Tutorial - R

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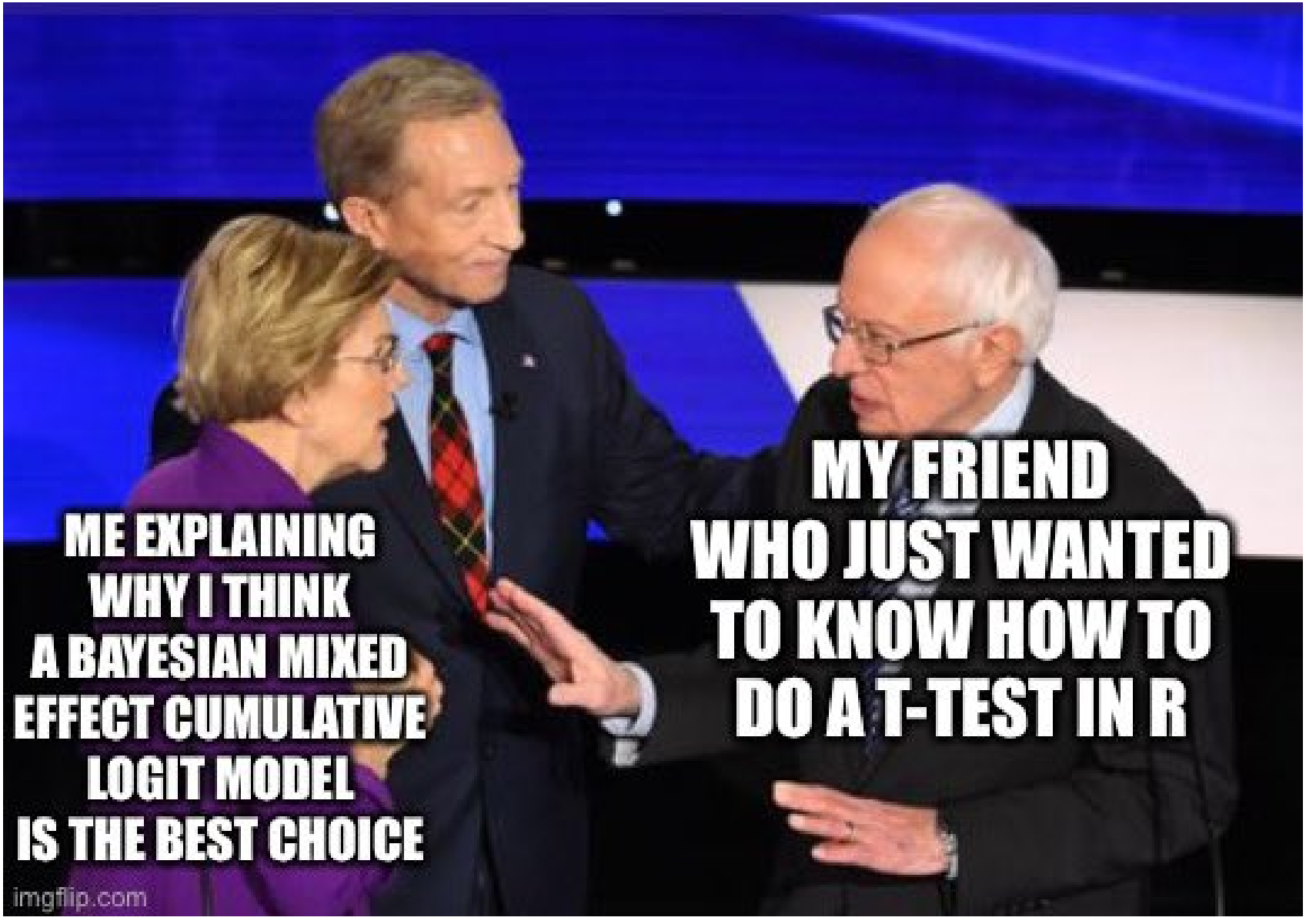
Why R?


ME EXPLAINING
WHY I THINK
A BAYESIAN MIXED
EFFECT CUMULATIVE
LOGIT MODEL
IS THE BEST CHOICE
MY FRIEND
WHO JUST WANTED
TO KNOW HOW TO
DO A T-TEST IN R
imgflip.com

Why R?

- Flexible
  - Multiple packages
  - Multiple functions
  - Create functions and packages yourself!

Why R?

- Data wrangling
  - Merge datasets
  - Score questionnaires
  - Transform scores
  - Exclude subjects
  - Group data together

Why R?

- Centralize workflow
  - Clean data
  - Score data
  - Analyze data
  - Create figures
  - Create tables
  - Write manuscripts
  - Create this presentation!

Why R?

- Reproducible
  - No point and click
  - Publish your code
  - Re-run your analyses with new data instantly

Why R?

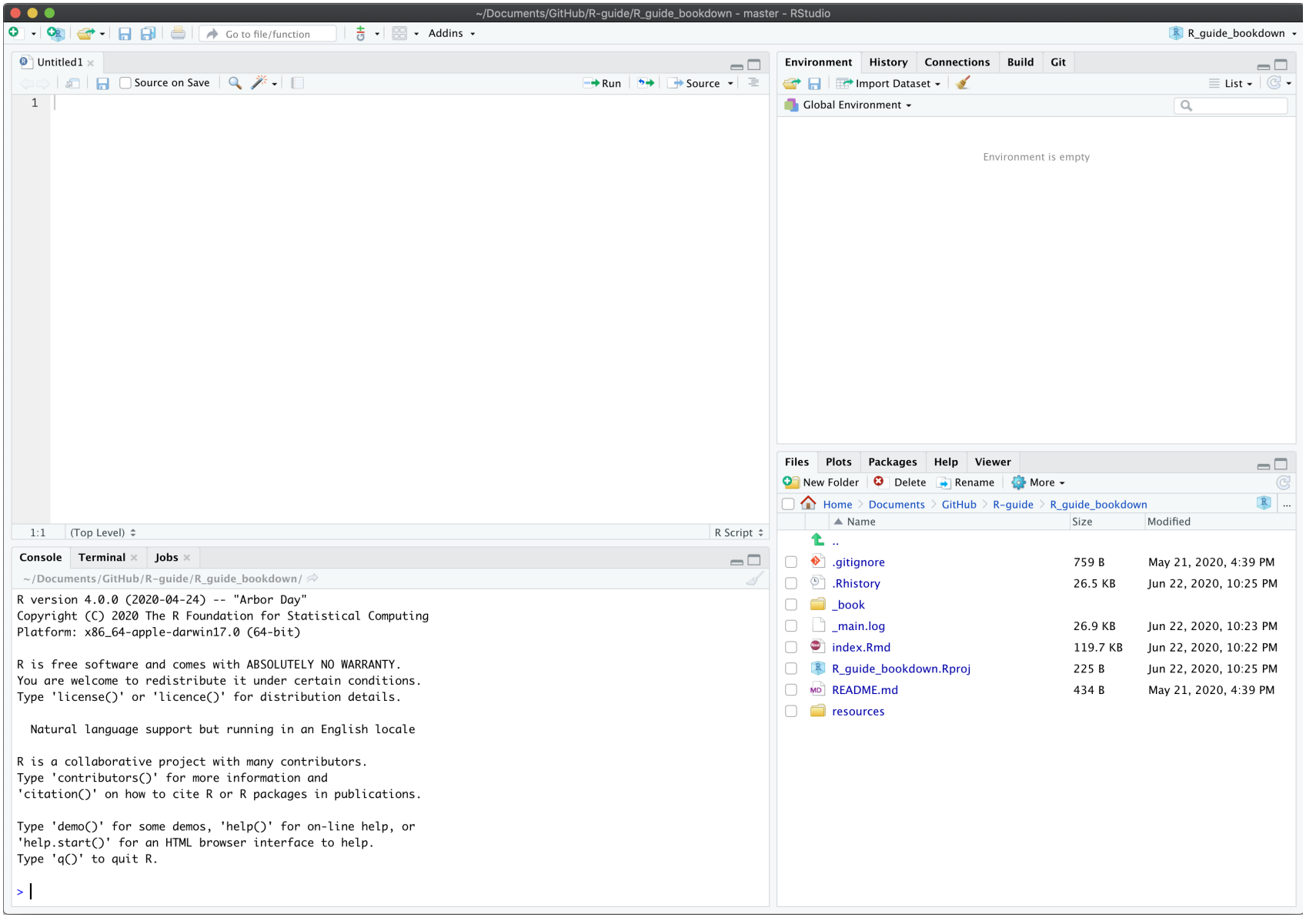
- Re-usable
  - Make your own code repository
  - Use the same code for multiple studies
  - Make the same types of figures for multiple datasets

Basics

Basics - Software

- R
  - Runs in the background
  - Download **here**
    - https://www.r-project.org/
- R-Studio
  - Where you will do your work
  - Download **here**
    - https://www.rstudio.com/products/rstudio/download

Basics - Environment



Basics - Creating a script

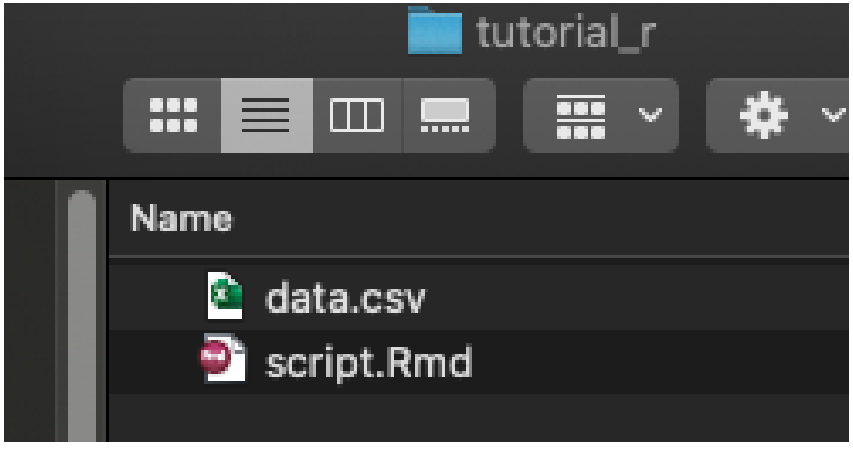
- You can type and execute code straight from the console - but to save it and come back to it later, you want to use a script
- Make a folder on your computer where your data, scripts, and code will live
- Click: File -> New File -> R Markdown (recommended)

Programming in R

- What is a working directory?

```
> getwd()
[1] "/Users/emily"
> 
```

- Benefits of R Markdown - sets working directory to root folder



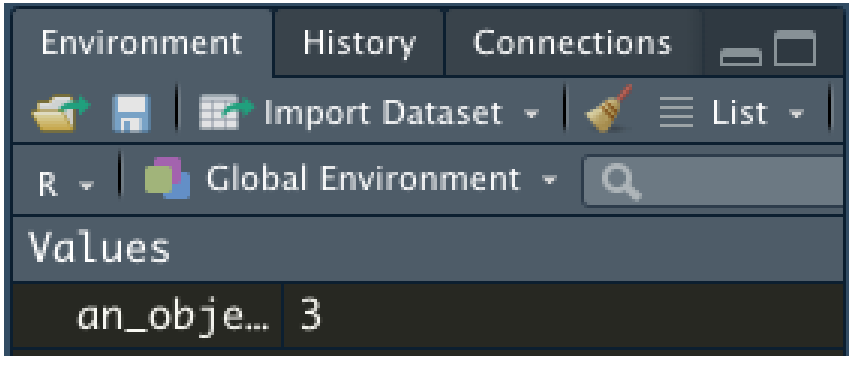
Programming in R

- Object-oriented programming
- You create objects and store them in the computer's "memory"

```
an_object <- 2 + 1
an_object
```

```
## [1] 3
```

- It also shows up in your environment



Programming in R

- Then you can do other things with it!
- Great for complex objects like sets of data.

```
another_object <- 10
sum_of_objects <- an_object + another_object
sum_of_objects
```

```
## [1] 13
```

Programming in R - Data Types

- Objects can be more than just numbers
  - Numeric
  - Integer
  - Character/String
  - Logical
  - Factor

```
class(sum_of_objects)
```

```
## [1] "numeric"
```

Programming in R - Data Structures

- Several but will talk about **Data Frames**
- Let's make our own

```
participant <- as.factor(c(1,2,3,4,5))
sex <- c("Female", "Male", "Male", "Female", "Female")
age <- c(16.5, 21.4, 20.1, 18.2, 17.3)
score_1 <- c(85, 90, 73, 70, 92)
score_2 <- c(87, 89, 85, 88, 97)
my_data_frame <- cbind.data.frame(participant, sex, age,
                  score_1, score_2)
my_data_frame
```

```
##   participant    sex  age score_1 score_2
## 1           1 Female 16.5      85      87
## 2           2   Male 21.4      90      89
## 3           3   Male 20.1      73      85
## 4           4 Female 18.2      70      88
## 5           5 Female 17.3      92      97
```

Programming in R - Data Structures

- Indexing
  - I want to know what my third participant's score_1 was
  - Third participant is in Row = 3 and score_1 is in Column = 4

```
my_data_frame[3,4]
```

```
## [1] 73
```

- Adding variables
  - I want to create a difference score between Score 2 and Score 1 to see if students improved

```
my_data_frame$difference <- my_data_frame$score_2 -
  my_data_frame$score_1
my_data_frame$difference
```

```
## [1]  2 -1 12 18  5
```

Summary Statistics

```
mean(my_data_frame$age)
```

```
## [1] 18.7
```

```
range(my_data_frame$age)
```

```
## [1] 16.5 21.4
```

```
levels(my_data_frame$sex)
```

```
## [1] "Female" "Male"
```

Summary Statistics

```
mean(my_data_frame$score_1[my_data_frame$sex == "Female"])
```

```
## [1] 82.33333
```

```
mean(my_data_frame$score_1[my_data_frame$sex == "Male"])
```

```
## [1] 81.5
```

Inferential Statistics

- Running inferential statistics in R is surprisingly easy
- Do females in this sample have statistically significantly higher test scores on score 1 than males?

```
t.test(my_data_frame$score_1 ~ my_data_frame$sex)
```

```
##
##  Welch Two Sample t-test
##
## data:  my_data_frame$score_1 by my_data_frame$sex
## t = 0.077925, df = 2.1416, p-value = 0.9446
## alternative hypothesis: true difference in means is not
## 95 percent confidence interval:
##  -42.38243  44.04910
## sample estimates:
## mean in group Female   mean in group Male
##             82.33333             81.50000
```

Inferential Statistics

- On average, did participants get better from their first score to their second?
- In other words, was the difference between score 2 and score 1 statistically significantly different from 0?

```
t.test(my_data_frame$difference)
```

```
##
##  One Sample t-test
##
## data:  my_data_frame$difference
## t = 2.0837, df = 4, p-value = 0.1056
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -2.393813 16.793813
## sample estimates:
## mean of x
##       7.2
```

Plotting - then a demonstration!

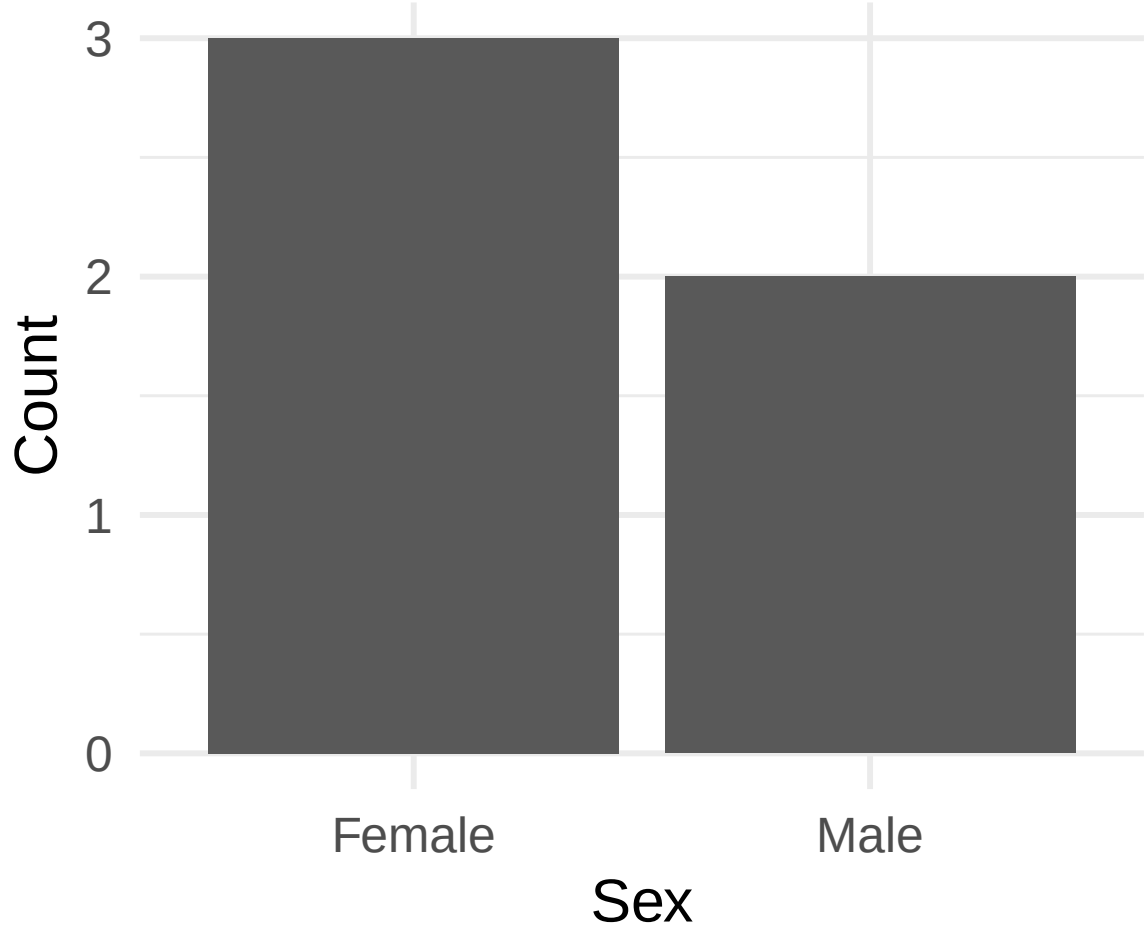
- You will find you may need to install and load "packages" for different uses
- Plotting is a good example

```
# Install the needed package
# (you only need to do this once)
# Note how I've 'commented' this out
# using hashtags

# install.packages('tidyverse')
library(tidyverse)
```

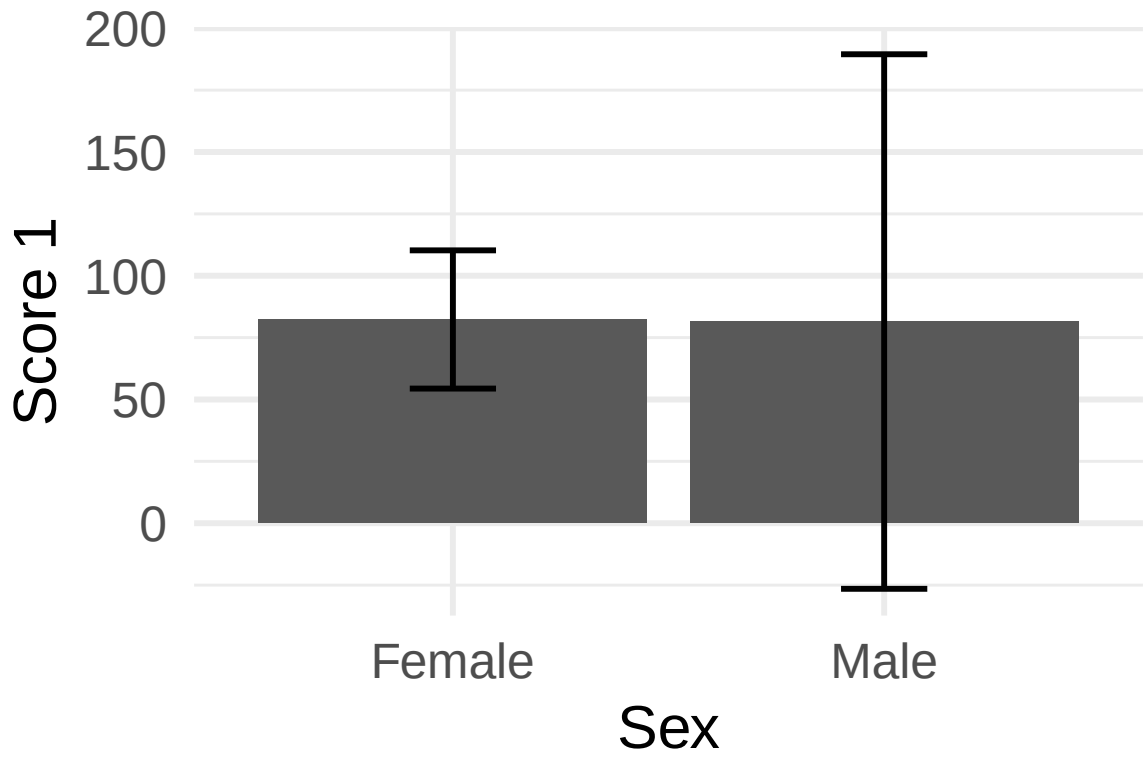
Plotting - histograms

```
ggplot(my_data_frame, aes(x = sex)) +
  geom_histogram(stat = "count") +
  xlab("Sex") + ylab("Count") +
  theme_minimal()
```



Plotting - bar plot

```
ggplot(my_data_frame, aes(x = sex, y = score_1)) +
  stat_summary(fun = mean, geom = "bar") +
  stat_summary(fun.data = mean_cl_normal,
               geom = "errorbar", width = .2) +
  xlab("Sex") + ylab("Score 1") +
  theme_minimal()
```



R-guide

- Code and simulated data for today's session can be found **here**
  - https://github.com/blakemorelab/tutorial_r
- I will send around an R-guide with more detailed instructions
  - Please do not distribute the guide as it is a work in-progress

A snippet from the guide:

7.4.1.2 Plotting a three-factor experimental design {#3-factor-plot}

Seriously? You're manipulating three factors in one experiment? I bet you're questioning some life decisions right now.

Thanks Ryan! Lolz

Now let's do a tutorial with a larger dataset!