Week 3: Data Visualization

`{ggplot2}`

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Housekeeping

- Homework 1 due today
- Groups due today
  - I need emails from everyone by 5pm (if you have not already emailed)

SPACE

NASA says its asteroid defense test was a success

NASA smashed a spacecraft into an asteroid in an attempt to throw it off course. The mission succeeded beyond expectations, officials said.

"NASA says its mission to knock an asteroid off course — a test of planetary defense — **succeeded beyond its expectations**" (npr.org, emphasis mine)

Data Visualization with {ggplot2}

Week 3

Agenda

`{ggplot2}`

- syntax
- continuous data visualizations
- categorical data visualizations
- options
    - color/fill
    - transparency
    - labels
    - facets

Learning Objectives

- Understand the basic syntax requirements for `{ggplot2}`
- Recognize various options for displaying continuous and categorical data
- Familiarity with various `{ggplot2}` options
    - color/fill
    - transparency
    - labels
    - facets

Share!

{datapasta}

- Copy and paste data to and from R
- VERY handy!
- Good for reprex
    - posting questions on Rstudio Community or stackoverflow

[demo]

The Bus!
THEY SAID MY CAR'S TOTALED. I DISAGREE.
HYBRID

TAXI

tidyverse

Providing grammar for:

- Graphics
    - `{ggplot2}`
- Data manipulations
    - `{dplyr}`
    - `{tidyr}`
- Expanding area of specialized topics
    - `{lubridate}`
    - `{glue}`
    - `{tidymodels}`
- Many more...

Providing grammar for:

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- Many more...

{ggplot2}

The `{ggplot2}` package

`gg` stands for the "grammar of graphics"

Resources

The `{ggplot2}` package is one of the most popular R packages, and there are many resources to learn the syntax

- ggplot2 book (email me for digital copy)
- RStudio cheat sheet
  - Can be helpful, perhaps more so after a little experience
- R Graphics Cookbook
- R Graph Gallery
  - past students have really liked this one

Components

Every `ggplot` plot has three components

1. **data**
    - the `data` used to produce the plot
2. **aesthetic mappings (`aes`)**
    - between variables and visual properties
3. **layer(s)**
    - usually through the `geom_*()` function to produce geometric shapes to be rendered

`ggplot()` always takes a data frame (tibble) as the first argument

Basic syntax

```
ggplot(data, aes(x = xvar, y = yvar ) ) +
            geom_function()
```

ggplot() = the function is `ggplot` and the package is `{ggplot2}`

data = the data to be plotted

aes(x = xvar, y = yvar) = the `aes`thetic mappings

geom_function() = the `geom`etrics of the plot; the "function" here represents any of the `geom_*` offerings

note the + and NOT the %>%

{ggplot2} template

```
ggplot(data, aes(mappings)) +
         geom_function()
```

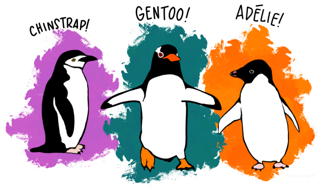
or equivalently

```
data %>%
  ggplot(aes(mappings)) +
  geom_function()
```

Some data for today

penguins from {palmerpenguins}

[run the following]



```r
library(tidyverse)
library(palmerpenguins)

head(penguins)
```

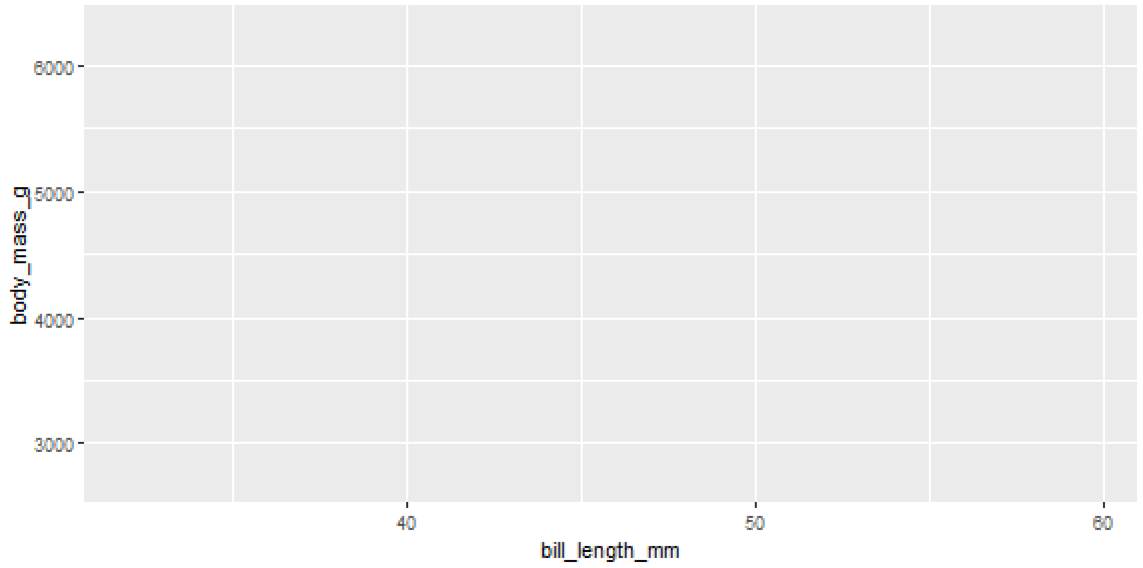
```
## # A tibble: 6 x 8
##   species island    bill_length_mm bill_depth_mm flipper_l~1 body_~2 sex
##   <fct>   <fct>              <dbl>         <dbl>       <int>   <int> <fct>
## 1 Adelie  Torgersen           39.1          18.7         181    3750 male
## 2 Adelie  Torgersen           39.5          17.4         186    3800 fema~
## 3 Adelie  Torgersen           40.3          18           195    3250 fema~
## 4 Adelie  Torgersen           NA            NA            NA      NA <NA>
## 5 Adelie  Torgersen           36.7          19.3         193    3450 fema~
## 6 Adelie  Torgersen           39.3          20.6         190    3650 male
## # ... with abbreviated variable names 1: flipper_length_mm, 2: body_mass_g
```

Continuous Data

Setting up a plot

Run the following code. What do you see?

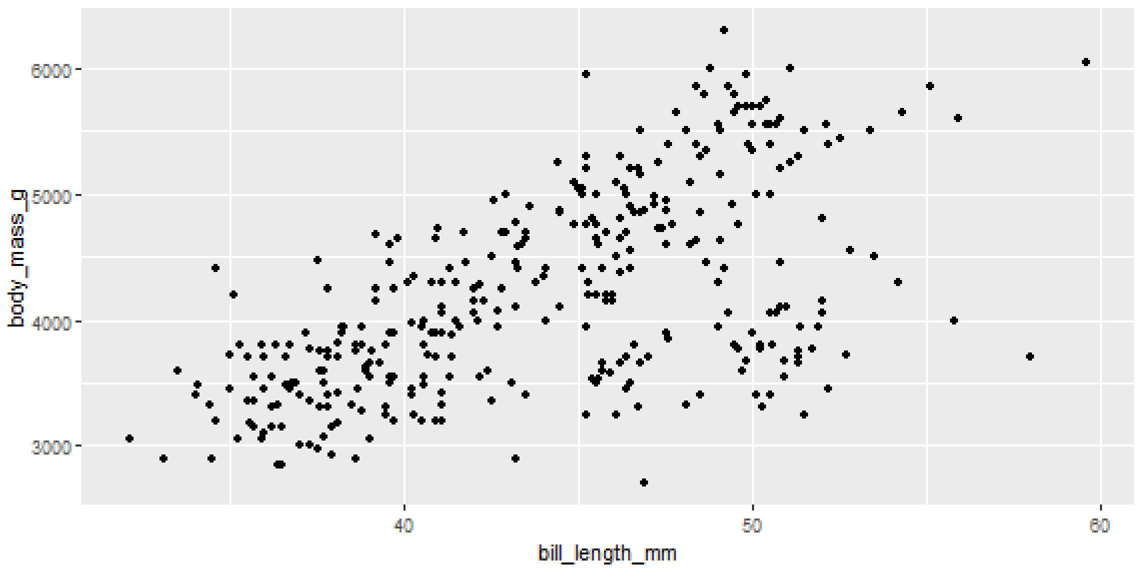
```
ggplot(penguins, aes(bill_length_mm, body_mass_g))
```



It's ready for you to add some geometric layers...what should we add?

How about points?

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point()
```



Adding layers

- In the previous slide, we added a layer of points
- The `geom_point()` layer is a function, complete with it's own arguments

Let’s change the color of the points

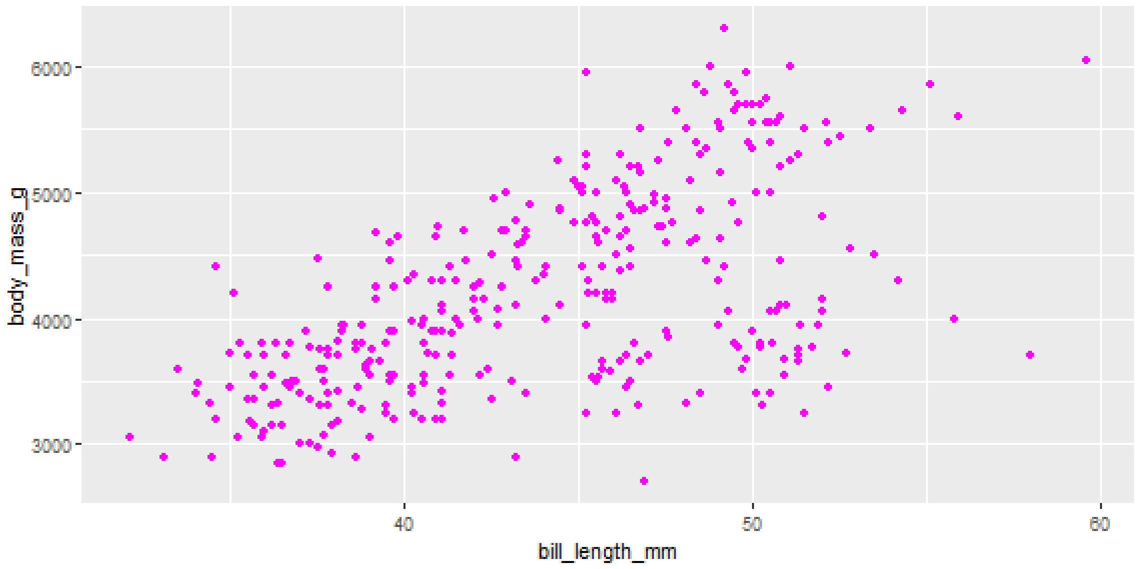
How would you change the color of the points?

> or

How would you find out about changing the color of the points?

color

```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "magenta")
```

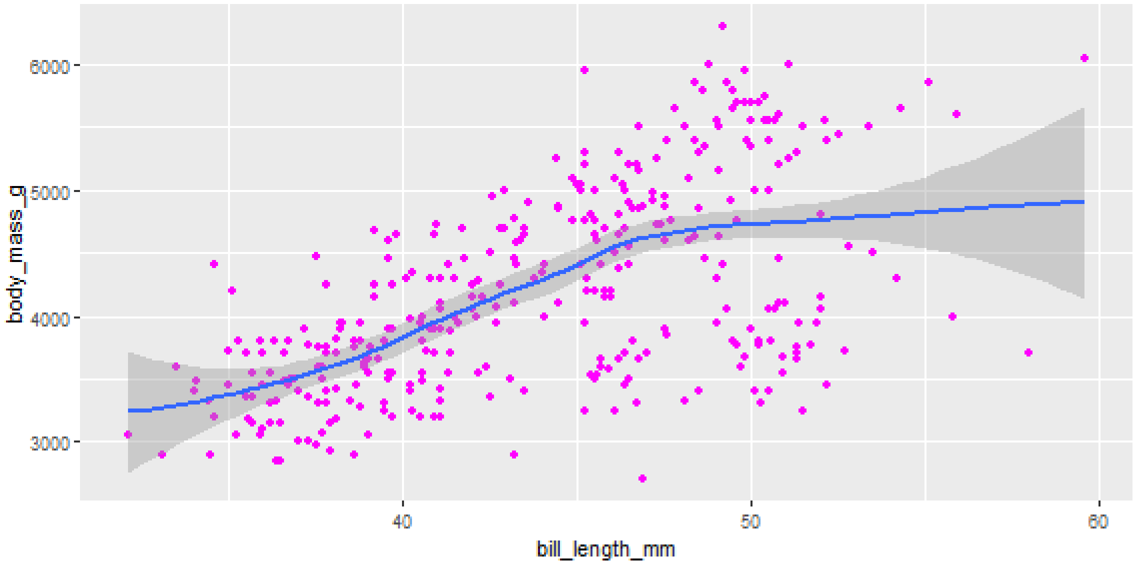


]

Add another layer

Let's add a smoothed line with `geom_smooth()`

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "magenta") +
  geom_smooth()
```



You try

You probably got the **message** below when you ran (defaults)

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "magenta") +
  geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

Change the `method` to `"lm"`

Let's do this one together

Look at the help page – `?geom_smooth`

1. Remove the confidence interval around the line

2. Now change the *SE* band to reflect a 68% confidence interval

`color`: global vs. conditional

Prior examples changed colors globally

- `geom_point(color = "magenta")`

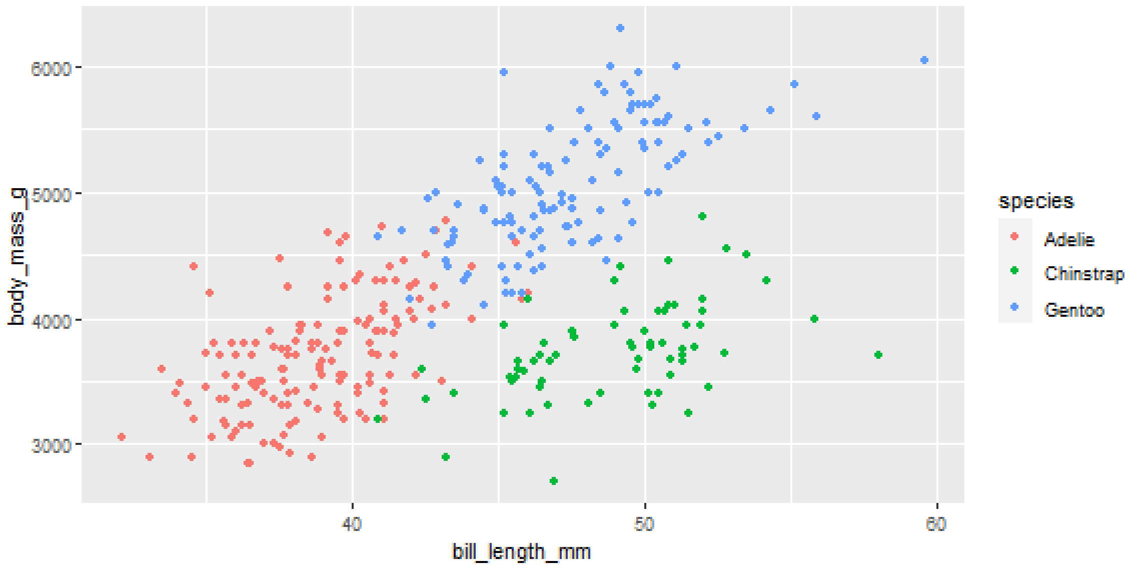
Use `aes()` to access variables, and color according to a specific variable

- We use variable names within `aes()`

Let’s check the data again (`head()`) and the "species" variable (`table()`)

[let's do this together]

```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(aes(color = species))
```



`color`: global vs. conditional

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(aes(color = species))
```

- When we did `geom_point(color = "magenta")` we put quotes around the color
- Why now is "species" not in quotes?
  - color names/hex codes are in quotes **NOT** in the `aes()`
  - variable names are in the `aes()` **NOT** in quotes
  - `aes()` is where you map to your data!

Conditional flow through layers

If we use something like `color = “x”` in the first `aes`thetic, it will carry on through all additional layers

- These two codes are the same:

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(aes(color = species))
```

```
ggplot(penguins, aes(bill_length_mm, body_mass_g, color = species)) +
  geom_point()
```

- But these two are not…why? [run to find out]

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(aes(color = species)) +
  geom_smooth()
```

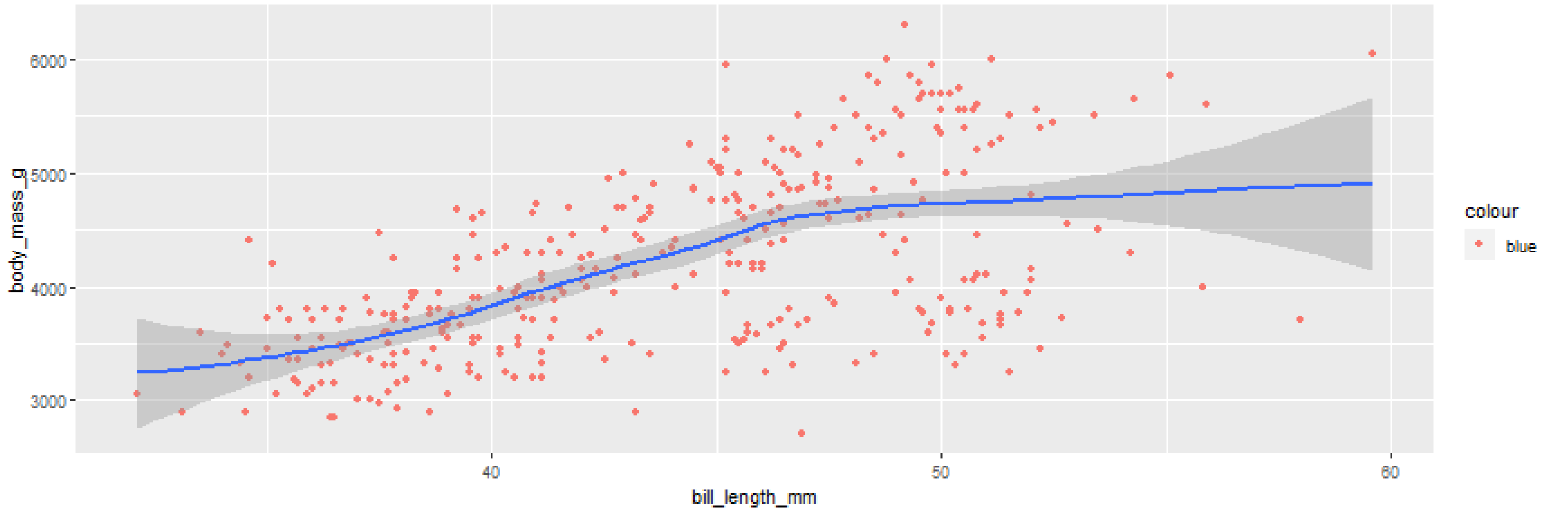
```
ggplot(penguins, aes(bill_length_mm, body_mass_g, color = species)) +
  geom_point() +
  geom_smooth()
```

Be mindful with `aes()`

Using `aes()` when you **don't** need it

What is happening here?

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(aes(color = "blue")) +
  geom_smooth()
```



Be mindful with aes()

Not using aes() when you need it

What is happening here?

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = species) +
  geom_smooth()
```

```
## Error in layer(data = data, mapping = mapping, stat = stat, geom = GeomPoin
```

Kind of helpful message here.

Themes

Let's talk themes

- The default is `theme_gray`
    - I don't like it
- But there are a lot of build-in alternative in `{ggplot2}`
    - `theme_minimal` is my favorite
- Check out the `{ggthemes}` package for a lot of alternatives
    - These days I nearly always use the `colorblind` theme for discrete values in my plots
- Check out the `{ggthemeassist}` add-in

More themes

- The `{hrbrthemes}` are nice
- Consider building your own theme!
- Or Google around
- Set the theme globally
    - One of the first lines in your .Rmd file could be:

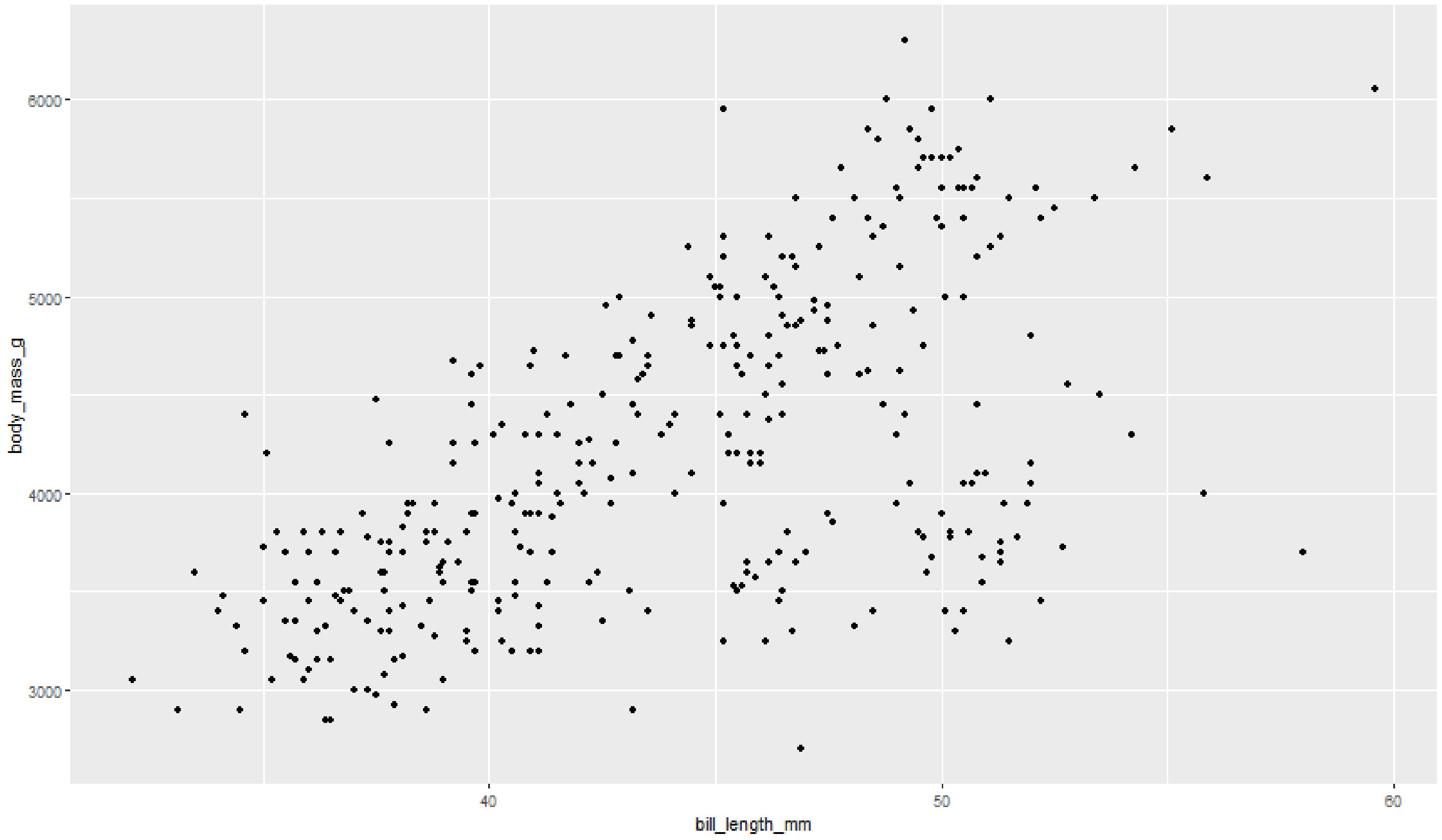
```
theme_set(theme_minimal())
```

- I often put this in the `setup` chunk

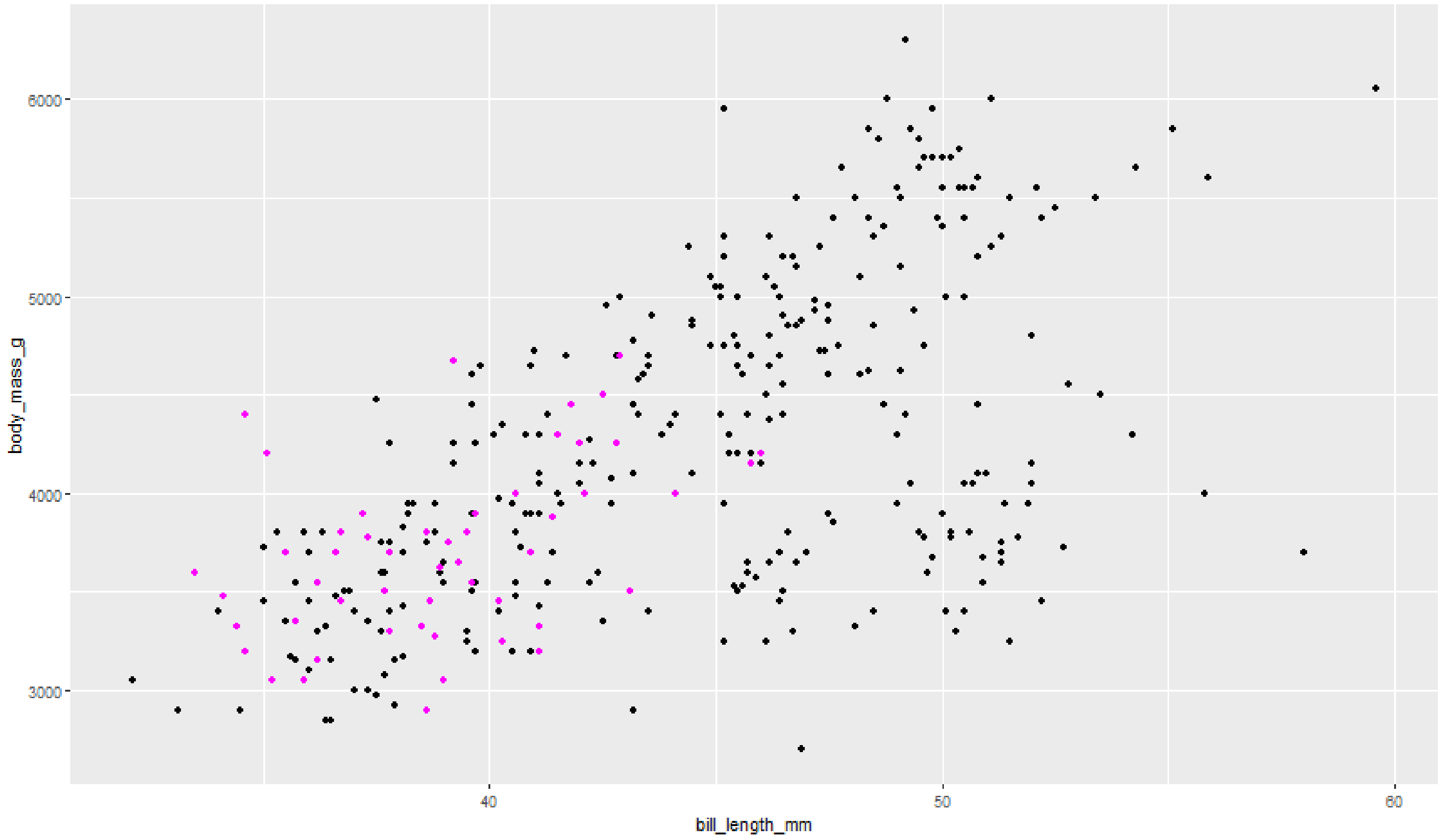
Get a little fancy

- You can use `geom_point()` for more than one layer
- You can also use a different data source on a layer
- Use these two properties to highlight points
    - How about penguins from Torgersen Island?

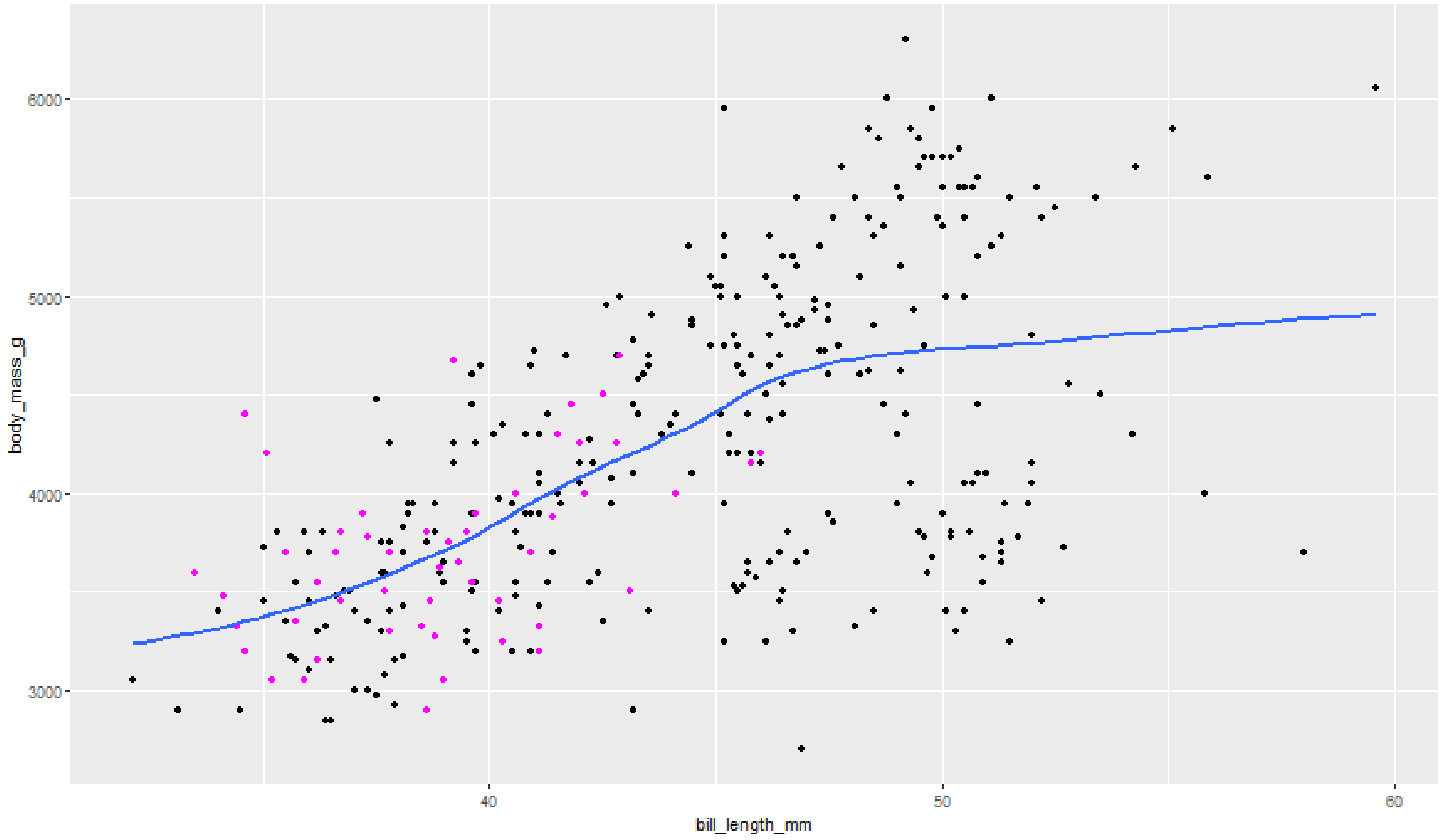
```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "black")
```



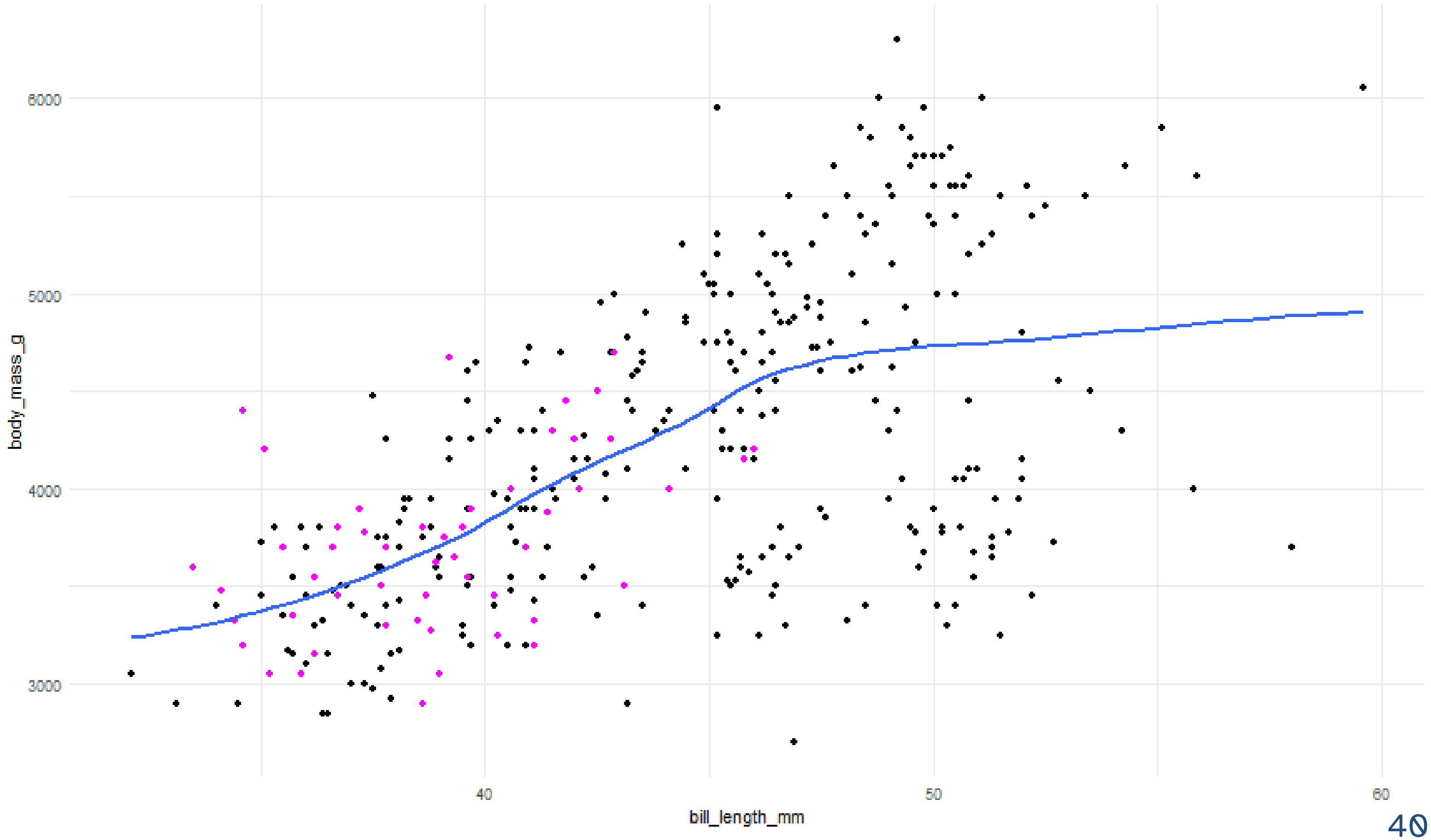
```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "black") +
  geom_point(data = dplyr::filter(penguins, island == "Torgersen"), colo
```



```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "black") +
  geom_point(data = dplyr::filter(penguins, island == "Torgersen"), colo
  geom_smooth(se = FALSE)
```



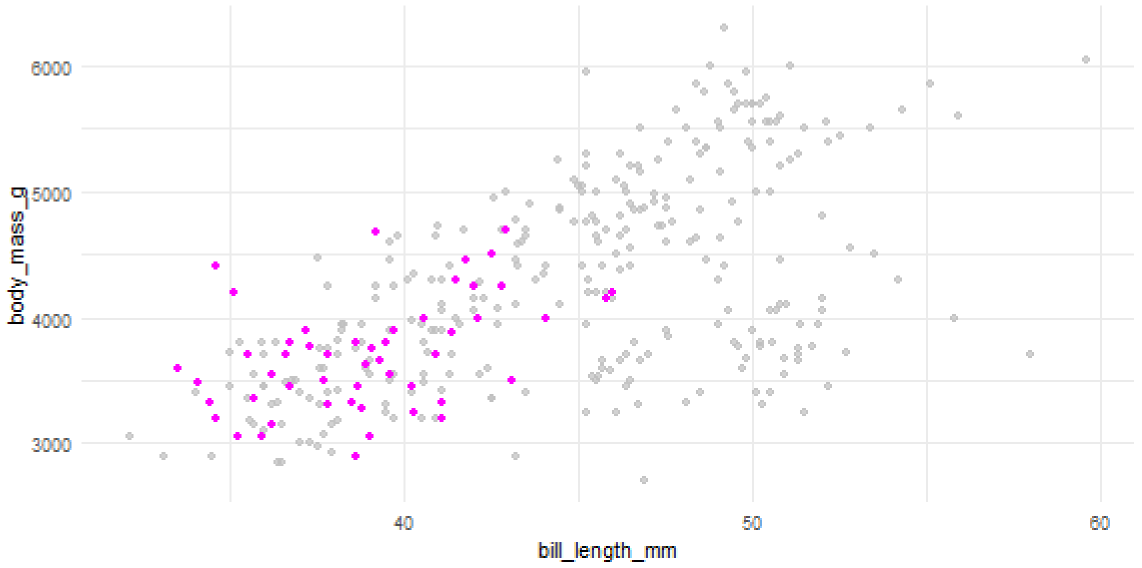
```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "black") +
  geom_point(data = dplyr::filter(penguins, island == "Torgersen"), colo
  geom_smooth(se = FALSE) +
  theme_minimal()
```



Another option

{gghighlight} varying flexibility

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point(color = "magenta") +
  gghighlight::gghighlight(island == "Torgersen") +
  theme_minimal()
```



Line plots

- When should you use line plots instead of smooths?
    - usually when time is involved
- What are some good candidate data for line plots?
    - observed versus model-implied (estimated)

geom_line()

Classic time series example

economics data from `{ggplot2}`

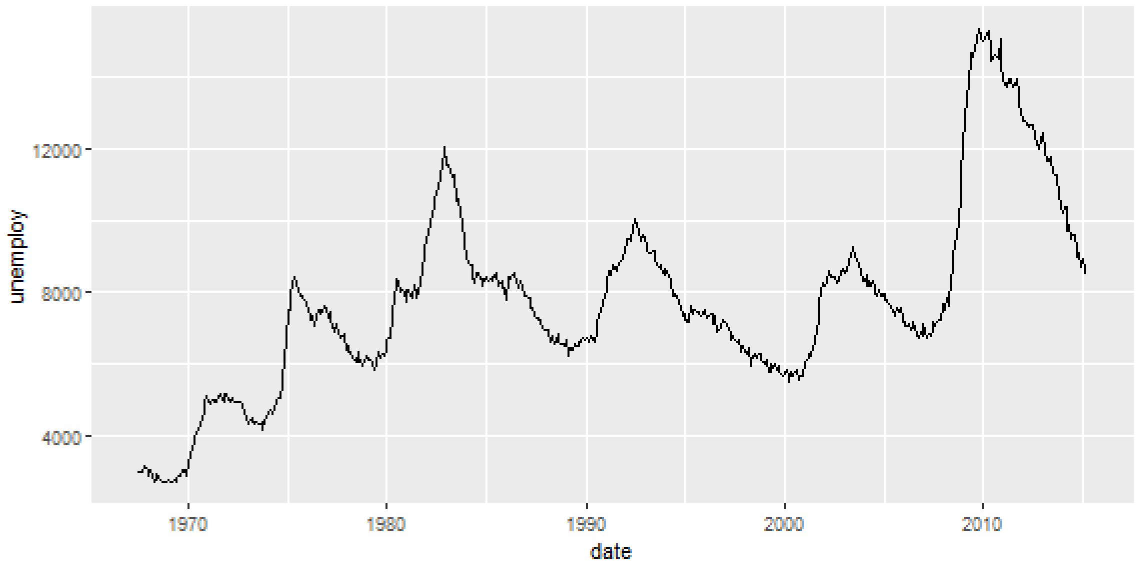
```
economics
```

```
## # A tibble: 574 x 6
##    date         pce    pop psavert uempmed unemploy
##    <date>     <dbl>  <dbl>   <dbl>   <dbl>    <dbl>
##  1 1967-07-01  507. 198712    12.6     4.5     2944
##  2 1967-08-01  510. 198911    12.6     4.7     2945
##  3 1967-09-01  516. 199113    11.9     4.6     2958
##  4 1967-10-01  512. 199311    12.9     4.9     3143
##  5 1967-11-01  517. 199498    12.8     4.7     3066
##  6 1967-12-01  525. 199657    11.8     4.8     3018
##  7 1968-01-01  531. 199808    11.7     5.1     2878
##  8 1968-02-01  534. 199920    12.3     4.5     3001
##  9 1968-03-01  544. 200056    11.7     4.1     2877
## 10 1968-04-01  544  200208    12.3     4.6     2709
## # ... with 564 more rows
```

Let's try it

How do you think we'd fit a line plot to these data, showing unemployment ("unemploy") over time?

```
ggplot(economics, aes(date, unemploy)) +
  geom_line()
```



Layers

What happens when we layer geom_line and geom_point?

```
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  geom_point()
```

[try it!]

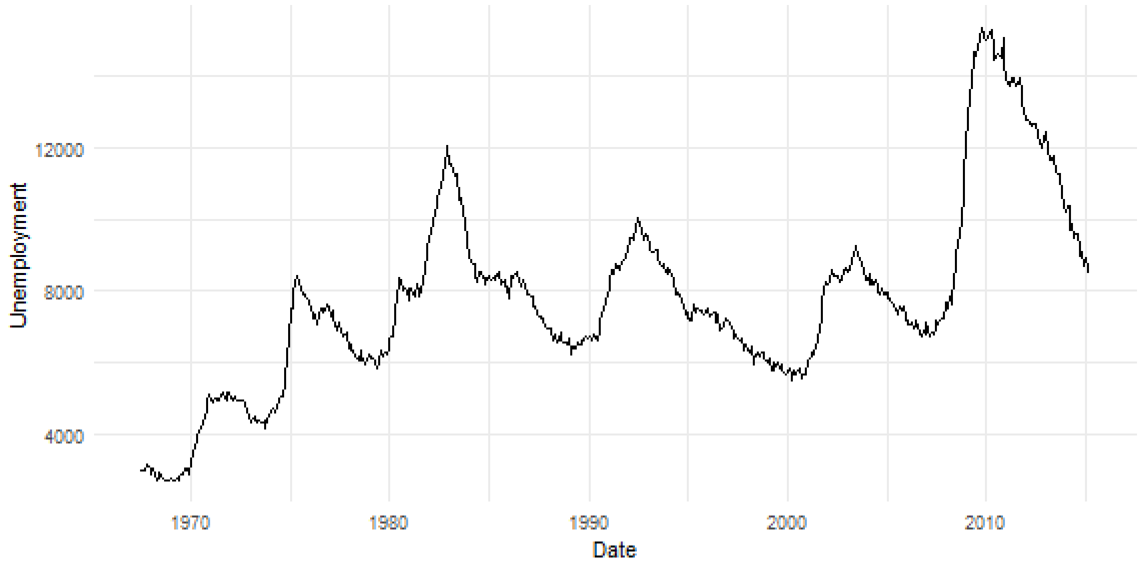
Not the best instance of this It would work better on a plot with fewer time points, but you get the idea

Labels

"labs()"

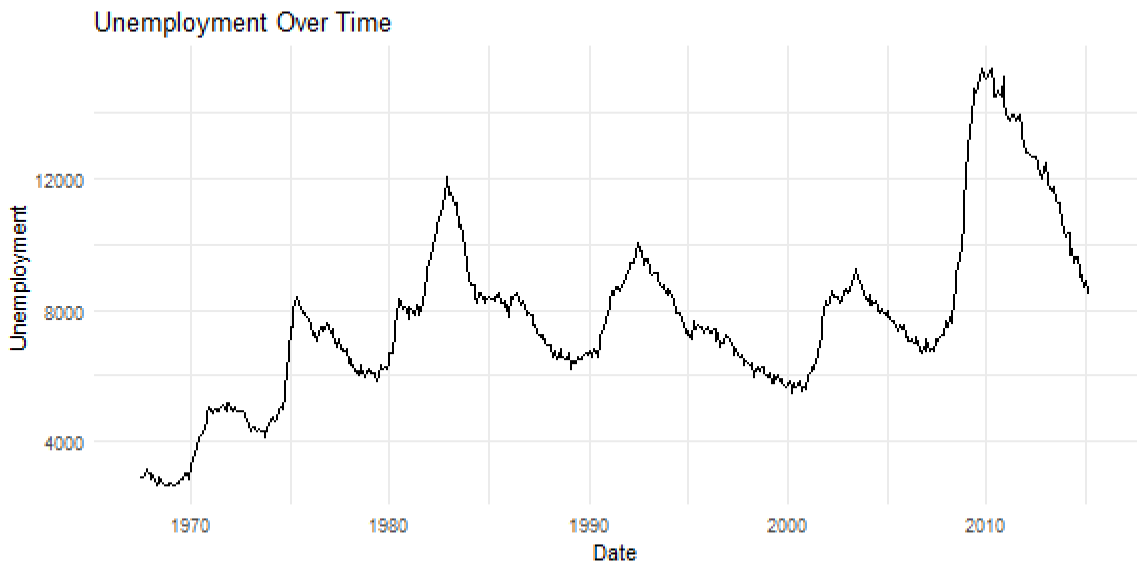
Axis Labels

```
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  theme_minimal() +
  labs(x = "Date",
       y = "Unemployment")
```



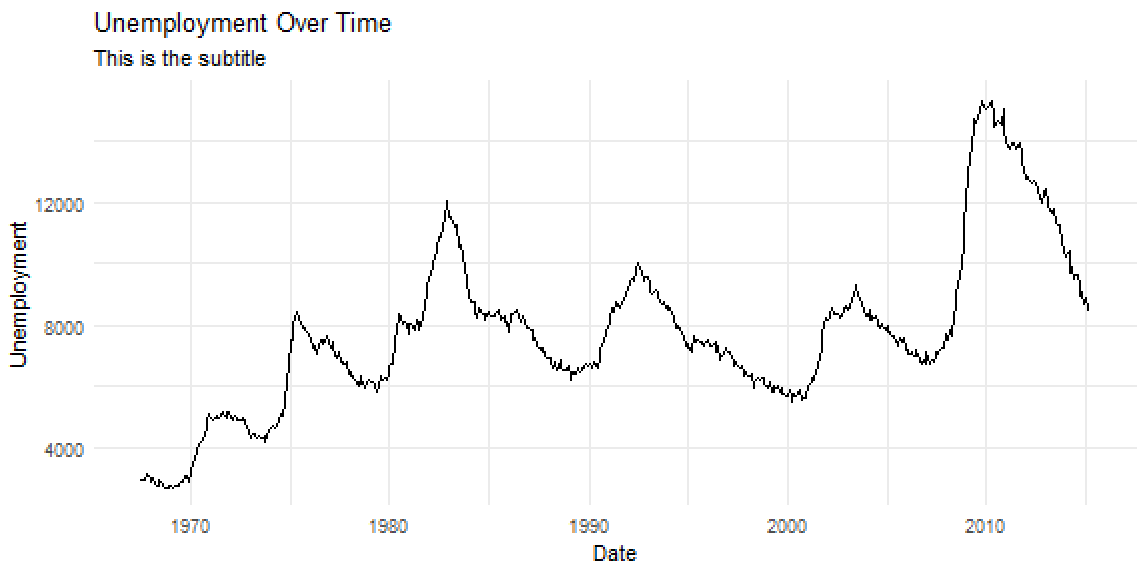
Title

```r
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  theme_minimal() +
  labs(x = "Date",
       y = "Unemployment",
       title = "Unemployment Over Time")
```



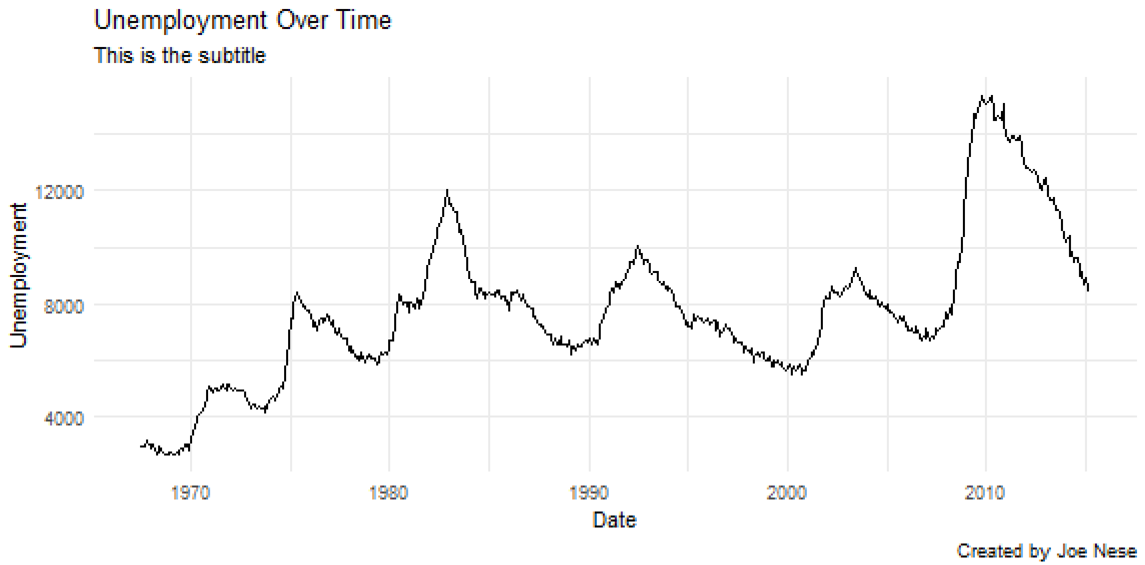
Subtitle

```
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  theme_minimal() +
  labs(x = "Date",
       y = "Unemployment",
       title = "Unemployment Over Time",
       subtitle = "This is the subtitle")
```



Caption

```r
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  theme_minimal() +
  labs(x = "Date",
       y = "Unemployment",
       title = "Unemployment Over Time",
       subtitle = "This is the subtitle",
       caption = "Created by Joe Nese")
```

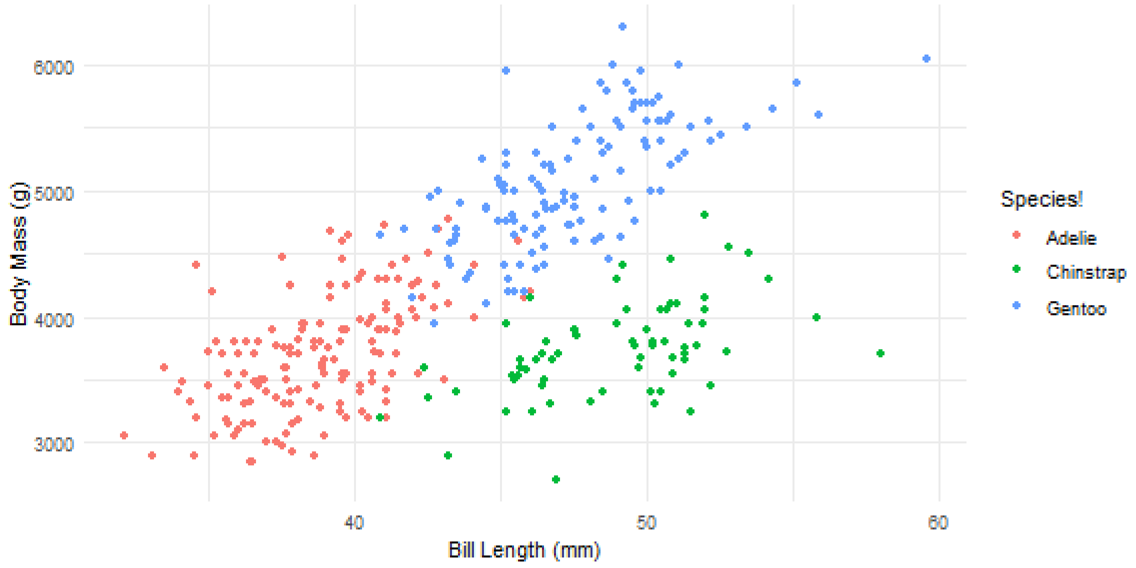


Tag

```r
ggplot(economics, aes(date, unemploy)) +
  geom_line() +
  theme_minimal() +
  labs(x = "Date",
       y = "Unemployment",
       title = "Unemployment Over Time",
       subtitle = "This is the subtitle",
       caption = "Created by Joe Nese",
       tag = "(A)")
```

Legend (one way)

```r
ggplot(penguins, aes(bill_length_mm, body_mass_g, color = species)) + #
  geom_point() +
  theme_minimal() +
  labs(x = "Bill Length (mm)",
       y = "Body Mass (g)",
       color = "Species!") # 'color = '
```



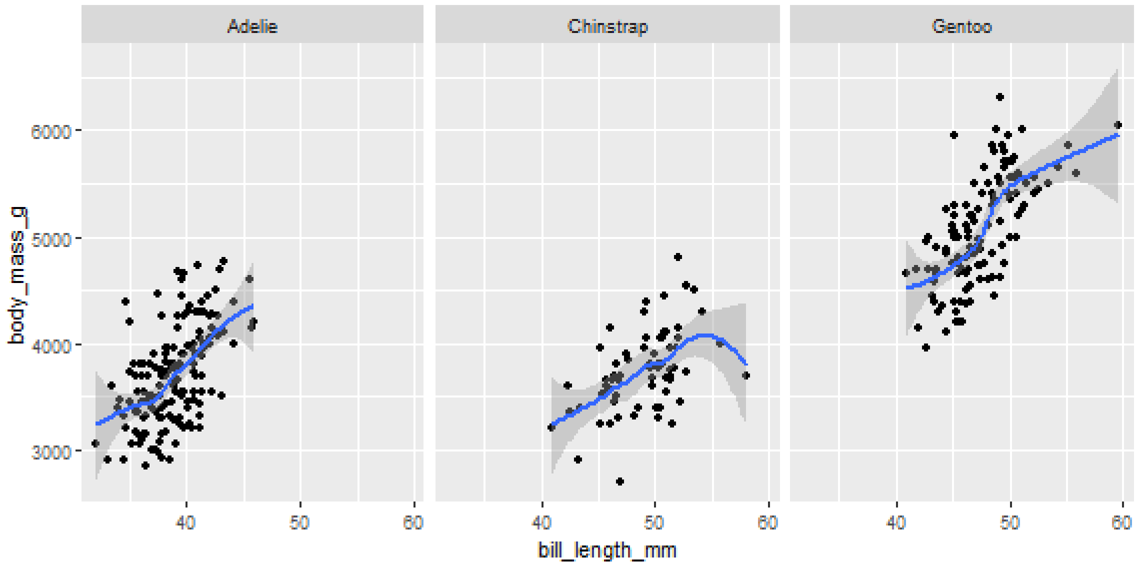
Facets

Faceting

- One of the most powerful features of `{ggplot2}`
- Produce *n* plots by a specific variable
- `facet_wrap()`
    - wrap a sequence of panels into two dimensions
    - based on variables(s)

Faceting

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(~species)
```



Careful about the ~

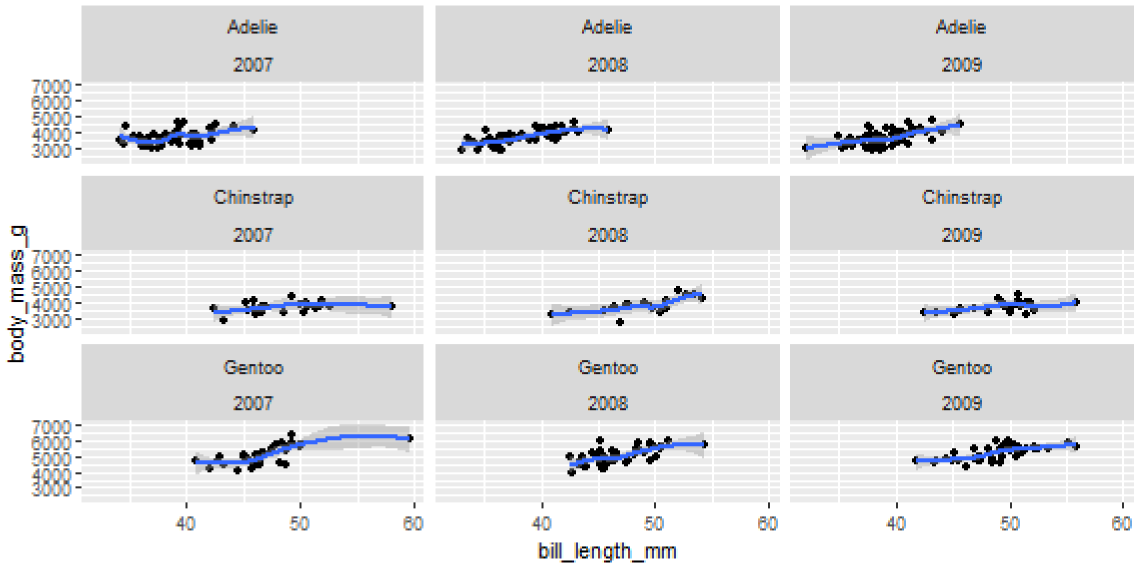
```r
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(species)
```

```
## Error in validate_facets(x): object 'species' not found
```

Faceting

two variables (like a matrix)

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(species ~ year)
```



Alternative specification - `vars()`

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(vars(species))
```

```
ggplot(penguins, aes(bill_length_mm, body_mass_g)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(vars(species, year))
```

Heatmaps

> A heatmap is a literal way of visualizing a table of numbers, where you substitute the numbers with colored cells. -- Nathan Yau

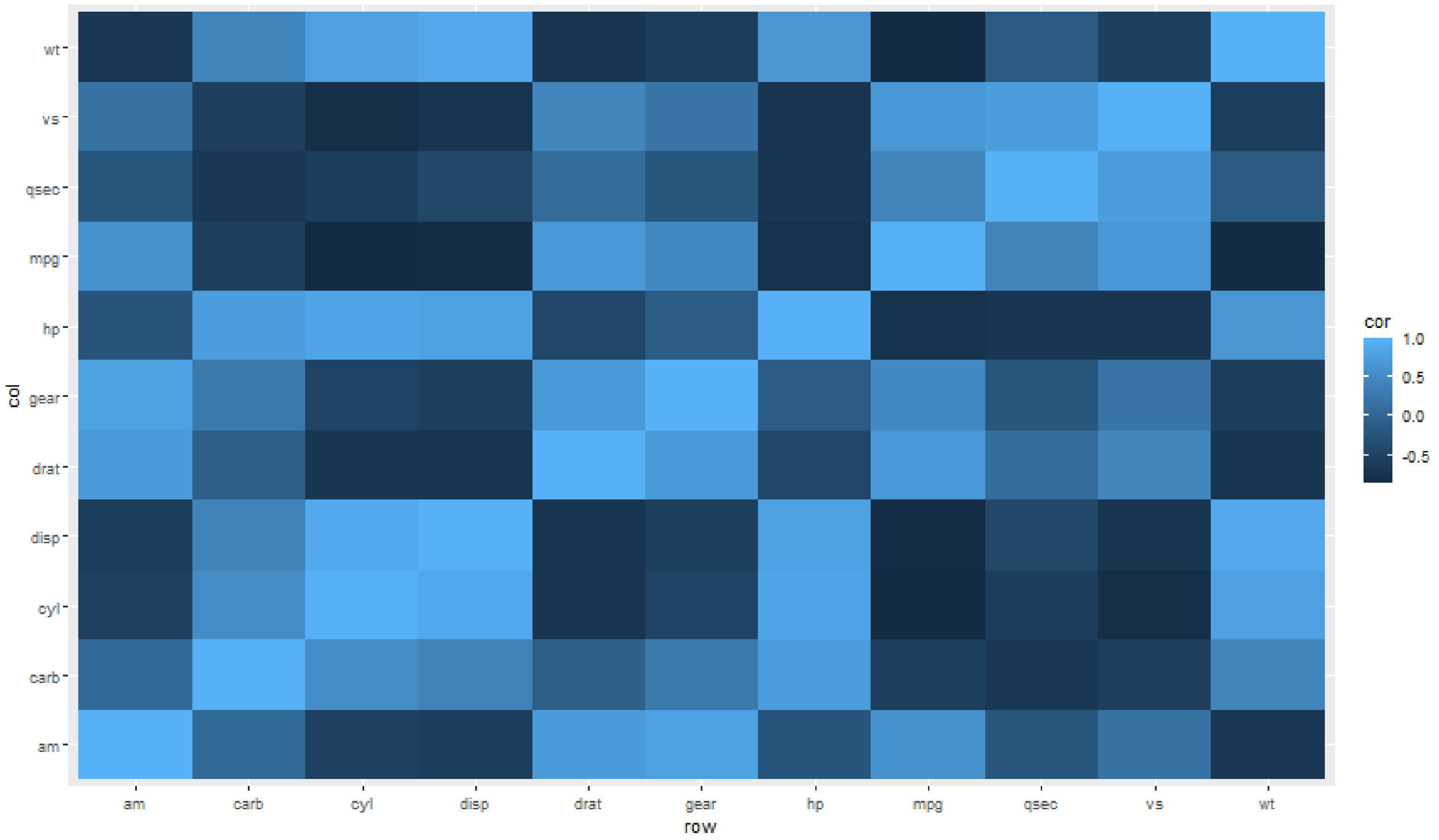
- Useful for finding highs and lows - and sometimes patterns
- They don't always work well

Example with correlations

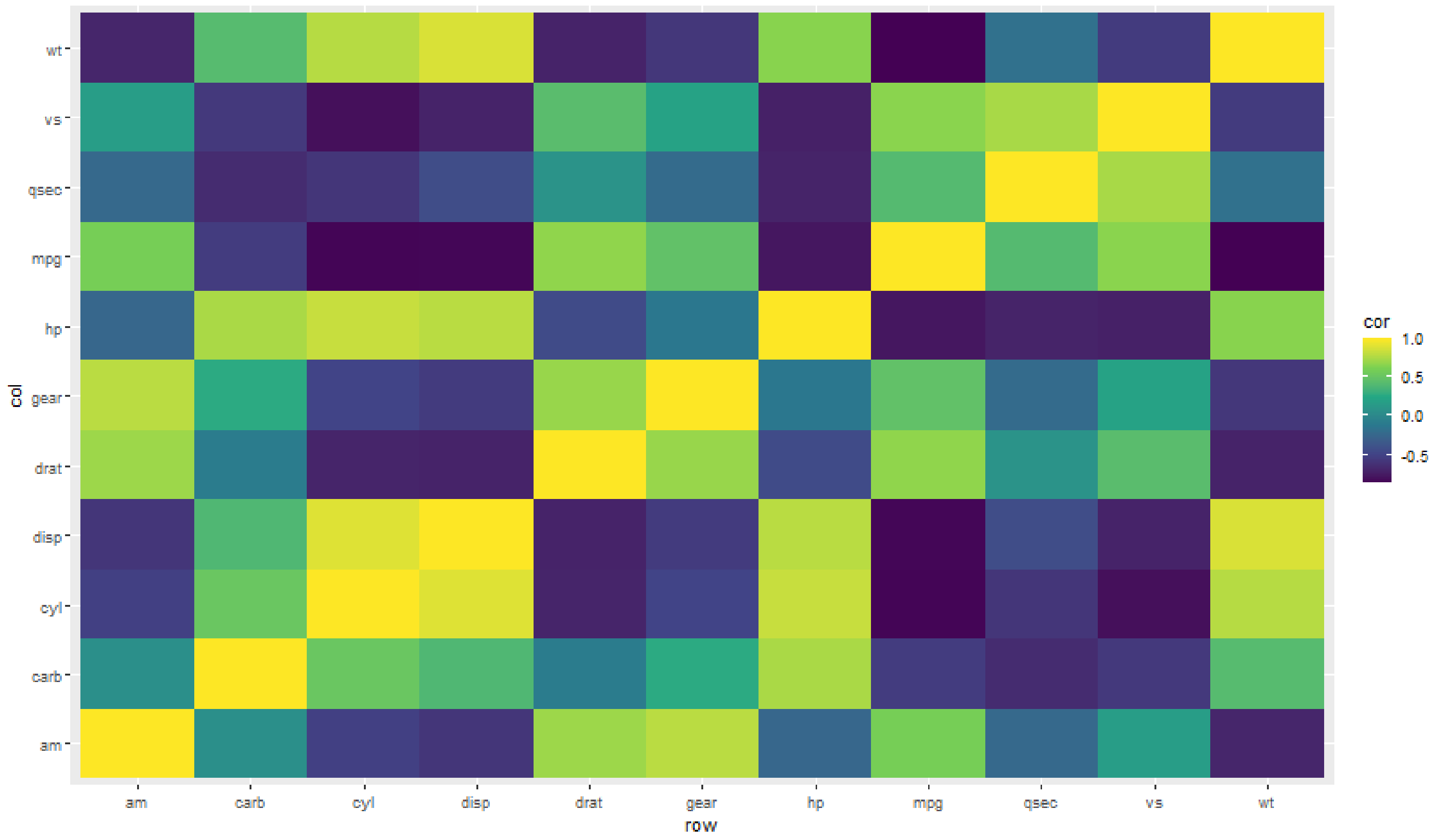
```r
corr <- cor(mtcars)

pc <- corr %>%
  as.data.frame() %>%
  mutate(row = rownames(.)) %>%
  pivot_longer(
    cols = -row,
    names_to = "col",
    values_to = "cor"
  )
head(pc)
```

```
## # A tibble: 6 x 3
##   row   col      cor
##   <chr> <chr>  <dbl>
## 1 mpg   mpg    1
## 2 mpg   cyl   -0.852
## 3 mpg   disp  -0.848
## 4 mpg   hp    -0.776
## 5 mpg   drat   0.681
## 6 mpg   wt    -0.868
```

```r
ggplot(pc, aes(row, col, fill = cor)) +
  geom_tile()
```



```r
ggplot(pc, aes(row, col, fill = cor)) +
  geom_tile() +
  scale_fill_viridis_c()
```



Categorical Data

Data

`{fivethirtyeight}` package

- *college_grad_students*

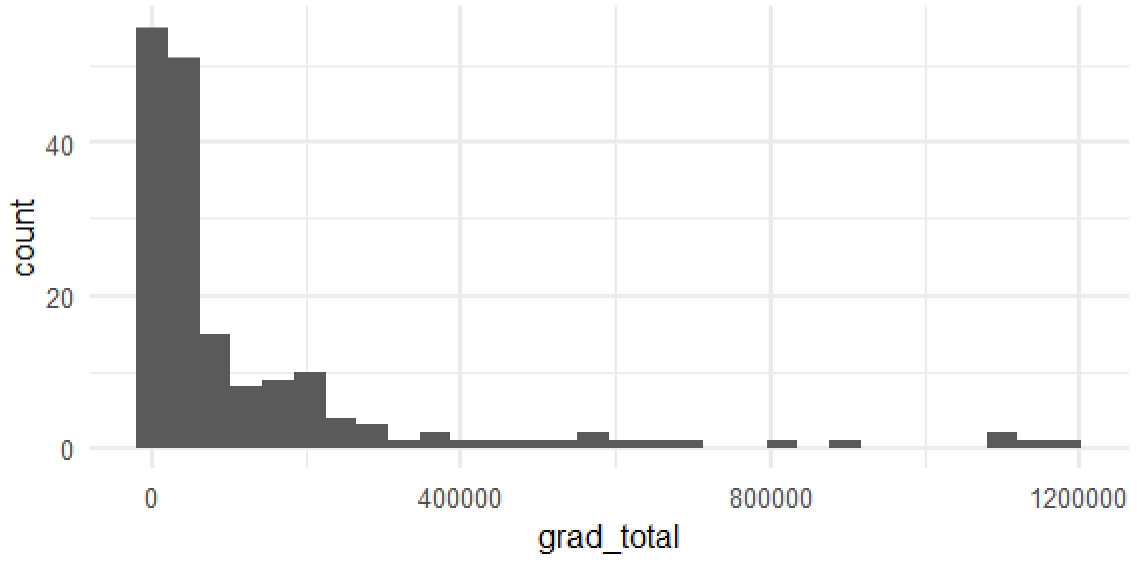
```r
theme_set(theme_minimal(base_size = 16))

#install.packages("fivethirtyeight")
library(fivethirtyeight)
# View(college_grad_students)
d <- college_grad_students # simpler reference
d
```

```
## # A tibble: 173 x 22
##    major~1 major major~2 grad_~3 grad_~4 grad_~5 grad_~6 grad_~7 grad_~8 gr
##      <int> <chr> <chr>     <int>   <int>   <int>   <int>   <int>   <dbl>
## 1     5601 Cons~ Indust~    9173     200    7098    6511     681  0.0875  1
## 2     6004 Comm~ Arts      53864     882   40492   29553    2482  0.0578   8
## 3     6211 Hosp~ Busine~   24417     437   18368   14784    1465  0.0739  1
## 4     2201 Cosm~ Indust~    5411      72    3590    2701     316  0.0809   8
## 5     2001 Comm~ Comput~    9109     171    7512    5622     466  0.0584   8
## 6     3201 Cour~ Law & ~    1542      22    1008     860       0  0       1
## 7     6206 Mark~ Busine~  190996    3738  151570  123045    8324  0.0521  1
```

Histogram

Histogram of "grad_total"

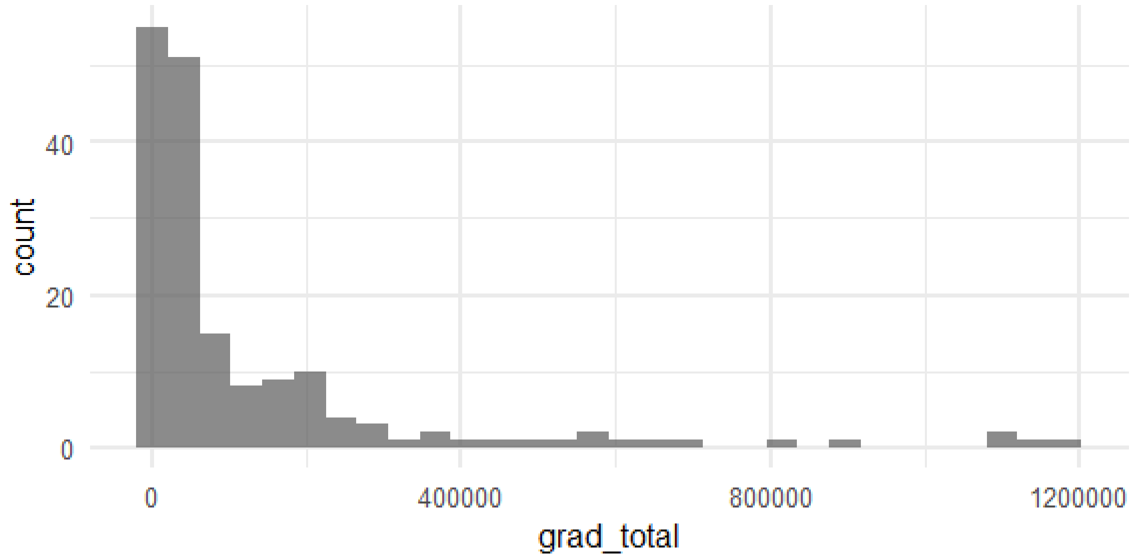
```
ggplot(d, aes(x = grad_total)) +
  geom_histogram()
```



Transparency - `alpha`

Add some transparency – perhaps this looks nicer

```r
ggplot(d, aes(x = grad_total)) +
  geom_histogram(alpha = 0.7)
```



`color` vs. `fill`

In general

- `color` defines the color a geom is *outlined*
- `fill` defines the color a geom is *filled*

For example:

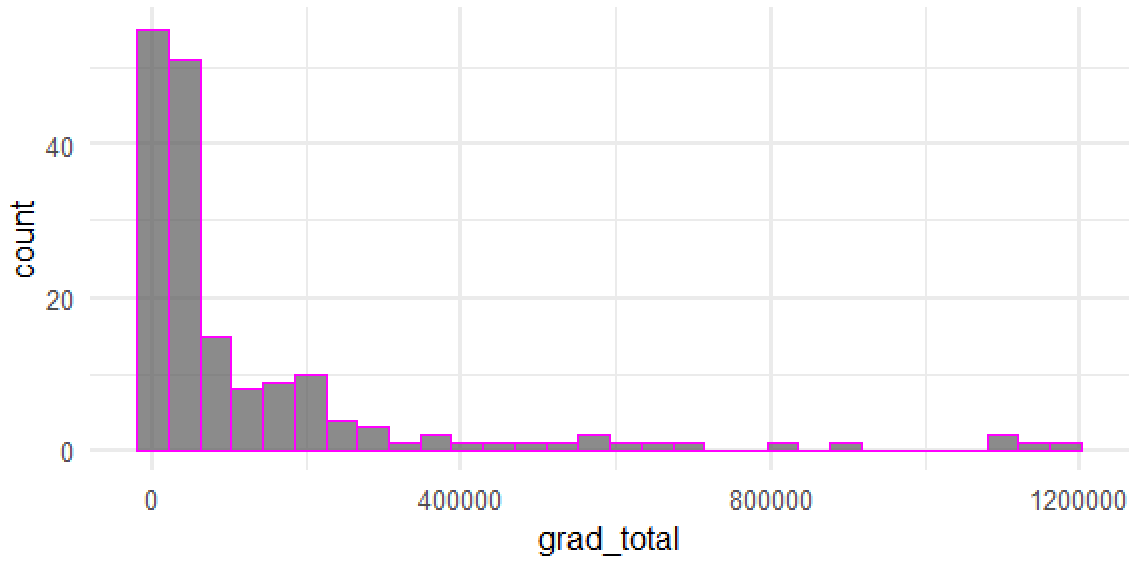
- `geom_point()` default has only has a color and **NO** fill because they're just points
- Point shapes 21–24 include both a color and a fill

How would we change the color of this plot?

```r
ggplot(d, aes(x = grad_total)) +
  geom_histogram(alpha = 0.7)
```

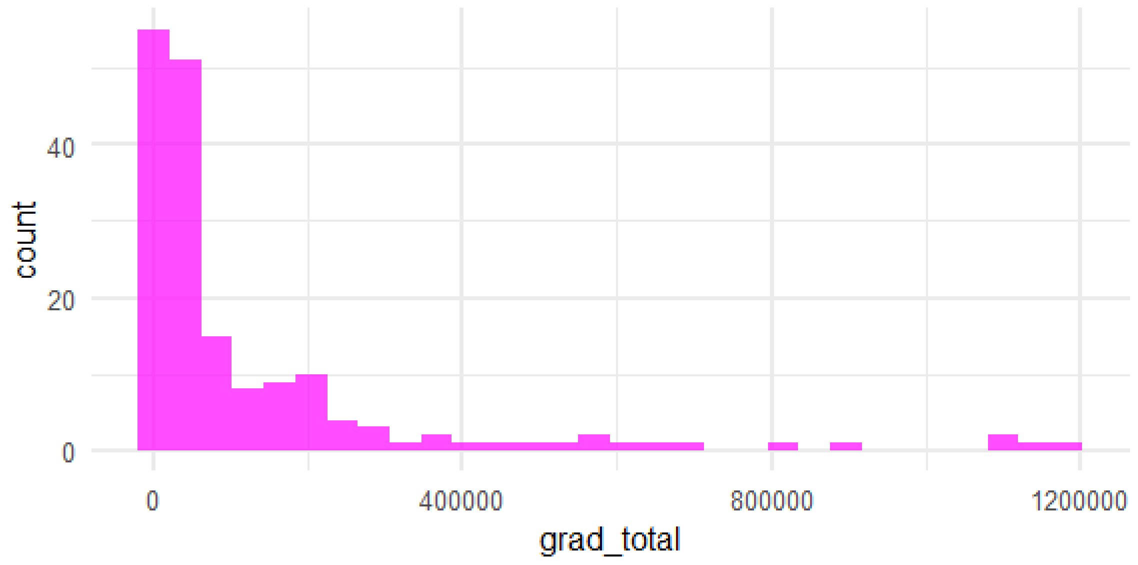
How would we change the color of this plot?

```
ggplot(d, aes(x = grad_total)) +
  geom_histogram(alpha = 0.7, color = "magenta")
```



How would we change the ~~color~~ fill of this plot?

```r
ggplot(d, aes(x = grad_total)) +
  geom_histogram(alpha = 0.7, fill = "magenta")
```

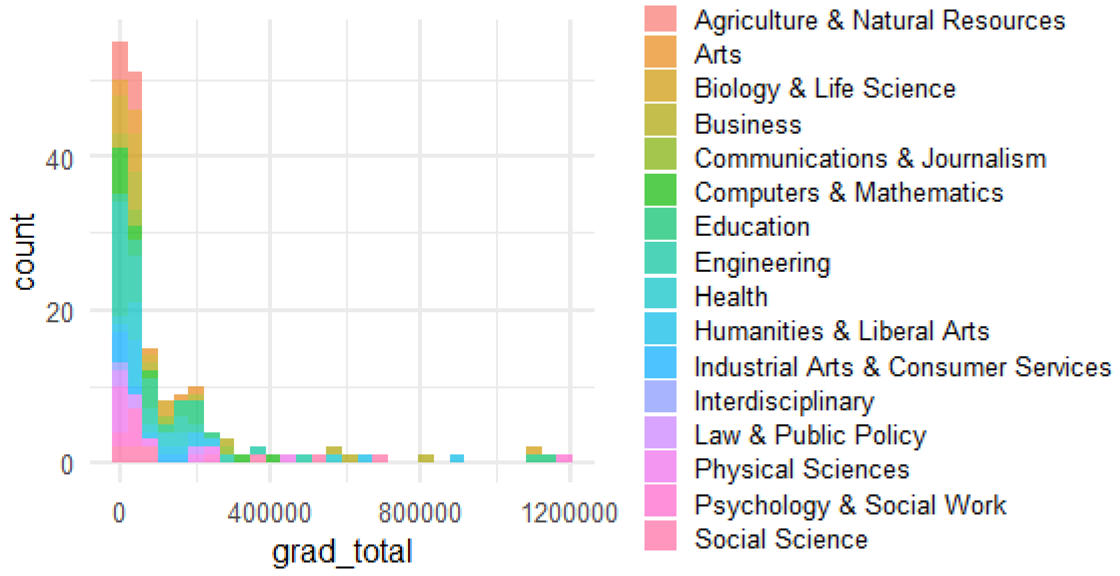


Color by variable

What if we wanted different colors by a variable

- *major_category*

```
ggplot(d, aes(x = grad_total)) +
  geom_histogram(aes(fill = major_category), alpha = 0.7)
```



Density plot

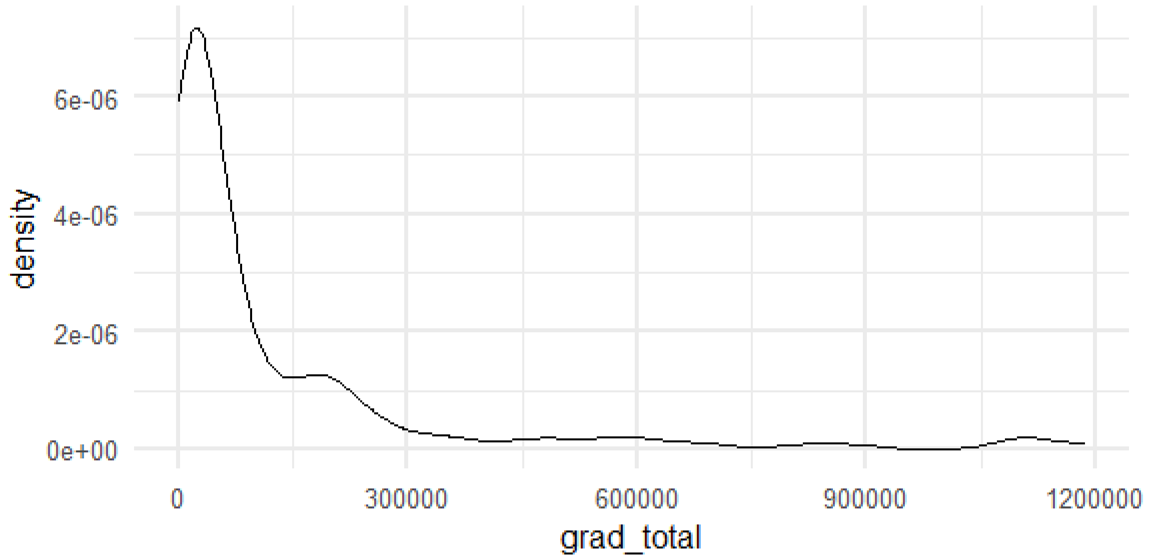
Alternative representation of distribution

- Think of it as a smoothed histogram (uses kernel smoothing)
- The depiction of the distribution is **NOT** determined by the number of the bins you use, as are histograms

Density plot

`geom_density()`

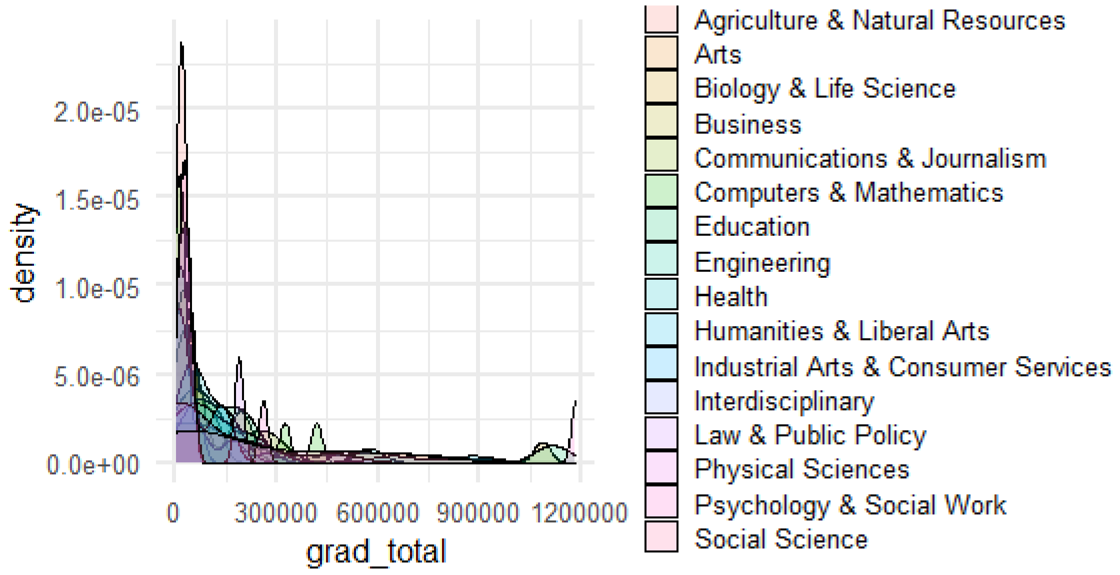
```
ggplot(d, aes(x = grad_total)) +
  geom_density()
```



Density plot

Now let's fill by *major_category*

```r
ggplot(d, aes(x = grad_total)) +
  geom_density(aes(fill = major_category), alpha = 0.2)
```



Not a good plot, just an example

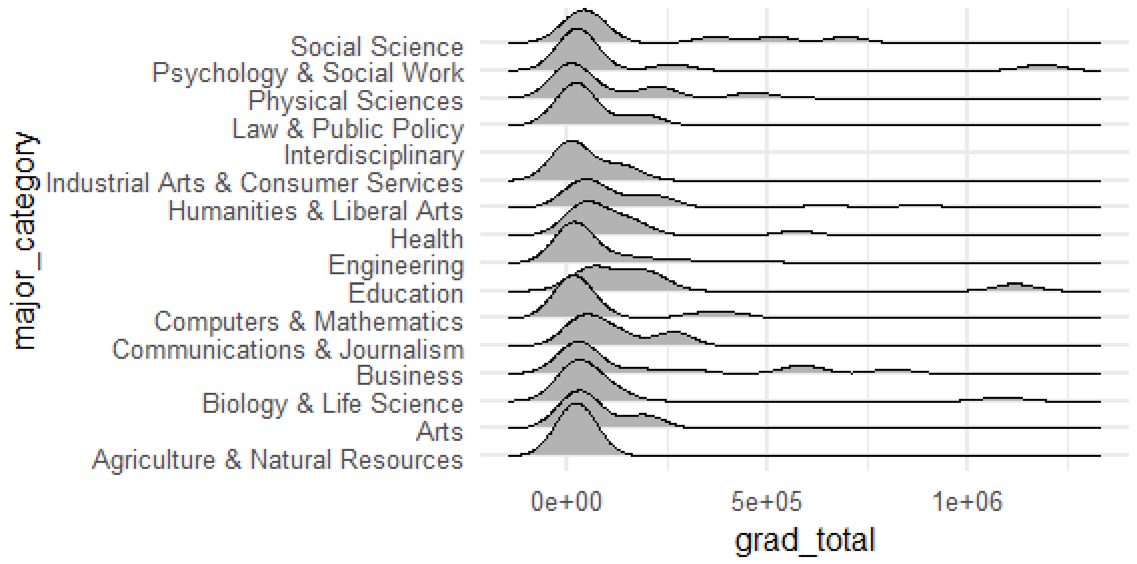
Possible alternative? `facet_wrap`

```r
ggplot(d, aes(x = grad_total)) +
  geom_density(alpha = 0.2) +
  facet_wrap(~major_category)
```

Even better

density ridges

```r
library(ggridges)
ggplot(d, aes(x = grad_total, y = major_category)) +
  geom_density_ridges()
```



Density Ridges

```
ggplot(penguins, aes(bill_length_mm , species)) +
  geom_density_ridges()
```

`fill`

```r
ggplot(penguins, aes(bill_length_mm , species)) +
  geom_density_ridges(aes(fill = factor(year)))
```

Add transparency for clarity

```r
ggplot(penguins, aes(bill_length_mm , species)) +
  geom_density_ridges(aes(fill = factor(year)),
                      alpha = 0.5)
```

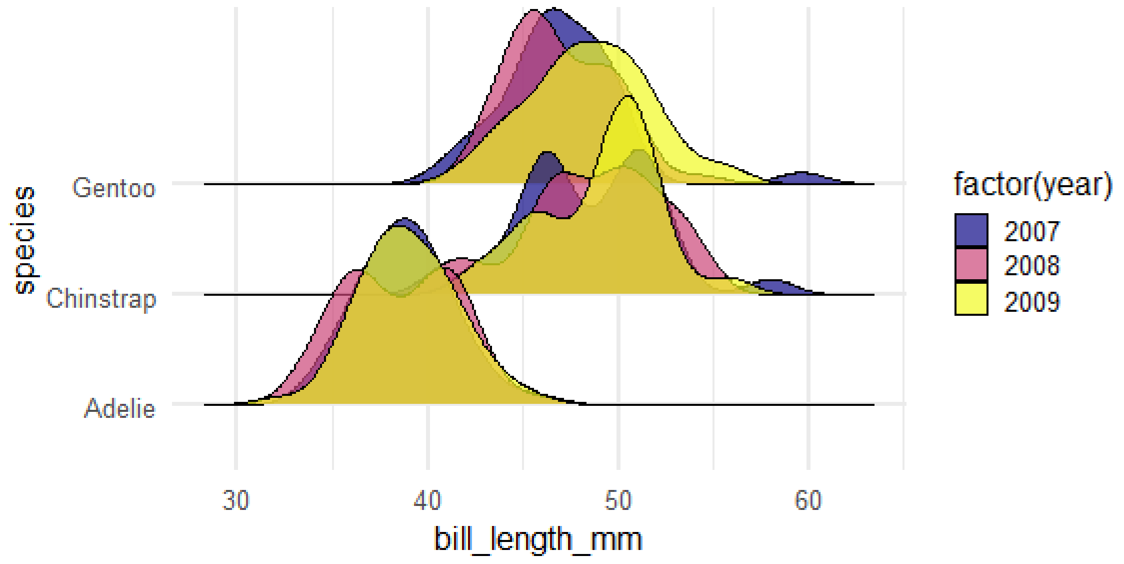
Viridis

- easier to read by those with colorblindness
- prints well in gray scale

```r
ggplot(penguins, aes(bill_length_mm , species)) +
  geom_density_ridges(aes(fill = factor(year)),
                      alpha = 0.5) +
                      scale_fill_viridis_d()
```

Same fill function, different "option"

```r
ggplot(penguins, aes(bill_length_mm , species)) +
  geom_density_ridges(aes(fill = factor(year)),
                      alpha = 0.7) +
                      scale_fill_viridis_d(option = "plasma")
```



Candy rankings `{fivethirtyeight}`

```r
candy <- candy_rankings %>%
  pivot_longer(
    cols = chocolate:pluribus,
    names_to = "type",
    values_to = "foo") %>%
  filter(foo) %>%
  select(-foo)
candy
```

```
## # A tibble: 197 x 5
##    competitorname sugarpercent pricepercent winpercent type
##    <chr>                 <dbl>        <dbl>      <dbl> <chr>
##  1 100 Grand             0.732        0.860       67.0 chocolate
##  2 100 Grand             0.732        0.860       67.0 caramel
##  3 100 Grand             0.732        0.860       67.0 crispedricewafer
##  4 100 Grand             0.732        0.860       67.0 bar
##  5 3 Musketeers          0.604        0.511       67.6 chocolate
##  6 3 Musketeers          0.604        0.511       67.6 nougat
##  7 3 Musketeers          0.604        0.511       67.6 bar
##  8 Air Heads             0.906        0.511       52.3 fruity
```

Boxplot

```
ggplot(candy, aes(type, sugarpercent)) +
  geom_boxplot()
```

Violin plots

```r
ggplot(candy, aes(type, sugarpercent)) +
  geom_violin()
```

Bar Charts

```r
head(mpg)
```

```
## # A tibble: 6 x 11
##   manufacturer model displ  year   cyl trans      drv     cty   hwy fl    c
##   <chr>        <chr> <dbl> <int> <int> <chr>      <chr> <int> <int> <chr> <
## 1 audi         a4      1.8  1999     4 auto(l5)   f        18    29 p     c
## 2 audi         a4      1.8  1999     4 manual(m5) f        21    29 p     c
## 3 audi         a4      2    2008     4 manual(m6) f        20    31 p     c
## 4 audi         a4      2    2008     4 auto(av)   f        21    30 p     c
## 5 audi         a4      2.8  1999     6 auto(l5)   f        16    26 p     c
## 6 audi         a4      2.8  1999     6 manual(m5) f        18    26 p     c
```

Bar/Col Charts

`geom_bar()`

- expects *x* **OR** *y*
- counts rows
- if you want to count the number of cases at each *x* or *y* position
- makes the height of the bar proportional to the number of cases in each group
- uses `stat_count()` by default

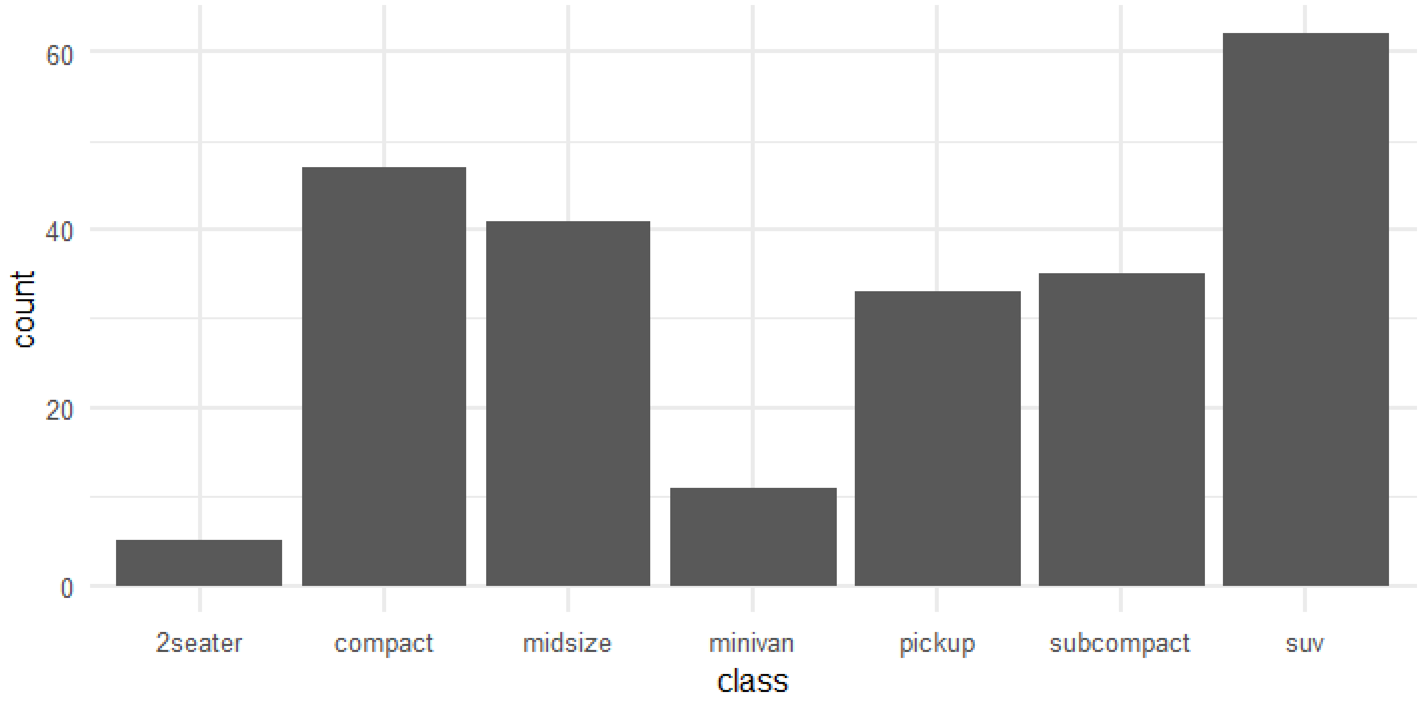
`geom_col()`

- expects *x* **AND** *y*
- expects numbers in your data
- if you want the heights of the bars to represent values in the data
- leaves the data as is
- uses `stat_identity()` by default

geom_bar()

mpg data

```r
ggplot(mpg, aes(class)) + # one variable in the `aes()`
  geom_bar() # counts the rows per class
```



summarized_mpg data

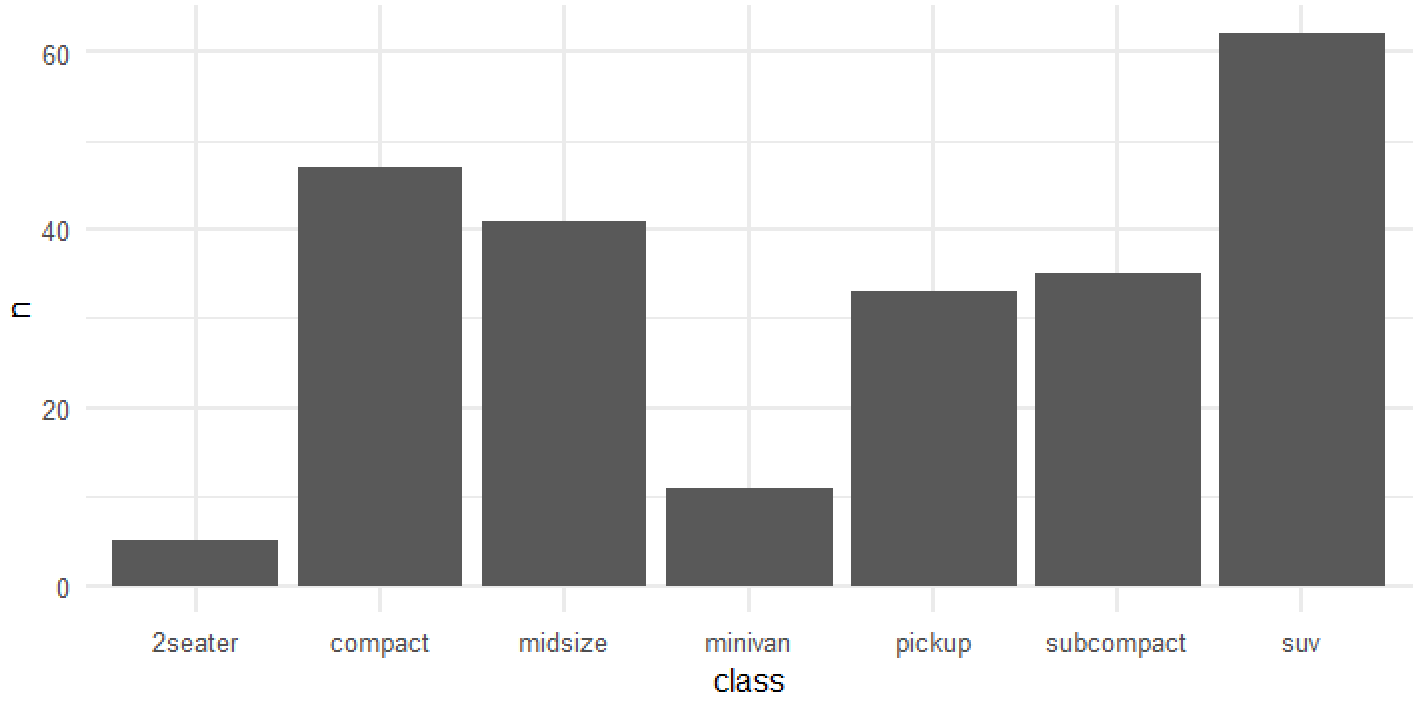
```
summarized_mpg <- mpg %>%
  group_by(class) %>%
  count()

head(summarized_mpg)
```

```
## # A tibble: 6 x 2
## # Groups:   class [6]
##   class          n
##   <chr>      <int>
## 1 2seater        5
## 2 compact       47
## 3 midsize       41
## 4 minivan       11
## 5 pickup        33
## 6 subcompact    35
```

geom_col()

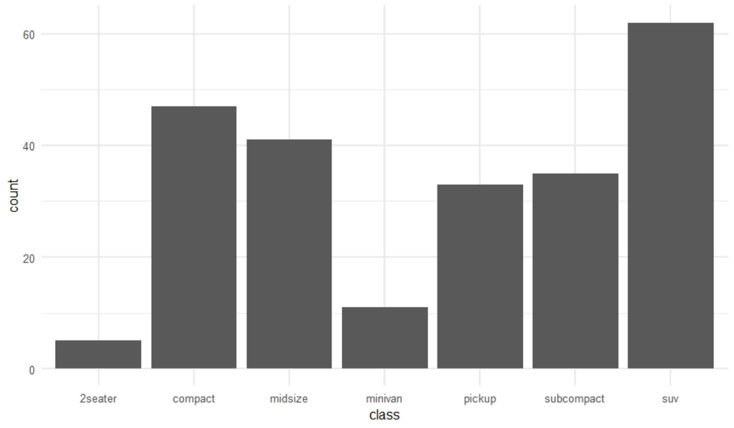
summarized_mpg data

```r
ggplot(summarized_mpg, aes(class, n)) + # two variables in the `aes()`
  geom_col() # data has the rows per class in "n"
```



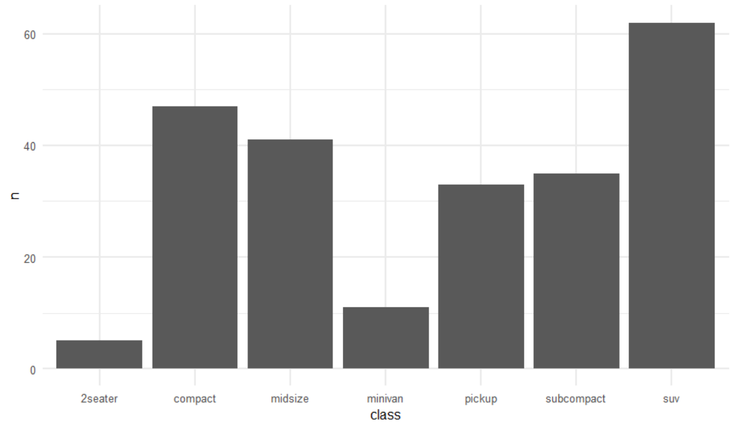
`geom_bar()` **default**

```r
ggplot(mpg, aes(class)) +
  geom_bar()
```



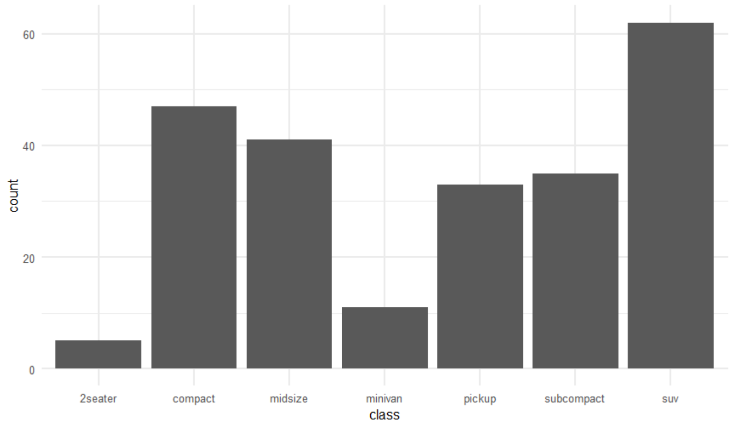
`geom_bar(stat = "identity")`

```r
ggplot(summarized_mpg, aes(class,
  geom_bar(stat = "identity")
```



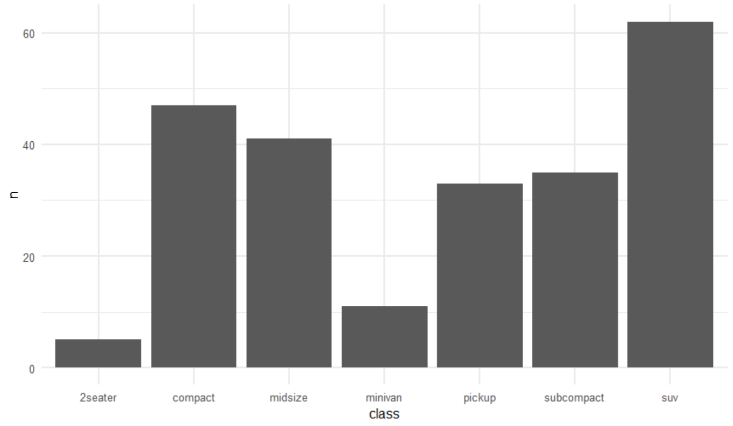
`geom_bar()` default

```
ggplot(mpg, aes(class)) +
  geom_bar()
```



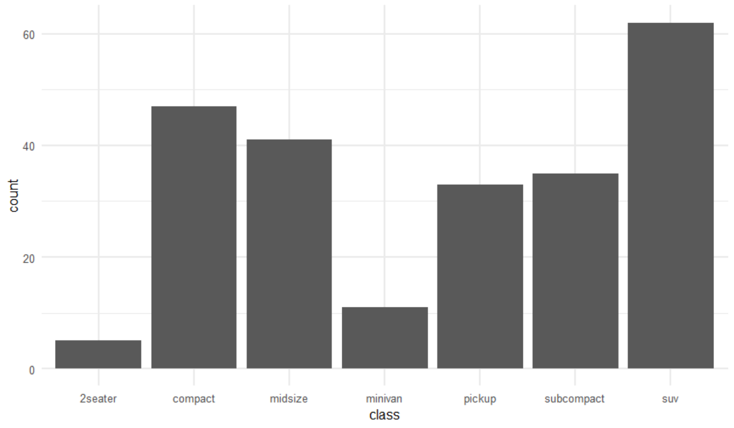
`geom_col()` default

```
ggplot(summarized_mpg, aes(class,
  geom_col()
```



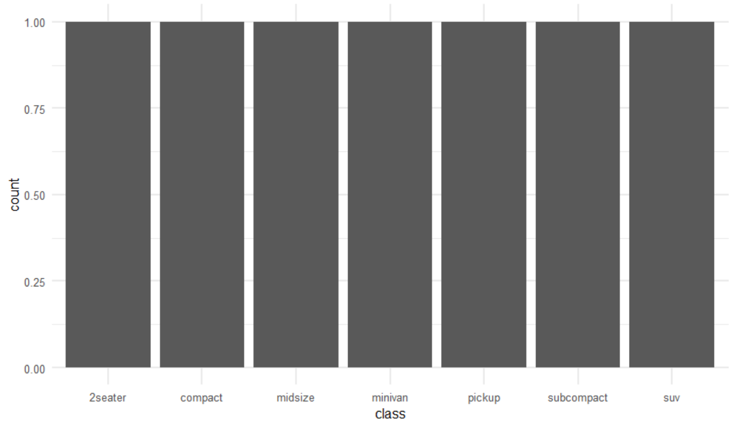
`geom_bar()` default

```
ggplot(mpg, aes(class)) +
  geom_bar()
```



`geom_bar()` uh-oh

```
ggplot(summarized_mpg, aes(class)
  geom_bar()
```



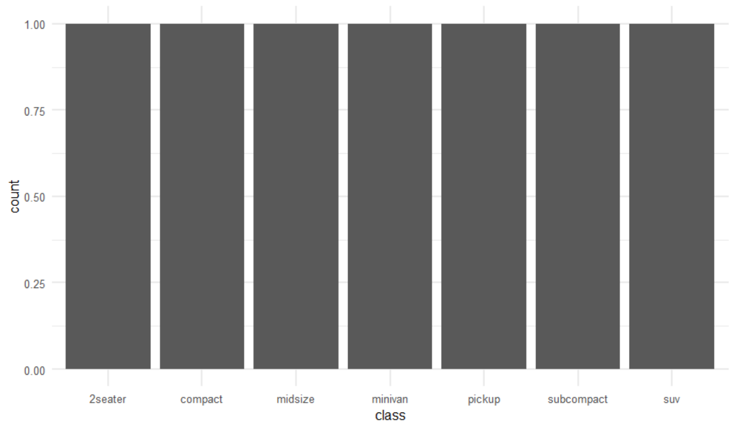
What happened?

Let's look at our data again

```
summarized_mpg
```

```
## # A tibble: 7 x 2
## # Groups:   class [7]
##   class          n
##   <chr>      <int>
## 1 2seater        5
## 2 compact       47
## 3 midsize       41
## 4 minivan       11
## 5 pickup        33
## 6 subcompact    35
## 7 suv           62
```

```
ggplot(summarized_mpg, aes(class)
  geom_bar()
```



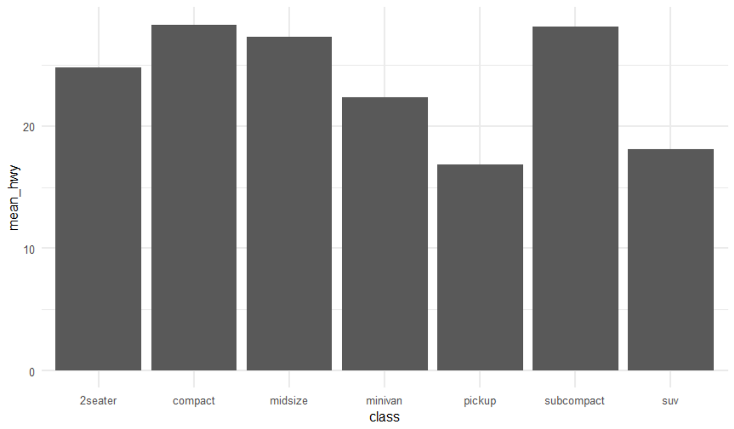
Change the order of the *x*-axis

- We'll talk about betters methods for this when we talk about `factors` in Week 9
- Basically - define *x*-axis variable as a `factor` with levels in the order you want

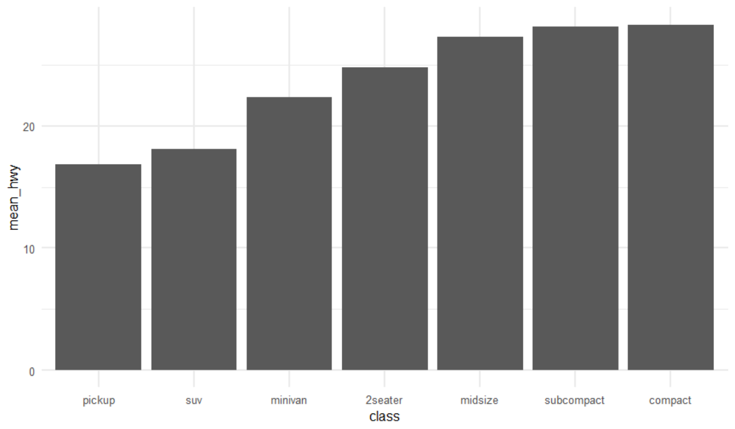
```
(mean_hmiles <- mpg %>%
  group_by(class) %>%
  summarize(mean_hwy = mean(hwy)))
```

```
## # A tibble: 7 x 2
##   class      mean_hwy
##   <chr>         <dbl>
## 1 2seater        24.8
## 2 compact        28.3
## 3 midsize        27.3
## 4 minivan        22.4
## 5 pickup         16.9
## 6 subcompact     28.1
## 7 suv            18.1
```

```r
mean_hmiles %>%
  ggplot(aes(class, mean_hwy)) +
  geom_col()
```



```r
mean_hmiles %>%
  mutate(class = factor(class,
                        levels =







  ggplot(aes(class, mean_hwy)) +
  geom_col()
```



More bar plot options

Data

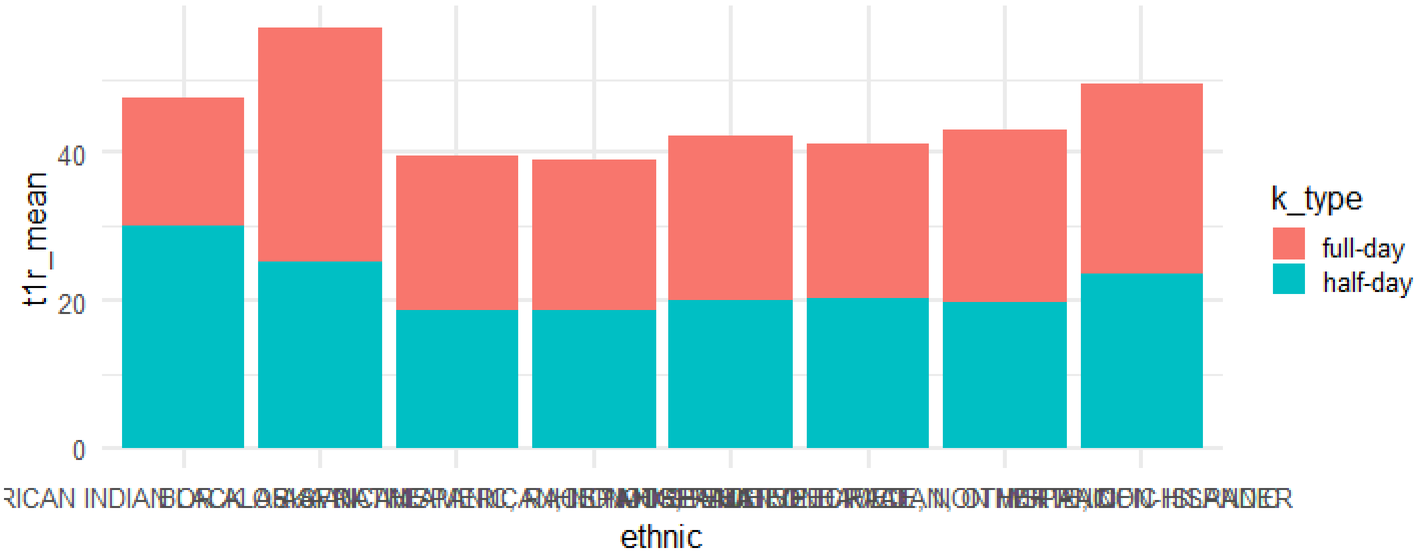
```
eclsk <- haven::read_sav(here::here("data", "ecls-k_samp.sav")) %>%
  rio::characterize() %>%
  janitor::clean_names()

ecls_smry <- eclsk %>%
    group_by(k_type, ethnic) %>%
    summarize(t1r_mean = mean(t1rscale))

ecls_smry
```

```
## # A tibble: 16 x 3
## # Groups:   k_type [2]
##    k_type   ethnic                                    t1r_mean
##    <chr>    <chr>                                        <dbl>
##  1 full-day AMERICAN INDIAN OR ALASKA NATIVE              17.5
##  2 full-day ASIAN                                         31.8
##  3 full-day BLACK OR AFRICAN AMERICAN, NON-HISPANIC       21.1
##  4 full-day HISPANIC, RACE NOT SPECIFIED                  20.3
##  5 full-day HISPANIC, RACE SPECIFIED                      22.3
##  6 full-day MORE THAN ONE RACE, NON HISPANIC              20.8
```

Stacked bar plot

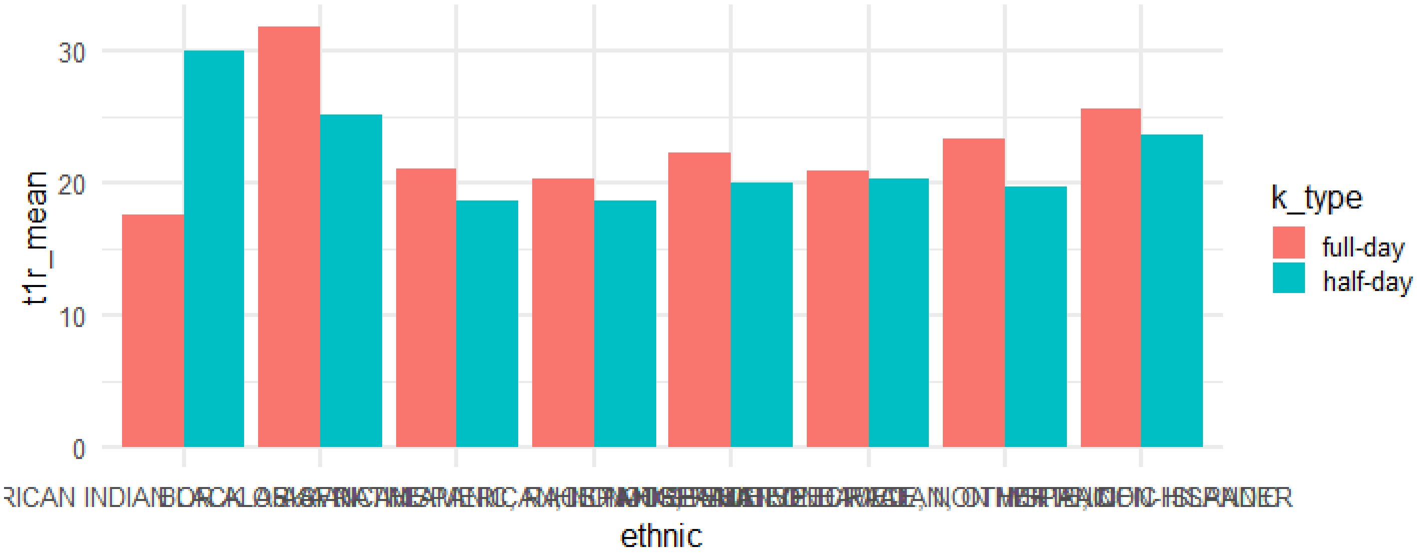
Look for effects in "ethnicity" by "k_type" (full/half day K)

```
ggplot(ecls_smry, aes(ethnic, t1r_mean)) +
    geom_col(aes(fill = k_type))
```



Grouped bar plot

```r
ggplot(ecls_smry, aes(ethnic, t1r_mean)) +
    geom_col(aes(fill = k_type),
             position = "dodge")
```



Rotating Labels

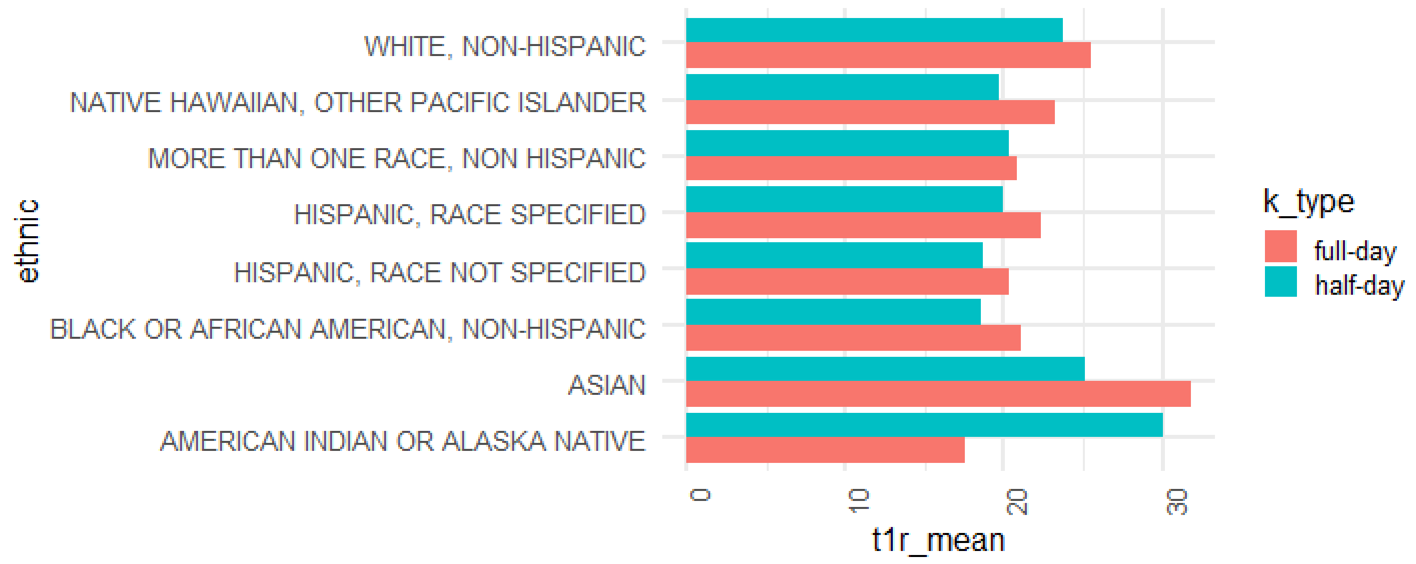
I have to look this up *every* time

```r
ggplot(ecls_smry, aes(ethnic, t1r_mean)) +
  geom_col(aes(fill = k_type),
           position = "dodge") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1))
```

Flip the coordinates

`coord_flip()`

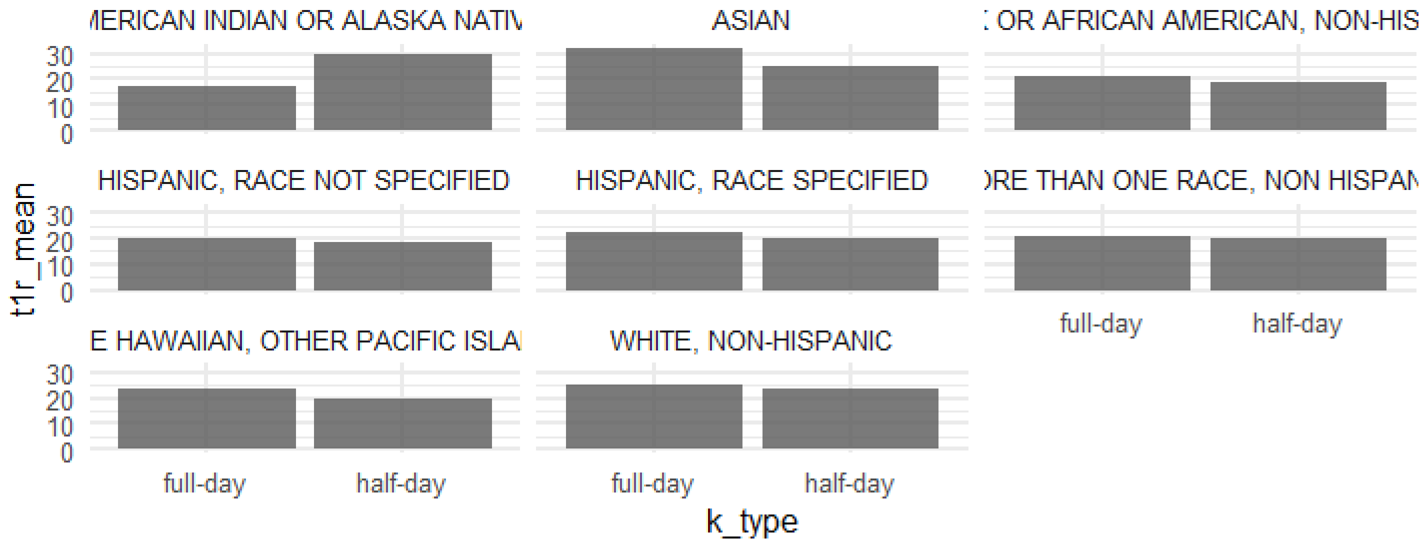
```
ggplot(ecls_smry, aes(ethnic, t1r_mean)) +
  geom_col(aes(fill = k_type),
           position = "dodge") +
  theme(axis.text.x = element_text(angle = 90, hjust = 1)) +
  coord_flip()
```



Alternatively

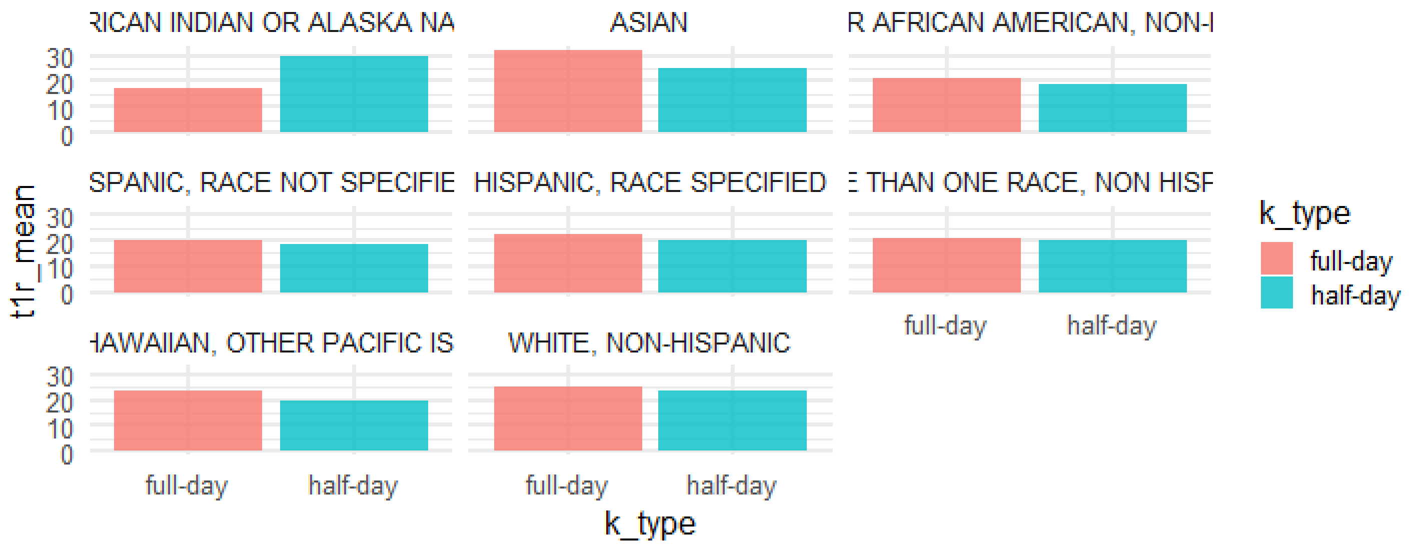
`facet_wrap()`

```
ggplot(ecls_smry, aes(k_type, t1r_mean)) +
    geom_col(alpha = 0.8) +
    facet_wrap(~ethnic)
```



Sometimes some redundancy works well

```
ggplot(ecls_smry, aes(k_type, t1r_mean, fill = k_type)) +
    geom_col(alpha = 0.8) +
    facet_wrap(~ethnic)
```



`geom_*()` Review

- `geom_point()`
- `geom_smooth()`
- `geom_line()`
- `geom_tile()`
- `geom_histogram()`
- `geom_density()`
- `ggridges::geom_density_ridges()`
- `geom_boxplot()`
- `geom_violin()`
- `geom_bar()`
- `geom_col()`

Challenge

- Start a new R project
- Create a new script, save it as "practice-plots.R"
- Load the `{tidyverse}`
- Print the **msleep** dataset to see it's structure (it's from `{ggplot2}`)

For each of the following, produce a separate plot

1. Plot the relation between "sleep_total" and "brainwt" (with "brainwt" as the DV) - scatter plot
2. Overlay a smooth on the previous plot
3. Color the points by "vore", but fit a single smooth
4. Fit separate smooths by "vore", but with all points being gray
5. Omit the standard error of the smooths
6. Use `ylim()` as an additional layer to restrict the *y*-axis to range from `0` to 5

Next time

Before next class

- Reading
  - R4DS 5
- Supplemental Learning
  - RStudio Primer: Working with Tibbles
  - Rbootcamp: Ch 3
  - Codecademy: Aggregates in R
- Homework
  - **Homework 2**
  - **Homework 3**

```
renderthis::to_pdf(here::here("slides", "w3_ggplot2.Rmd"), complex_slide
```