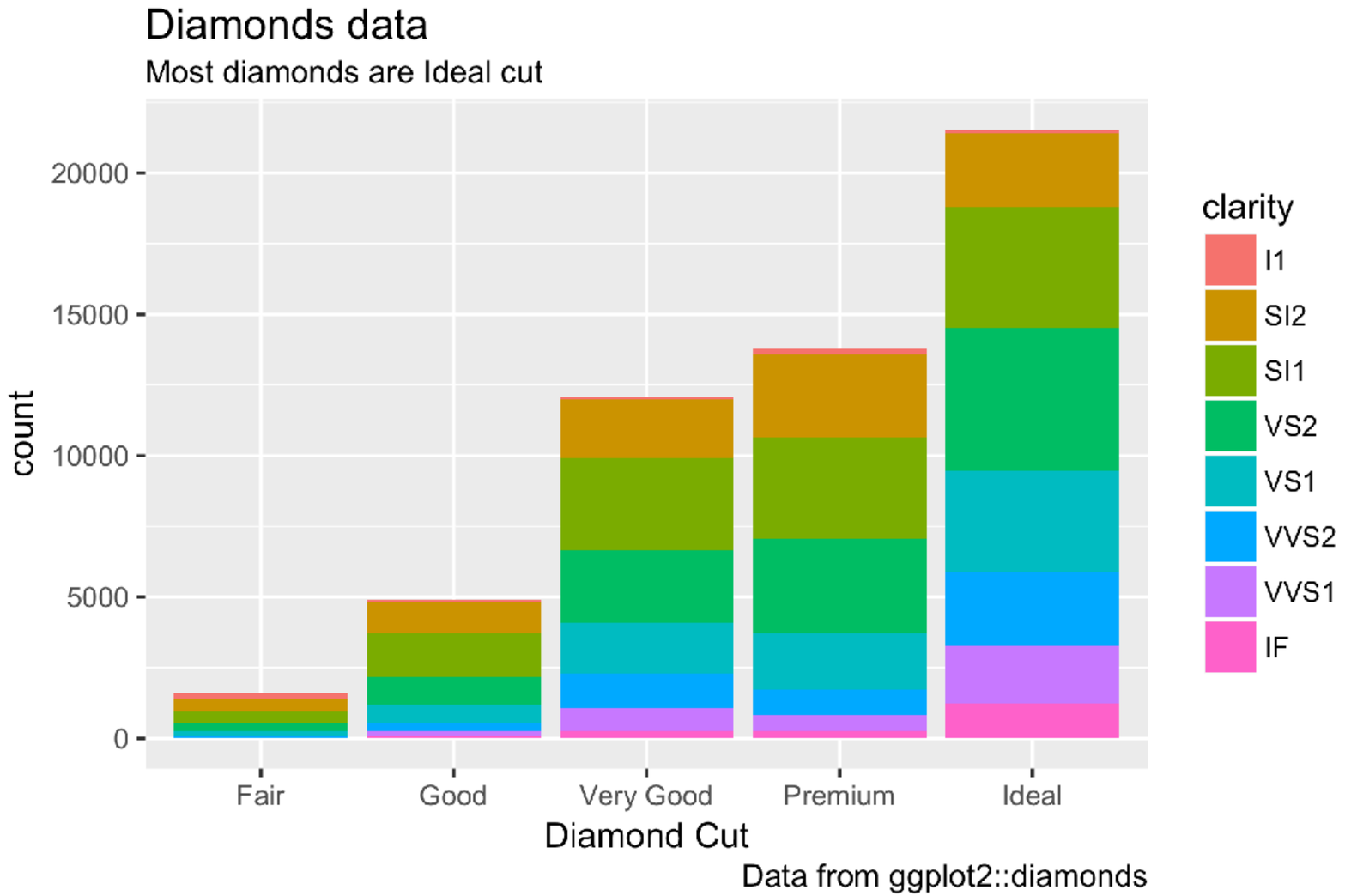
2. Choose a **geom** to display cases

3. **Map** aesthetic properties to variables

What else?

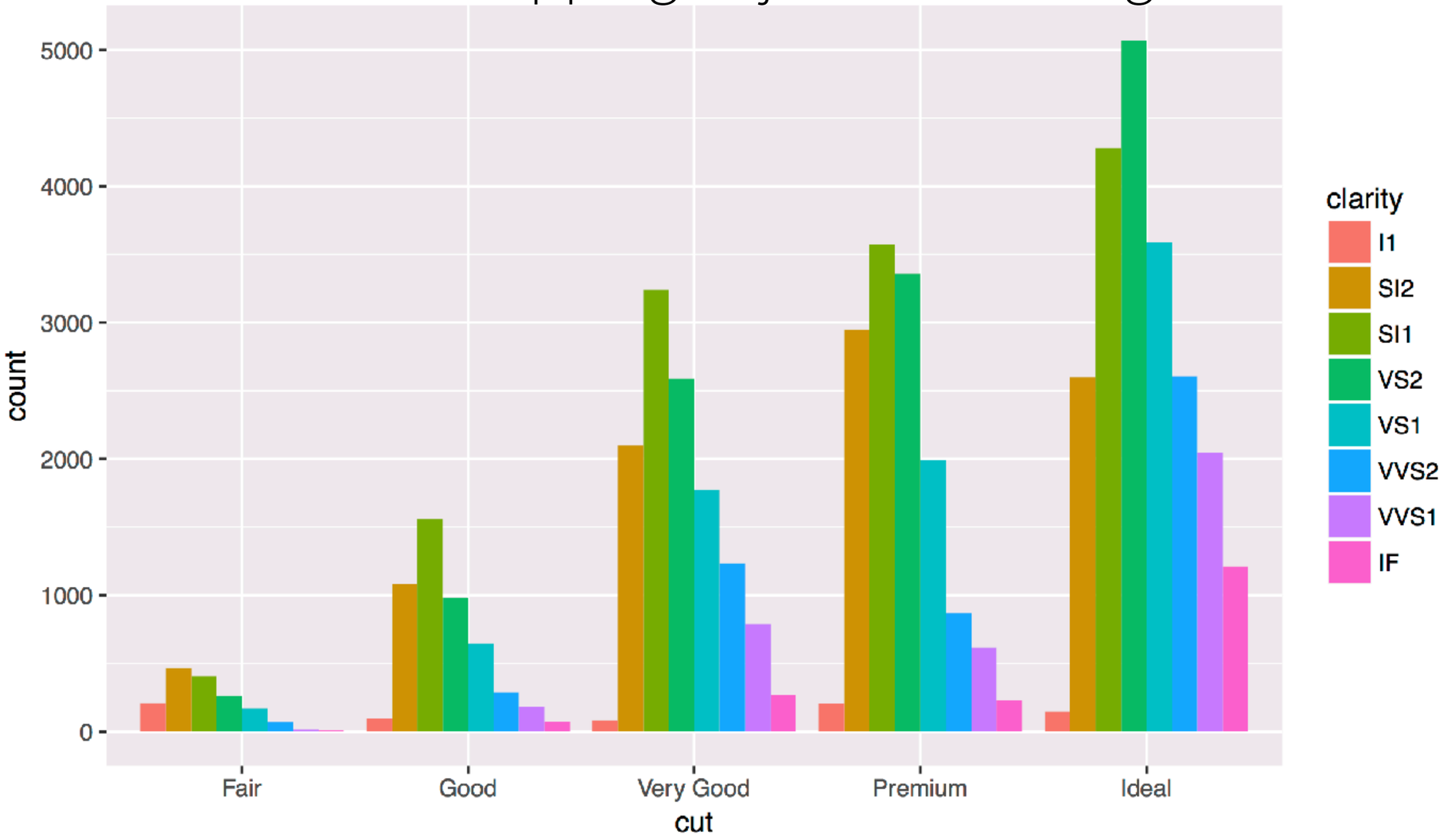


Titles and captions



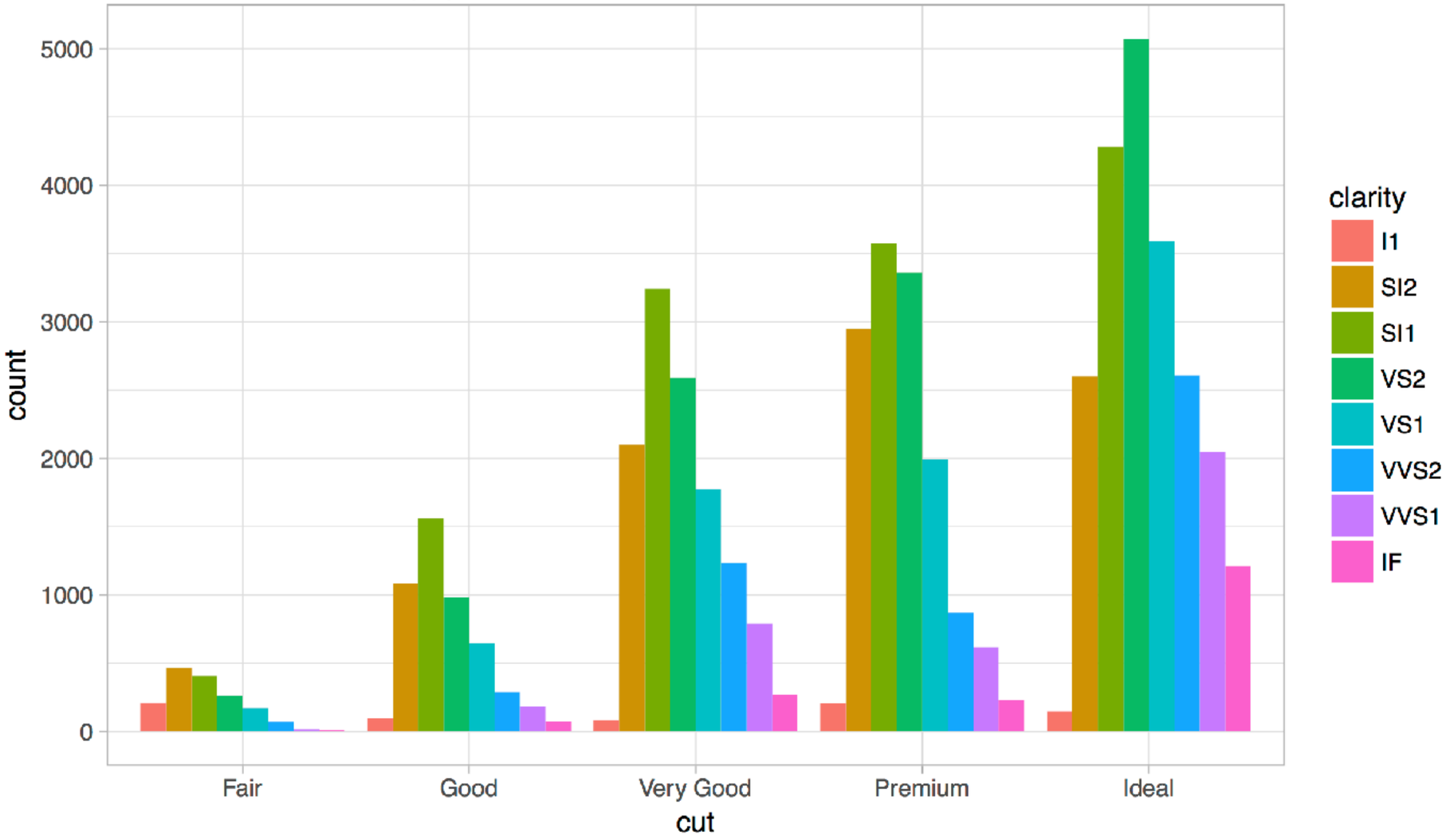
Position Adjustments

How overlapping objects are arranged



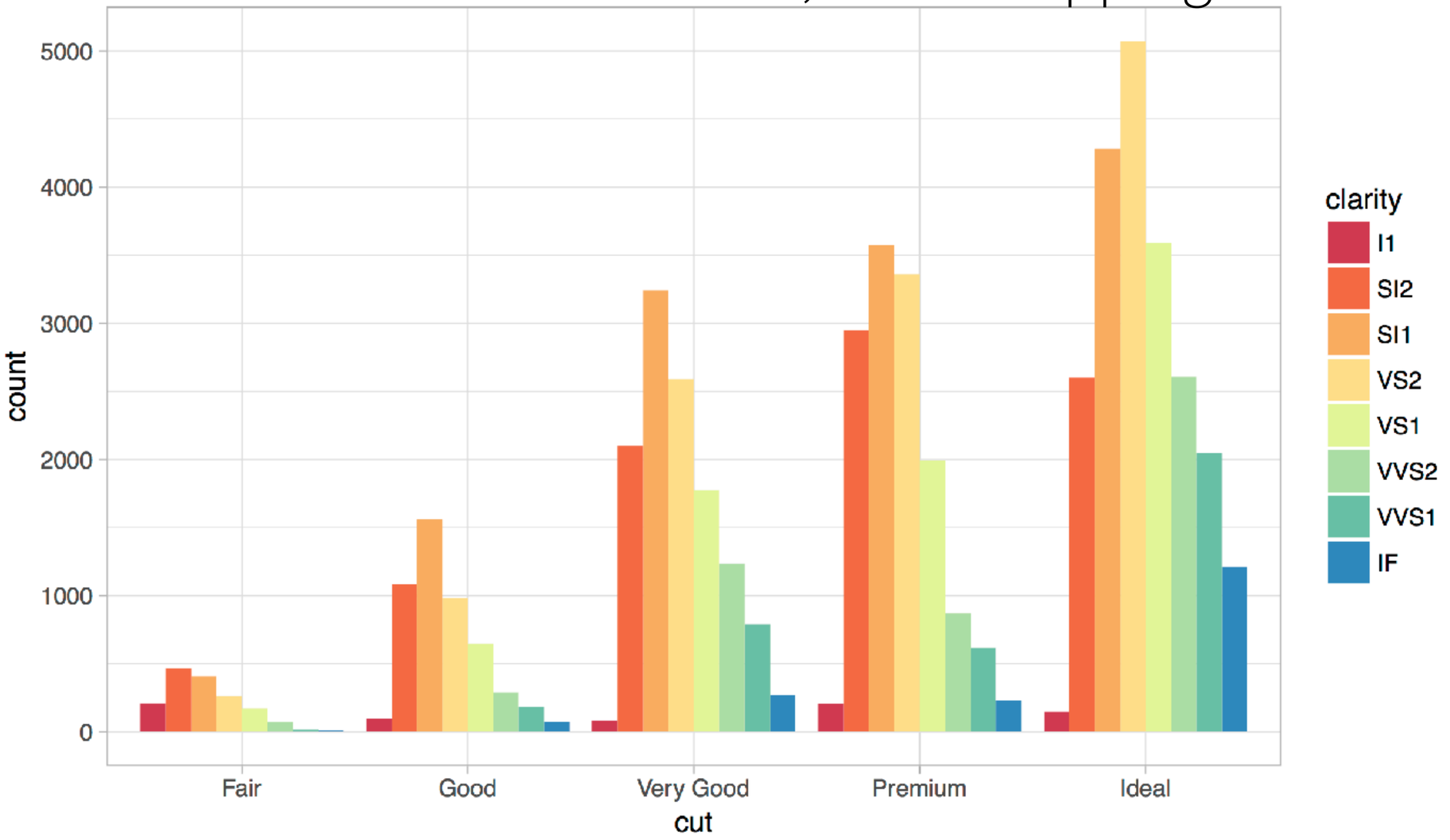
Themes

Visual appearance of non-data elements



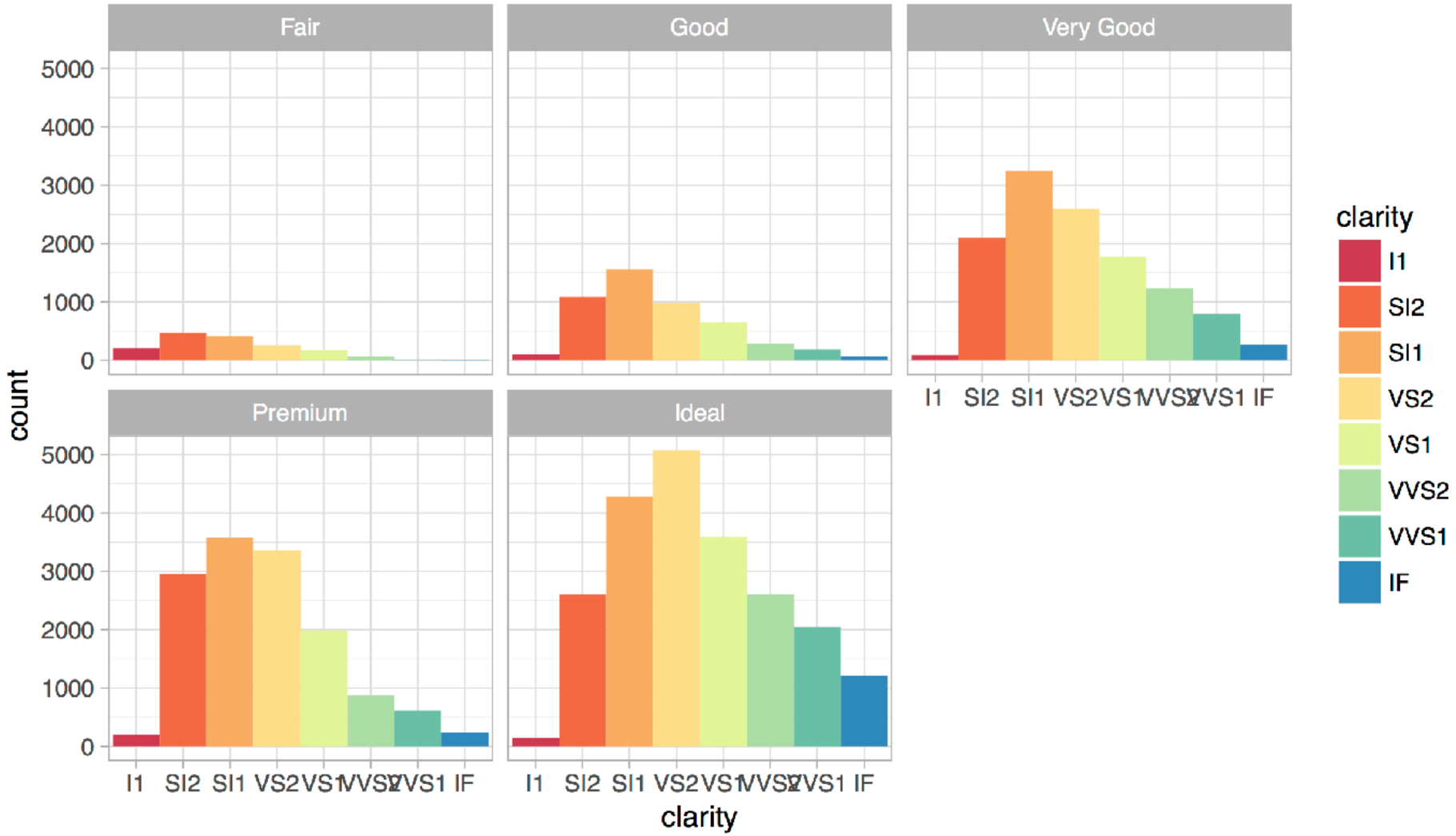
Scales

Customize color scales, other mappings

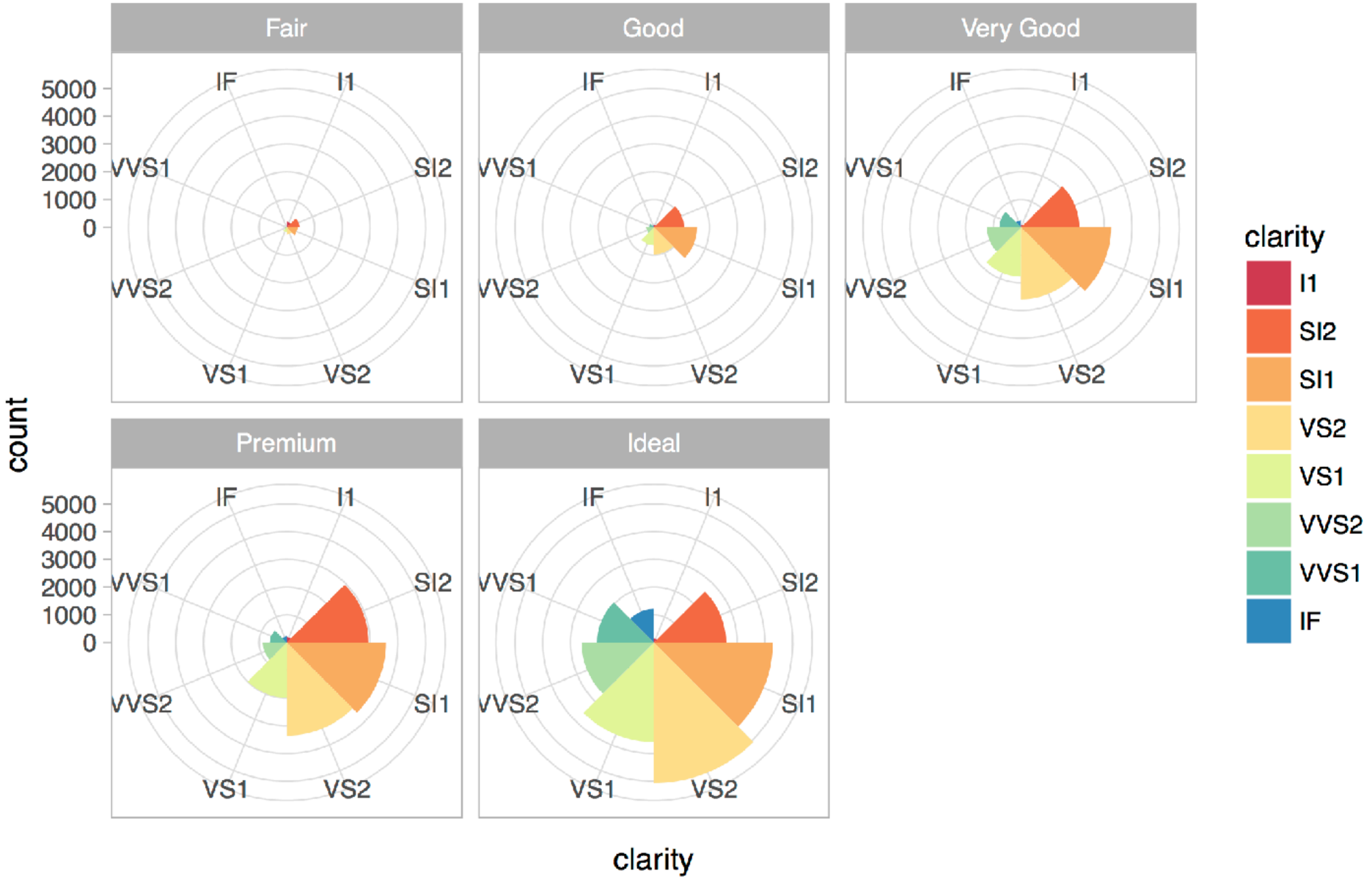


Facets

Subplots that display subsets of the data.



Coordinate systems



A ggplot2 template

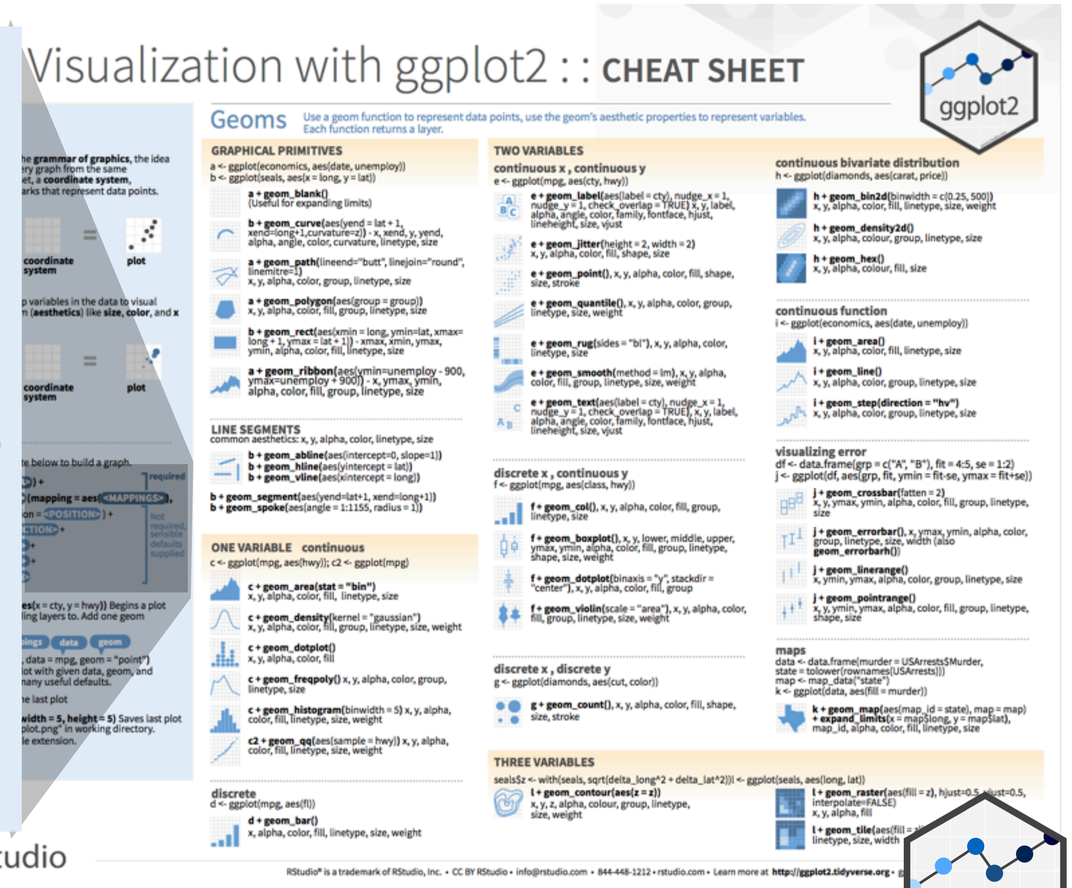
Make any plot by filling in the parameters of this template

Complete the template below to build a graph.

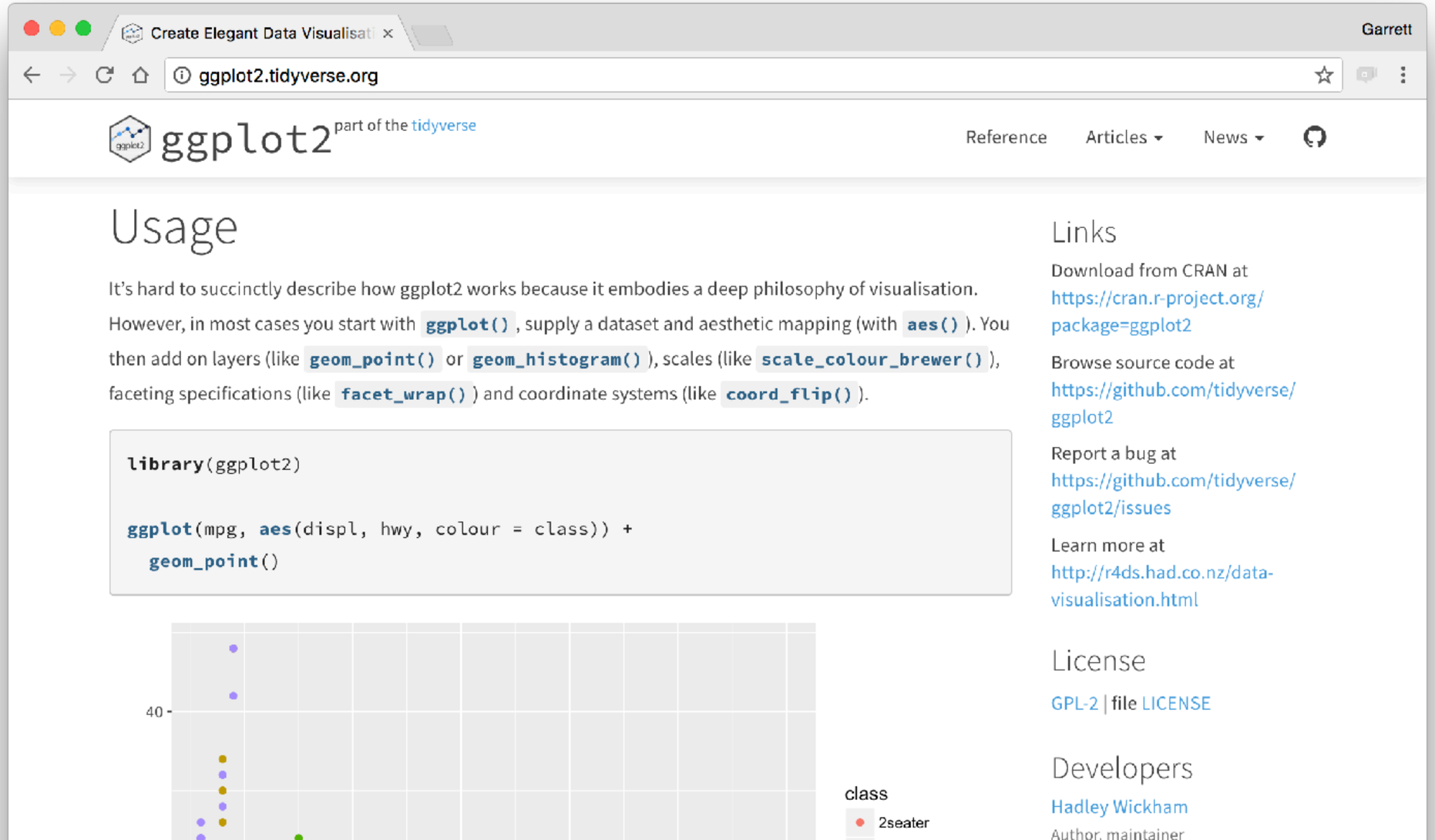
```
ggplot (data = <DATA>) +
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
 stat = <STAT> , position = <POSITION> ) +
<COORDINATE_FUNCTION> +
<FACET_FUNCTION> +
<SCALE_FUNCTION> +
<THEME_FUNCTION>
```

required

Not required, sensible defaults supplied



ggplot2.tidyverse.org



Visualize Data with