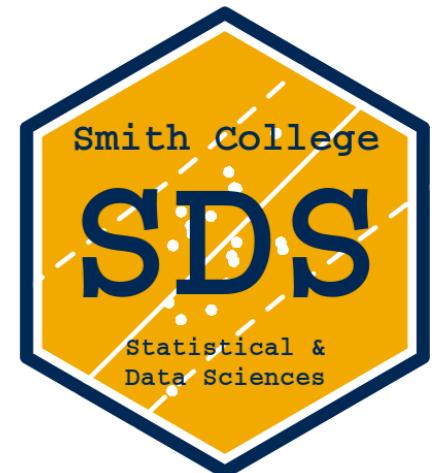
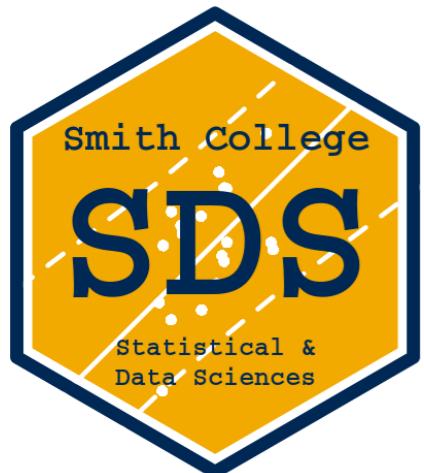


Statistical inference via data science: A "tidy" approach



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?

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

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2. It’s transferable

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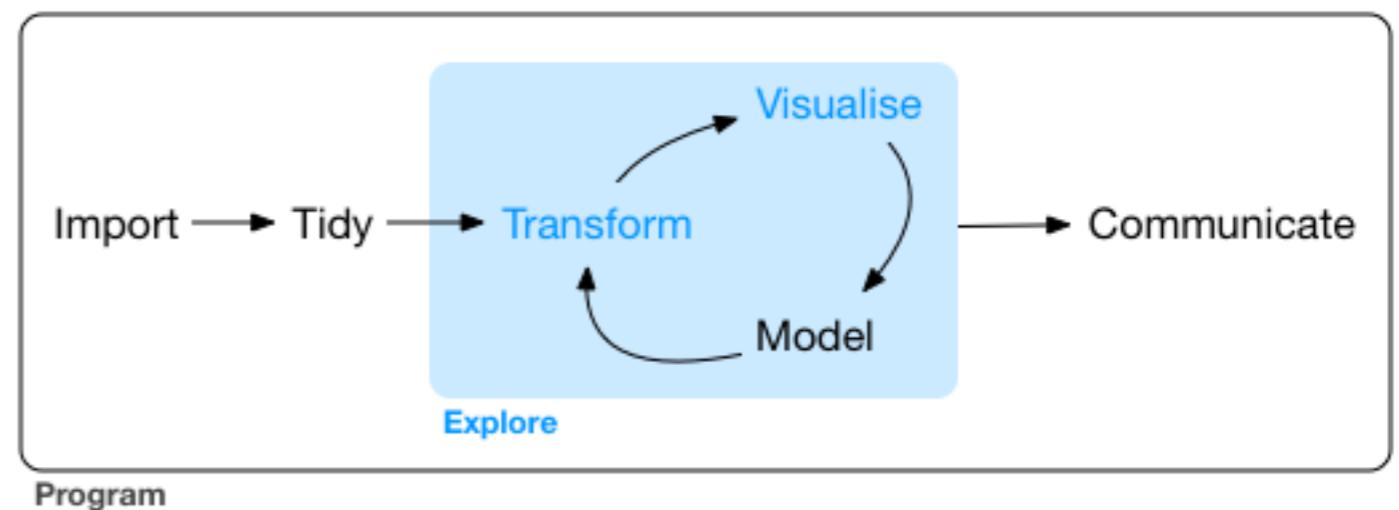
1. It encourages students to “play the whole game”
2. It’s transferable
3. It bridges the gap between tools for *learning* statistics & tools for *doing* statistics

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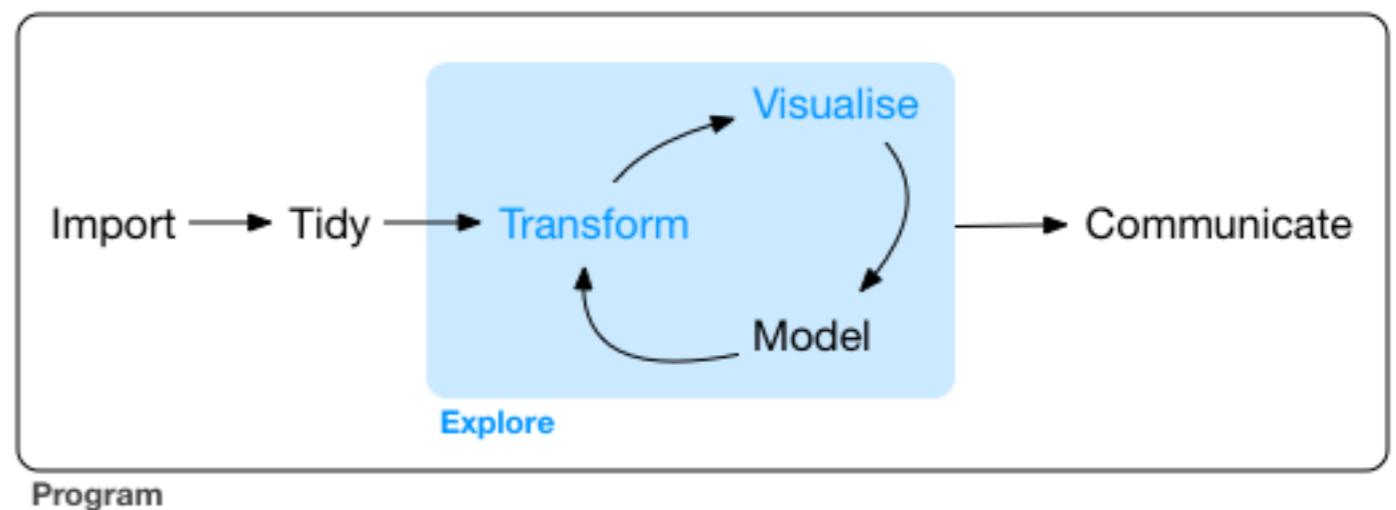
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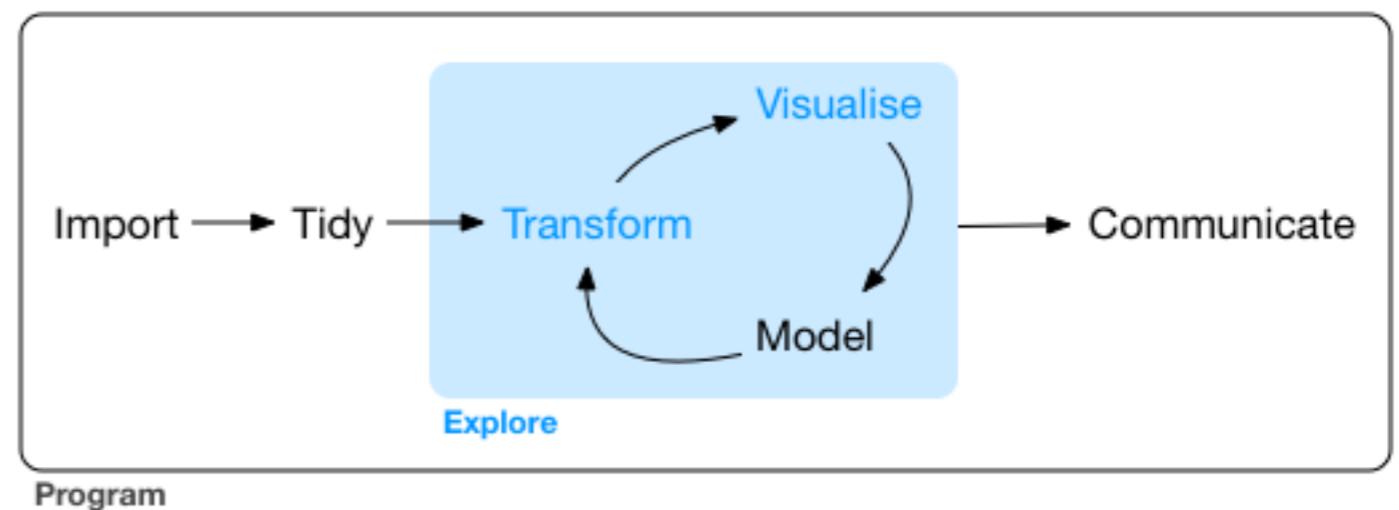


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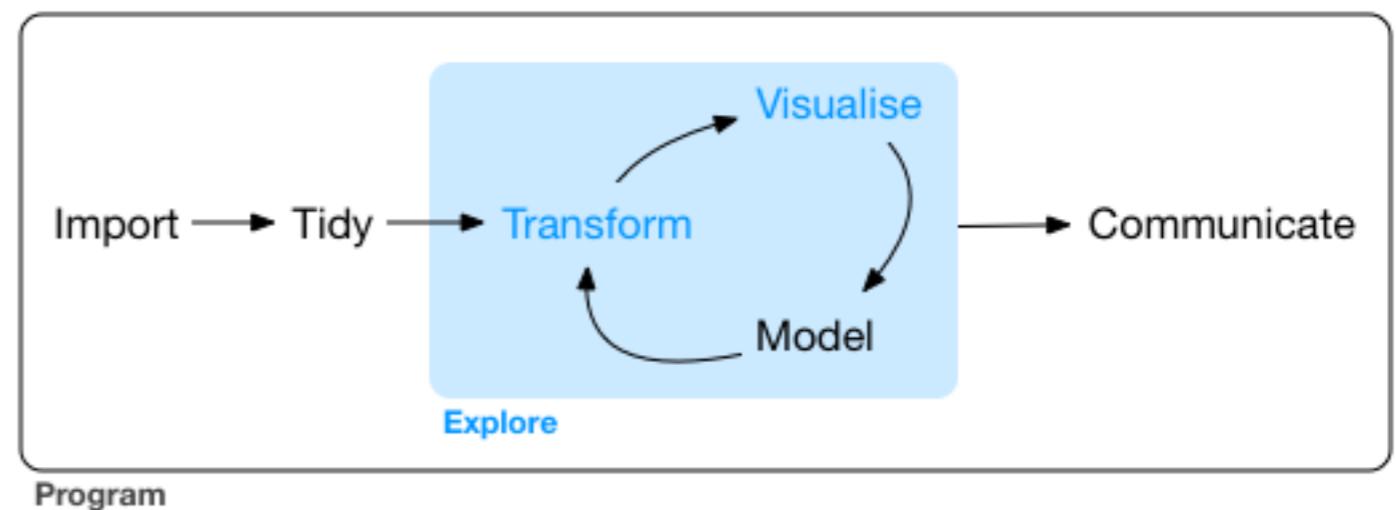
- Exploratory data analysis (EDA)

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



- Exploratory data analysis (EDA)
- “To (data) wrangle or not to wrangle?”

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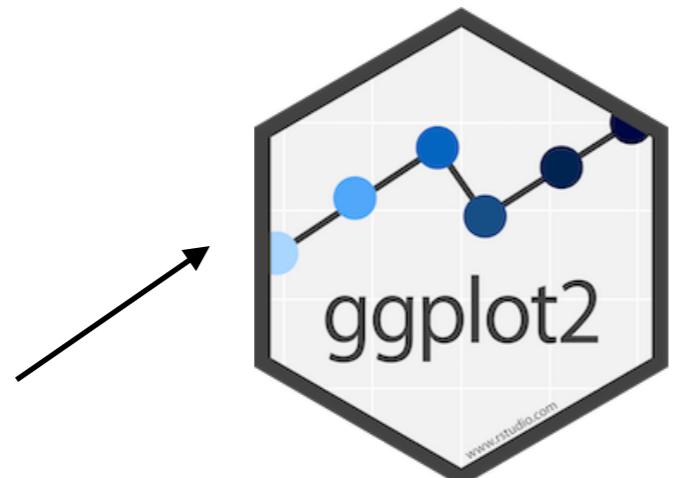
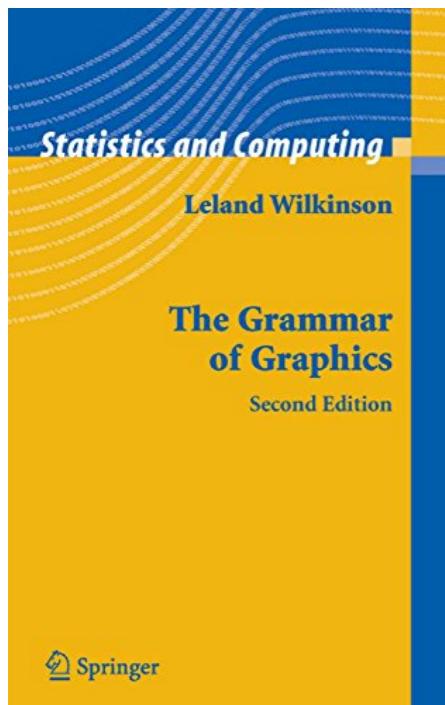
- Exploratory data analysis (EDA)
- “To (data) wrangle or not to wrangle?”
- IMO to do no data wrangling betrays true nature of the work

2.a) It transfers: Data visualization

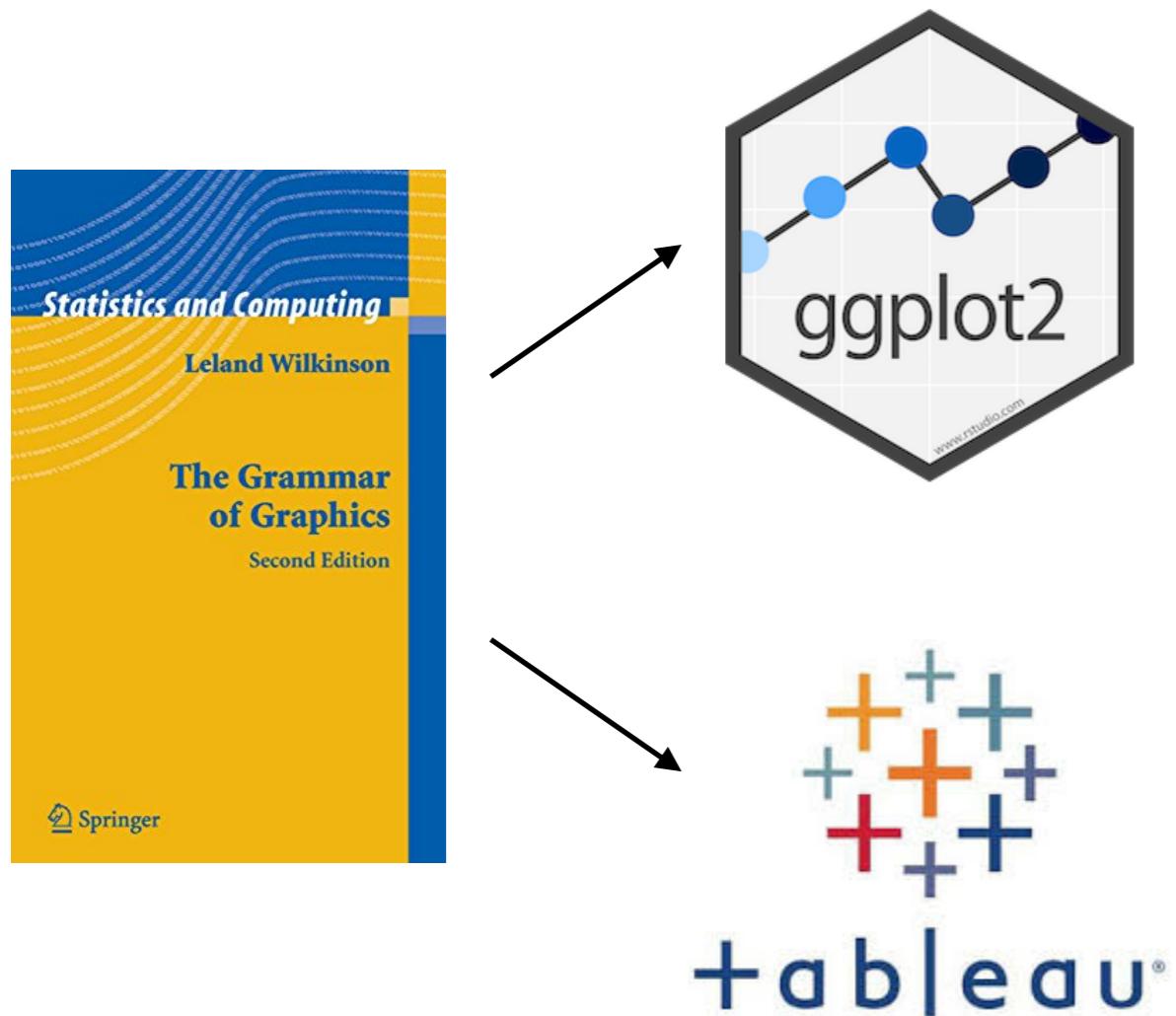
2.a) It transfers: Data visualization



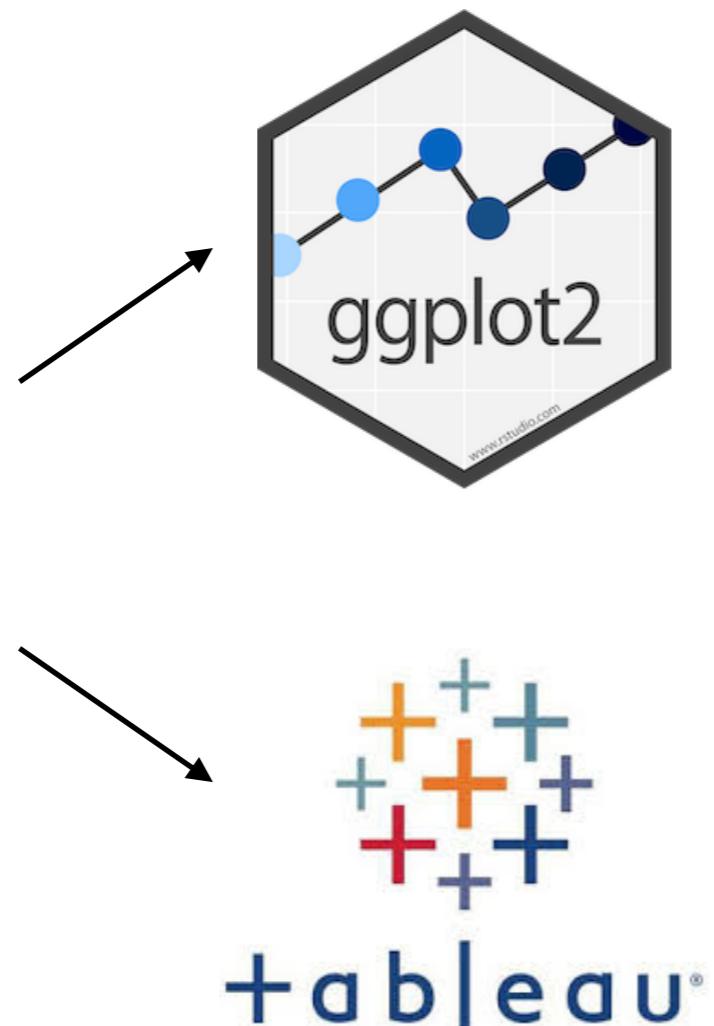
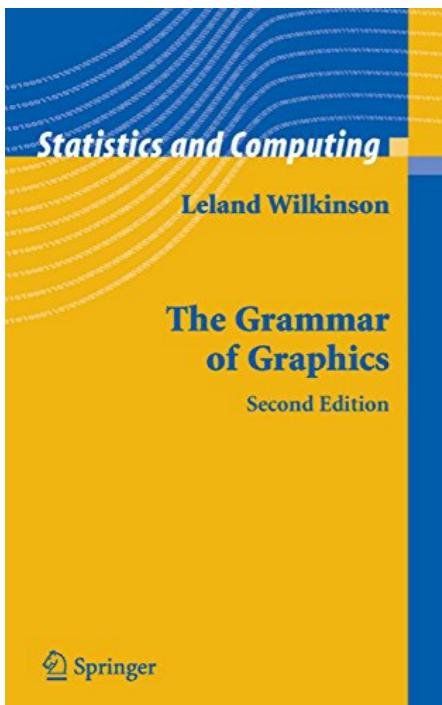
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Salesforce closes \$15.7B Tableau deal

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

Comment



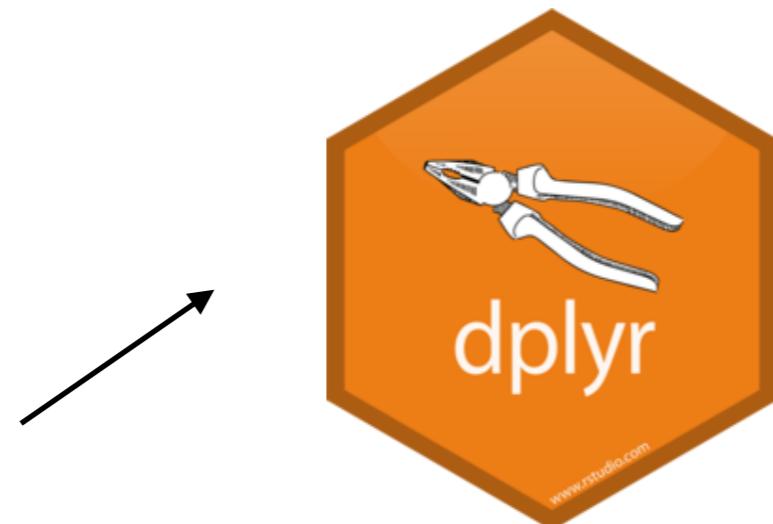
2.b) It transfers: Data wrangling

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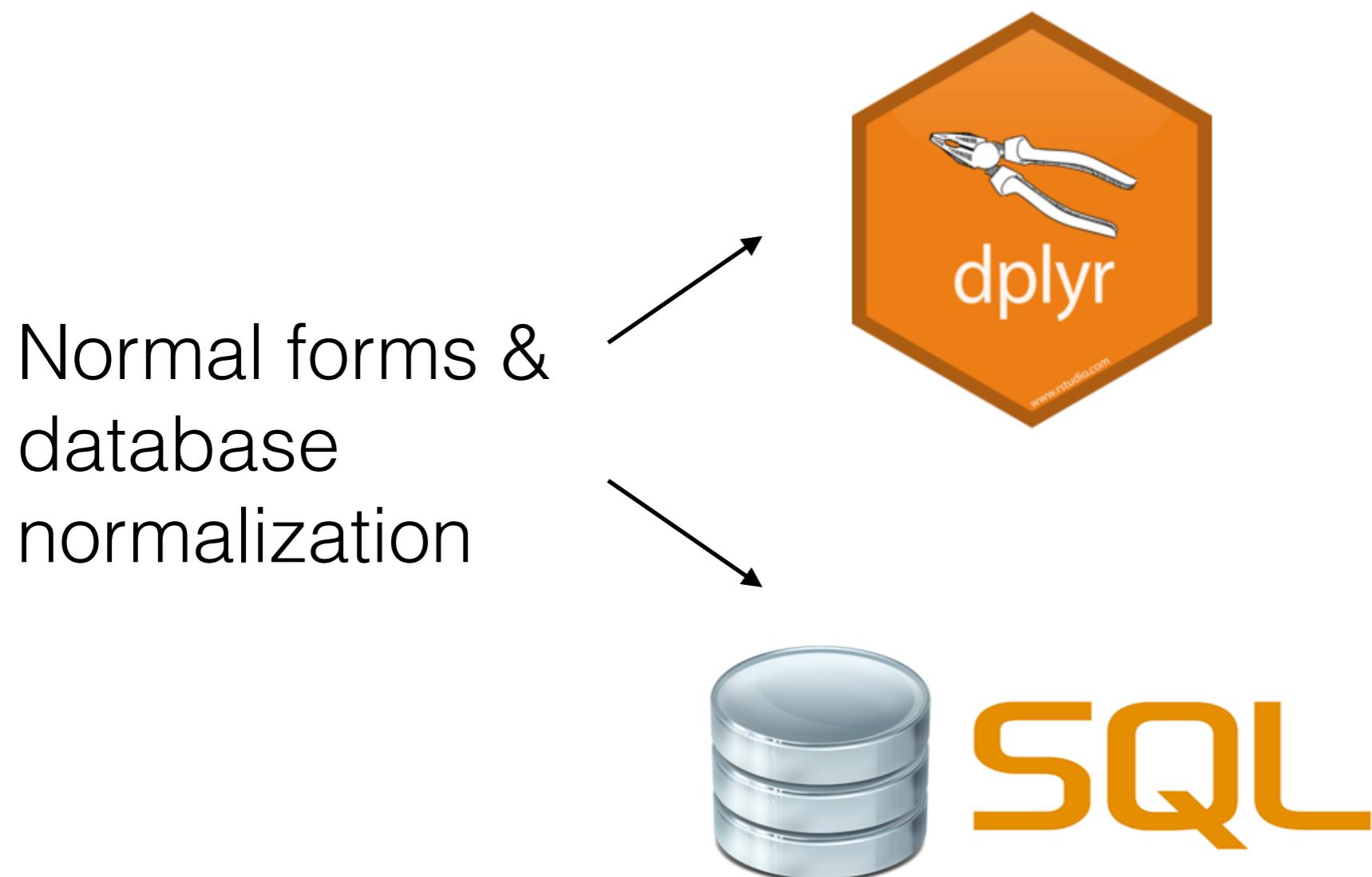


2.b) It transfers: Data wrangling

Normal forms &
database
normalization

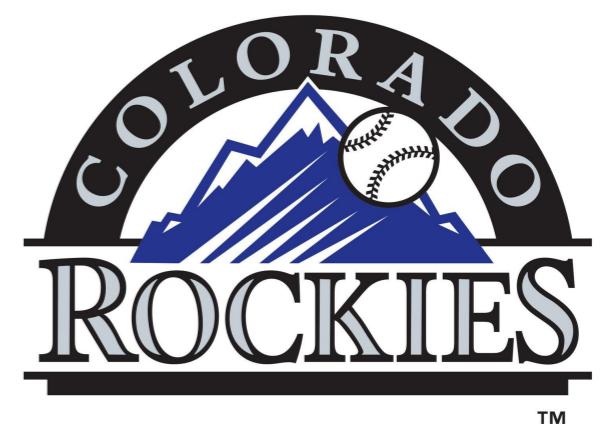
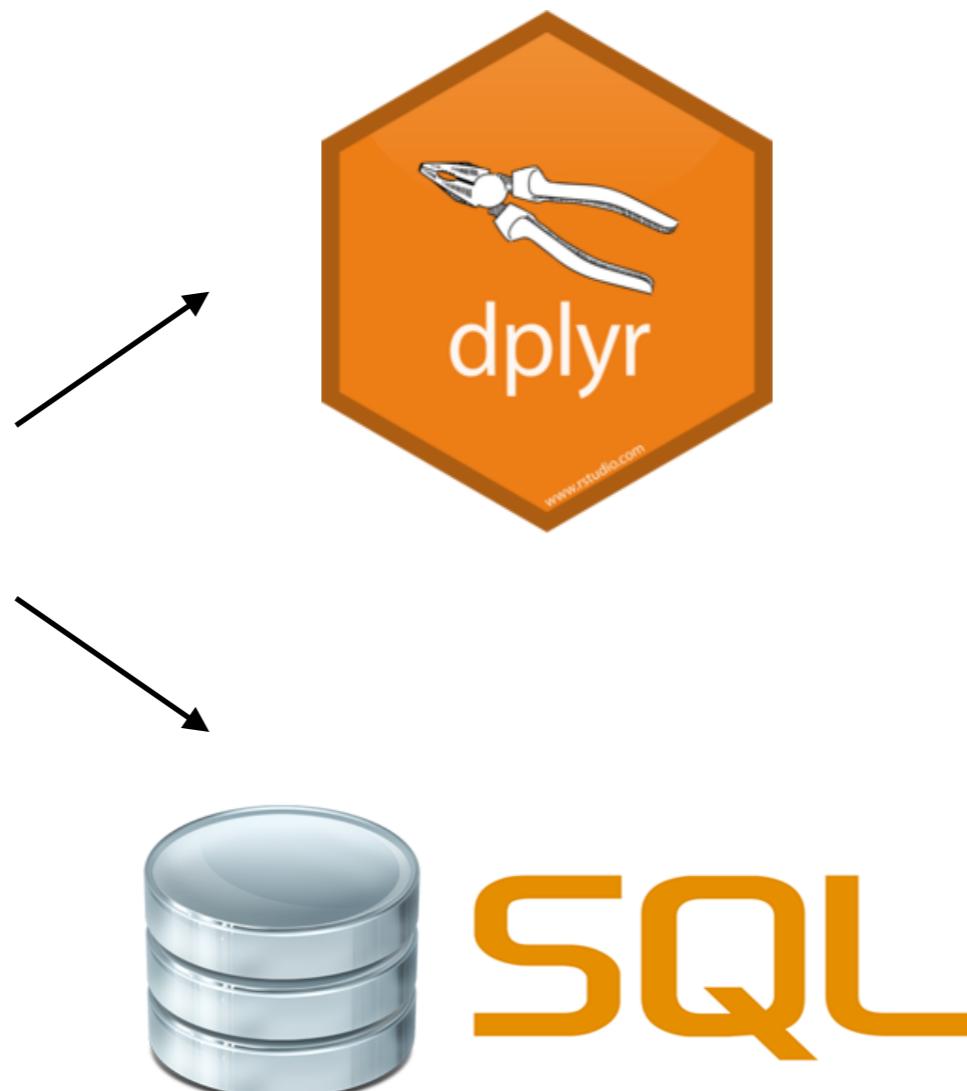


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Normal forms &
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David Robinson

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....

tidyverse principle #4: Design for humans

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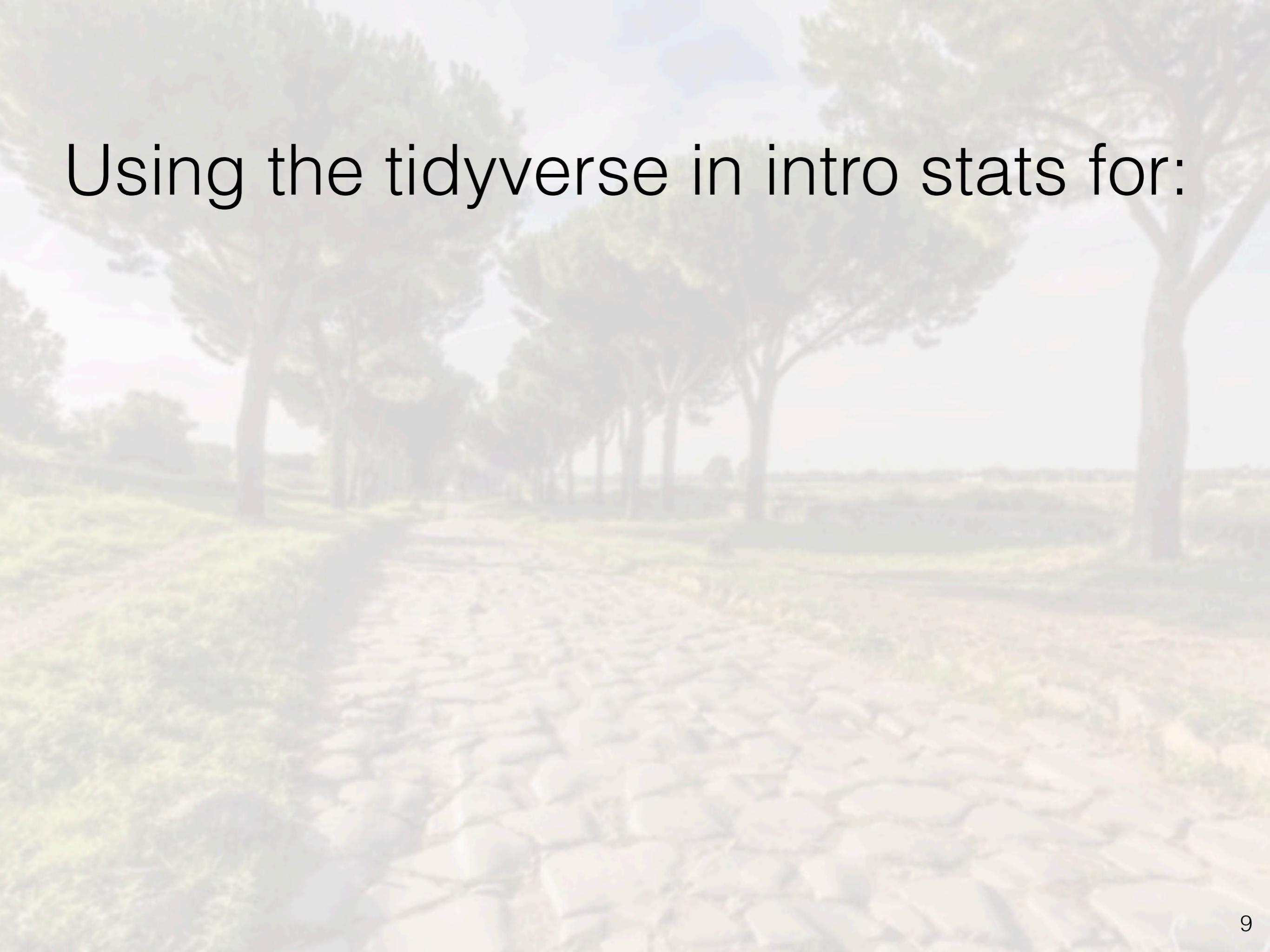
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A blurry, overexposed photograph of a park or forest scene. The foreground is dominated by out-of-focus greenery and trees. In the background, a path or road leads through the woods under a bright, hazy sky.

Using the tidyverse in intro stats for:

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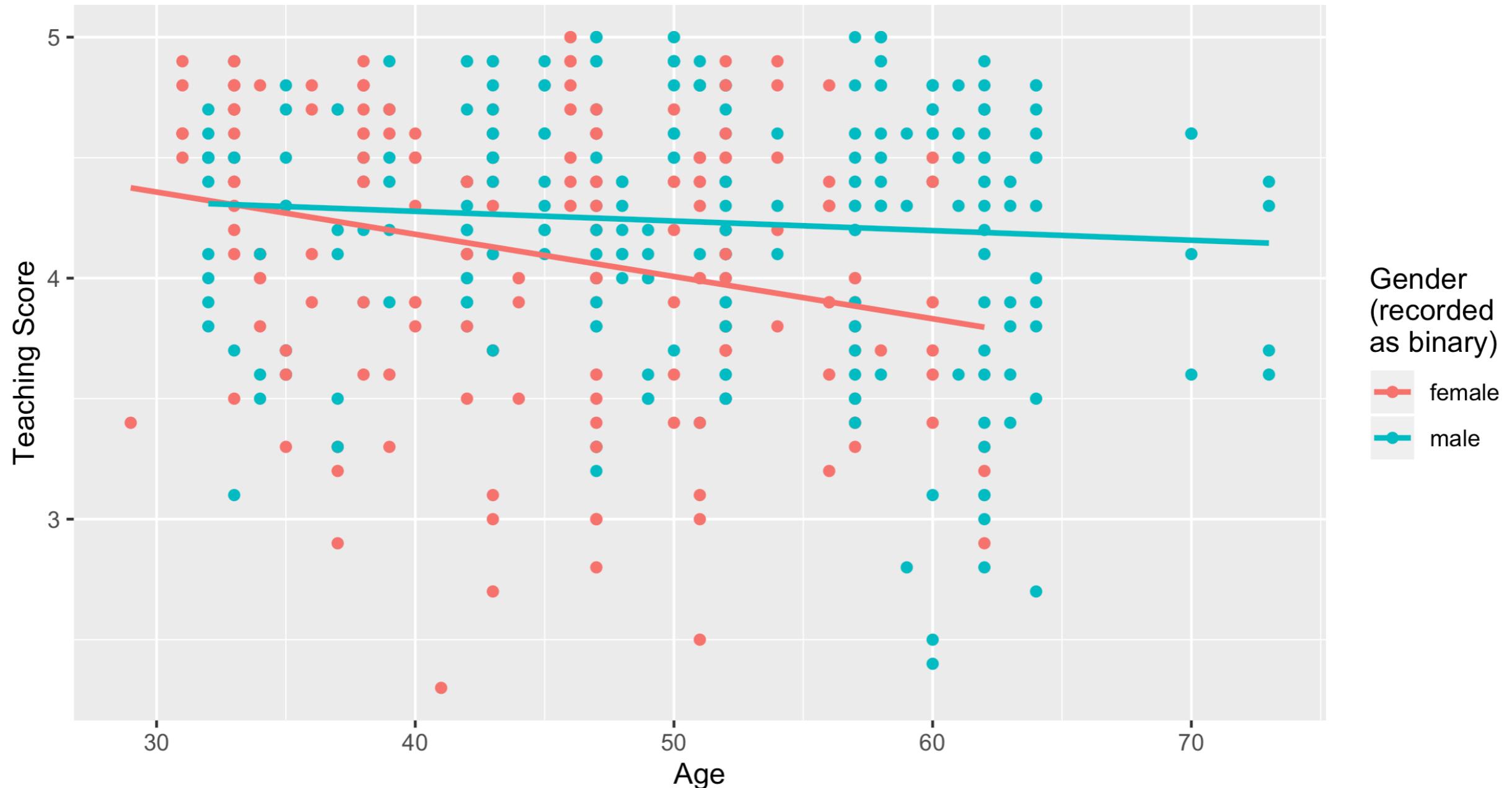
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Using the tidyverse in intro stats for:

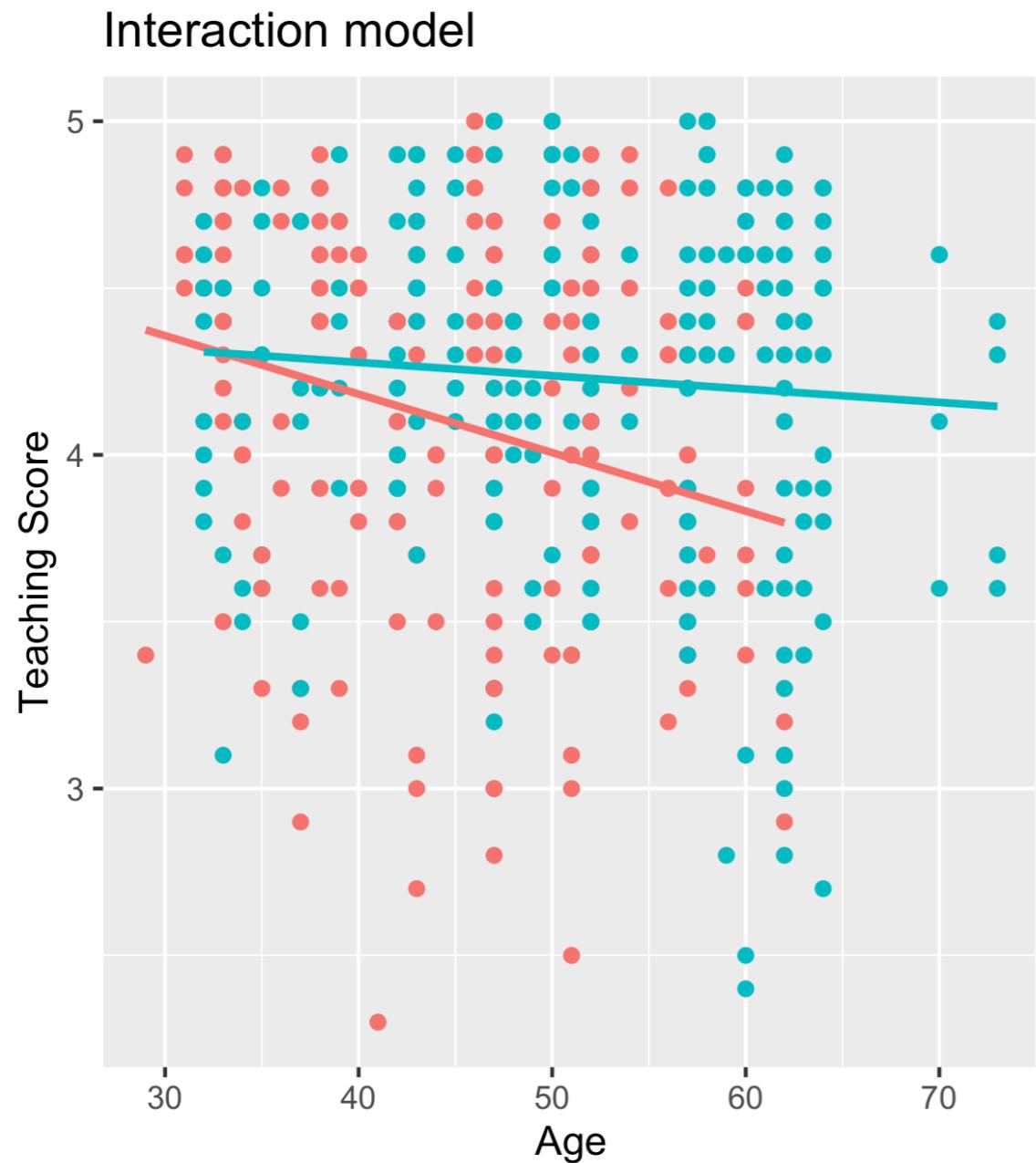
1. Statistical modeling
2. Statistical inference

EDA to Motivate Statistical Modeling

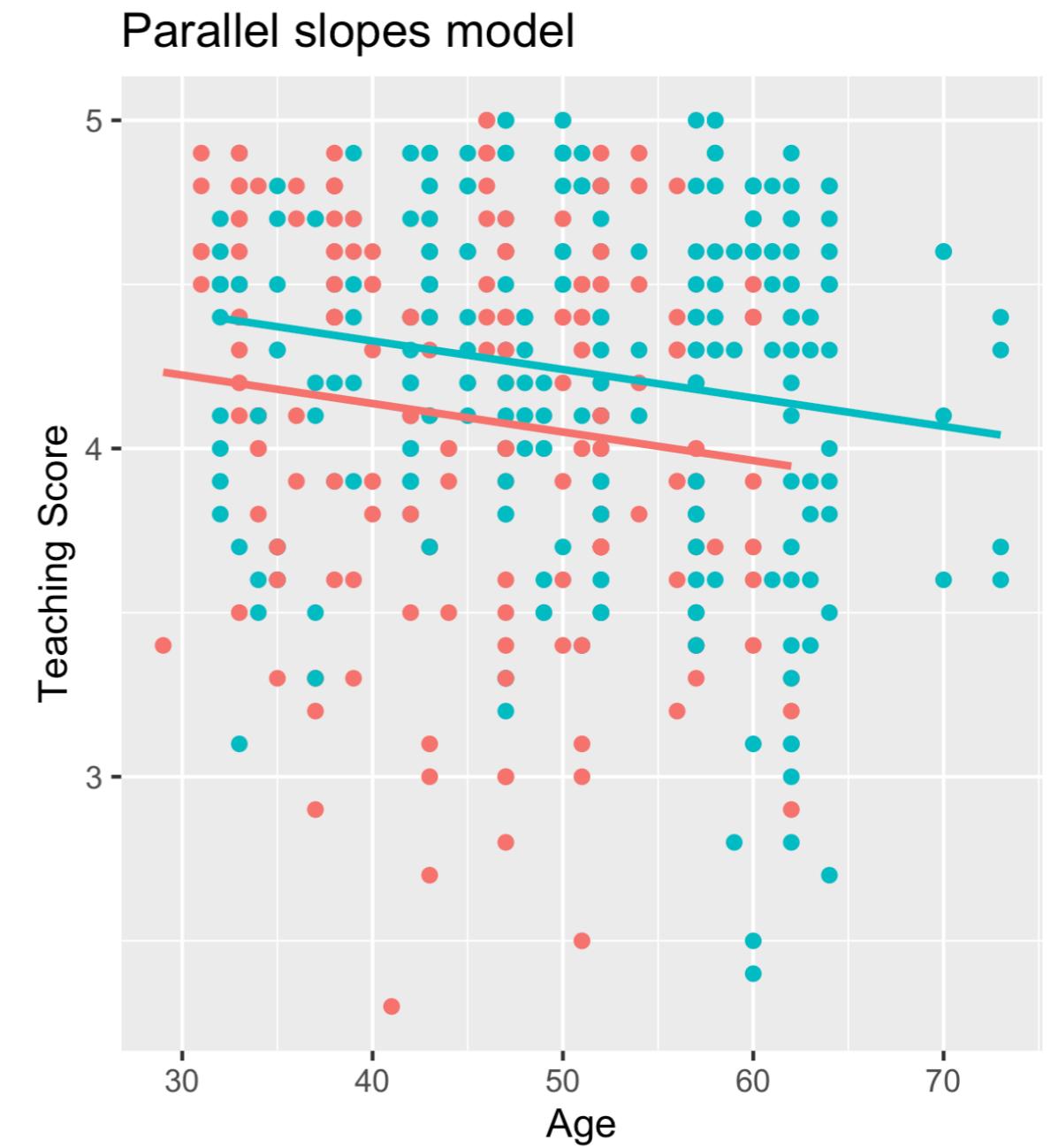
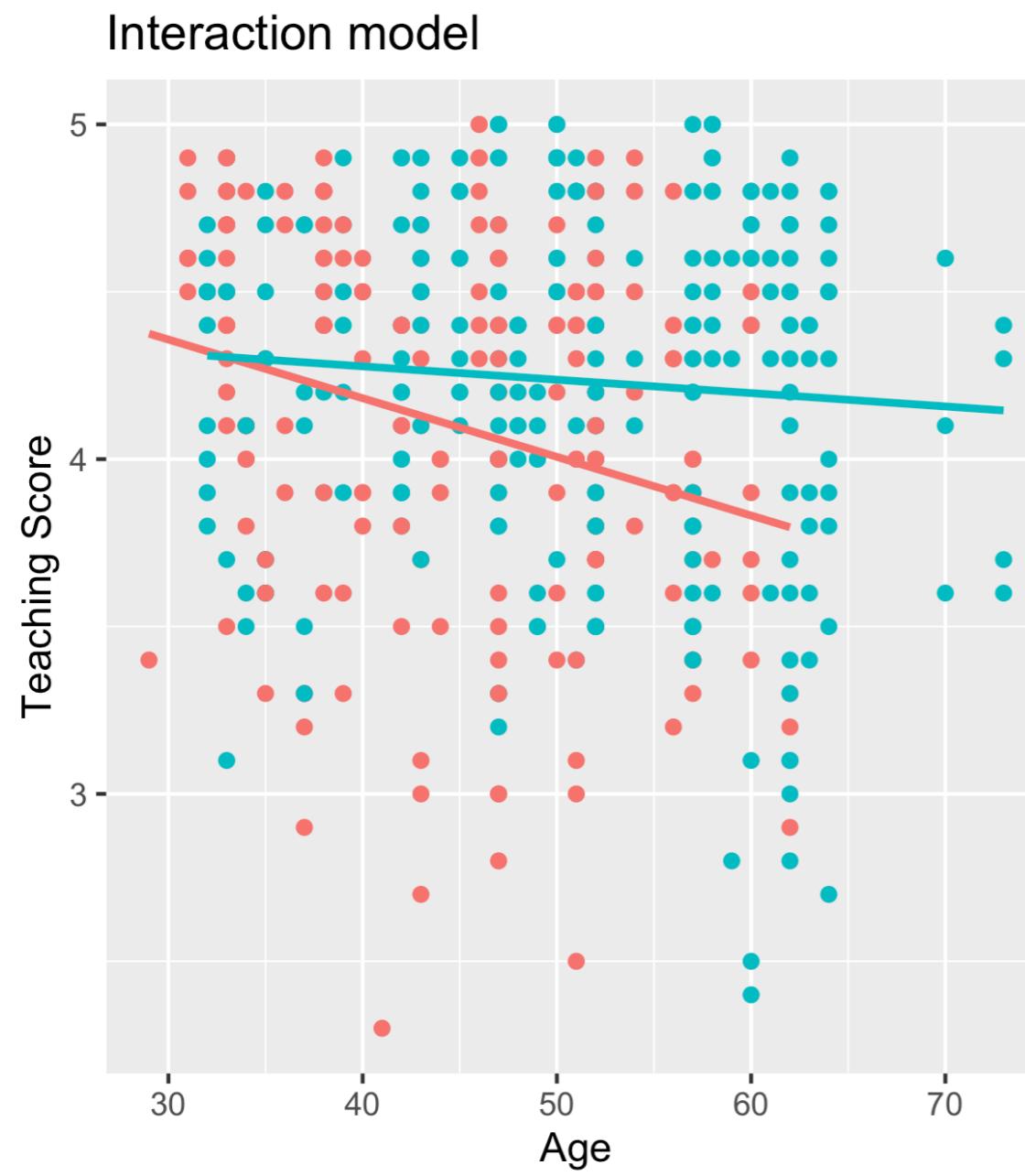
Teaching evals for 463 UT Austin courses (taught by 94 profs)



EDA to Motivate Model Selection



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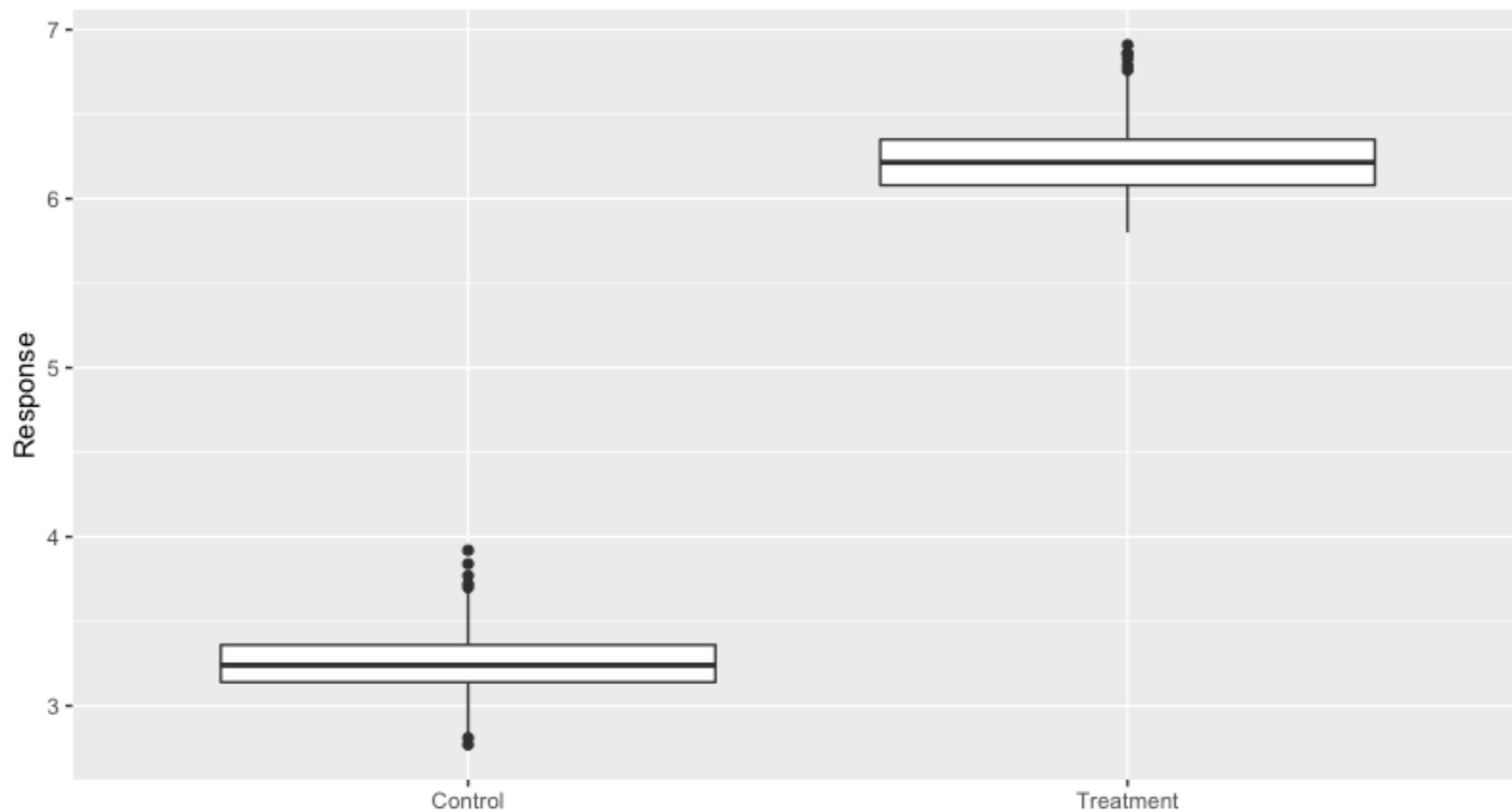
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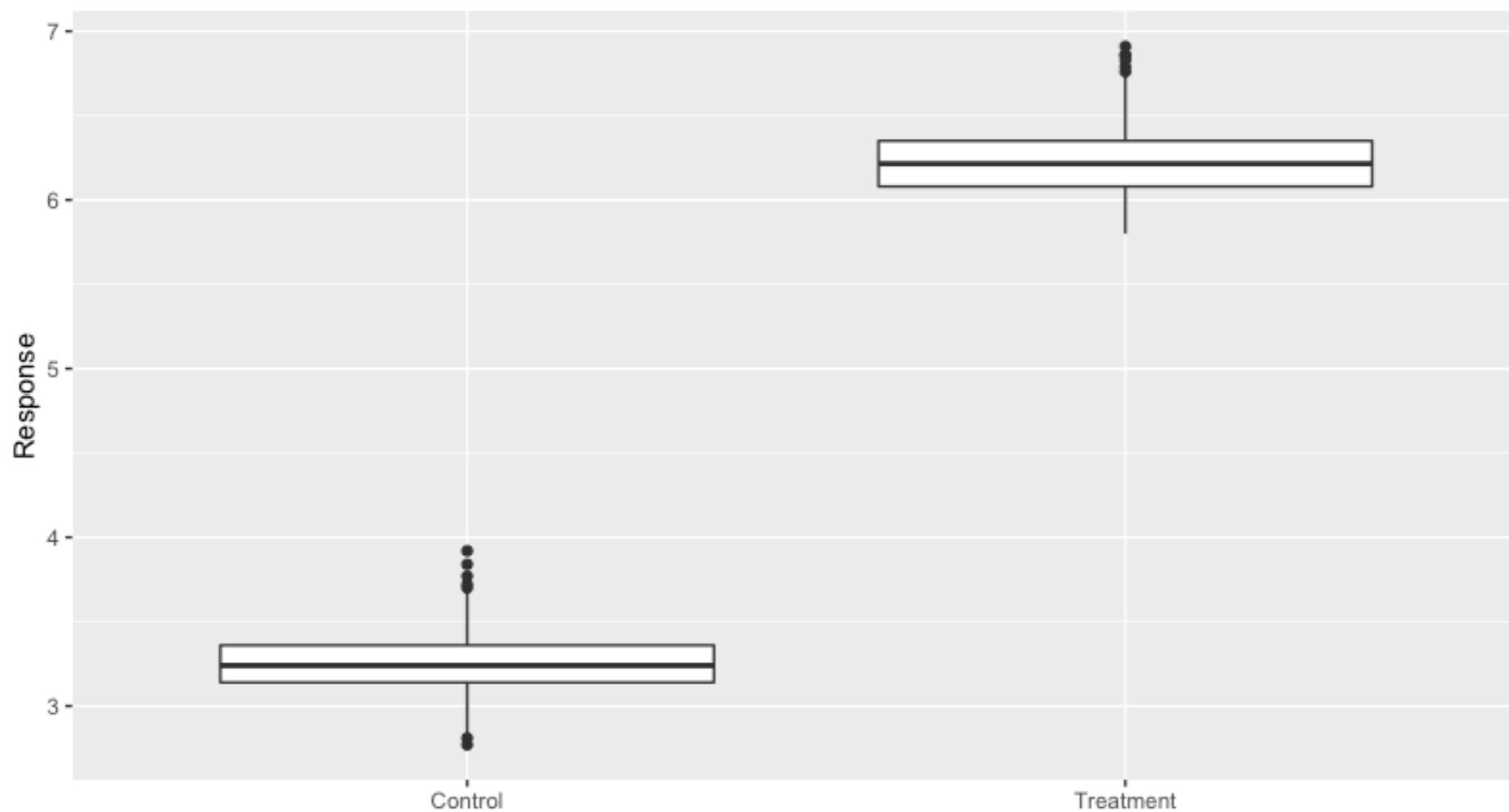
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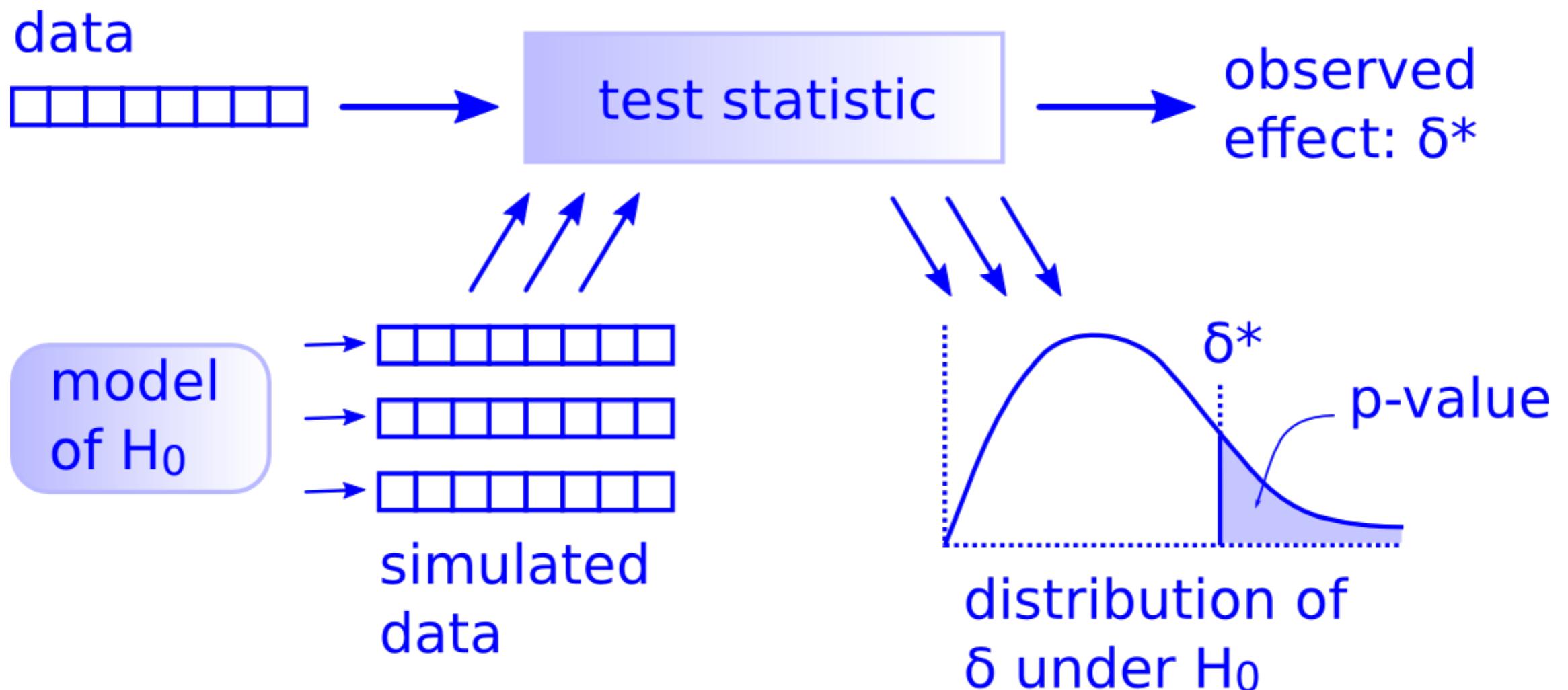
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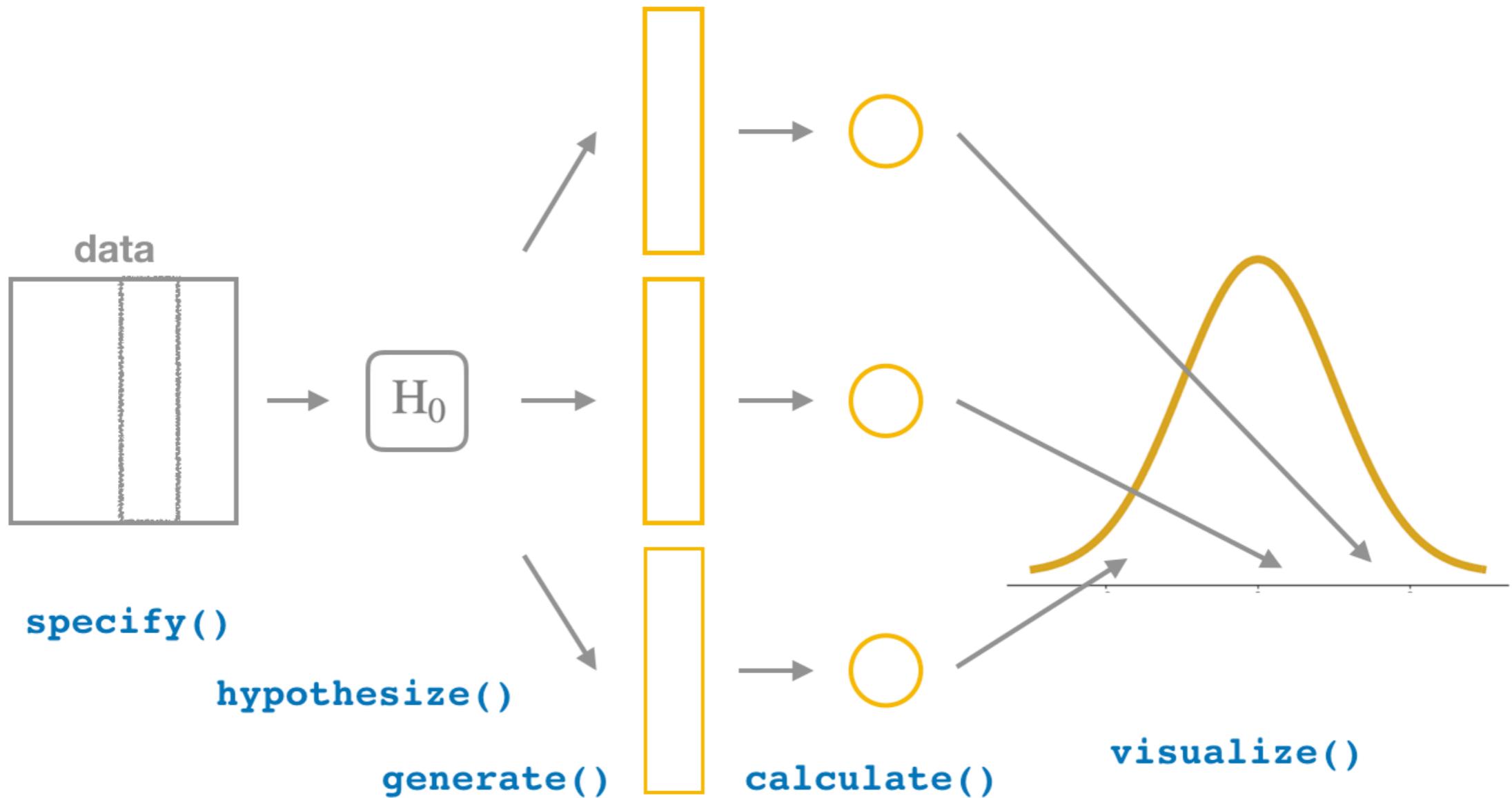


vs just reporting “the p-value is 0”

“There is only one test”



infer package for “tidy” statistical inference



Ex: Inferring the mean year of all  pennies

Ex: Inferring the mean year of all 🇺🇸 pennies



Ex: Inferring the mean year of all 🇺🇸 pennies



```
> library(moderndive)
```

```
> pennies_sample
```

```
# A tibble: 50 × 2
```

ID	year
<int>	<dbl>
1	<u>2002</u>
2	<u>1986</u>
3	<u>2017</u>
4	<u>1988</u>
5	<u>2008</u>
6	<u>1983</u>
7	<u>2008</u>
8	<u>1996</u>
9	<u>2004</u>
10	<u>2000</u>

```
# ... with 40 more rows
```

Ex: Inferring the mean year of all 🇺🇸 pennies



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> pennies_sample
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Using bootstrap resampling with replacement:

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library(tidyverse)
library(infer)

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

Ex: Inferring the mean year of all 🇺🇸 pennies

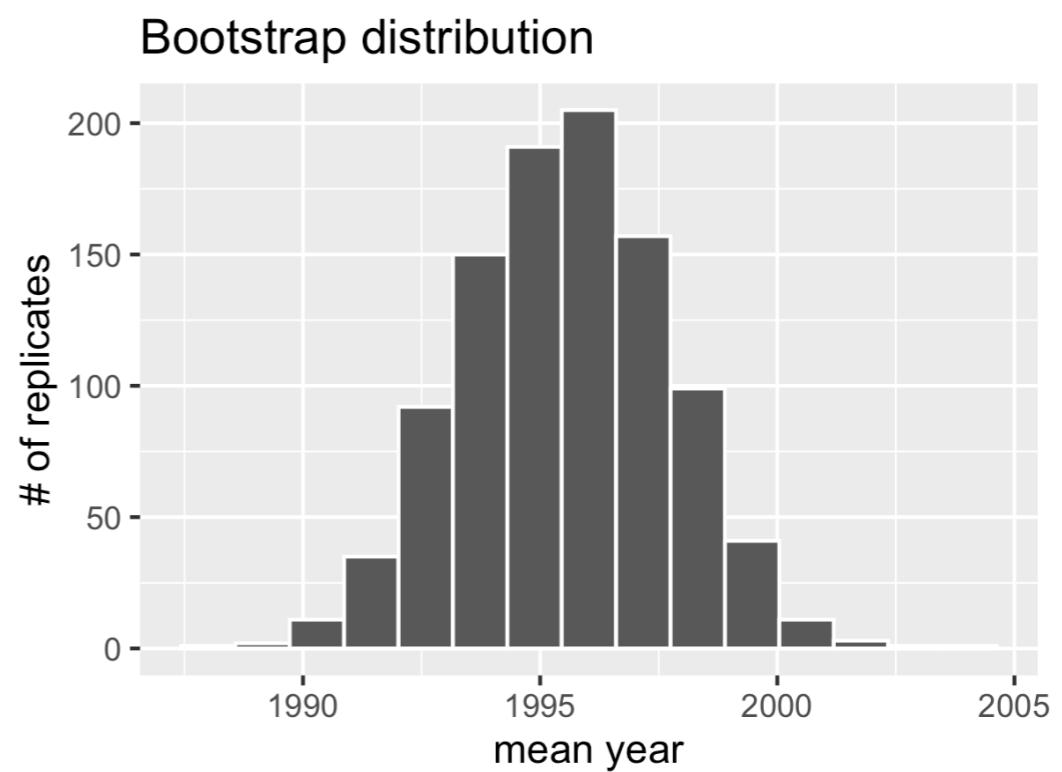


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How to make room for the tidyverse

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How to make room for the tidyverse

- Drop probability theory
- IMO: De-emphasize χ^2 tests & ANOVA
- Lean on “There is only one test” framework
- Drop asymptotic theory in favor of simulation based inference

Guiding Paper

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

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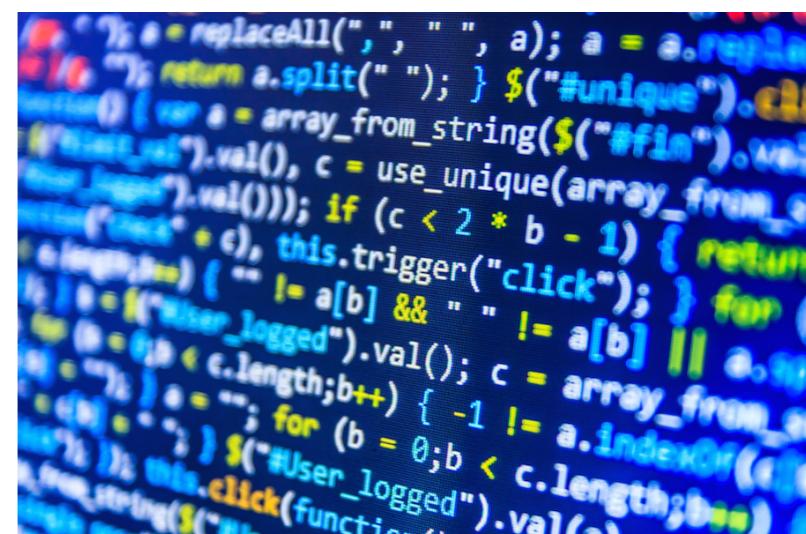
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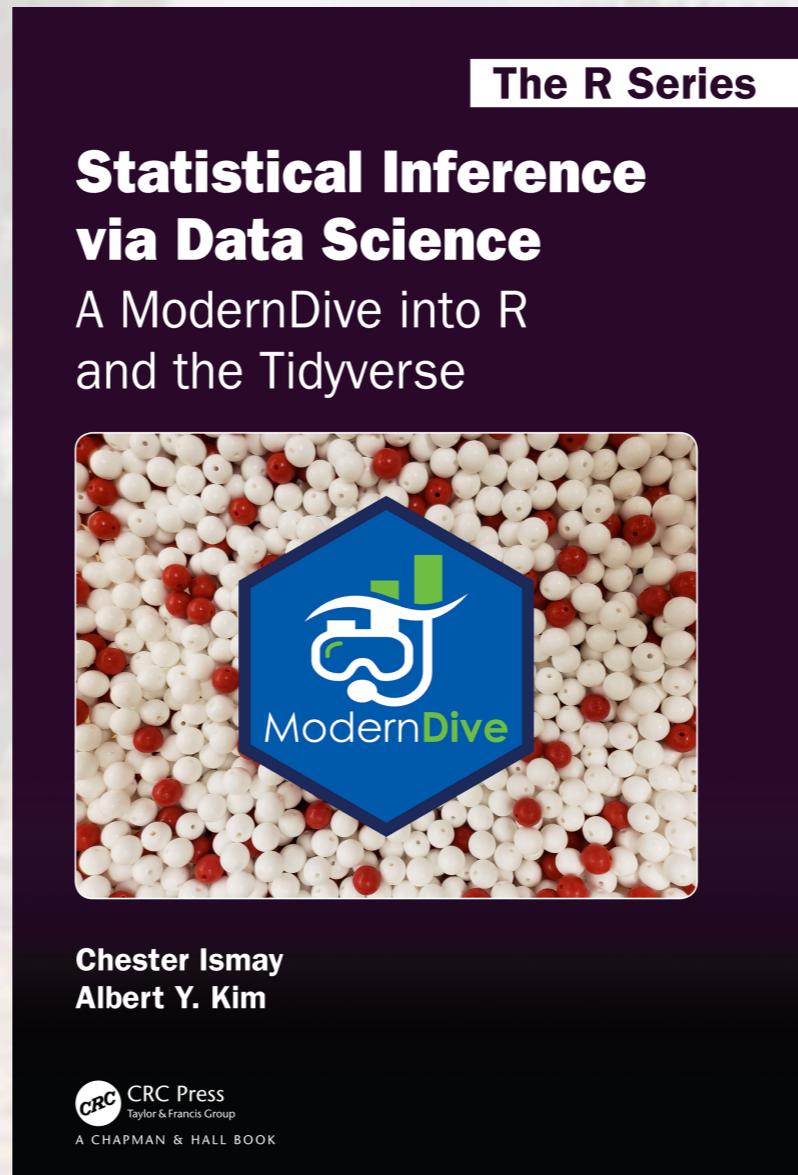
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$$t = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_{\bar{X}_1 - \bar{X}_2}} = \frac{\bar{X}_1 - \bar{X}_2}{S_{\bar{X}_1 - \bar{X}_2}}$$

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



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

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) %>%
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  calculate(stat = "mean")
```

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

