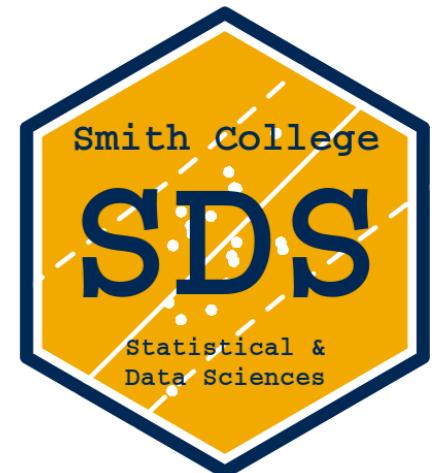
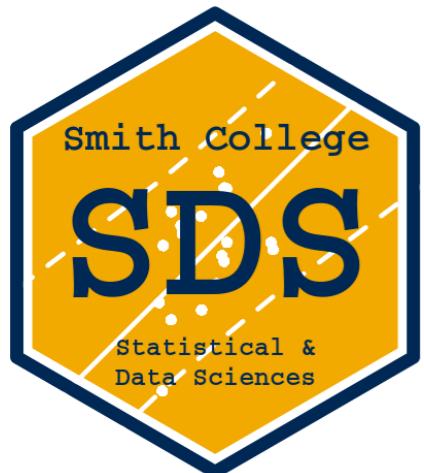


Statistical inference via data science: A "tidy" approach



Albert Y. Kim
Joint Math Meetings
Denver CO, USA
January 18, 2020

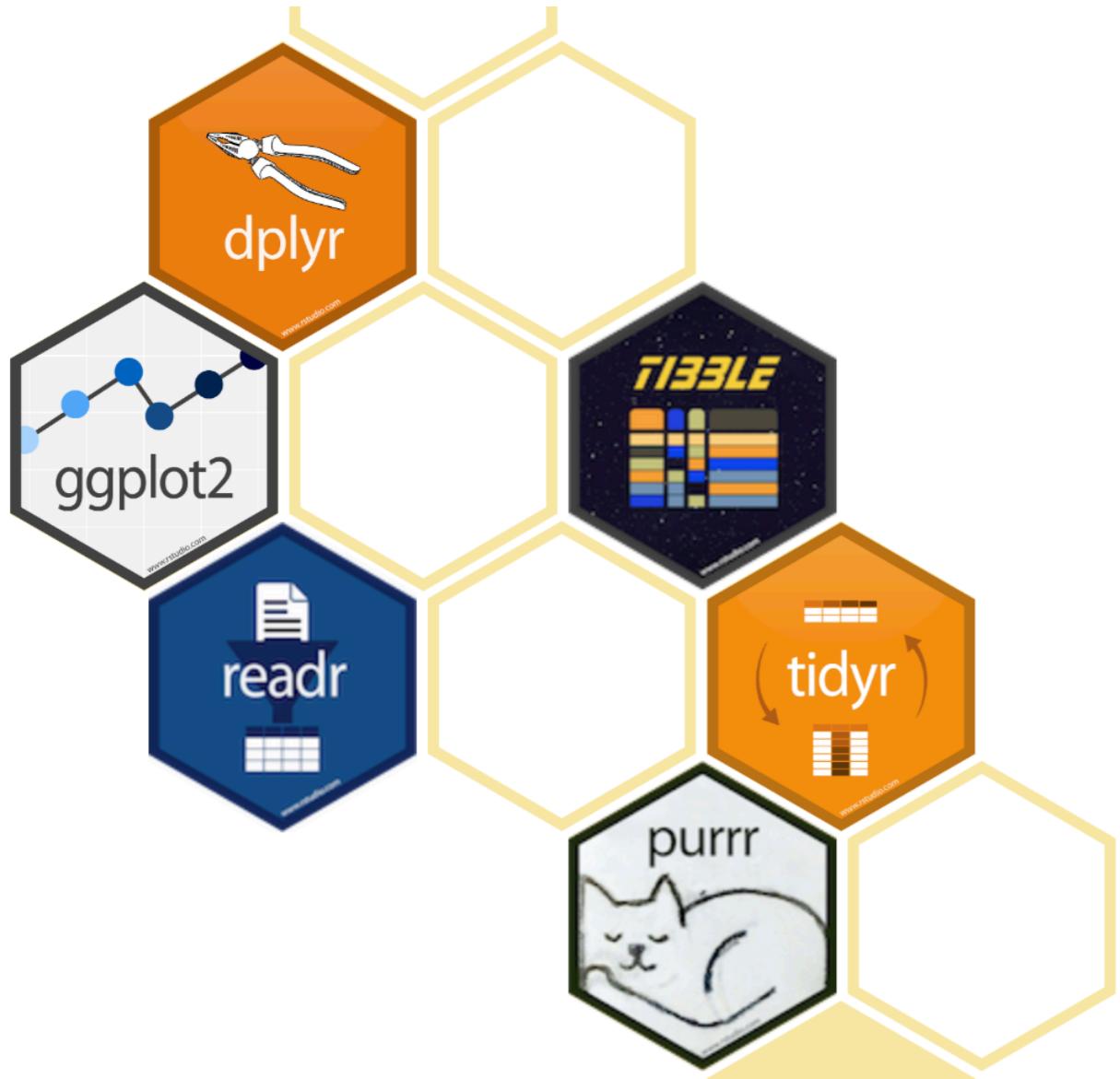


Slides available at twitter.com/rudeboybert



Statistical inference **via**
data science...

What is the tidyverse?



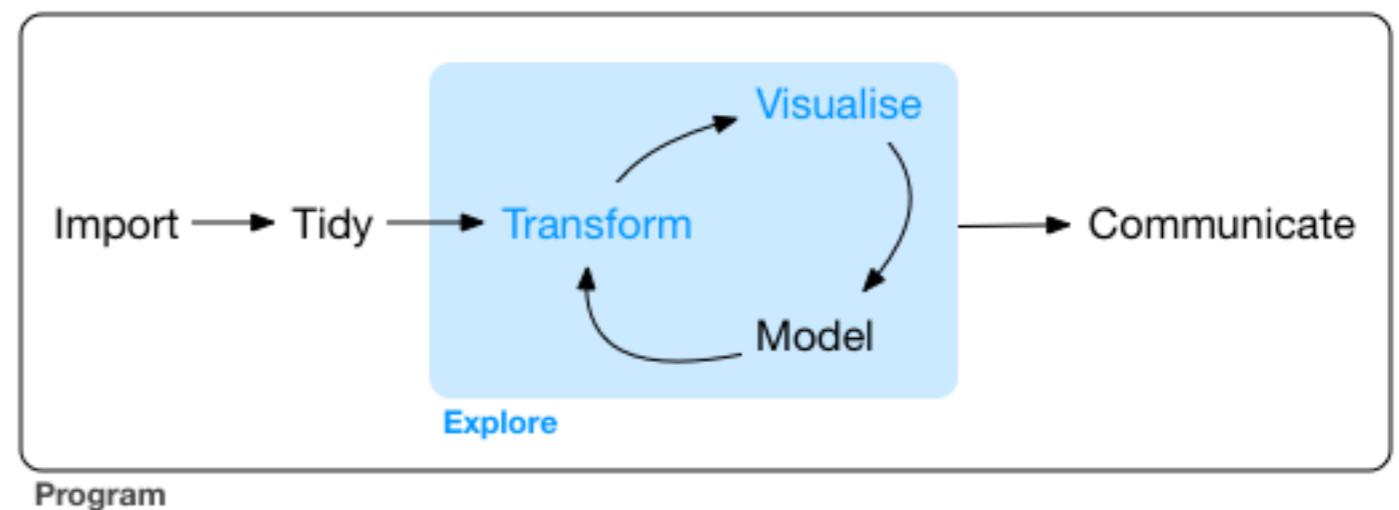
R packages for data science

The tidyverse is an **opinionated collection of R packages** designed for data science. All packages share an underlying design philosophy, grammar, and data structures.

Why use the tidyverse?

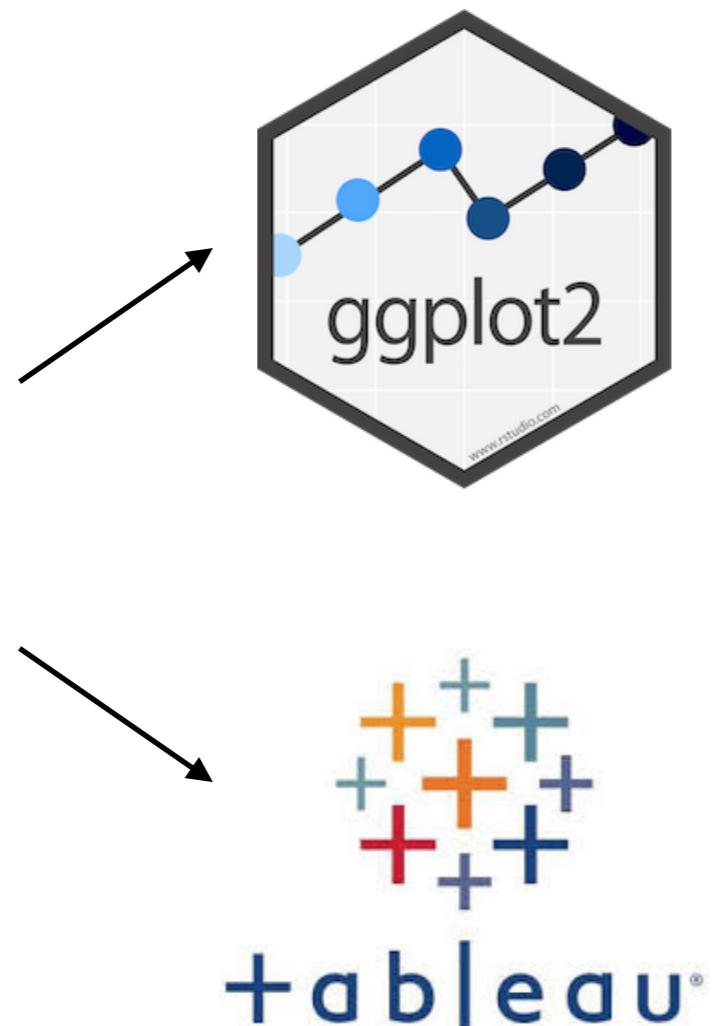
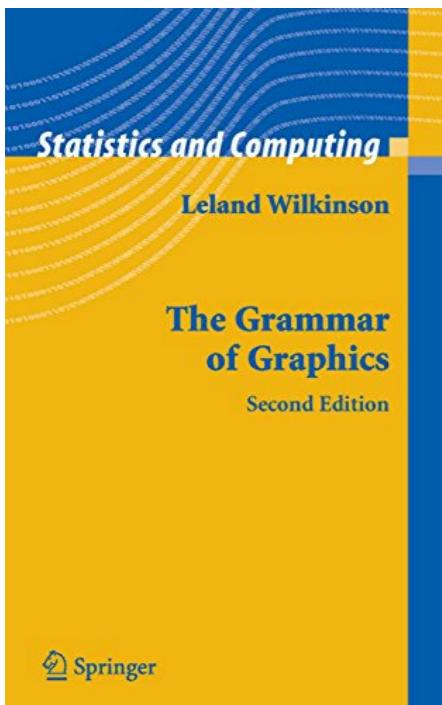
1. It encourages students to “play the whole game”
2. It’s transferable
3. It bridges the gap between tools for *learning* statistics & tools for *doing* statistics

1. It encourages students to “play the whole game”



- Emphasize exploratory data analysis (EDA)
- “To (data) wrangle or not to wrangle? That is the question”
- IMO to do no data wrangling betrays true nature of the work

2.a) It transfers: Data visualization



Salesforce closes \$15.7B Tableau deal

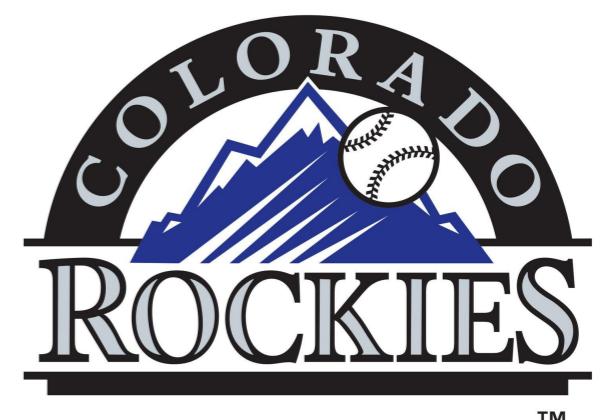
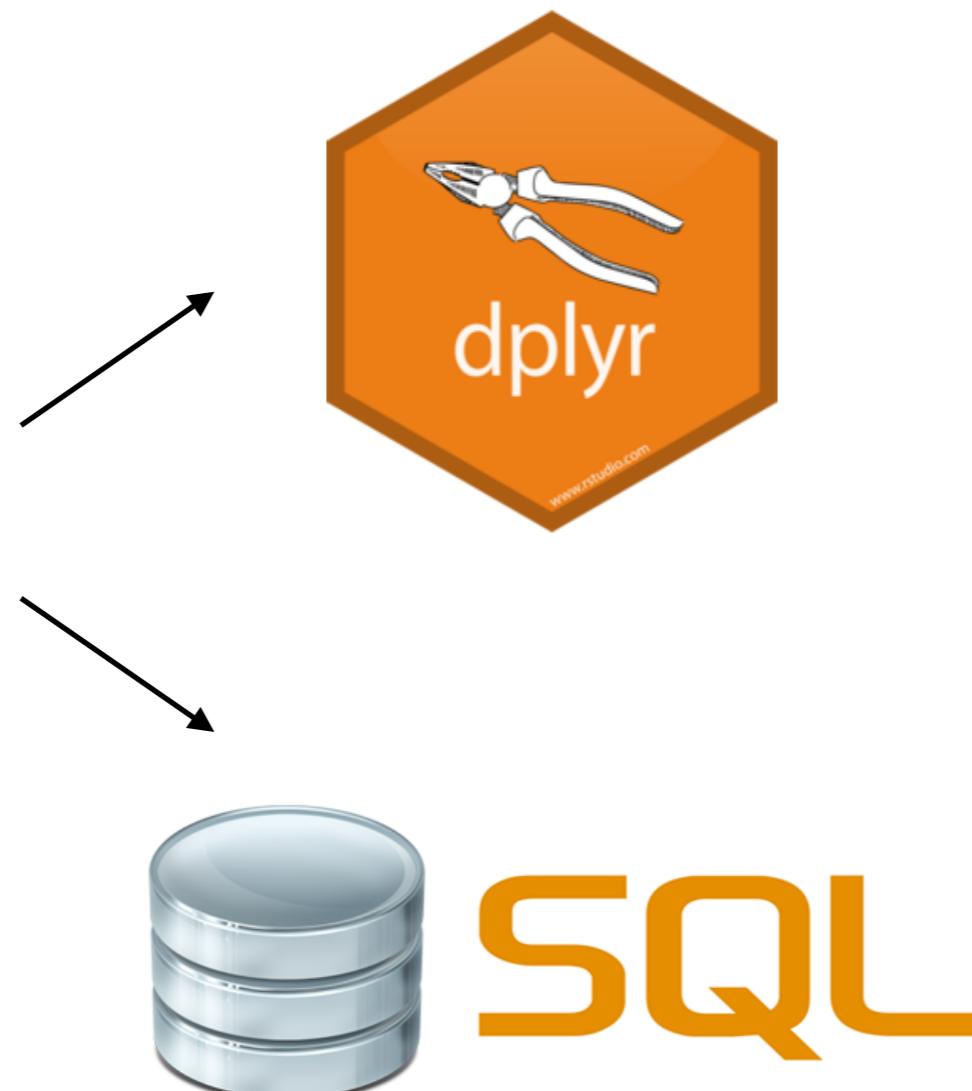
Ron Miller @ron_miller 7:44 am MDT • August 1, 2019

Comment



2.b) It transfers: Data wrangling

Normal forms &
database
normalization



3. It bridges the gap between tools for *learning* statistics & tools for *doing* statistics

tidyverse design principle #4: Design for humans



David Robinson

Data Scientist at Stack Overflow, works in R and Python.

Teach the tidyverse to beginners

A few years ago, I wrote a post [Don't teach built-in plotting to beginners \(teach ggplot2\)](#). I argued that ggplot2 was not an advanced approach meant for experts, but rather a suitable introduction to data visualization.

Many teachers suggest I'm overestimating their students: "No, see, my students are beginners...". If I push the point, they might insist I'm not understanding just how much of a beginner these students are, and emphasize they're looking to keep it simple and teach the basics, and that that students can get to the advanced methods later....

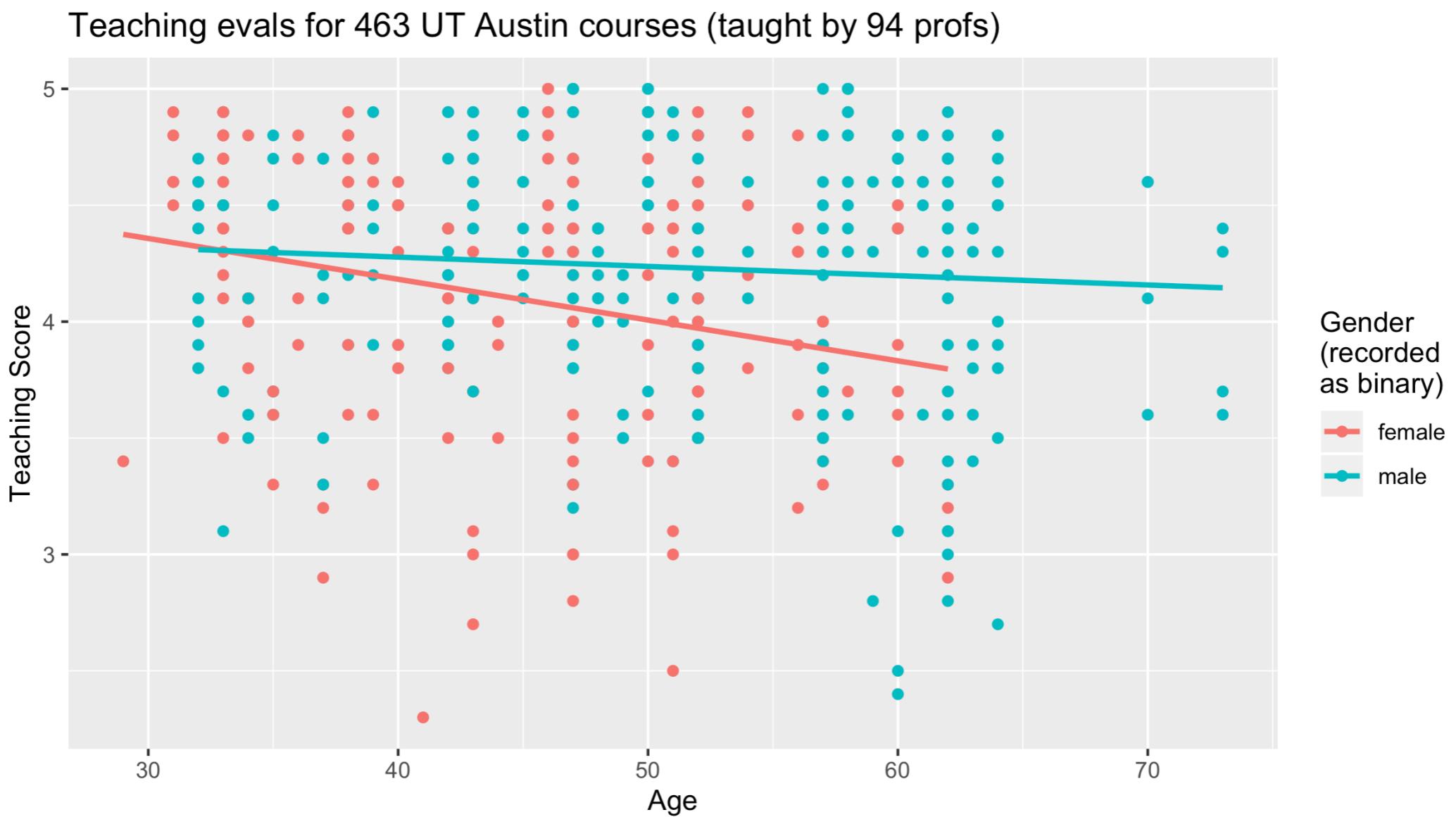


Using the tidyverse in intro stats for:

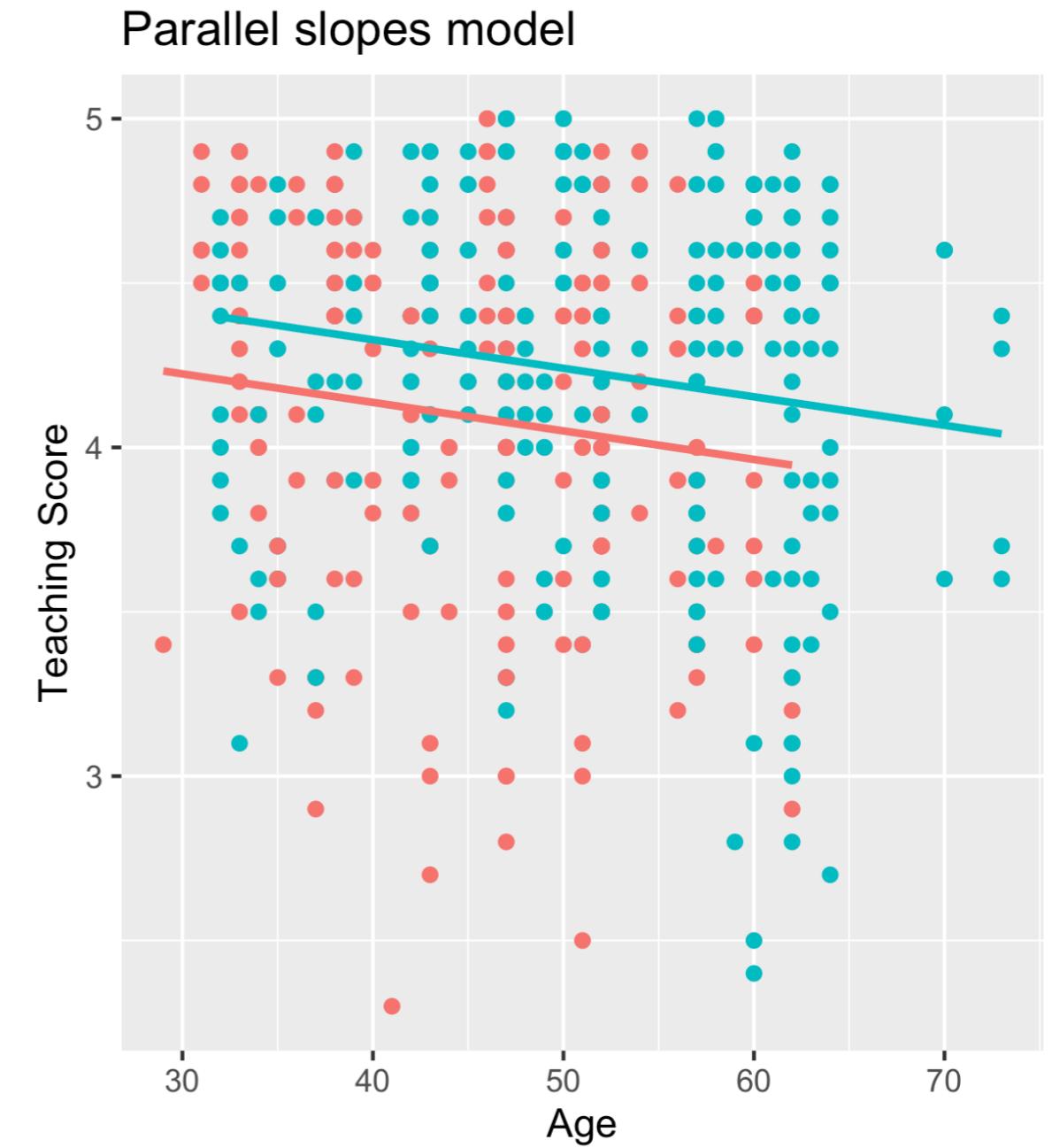
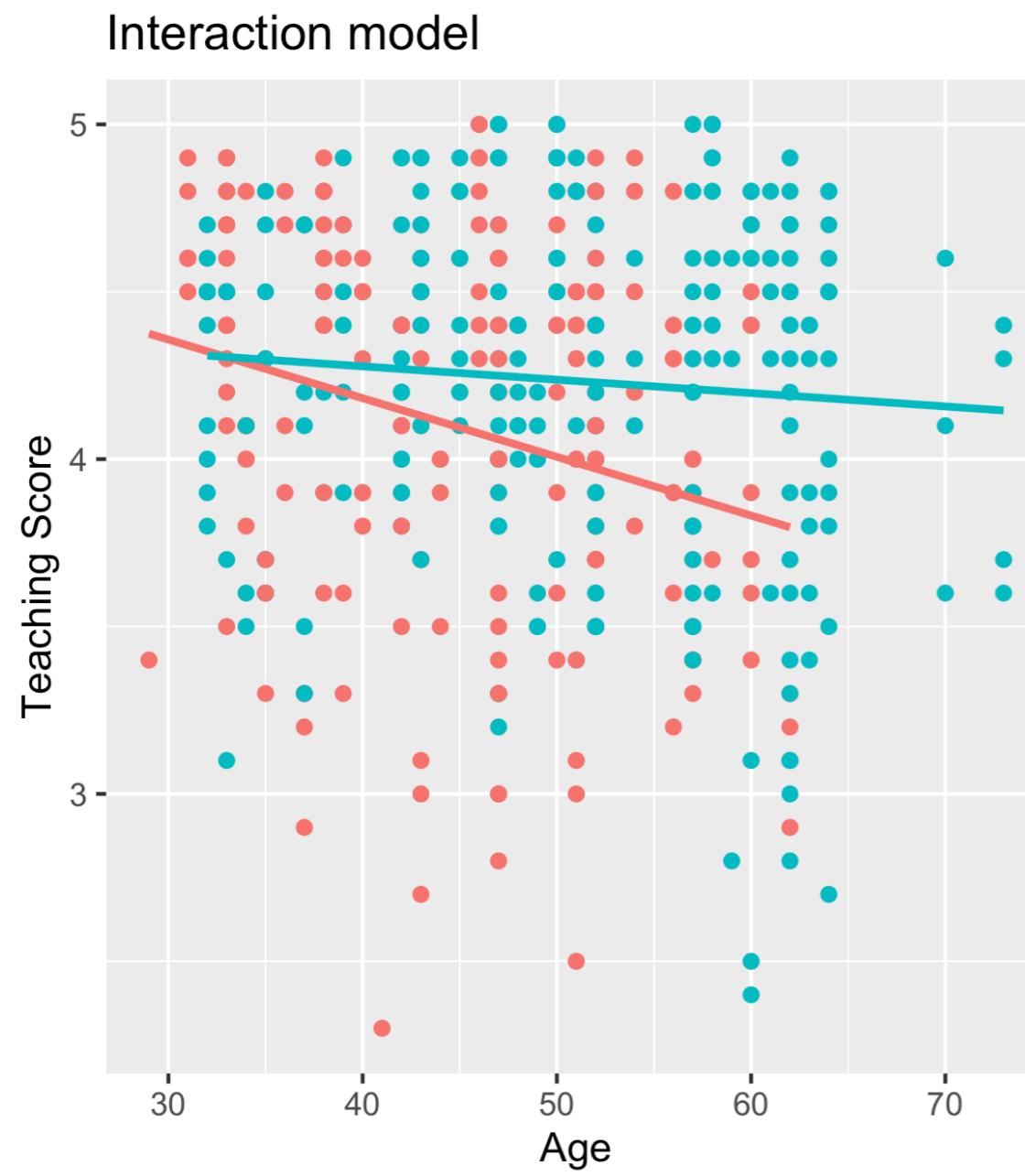
1. Statistical modeling
2. Statistical inference

EDA to Motivate Statistical Modeling

Question: Are there demographic differences in teaching evaluations?

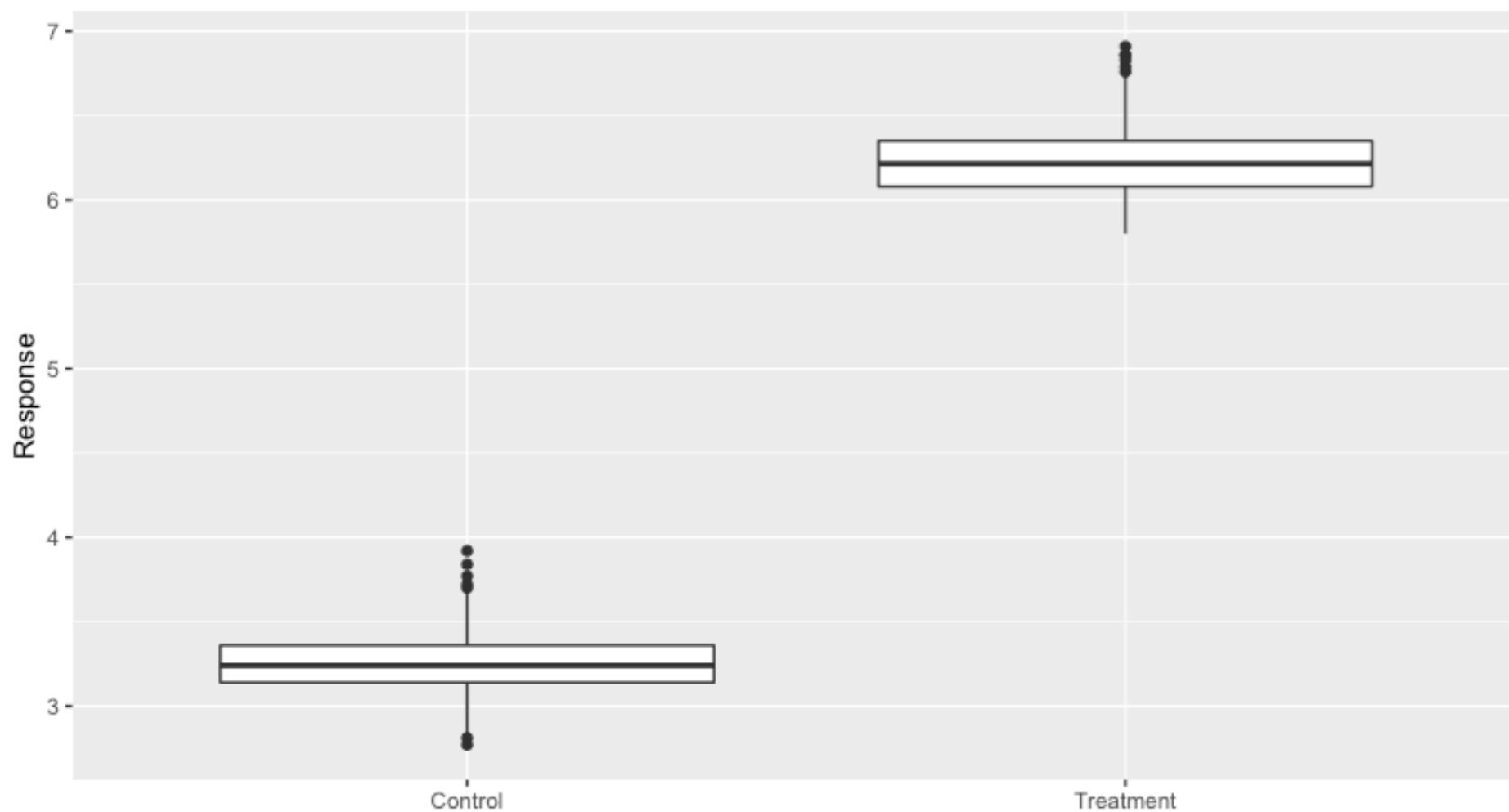


EDA to Motivate Model Selection



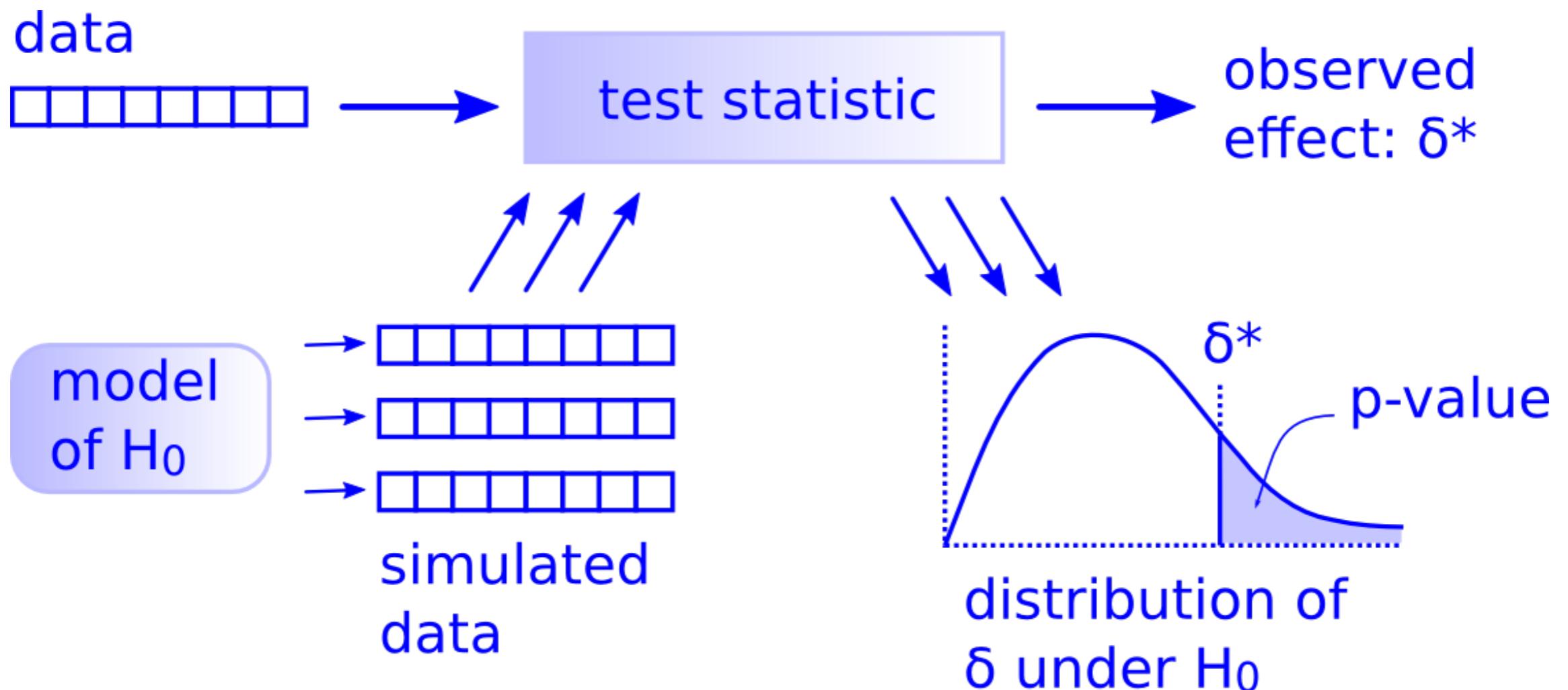
EDA to Motivate Statistical Inference

A “you don’t need no PhD in Statistics” moment:
Question: Is there a difference in response?

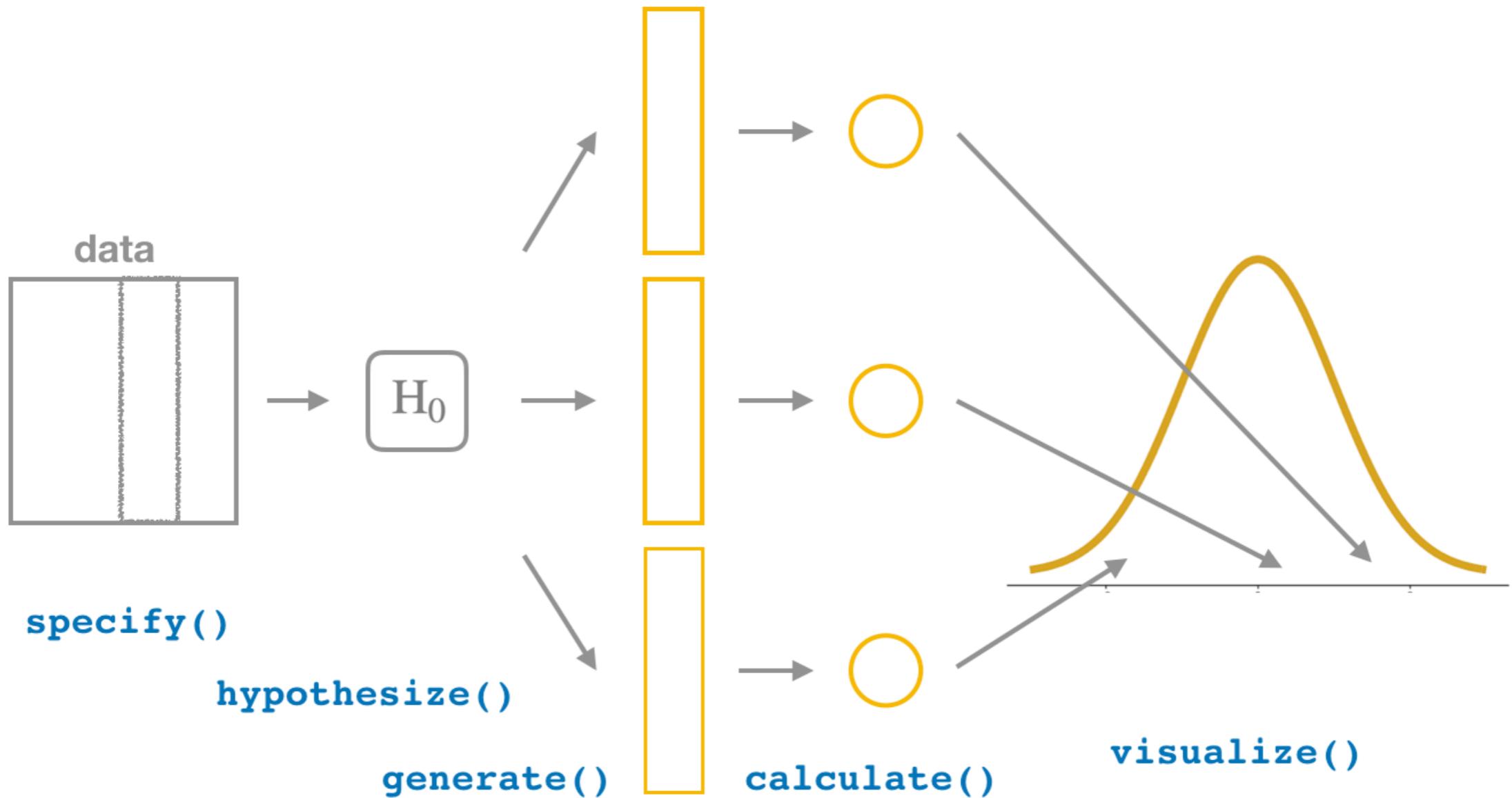


Versus just saying: “The p-value is 0!”

“There is only one test”



infer package for “tidy” statistical inference



What is mean year of minting of all 🇺🇸 pennies?

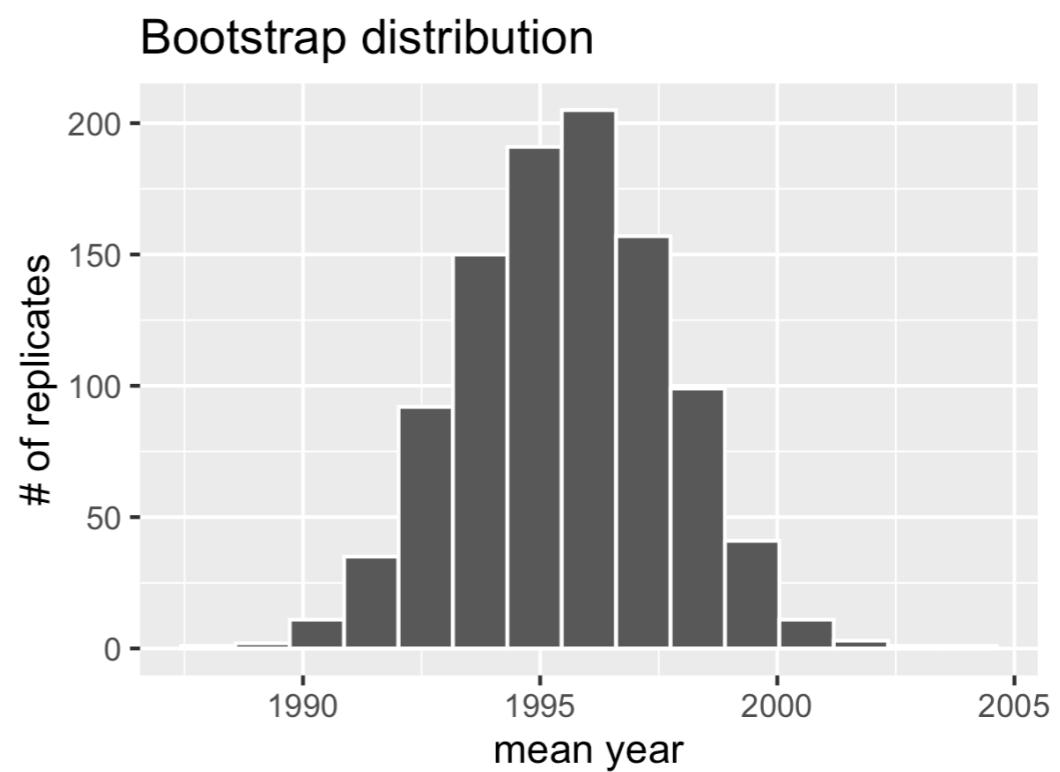


```
> library(moderndive)
> pennies_sample
# A tibble: 50 x 2
  ID    year
  <int> <dbl>
1 1     2002
2 2     1986
3 3     2017
4 4     1988
5 5     2008
6 6     1983
7 7     2008
8 8     1996
9 9     2004
10 10    2000
# ... with 40 more rows
```

Using bootstrap resampling with replacement:

```
library(tidyverse)
library(infer)

pennies_sample %>%
  specify(response = year) %>%
  generate(reps = 1000) %>%
  calculate(stat = "mean")
```



How to make room for the tidyverse

In my opinion:

- Drop (combinatorics-based) probability theory
- De-emphasize χ^2 tests & ANOVA as much as feasible given upstream consequences
- Lean on “There is only one test” framework
- Drop asymptotic theory in favor of simulation based inference: bootstrap & permutation tests

Guiding Paper

“Mere Renovation is Too Little Too Late: We Need to Rethink Our Undergraduate Curriculum from the Ground Up” by [Cobb \(2015\)](#)

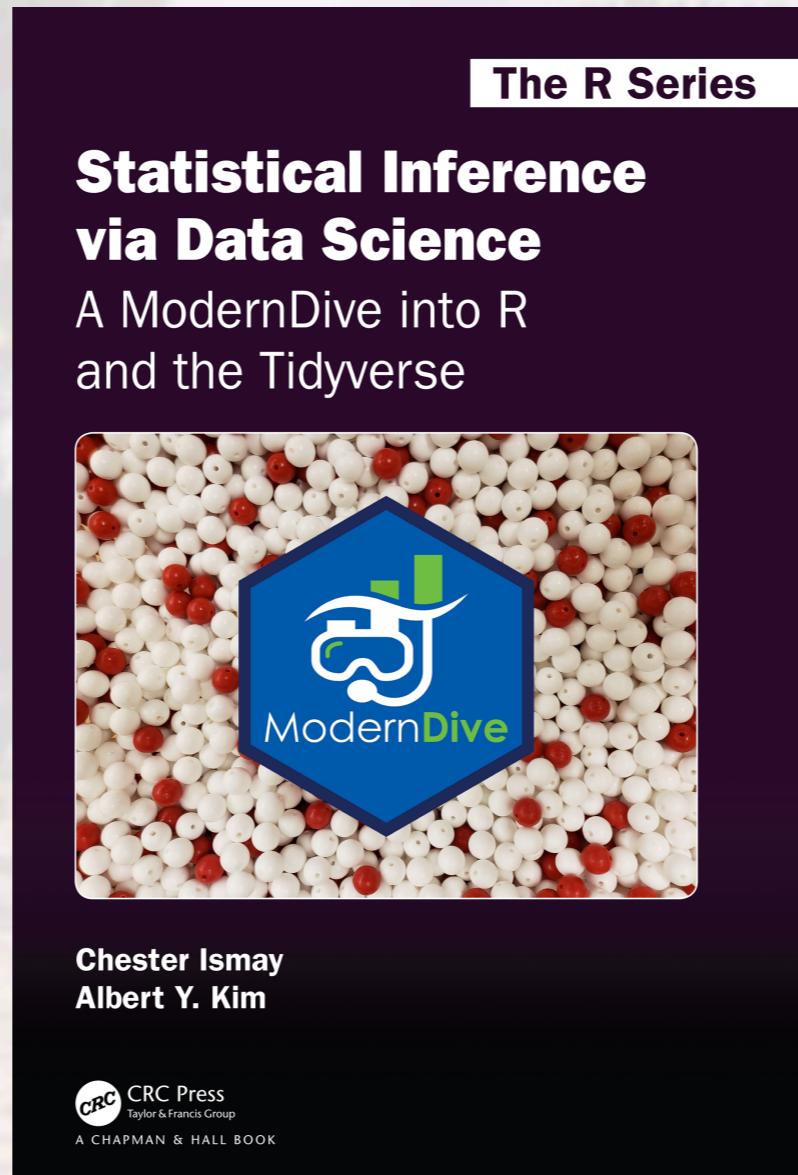
- Make fundamental concepts accessible
- Minimize prerequisites to research
- Substitute “mathematics” with “computation” as the *engine of statistics*

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_{\bar{X}_1 - \bar{X}_2}} = \frac{\bar{X}_1 - \bar{X}_2}{S_{\bar{X}_1 - \bar{X}_2}}$$

$$S_{\bar{X}_1 - \bar{X}_2} = \sqrt{\frac{(N_1 - 1)s_1^2 + (N_2 - 1)s_2^2}{N_1 + N_2 - 2} \left[\frac{1}{N_1} + \frac{1}{N_2} \right]}$$



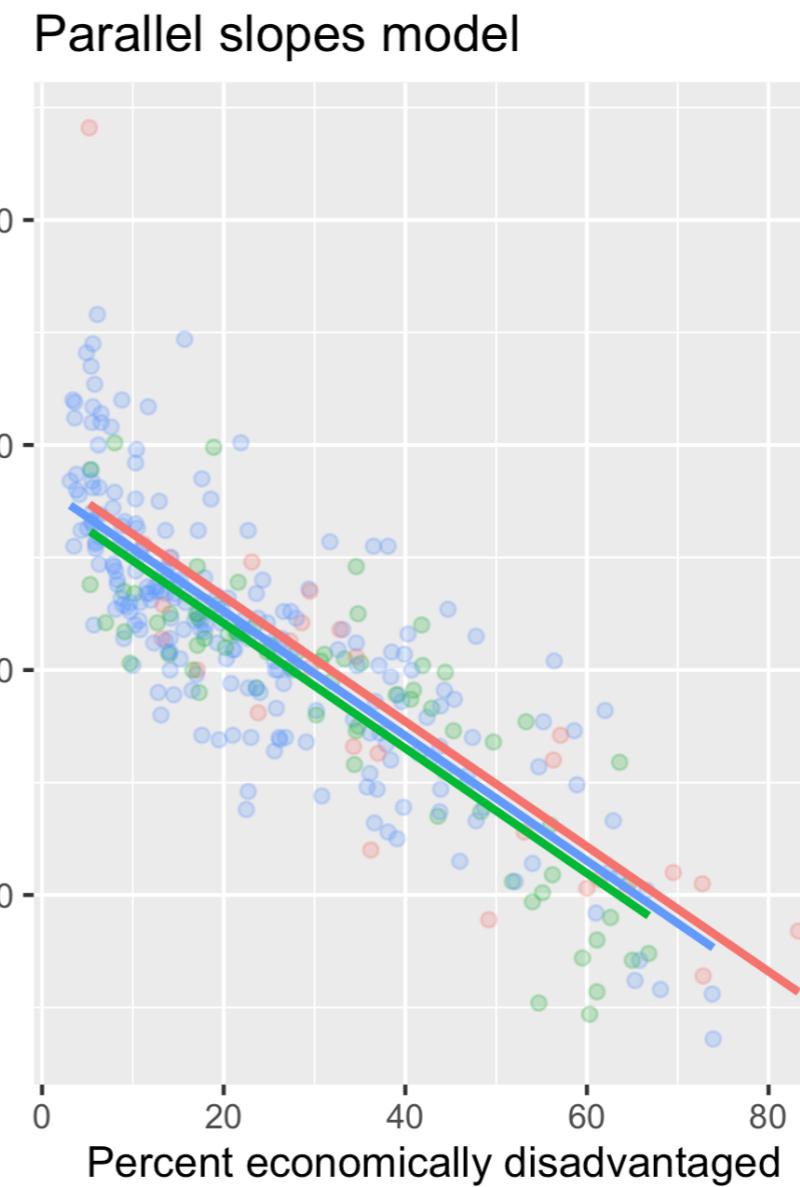
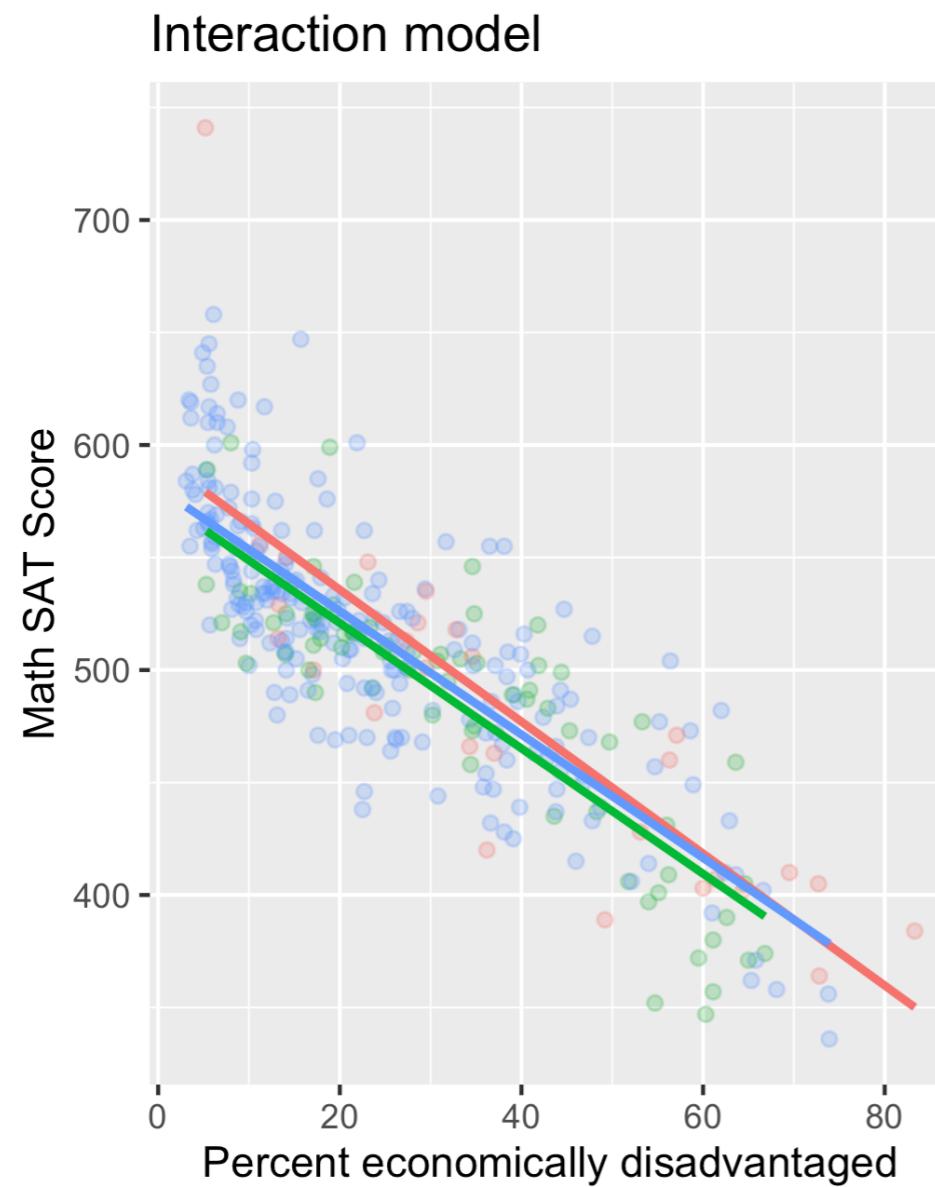
For more info check out:



- Available free online at moderndive.com
- Print copies now on sale at Taylor & Francis booth & CRC Press website: Use discount code ASA18
- Slides available at twitter.com/rudeboybert

EDA to Motivate Model Selection

2017 Massachusetts Public High School Data



School size

- small
- medium
- large

infer-ring the mean year of all 🇺🇸 pennies using bootstrap resampling with replacement

Collect a sample of 50 pennies
(is sampling representative?)



```
> library(moderndive)
> pennies_sample
# A tibble: 50 x 2
  ID    year
  <int> <dbl>
1     1 2002
2     2 1986
3     3 2017
4     4 1988
5     5 2008
6     6 1983
7     7 2008
8     8 1996
9     9 2004
10   10 2000
# ... with 40 more rows
```

Then generate 1000 resamples with replacement of size 50, compute mean for each.



```
library(tidyverse)
library(infer)

pennies_sample %>%
  specify(response = year) %>%
  generate(reps = 1000) %>%
  calculate(stat = "mean")
```

Then visualize. In what range do “most” values lie? →

