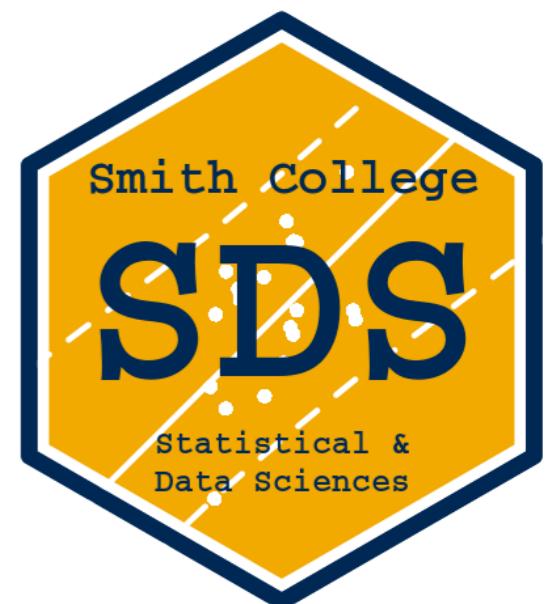


# moderndive: statistical inference via the tidyverse



Albert Y. Kim  
[@rudeboybert](https://twitter.com/rudeboybert)

Statistical Society of Canada  
Calgary, Alberta  
May 29, 2019



# My Context for moderndive

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- Goal 1: Modeling with regression
- Goal 2: Sampling for inference

# Getting from Point A to Point B

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Point A:  
Modal 1st time  
stats student



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Point B:  
Two goals



1. Modeling with regression
2. Sampling for inference

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Calculus?

😁 thru 😤

# Getting from Point A to Point B

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Calculus?



Coding?



# Getting from Point A to Point B

Point A:  
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via the  
**tidyverse**

Point B:  
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1. Modeling with regression
2. Sampling for inference

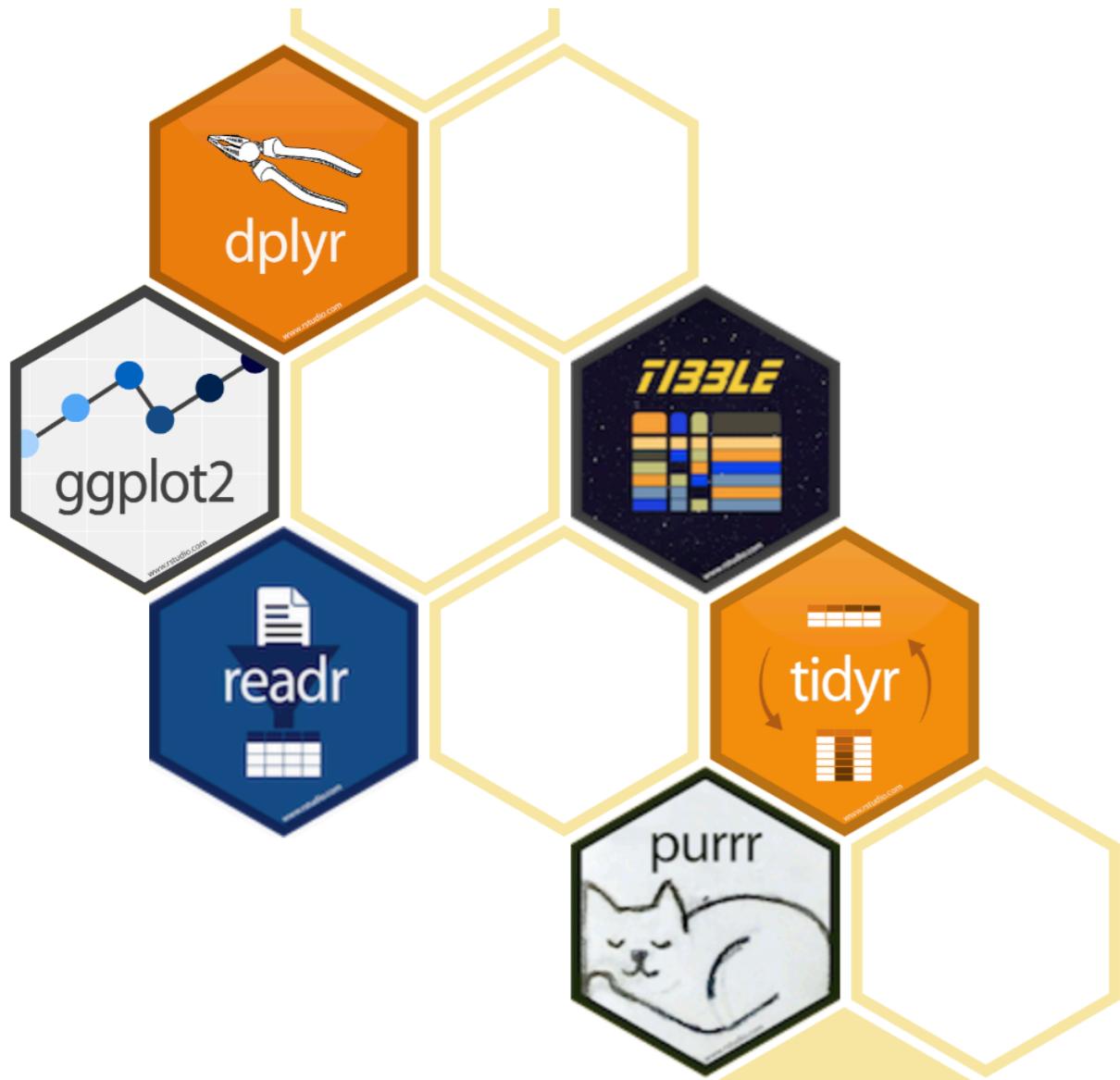


Calculus?  
😁 thru 🤢

Coding?  
😱 & 🤔

# What is the tidyverse?

From [tidyverse.org](https://tidyverse.org):



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.

Install the complete tidyverse with:

```
install.packages("tidyverse")
```

# Why tidyverse for stats newbies?

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- IMO it's easier to learn than base R. [Others too.](#)

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# Why tidyverse for stats newbies?

- IMO it's easier to learn than base R. [Others too.](#)
- It scales. You leverage an entire ecosystem of online developers and support: Google & StackOverflow
- Satisfy learning goals *while learning tools they can use beyond the classroom.*

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- 15-20min of lecturing + 50-55min of open exercises

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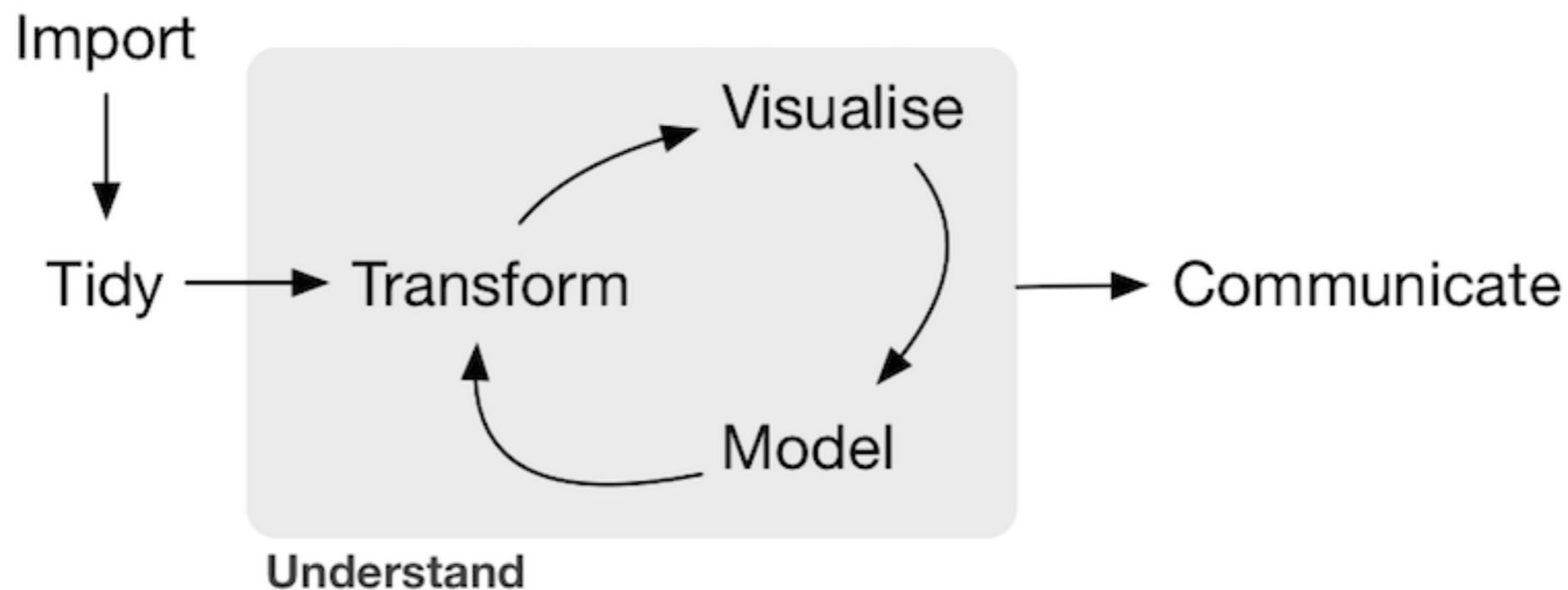
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- Think of how youths learn to play sports...
- IMO stats newbies should learn to “*play the whole game*” in simplified form first
  - %>% then add layers of complexity...
  - %>% then add more layers of complexity...
  - %>% then add more layers of complexity...
- Do this instead of learning individual components in isolation

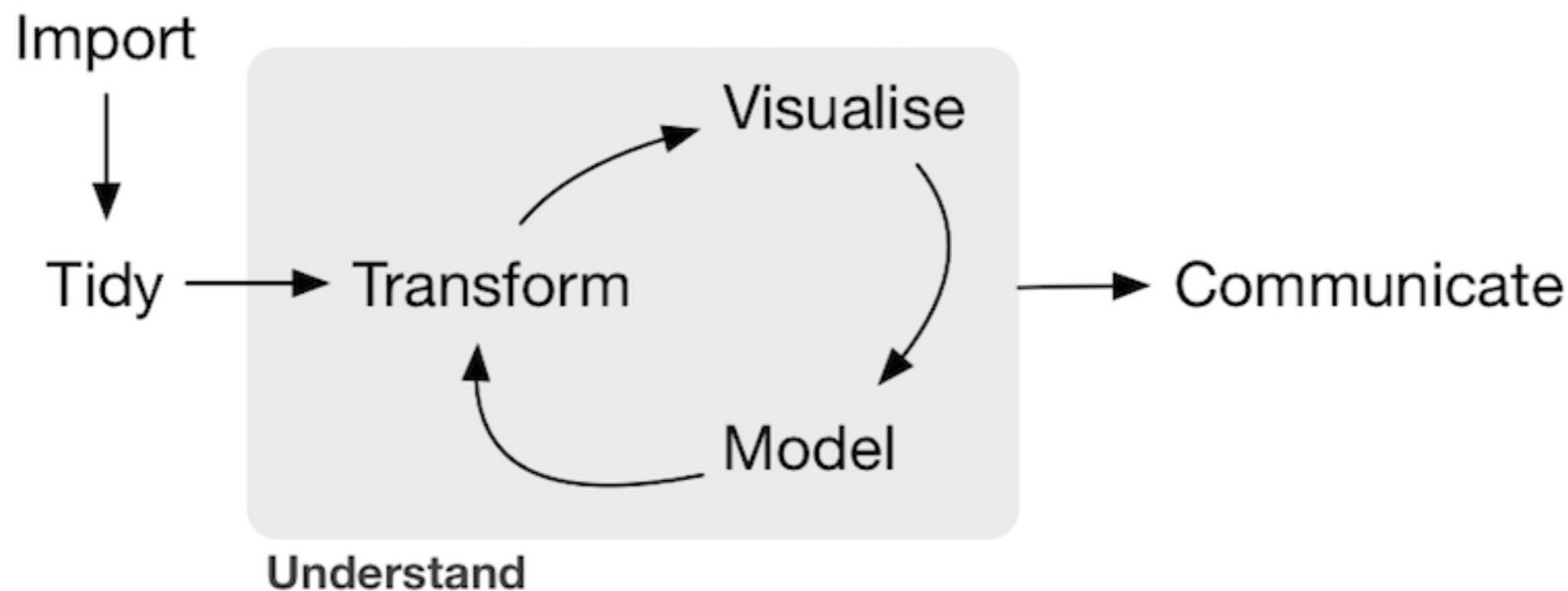
# End Deliverable of Course

Final project that “plays the whole game”  
of *all components* of data/science pipeline:



# End Deliverable of Course

Final project that “plays the whole game”  
of *all components* of data/science pipeline:



Example template given to students this semester,  
based on work by students  
Alexis, Andrianne, & Isabel.

**The R Series**

# **Statistical Inference via Data Science**

**A moderndive into R & the tidyverse**



**Chester Ismay  
Albert Y. Kim**

CRC Press  
Taylor & Francis Group  
A CHAPMAN & HALL BOOK

**Fall 2019!**

Development version at [moderndive.netlify.com](https://moderndive.netlify.com)

# Part I: Data Science via the tidyverse

Chapters 2 - 5

# Chapter 2: Getting Started

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R: Engine



RStudio: Dashboard



# Chapter 2: Getting Started

R: Engine



RStudio: Dashboard



R: A new phone



R Packages: Apps you can download



# Chapter 2: Getting Started

R: Engine



RStudio: Dashboard



R: A new phone



R Packages: Apps you can download



Getting students over initial 😱 of coding

# Chapter 3: Data Viz via `ggplot2`

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Often said “Intro students can’t learn ggplot”

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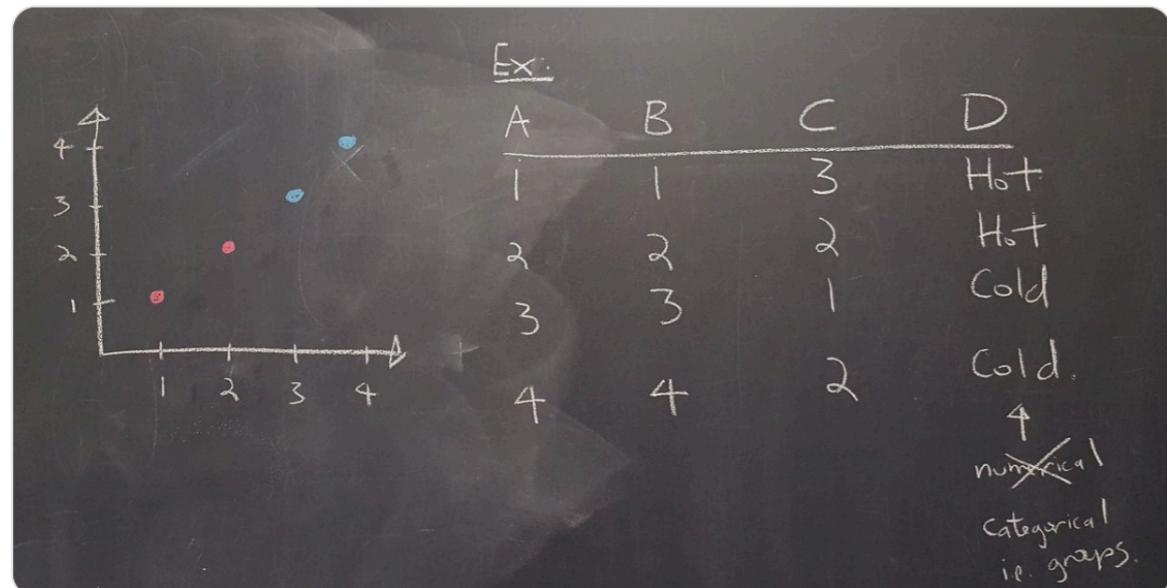


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Intro stats & data science #chalktalk of  
grammar of graphics + homage to  
@katyperry today, #ggplot2 tomorrow  
#rstats



11:58 AM - 11 Sep 2017 from Amherst College

5 Retweets 29 Likes



3

5

29



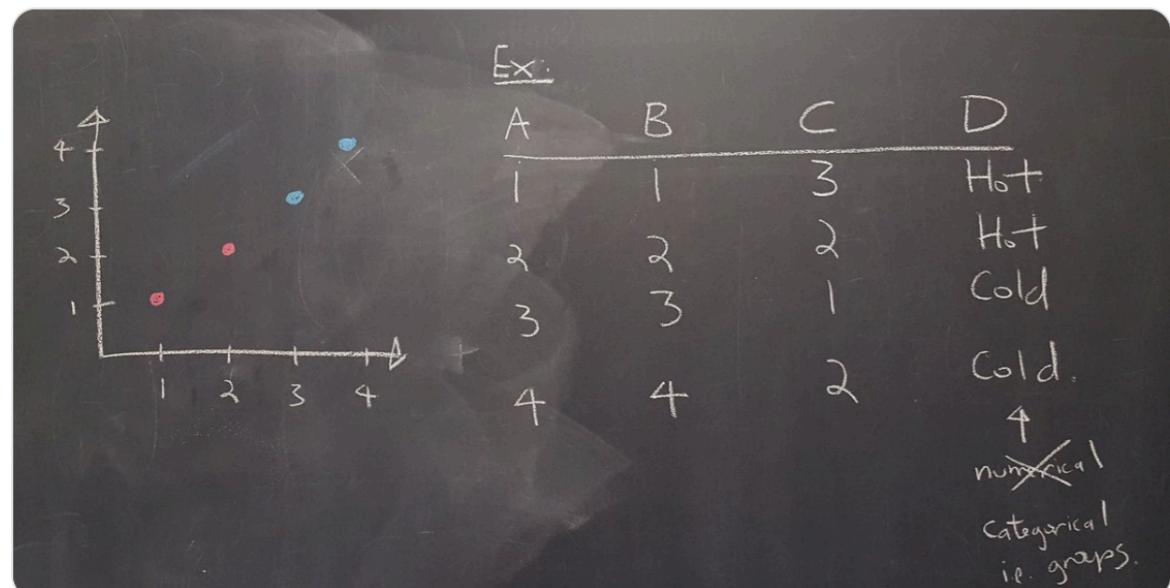
# Chapter 3: Data Viz via ggplot2

Often said “Intro students can’t learn ggplot”



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Intro stats & data science #chalktalk of grammar of graphics + homage to @katyperry today, #ggplot2 tomorrow #rstats



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3 5 29



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#chalktalk of #GrammarOfGraphics definition of "statistical graphic" + @ModernDive's "Five Named Graphs" #5NG #ggplot2

Recall:

A statistical graphic is a mapping of data variables to aesthetic attributes of geometric objects.

Five Named Graphs 5NG

- ① Scatterplots geom\_point()
- ② Line graphs geom\_line()
- ③ Histograms geom\_histogram()
- ④ Boxplots geom\_boxplot()
- ⑤ Barplots geom\_bar()

12:50 PM - 12 Sep 2017 from Amherst College

15 Retweets 61 Likes



Q 15 61

Chapter 4: Data Wrangling via `dplyr`

Chapter 5: “Tidy” Data via `tidyverse`

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# Chapter 4: Data Wrangling via dplyr

# Chapter 5: “Tidy” Data via tidyverse

- Essential: `%>%` operator as it's needed later.
- Balance of how much students wrangling do vs how much you do for them?
- To *completely* shield students from *any* data wrangling is to betray [true nature of work in our fields](#).
- How much data [“taming”](#) is necessary?

# **Part II: Data Modeling via moderndive**

**Chapters 6, 7, & 11**

# Goal 1: Modeling with Regression

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## 1. Data: evals

ID	score	age	gender
1	4.7	36	female
2	4.1	36	female
3	3.9	36	female
4	4.8	36	female
5	4.6	59	male
6	4.3	59	male
7	2.8	59	male
8	4.1	51	male
9	3.4	51	male
10	4.5	40	female
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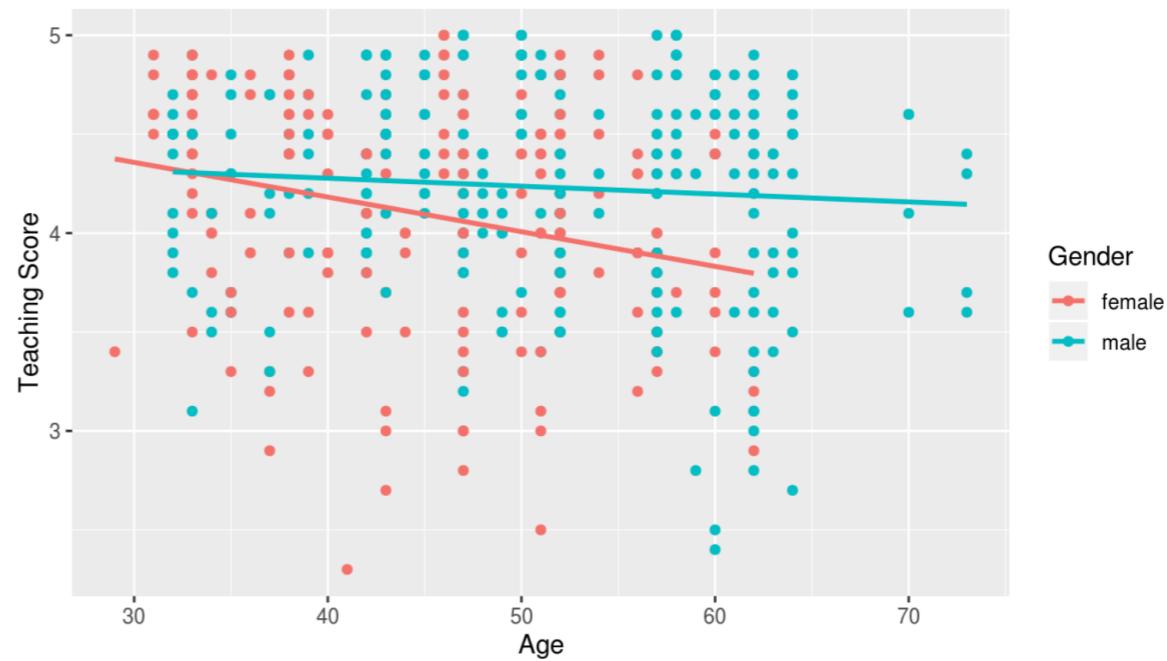
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## 2. Exploratory Data Analysis

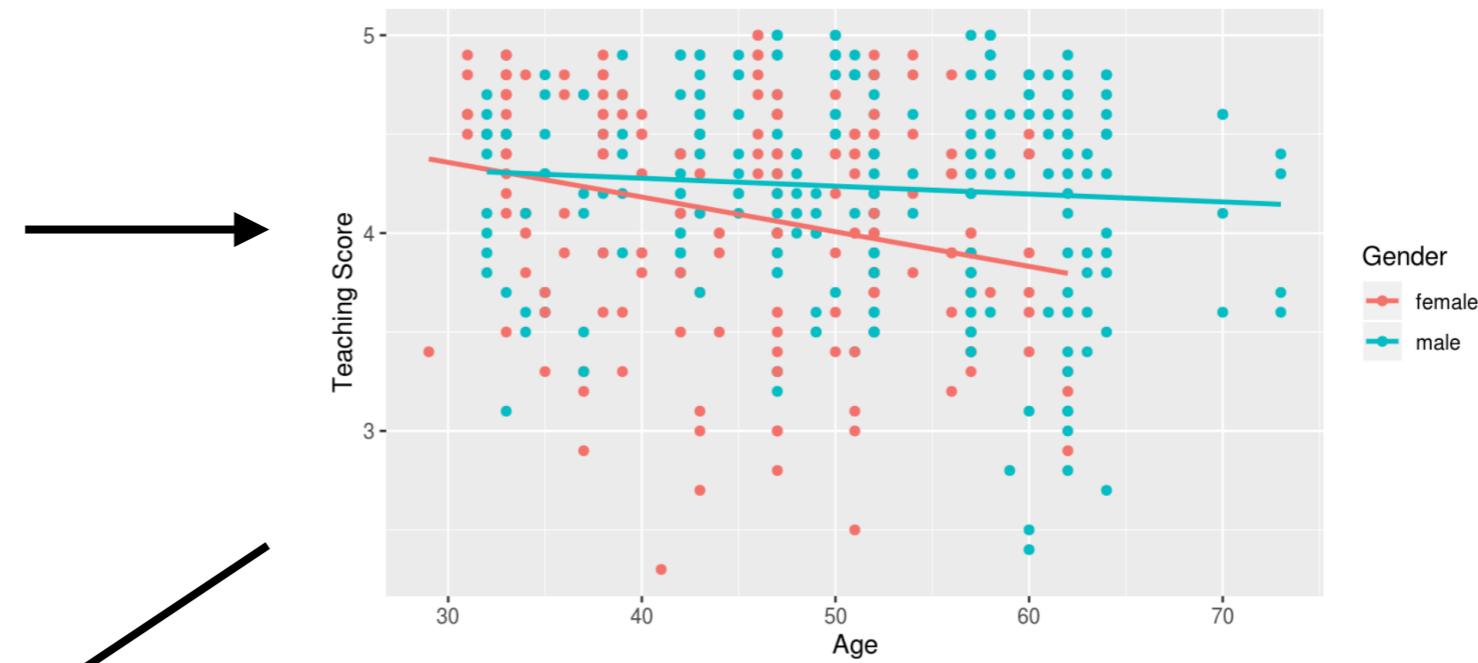


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## 2. Exploratory Data Analysis



## 3. Regression Coeff

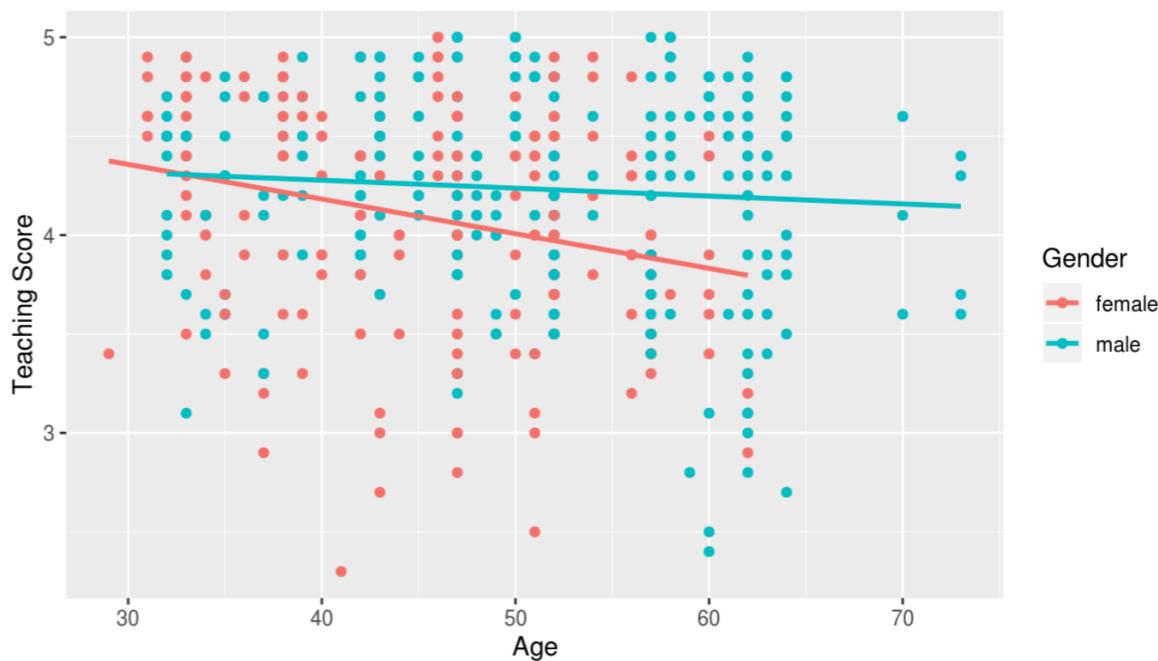
```
Console ~ / ↗
> score_model <- lm(score ~ age * gender, data = evals)
> get_regression_table(score_model)
# A tibble: 4 x 7
  term      estimate
  <chr>    <dbl>
1 intercept  4.88
2 age        -0.018
3 gendermale -0.446
4 age:gendermale  0.014
> |
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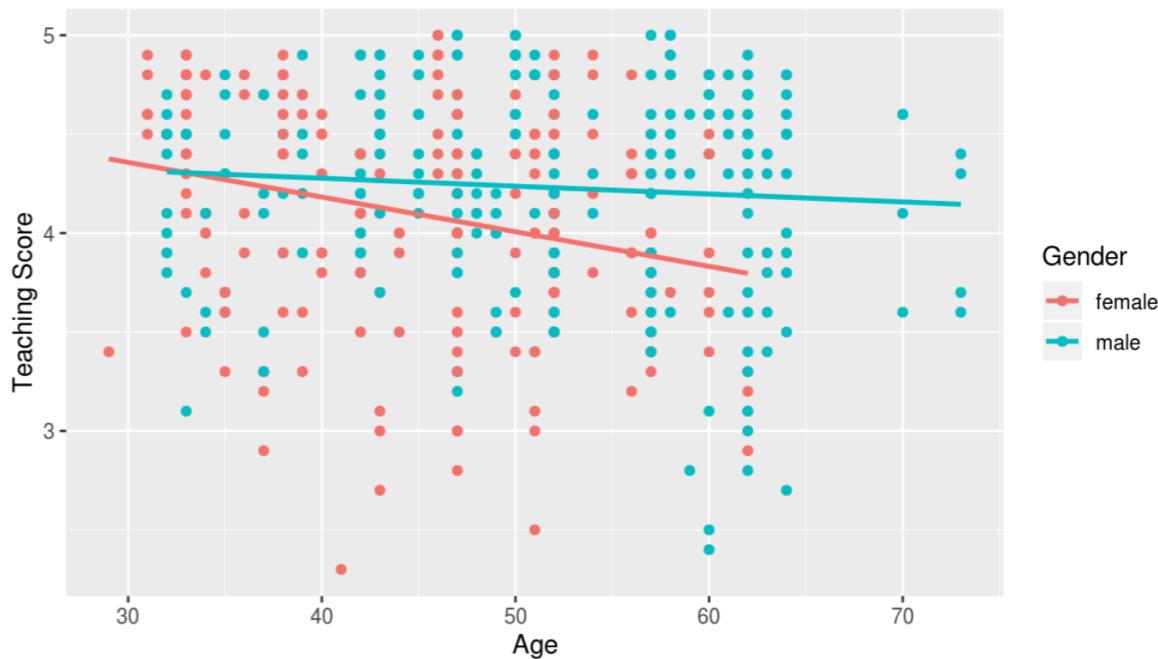
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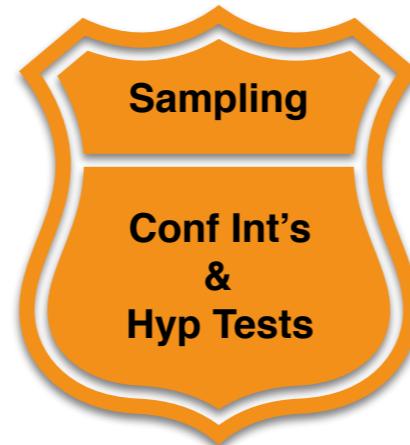
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# A tibble: 4 x 7
  term      estimate std_error statistic p_value lower_ci upper_ci
  <chr>    <dbl>     <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 intercept 4.88      0.205     23.8     0        4.48      5.29
2 age       -0.018    0.004     -3.92    0        -0.026     -0.009
3 gendermale -0.446    0.265     -1.68    0.094   -0.968     0.076
4 age:gendermale 0.014    0.006     2.45    0.015   0.003     0.024
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```

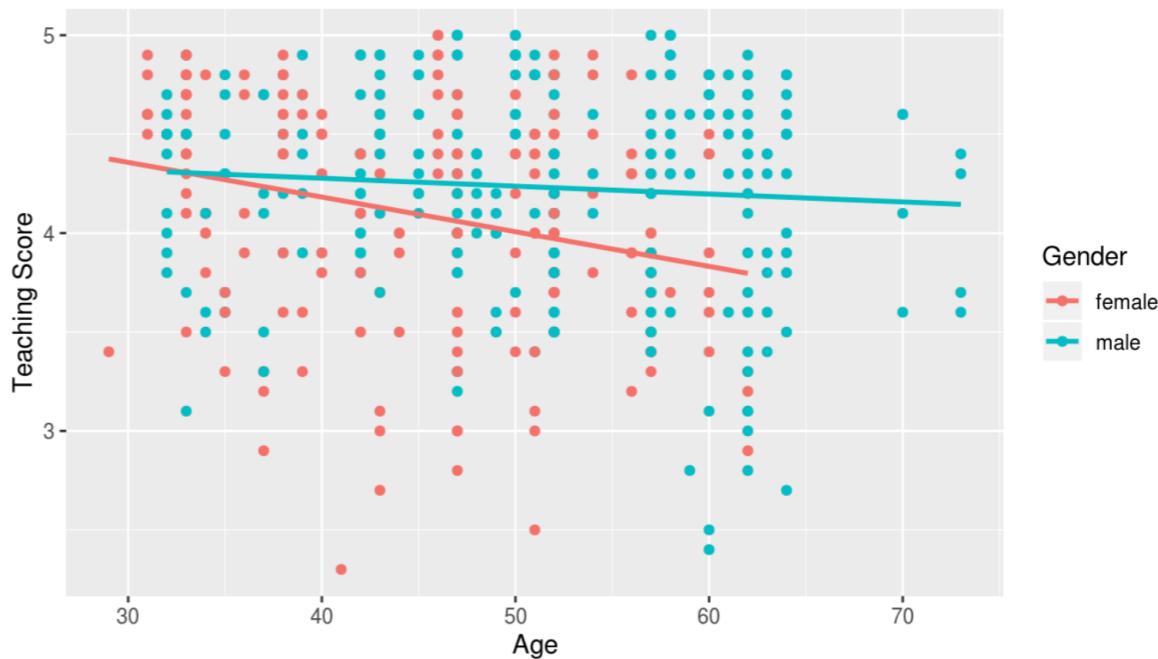
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> |
```

Early: Descriptive regression

Later: Inference for Regression

# Part III: Statistical Inference via infer

Chapters 8 - 11

# Goal 2: Sampling for Inference



# Goal 2: Sampling for Inference



# Goal 2: Sampling for Inference

1. Tactile Sampling → 2. Virtual Sampling → 3. Theoretical

Population



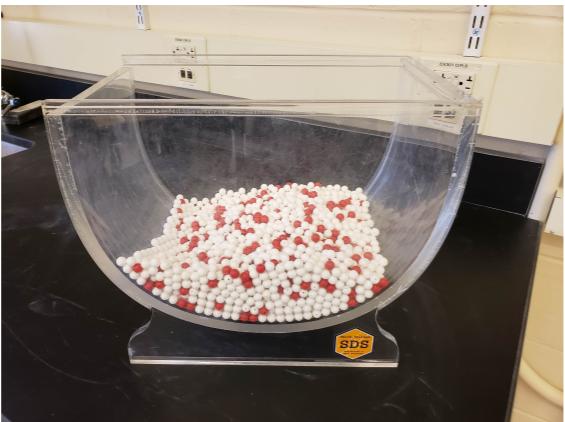
Sample

Sampling  
Distributions &  
Standard Errors

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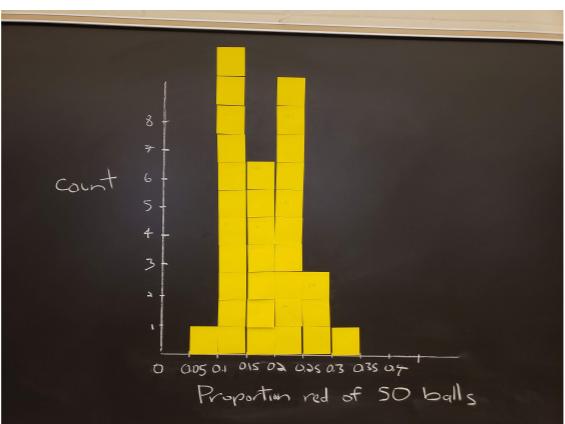
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Sample



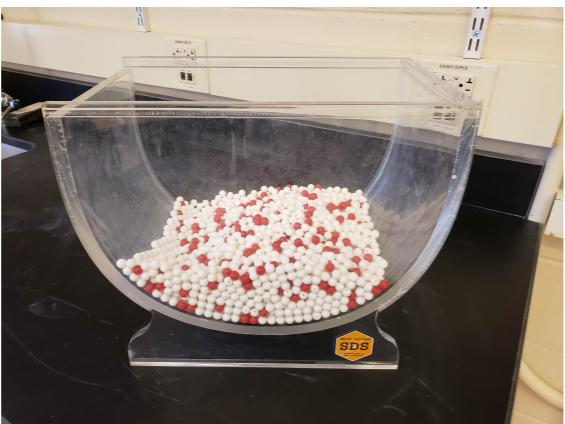
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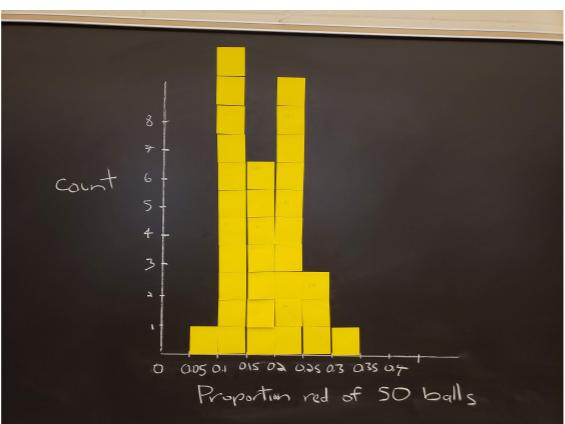


```
Console ~/ ↵
> library(moderndive)
> bowl
# A tibble: 2,400 x 2
  ball_ID color
  <int> <chr>
1     1 white
2     2 white
3     3 white
4     4 red
5     5 white
6     6 white
7     7 red
8     8 white
9     9 red
10    10 white
# ... with 2,390 more rows
> |
```

Sample



Sampling  
Distributions &  
Standard Errors



# Goal 2: Sampling for Inference

1. Tactile Sampling → 2. Virtual Sampling → 3. Theoretical

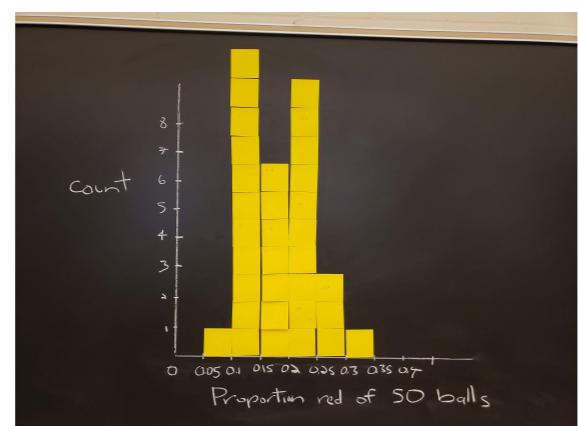
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Sample



Sampling  
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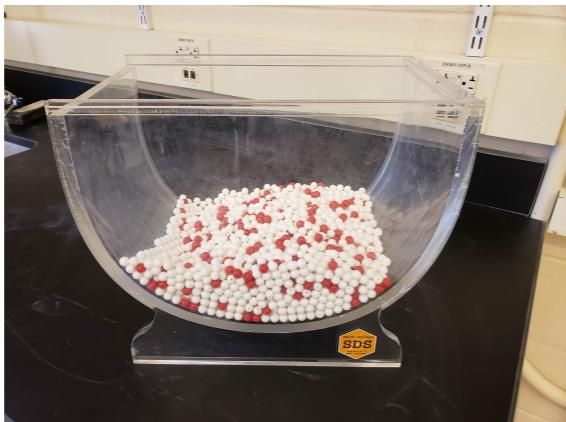
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6     6 white
7     7 red
8     8 white
9     9 red
10    10 white
# ... with 2,390 more rows
> |
```

```
Console ~/ ↵
> bowl %>%
+   rep_sample_n(size = 50, reps = 1)
# A tibble: 50 x 3
# Groups:   replicate [1]
  replicate ball_ID color
  <int> <int> <chr>
1       1     226 white
2       1    1304 red
3       1    1230 white
4       1     984 white
5       1      68 white
6       1    1965 white
7       1     431 white
8       1    1184 white
9       1    1610 red
10      1     978 white
# ... with 40 more rows
>
```

# Goal 2: Sampling for Inference

1. Tactile Sampling → 2. Virtual Sampling → 3. Theoretical

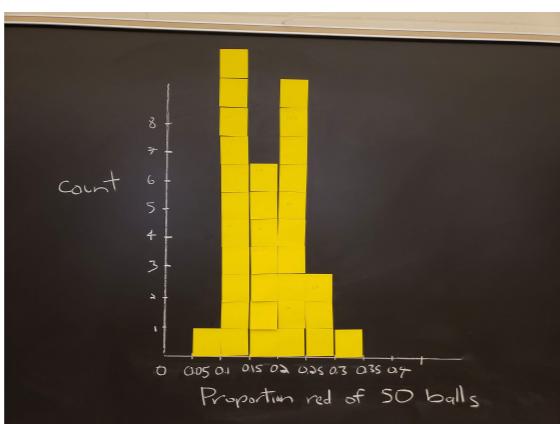
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Sample

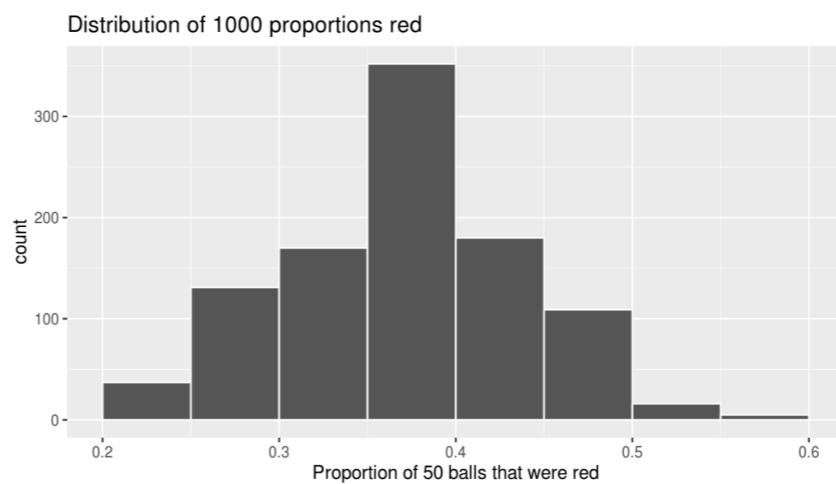


Sampling  
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> bowl
# A tibble: 2,400 x 2
  ball_ID color
  <int> <chr>
1     1 white
2     2 white
3     3 white
4     4 red
5     5 white
6     6 white
7     7 red
8     8 white
9     9 red
10    10 white
# ... with 2,390 more rows
> |
```

```
Console ~/ ↵
> bowl %>%
+   rep_sample_n(size = 50, reps = 1)
# A tibble: 50 x 3
# Groups:   replicate [1]
  replicate ball_ID color
  <int> <int> <chr>
1       1     1 226 white
2       1     1 1304 red
3       1     1 1230 white
4       1     1 984 white
5       1     1 68 white
6       1     1 1965 white
7       1     1 431 white
8       1     1 1184 white
9       1     1 1610 red
10      1     1 978 white
# ... with 40 more rows
> |
```



# Goal 2: Sampling for Inference

1. Tactile Sampling → 2. Virtual Sampling → 3. Theoretical

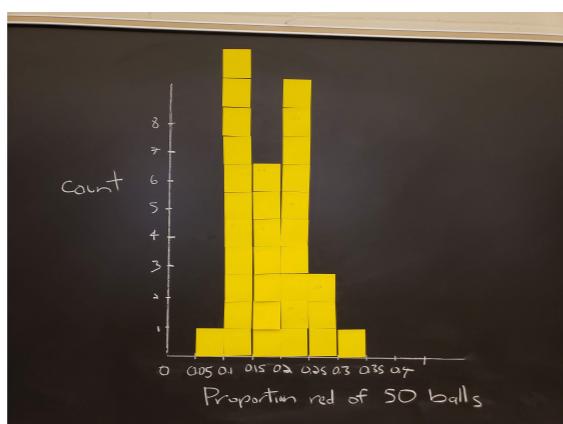
Population



Sample

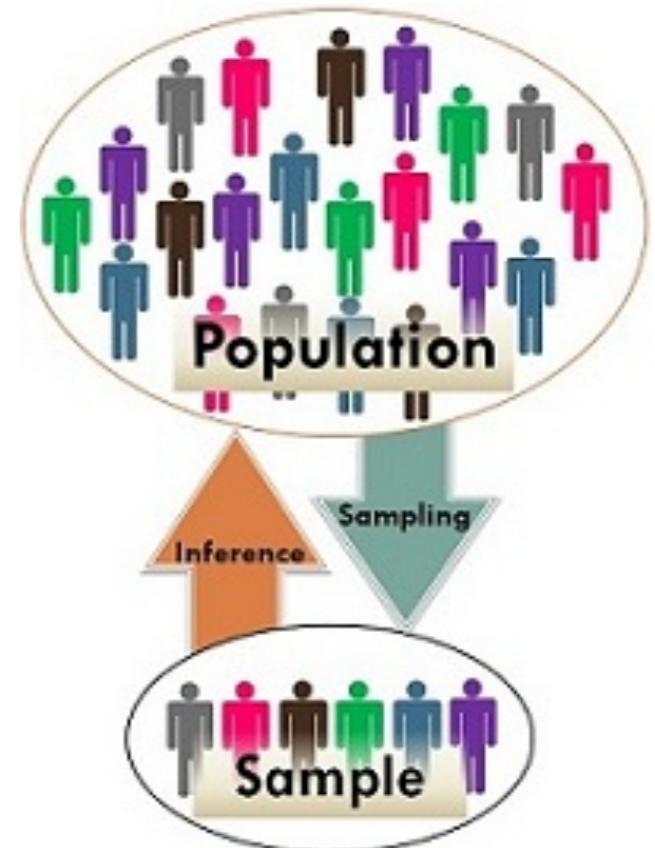
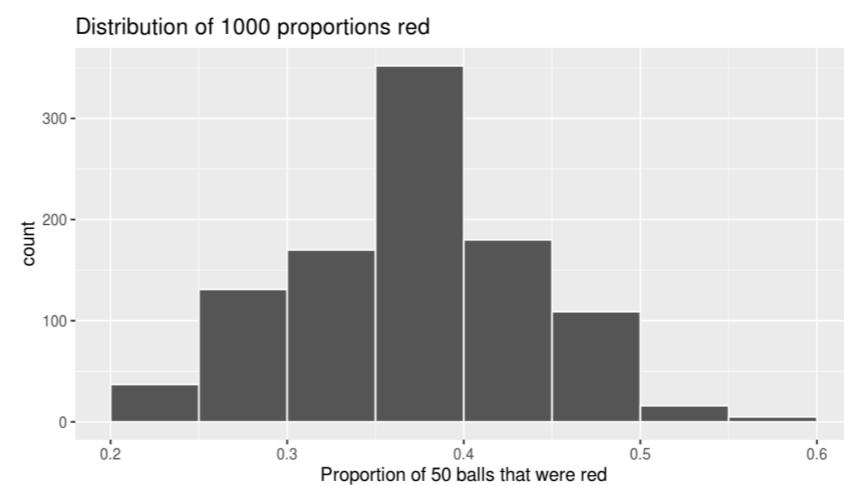


Sampling  
Distributions &  
Standard Errors



```
Console ~/ ↵
> library(moderndive)
> bowl
# A tibble: 2,400 x 2
  ball_ID color
  <int> <chr>
1     1 white
2     2 white
3     3 white
4     4 red
5     5 white
6     6 white
7     7 red
8     8 white
9     9 red
10    10 white
# ... with 2,390 more rows
> |
```

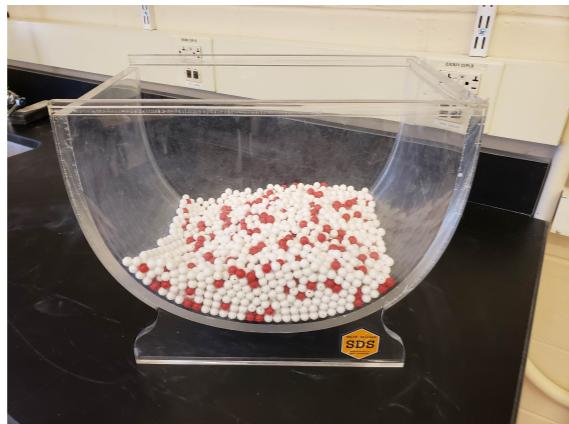
```
Console ~/ ↵
> bowl %>%
+   rep_sample_n(size = 50, reps = 1)
# A tibble: 50 x 3
# Groups: replicate [1]
  replicate ball_ID color
  <int> <int> <chr>
1       1     1  white
2       1     1  red
3       1     1  white
4       1     1  white
5       1     1  white
6       1     1  white
7       1     1  white
8       1     1  white
9       1     1  red
10      1     1  white
# ... with 40 more rows
> |
```



# Goal 2: Sampling for Inference

1. Tactile Sampling → 2. Virtual Sampling → 3. Theoretical

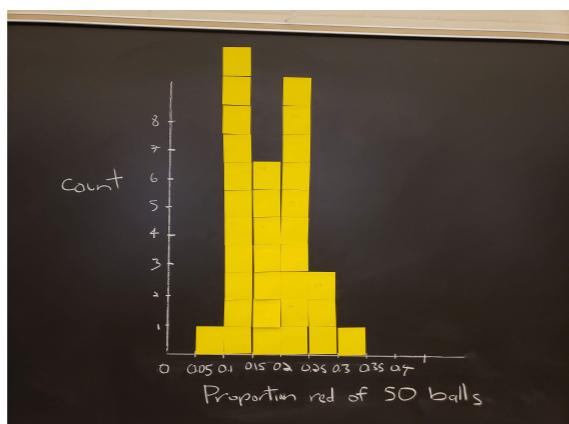
Population



Sample

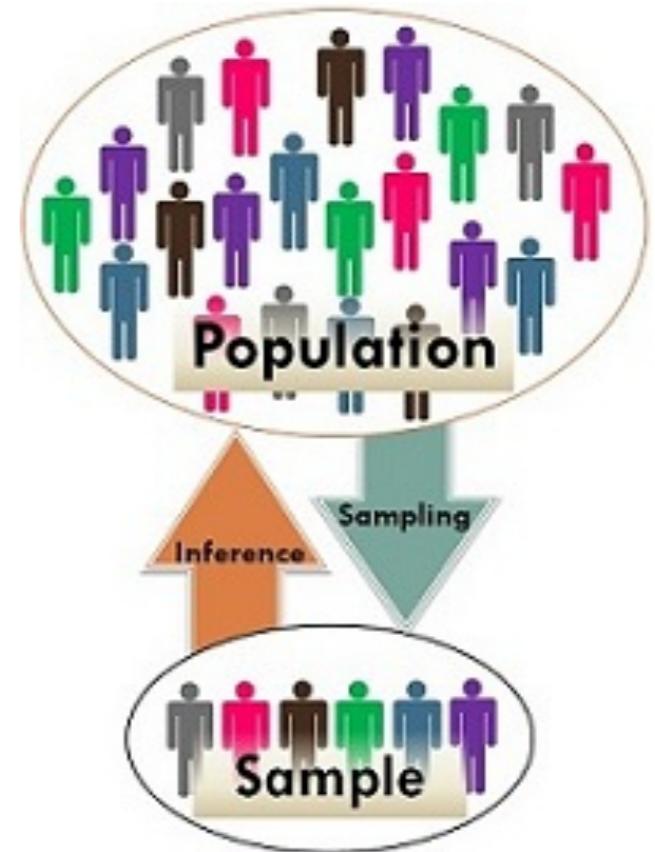
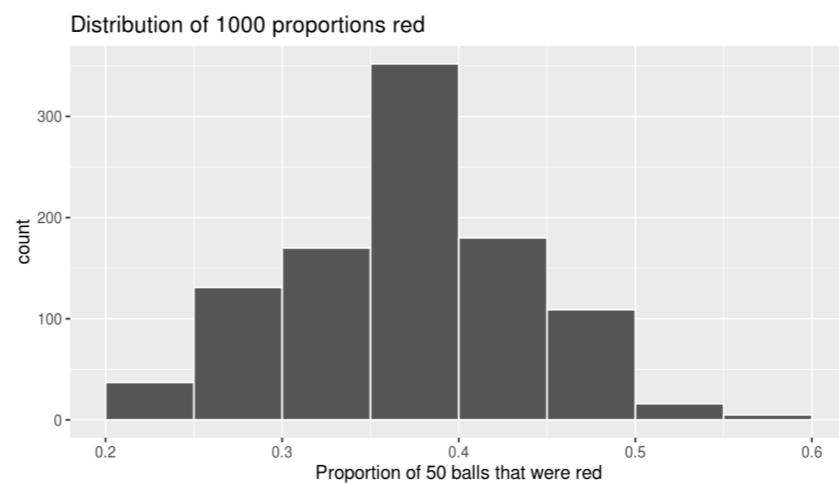


Sampling  
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8       1     1  white
9       1     1  red
10      1     1  white
# ... with 40 more rows
> |
```



$$SE = \sqrt{\frac{p(1-p)}{n}}$$

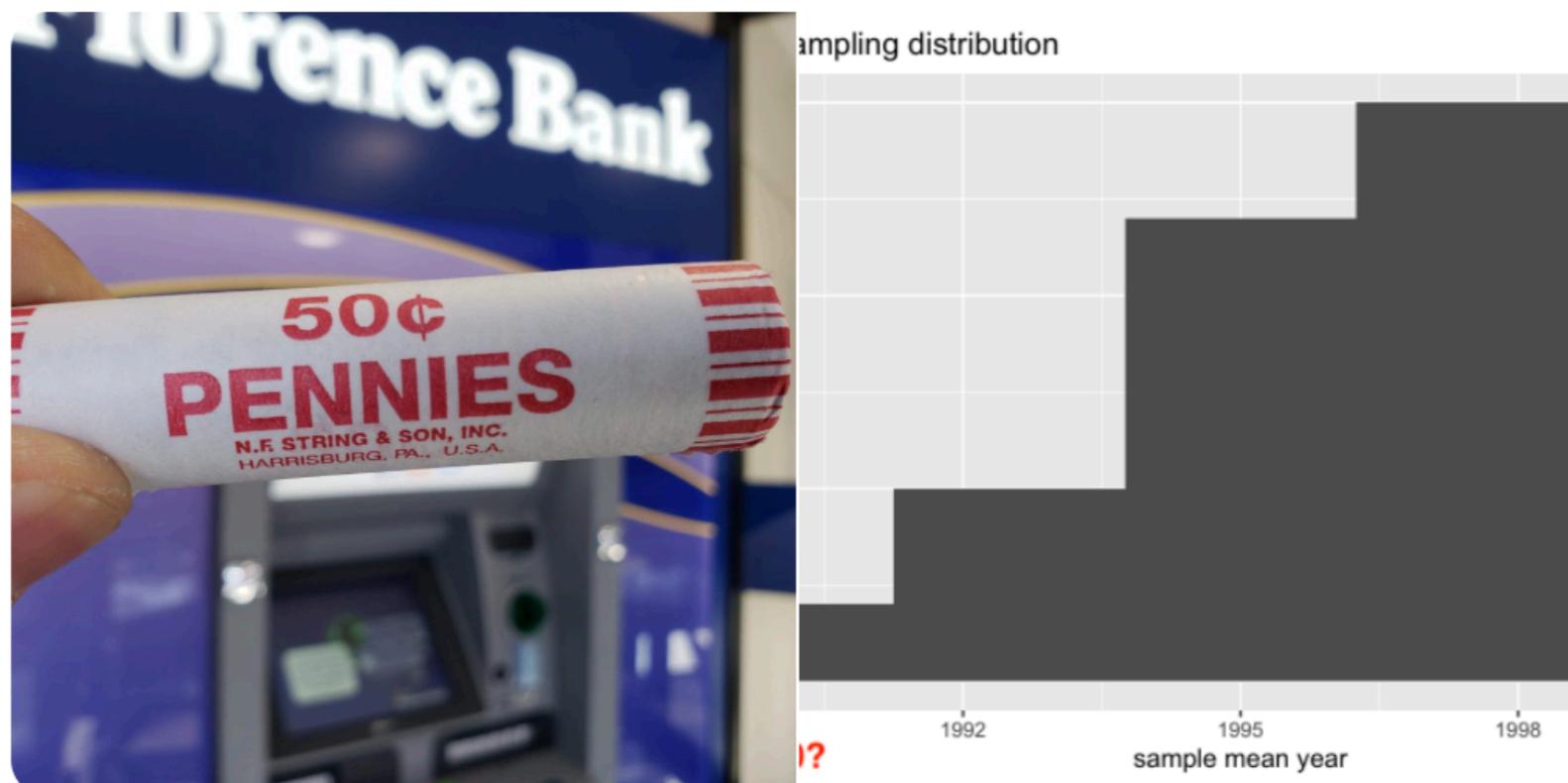
# Chap 9: Confidence Intervals

**Click me!!!**



**ModernDive** @ModernDive · Mar 27

Hey intro stats profs! Do you teach statistical inference w/ the bootstrap method? Do you get Q's like "Why do we resample WITH replacement?" or "How many samples are there?" If so, consider doing "tactile resampling" first, THEN %>% do "virtual resampling" the [@moderndive way!](#)



2



7



15



[Show this thread](#)

# Chap 10: Hypothesis Testing via infer

Click me!!!



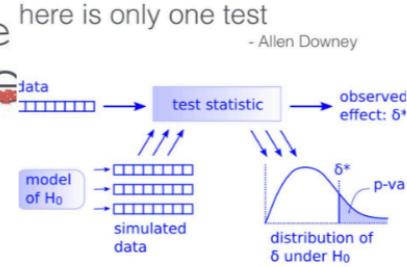
Albert Y. Kim

@rudeboybert

Replies to @AmeliaMN @djnavarro and 3 others

Indeed! Per @crite: "the `infer` package makes statistical inference tidy & transparent!"  
[github.com/rudeboybert/JS ...](https://github.com/rudeboybert/JS ...)

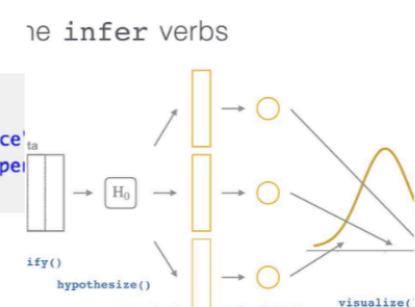
~~infer makes p-value easier to compute.~~  
tidy and transparent.



The diagram illustrates the statistical inference process. It starts with 'data' which is processed by a 'test statistic' to produce an 'observed effect:  $\delta^*$ '. This observed effect is then compared against a 'model of  $H_0$ ' to generate 'simulated data'. These simulated data are used to create a 'distribution of  $\delta$  under  $H_0$ ', from which a 'p-value' is calculated. A quote from Allen Downey is included: 'here is only one test'.

.test(gss\$party, gss\$space)

```
gss %>%  
  specify(space ~ party) %>%  
  hypothesize(null = "independence")  
  generate(reps = 1000, type = "perm")  
  calculate(stat = "Chisq")
```



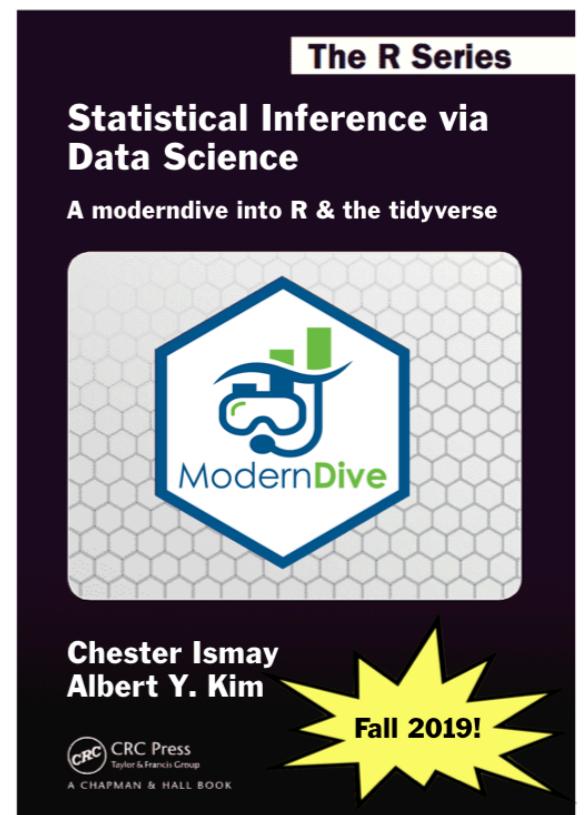
8:39 AM - 21 May 2019

1 Retweet 9 Likes



# Conclusion

# Timeline



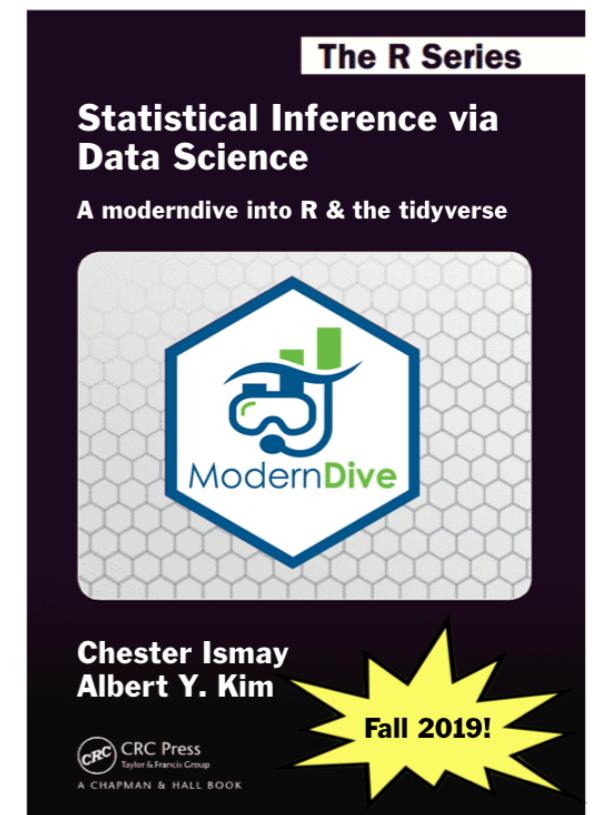
# Timeline

- **Now:** Development version on [moderndive.netlify.com](https://moderndive.netlify.com) being edited.



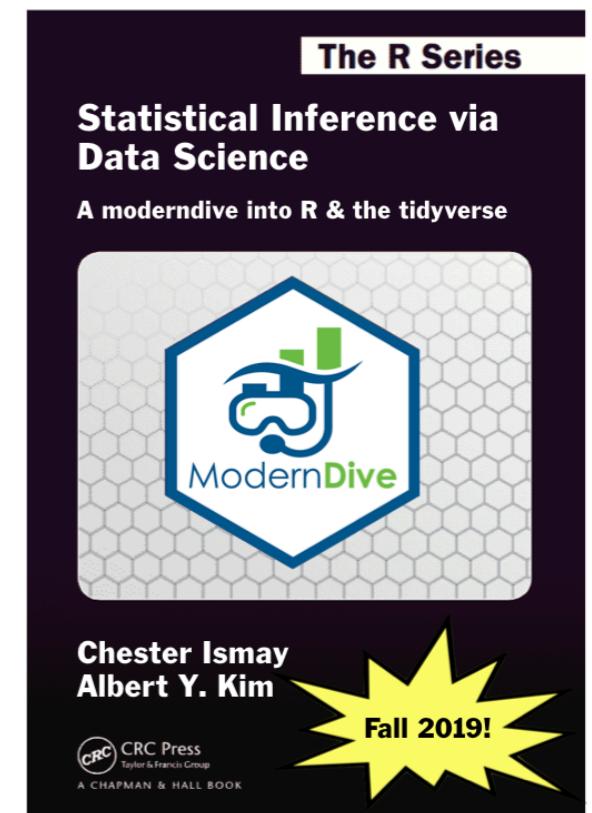
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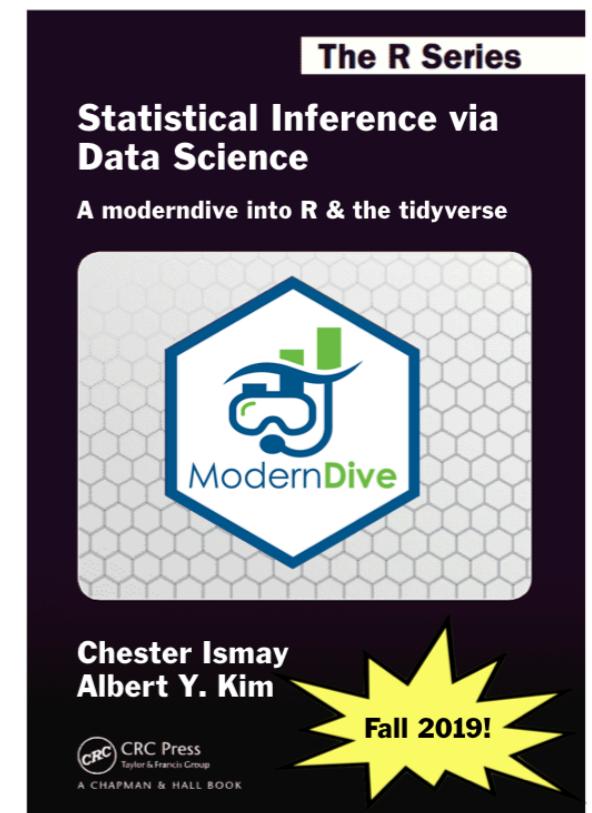
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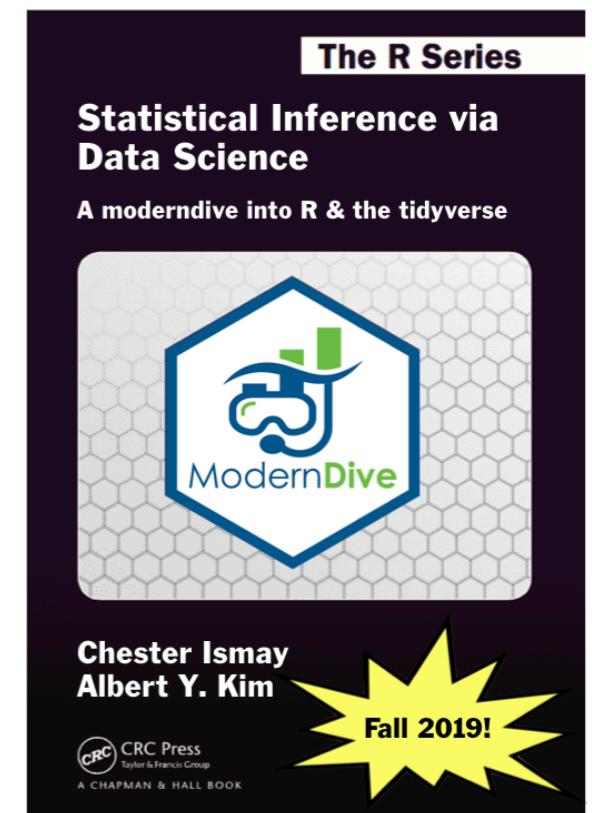
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# Resources

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  2. **moderndive** package source code

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- moderndive mailing list: [eepurl.com/cBkltf](https://eepurl.com/cBkltf)

# Thank you!

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- 1. Don't reinvent the wheel!

# Why tidyverse in general?

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- 1. Don't reinvent the wheel!
  - 2. Breakdown large tasks into steps using `%>%` "then"
  - 3. What is the [goal](#) of your code?
  - 4. Make code understandable to humans