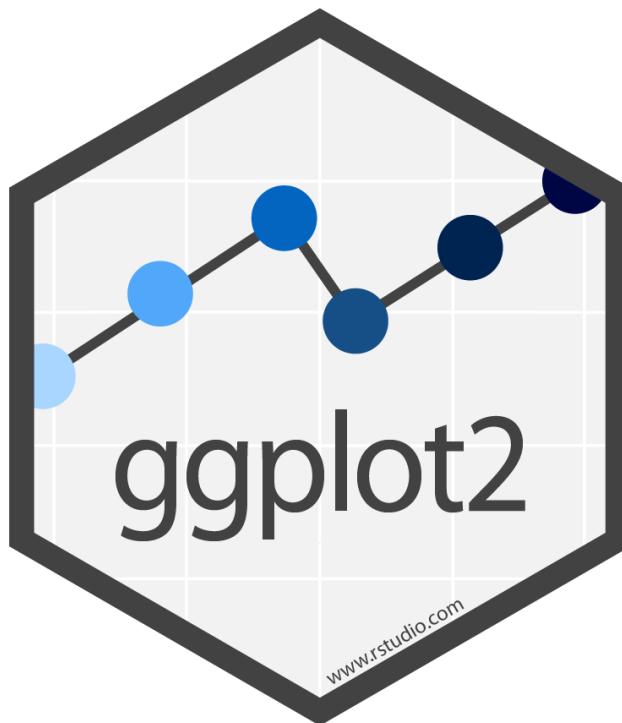


# Visualising Data with



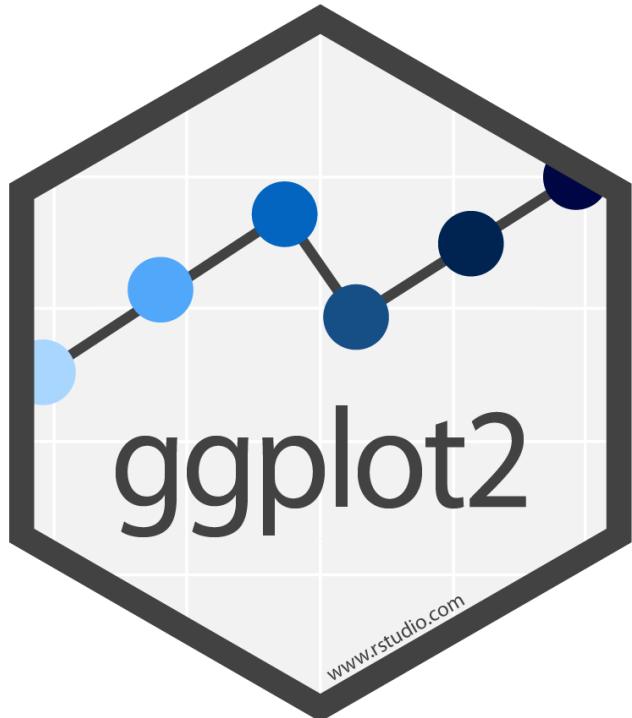
Adapted from “Explore the Tidyverse” CC by Hadley Wickham

# Why Visualise?

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

**- John Tukey**

# ggplot2



One of the earliest tidyverse packages.

Complex plots, by layering simple components.

# Your Turn

Open 01-Visualise.Rmd



I'm working on it



I'm stuck!



I'm done!

The screenshot shows the RStudio interface with the 'Files' tab selected. The current directory is 'Home > Desktop > data-science-in-tidyverse'. The file list includes:

|  | Name                                | Size   | Modified              |
|--|-------------------------------------|--------|-----------------------|
|  | ..                                  |        |                       |
|  | .gitignore                          | 47 B   | Mar 6, 2018, 9:48 AM  |
|  | 00-Getting-started.Rmd              | 1.3 KB | Mar 6, 2018, 10:28 AM |
|  | 01-Visualize.Rmd                    | 1.6 KB | Mar 6, 2018, 10:28 AM |
|  | 02-Transform.Rmd                    | 3.7 KB | Mar 6, 2018, 10:28 AM |
|  | 03-Tidy.Rmd                         | 2.6 KB | Mar 6, 2018, 10:28 AM |
|  | 04-Case-Study.Rmd                   | 5 KB   | Mar 6, 2018, 10:28 AM |
|  | 05-Data-Types.Rmd                   | 3.4 KB | Mar 6, 2018, 10:28 AM |
|  | 06-Iterate.Rmd                      | 2.9 KB | Mar 6, 2018, 10:28 AM |
|  | 07-Model.Rmd                        | 2.5 KB | Mar 6, 2018, 10:28 AM |
|  | 08-Organize.Rmd                     | 2 KB   | Mar 6, 2018, 10:28 AM |
|  | 99-Setup.md                         | 1.4 KB | Mar 6, 2018, 9:48 AM  |
|  | cheatsheets                         |        |                       |
|  | data-science-in-the-tidyverse.Rproj | 205 B  | Mar 6, 2018, 9:49 AM  |
|  | email-to-participants.md            | 2.7 KB | Mar 6, 2018, 9:48 AM  |
|  | README.md                           | 2.3 KB | Mar 6, 2018, 9:59 AM  |

# If you get lost or need to restart

```
01-Visualize.Rmd ×
ABC 🔎 Preview ⚙️ Insert ⚡ Run ⚡

1 - title: "Visualize Data"
2 - output: html_notebook
3 -
4 -
5 <-- This file by RStudio is taken from
6 https://github.com/rstudio/master-the-tidyverse and is licensed under
7 Creative Commons Attribution 4.0 International License. -->
8 `r setup::`library(tidyverse)`
9 `r setup::`library(ggplot2)
10 `r setup::`library(dplyr)
11 
12 `r`{r}
13 mpg
14 `r`{r}
15 
16 
17 ## Quiz
18 
19 What relationship do you expect to see between engine size (displ)
20 and highway fuel efficiency (hwy)?
21 
22 ## Your Turn 1
23 
24 Run the code on the slide to make a graph. Pay strict attention to
25 spelling, capitalization, and parentheses!
26 
27 `r`{r}
```

Check you are in the right file

# If you get lost or need to restart

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3 output: html_notebook  
4 ---  
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6 <!-- This file by RStudio is taken from  
7 https://github.com/rstudio/master-the-tidyverse and is licensed under  
8 a Creative Commons Attribution 4.0 International License. -->  
9  
10 ```{r setup}  
11 library(tidyverse)  
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13 ````{r}  
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15 ` Visualize Data  
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17 # Chunk 2  
18 Quiz  
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21 # Your Turn 2  
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565 Your Turn 683  
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567 Your Turn 684  
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569 Your Turn 685  
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561 Your Turn 686  
562  
563 Your
```

# If you get lost or need to restart

```
01-Visualize.Rmd x
ABC Preview Insert Run
15 ``
16
17 ## Quiz
18
19 What relationship do you expect to see between engine size (displ)
and highway fuel efficiency (hwy)?
20
21 ## Your Turn 1
22
23 Run the code on the slide to make a graph. Pay strict attention to
spelling, capitalization, and parentheses!
24
25 ``{r}
26
27 ``
28
29
30 ## Your Turn 2
31
32 Add `color`, `size`, `alpha`, and `shape` aesthetics to your graph.
Experiment.
33
34 ``{r}
35 ggplot(data = mpg) +
36   geom_point(mapping = aes(x = displ, y = hwy))
37 ``
38
39 ## Your Turn 3
40
41 Replace this scatterplot with one that draws boxplots. Use the
cheatsheet. Try your best guess.
21:1 # Your Turn 1 R Markdown
```

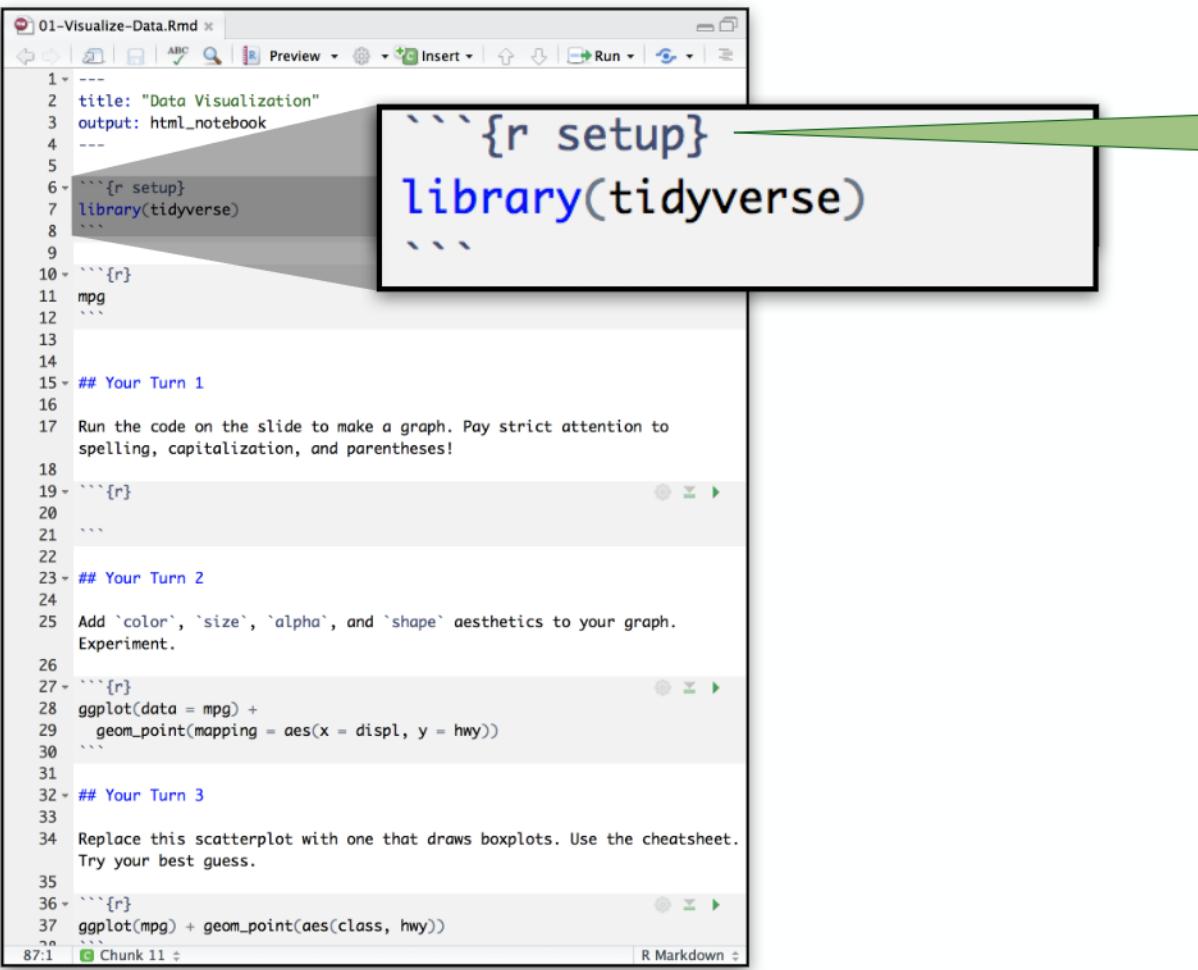
Click to run all  
chunks before this  
one.



You should be ready  
to go.

# Setup

The setup chunk is always run once before anything else



A screenshot of the RStudio interface showing an R Markdown file titled "01-Visualize-Data.Rmd". The code editor displays the following content:

```
1 ---  
2 title: "Data Visualization"  
3 output: html_notebook  
4 ---  
5  
6 ```{r setup}  
7 library(tidyverse)  
8 ```  
9  
10 ````{r}  
11 mpg  
12  
13  
14  
15 ## Your Turn 1  
16  
17 Run the code on the slide to make a graph. Pay strict attention to  
spelling, capitalization, and parentheses!  
18  
19 ````{r}  
20  
21  
22  
23 ## Your Turn 2  
24  
25 Add `color`, `size`, `alpha`, and `shape` aesthetics to your graph.  
Experiment.  
26  
27 ````{r}  
28 ggplot(data = mpg) +  
29   geom_point(mapping = aes(x = displ, y = hwy))  
30  
31  
32 ## Your Turn 3  
33  
34 Replace this scatterplot with one that draws boxplots. Use the cheatsheet.  
Try your best guess.  
35  
36 ````{r}  
37 ggplot(mpg) + geom_point(aes(class, hwy))
```

A callout bubble points to the line `library(tidyverse)` with the text "(optional) label for chunk".



# 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!

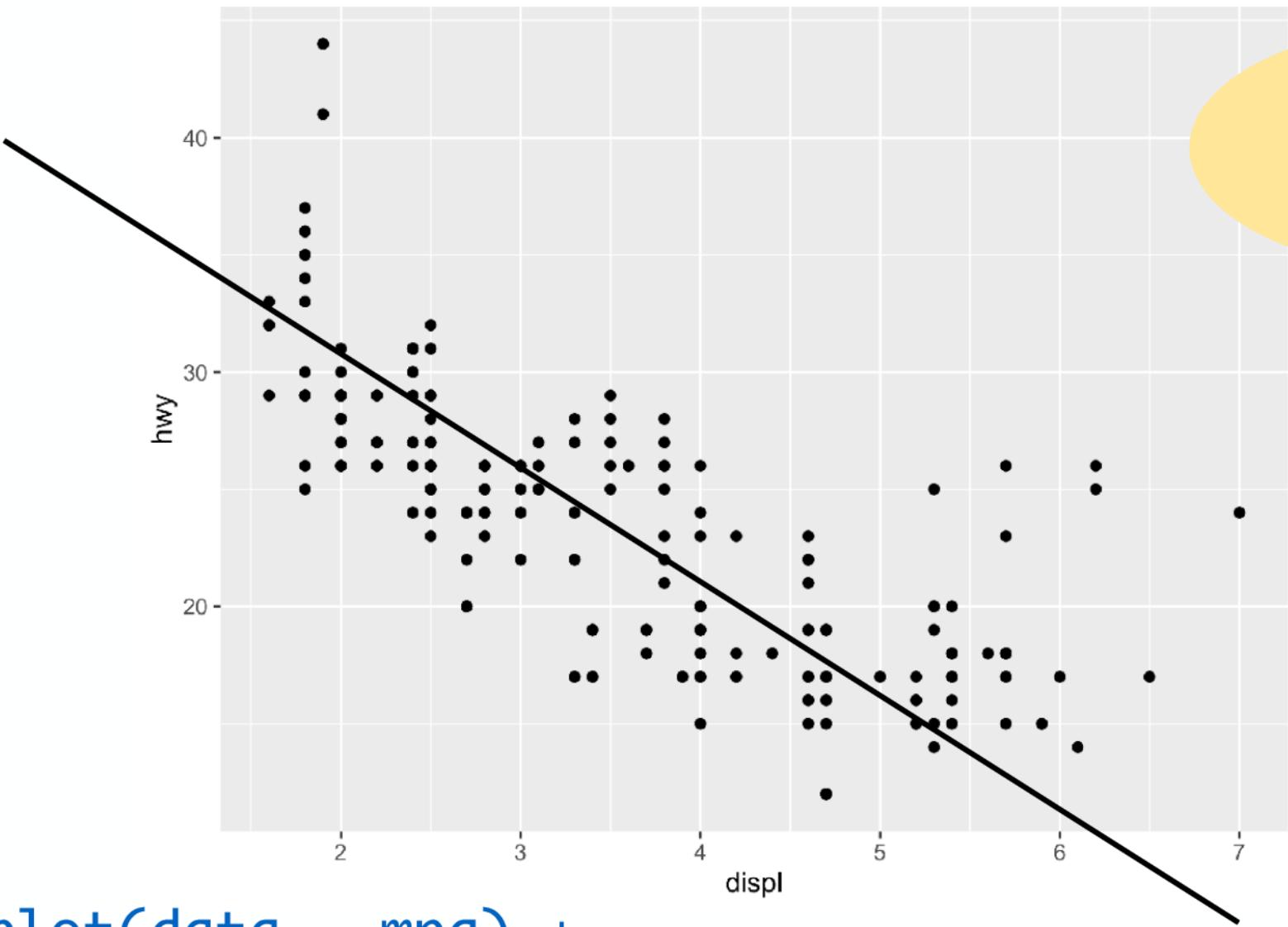
```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy))
```

I'm working on it

I'm stuck!

I'm done!





What do you think  
about the line of  
best fit?

```
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))
```



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

data

+ before new line

type of layer

aes()

x variable

y variable

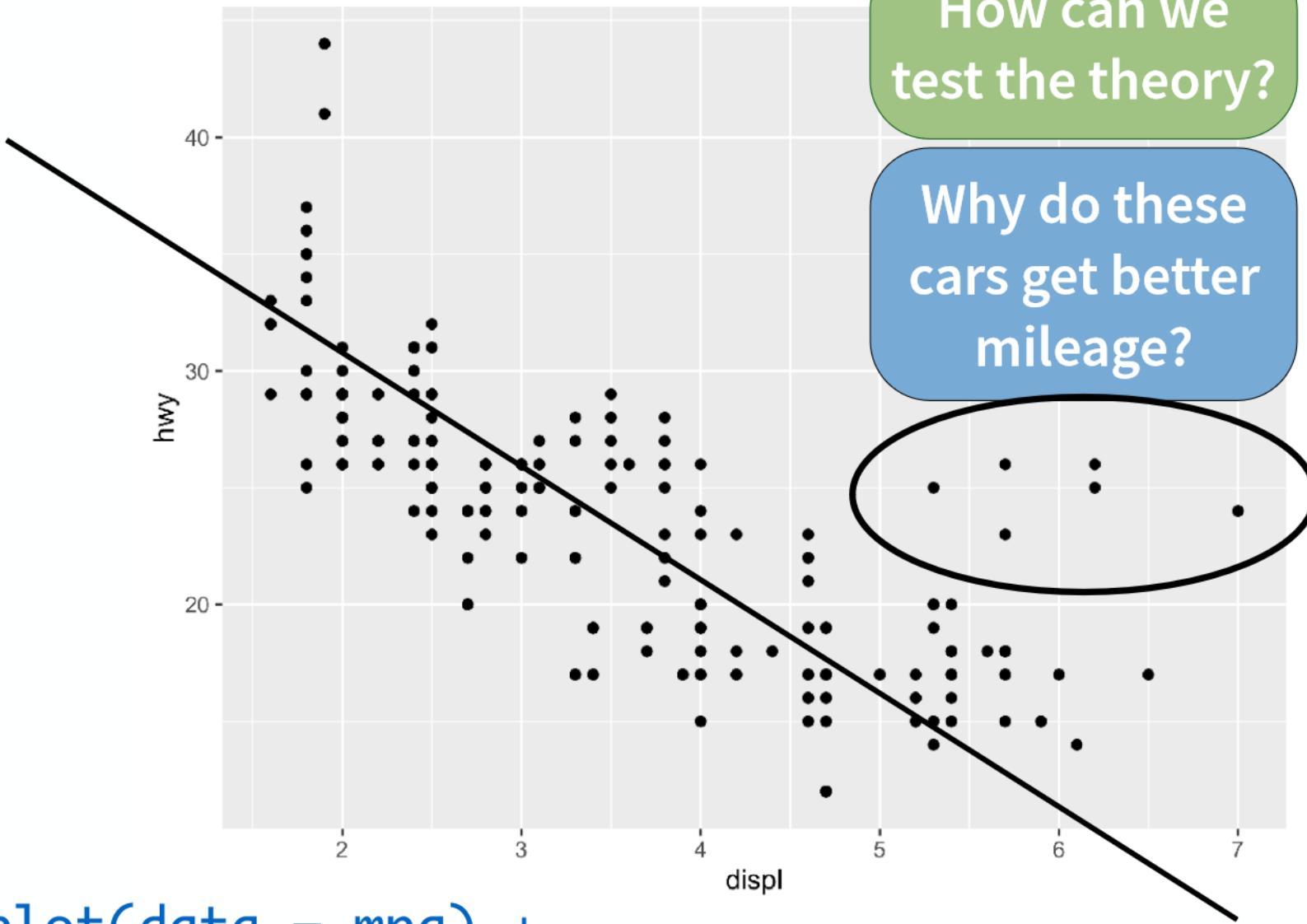


# A Template

```
ggplot(data = <DATA>) +  
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>))  
  
geom_point(mapping = aes(x = displ, y = hwy))
```



# Mappings



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

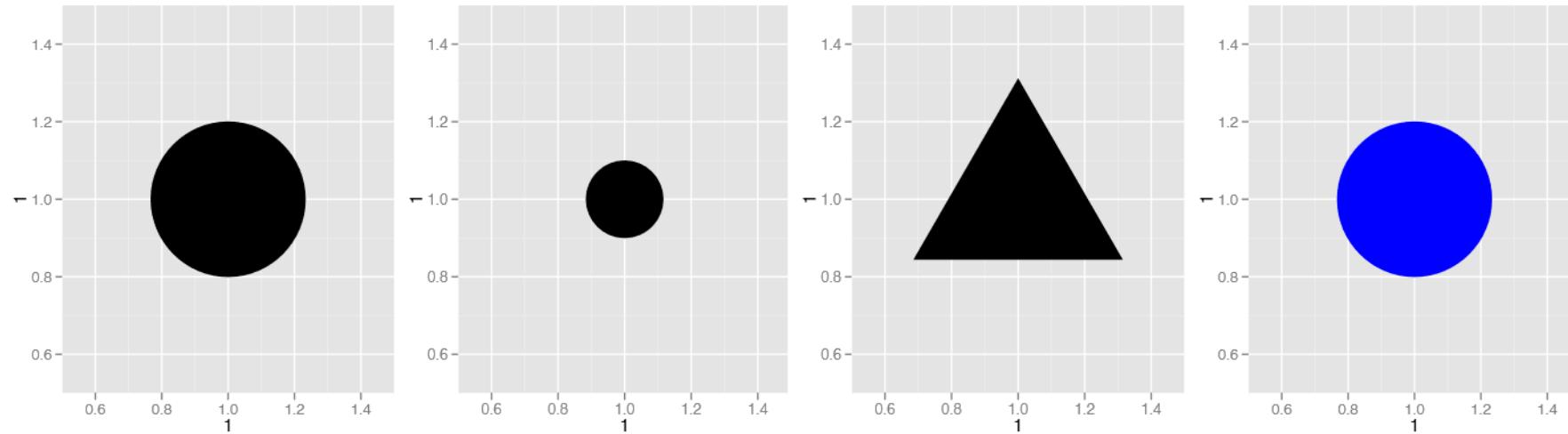
How can we  
test the theory?

Why do these  
cars get better  
mileage?



# 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

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

aesthetic  
property

Variable to  
map it to

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



# Aesthetics

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

aesthetic  
property

Variable to  
map it to

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



# Aesthetics

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

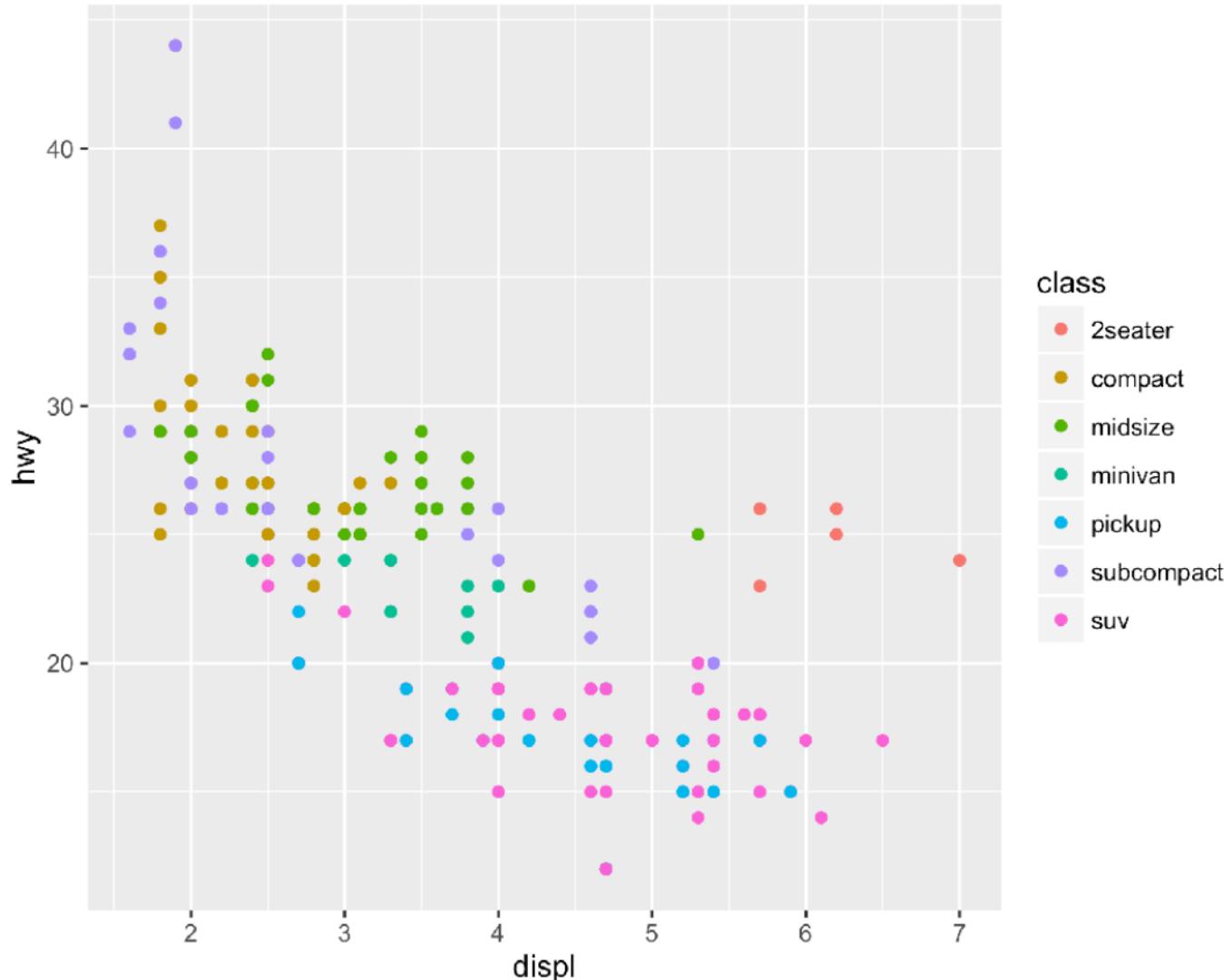
aesthetic  
property

Variable to  
map it to

```
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

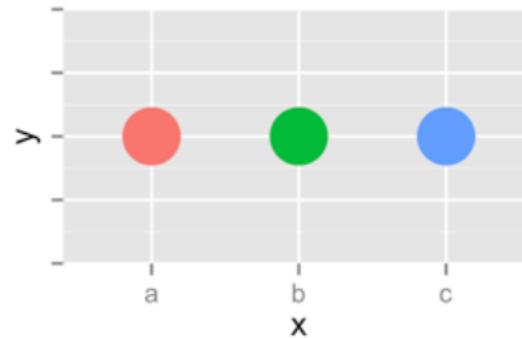
In the next chunk, add color, size, alpha, and shape aesthetics to your graph. Experiment.

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



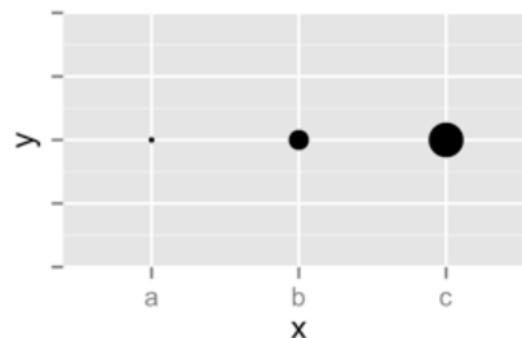
Color

Discrete

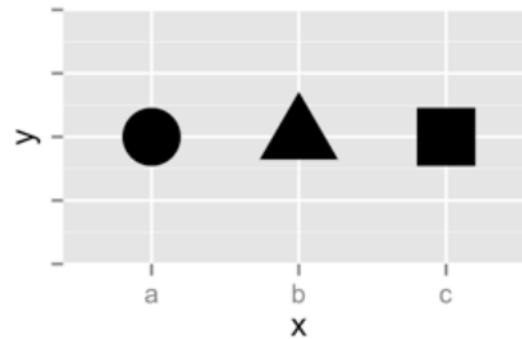


Size

Continuous

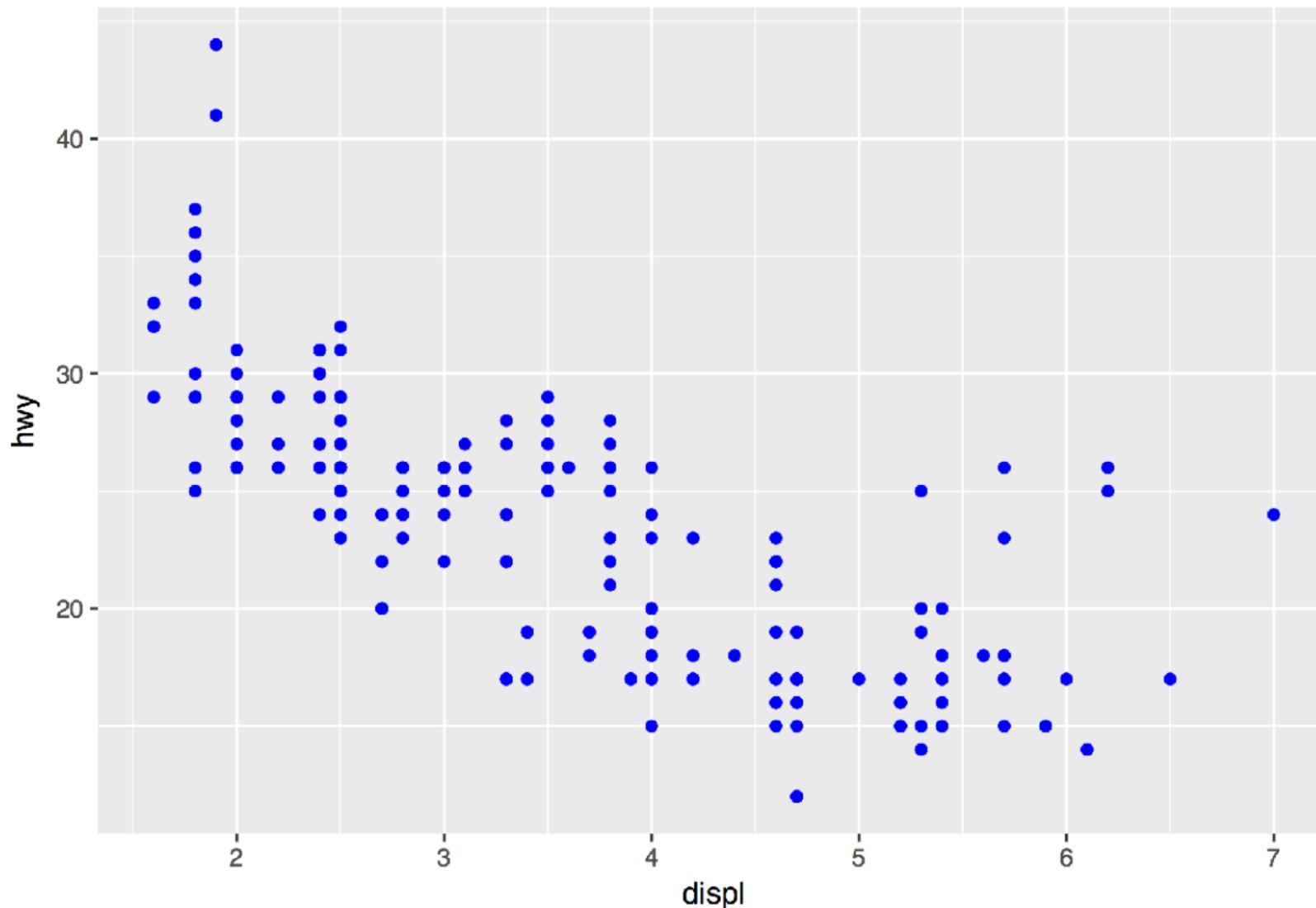


Shape

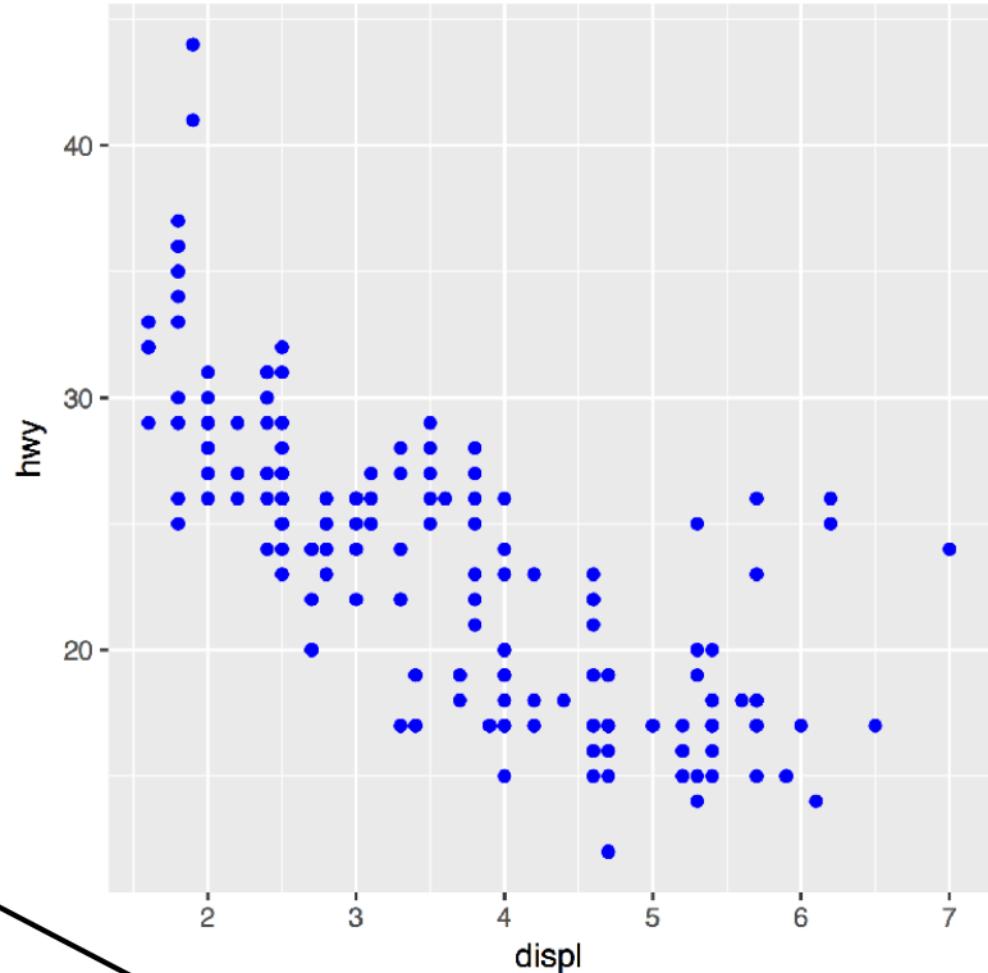


# Setting vs. Mapping an aesthetic

# How would you make this plot?

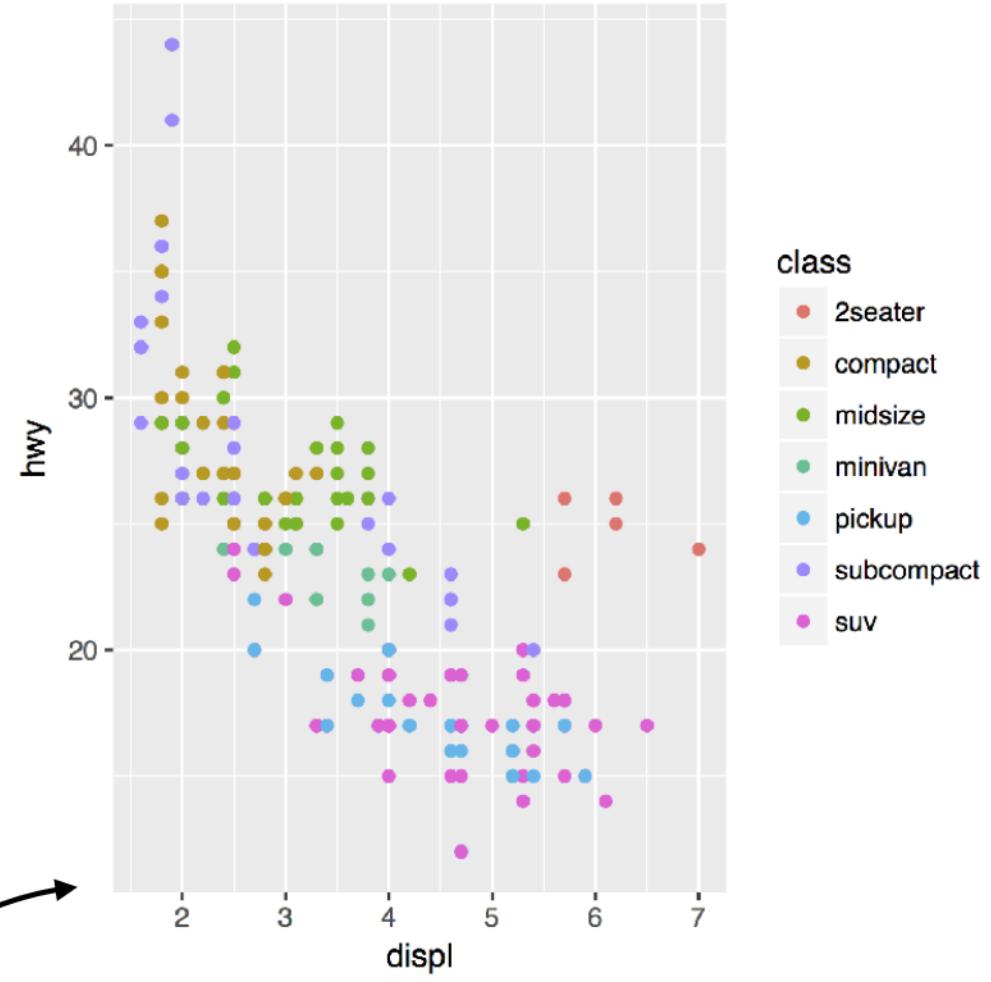


**Outside of aes():** sets  
an aesthetic to a value



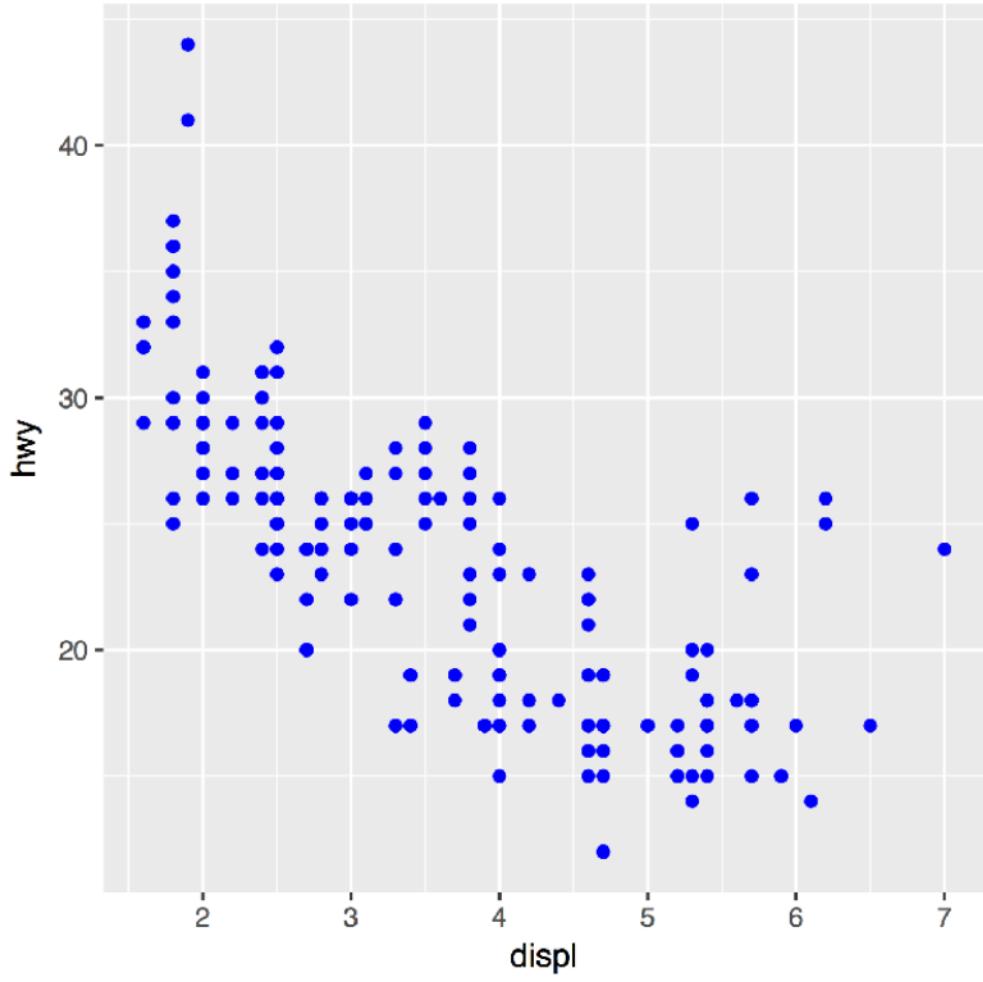
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = class))
```

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



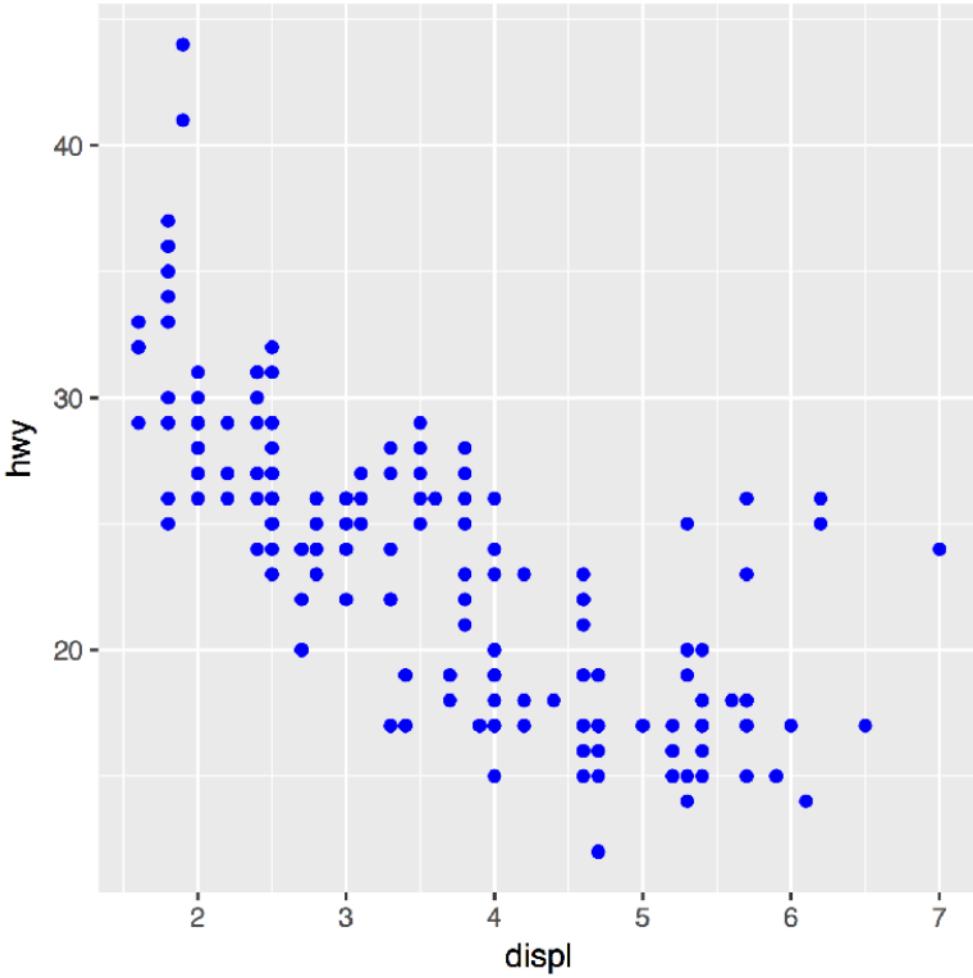
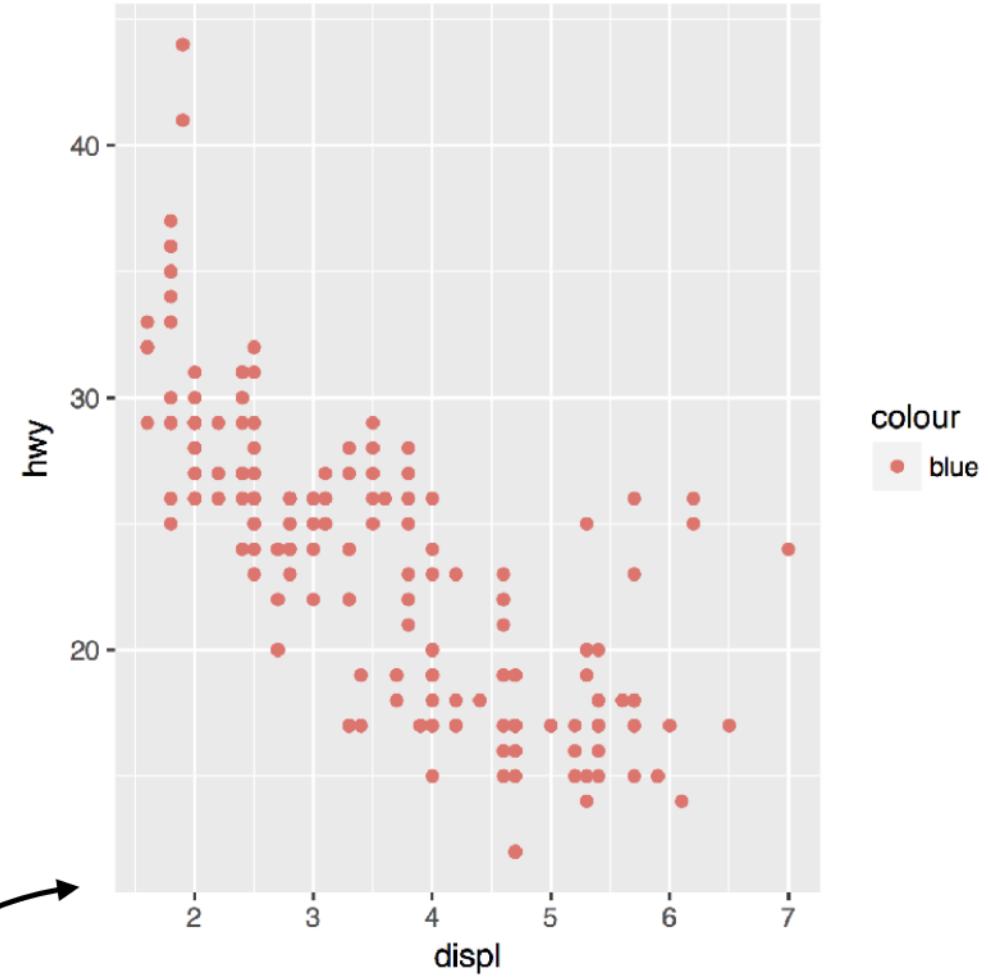
class

- 2seater
- compact
- midsize
- minivan
- pickup
- subcompact
- suv



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

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



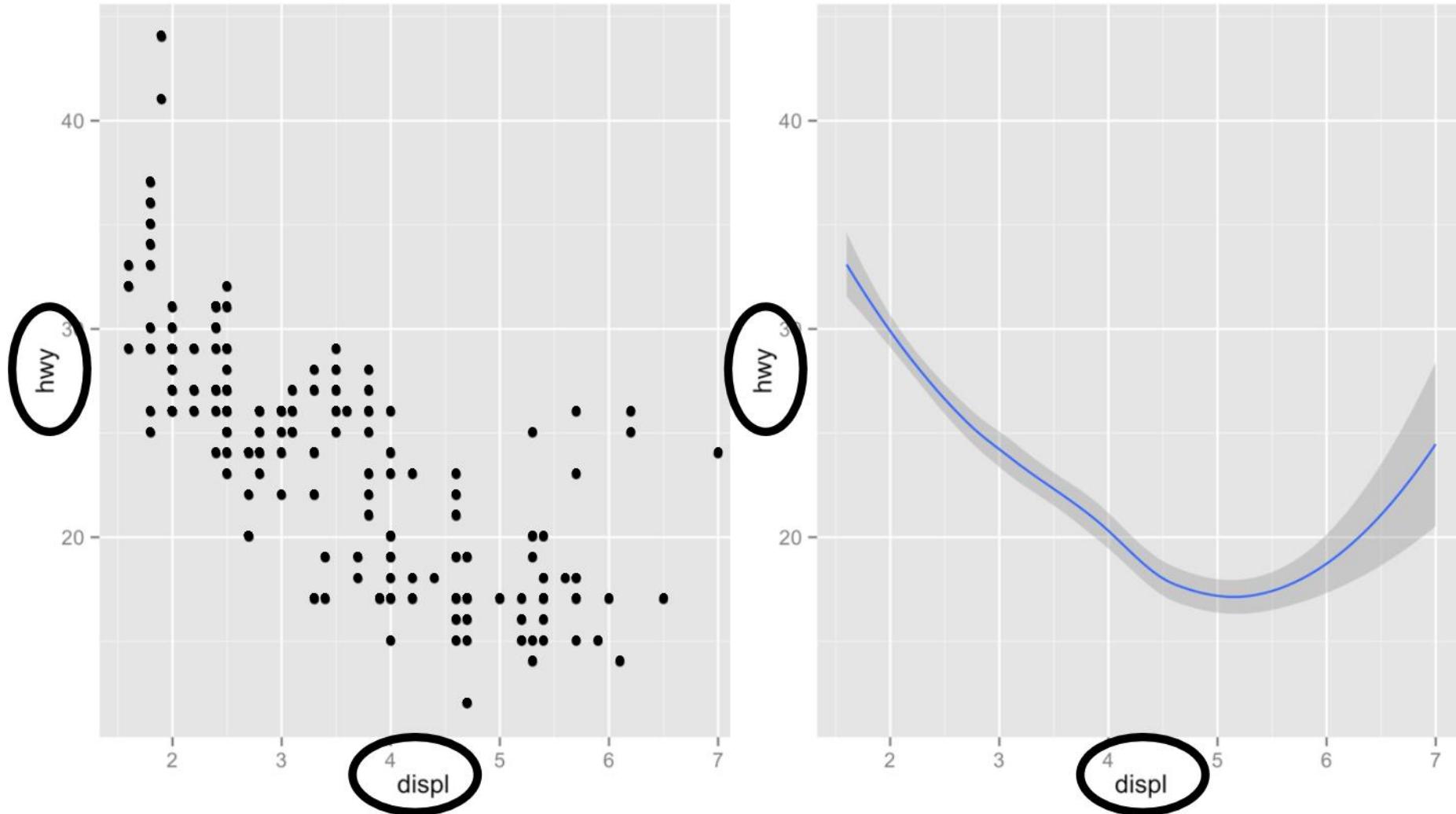
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = "blue"))
```

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

# Geoms

How are these plots similar?

How are they different?



# geoms

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



# Every geom requires a mapping argument.

Data Visualization with ggplot2 :: CHEAT SHEET



R Studio

# geom\_functions

## 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 = 2)) -> x, xend, y, yend,
alpha, angle, color, curvature, linetype, size
a + geom_path(lineend = "butt", linejoin = "round",
linemiter = 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)) -> x, ymax, xmin, ymax,
ymin, alpha, color, fill, linetype, size
a + geom_ribbon(aes(ymin = unemploy - 900,
ymax = unemploy + 900))
x, ymax, ymn, 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(aesthetics = list(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(binaxis = "y", stackdir =
"center")
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
```

### 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, alpha, color, family, fontface, hjust,
lineheight, size, vjust
e + geom_linerange(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, 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, size, weight
f + geom_dotplot(binaxis = "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
```

ggplot2

### 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, color, group, linetype, size
h + geom_hex()
x, y, alpha, color, fill, size
```

### continuous function

```
i <- ggplot(economics, aes(date, unemploy))
i + geom_area()
x, y, alpha, color, fill, linetype, size
i + geom_line()
x, y, alpha, color, group, linetype, size
i + geom_step(direction = "hv")
x, y, alpha, color, group, linetype, size
```

### visualizing error

```
df <- data.frame(grp = c("A", "B"), fit = 4.5, se = 1.2)
j <- ggplot(df, aes(grp, fit, ymin = fit - se, ymax = fit + se))
j + geom_crossbar(fatten = 2)
x, y, ymn, ymx, alpha, color, fill, group, linetype, size
j + geom_errorbar()
x, y, ymn, ymx, alpha, color, group, linetype, size, width (also
geom_errorbarh())
j + geom_linerange()
x, ymn, ymx, alpha, color, group, linetype, size
j + geom_pointrange()
x, y, ymn, ymx, alpha, color, fill, group, linetype, size
```

### maps

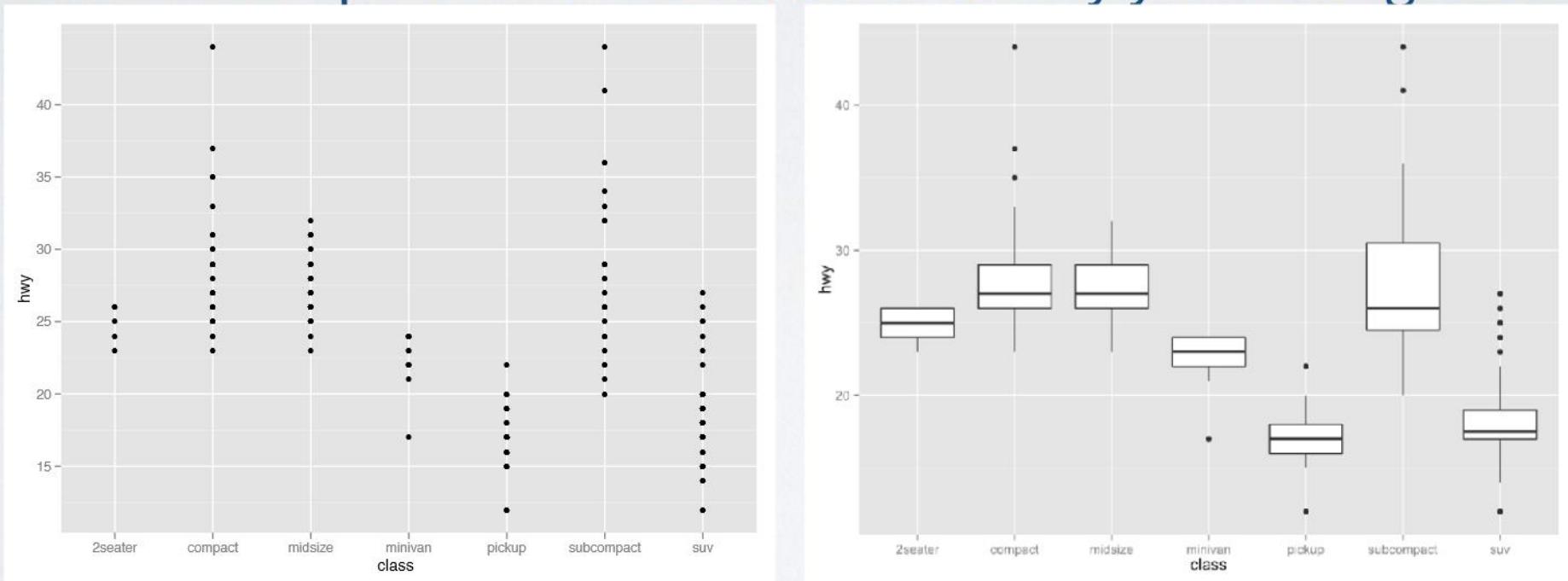
```
data <- data.frame(murder = USArrests$Murder,
state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))
k + geom_map(aes(map_id = state), map = map)
+ expand_limits(x = map$long, y = map$lat),
map_id, alpha, color, fill, linetype, size)
```

### THREE VARIABLES

```
sealsSz <- with(seals, sqrt(delta_long^2 + delta_lat^2))
l <- ggplot(seals, aes(long, lat))
l + geom_point(size = sealsSz)
l + geom_text(aes(label = state))
l + geom_rect(xmin = -1, xmax = 2.5, ymin = -2.5,
```

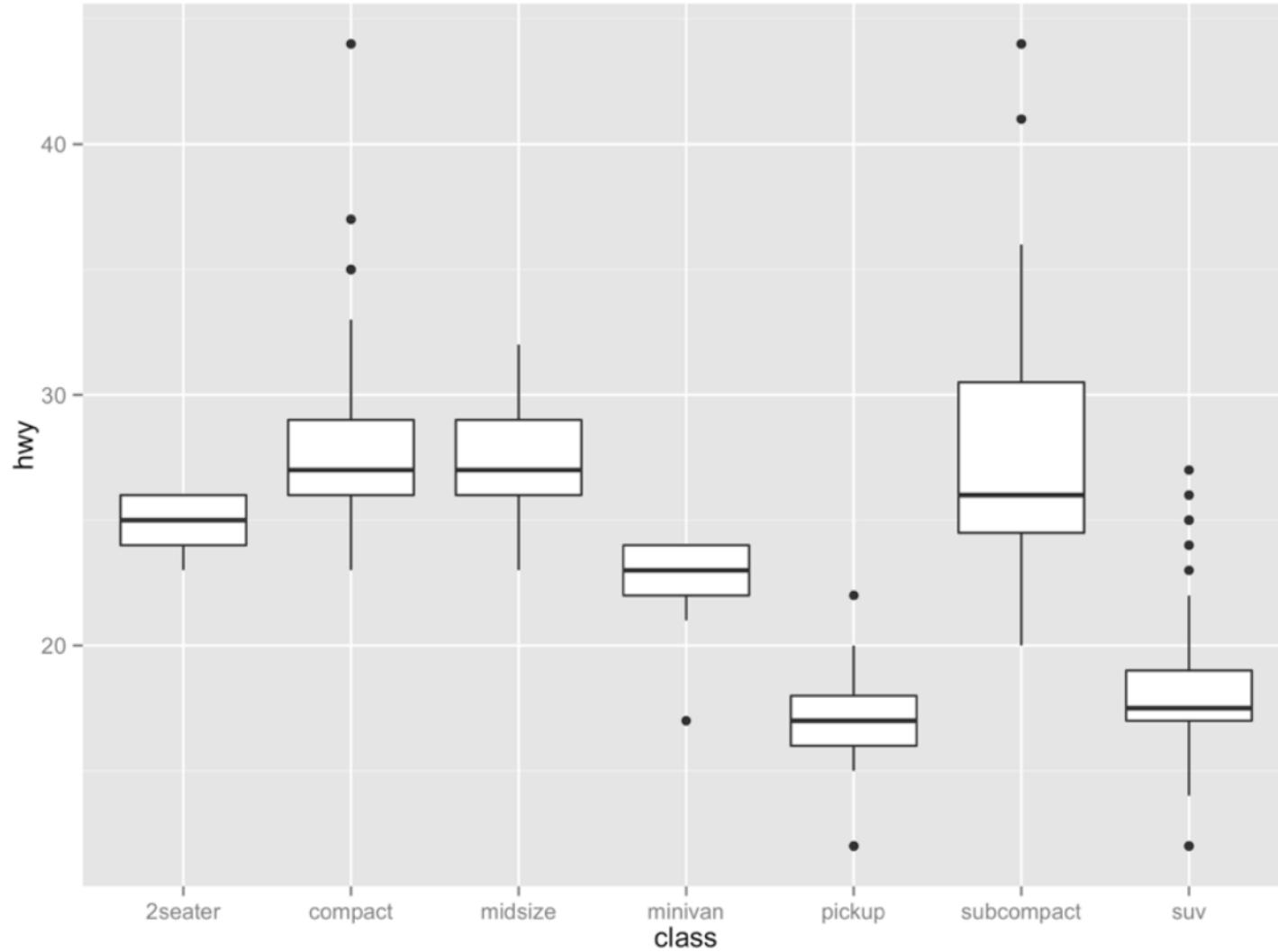
# Your Turn 3

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))`

02 : 00

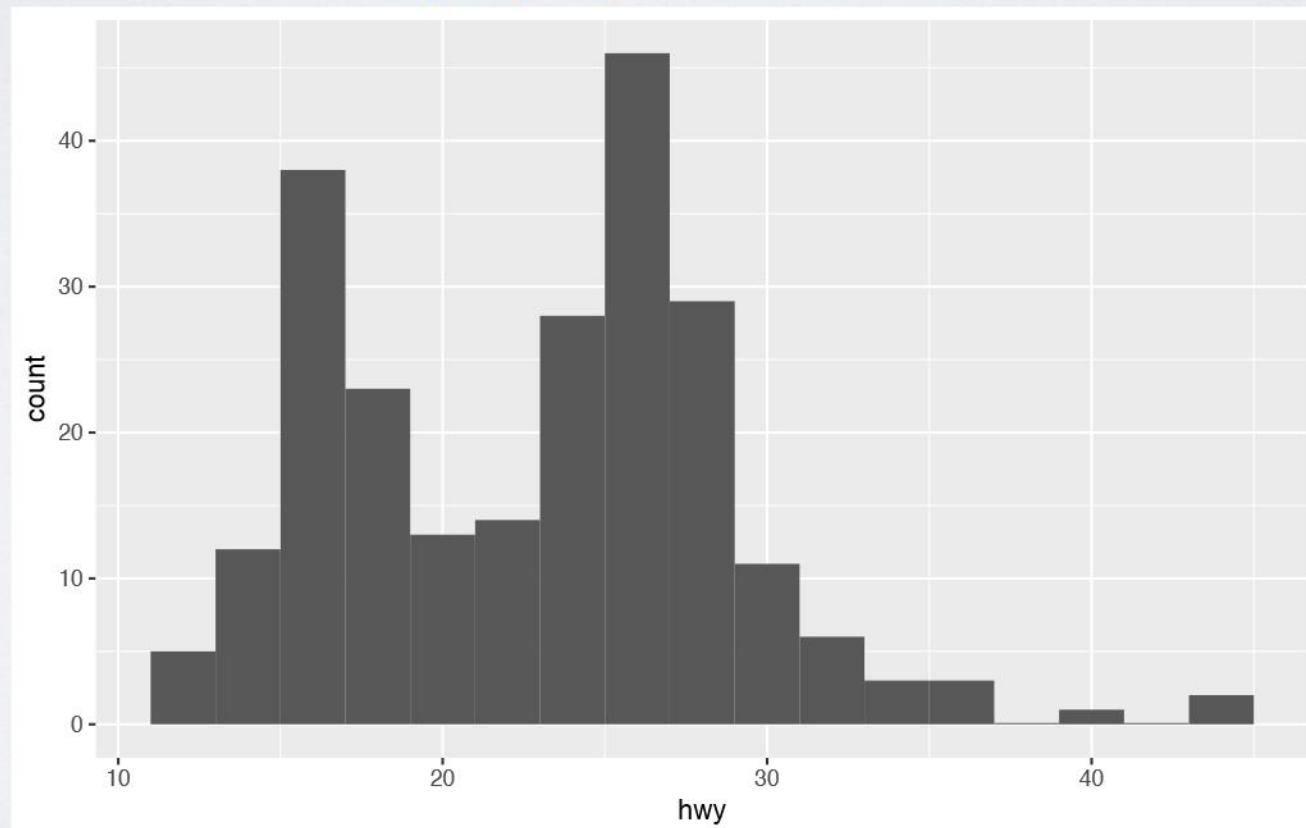


```
ggplot(data = mpg) +  
  geom_boxplot(mapping = aes(x = class, y = hwy))
```

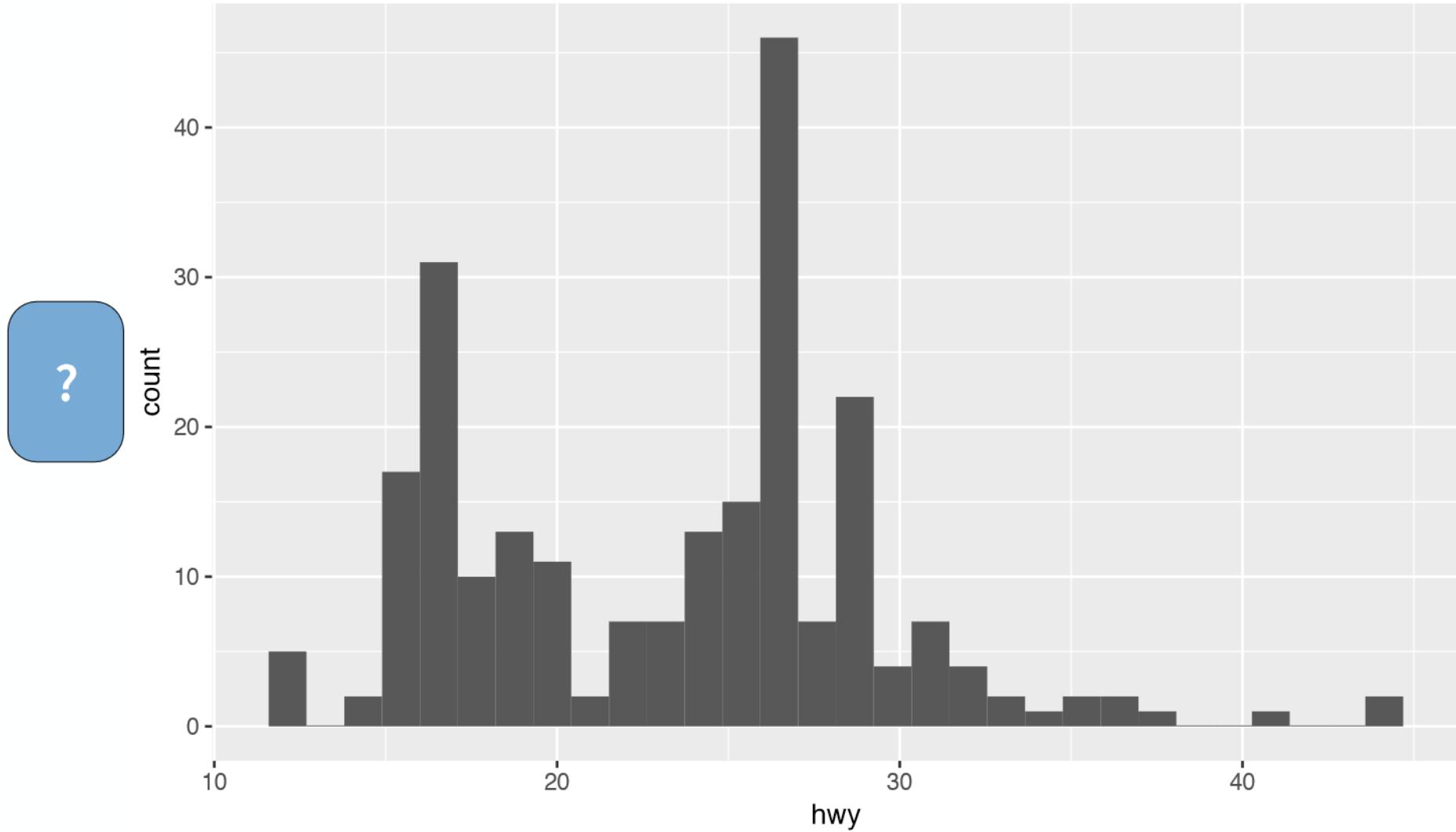


# Your Turn 4

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



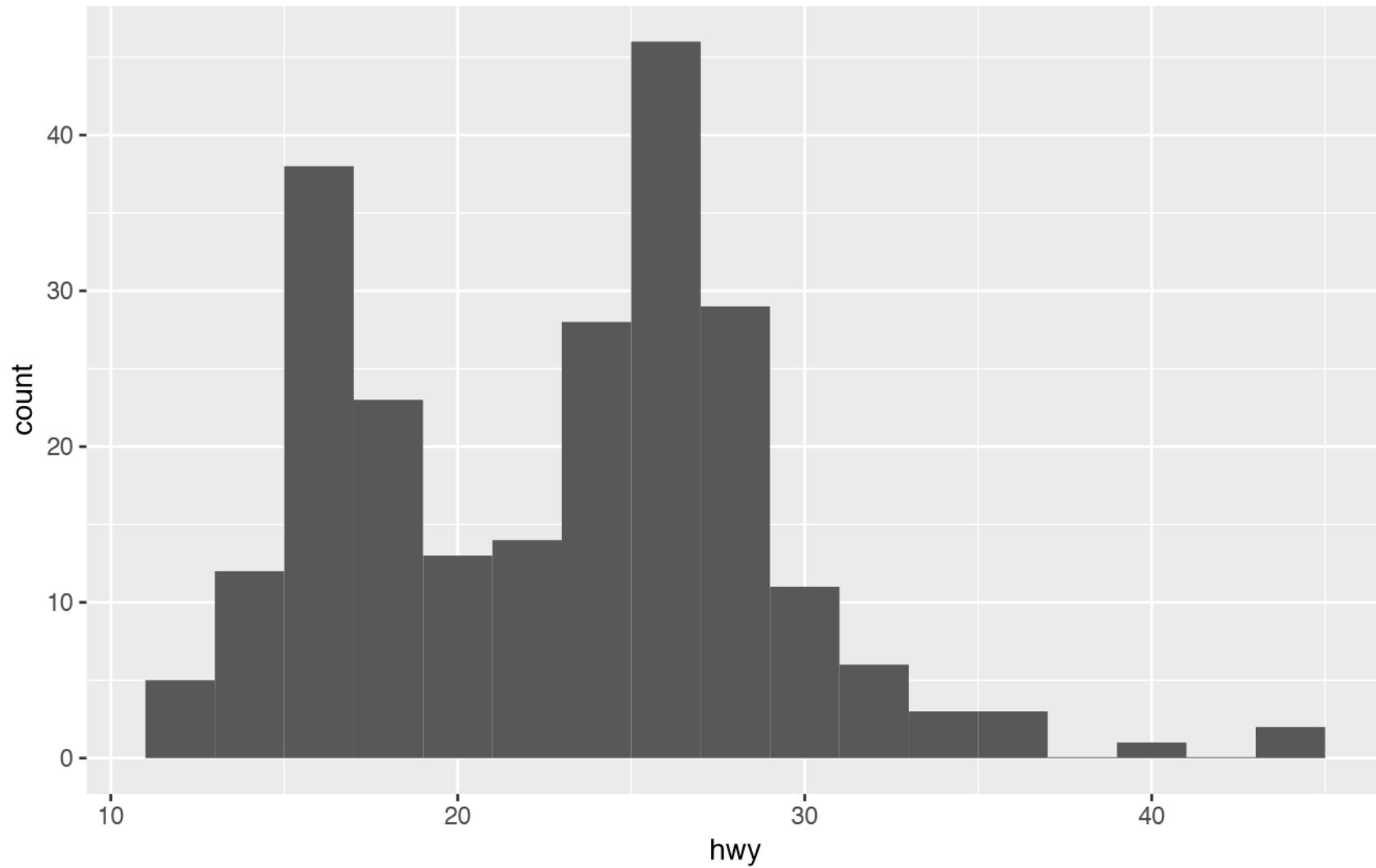
02 : 00



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

No y aesthetic

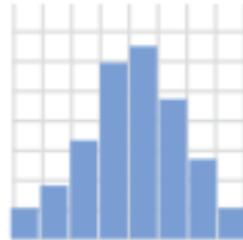




```
ggplot(data = mpg) +  
  geom_histogram(mapping = aes(x = hwy), binwidth = 2)
```



On the cheatsheat:



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

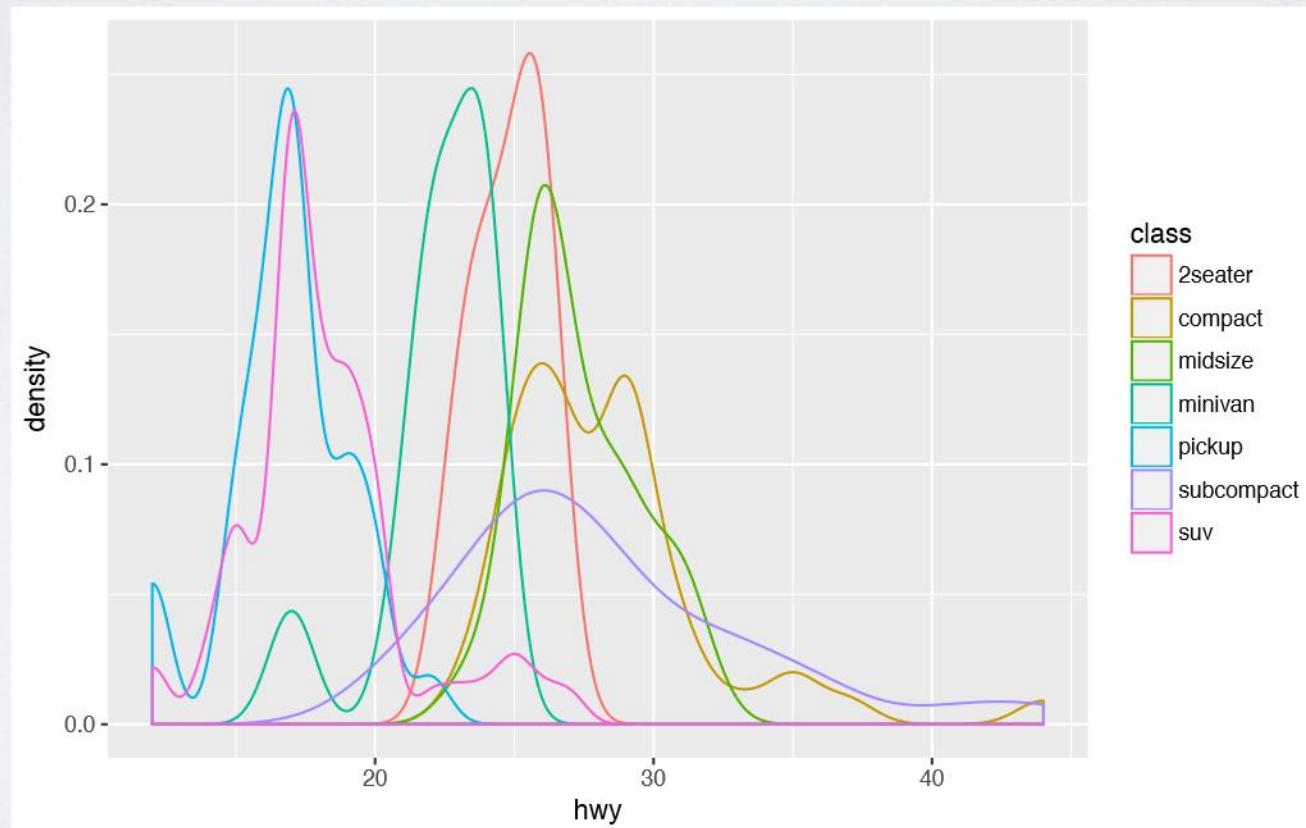
Arguments inside (), are  
geom specific options

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

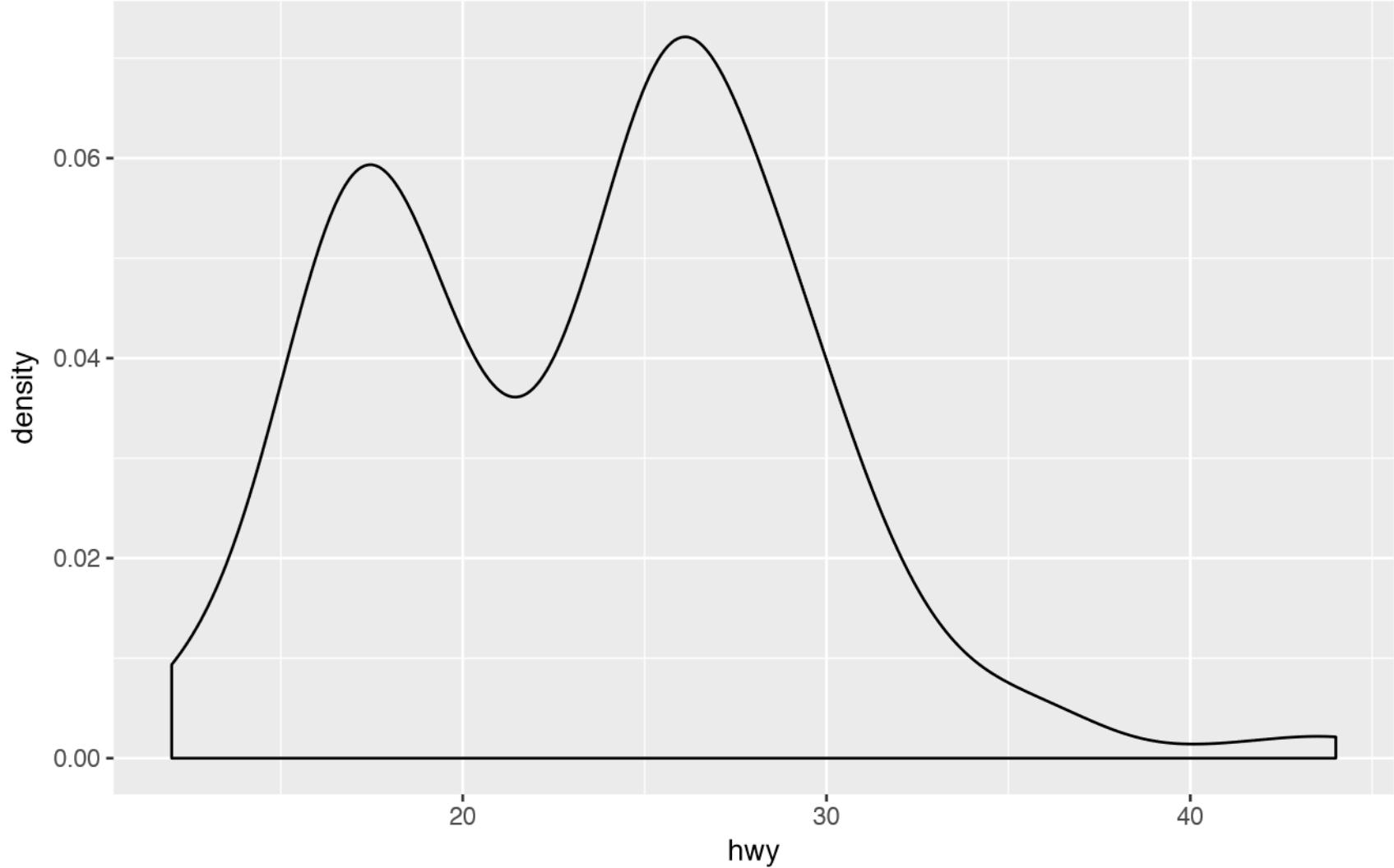


# Your Turn 5

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

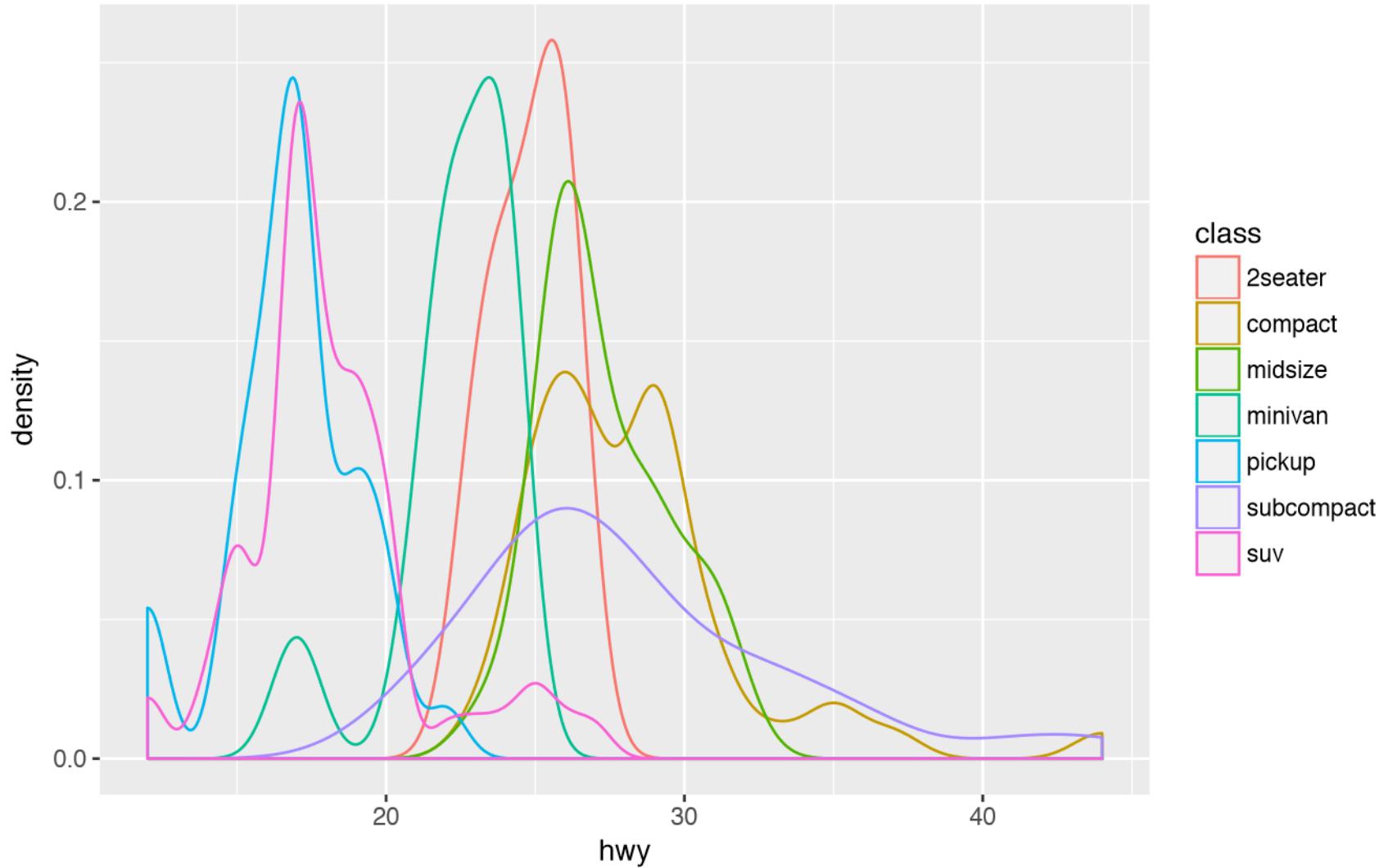


02 : 00

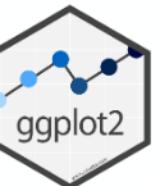


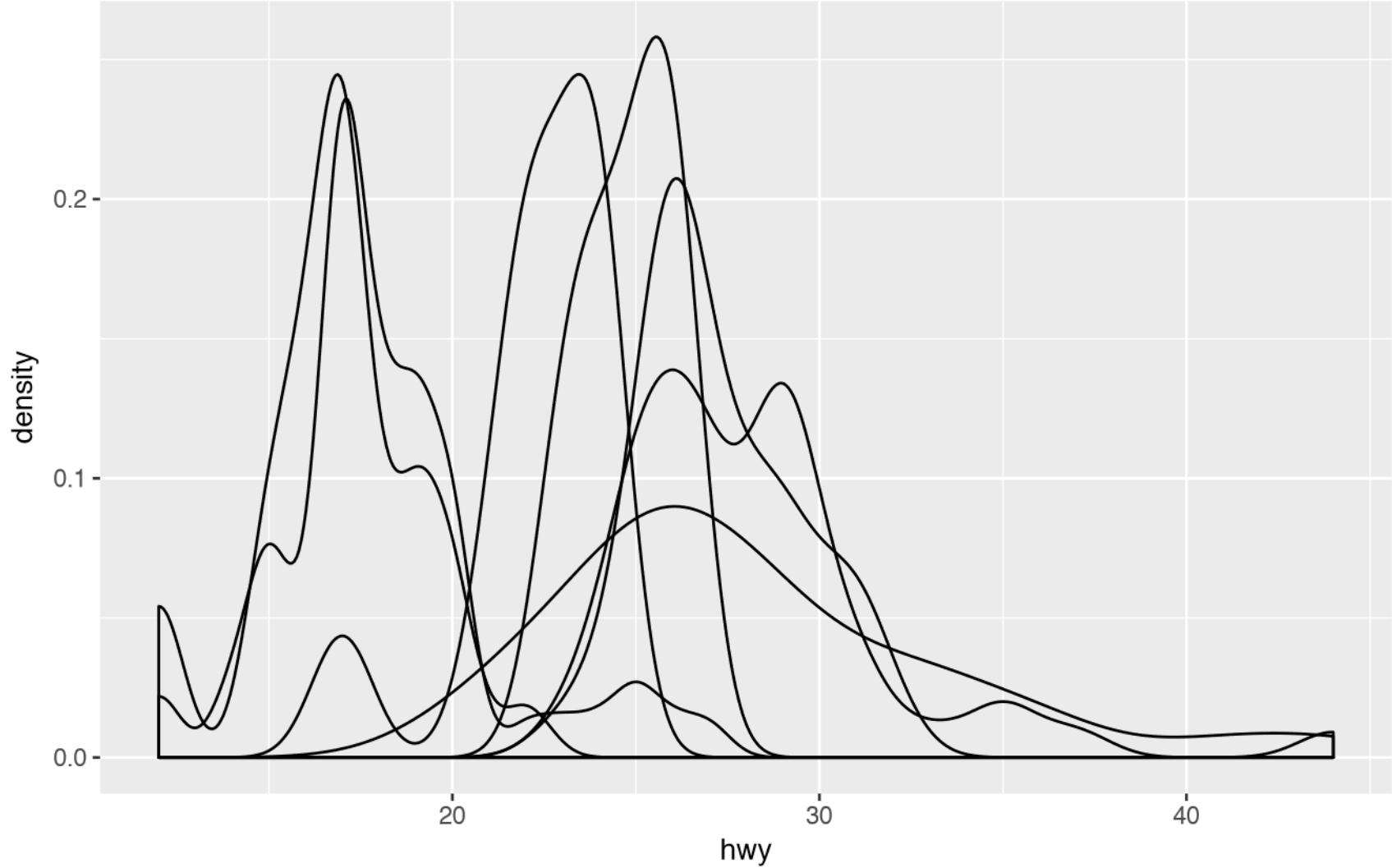
```
ggplot(data = mpg) +  
  geom_density(mapping = aes(x = hwy))
```





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



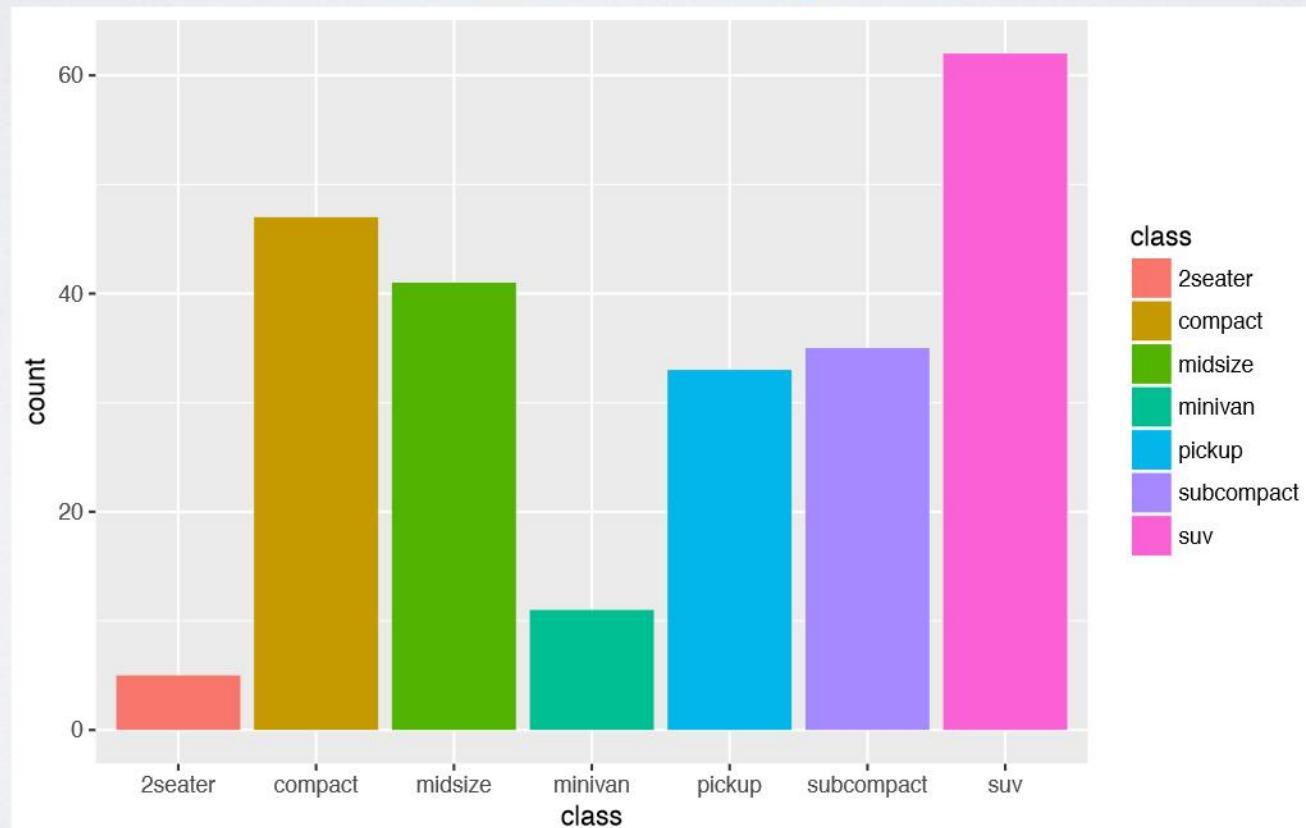


```
ggplot(data = mpg) +  
  geom_density(mapping = aes(x = hwy, group = class))
```

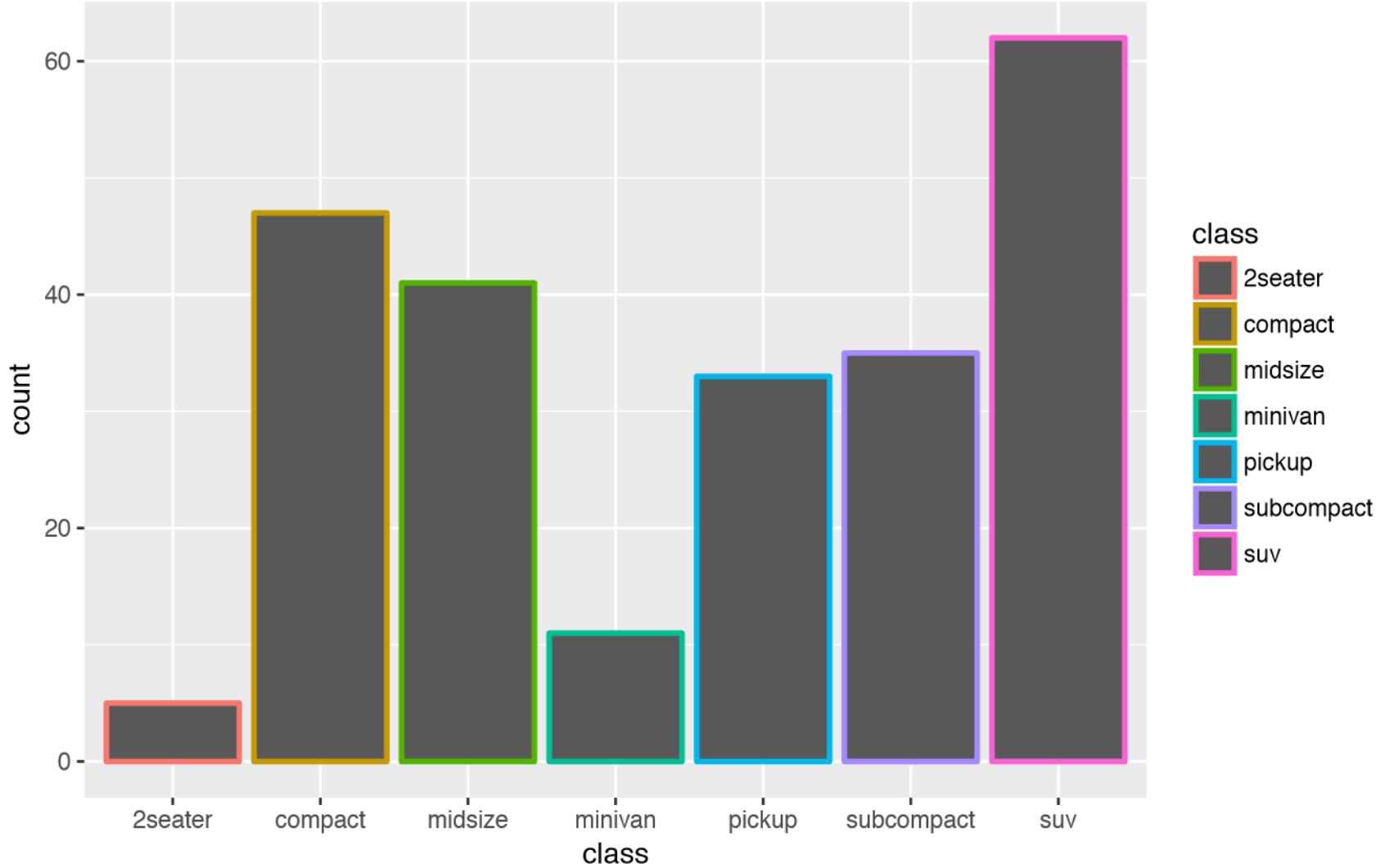


# Your Turn 6

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

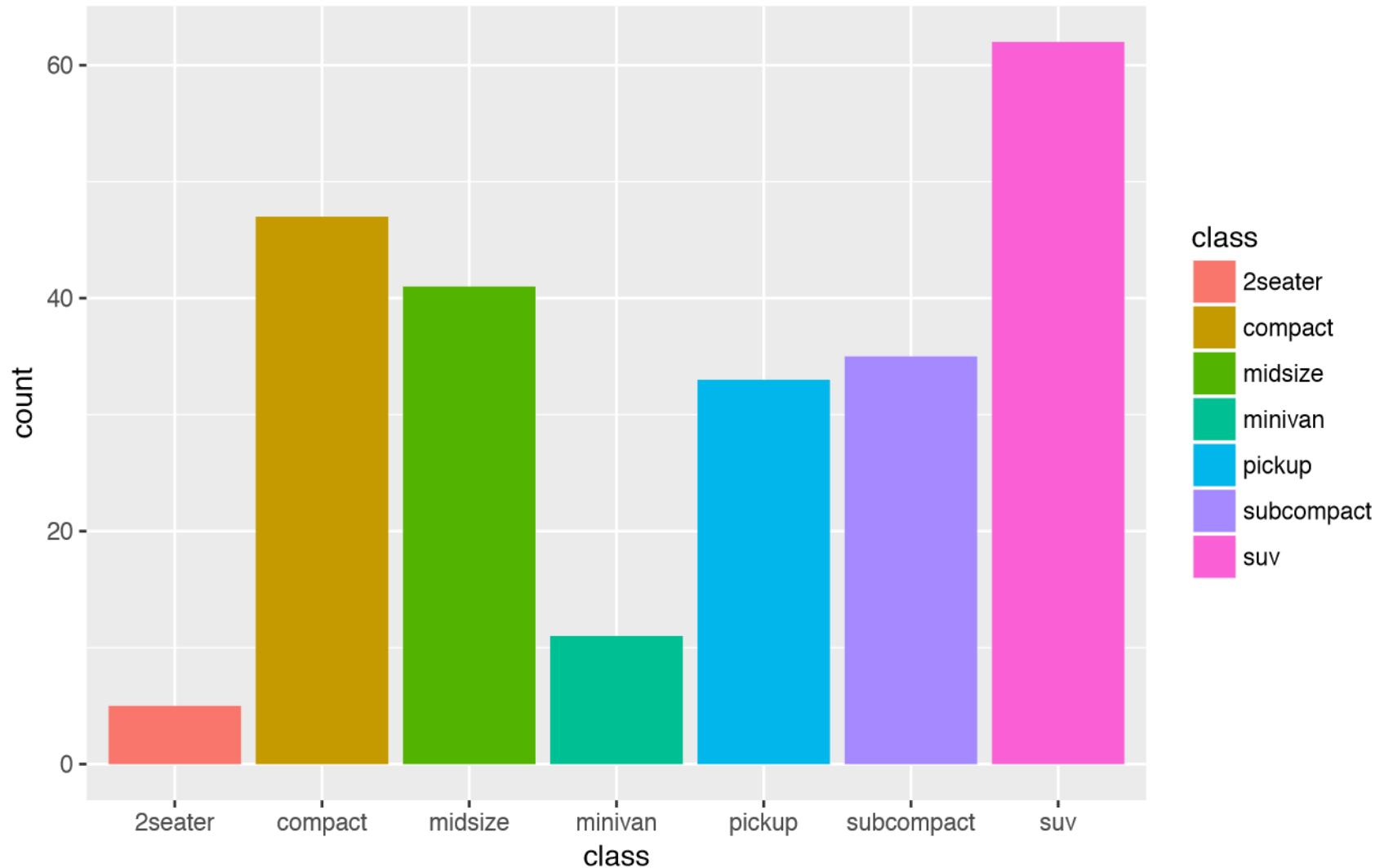


02 : 00



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





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

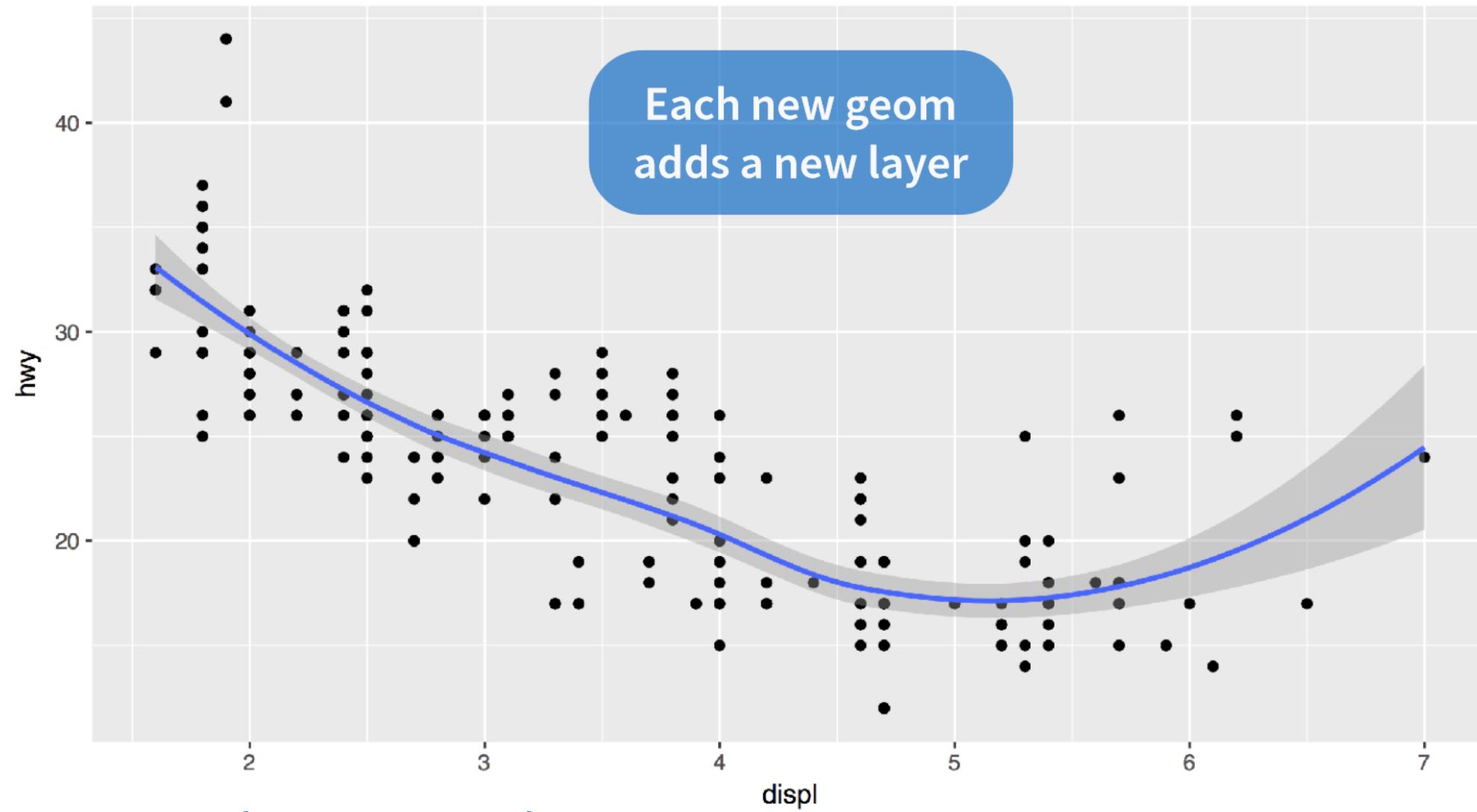


# Your Turn 7

With your partner, predict what this code will do.  
Then run it.

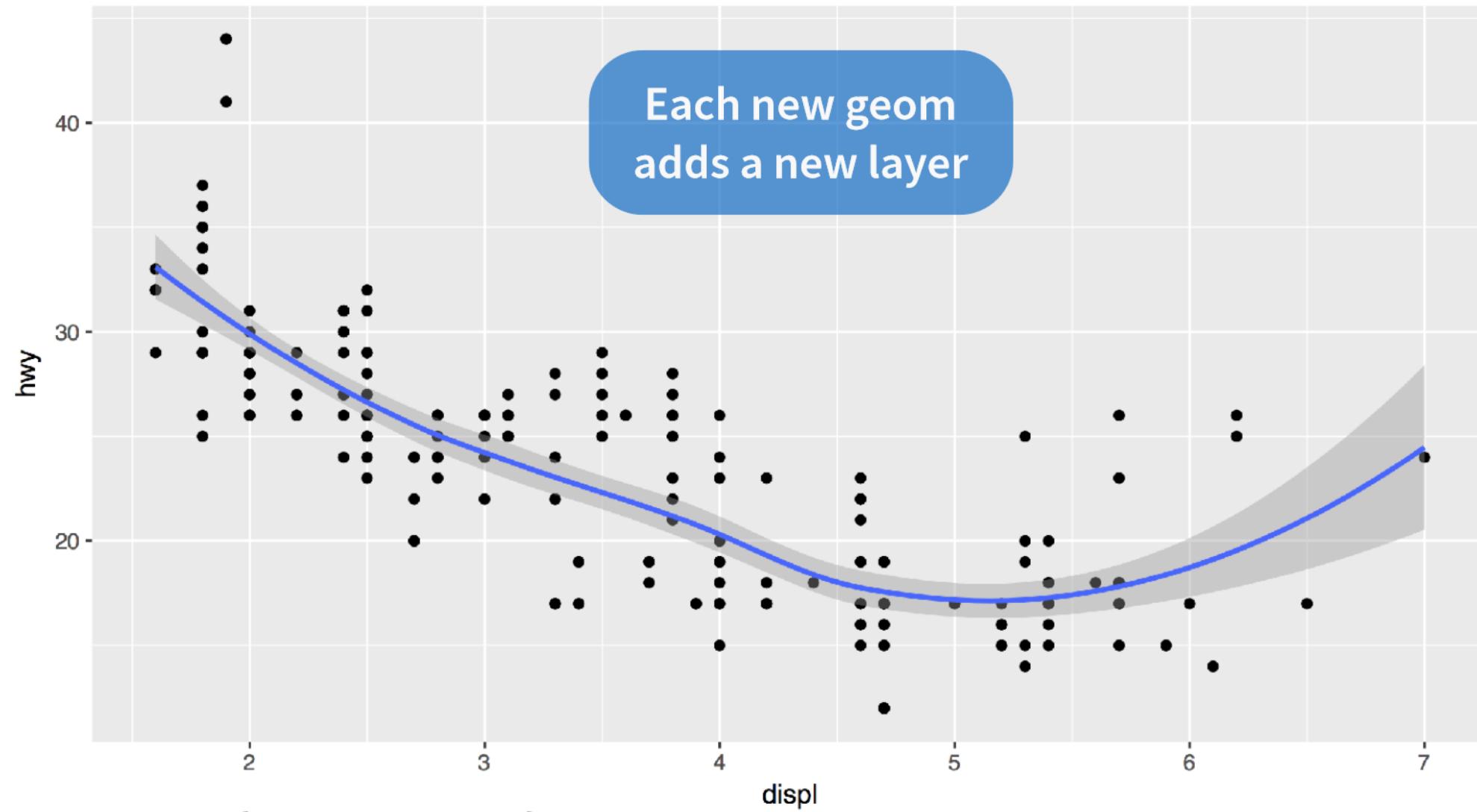
```
ggplot(mpg) +  
  geom_point(aes(displ, hwy)) +  
  geom_smooth(aes(displ, hwy))
```





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

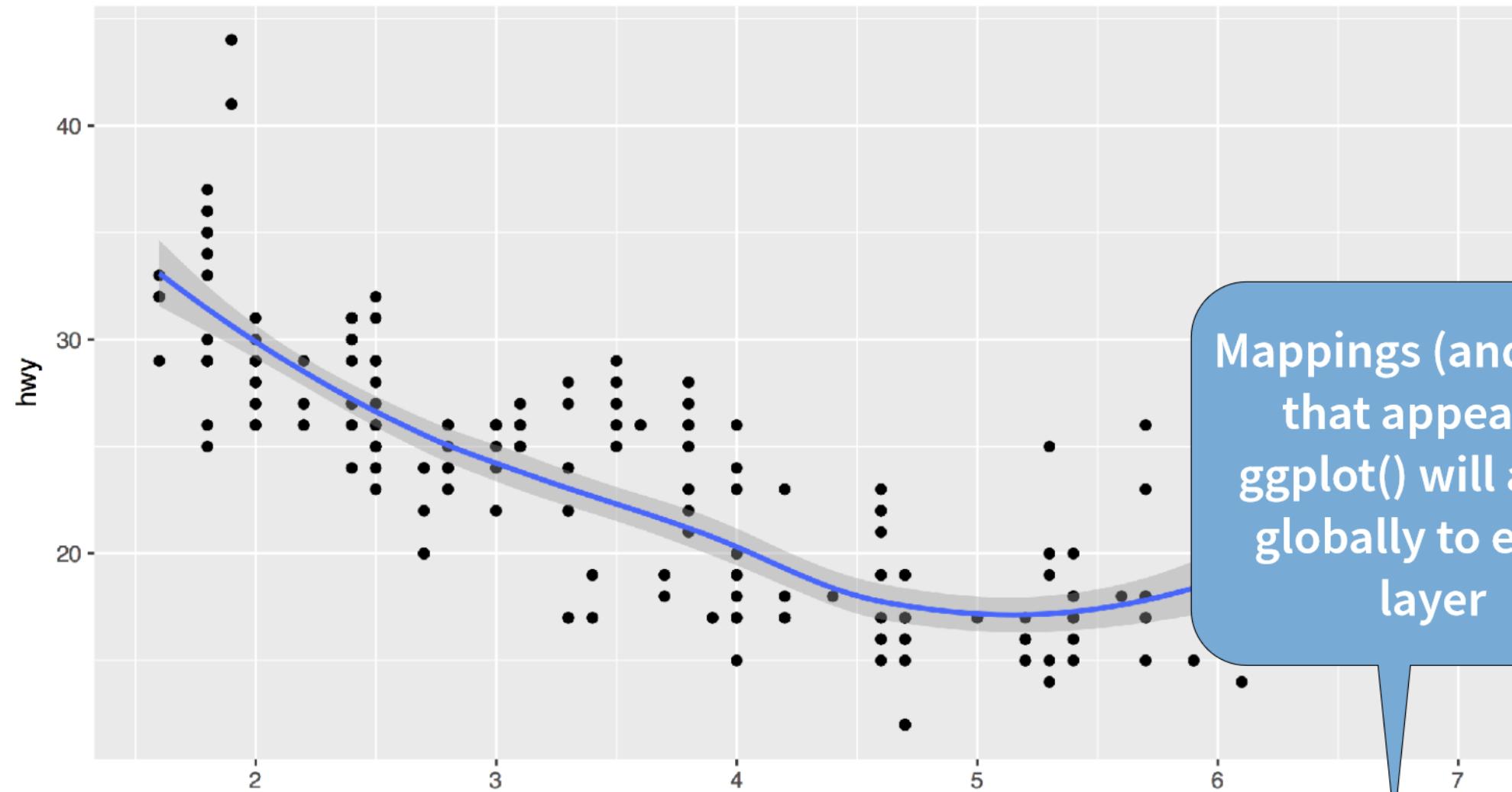




```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy)) +  
  geom_smooth(mapping = aes(x = displ, y = hwy))
```

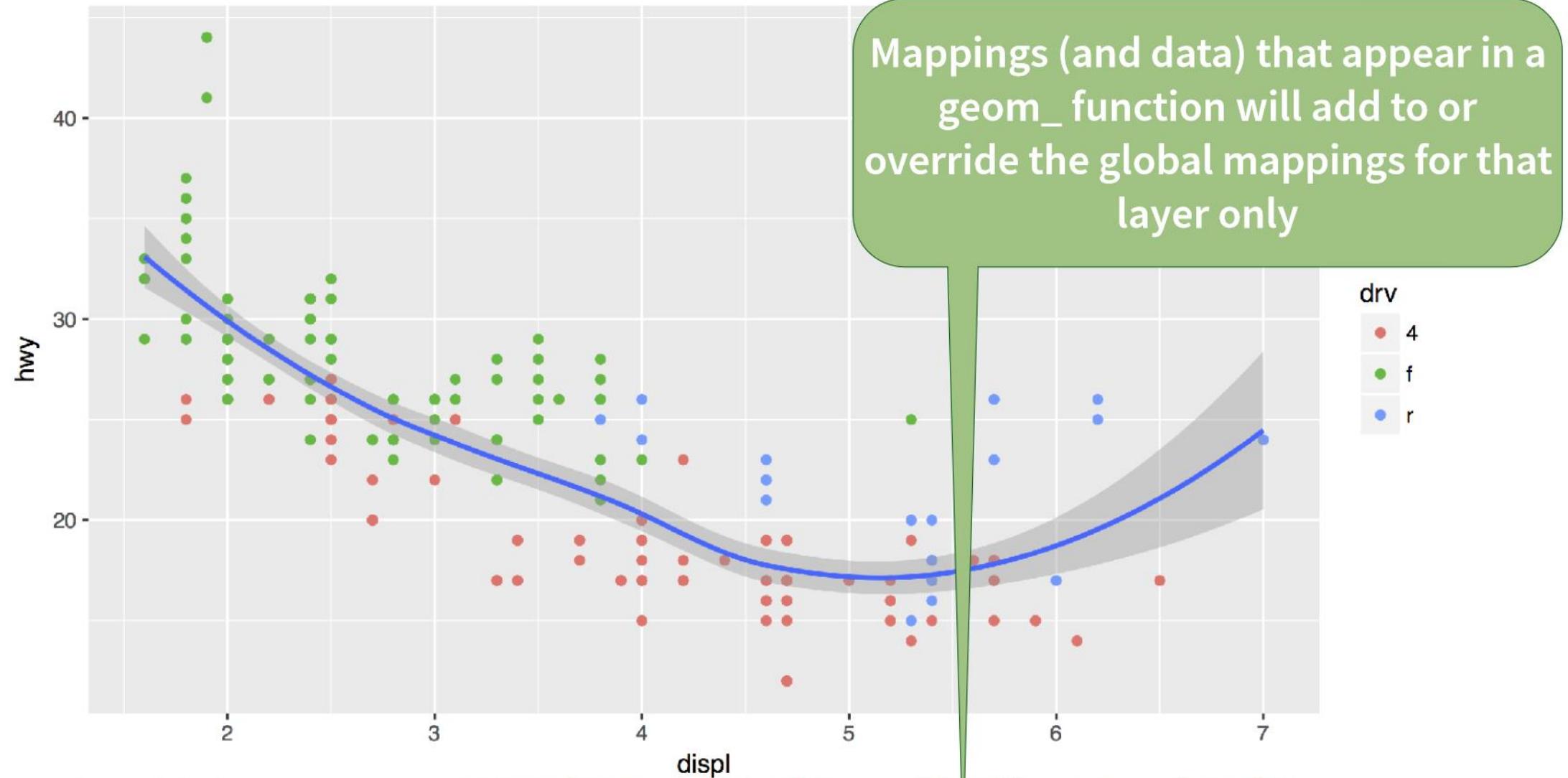


# Global vs. Local



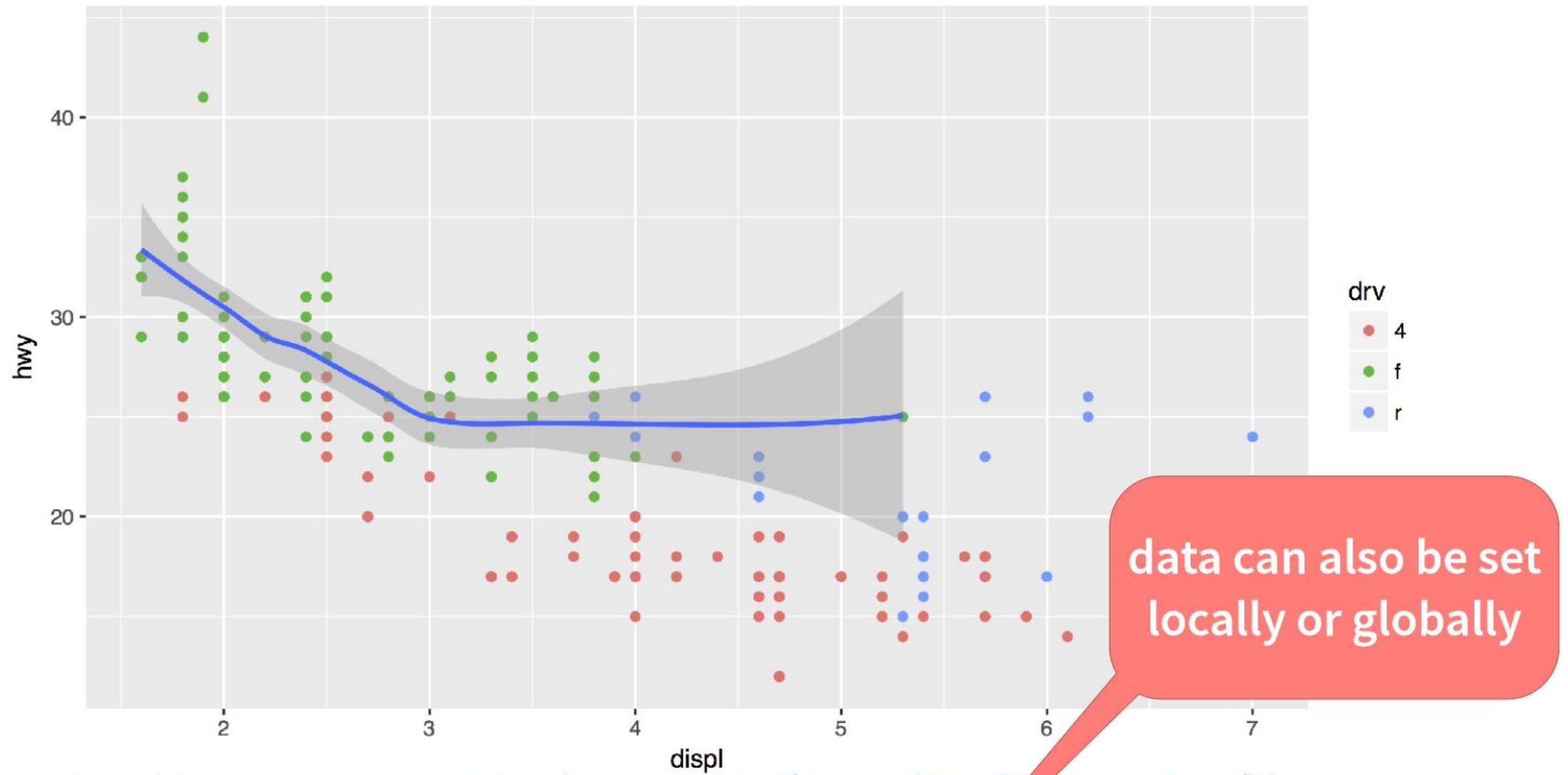
```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +  
  geom_point() +  
  geom_smooth()
```





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





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



# Exporting Graphs

# Your Turn 8

What does this command return?

`getwd()`

00 : 30

# 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

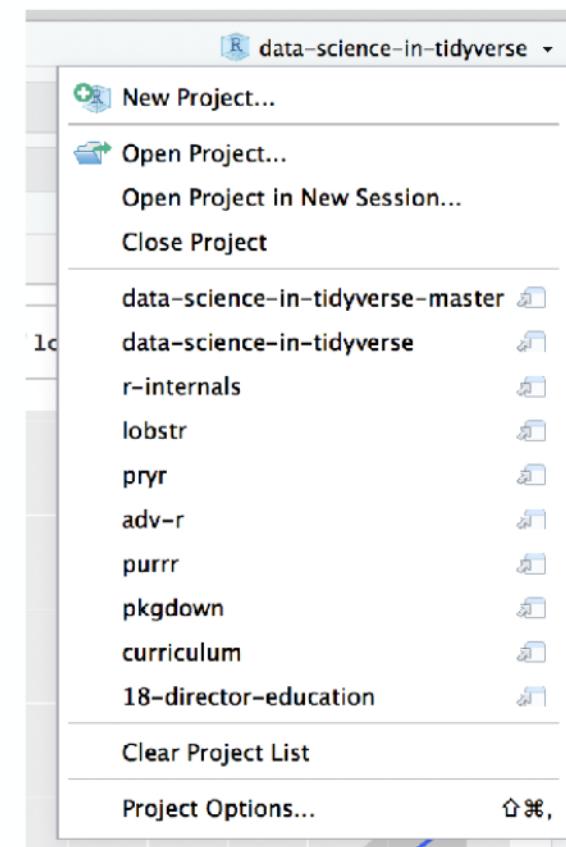


# Projects

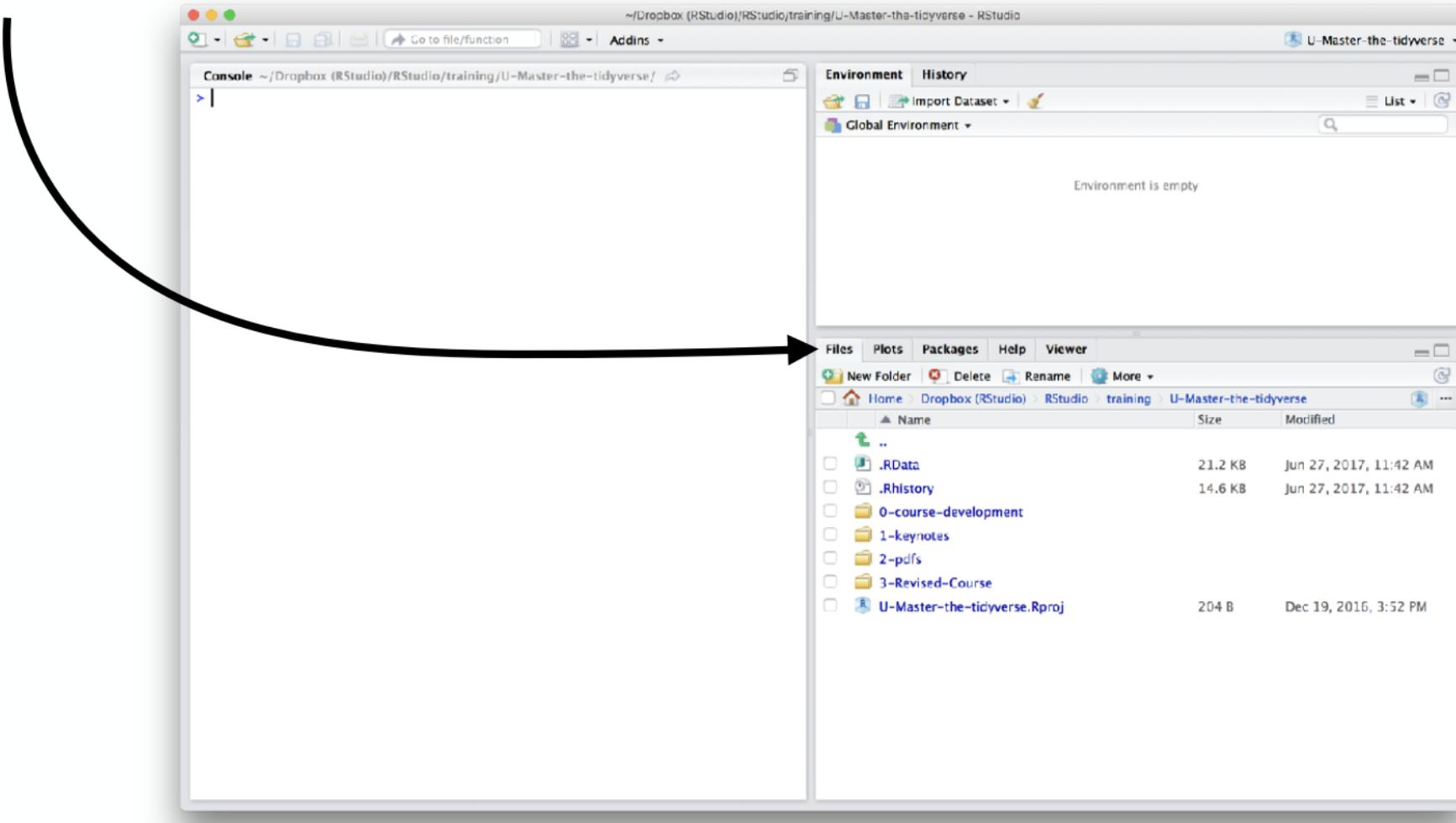
The best way of managing your working directory is with RStudio Projects.

One RStudio project = one real life project

One RStudio project = one directory



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



# Saving plots

`ggsave()` saves the last plot.

Uses size on screen:

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

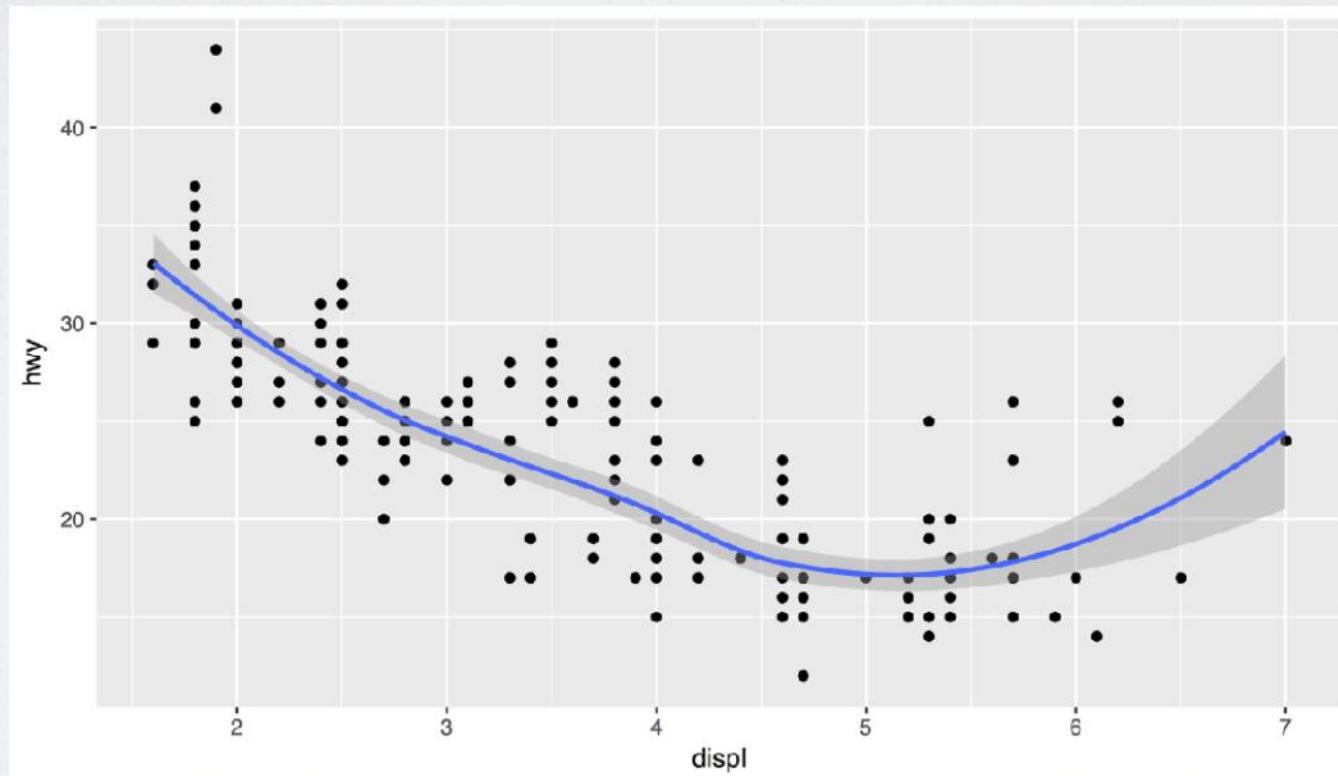
Specify size in inches

```
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).



01 : 00

# The 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>) +  
<GEO_M_FUNCTION>(mapping = aes(<MAPPIINGS>))
```



# To make a graph

| mpg  | cyl | disp  | hp | geom |
|------|-----|-------|----|------|
| 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  | •    |

1. Pick a **data** set

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

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

data

geom



mappings

| 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

# To make a graph

1. Pick a **data** set

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

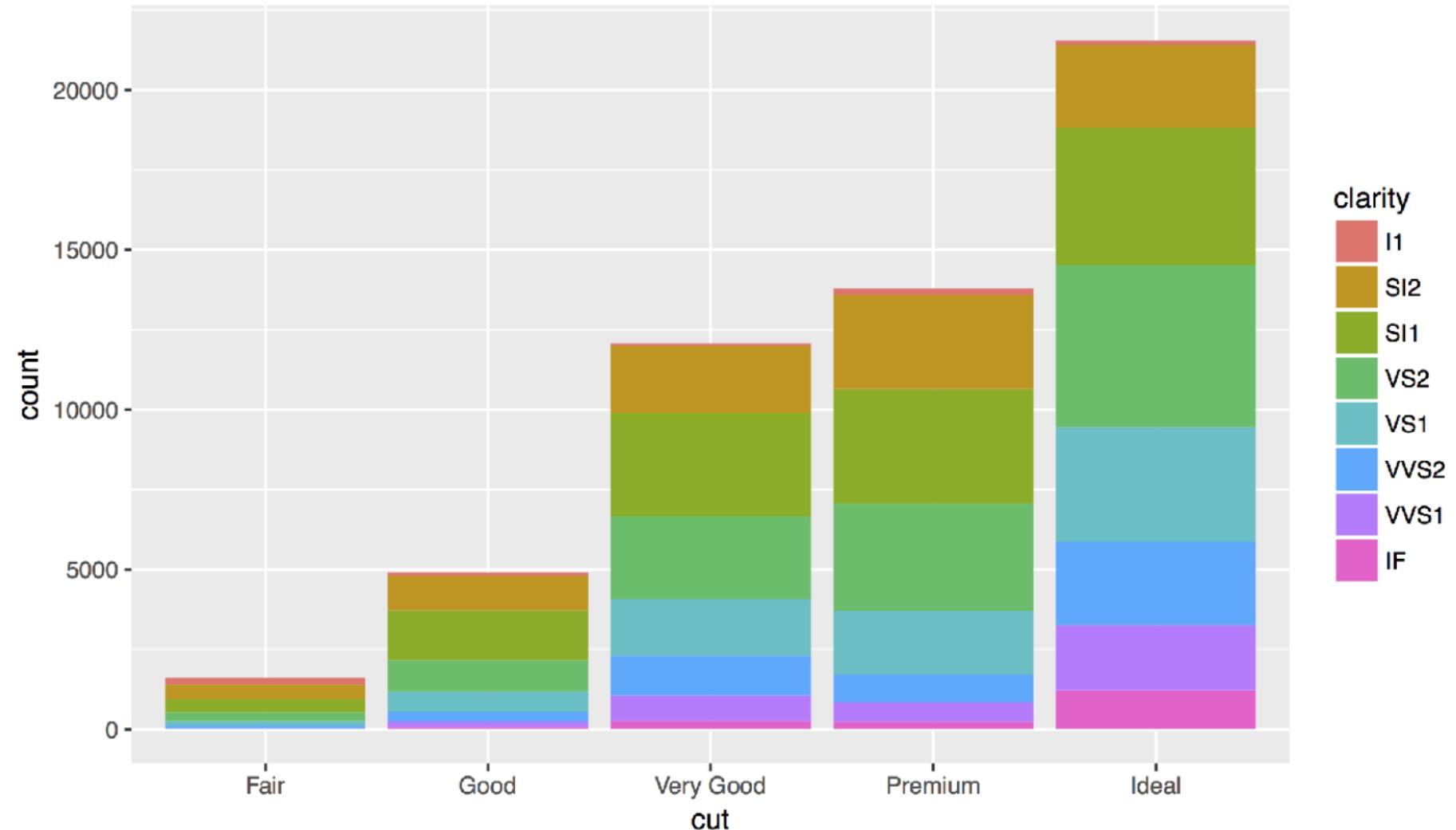
2. Choose a **geom**  
to display cases

3. **Map** aesthetic  
properties to  
variables

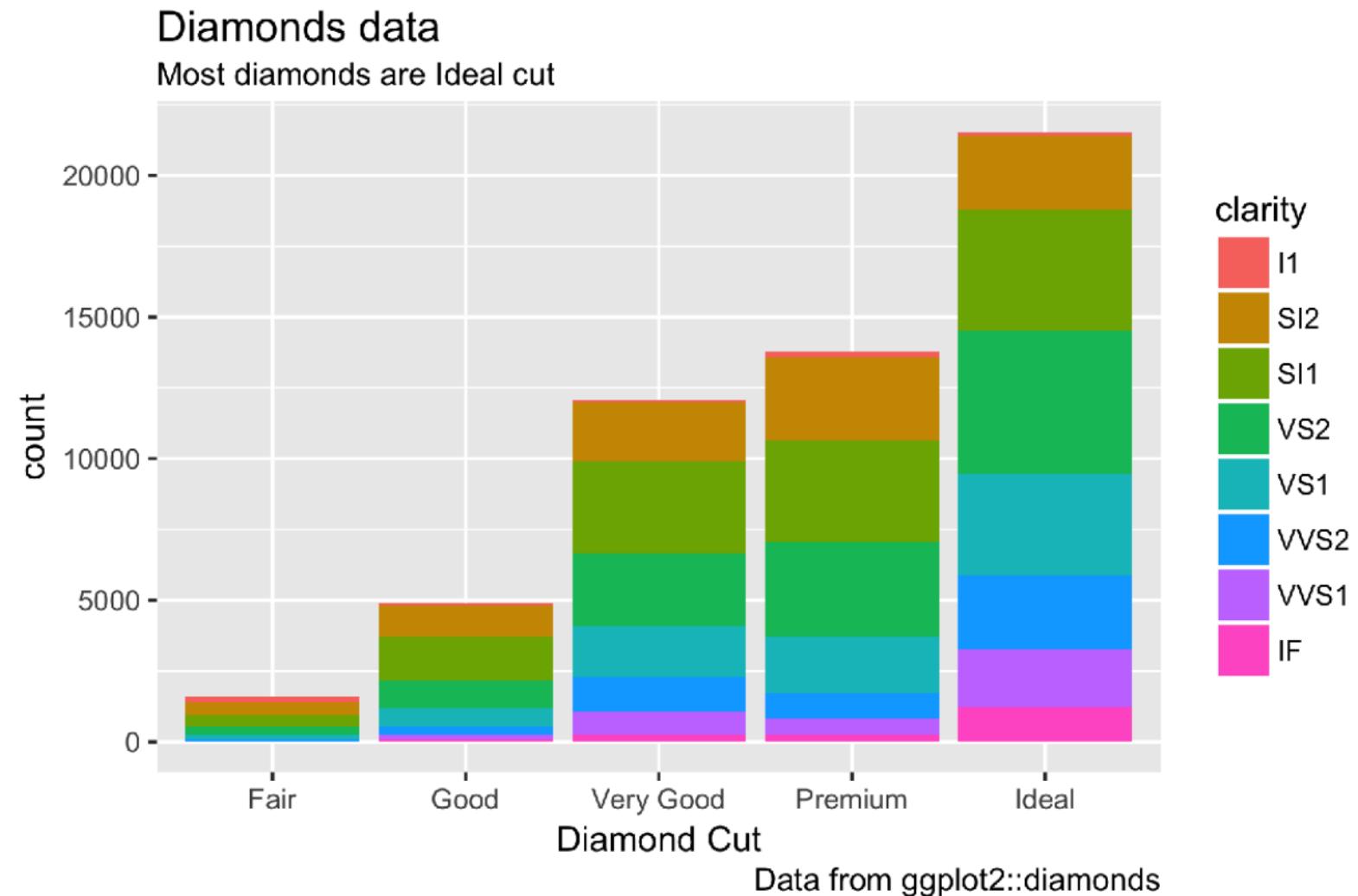


# What else?

# For example: (see gg\_example.Rmd)

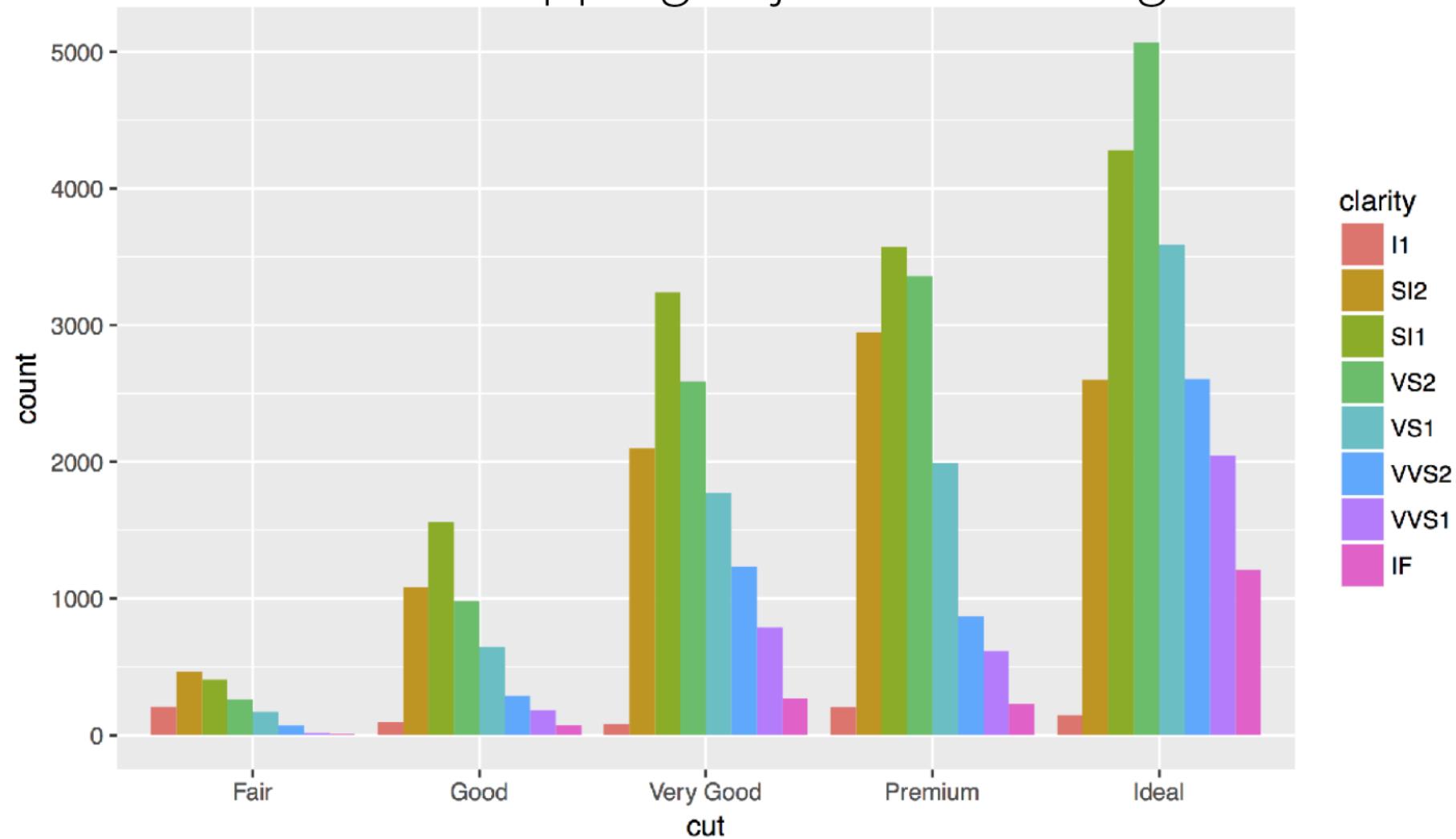


# Titles and captions + labs()



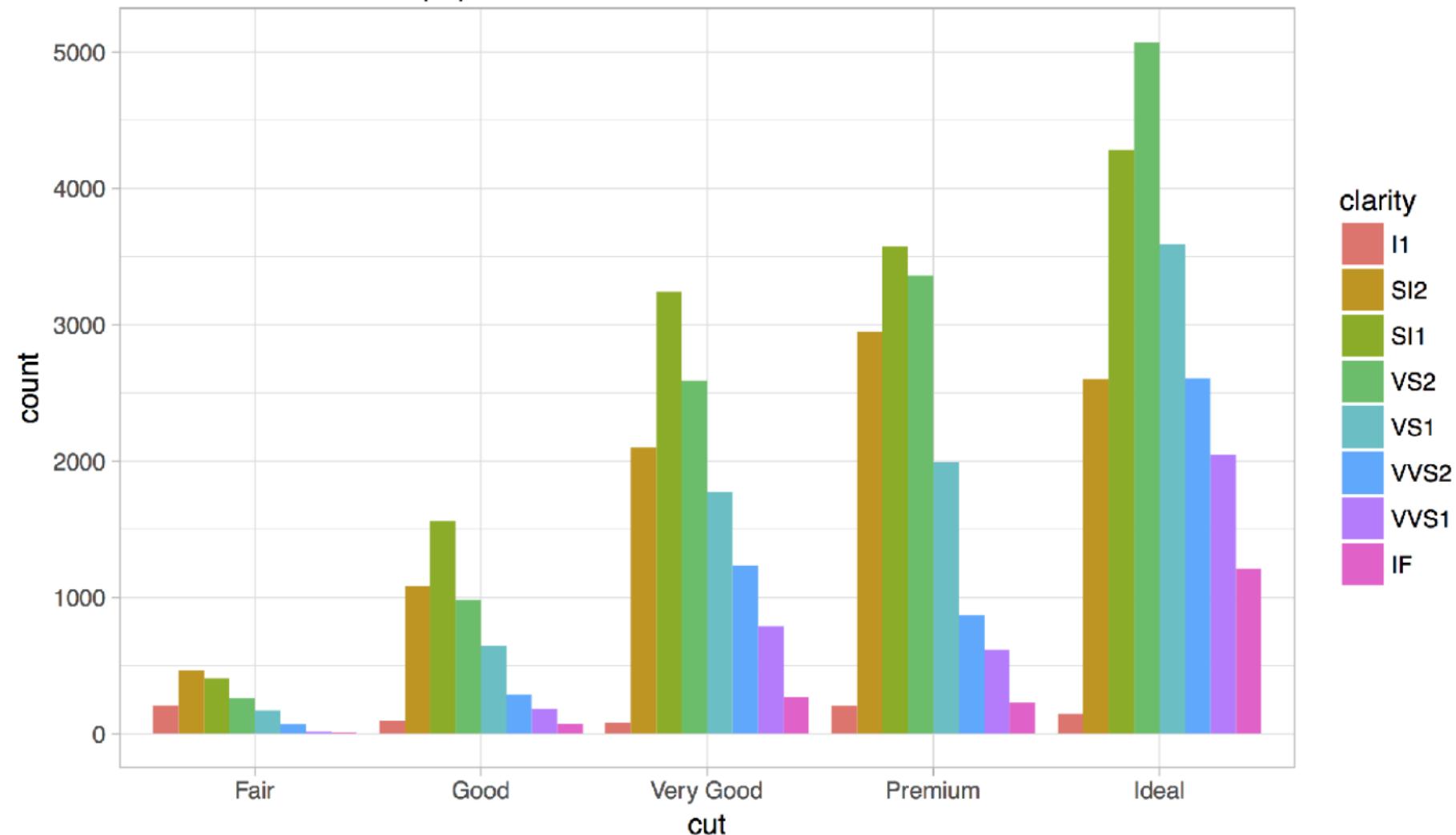
# Position Adjustments

How overlapping objects are arranged



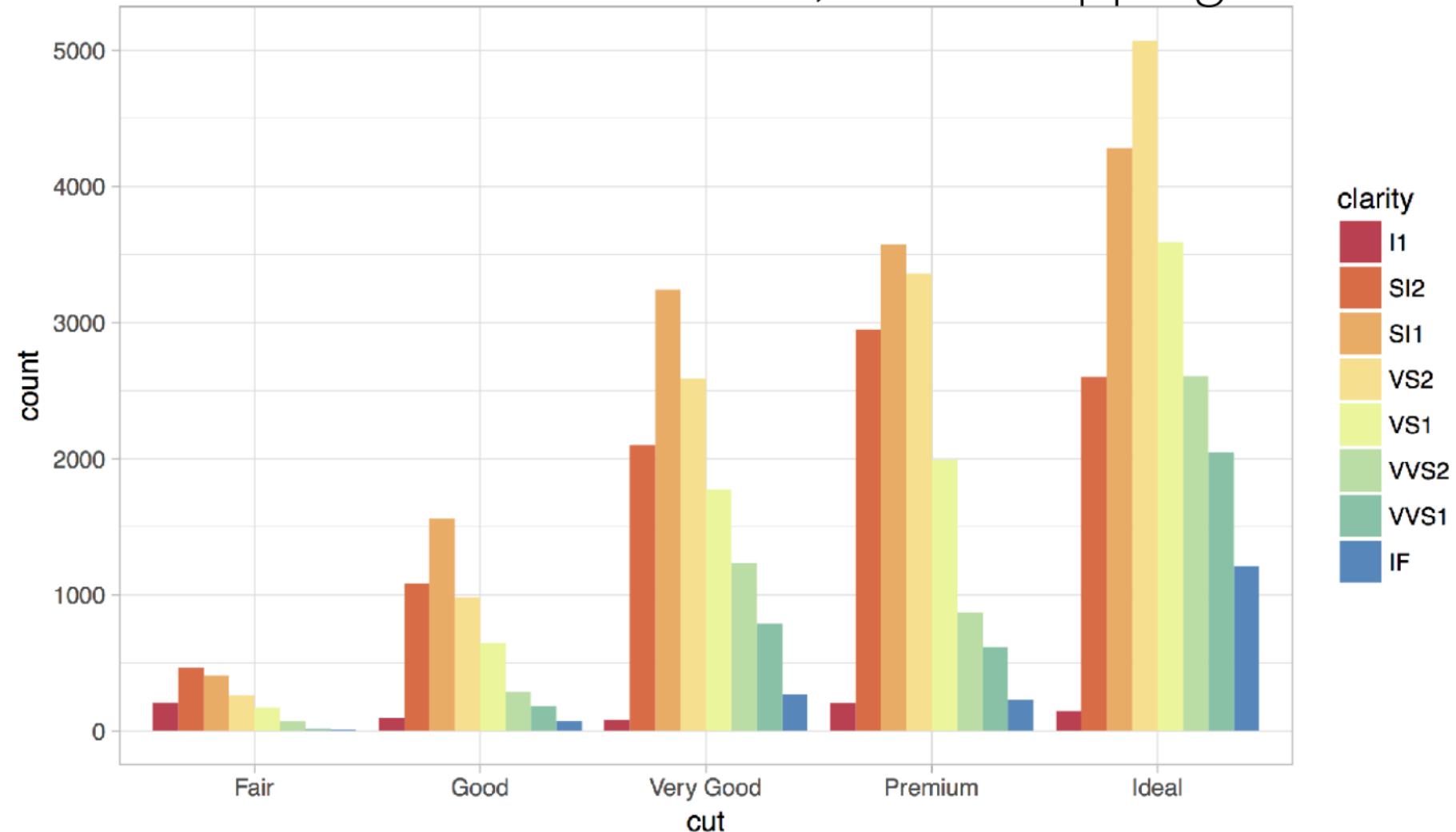
# Themes

## Visual appearance of non-data elements



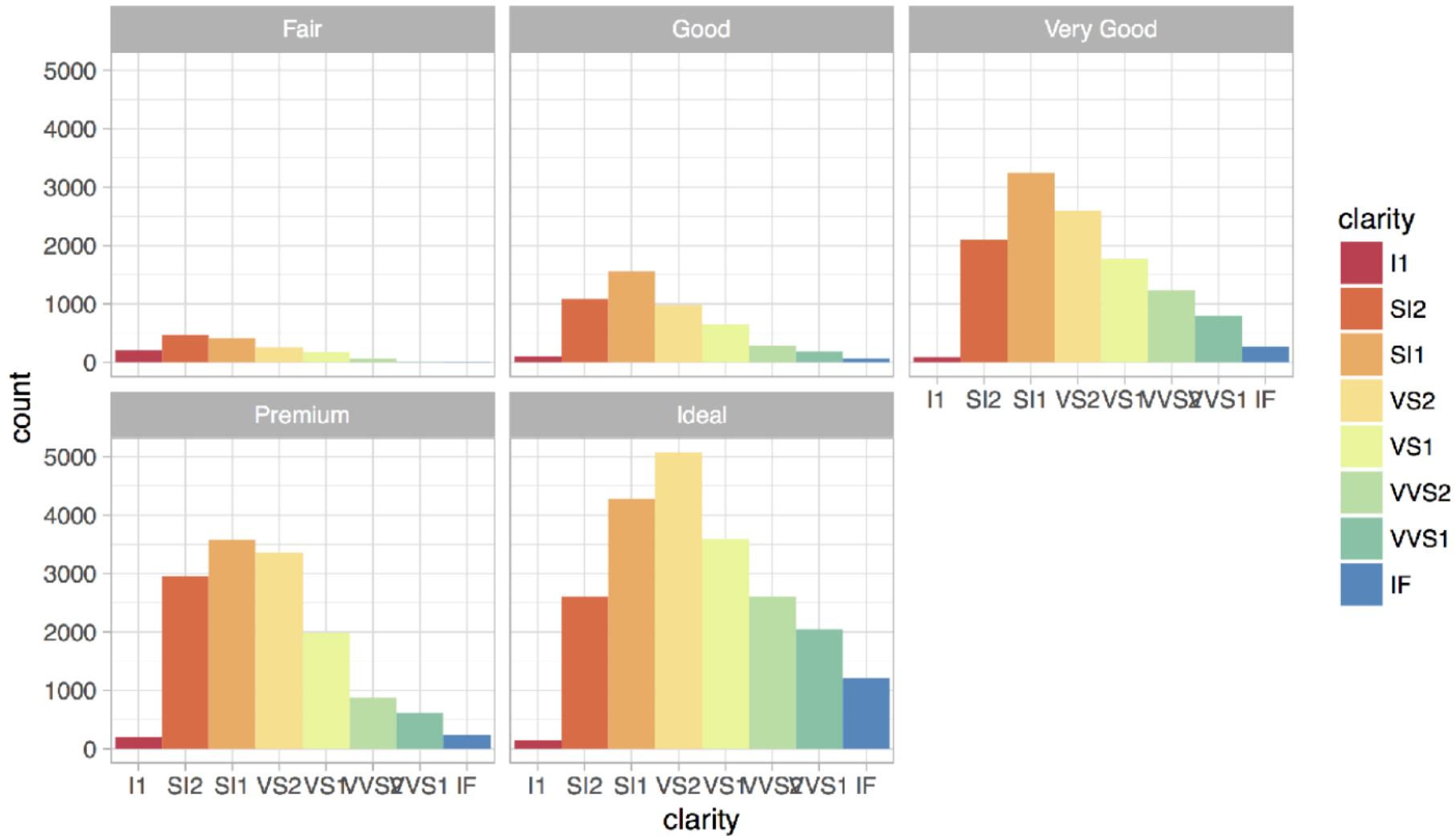
# Scales

Customize color scales, other mappings

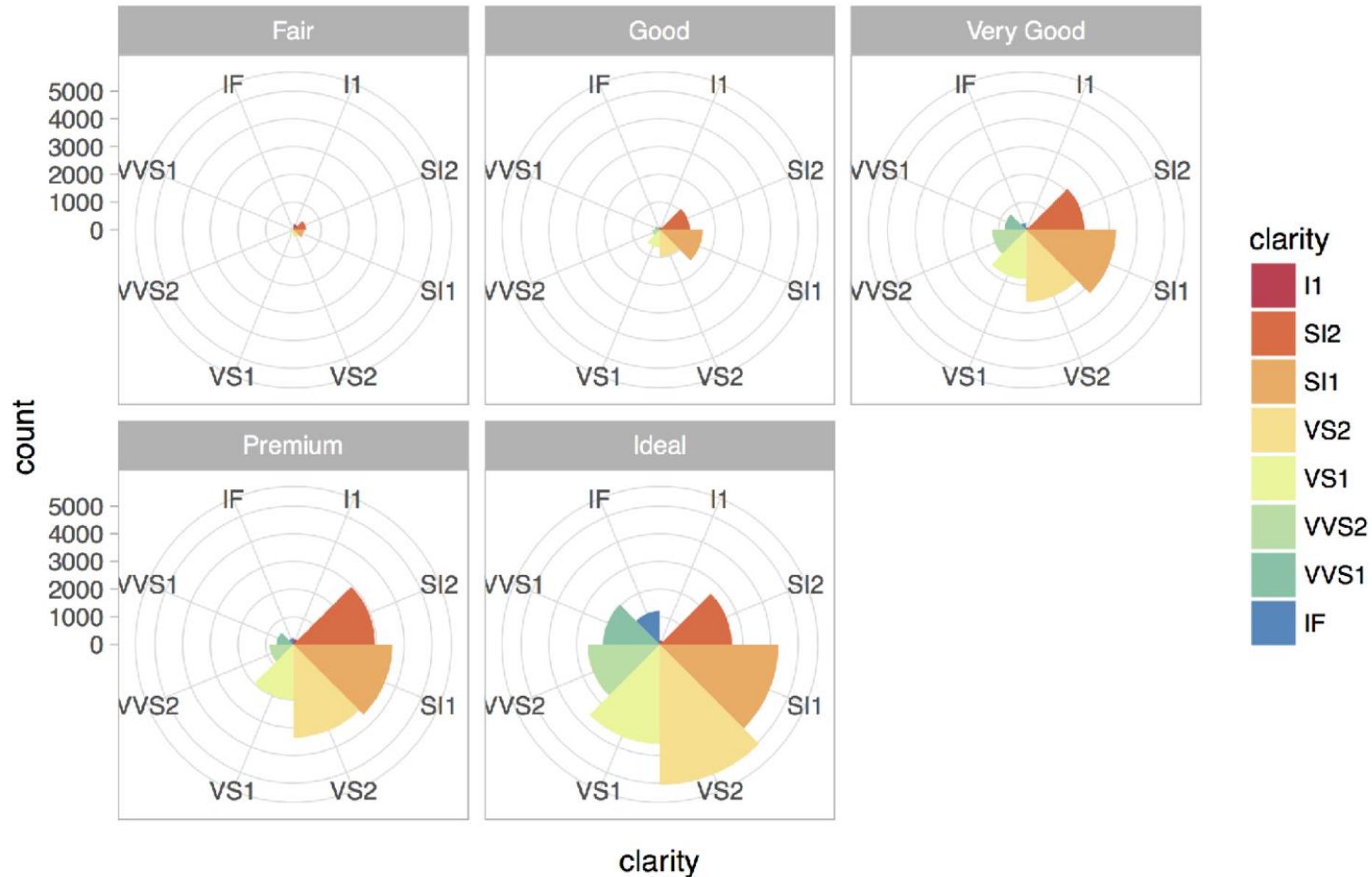


# Facets

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

## Visualization with ggplot2 :: CHEAT SHEET

| Geoms   |  |
|---|--|
| Use a geom function to represent data points, use the geom's aesthetic properties to represent variables.<br>Each function returns a layer. |  |
| GRAPHICAL PRIMITIVES  |  |
| a + geom_blank()  | (useful for expanding limits)  |
| b + geom_curve(mapping = lat ~ long, y = lat)   | b + geom_curve(mapping = lat ~ long, curvature = 0)                    |
| c + geom_rect(mapping = xmin ~ ymax, xmax ~ ymin)   | c + geom_rect(mapping = x ~ y, xmin = 1, xmax = 1, ymin = 1, ymax = 1) |
| d + geom_polygon(mapping = group ~ group)   | d + geom_polygon(mapping = group ~ group, linetype = 1)                |
| e + geom_ribbon(mapping = ymin ~ ymax, ymax ~ ymin)   | e + geom_ribbon(mapping = y ~ y, ymin = -900, ymax = 900)              |
| LINE SEGMENTS   |  |
| f + geom_abline(mapping = intercept ~ slope, intercept = 0, slope = 1)  | f + geom_abline(mapping = intercept ~ slope, intercept = 0, slope = 1) |
| g + geom_hline(mapping = intercept ~ slope, intercept = 0)  | g + geom_hline(mapping = intercept ~ slope, intercept = 0)             |
| h + geom_segment(mapping = start_x ~ end_x, start_y ~ end_y)  | h + geom_segment(mapping = start_x ~ end_x, start_y ~ end_y)           |
| i + geom_spoke(mapping = angle ~ angle)   | i + geom_spoke(mapping = angle ~ angle)                                |
| ONE VARIABLE  | continuous   |
| c + geom_area(mapping = aes(y = y))   | c + geom_area(mapping = aes(y = y))                                    |
| c + geom_bar(mapping = aes(y = y))  | c + geom_bar(mapping = aes(y = y))                                     |
| c + geom_dotplot(mapping = aes(y = y))  | c + geom_dotplot(mapping = aes(y = y))                                 |
| c + geom_freqpoly(mapping = aes(y = y))   | c + geom_freqpoly(mapping = aes(y = y))                                |
| c + geom_histogram(mapping = binwidth = 5)  | c + geom_histogram(mapping = binwidth = 5)                             |
| c + geom_qq(mapping = aes(sample = sample))   | c + geom_qq(mapping = aes(sample = sample))                            |
| c2 + geom_violin(mapping = aes(y = y))  | c2 + geom_violin(mapping = aes(y = y))                                 |
| discrete x, continuous y  |  |
| f + geom_crossbar(mapping = aes(x = x, y = y, ymin = y, ymax = y))  | f + geom_crossbar(mapping = aes(x = x, y = y, ymin = y, ymax = y))     |
| f + geom_boxplot(mapping = aes(x = x, y = y))   | f + geom_boxplot(mapping = aes(x = x, y = y))                          |
| f + geom_dotplot(mapping = aes(x = x, y = y, stackdir = "center"))  | f + geom_dotplot(mapping = aes(x = x, y = y, stackdir = "center"))     |
| f + geom_violin(mapping = aes(x = x, y = y))  | f + geom_violin(mapping = aes(x = x, y = y))                           |
| discrete x, discrete y  |  |
| g + geom_count(mapping = aes(x = x, y = y))   | g + geom_count(mapping = aes(x = x, y = y))                            |
| THREE VARIABLES   |  |
| sealsSz <- with(seals, sqrt(delta_long^2 + delta_lat^2))  | sealsSz <- with(seals, sqrt(delta_long^2 + delta_lat^2))               |
| i + geom_contour(mapping = aes(z = z))  | i + geom_contour(mapping = aes(z = z))                                 |
| i + geom_raster(mapping = aes(z = z))   | i + geom_raster(mapping = aes(z = z))                                  |
| i + geom_tile(mapping = aes(z = z))   | i + geom_tile(mapping = aes(z = z))                                    |



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# ggplot2.tidyverse.org

The screenshot shows a web browser window displaying the ggplot2.tidyverse.org website. The title bar reads "Create Elegant Data Visualisation" and "Garrett". The address bar shows the URL "ggplot2.tidyverse.org". The page header features the ggplot2 logo and the text "part of the tidyverse". Navigation links include "Reference", "Articles", "News", and a user icon.

## Usage

It's hard to succinctly describe how ggplot2 works because it embodies a deep philosophy of visualisation. However, in most cases you start with `ggplot()`, supply a dataset and aesthetic mapping (with `aes()`). You then add on layers (like `geom_point()` or `geom_histogram()`), scales (like `scale_colour_brewer()`), faceting specifications (like `facet_wrap()`) and coordinate systems (like `coord_flip()`).

```
library(ggplot2)

ggplot(mpg, aes(displ, hwy, colour = class)) +
  geom_point()
```

A scatter plot is displayed below the code snippet, showing the relationship between engine displacement (displ) on the x-axis and fuel economy (hwy) on the y-axis. The points are colored by vehicle class, with a legend indicating "2seater" (red). The plot has a light gray grid background.

### Links

- Download from CRAN at <https://cran.r-project.org/package=ggplot2>
- Browse source code at <https://github.com/tidyverse/ggplot2>
- Report a bug at <https://github.com/tidyverse/ggplot2/issues>
- Learn more at <http://r4ds.had.co.nz/data-visualisation.html>

### License

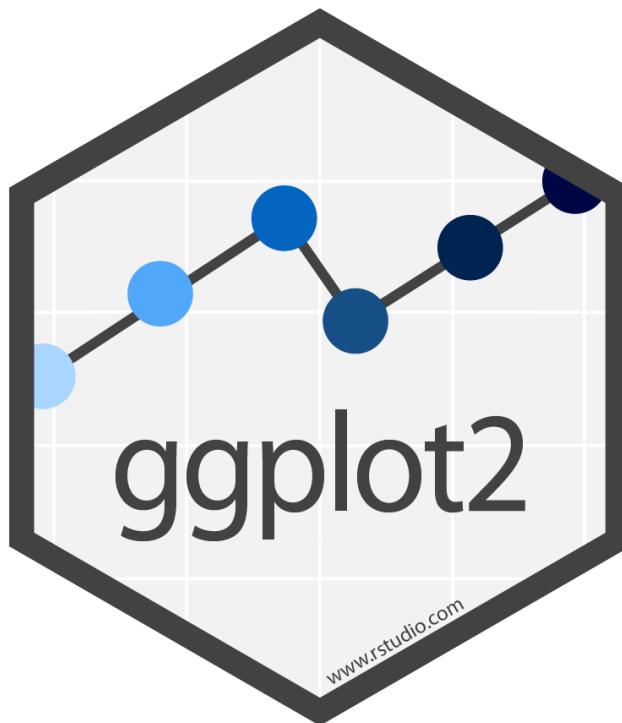
[GPL-2](#) | file [LICENSE](#)

### Developers

Hadley Wickham  
Author, maintainer

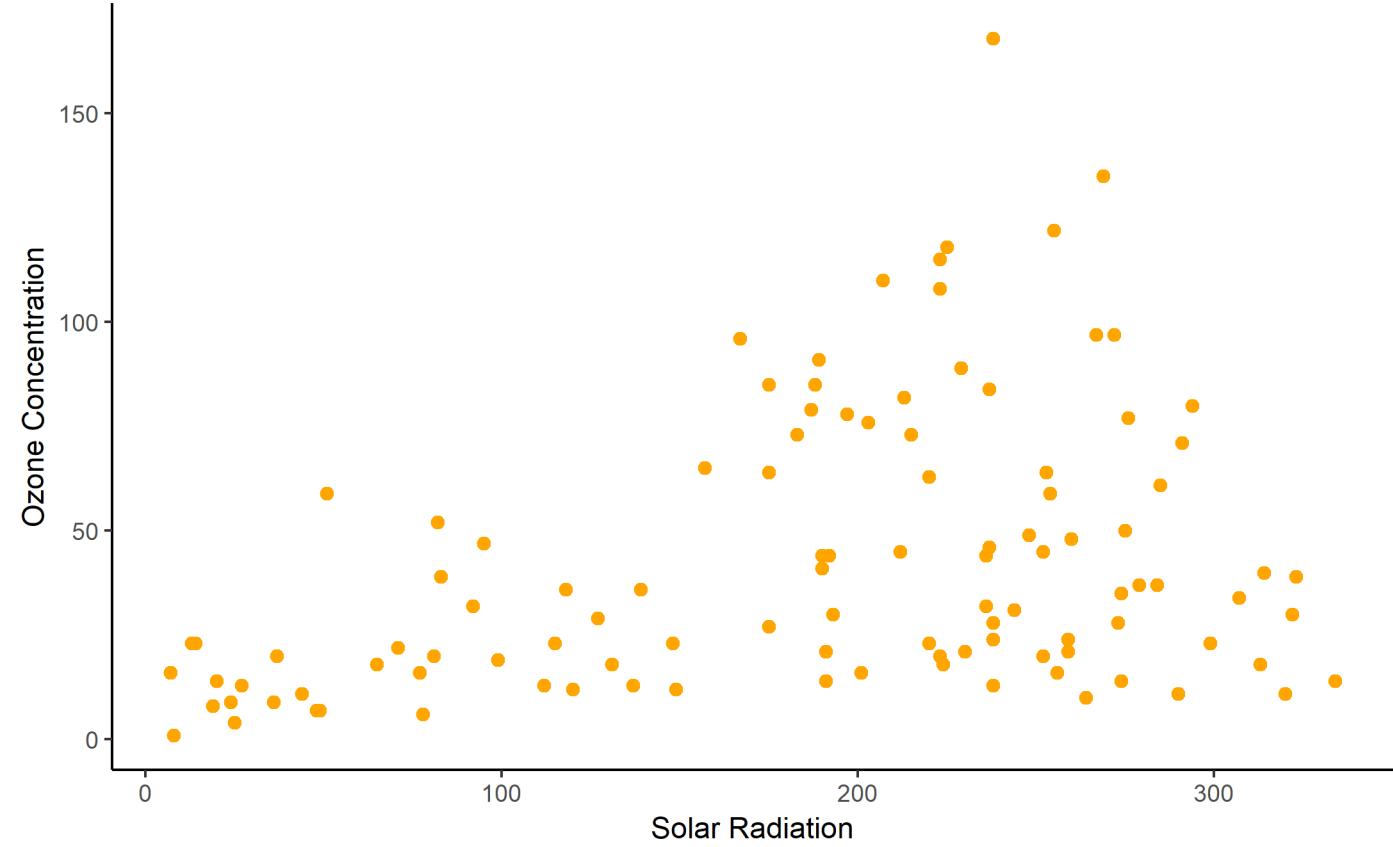
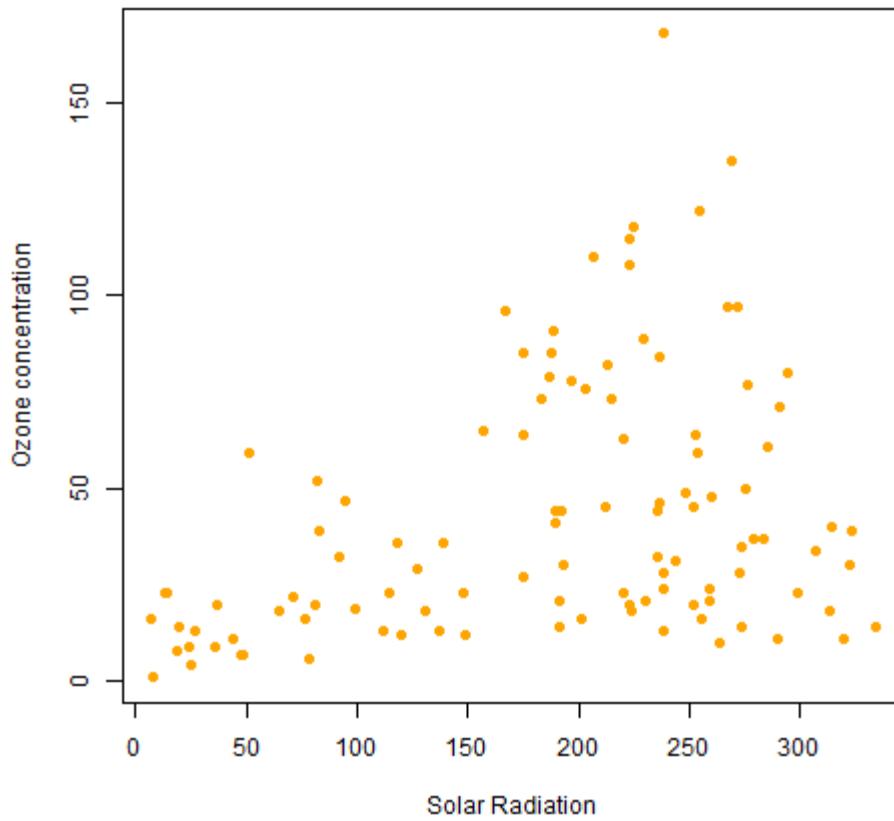


# Visualising Data with



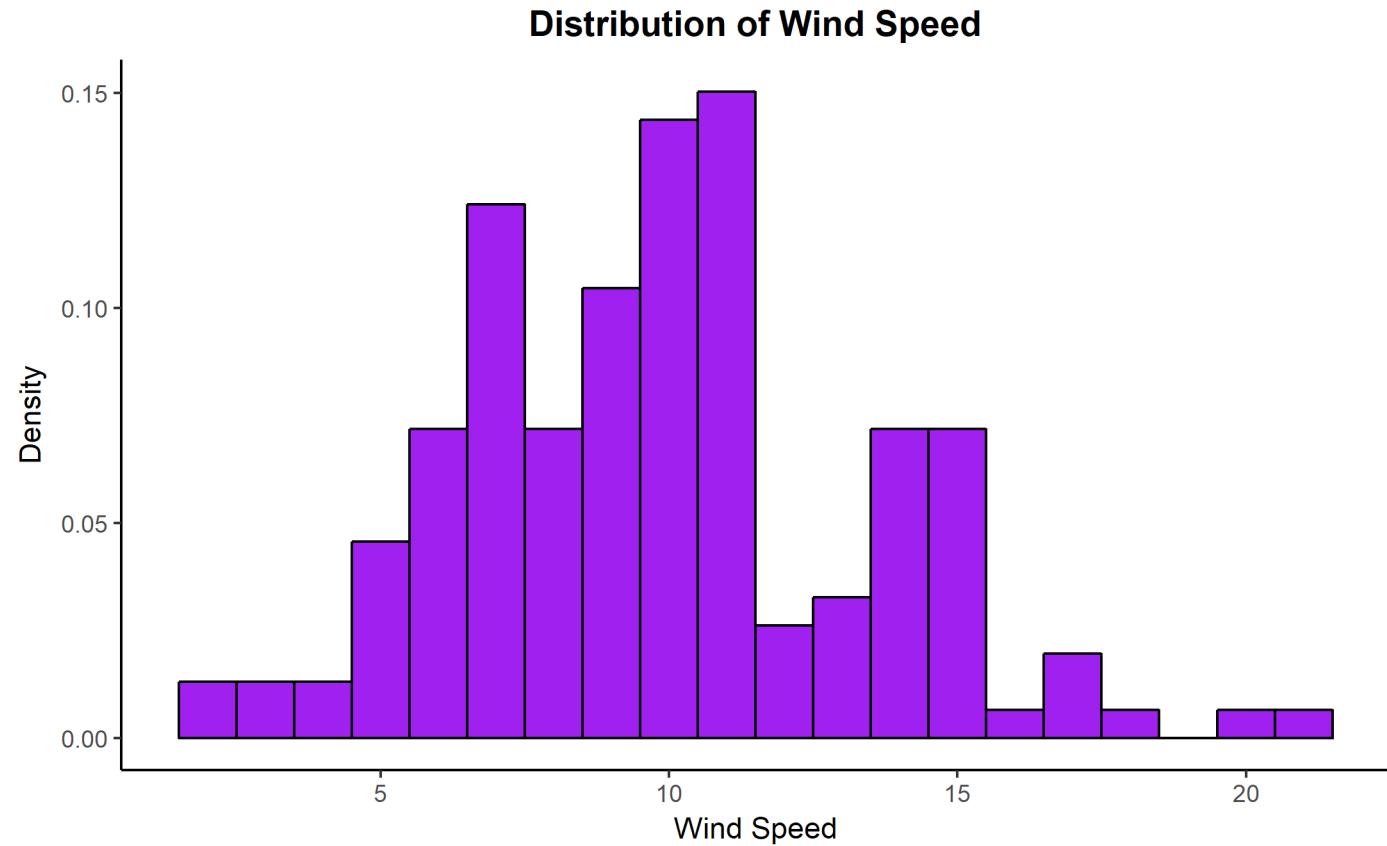
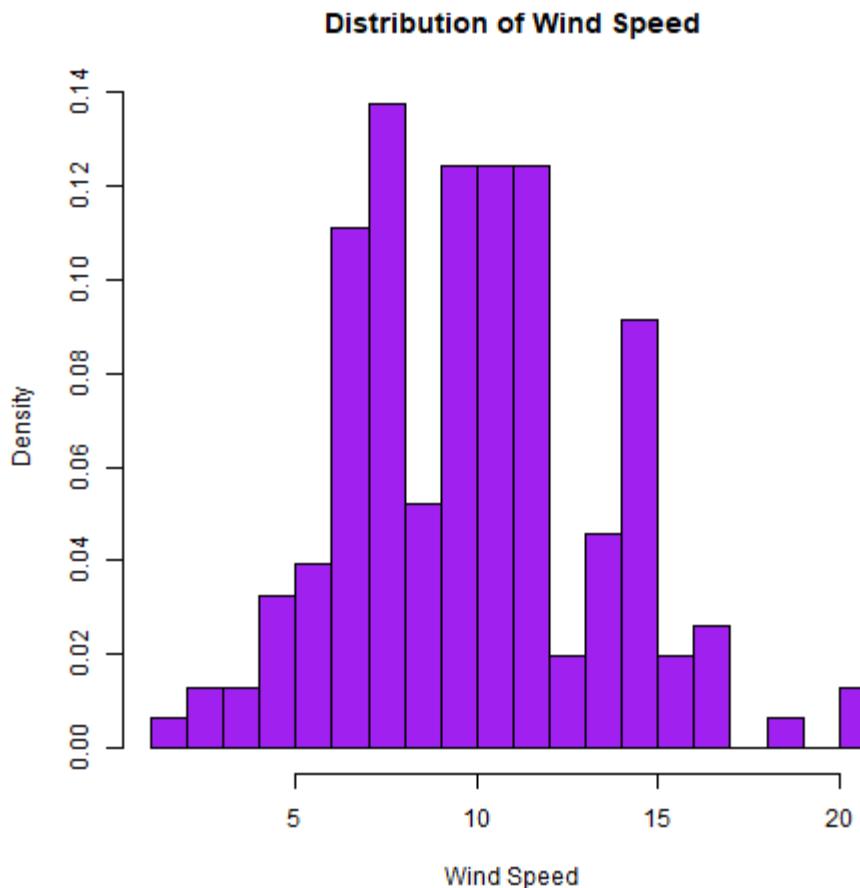
Adapted from “Explore the Tidyverse” CC by Hadley Wickham

# Example comparisons: Scatterplot



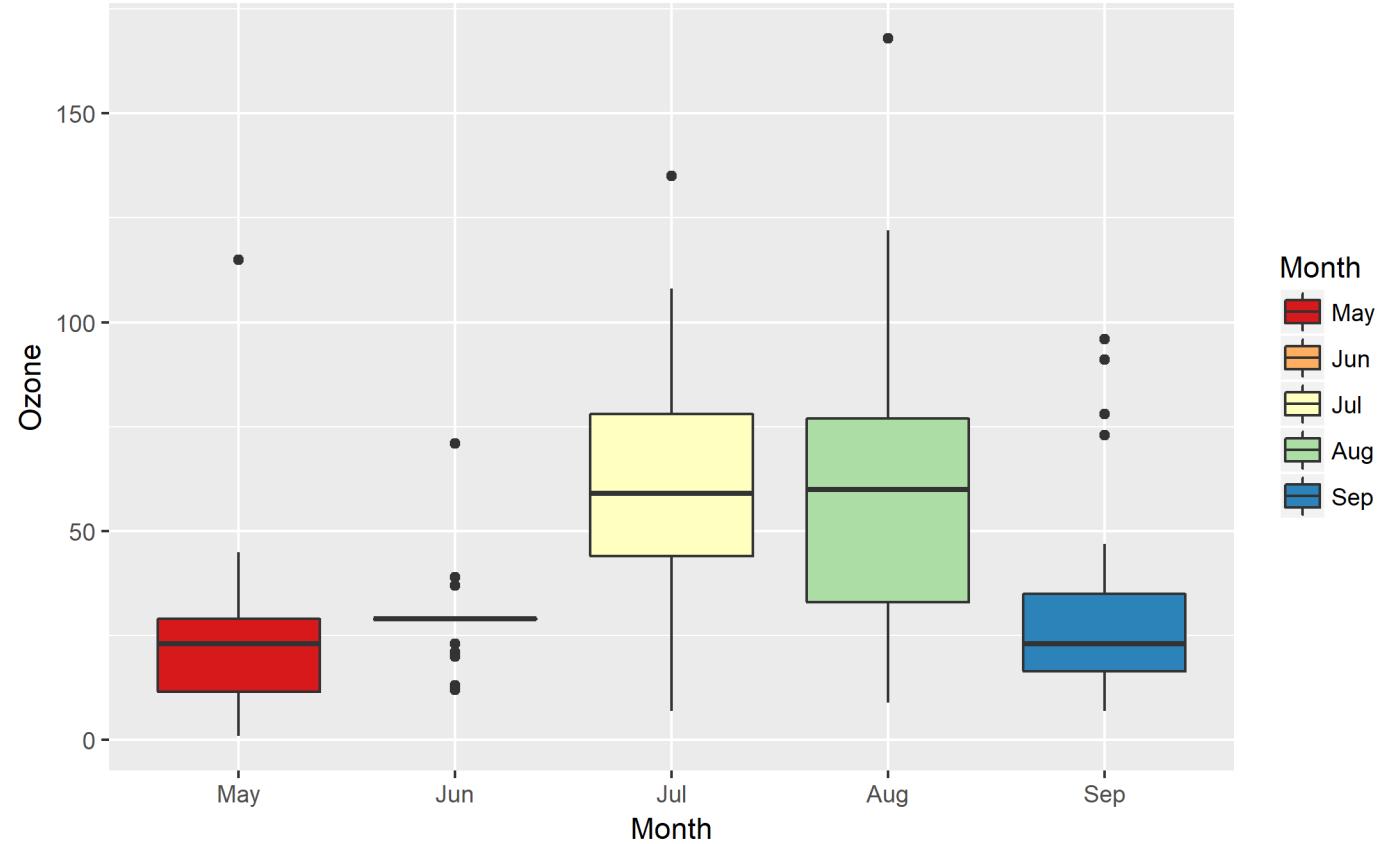
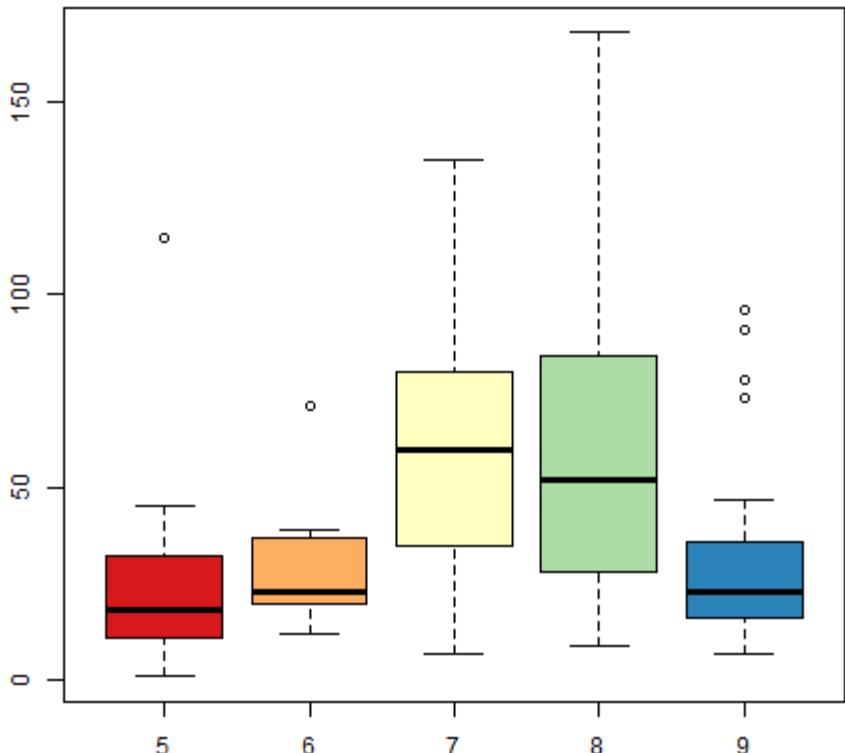
[https://github.com/PMacDaSci/r-intro/Day-3/ozone\\_solar\\_relationship.Rmd](https://github.com/PMacDaSci/r-intro/Day-3/ozone_solar_relationship.Rmd)

# Example comparisons: Histogram



[https://github.com/PMacDaSci/r-intro/Day-3/ozone\\_windspeed.Rmd](https://github.com/PMacDaSci/r-intro/Day-3/ozone_windspeed.Rmd)

# Example comparisons: Boxplot



[https://github.com/PMacDaSci/r-intro/Day-3/ozone\\_boxplot.Rmd](https://github.com/PMacDaSci/r-intro/Day-3/ozone_boxplot.Rmd)

Note: Dataset transformed with [https://github.com/PMacDaSci/r-intro/Day-3/fix\\_ozone.Rmd](https://github.com/PMacDaSci/r-intro/Day-3/fix_ozone.Rmd)