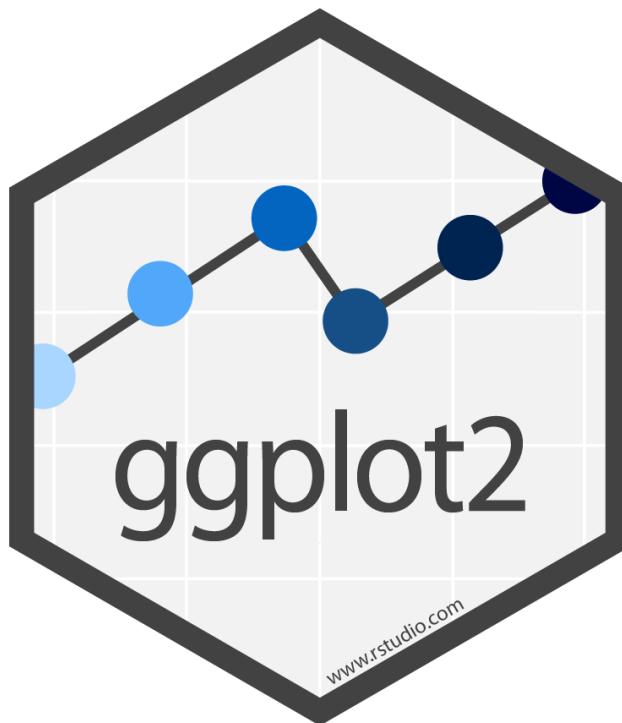


# Visualising Data with



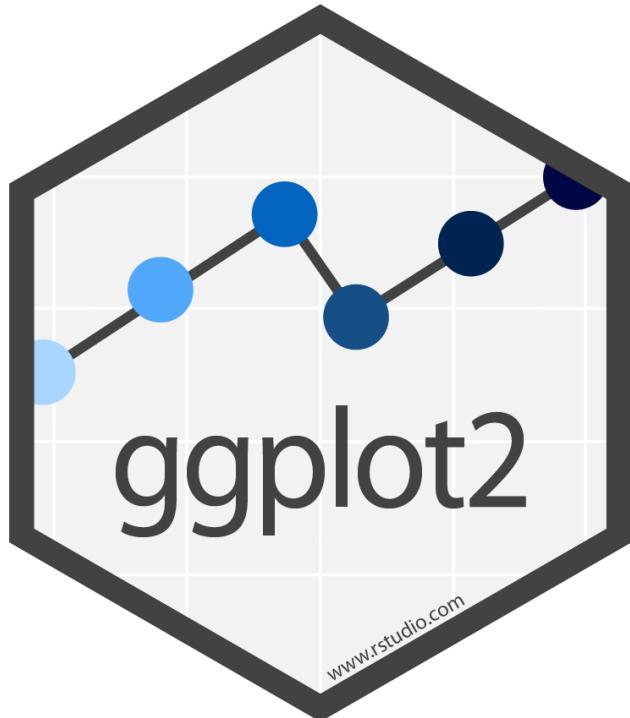
Adapted from “Explore the Tidyverse” CC by Hadley Wickham

# 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!
9 library(tidyverse)
10 ...
11
12
13 ``{r}
14 mpg
15 ...
16
17 ## Quiz
18
19 What relationship do you expect to see between engine size (displ)
20 and highway fuel efficiency (hwy)?
21 ## Your Turn 1
22
23 Run the code on the slide to make a graph. Pay strict attention to
24 spelling, capitalization, and parentheses!
25 ``{r}
26
27
1:1 # Visualize Data ▾ R Markdown ▾
```

Check you are in the right file

# If you get lost or need to restart

```
1 ---  
2 title: "Visualize Data"  
3 output: html_notebook  
4 ---  
5  
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)  
12  
13 ````{r}  
14 mma  
15 ` Visualize Data  
16 Chunk 1: setup  
17 # Chunk 2  
18 Quiz  
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20 a Your Turn 1  
21 #  
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25 Your Turn 2  
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1281 Your Turn 316  
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1283 R  
1284 S  
1285 Your Turn 317  
1286  
1287 R  
1288 S  
1289 Your Turn 318  
1290  
1291 R  
1292 S  
1293 Your Turn 319  
1294  
1295 R  
1296 S  
1297 Your Turn 320  
1298  
1299 R  
1300 S  
1301 Your Turn 321  
1302  
1303 R  
1304 S  
1305 Your Turn 322  
1306  
1307 R  
1308 S  
1309 Your Turn 323  
1310  
1311 R  
1312 S  
1313 Your Turn 324  
1314  
1315 R  
1316 S  
1317 Your Turn 325  
1318  
1319 R  
1320 S  
1321 Your Turn 326  
1322  
1323 R  
1324 S  
1325 Your Turn 327  
1326  
1327 R  
1328 S  
1329 Your Turn 328  
1330  
1331 R  
1332 S  
1333 Your Turn 329  
1334  
1335 R  
1336 S  
1337 Your Turn 330  
1338  
1339 R  
1340 S  
1341 Your Turn 331  
1342  
1343 R  
1344 S  
1345 Your Turn 332  
1346  
1347 R  
1348 S  
1349 Your Turn 333  
1350  
1351 R  
1352 S  
1353 Your Turn 334  
1354  
1355 R  
1356 S  
1357 Your Turn 335  
1358  
1359 R  
1360 S  
1361 Your Turn 336  
1362  
1363 R  
1364 S  
1365 Your Turn 337  
1366  
1367 R  
1368 S  
1369 Your Turn 338  
1370  
1371 R  
1372 S  
1373 Your Turn 339  
1374  
1375 R  
1376 S  
1377 Your Turn 340  
1378  
1379 R  
1380 S  
1381 Your Turn 341  
1382  
1383 R  
1384 S  
1385 Your Turn 342  
1386  
1387 R  
1388 S  
1389 Your Turn 343  
1390  
1391 R  
1392 S  
1393 Your Turn 344  
1394  
1395 R  
1396 S  
1397 Your Turn 345  
1398  
1399 R  
1400 S  
1401 Your Turn 346  
1402  
1403 R  
1404 S  
1405 Your Turn 347  
1406  
1407 R  
1408 S  
1409 Your Turn 348  
1410  
1411 R  
1412 S  
1413 Your Turn 349  
1414  
1415 R  
1416 S  
1417 Your Turn 350  
1418  
1419 R  
1420 S  
1421 Your Turn 351  
1422  
1423 R  
1424 S  
1425 Your Turn 352  
1426  
1427 R  
1428 S  
1429 Your Turn 353  
1430  
1431 R  
1432 S  
1433 Your Turn 354  
1434  
1435 R  
1436 S  
1437 Your Turn 355  
1438  
1439 R  
1440 S  
1441 Your Turn 356  
1442  
1443 R  
1444 S  
1445 Your Turn 357  
1446  
1447 R  
1448 S  
1449 Your Turn 358  
1450  
1451 R  
1452 S  
1453 Your Turn 359  
1454  
1455 R  
1456 S  
1457 Your Turn 360  
1458  
1459 R  
1460 S  
1461 Your Turn 361  
1462  
1463 R  
1464 S  
1465 Your Turn 362  
1466  
1467 R  
1468 S  
1469 Your Turn 363  
1470  
1471 R  
1472 S  
1473 Your Turn 364  
1474  
1475 R  
1476 S  
1477 Your Turn 365  
1478  
1479 R  
1480 S  
1481 Your Turn 366  
1482  
1483 R  
1484 S  
1485 Your Turn 367  
1486  
1487 R  
1488 S  
1489 Your Turn 368  
1490  
1491 R  
1492 S  
1493 Your Turn 369  
1494  
1495 R  
1496 S  
1497 Your Turn 370  
1498  
1499 R  
1500 S  
1501 Your Turn 371  
1502  
1503 R  
1504 S  
1505 Your Turn 372  
1506  
1507 R  
1508 S  
1509 Your Turn 373  
1510  
1511 R  
1512 S  
1513 Your Turn 374  
1514  
1515 R<br
```

# 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
```

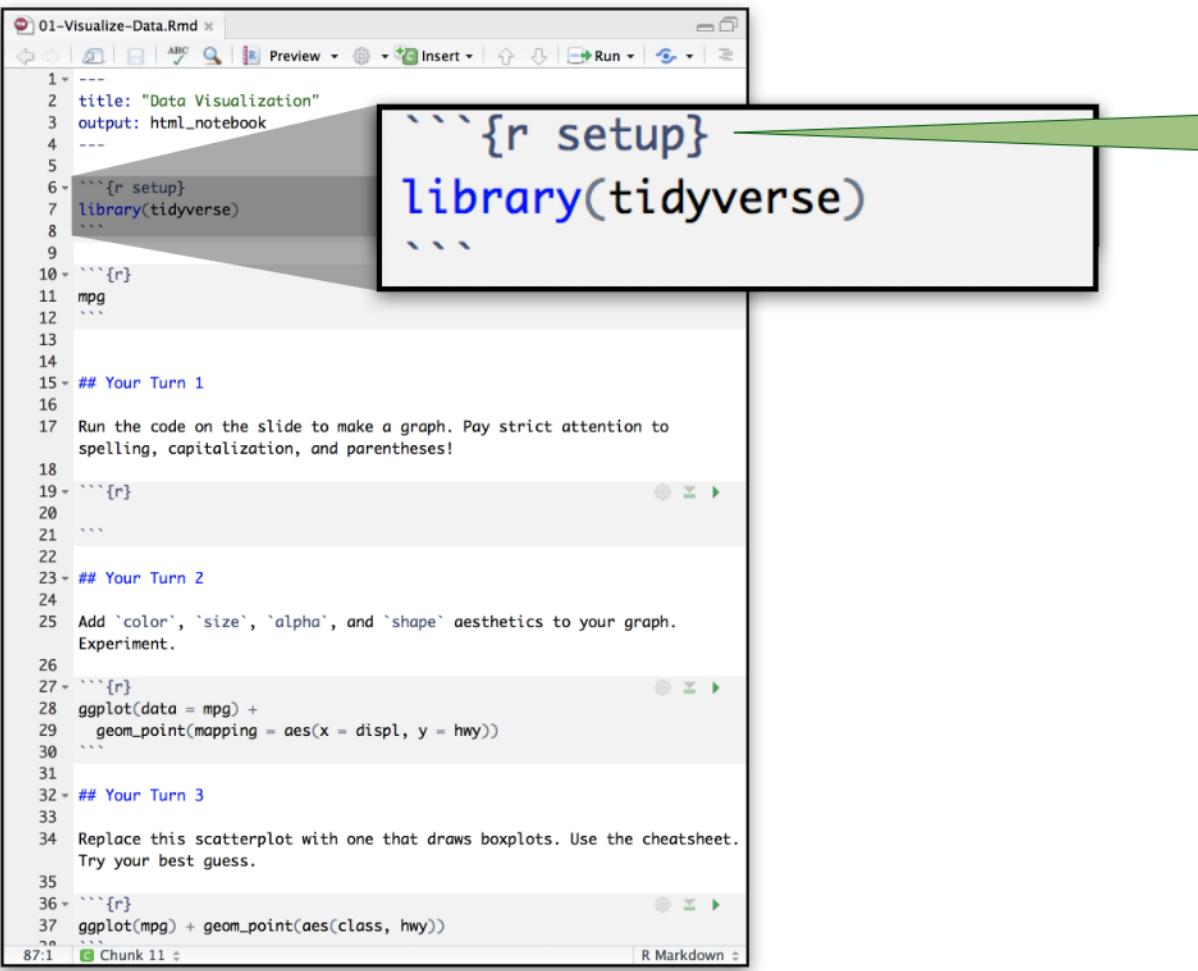
Click to run all  
chunks before this  
one.



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!

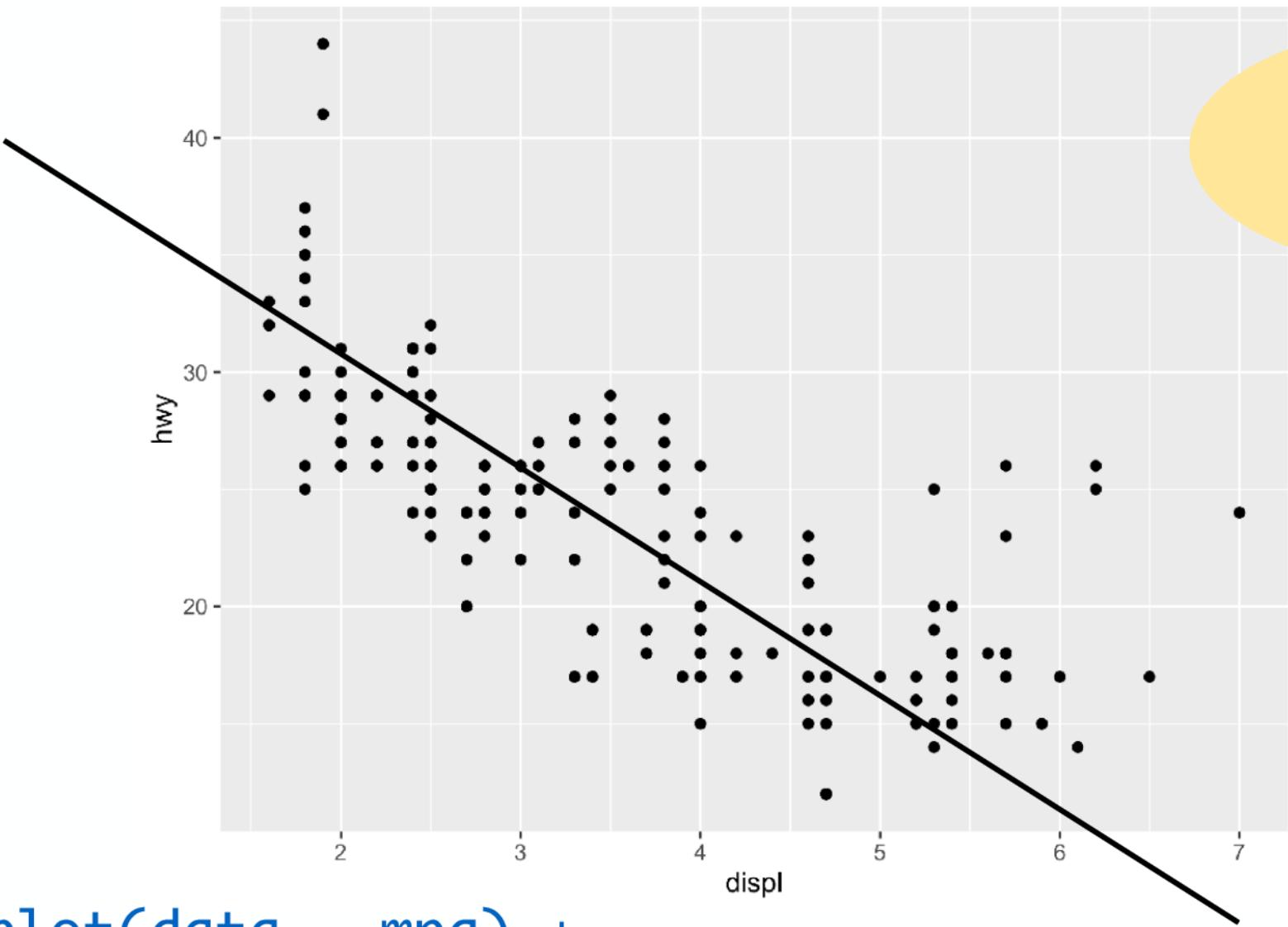
```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy))
```

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

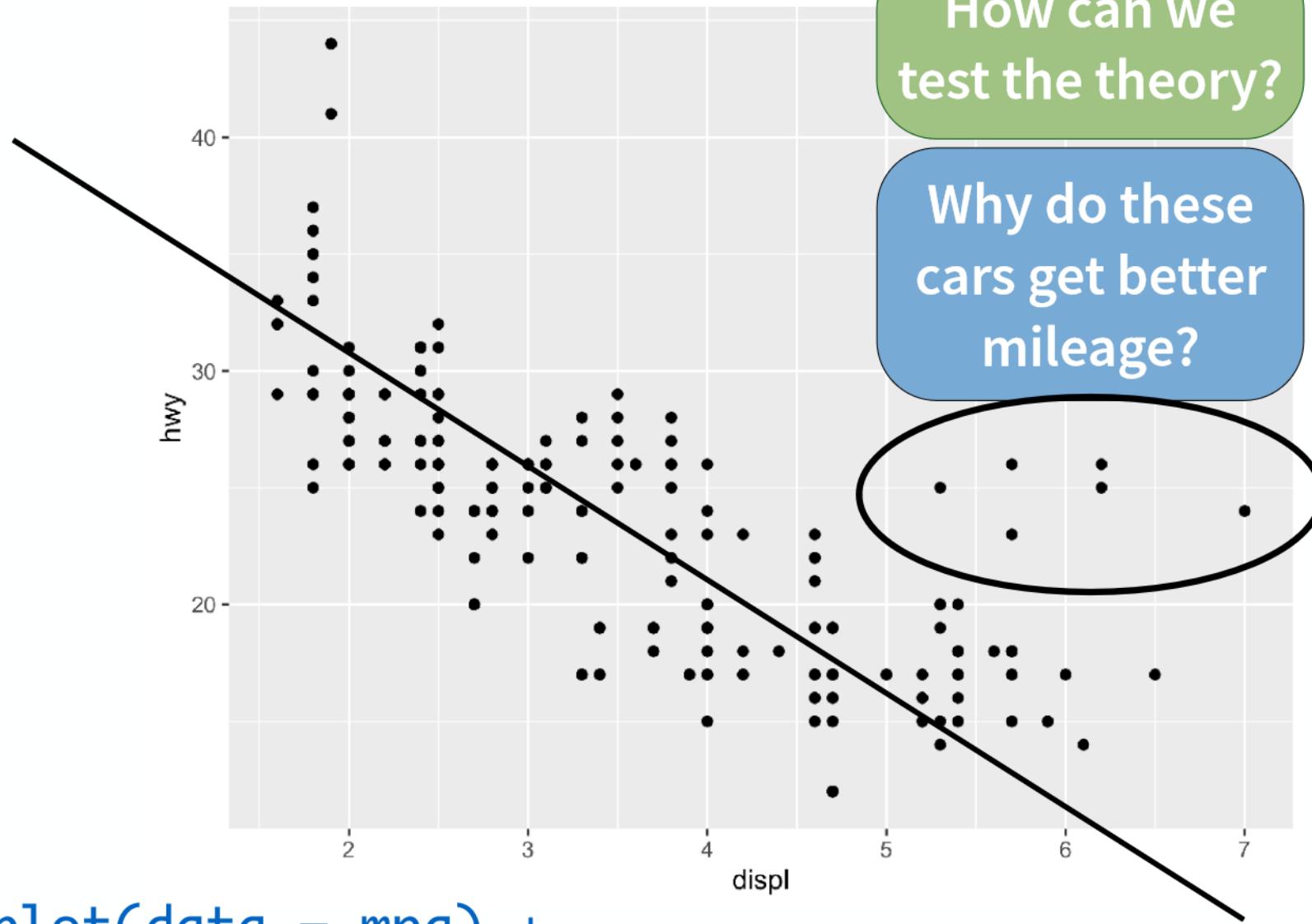


# A Template

```
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))
```

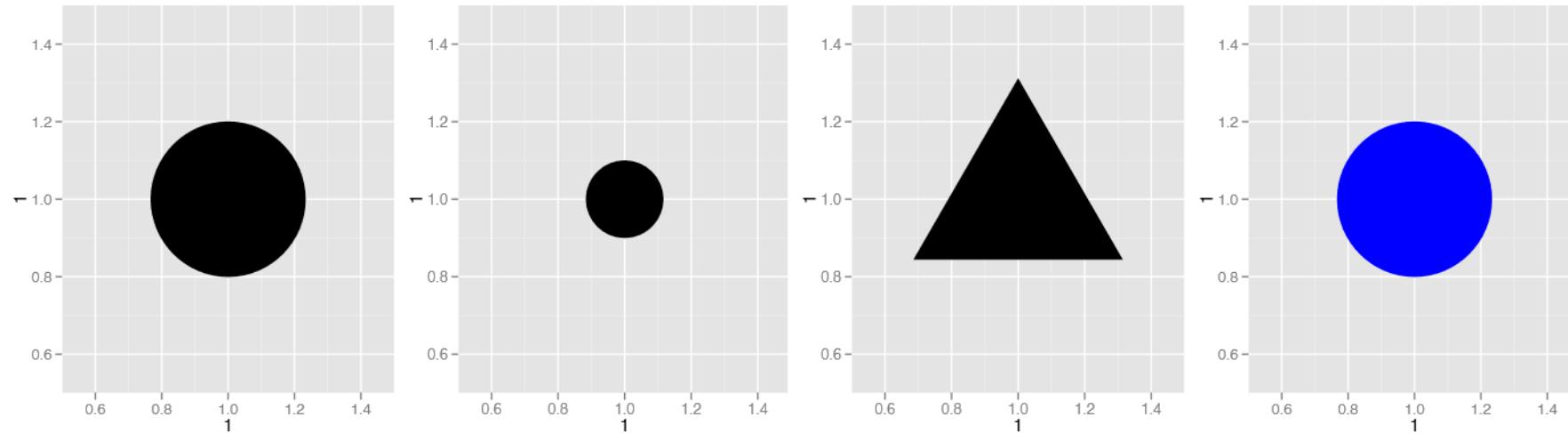
How can we  
test the theory?

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))
```

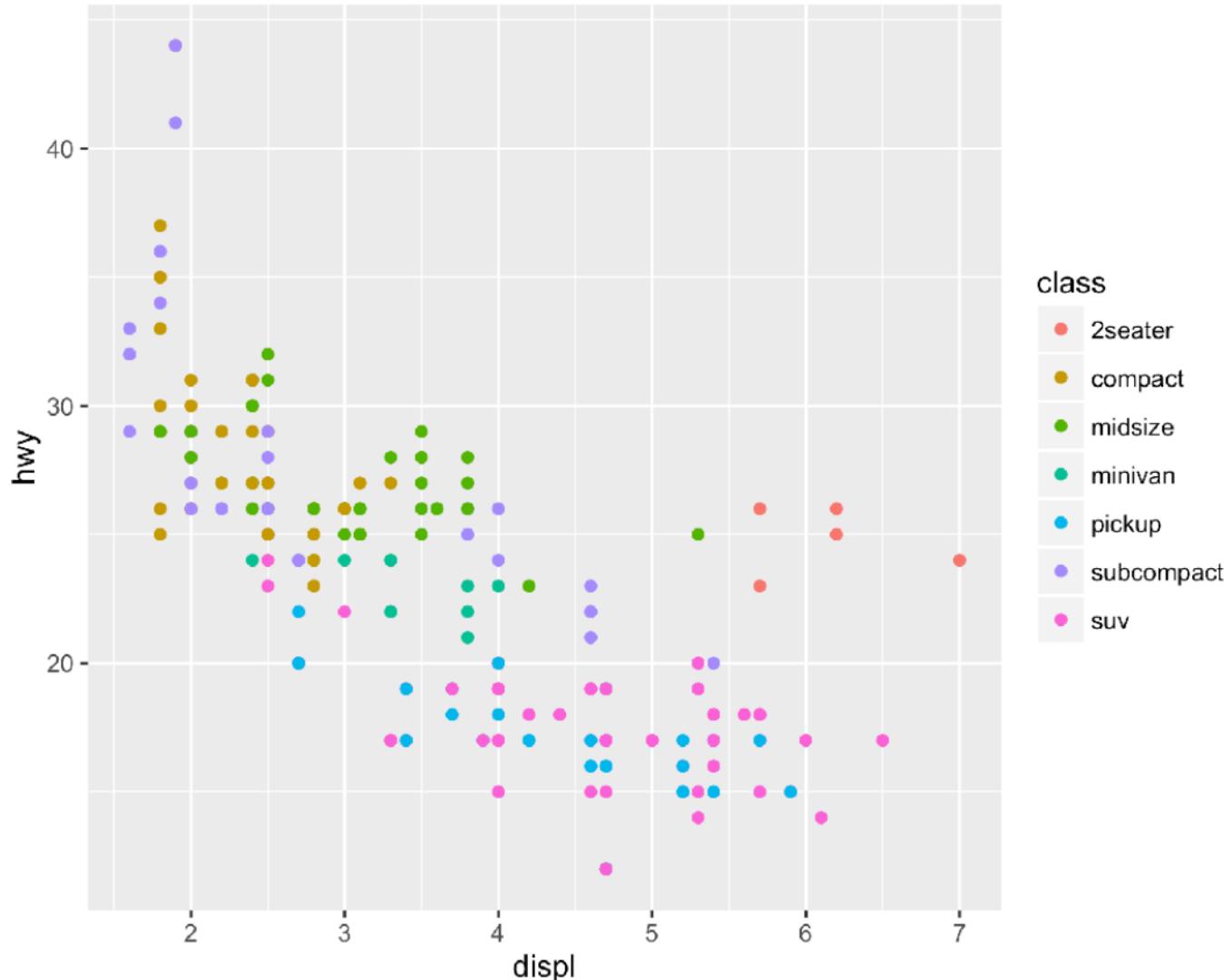
aesthetic  
property

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

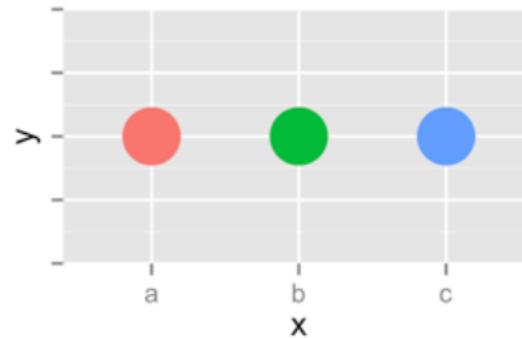
In the next chunk, add color, size, alpha, and shape aesthetics to your graph. Experiment.

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



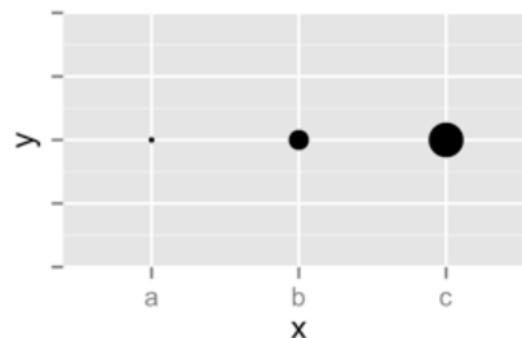
Color

Discrete

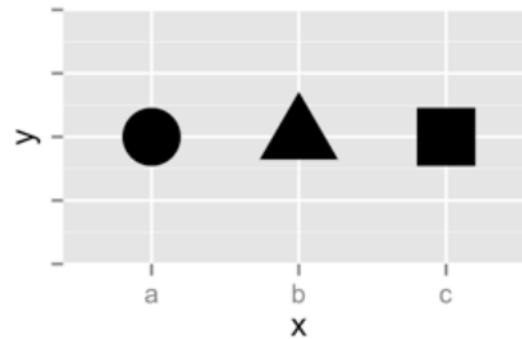


Size

Continuous

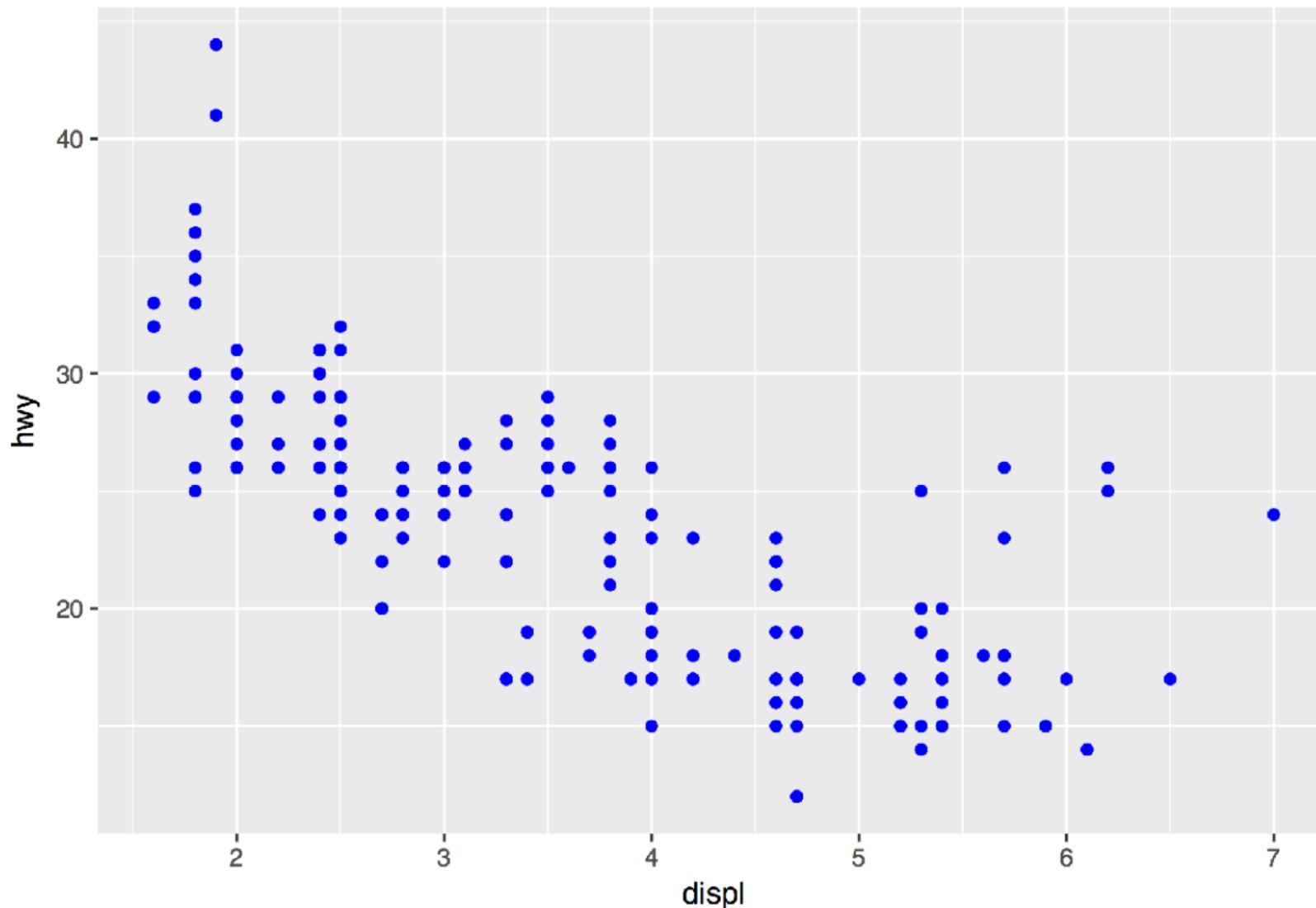


Shape

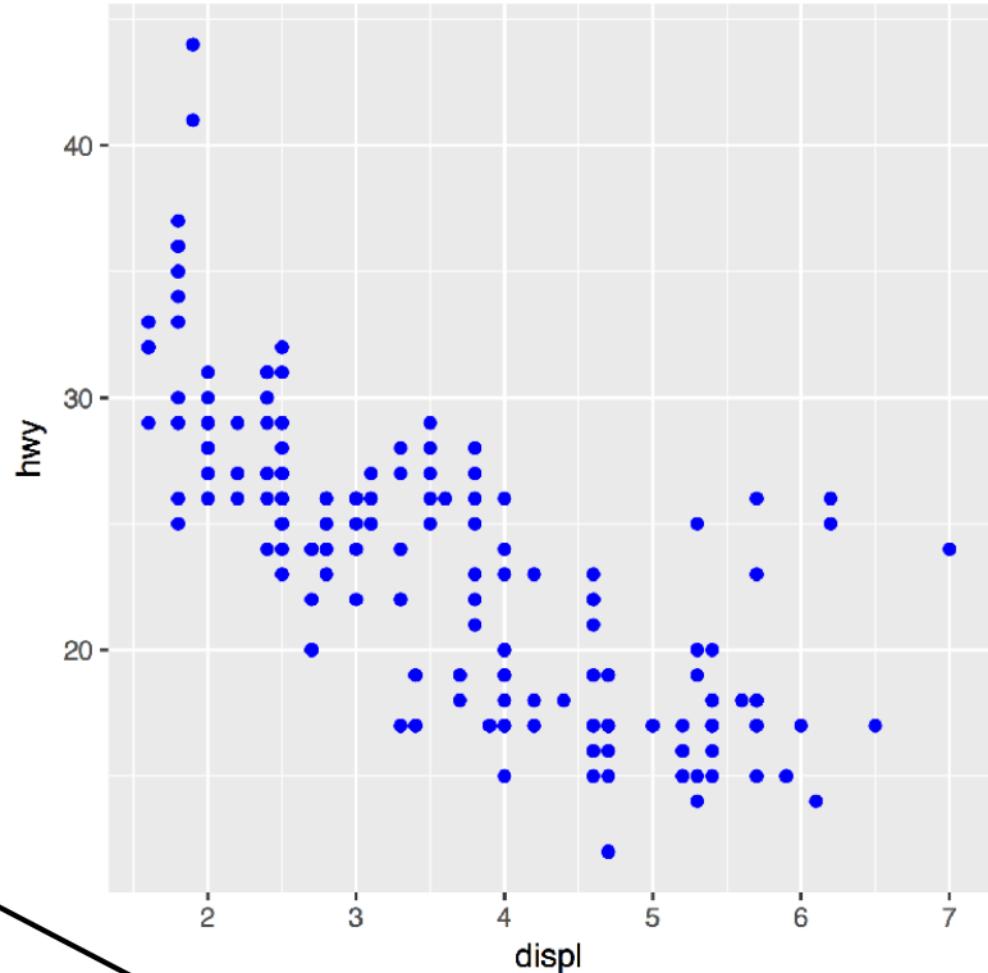


# Setting vs. Mapping an aesthetic

# How would you make this plot?

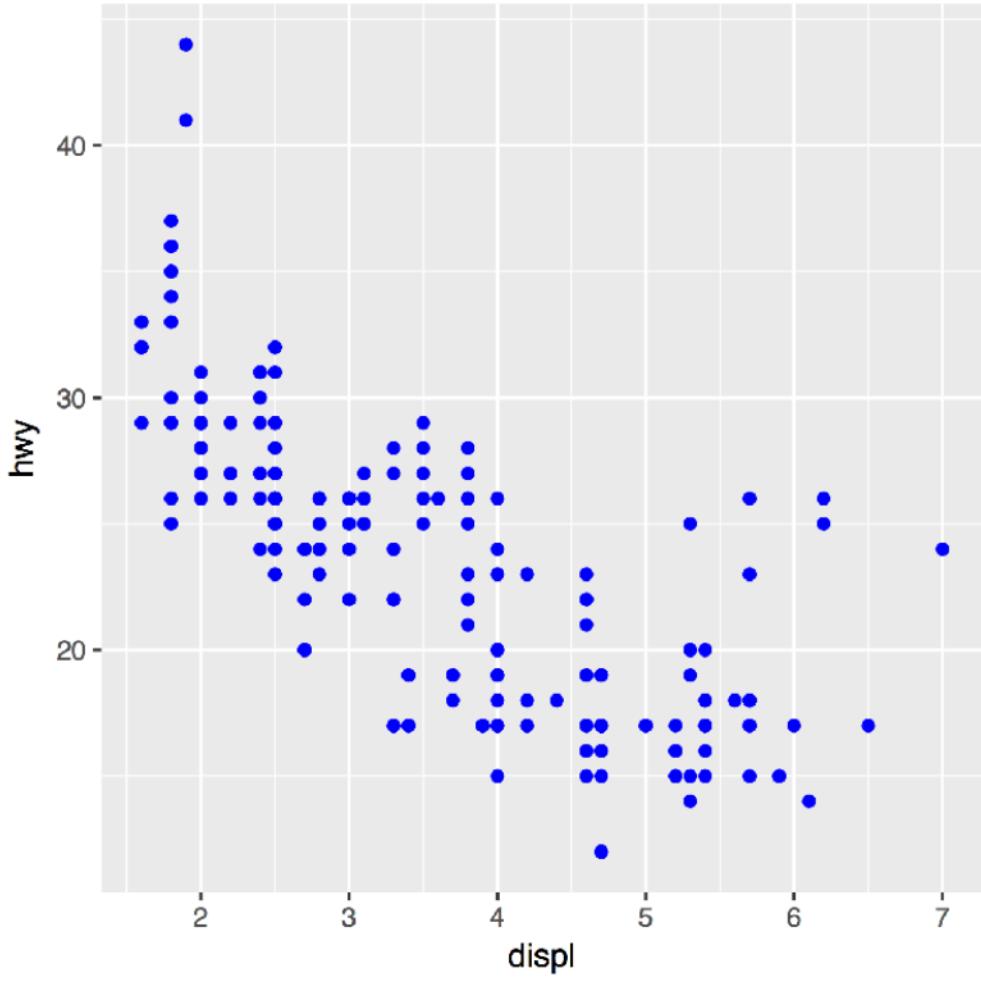
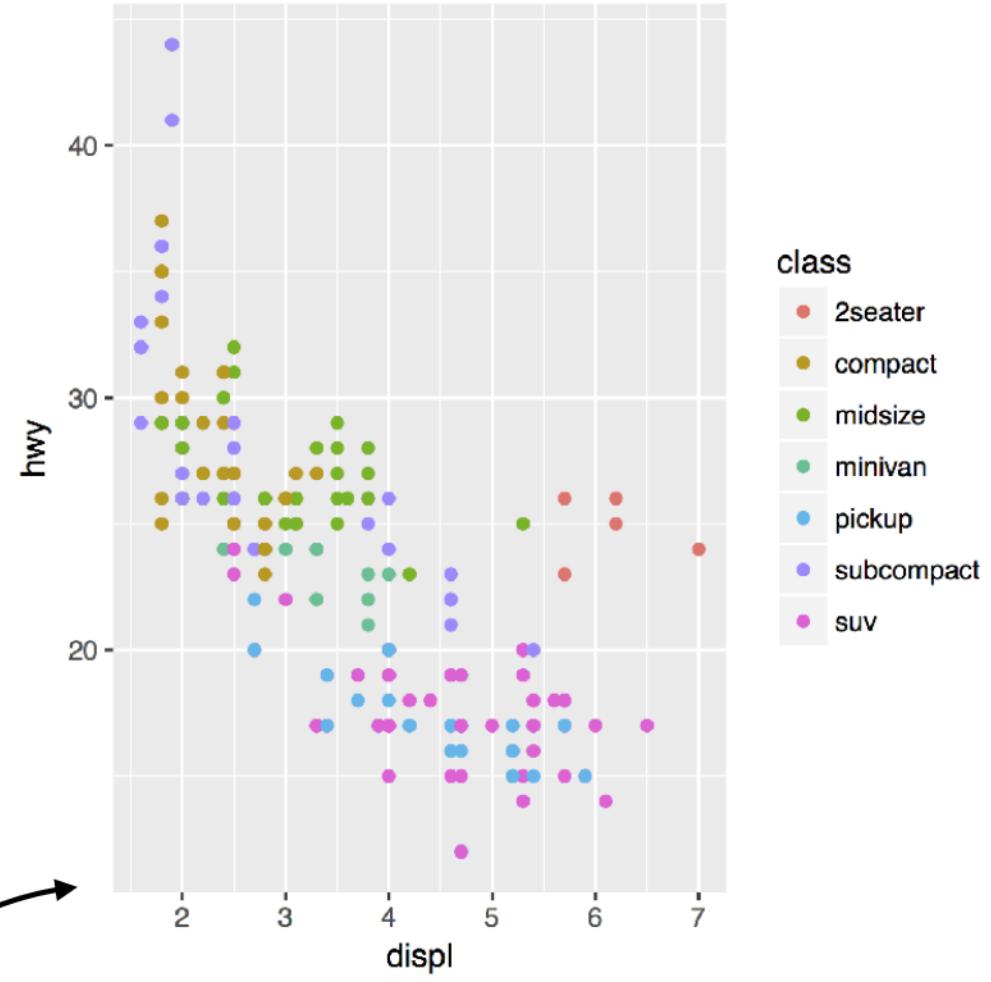


**Outside of aes():** sets  
an aesthetic to a value



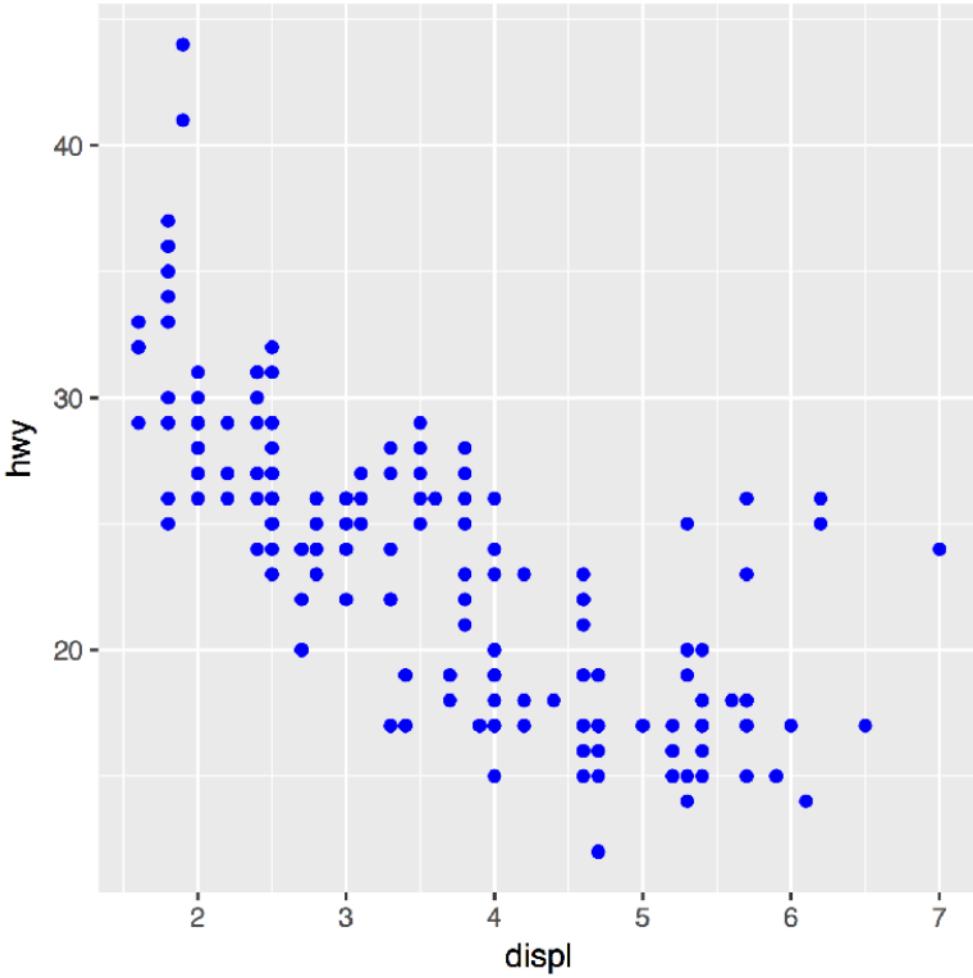
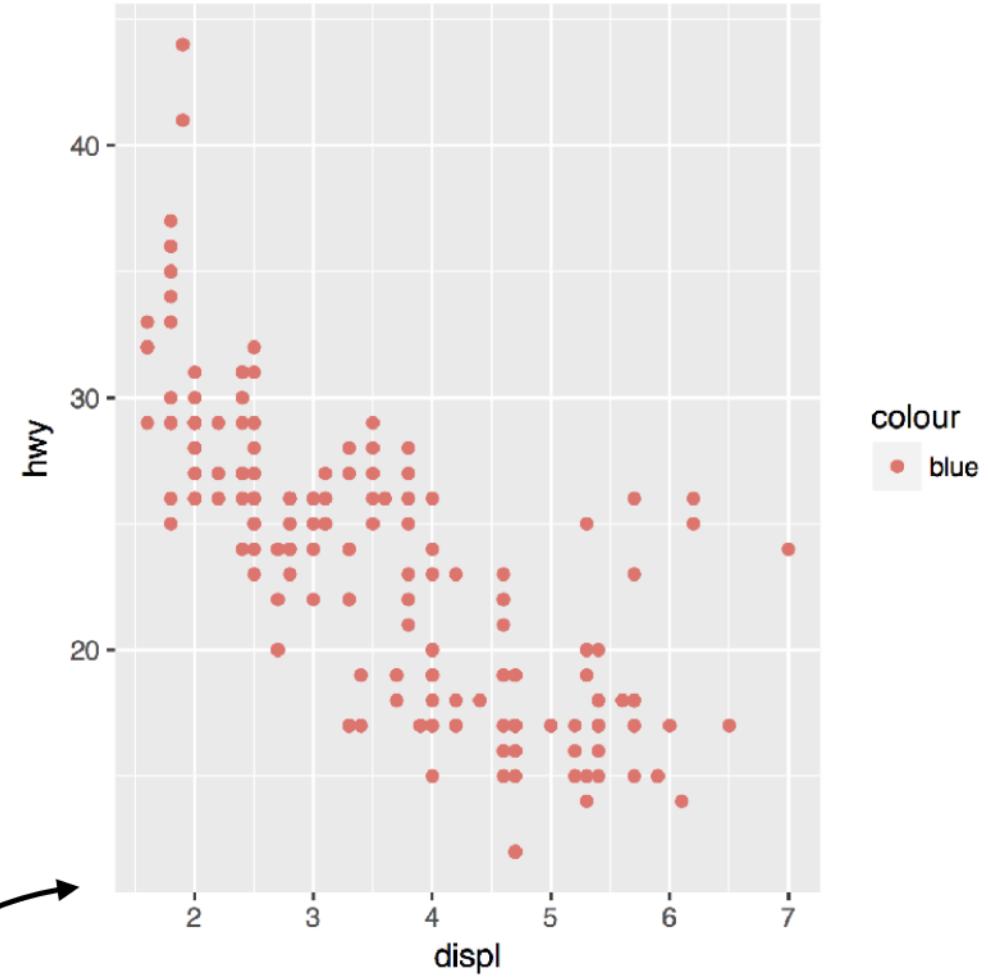
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = class))
```

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



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

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



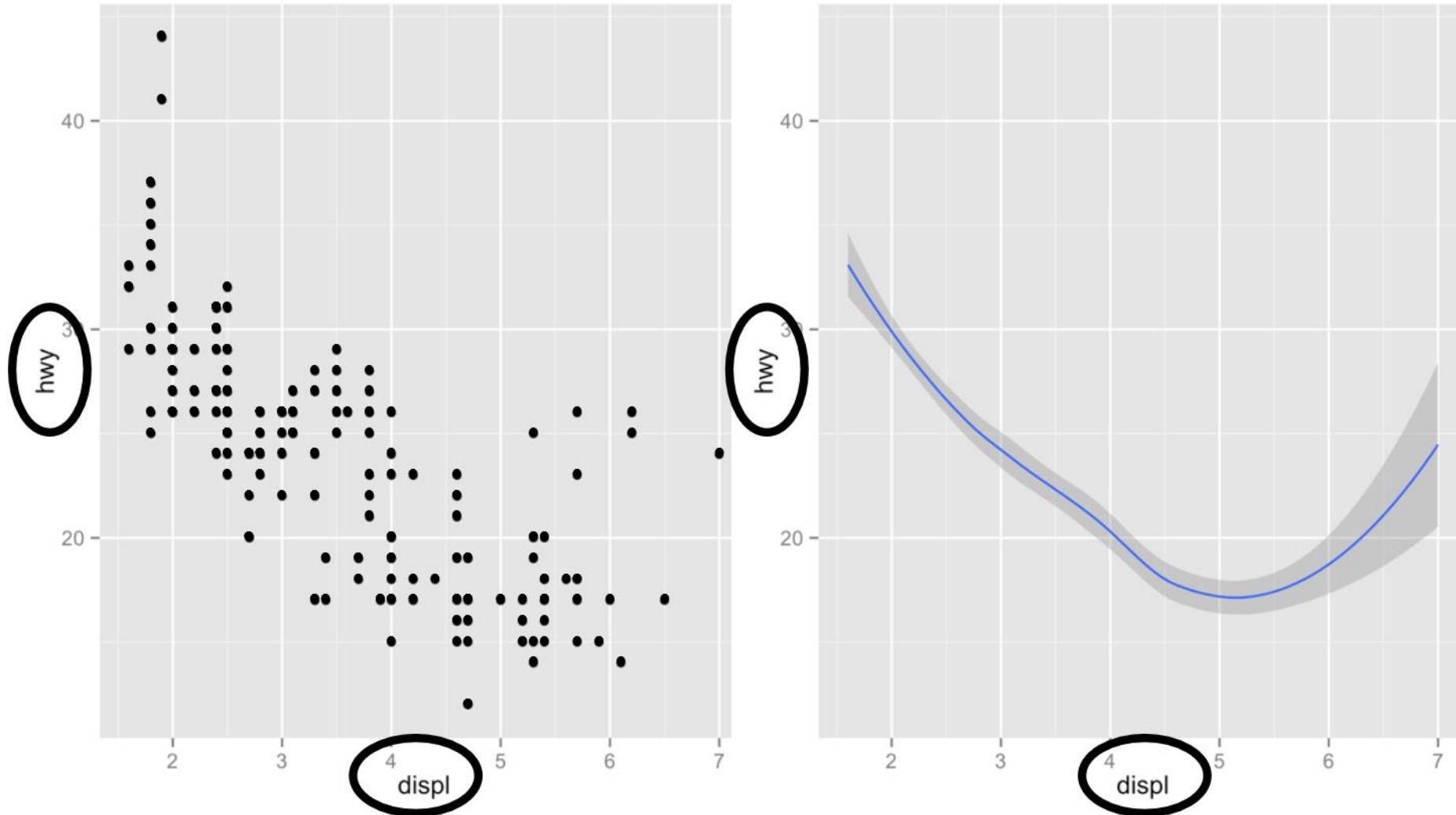
```
ggplot(mpg) + geom_point(aes(x = displ, y = hwy, color = "blue"))
```

```
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, xmin, ymin, xmax,
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
```

ggplot2

### 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, ymn, ymx, 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
```

### THREE VARIABLES

```
sealsSz <- with(seals, sqrt(delta_long^2 + delta_lat^2))
l <- ggplot(seals, aes(long, lat))
l + geom_point(aes(color = seal))
l + geom_text(aes(label = seal))
l + geom_hex()
x, y, alpha, color, fill, size
```

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
```

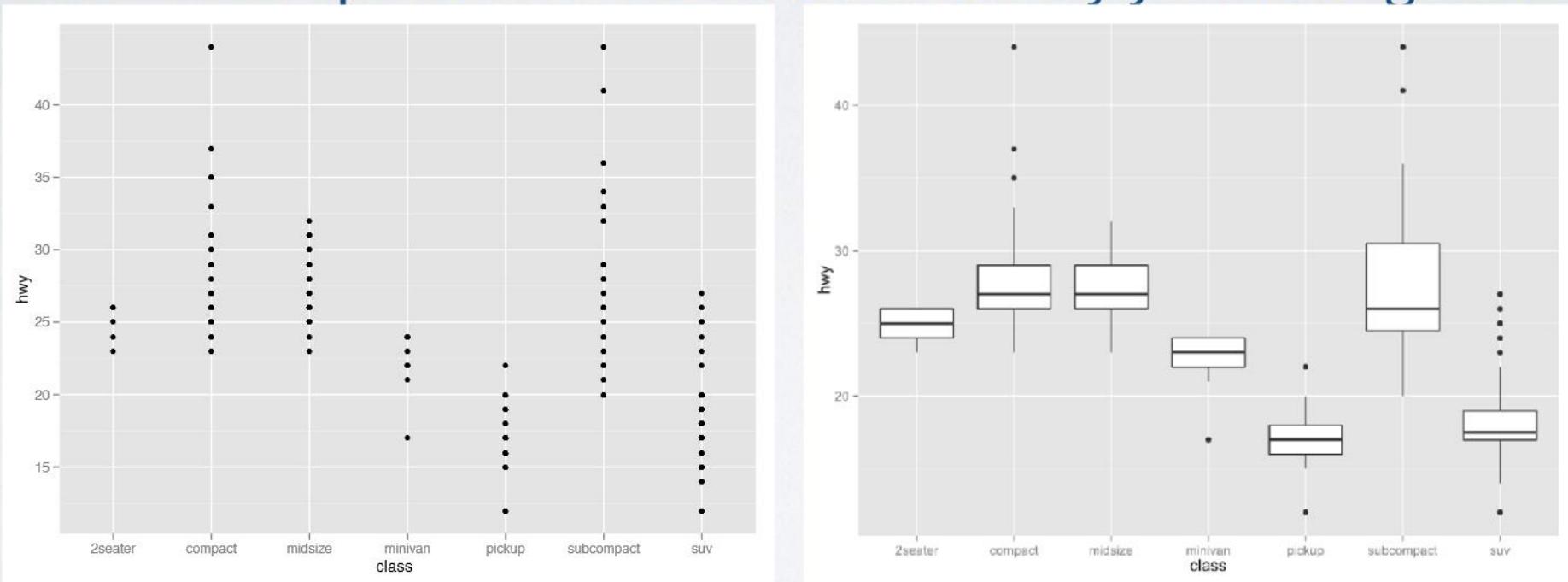
### maps

```
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
```

ggplot2

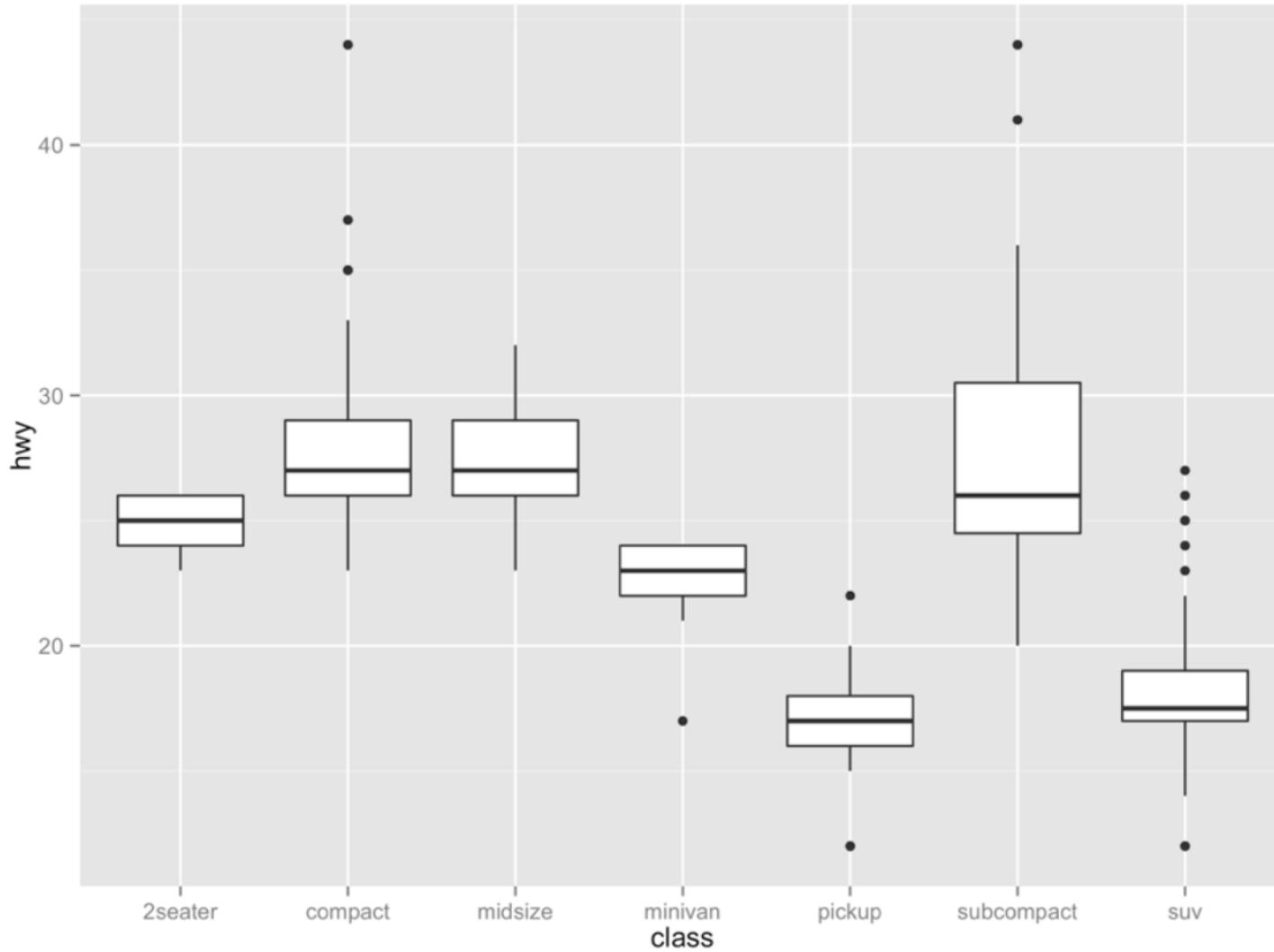
# Your Turn 3

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

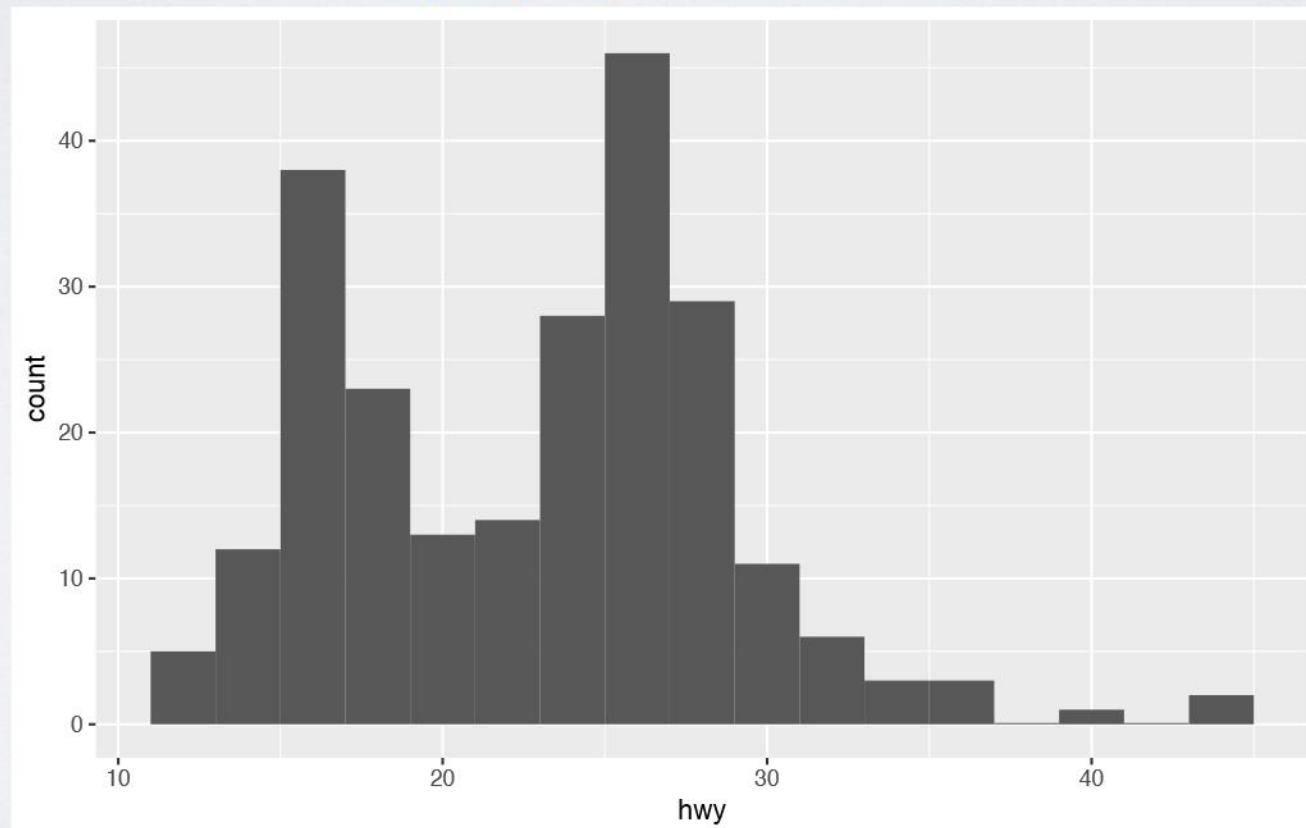


```
ggplot(data = mpg) +  
  geom_boxplot(mapping = aes(x = class, y = hwy))
```

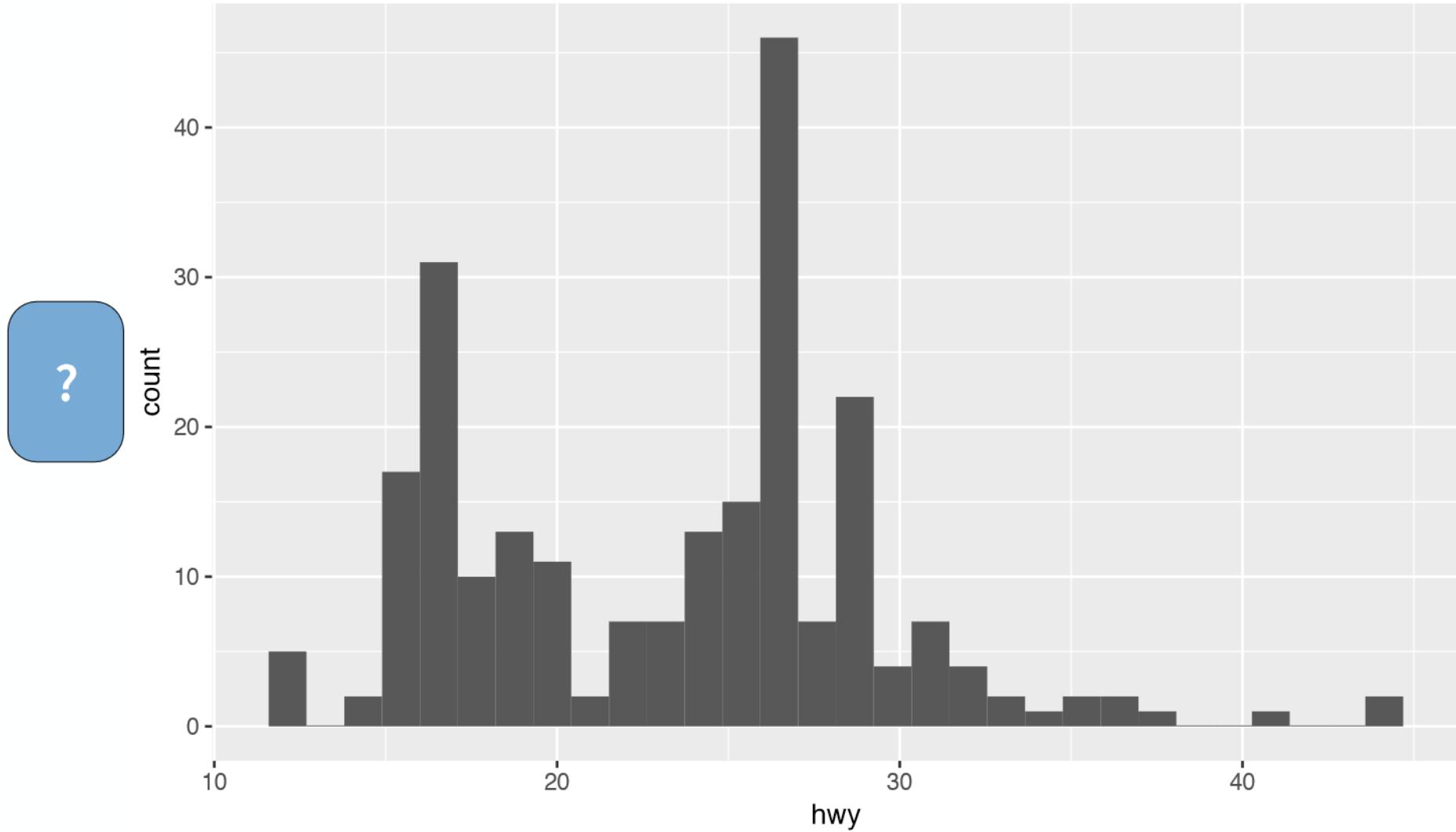


# Your Turn 4

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



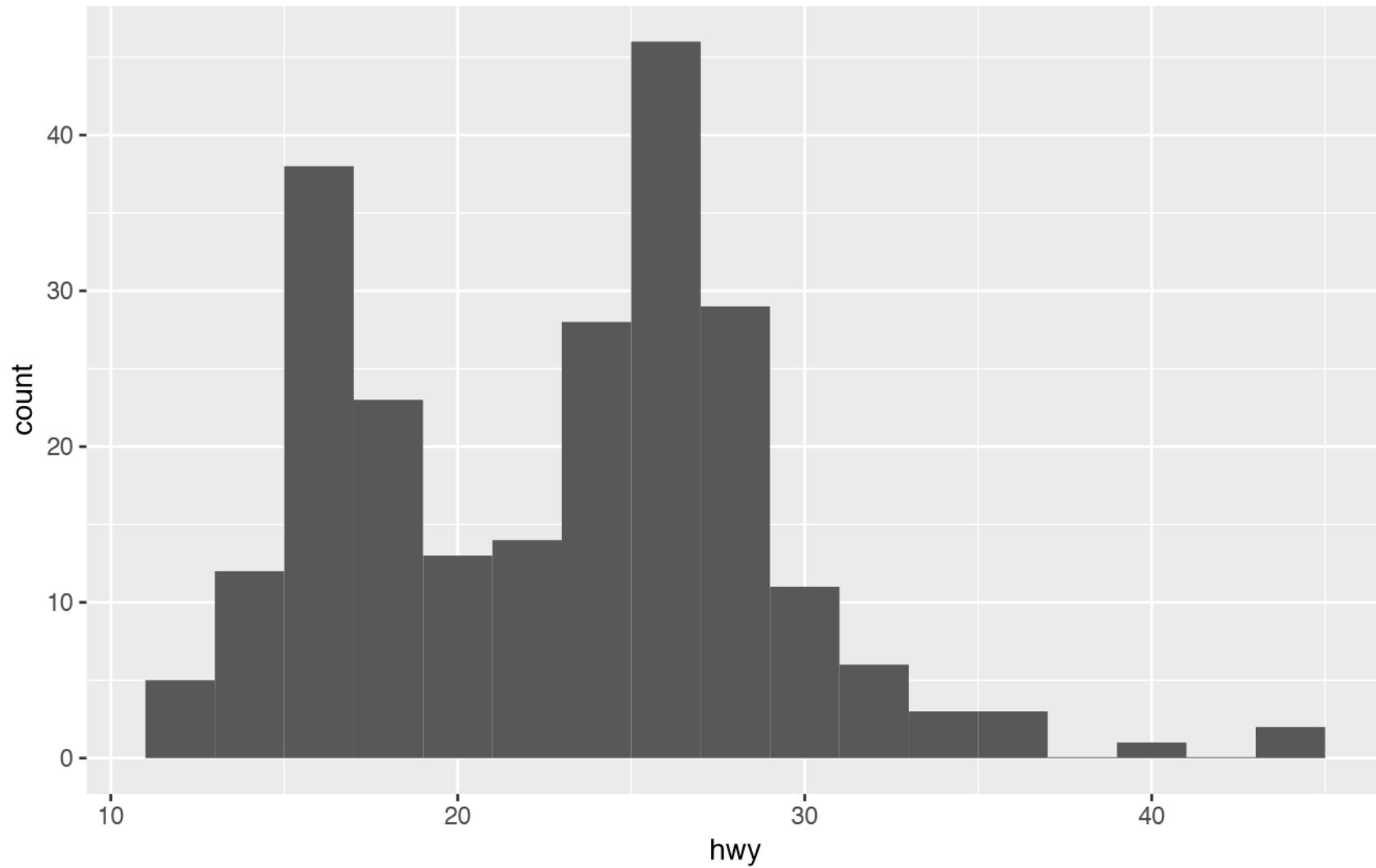
02 : 00



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

No y aesthetic

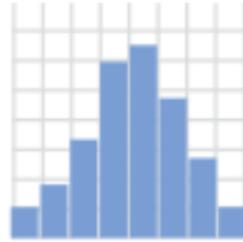




```
ggplot(data = mpg) +  
  geom_histogram(mapping = aes(x = hwy), binwidth = 2)
```



On the cheatsheat:



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

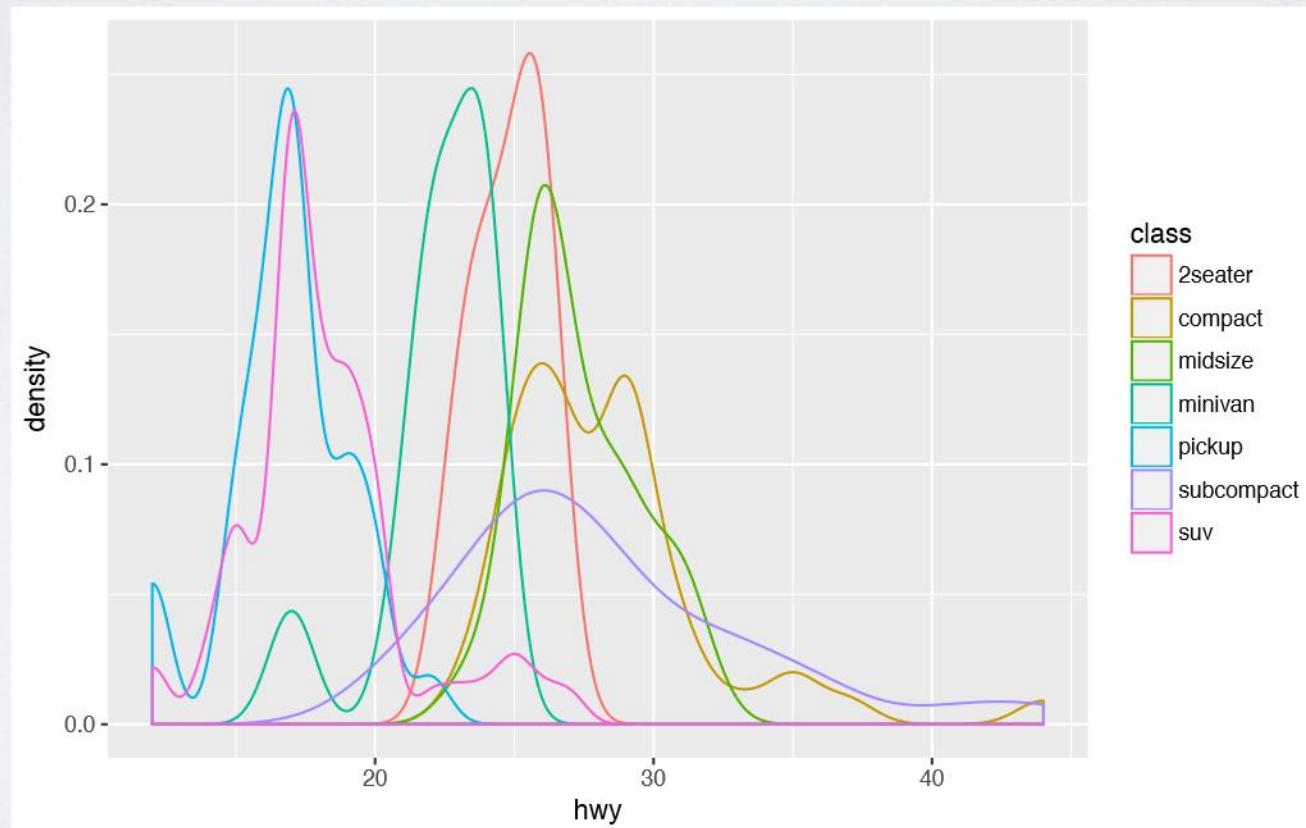
Arguments inside (), are  
geom specific options

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

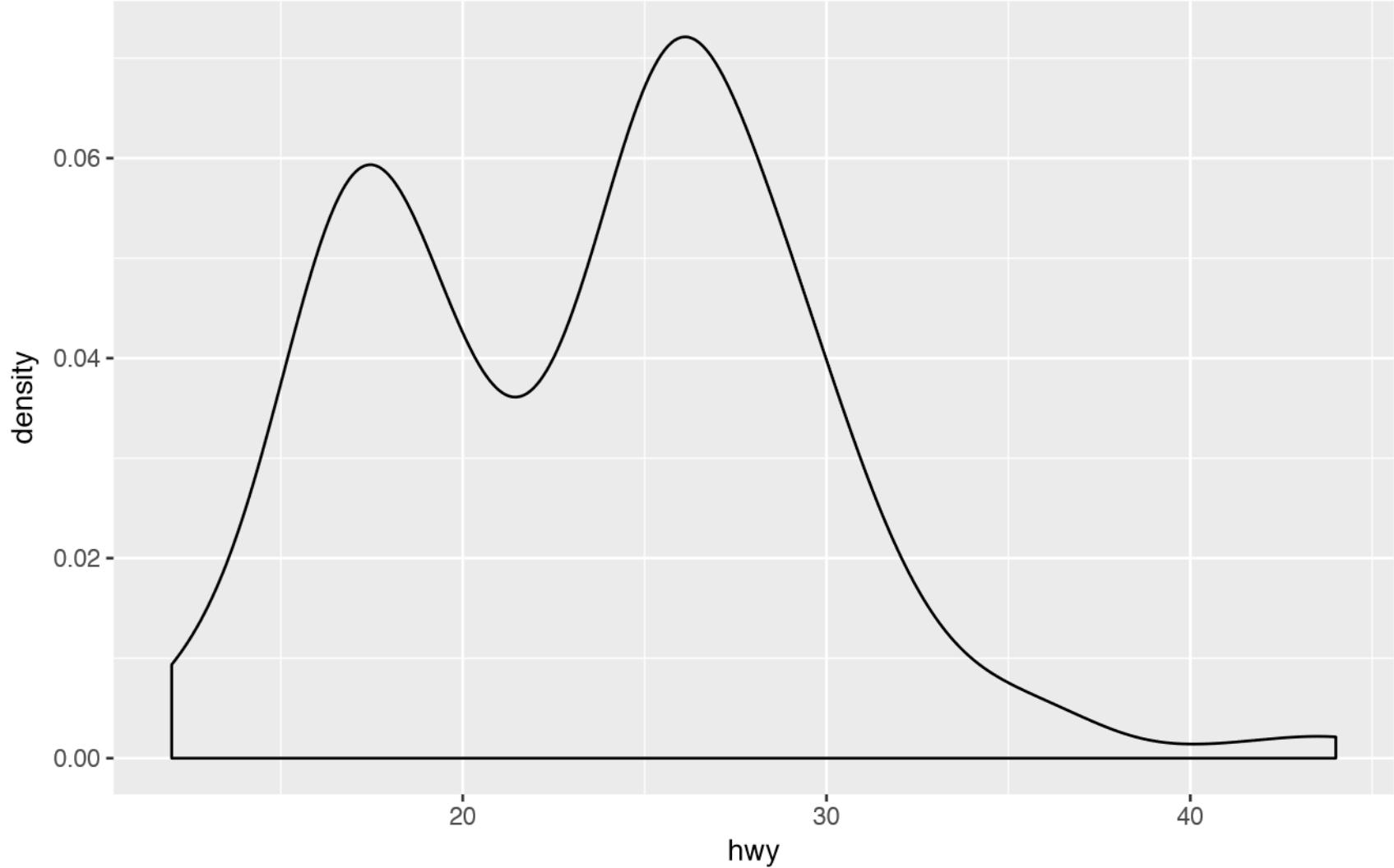


# Your Turn 5

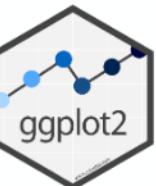
With your partner, make the density plot of `hwy` colored by `class` below. Use the cheatsheet. Try your best guess.

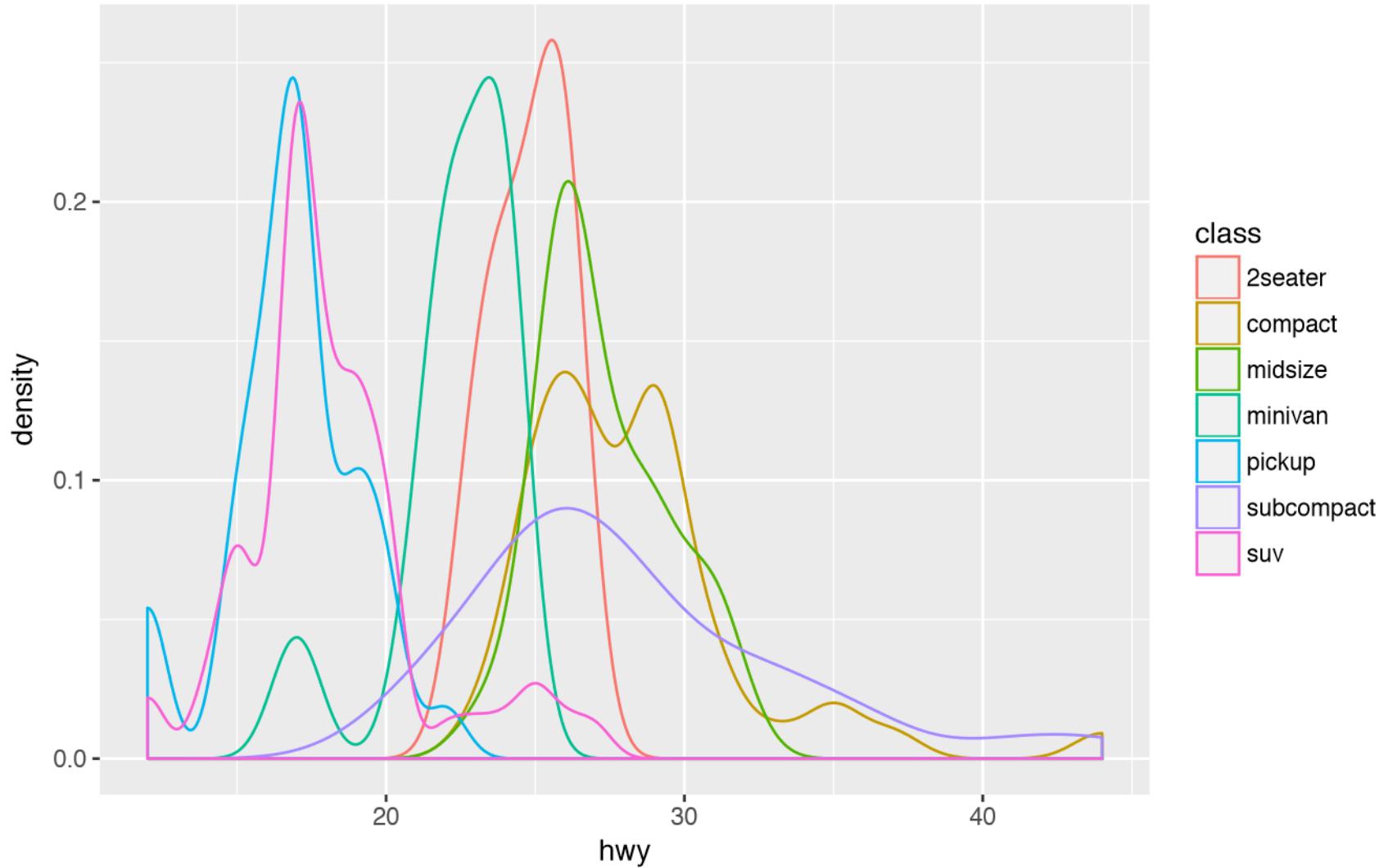


02 : 00

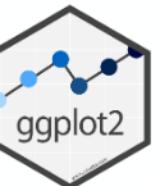


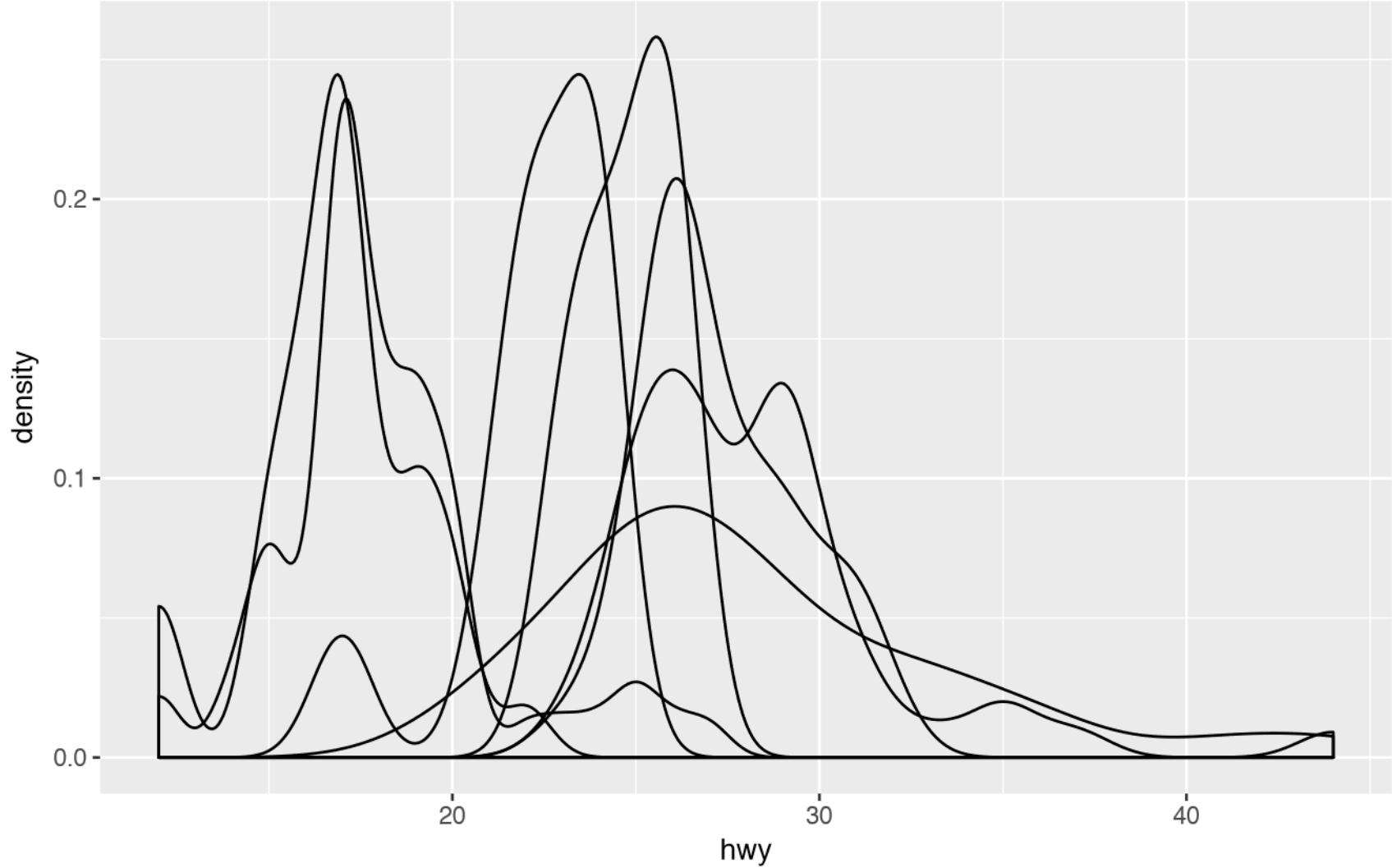
```
ggplot(data = mpg) +  
  geom_density(mapping = aes(x = hwy))
```





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



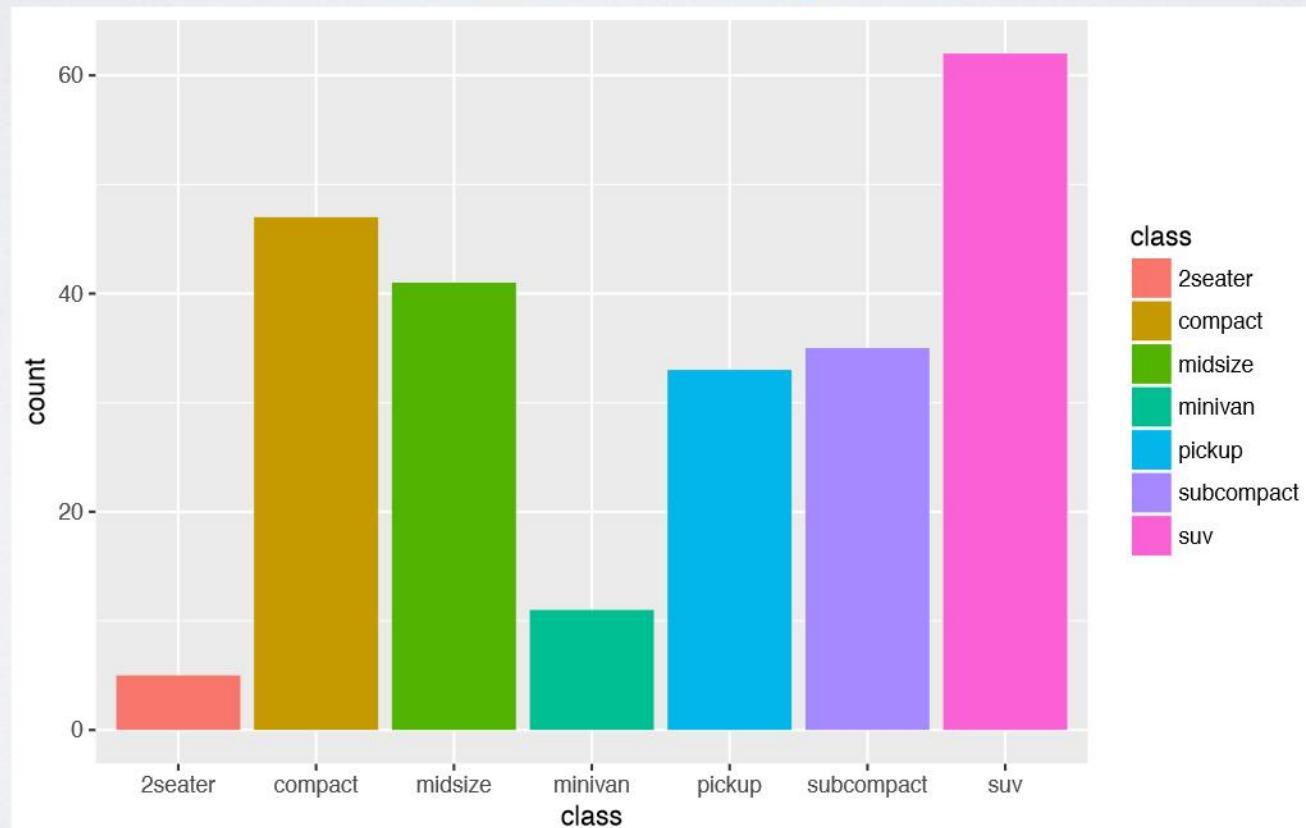


```
ggplot(data = mpg) +  
  geom_density(mapping = aes(x = hwy, group = class))
```

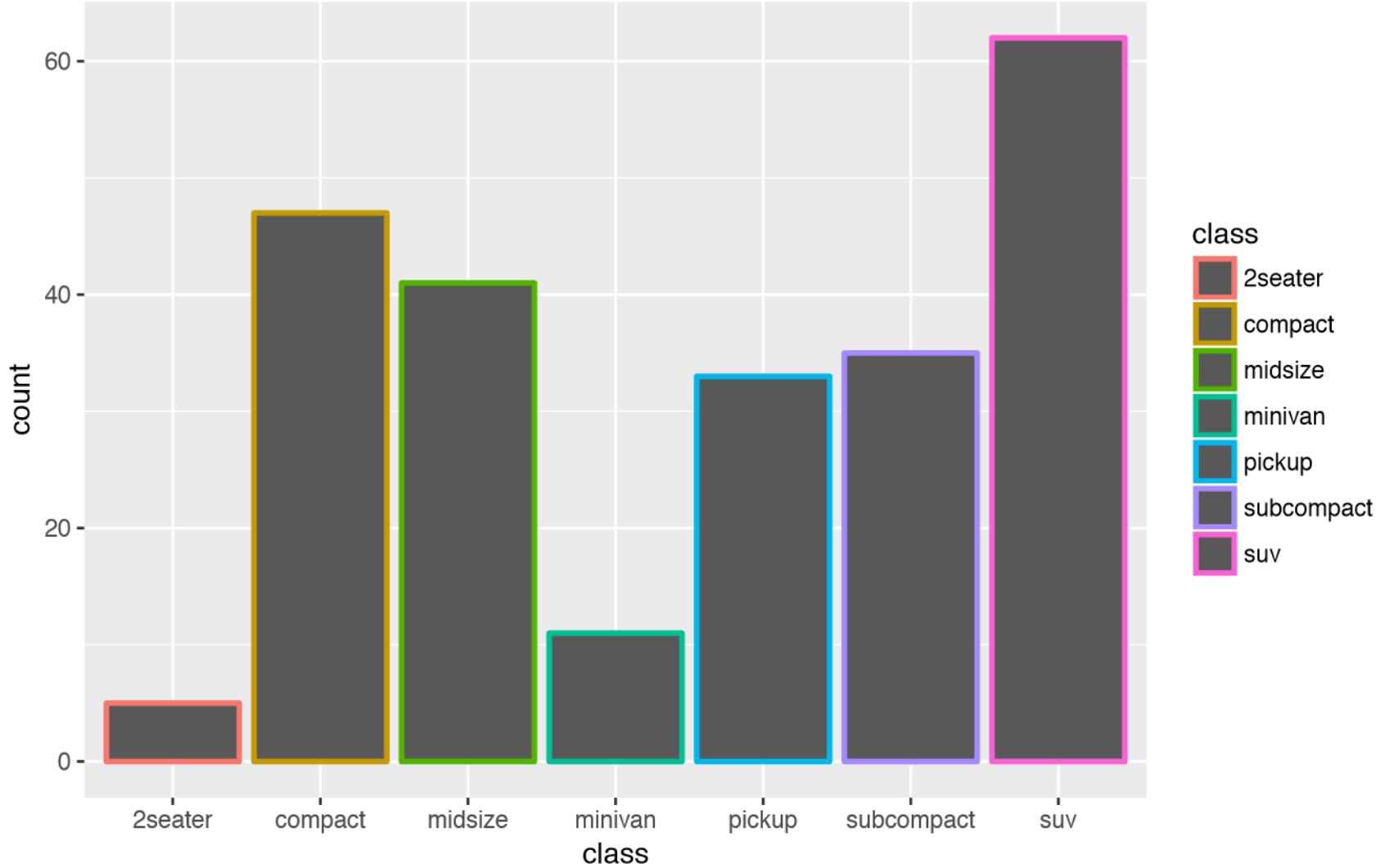


# Your Turn 6

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

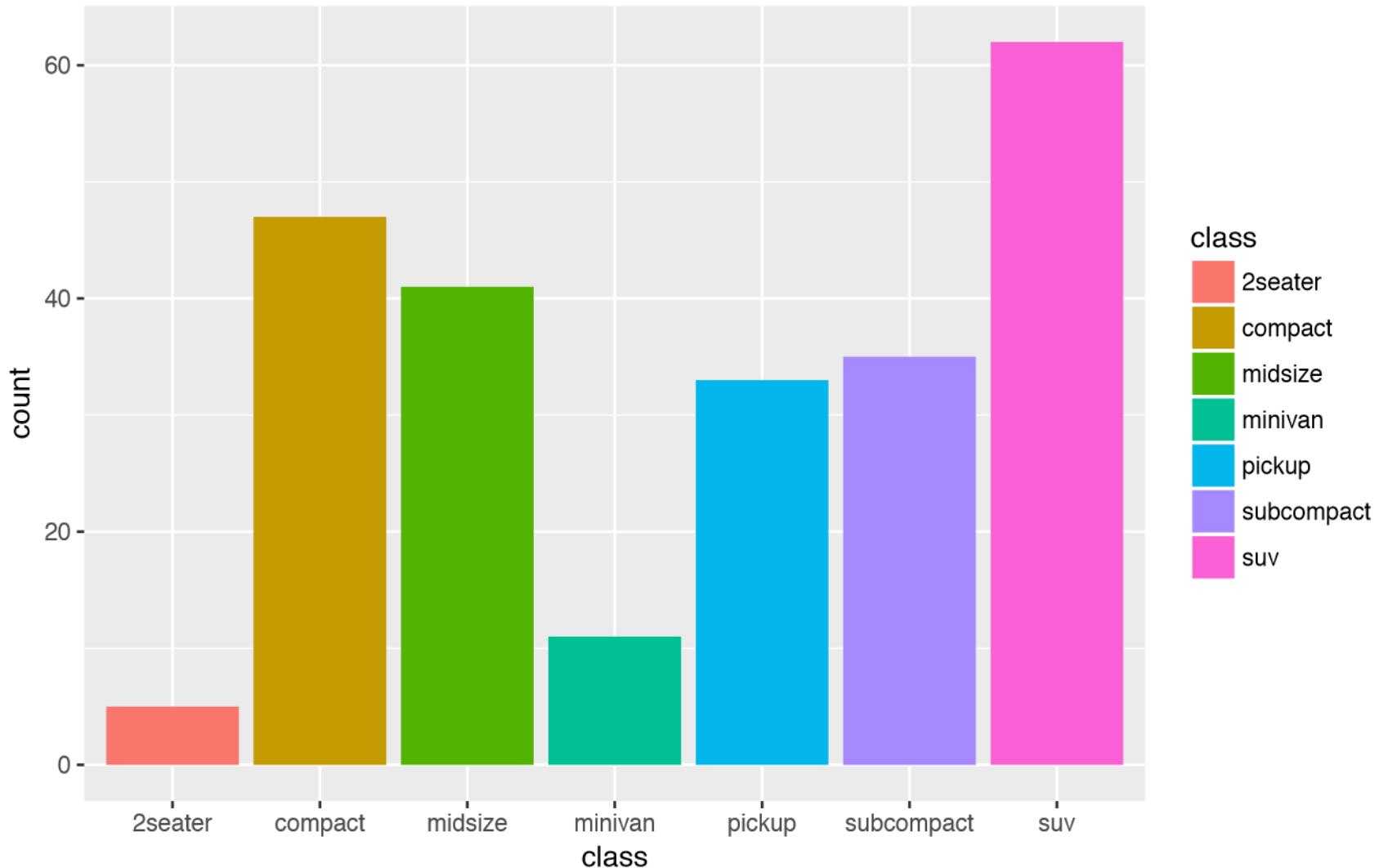


02 : 00



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





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

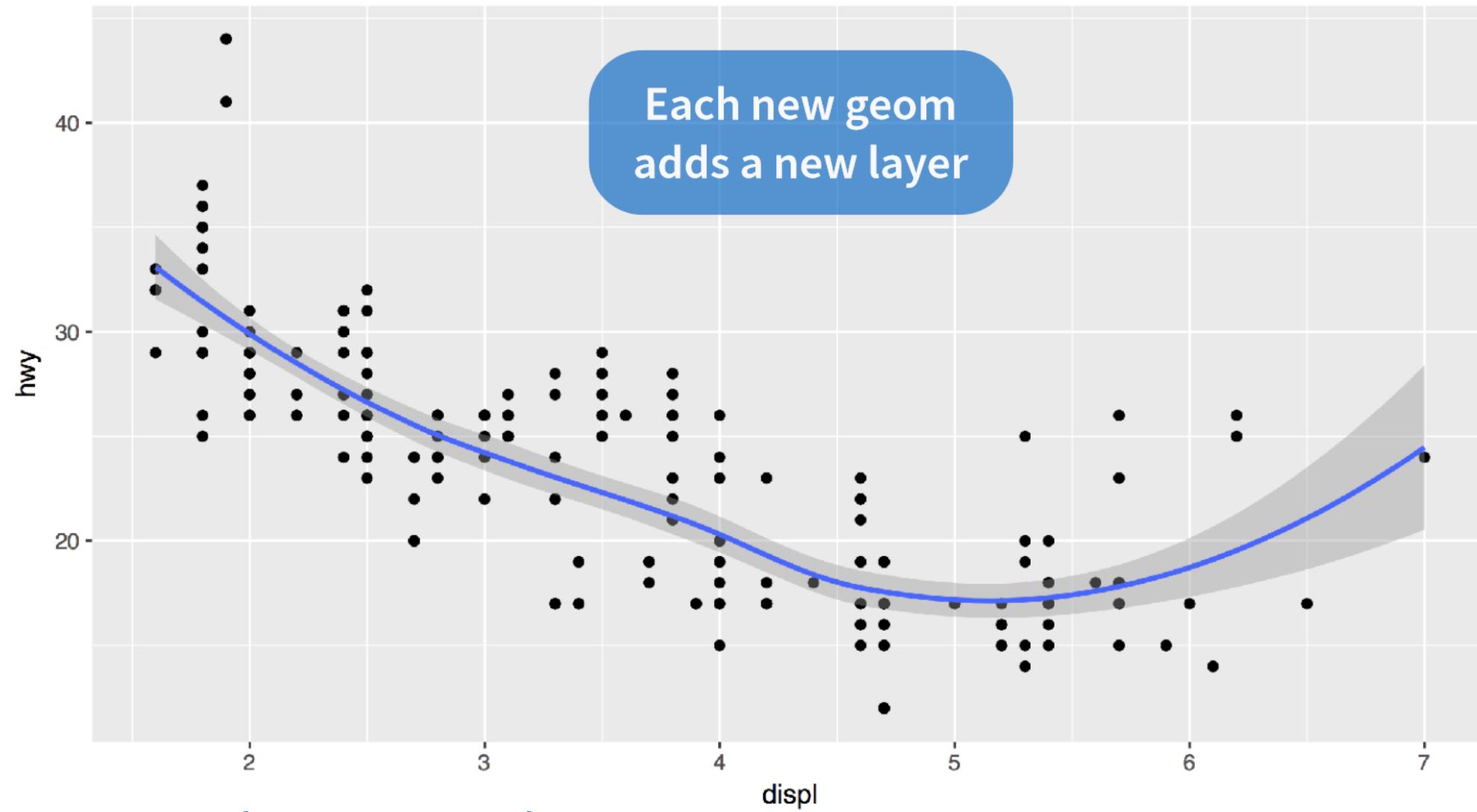


# Your Turn 7

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

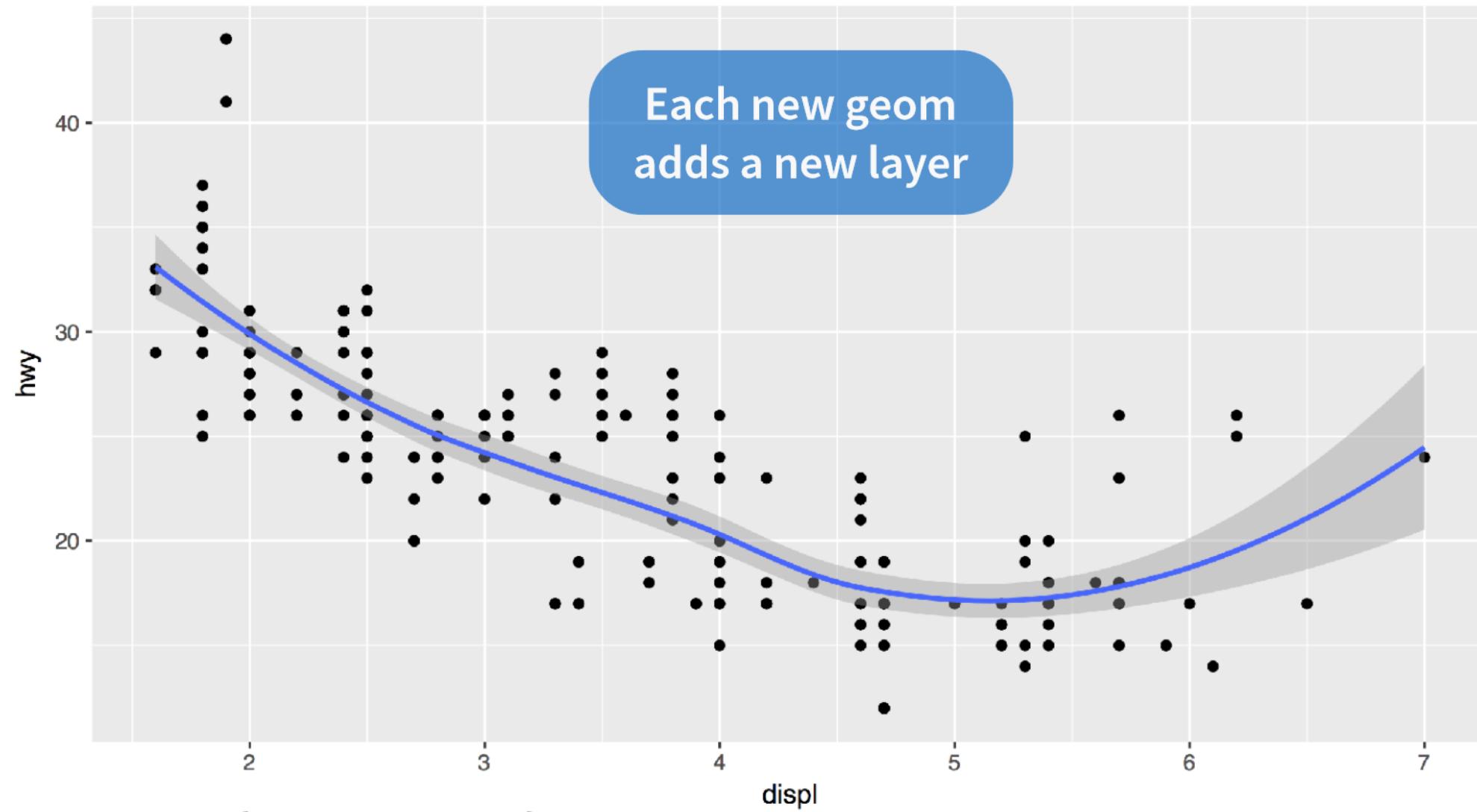
```
ggplot(mpg) +  
  geom_point(aes(displ, hwy)) +  
  geom_smooth(aes(displ, hwy))
```





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

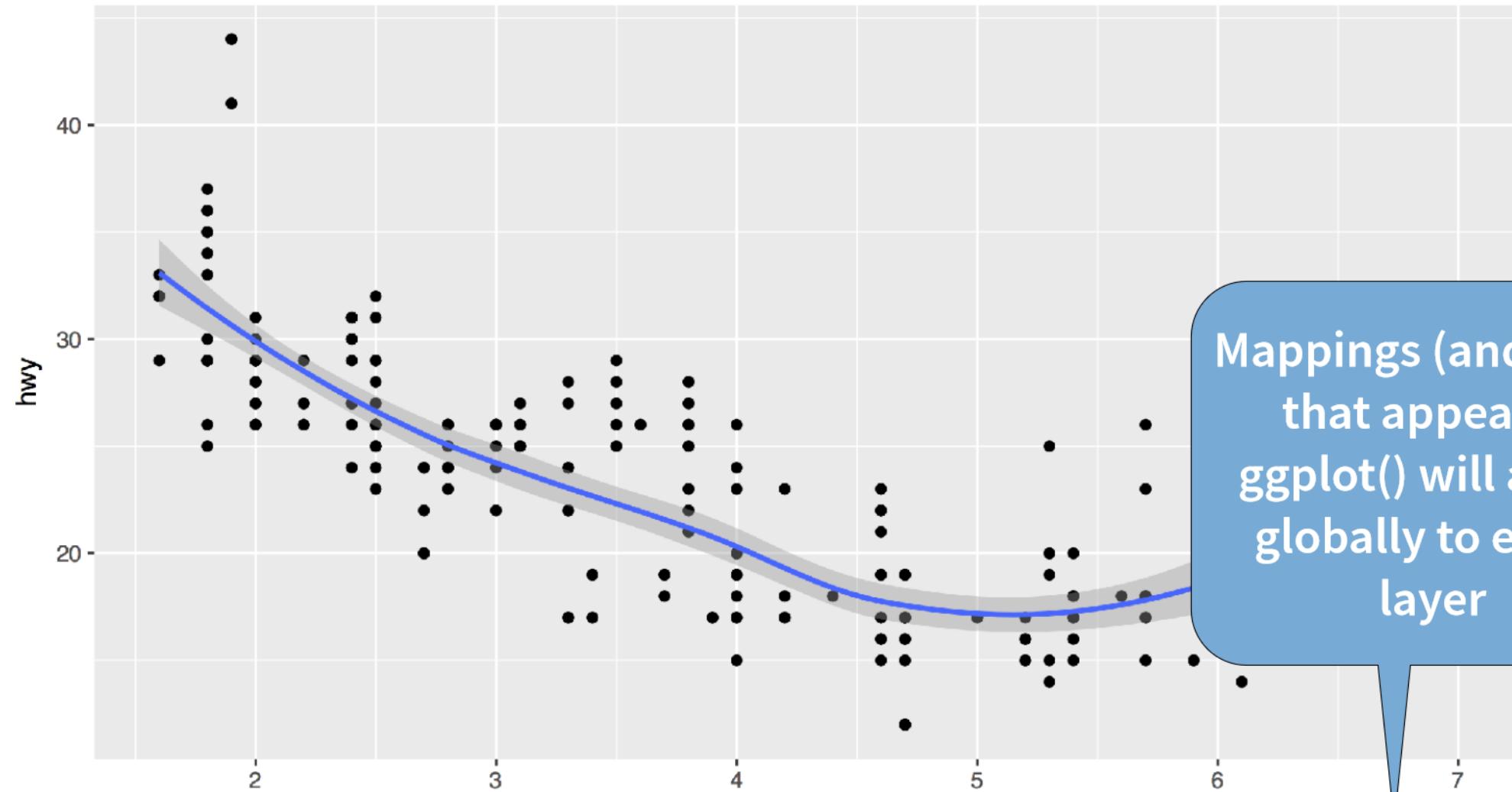




```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy)) +  
  geom_smooth(mapping = aes(x = displ, y = hwy))
```

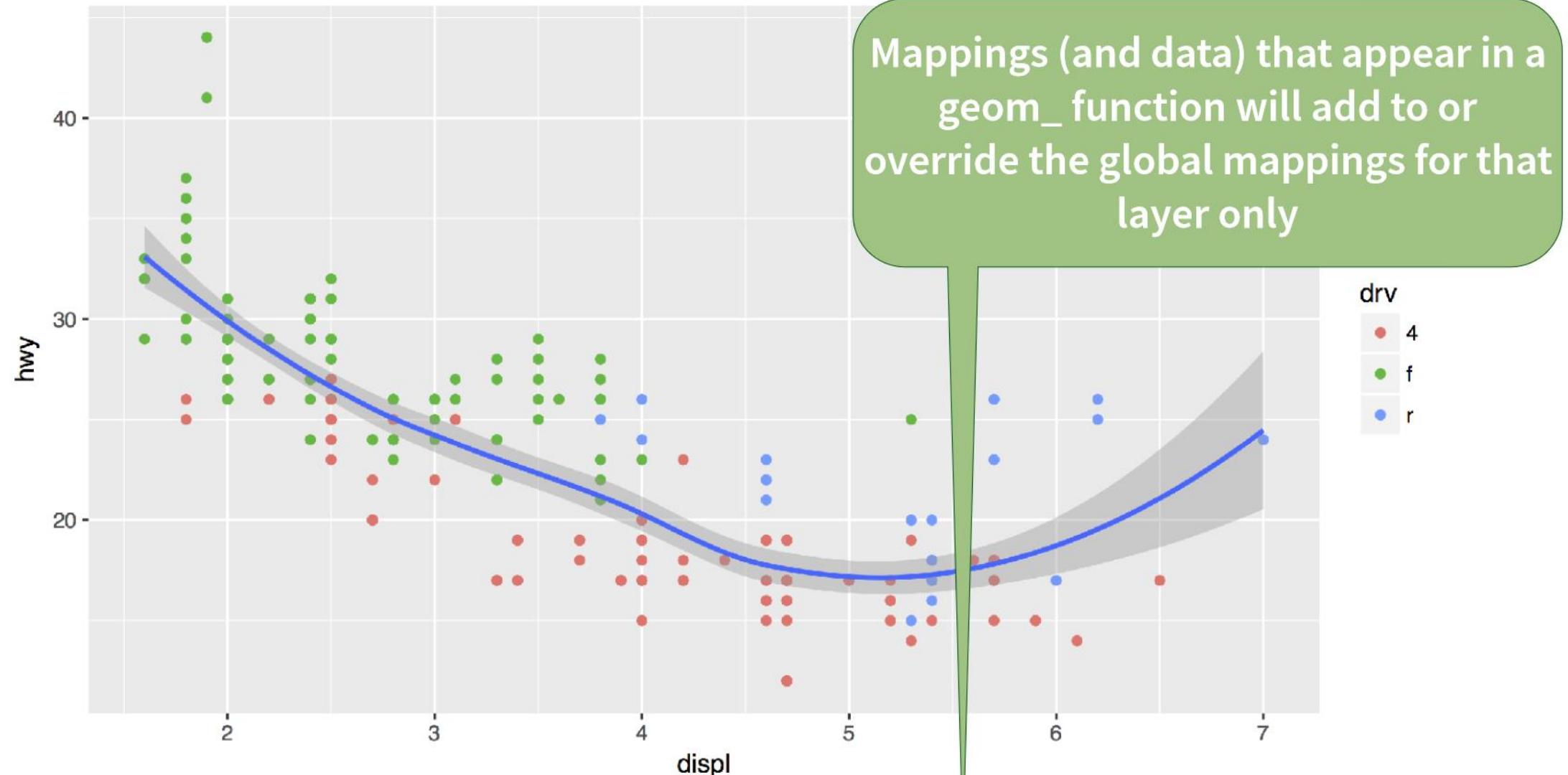


# Global vs. Local



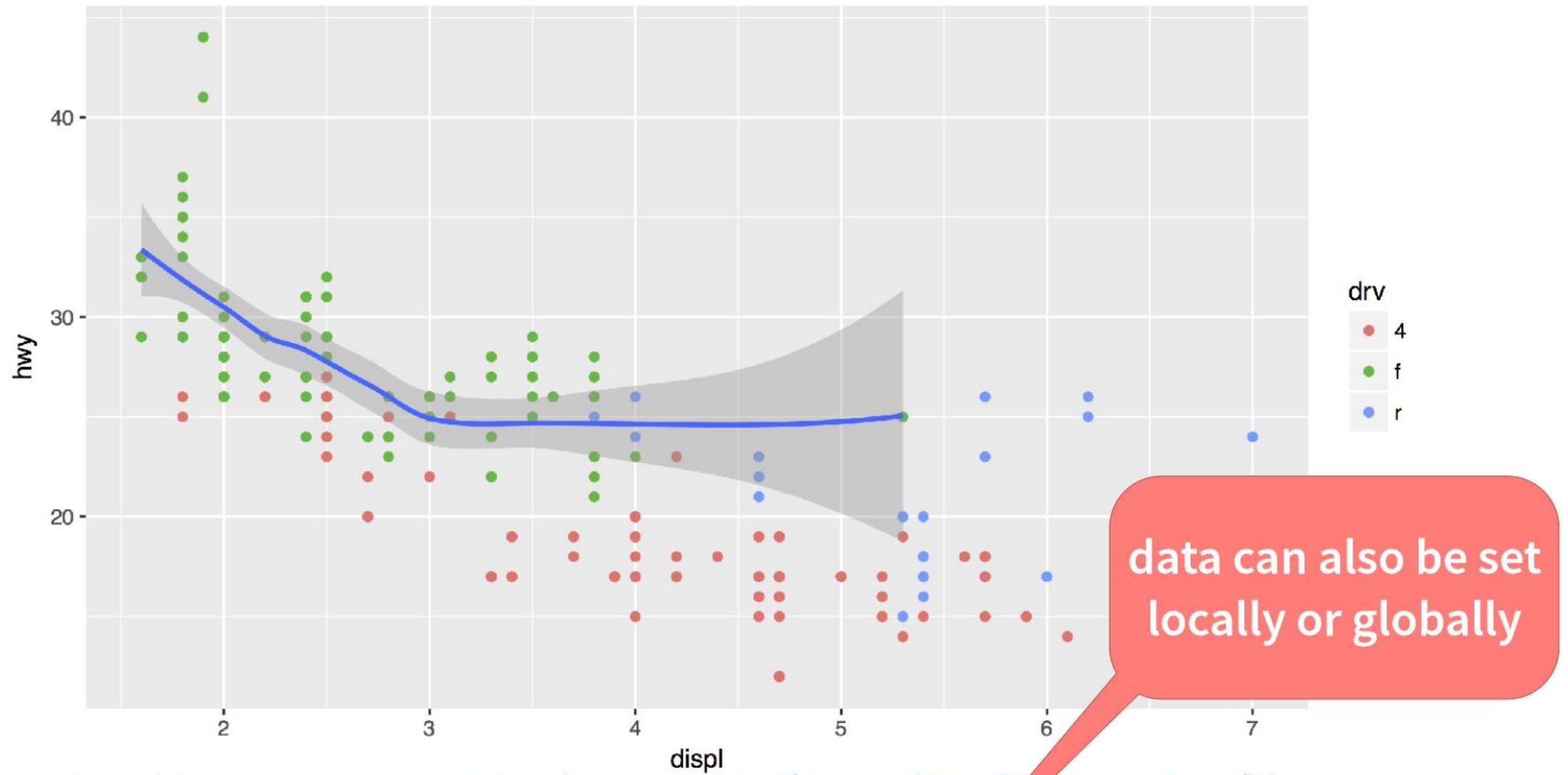
```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +  
  geom_point() +  
  geom_smooth()
```





```
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

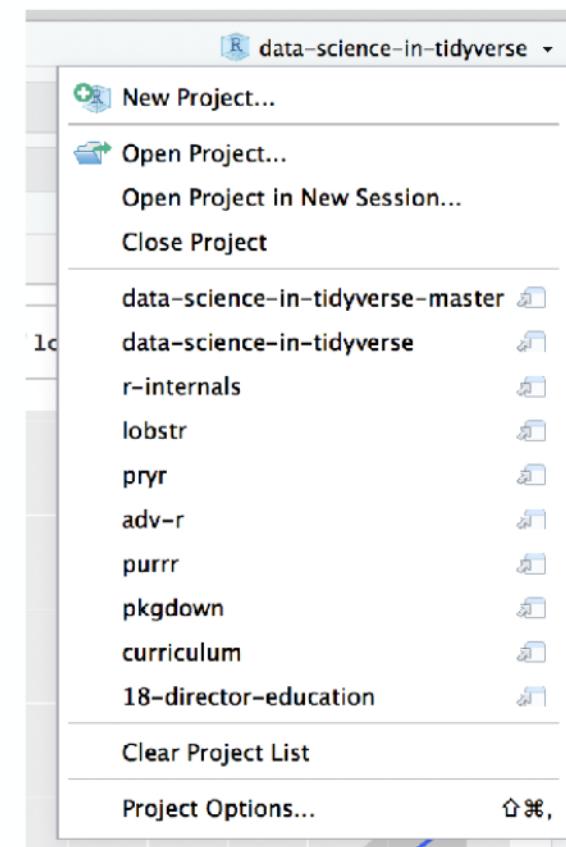


# Projects

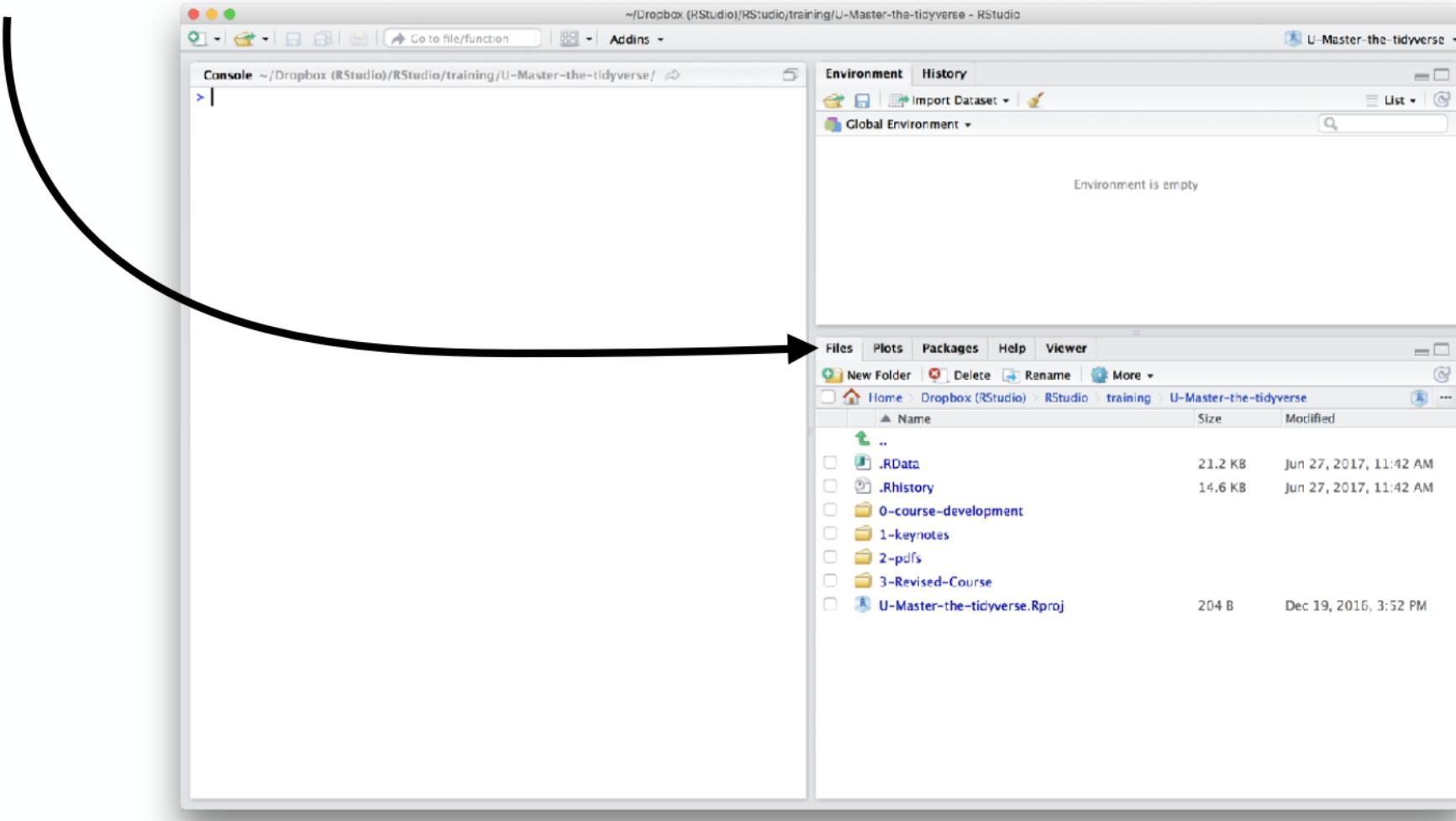
The best way of managing your working directory is with RStudio Projects.

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")
```

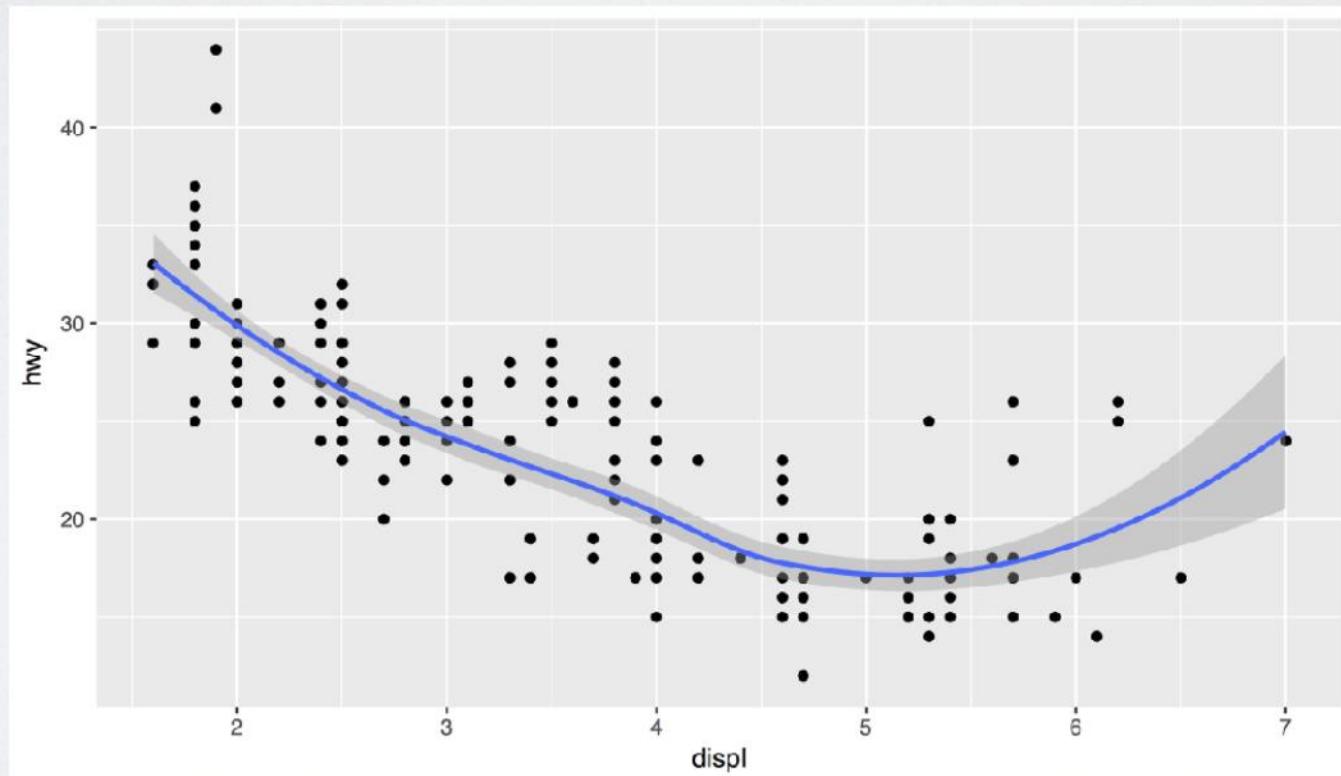
Specify size in inches

```
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>))
```

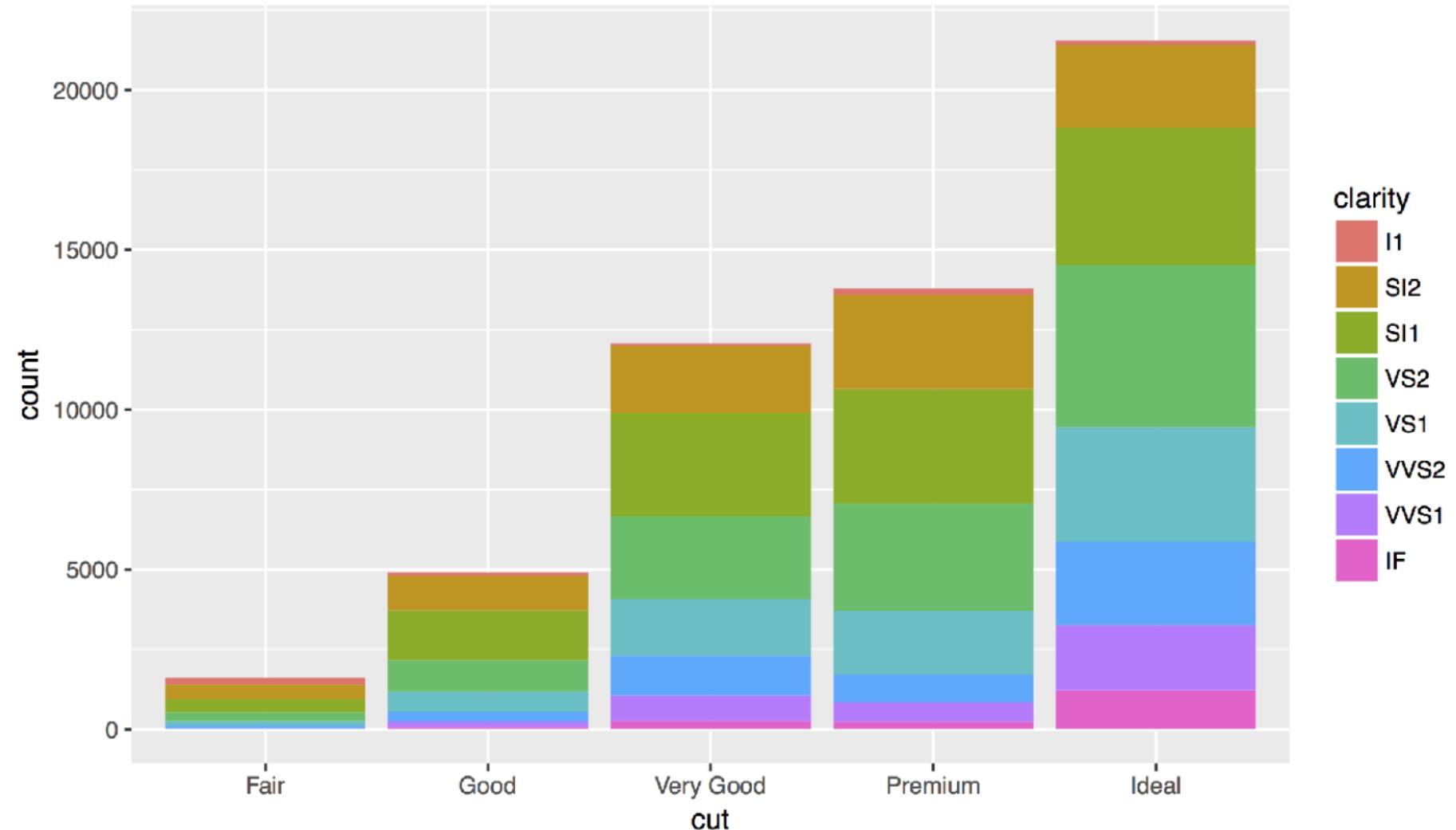
2. Choose a **geom**  
to display cases

3. **Map** aesthetic  
properties to  
variables

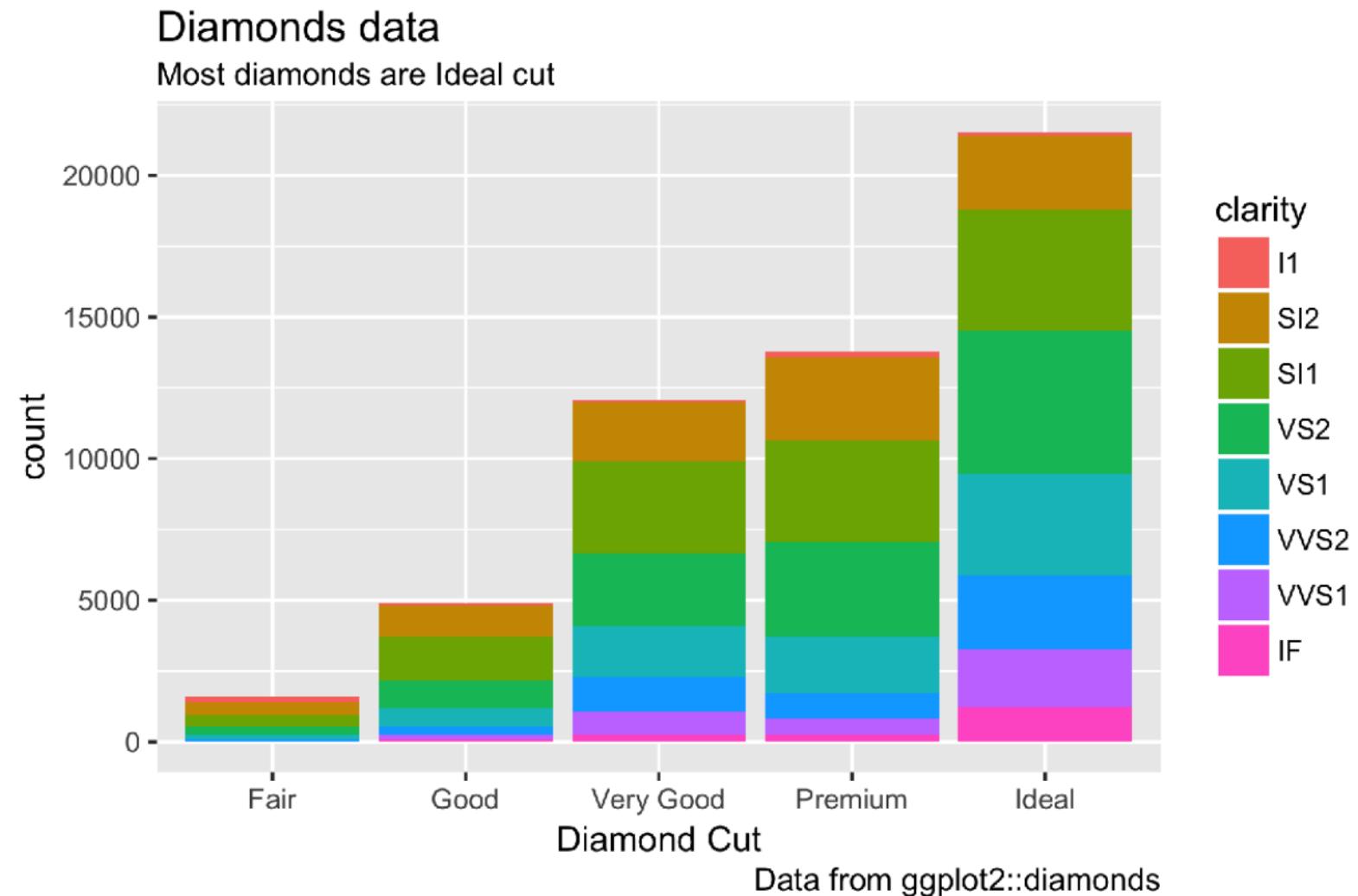


# What else?

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

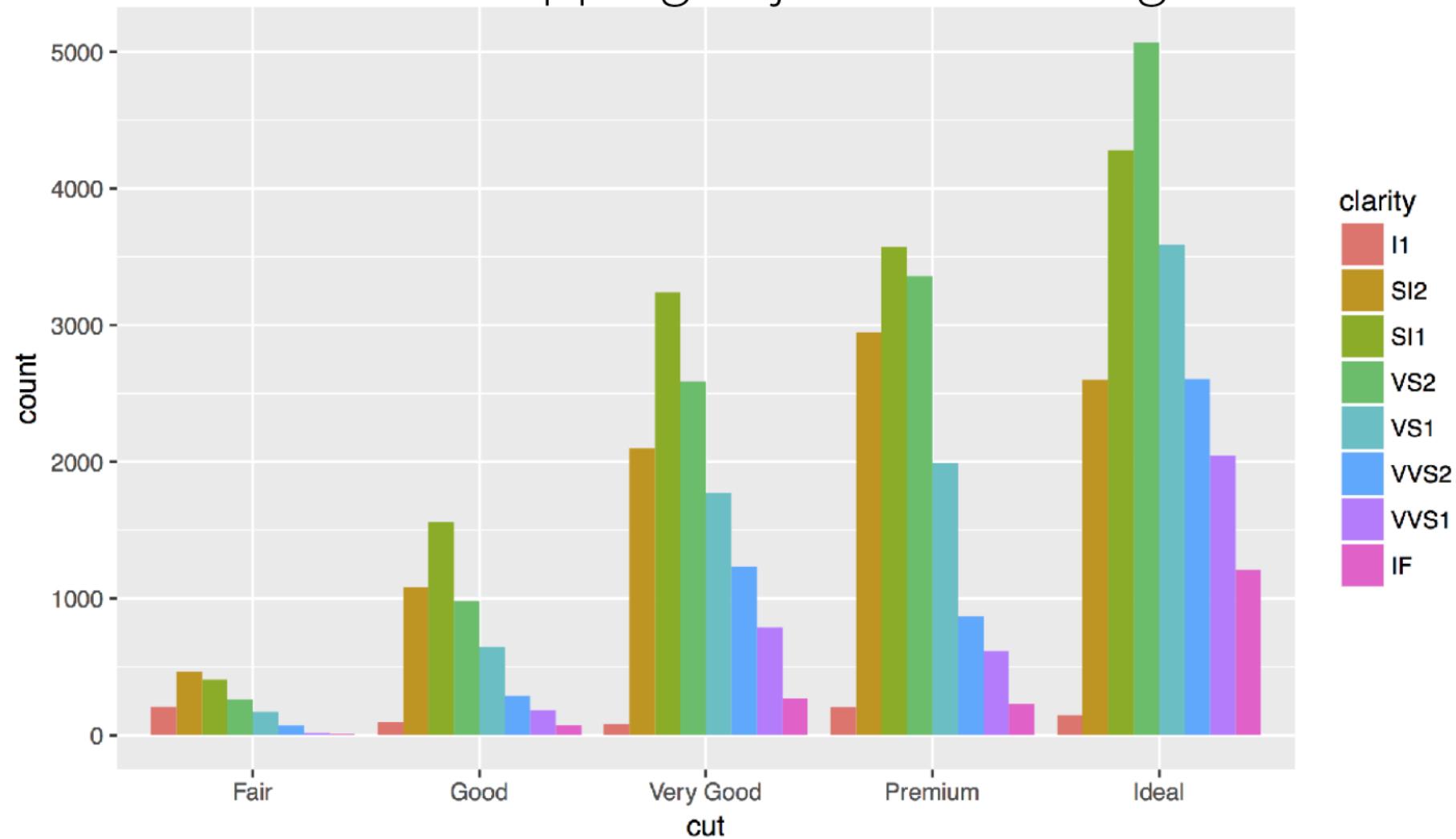


# Titles and captions + labs()



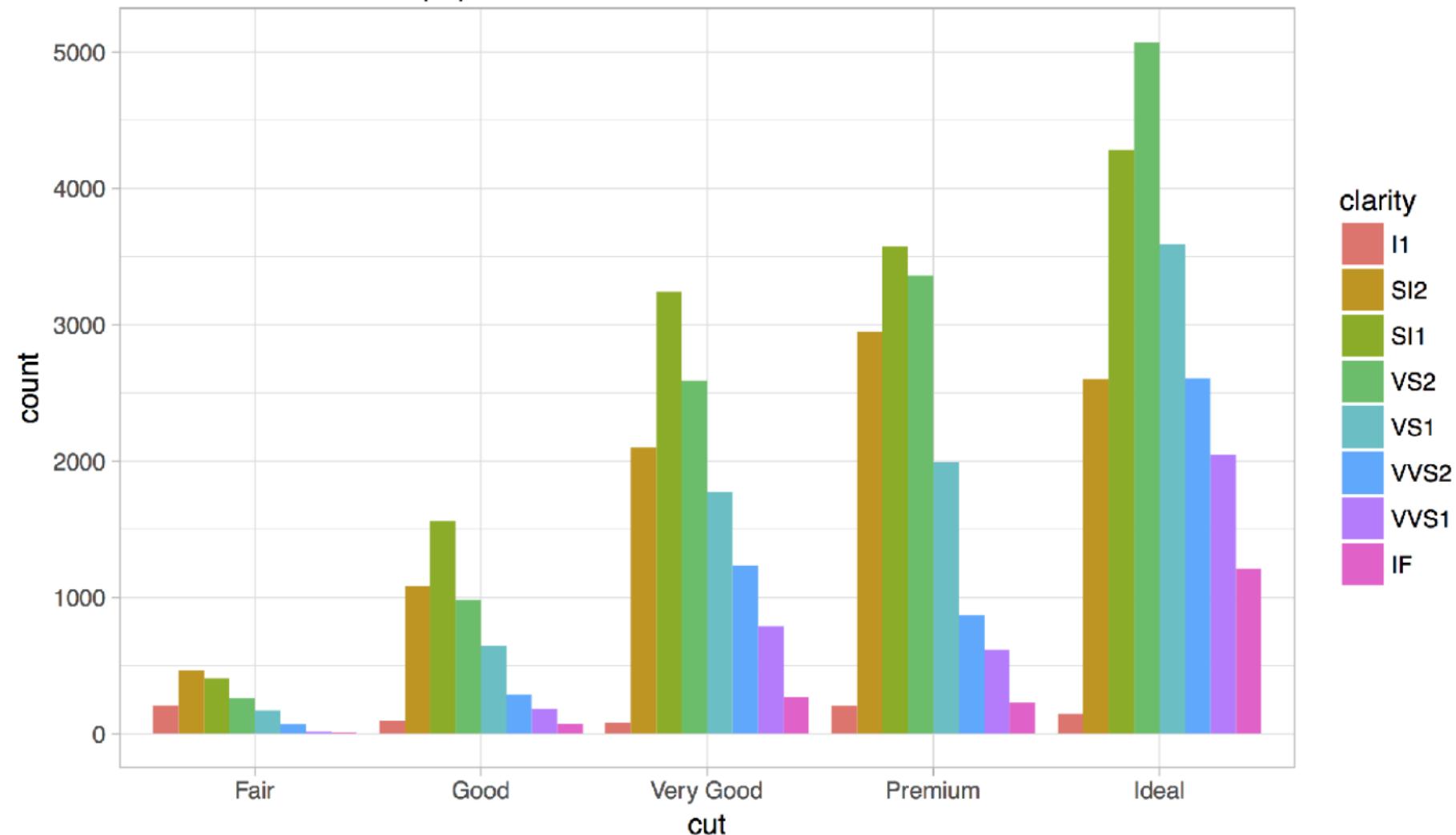
# Position Adjustments

How overlapping objects are arranged



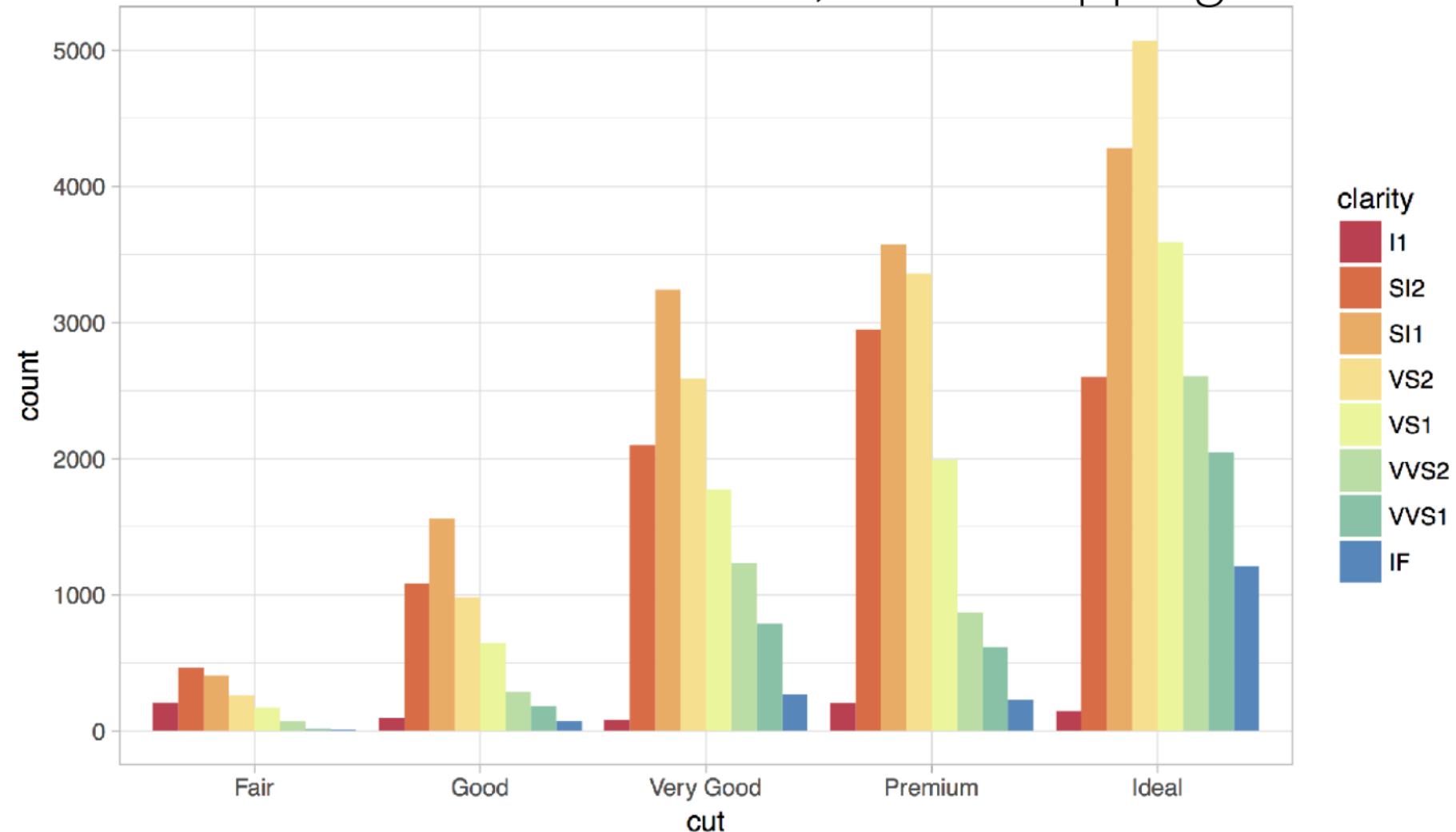
# Themes

## Visual appearance of non-data elements



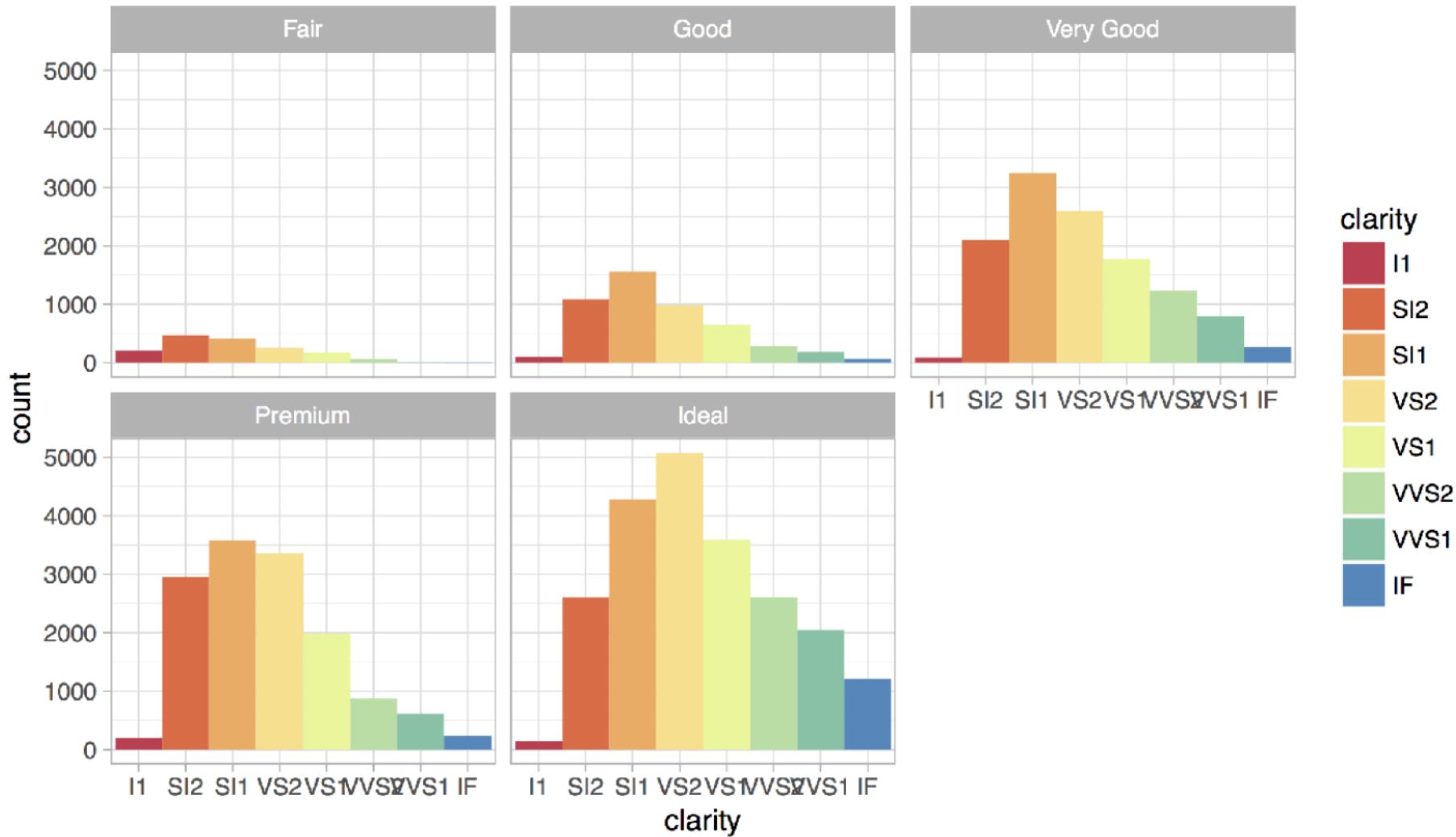
# Scales

Customize color scales, other mappings

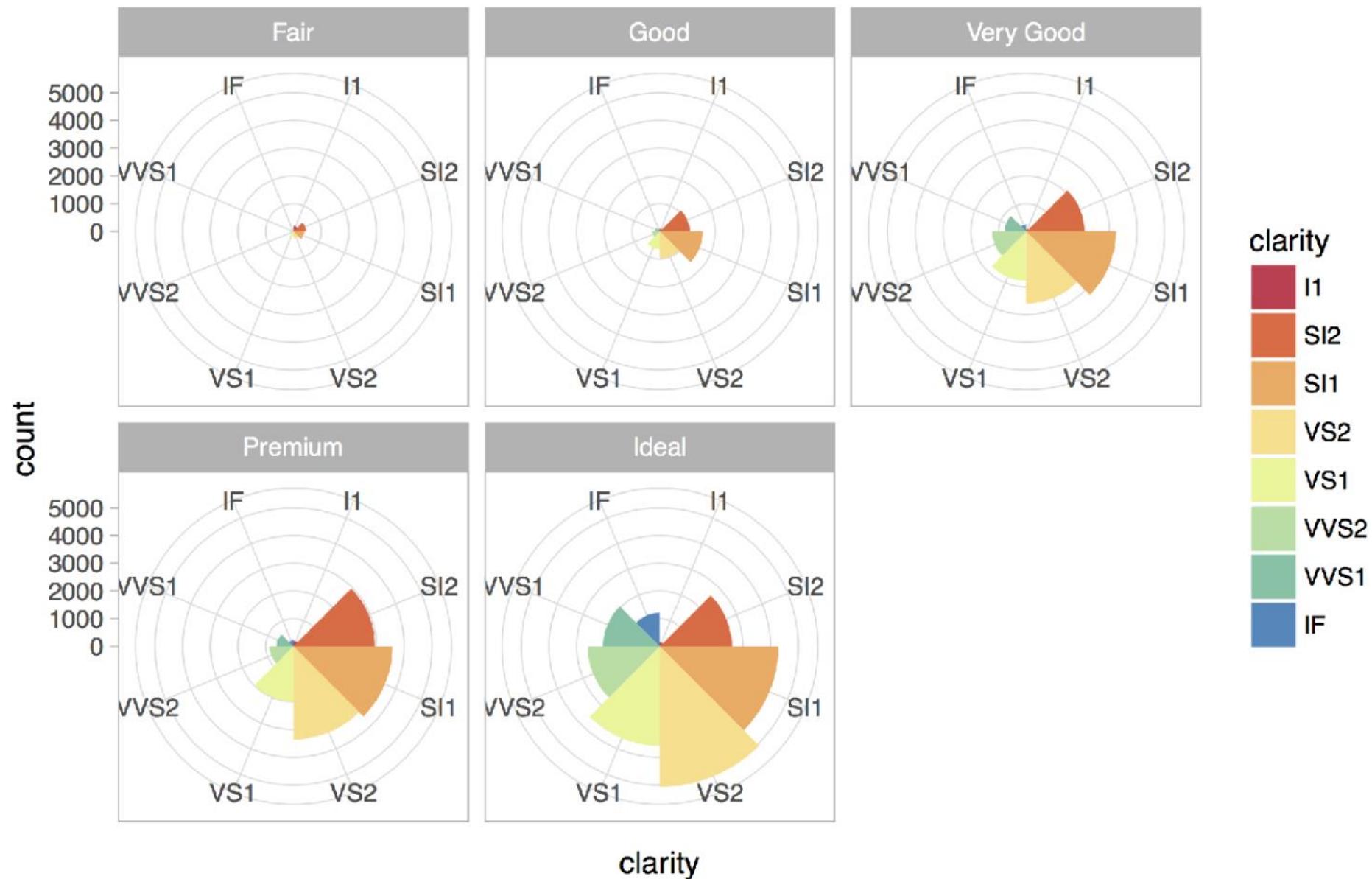


# Facets

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



RStudio® is a trademark of RStudio, Inc. • CC BY RStudio • info@rstudio.com • 844-448-1232 • rstudio.com • Learn more at <http://ggplot2.tidyverse.org>

# 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 shown with the x-axis labeled "displ" and the y-axis labeled "hwy". The legend indicates "class" with a red dot and "2seater".

### 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

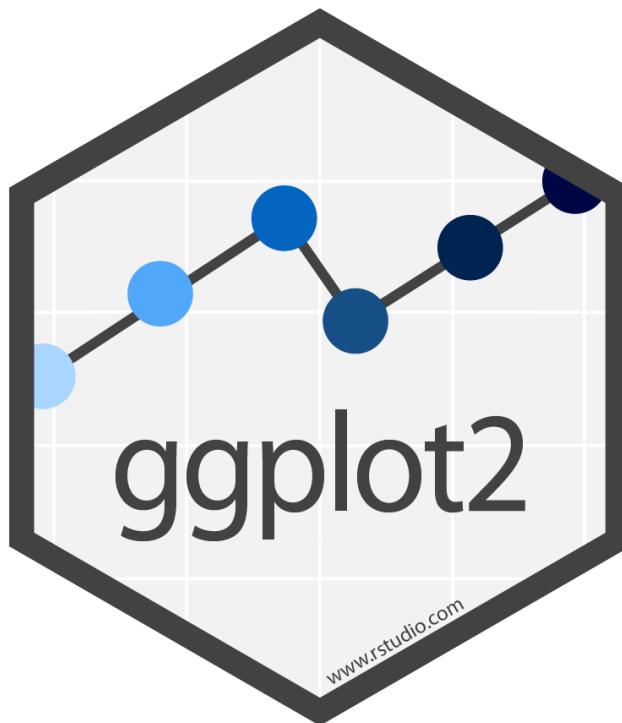
[GPL-2](#) | file [LICENSE](#)

### Developers

Hadley Wickham  
Author, maintainer

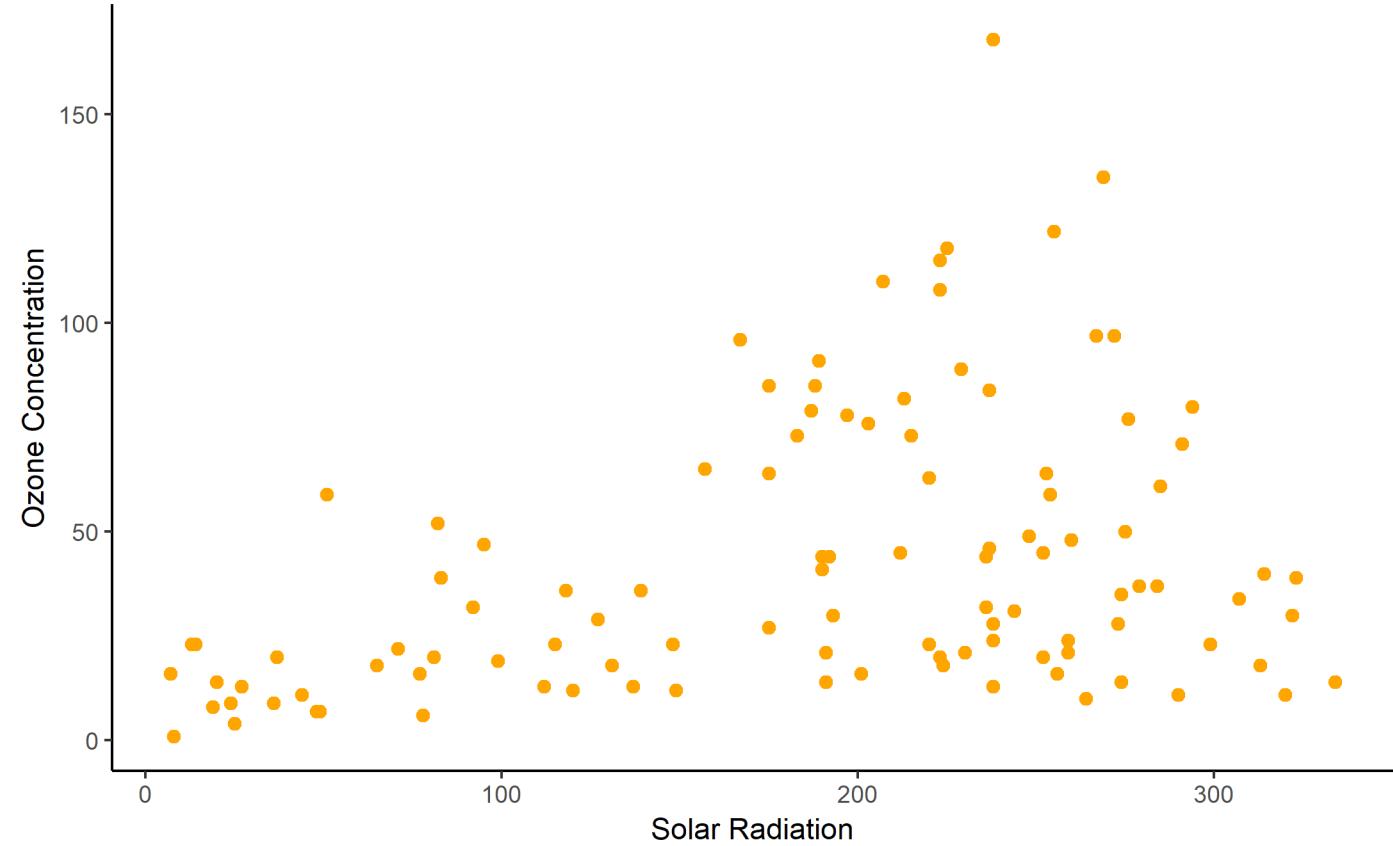
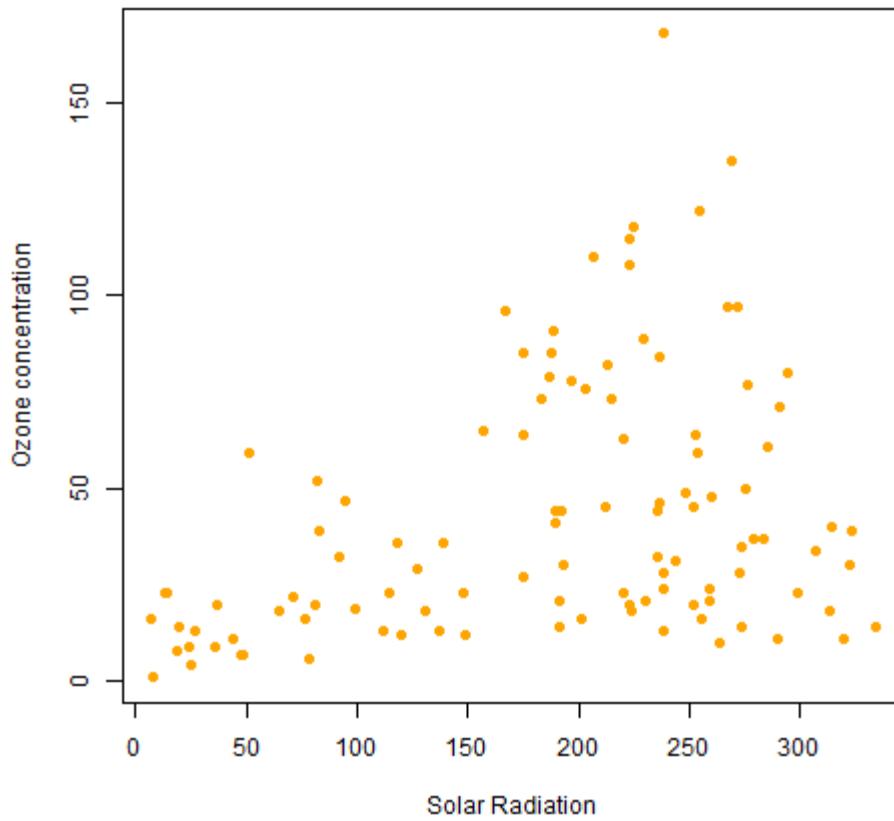


# Visualising Data with



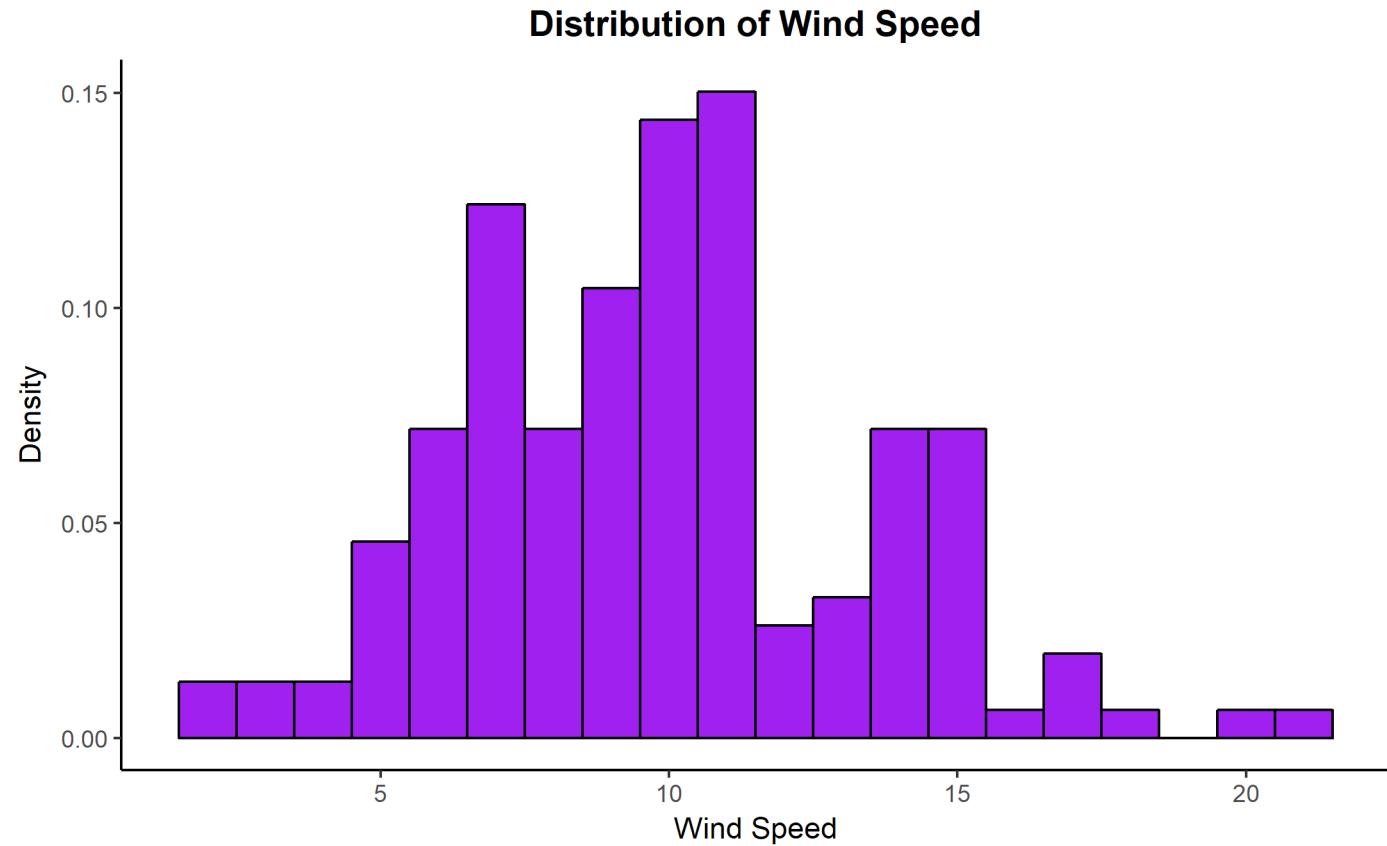
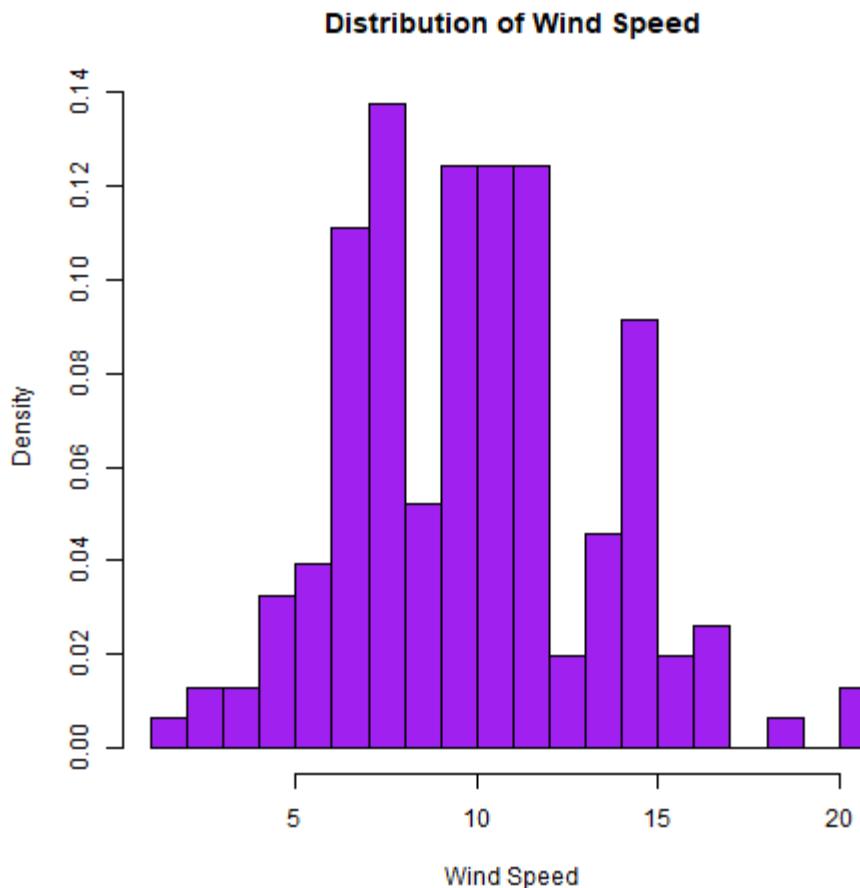
Adapted from “Explore the Tidyverse” CC by Hadley Wickham

# Example comparisons: Scatterplot



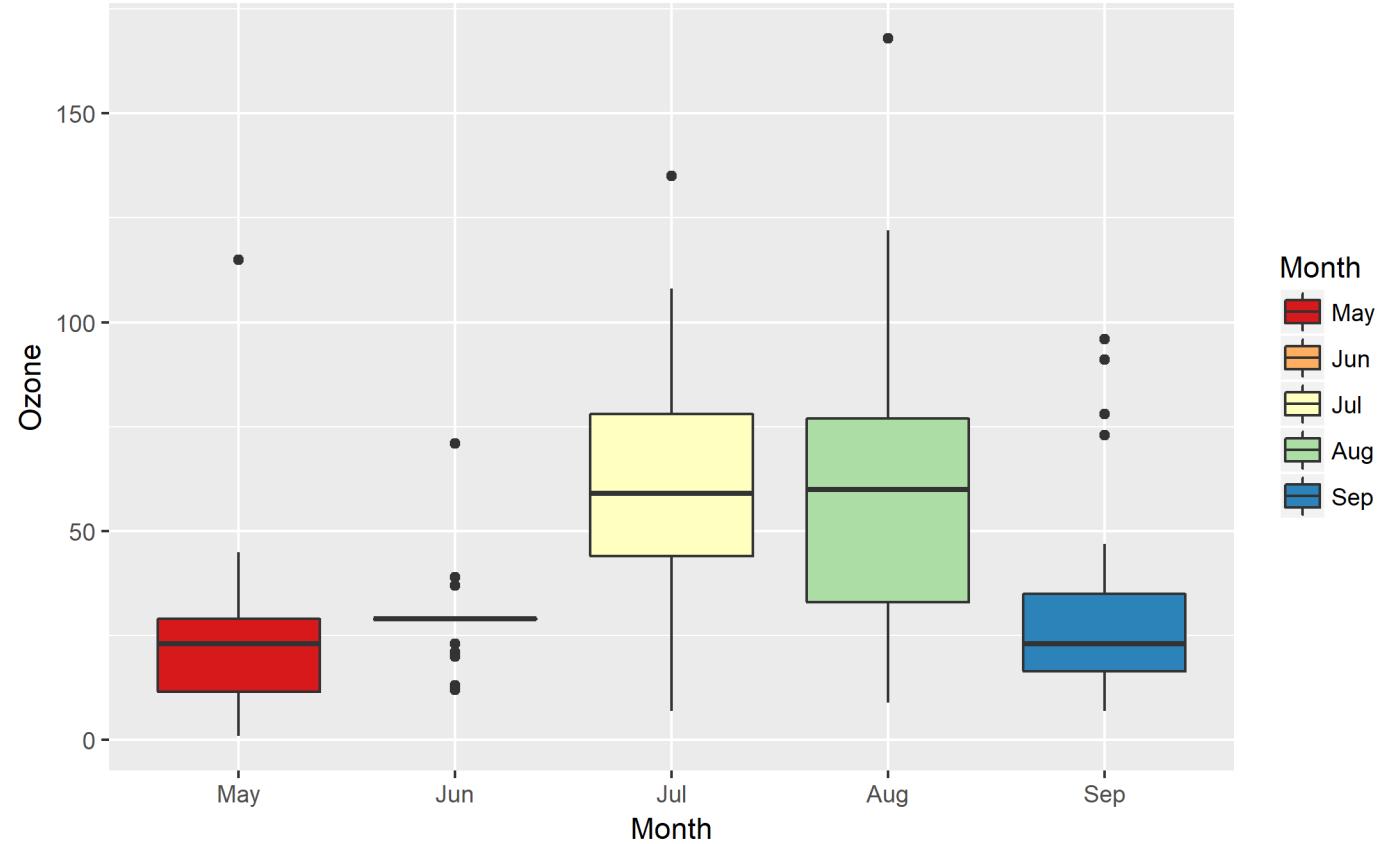
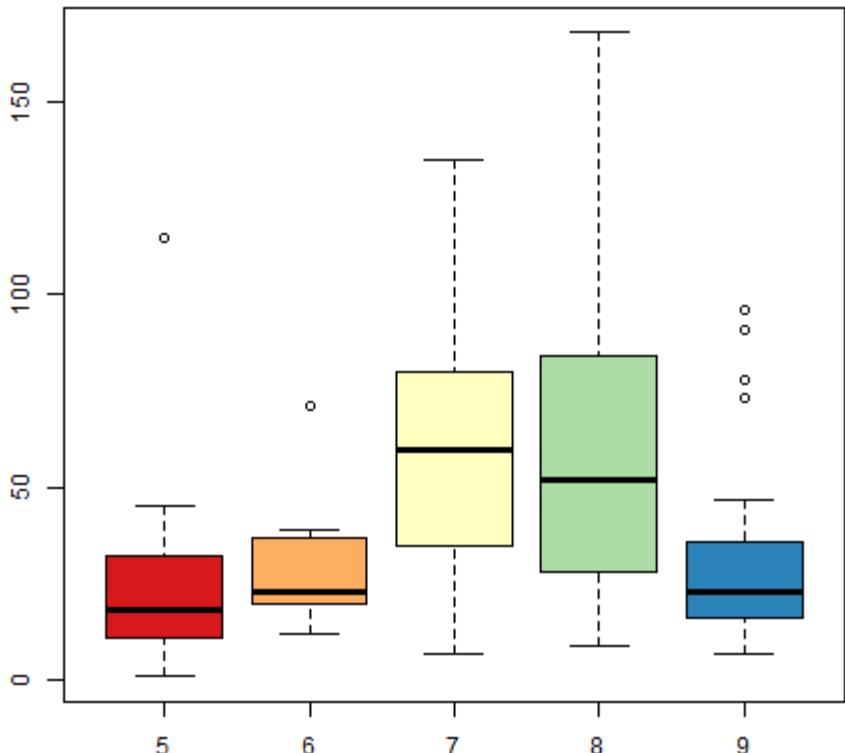
[https://github.com/PMacDaSci/r-intro/Day-3/ozone\\_solar\\_relationship.Rmd](https://github.com/PMacDaSci/r-intro/Day-3/ozone_solar_relationship.Rmd)

# 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)