TEACHING INTRO DATA SCIENCE & ASSESSING LEARNING

PREPARING TO TEACH
JSM 2019

🔗 bit.ly/ptt-repo

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MINE ÇETINKAYA-RUNDEL

UNIVERSITY OF EDINBURGH + DUKE + RSTUDIO

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mine-cetinkaya-rundel

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GAISE 2016

1. Teach statistical thinking.

   a. **Teach statistics as an investigative process of problem-solving and decision-making.** Students should not leave their introductory statistics course with the mistaken impression that statistics consists of an unrelated collection of formulas and methods. Rather, students should understand that statistics is a problem-solving and decision-making *process* that is fundamental to scientific inquiry and essential for making sound decisions.

   b. **Give students experience with multivariable thinking.** We live in a complex world in which the answer to a question often depends on many factors. Students will encounter such situations within their own fields of study and everyday lives. We must prepare our students to answer challenging questions that require them to investigate and explore relationships among many variables. Doing so will help them to appreciate the value of statistical thinking and methods.

2. Focus on conceptual understanding.
3. Integrate real data with a context and a purpose.
4. Foster active learning.
5. Use technology to explore concepts and analyze data.
6. Use assessments to improve and evaluate student learning.

(1) NOT a commonly used subset of tests and intervals and produce them with hand calculations

(2) Multivariate analysis requires the use of computing

(3) NOT use technology that is only applicable in the intro course or that doesn't follow good science principles

(4) Data analysis isn't just inference and modeling, it's also data importing, cleaning, preparation, exploration, and visualization

GAISE 2016, http://www.amstat.org/asa/files/pdfs/GAISE/GaiseCollege_Full.pdf.

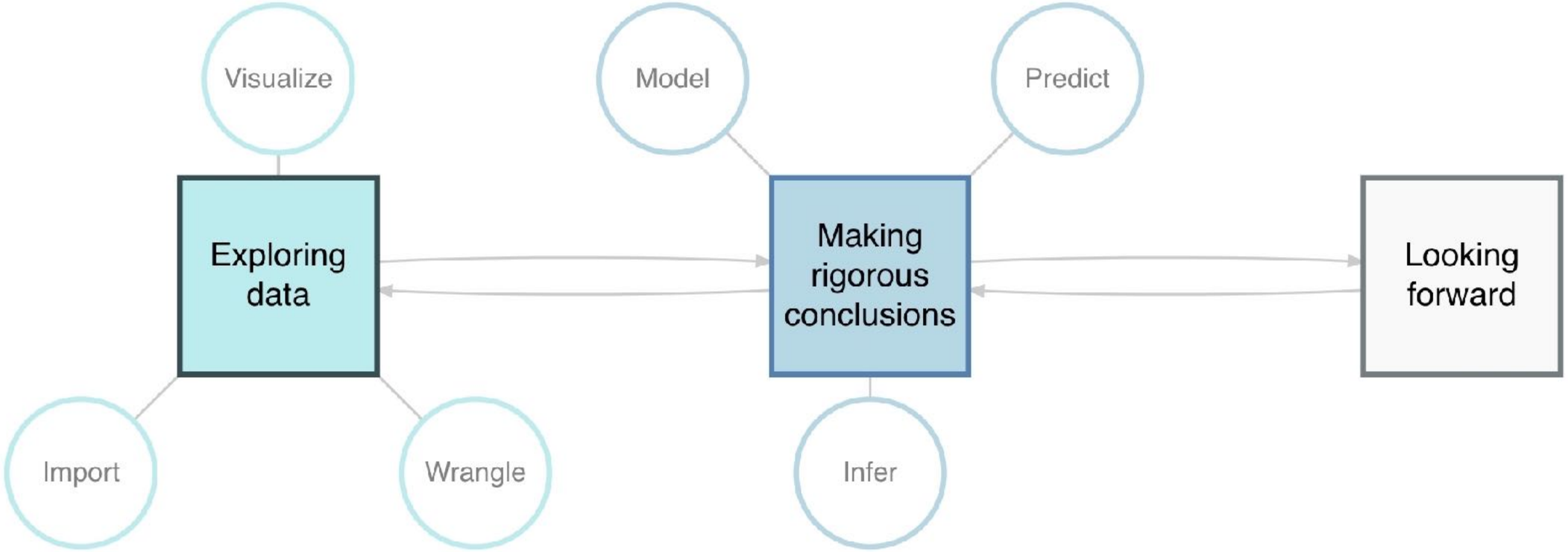
don't start with this

- Exploratory data analysis
- Study design
- Probability
- Random variables
- Central Limit Theorem
- One sample mean HT and CI
- One sample proportion HT and CI
- Two sample mean HT and CI
- Two sample proportion HT and CI
- Chi-square test
- ANOVA
- Simple linear regression

and add all this

+ R
+ R Markdown
+ git / GitHub
+ data scraping
+ iteration
+ working with non-rectangular data
+ interactive visualization

...



Fundamentals of data & data viz, confounding variables, Simpson's paradox
+
R / RStudio, R Markdown, simple Git

Tidy data, data frames vs. summary tables, recoding & transforming, web scraping & iteration
+
collaboration on GitHub

Building & selecting models, visualizing interactions, prediction & validation, inference via simulation

Data science ethics, interactive viz & reporting, text analysis, Bayesian inference
+
communication & dissemination

5 design principles

Which kitchen would you rather bake a cake?

Which kitchen would you rather bake a cake?

cherish

day

one

minimize
time spent
on course logistics

maximize
time spent on
creating a data
visualization

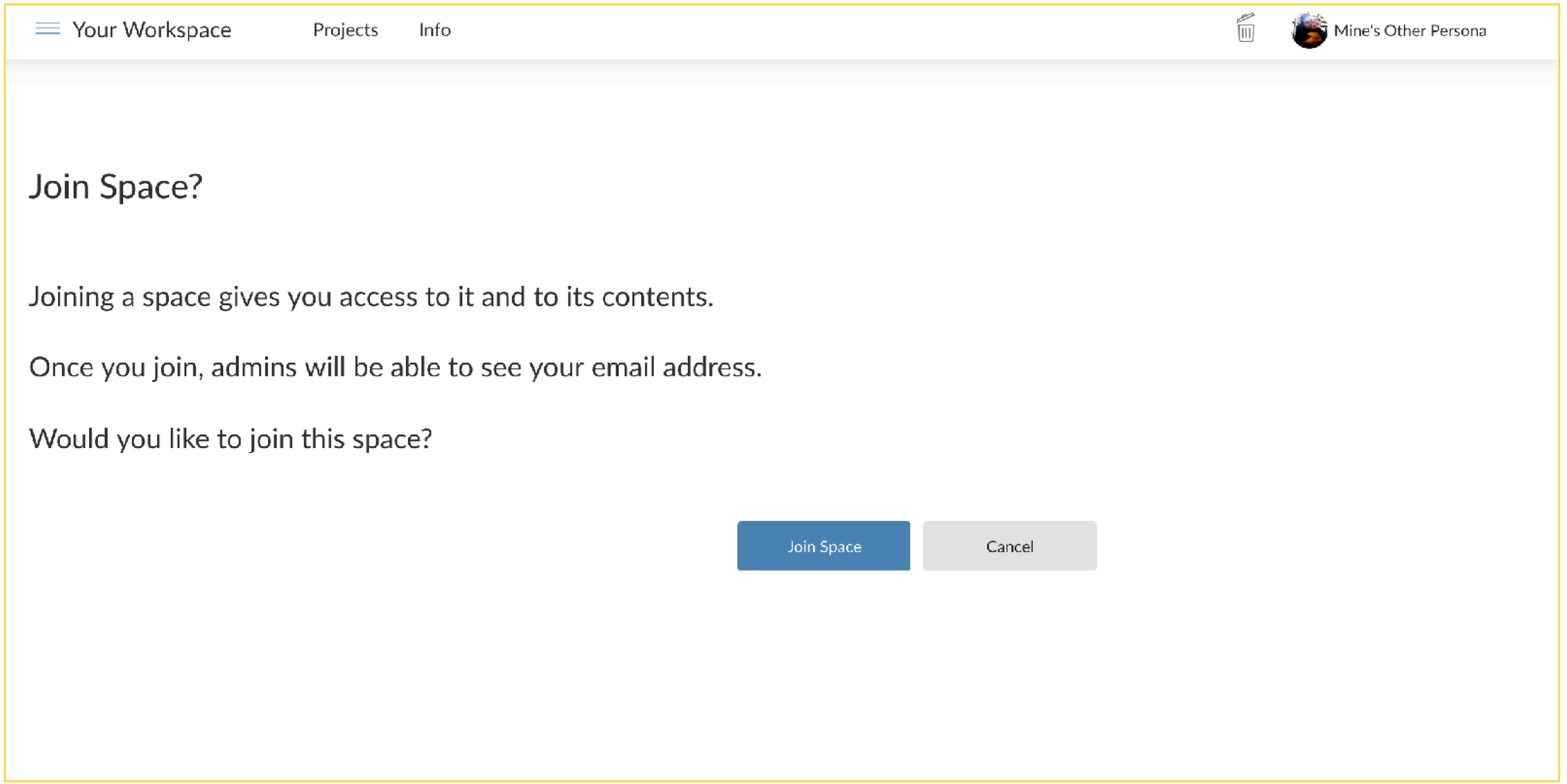
don't start like this

- Install R
- Install RStudio
- Install the following packages:
  - rmarkdown
  - tidyverse
  - ...
- Load these packages
- Install git

instead do this

- Go to rstudio.cloud (or some other server based solution)
- Log in with your ID & pass

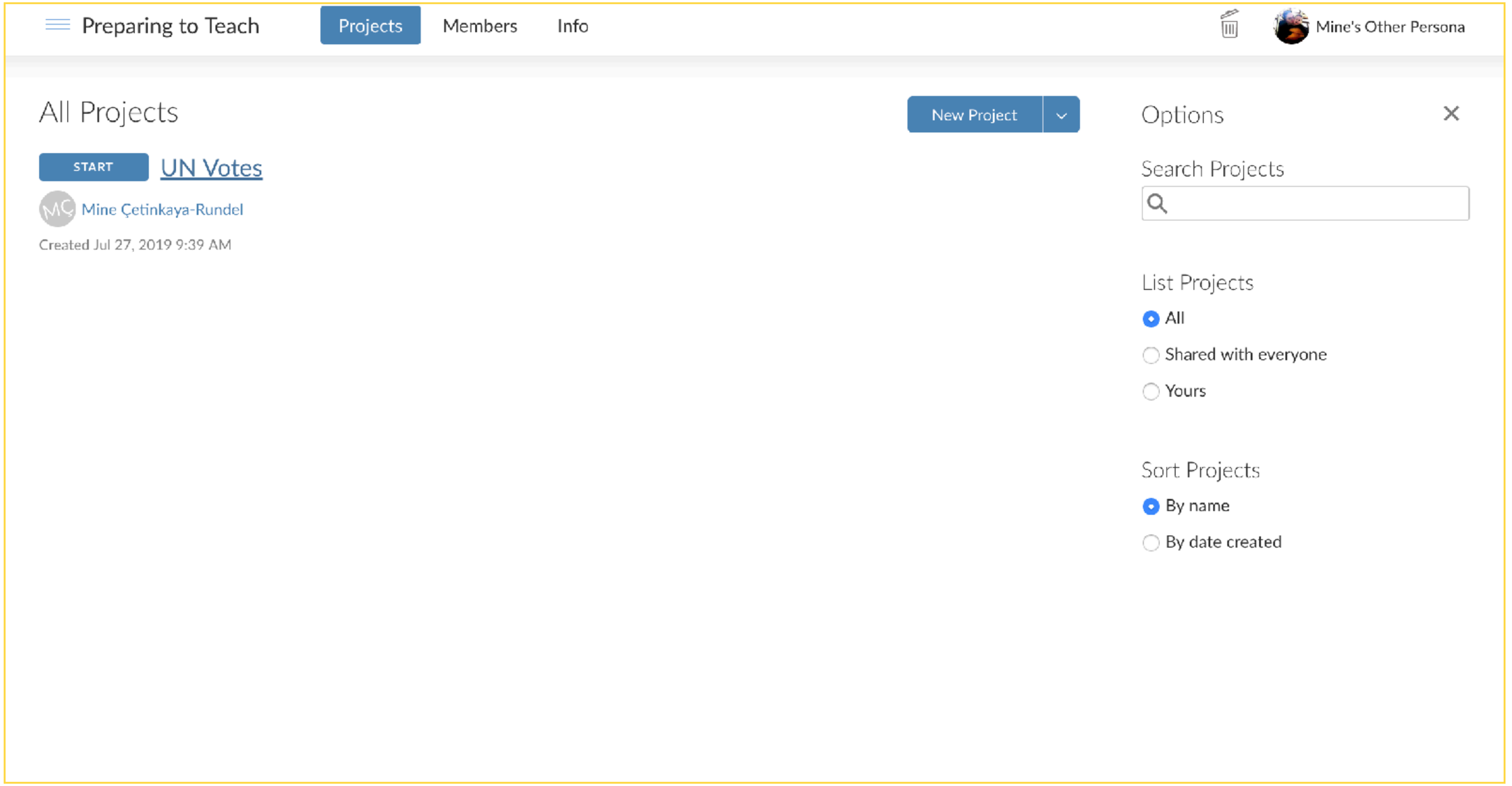
```
> hello R!
```

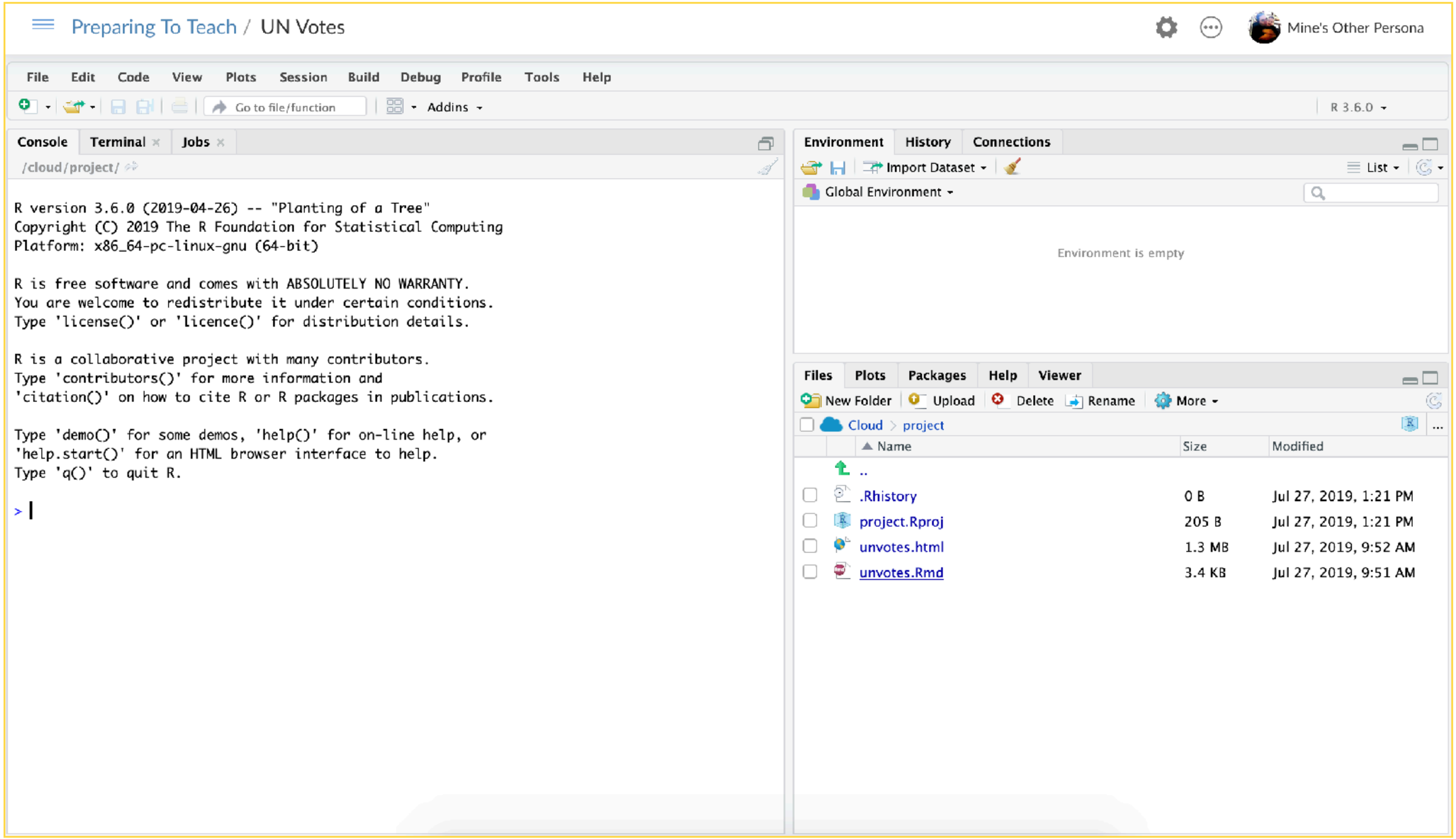

Your Workspace
Projects
Info
Mine's Other Persona
Join Space?
Joining a space gives you access to it and to its contents.
Once you join, admins will be able to see your email address.
Would you like to join this space?
Join Space
Cancel

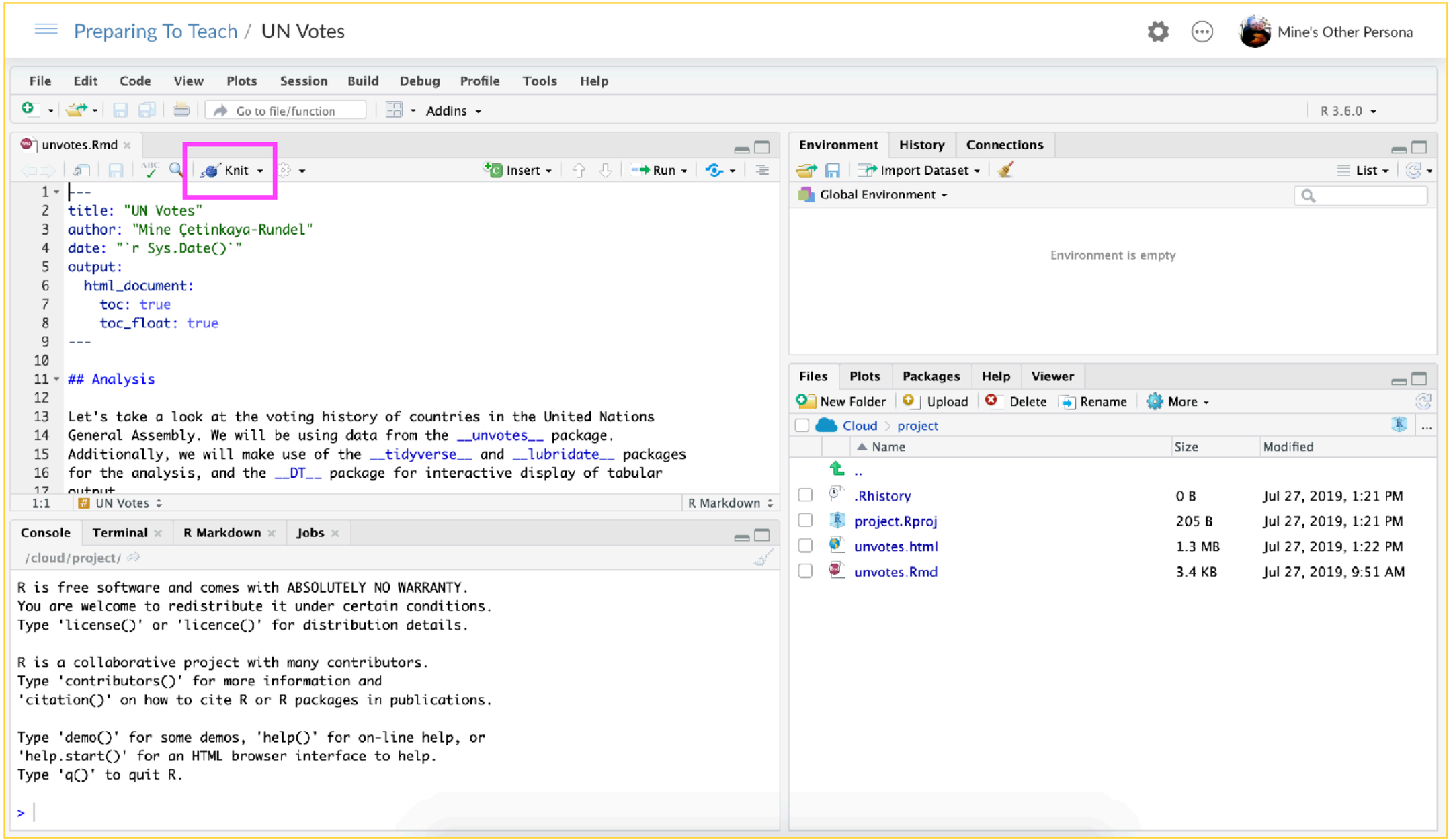
Welcome to Preparing to Teach

Workspace for the Preparing to Teach pre-JSM 2018 workshop

If you did not intend to join this space, or you later decide you don't want to be a member, just go to the Members area and click "Leave Space".


Preparing to Teach
Projects
Members
Info
Mine's Other Persona
All Projects
New Project
START
UN Votes
Mine Çetinkaya-Rundel
Created Jul 27, 2019 9:39 AM
Options
Search Projects
List Projects
All
Shared with everyone
Yours
Sort Projects
By name
By date created


Preparing To Teach / UN Votes
Mine's Other Persona
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
R 3.6.0
Console Terminal Jobs
/cloud/project/
R version 3.6.0 (2019-04-26) -- "Planting of a Tree"
Copyright (C) 2019 The R Foundation for Statistical Computing
Platform: x86_64-pc-linux-gnu (64-bit)
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
>
Environment History Connections
Import Dataset
List
Global Environment
Environment is empty
Files Plots Packages Help Viewer
New Folder Upload Delete Rename More
Cloud > project
Name Size Modified
..
.Rhistory 0 B Jul 27, 2019, 1:21 PM
project.Rproj 205 B Jul 27, 2019, 1:21 PM
unvotes.html 1.3 MB Jul 27, 2019, 9:52 AM
unvotes.Rmd 3.4 KB Jul 27, 2019, 9:51 AM


Preparing To Teach / UN Votes
Mine's Other Persona
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
R 3.6.0
unvotes.Rmd
Knit
Insert
Run
1 ---
2 title: "UN Votes"
3 author: "Mine Çetinkaya-Rundel"
4 date: "`r Sys.Date()`"
5 output:
6 html_document:
7 toc: true
8 toc_float: true
9 ---
10
11 ## Analysis
12
13 Let's take a look at the voting history of countries in the United Nations
14 General Assembly. We will be using data from the __unvotes__ package.
15 Additionally, we will make use of the __tidyverse__ and __lubridate__ packages
16 for the analysis, and the __DT__ package for interactive display of tabular
1:1 UN Votes
R Markdown
Console Terminal R Markdown Jobs
/cloud/project/
R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'license()' or 'licence()' for distribution details.
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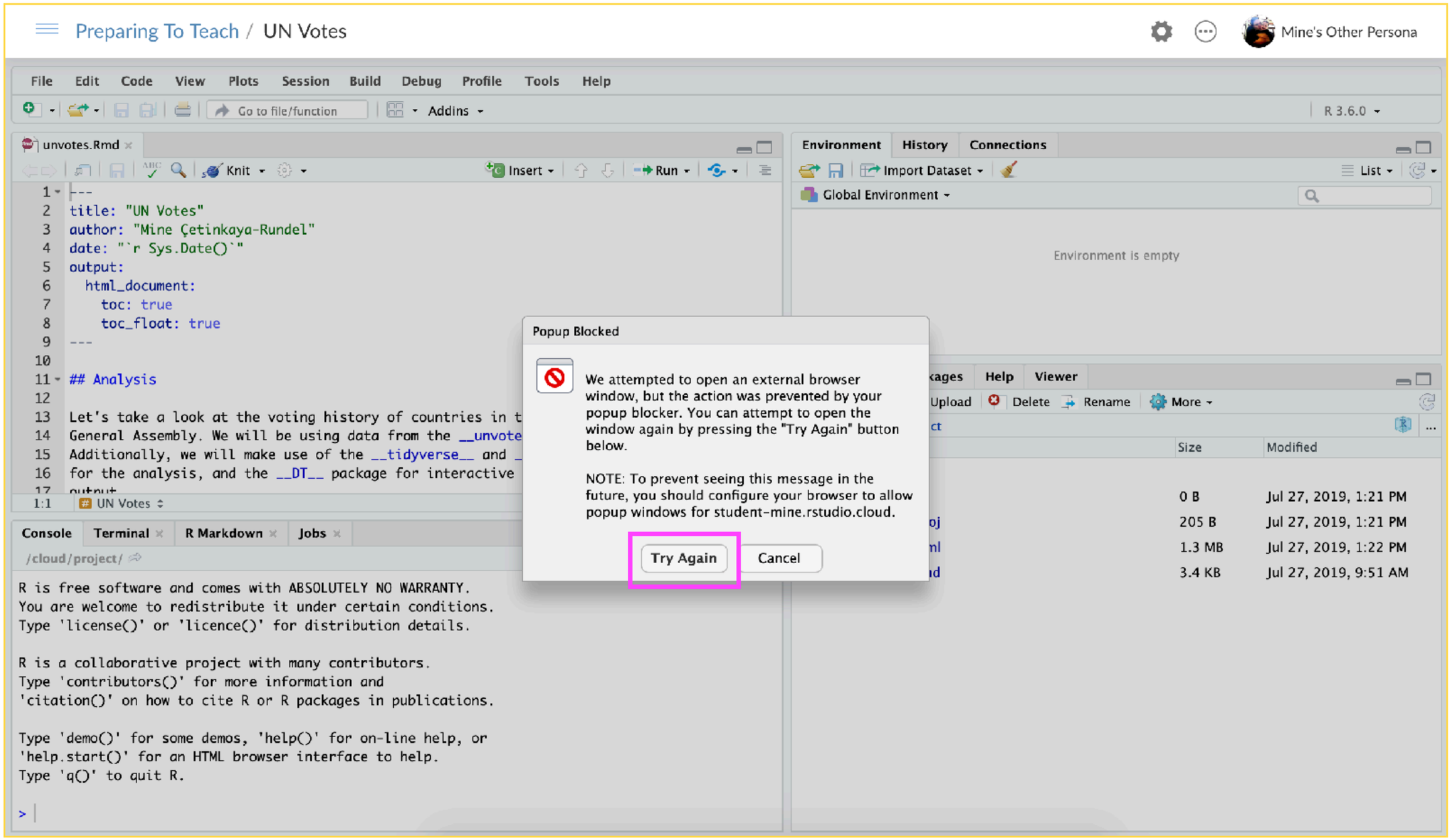
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15 Additionally, we will make use of the __tidyverse__ and _
16 for the analysis, and the __DT__ package for interactive
1:1 UN Votes
Environment History Connections
Import Dataset
List
Global Environment
Environment is empty
Popup Blocked
We attempted to open an external browser window, but the action was prevented by your popup blocker. You can attempt to open the window again by pressing the "Try Again" button below.
NOTE: To prevent seeing this message in the future, you should configure your browser to allow popup windows for student-mine.rstudio.cloud.
Try Again
Cancel
Help Viewer
Upload Delete Rename More
Size Modified
0 B Jul 27, 2019, 1:21 PM
205 B Jul 27, 2019, 1:21 PM
1.3 MB Jul 27, 2019, 1:22 PM
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>

- Go to bit.ly/ptt-rscloud and create an account to join the RStudio Cloud workspace for this workshop.
- Start the assignment called UN Votes.
- Open the R Markdown document called un-votes.Rmd, knit the document, view the result.
- Then, change “Turkey” to another country, and knit again.

Resources: Computing in the classroom

- **RStudio Cloud in the Classroom** (Mine Çetinkaya-Rundel)
  - Nitty-gritty of setting up your course on RStudio Cloud
  - Video and slides: https://resources.rstudio.com/webinars/rstudio-cloud-in-the-classroom
- **Infrastructure and tools for teaching computing throughout the statistical curriculum** (Mine Çetinkaya-Rundel and Colin Rundel)
  - Overview of cloud computing resources for teaching
  - Part of the Practical Data Science for Stats collection
  - https://peerj.com/preprints/3181/
- **JSM 2019 - BoF: Teaching (with) R** (Mine Doğucu)
  - Tue, 7/30/2019, 12:30 PM - 1:30 PM, CC-SocietyTables Registration Promenade

minimize
time spent
on course logistics

maximize
time spent on
creating a data
visualization

show examples of
data in the wild

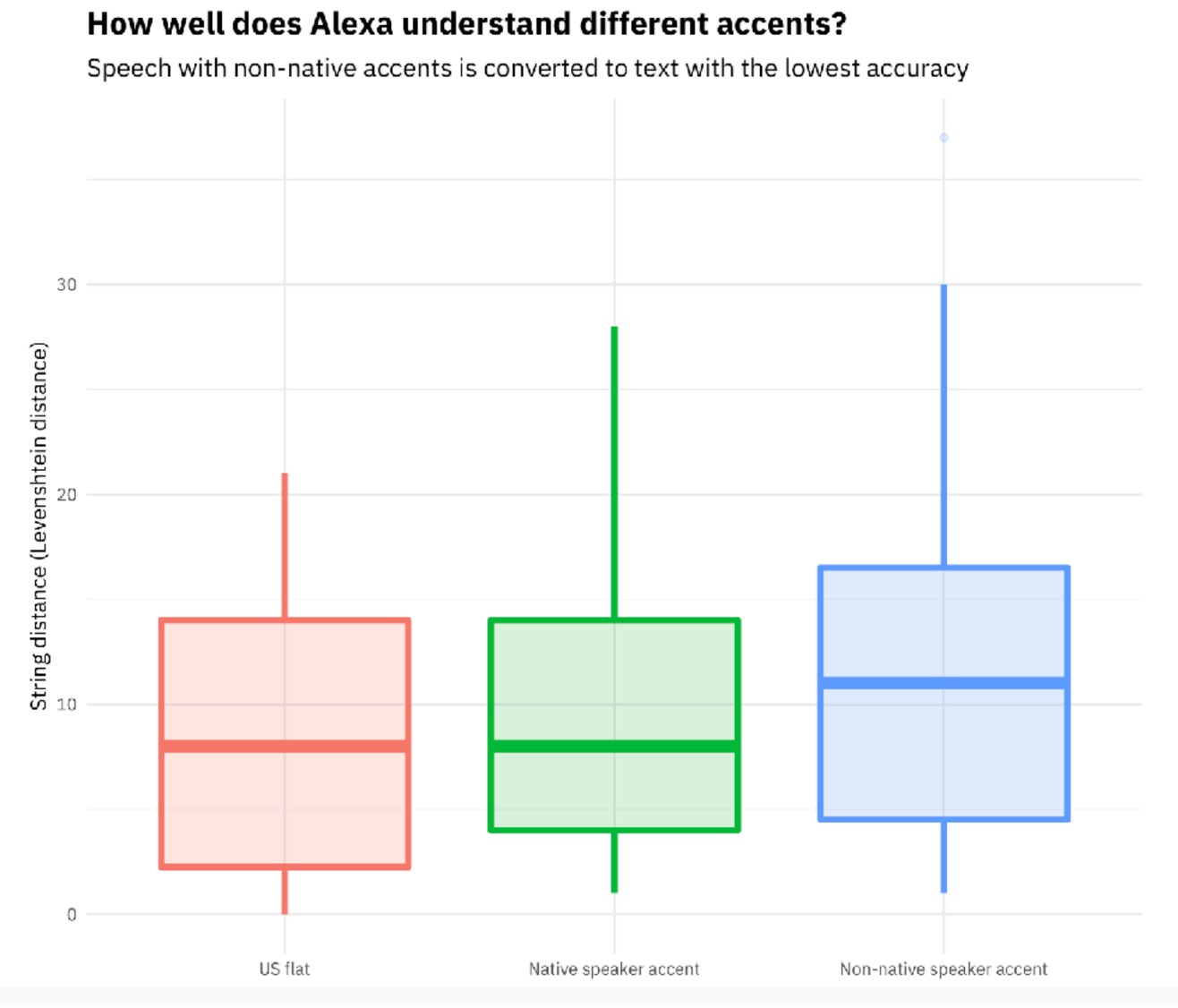
JULIA SILGE

BLOG ABOUT RESUME

AMAZON ALEXA AND ACCENTED ENGLISH

Jul 19, 2018 · 6 minute read · rstats

Earlier this spring, one of my data science friends here in SLC got in contact



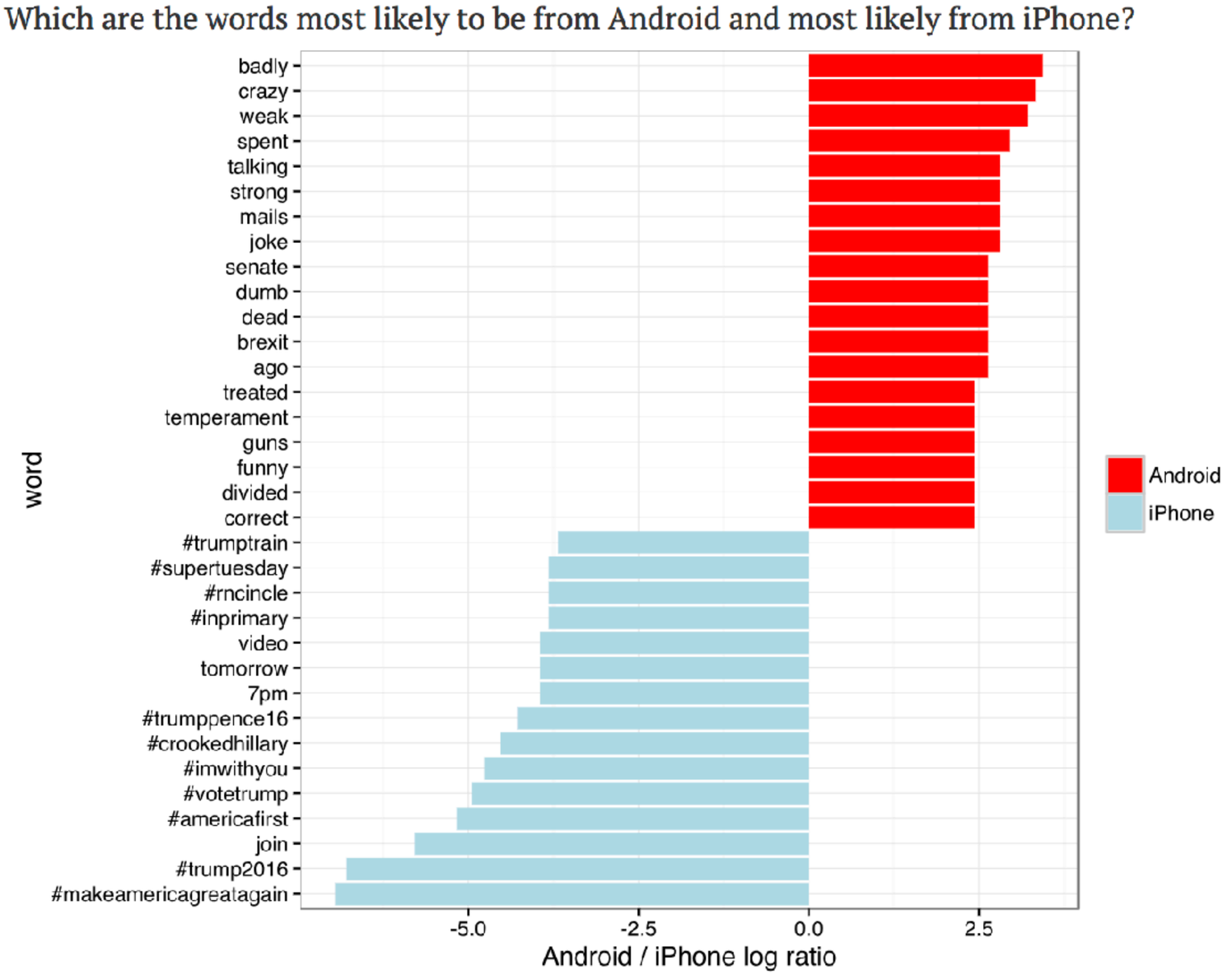
https://juliasilge.com/blog/amazon-alexa/

David Robinson

Chief Data Scientist at DataCamp, works in R and Python.

Text analysis of Trump's tweets confirms he writes only the (angrier) Android half

I don't normally post about politics (I'm not particularly savvy about polling, which is where data science has had the largest impact on politics). But this weekend I saw a hypothesis about Donald Trump's twitter account that simply begged to be investigated with data:

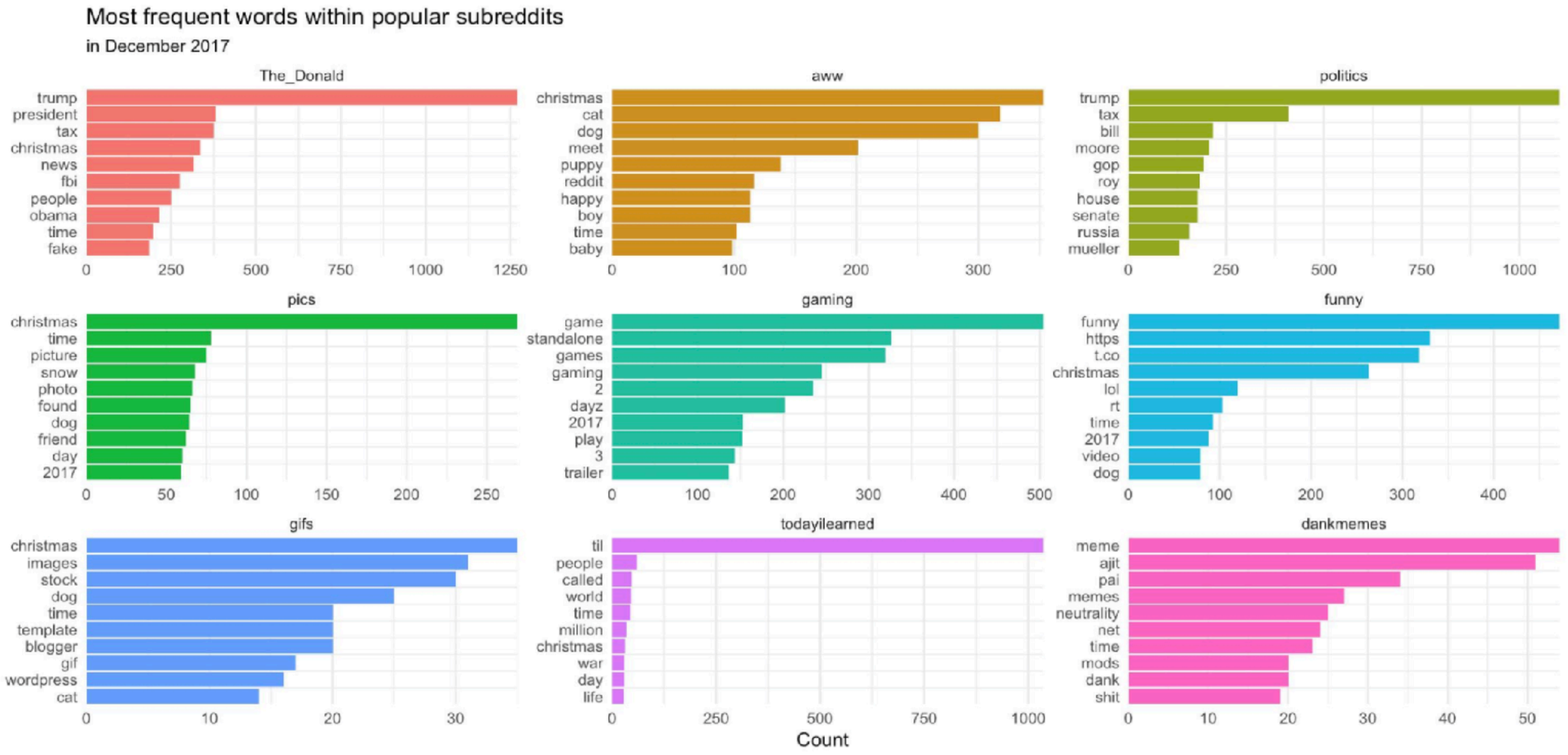


http://varianceexplained.org/r/trump-tweets/

How to Succeed on Reddit

Former intro DS students!!

Team InterstellR



How to Succeed on Reddit

Team InterstellR

Modeling Popularity

- Multivariate linear model
- Target: score
- Predictors: subreddit, sentiment, dog_cat, [text features], ...
- Stepwise selection by AIC
- R^2 = 0.177

	Terms									
Docs	1	12	2	2017	amp	christmas	game	https	time	world
7hbf0d	1	0	1	0	1	0	0	0	0	0
7hnto4	0	1	1	1	0	0	1	0	0	0
7iiku8	1	1	0	1	0	0	1	0	0	0
7ioafs	1	0	0	0	1	0	0	0	1	0
7ixrdt	0	0	1	1	0	0	1	0	0	0
7jvb0s	1	1	1	0	0	1	0	0	0	0
7kplv0	0	0	0	1	0	0	1	0	0	0
7l5l52	0	0	0	1	0	0	1	0	0	0
7m1umi	0	0	0	1	0	0	0	0	0	0
7mguty	1	1	1	0	0	0	0	0	0	0

How to Succeed on Reddit

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7iiku8	1	1	0	1	0	0	1	0	0	0
7ioafs	1	0	0	0	1	0	0	0	1	0
7ixrdt	0	0	1	1	0	0	1	0	0	0
7jvb0s	1	1	1	0	0	1	0	0	0	0
7kplv0	0	0	0	1	0	0	1	0	0	0
7l5l52	0	0	0	1	0	0	1	0	0	0
7m1umi	0	0	0	1	0	0	0	0	0	0
7mguty	1	1	1	0	0	0	0	0	0	0

Conclusions

1. Be negative
2. Dogs and cats are both good choices
3. Post on /r/gifs
4. Don't talk about December, games, and don't ask questions
5. Do talk about home and news
6. Don't use a linear model to predict Reddit post scores!

Ingredients

For the Cake:

16 ounces plain or toasted sugar (about 2 1/4 cups; 455g)

4 1/2 teaspoons baking powder

2 teaspoons (8g) Diamond Crystal kosher salt; for table salt, use about half as much by volume or the same weight

8 ounces unsalted butter (16 tablespoons; 225g), soft but cool, about 60°F (16°C)

3 large eggs, brought to about 65°F (18°C)

1/2 ounce vanilla extract (about 1 tablespoon; 15g)

16 ounces whole milk (about 2 cups; 455g), brought to about 65°F (18°C)

16 ounces all-purpose flour (about 3 1/2 cups, spooned; 455g)

Directions

1. **For the Cake:** Adjust oven rack to lower-middle position and preheat to 350°F (180°C). Lightly grease three 8-inch anodized aluminum cake pans and line with parchment (explanation and tutorial here). If you don't have three pans, it's okay to bake the cakes in stages, the batter will keep at room temperature until needed.

2. In the bowl of a stand mixer fitted with the paddle attachment, combine sugar, baking powder, salt, and butter. Mix on low speed to roughly incorporate, then increase to medium and beat until fluffy and light, about 5 minutes. About halfway through, pause to scrape the bowl and beater with a flexible spatula.

3. With the mixer still running, add the eggs one at a time, letting each fully incorporate before adding the next, then dribble in the vanilla. Reduce speed to low and sprinkle in about 1/3 of the flour, then drizzle in 1/3 of the milk. Repeat with remaining flour and milk, working in thirds as before.

4. Scrape the bowl and beater with a flexible spatula, and resume mixing on medium speed for about 3 seconds to ensure everything is well combined. The batter should look creamy and thick, registering between 65 and 68°F (18 and 20°C) on a digital thermometer. (Significant

5. Fold batter once or twice from the bottom up with a flexible spatula, then divide evenly between prepared cake pans (about 20 ounces or 565g if you have a scale). Stagger pans together on the oven rack, and bake until puffed, firm, and pale gold, about 32 minutes. If your oven has very uneven heat, pause to rotate the pans after about 20 minutes. Alternatively, bake two layers at once and finish the third when they're done.

6. Cool cakes directly in their pans for 1 hour, then run a butter knife around the edges to loosen. Invert onto a wire rack, peel off the parchment, and return cakes right-side-up (covered in plastic, the cakes can be left at room temperature for a few hours). Prepare the buttercream.

How do you prefer your cake recipes? Words only, or words & pictures?

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start

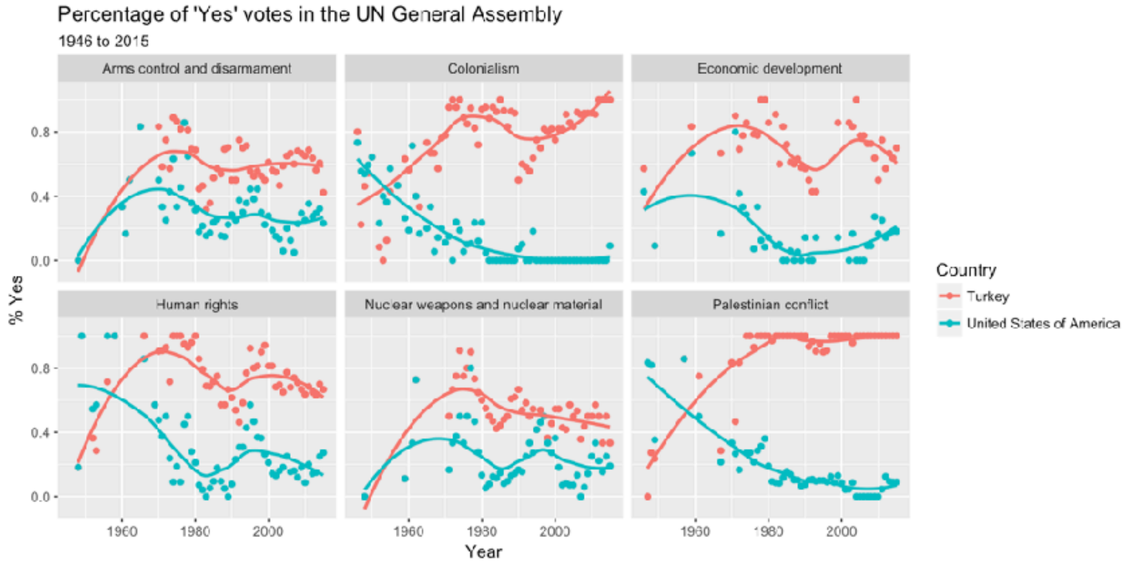
with

cake

don't start with this

```
class(mtcars$mpg)
#> [1] "numeric"
mean(mtcars$mpg)
#> [1] 20.09062
median(mtcars$mpg)
#> [1] 19.2
sd(mtcars$mpg)
#> [1] 6.026948
```

instead do this



WHY 🍰 = 📊?

more likely for students to have intuition coming in

easier for students to catch their own mistakes

who doesn't like a good piece of ~~cake~~ visualization?

Resources:
Data visualization

- **Data Science Through Data Visualization in the Intro Course** (Stacey Hancock)
  - Invited EPoster Session
  - Sun, 7/28/2019, 8:30 PM - 10:30 PM, CC-Hall C
- **BoF: Visualizing Visualization** (Jo Hardin)
  - Mon, 7/29/2019, 12:30 PM - 1:30 PM, CC-SocietyTables Registration Promenade

Which motivates you more to learn how to cook: perfectly chopped onions or ratatouille?

Which motivates you more to learn how to cook: perfectly chopped onions or ratatouille?

skip

baby

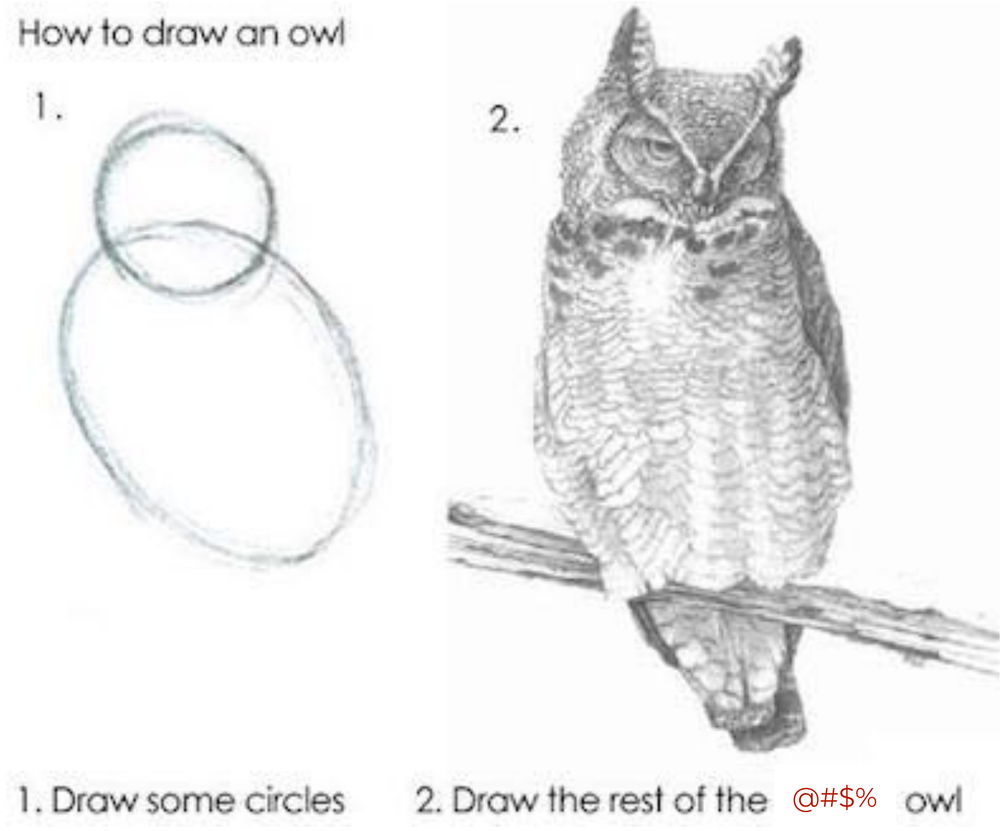
steps

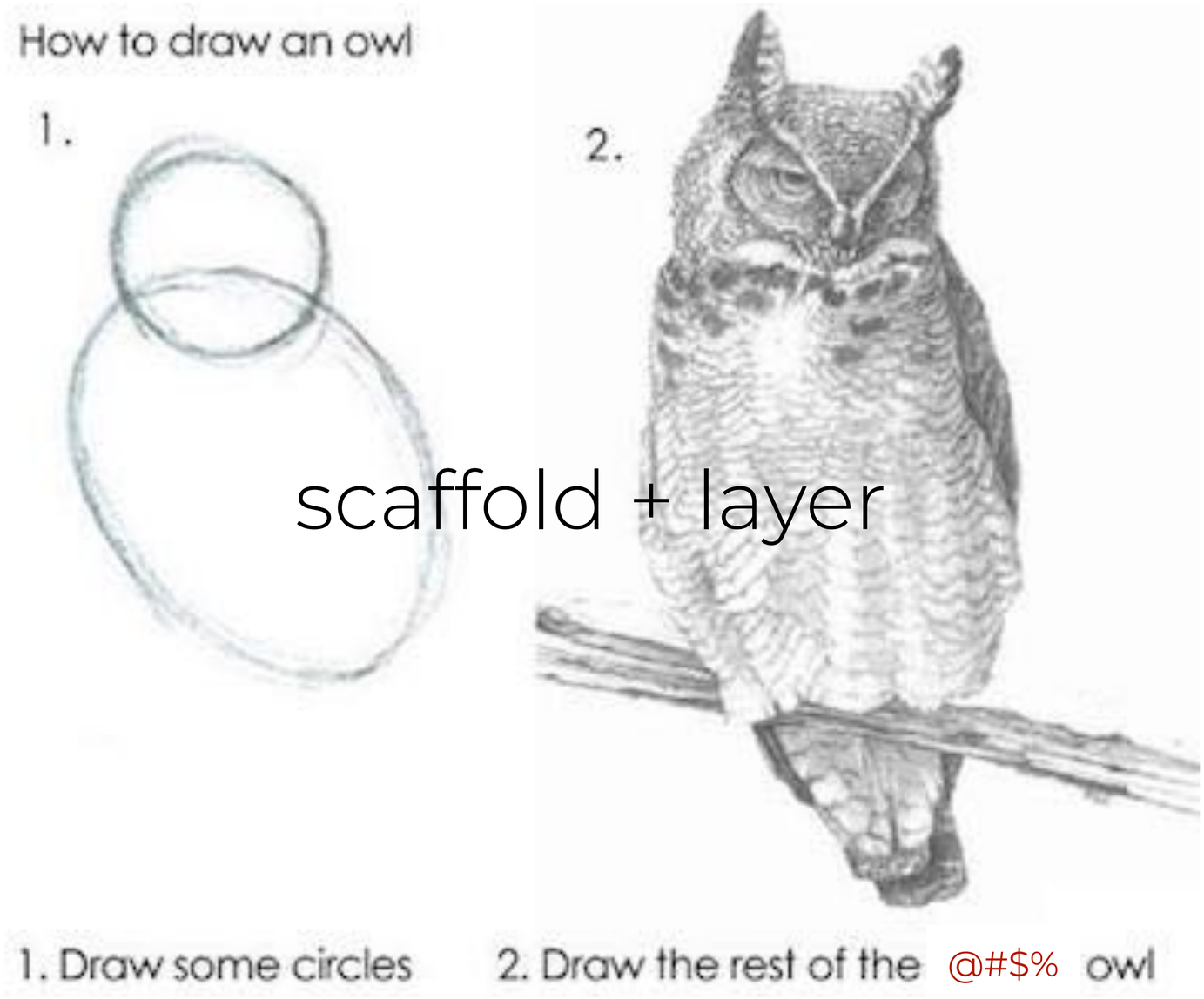
3

skip baby steps in your examples

non-trivial examples can be motivating,

but need to avoid 👇!

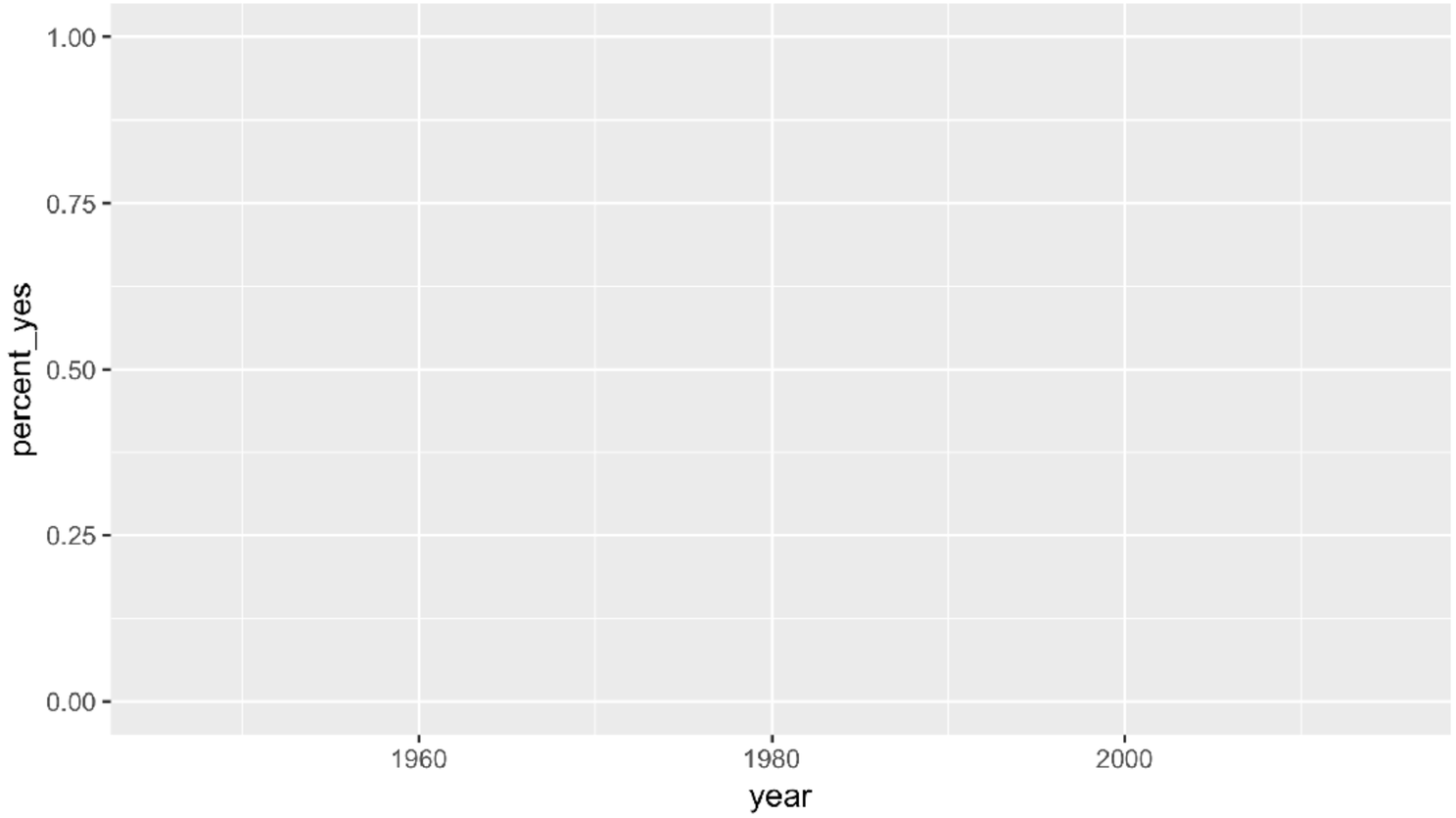




scaffold + layer

```
ggplot(data = un_votes_joined)
```

```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes))
```



```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes))
```

function(arguments)

often a verb

what to apply that verb to

```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes))
```

rows = observations

un_votes_joined

Filter

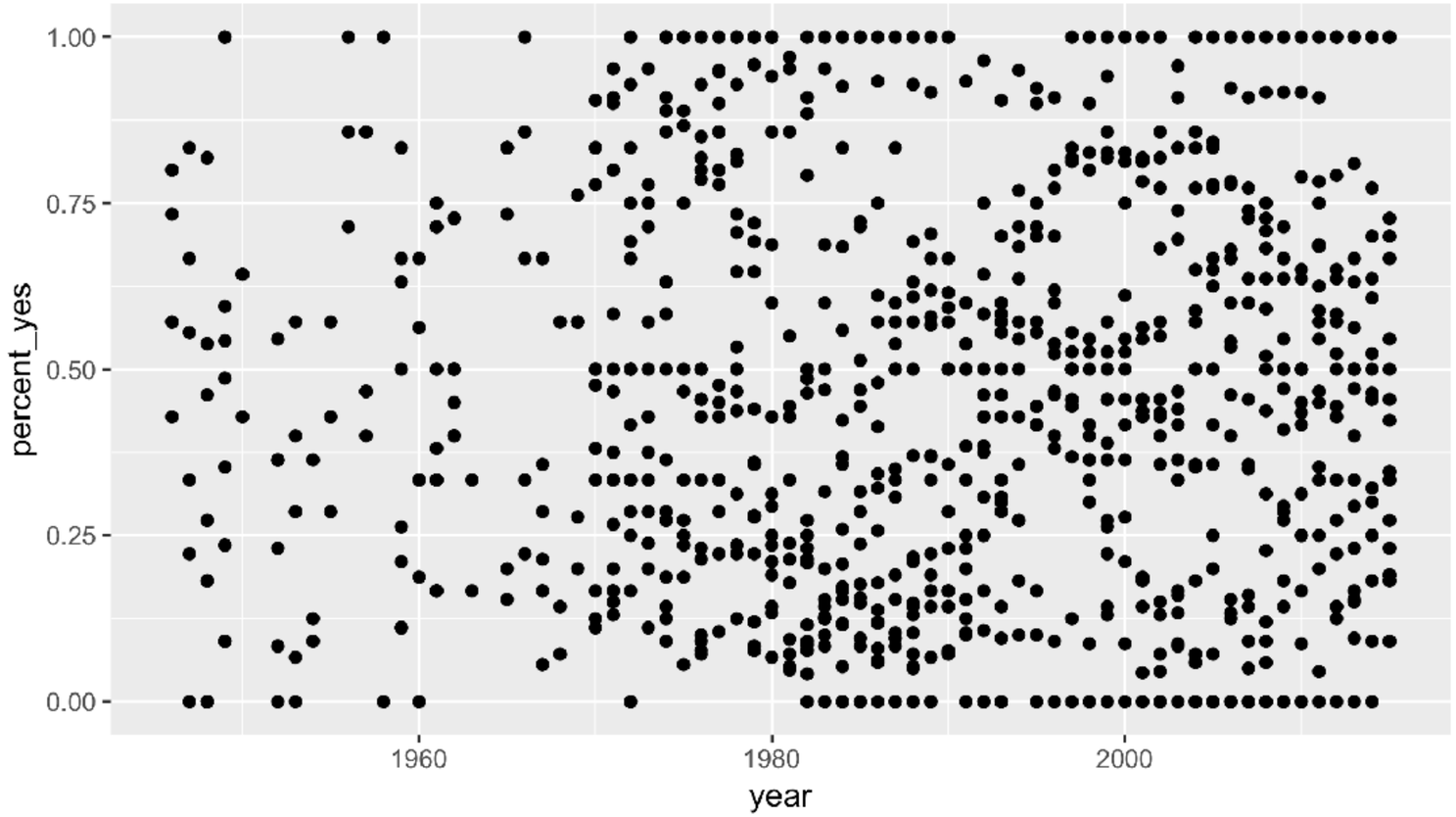
	country	year	issue	votes	percent_yes
1	Turkey	1946	Colonialism	15	0.80000000
2	Turkey	1946	Economic development	7	0.57142857
3	Turkey	1947	Colonialism	9	0.22222222
4	Turkey	1947	Palestinian conflict	6	0.00000000
5	Turkey	1948	Arms control and disarmament	8	0.00000000
6	Turkey	1948	Colonialism	13	0.46153846
7	Turkey	1948	Human rights	11	0.18181818
8	Turkey	1948	Nuclear weapons and nuclear material	7	0.00000000
9	Turkey	1948	Palestinian conflict	11	0.27272727
10	Turkey	1949	Colonialism	35	0.54285714
11	Turkey	1949	Economic development	11	0.09090909
12	Turkey	1949	Palestinian conflict	17	0.23529412
13	Turkey	1950	Colonialism	14	0.64285714
14	Turkey	1952	Colonialism	12	0.08333333
15	Turkey	1952	Human rights	11	0.36363636
16	Turkey	1953	Colonialism	9	0.00000000
17	Turkey	1953	Human rights	7	0.28571429
18	Turkey	1954	Colonialism	8	0.12500000

Showing 1 to 19 of 621 entries

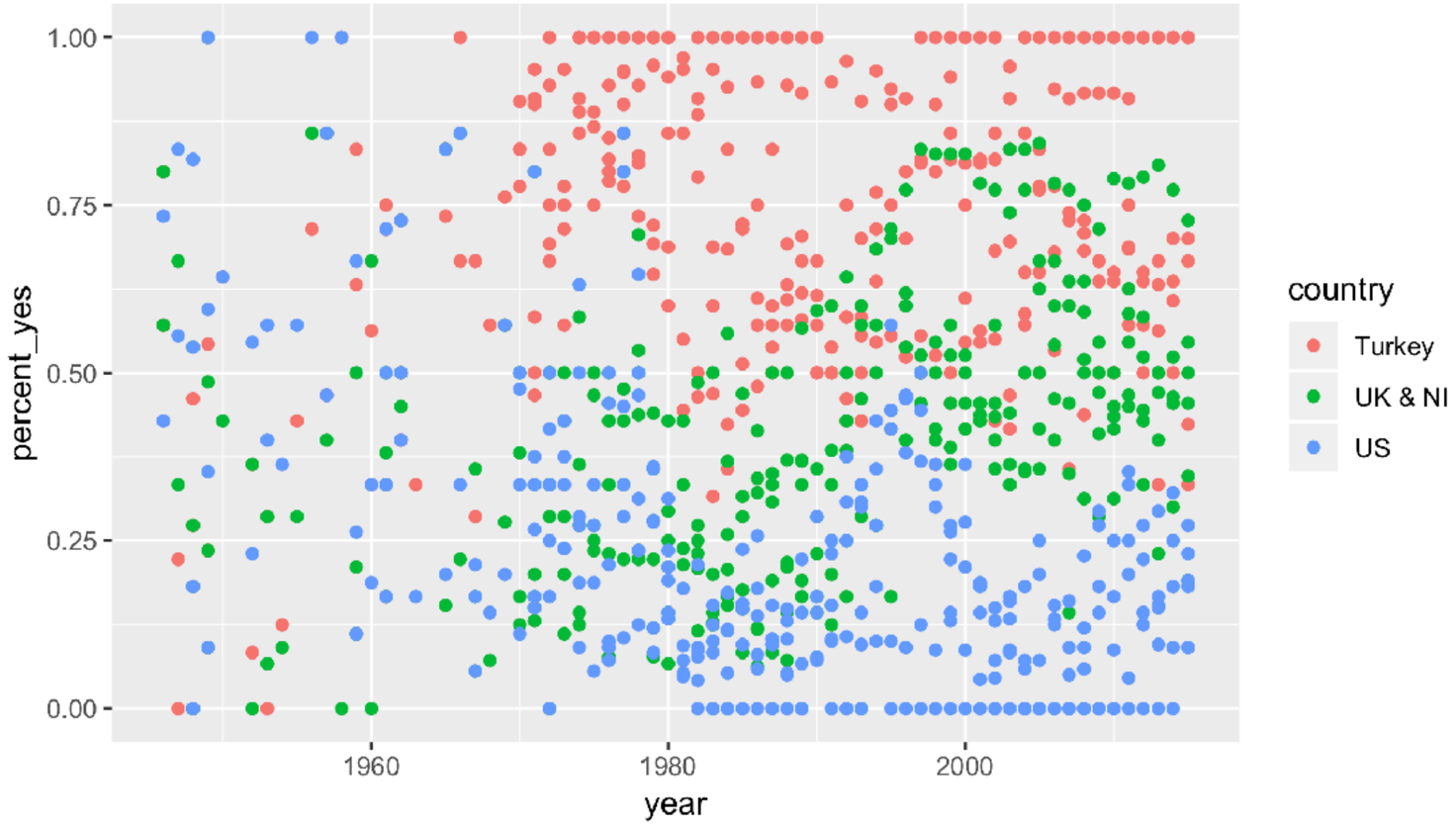
"tidy" data frame

columns = variables

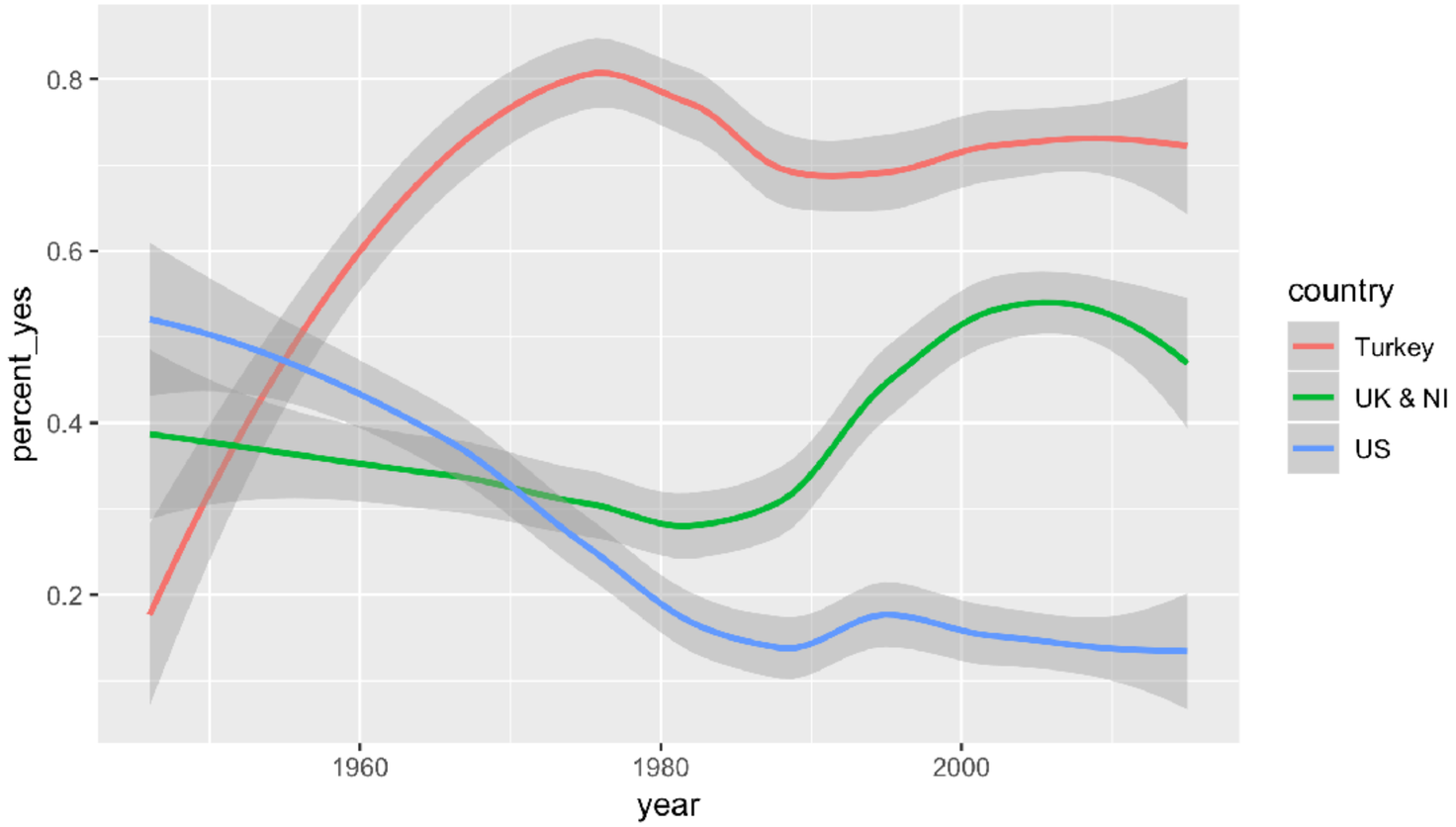
```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes)) +
  geom_point()
```



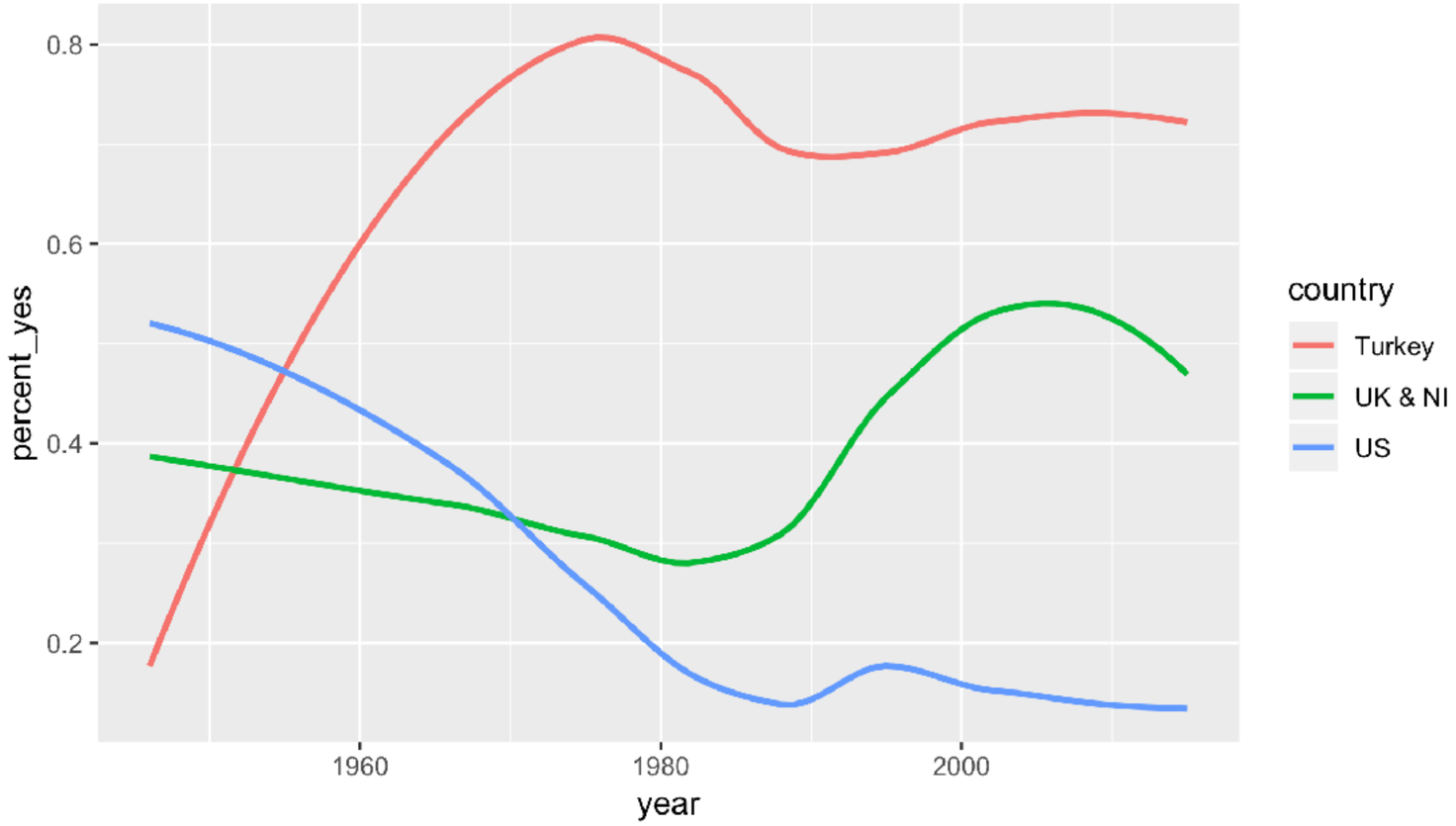
```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
  geom_point()
```



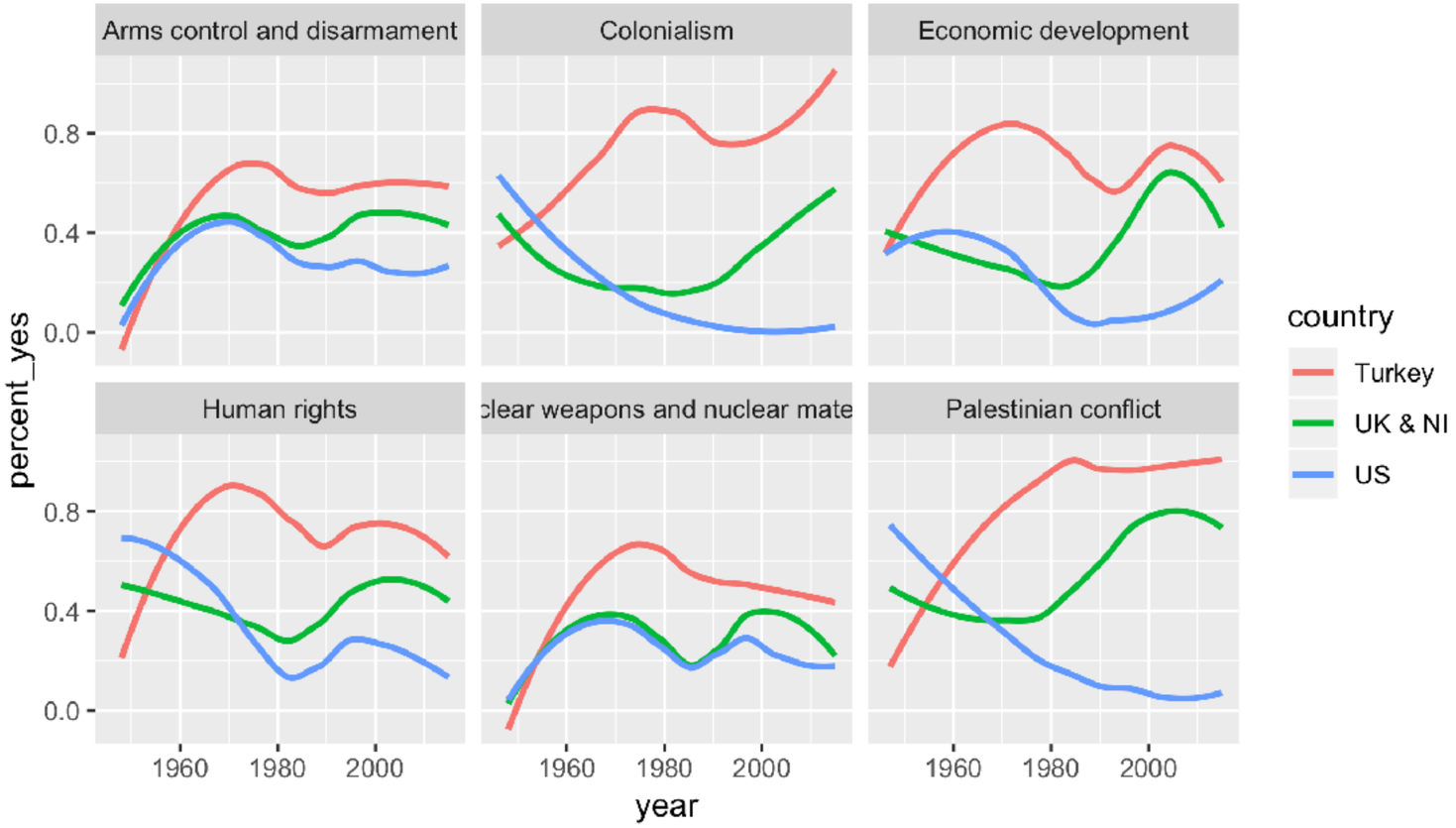
```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
 geom_smooth(method = "loess")
```



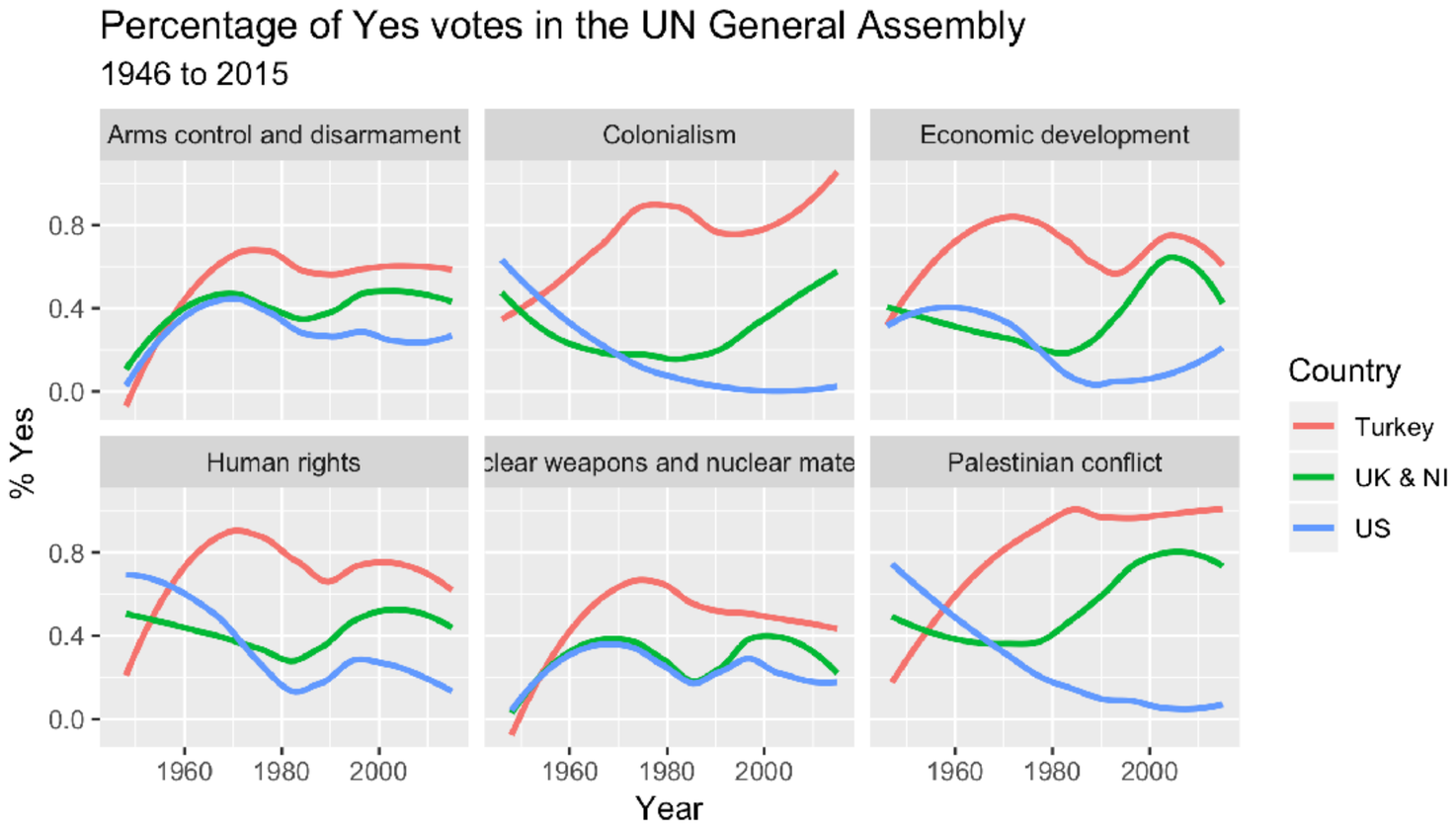
```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
 geom_smooth(method = "loess", se = FALSE)
```



```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
  geom_smooth(method = "loess", se = FALSE) +
  facet_wrap(~ issue)
```



```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
  geom_smooth(method = "loess", se = FALSE) +
  facet_wrap(~ issue) +
  labs(
    title = "Percentage of 'Yes' votes in the UN General Assembly",
    subtitle = "1946 to 2015",
    y = "% Yes",
    x = "Year",
    color = "Country"
  )
```



skip baby steps in your examples

re-insert baby steps into assessment, especially formative assessment

Visualizing data

Start Over

Scatterplots

How can we visualize the relationship between characters' heights and masses? Following the structure of the `ggplot` function that we laid out earlier, we pass `starwars` to the `data` argument, and map `height` and `mass` to the *x* and *y* `aes`thetics, respectively. Then, we specify on the next layer that we would like the data points to be represented by points with `geom_point`.

Fill in the blanks below to create the scatterplot.

Code | Start Over | Solution | Run Code | Submit Answer

```
1 ggplot(data = ___, mapping = aes(x = ___, y = ___)) +
2   ___
3
```

Notice the warning that tells us that 28 of the observations have not been graphed, which means that some of the necessary information (height and mass) was missing for those rows.

Your turn!

How would you describe the relationship between height and weight?

- positive and nonlinear
- positive and linear
- negative and nonlinear
- negative and linear

Submit Answer

How many outliers does the graph show?

- 0
- 1
- 2

Submit Answer

Resources: Curriculum design

- **JSM 2019 - Building Bridges for Data Science Education**
  - Panel with statisticians & computer scientists
  - Tue, July 30, 2019 : 2:00 PM to 3:50 PM, CC-603
- **JSM 2019 - Data Science: a Three Ring Circus or a Big Tent?** (Jennifer Bryan and Hadley Wickham)
  - Response to Donoho's 50 Years of Data Science paper
  - Mon, July 29, 2019 : 2:00 PM to 3:50 PM, CC-301
- **JSM 2019 - Teaching Data Science: R, Git, and the Undergraduate Curriculum**
  - Mon, 7/31/2019, 10:30 AM - 12:20 PM, CC-302
- **Curriculum Guidelines for Undergraduate Programs in Data Science**
  - https://www.amstat.org/asa/files/pdfs/EDU-DataScienceGuidelines.pdf

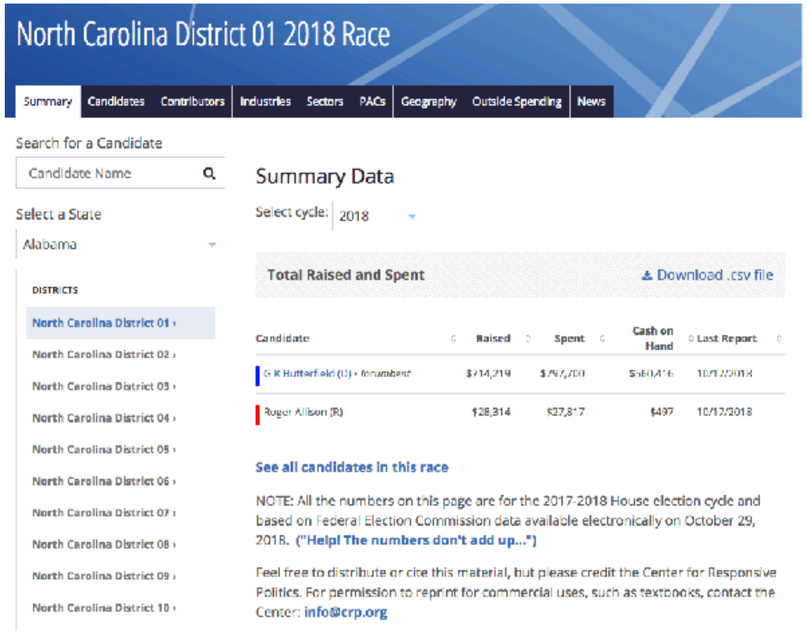
Which is more likely to appeal to someone who has never tried broccoli?

Which is more likely to appeal to someone who has never tried broccoli?

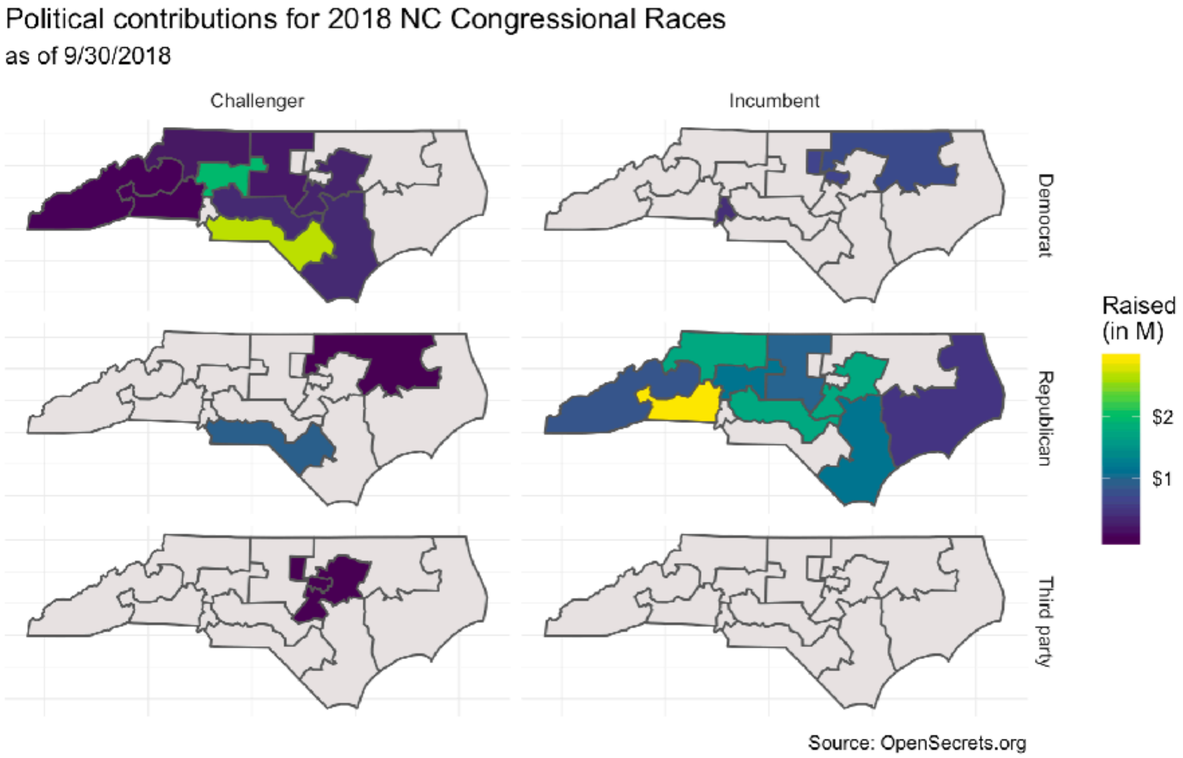
hide the veggies

4

- Today we go from this to that



→



- And do so in a way that is easy to replicate for another state

Lesson: Web scraping essentials for turning a structured table into a data frame in R.

Lesson: Web scraping essentials for turning a structured table into a data frame in R.

Ex 1: Scrape the table off the web and save as a data frame.

Candidate	Raised	Spent	Cash on Hand	Last Report
G K Butterfield (D) • *Incumbent*	$714,219	$797,700	$560,416	10/17/2018
Roger Allison (R)	$28,314	$27,817	$497	10/17/2018

↓

	candidate_info	raised	spent	cash_on_hand	last_report	race
1	G K Butterfield (D) • Incumbent	714219	797700	560416	2018-10-17	North Carolina District 01
2	Roger Allison (R)	28314	27817	497	2018-10-17	North Carolina District 01

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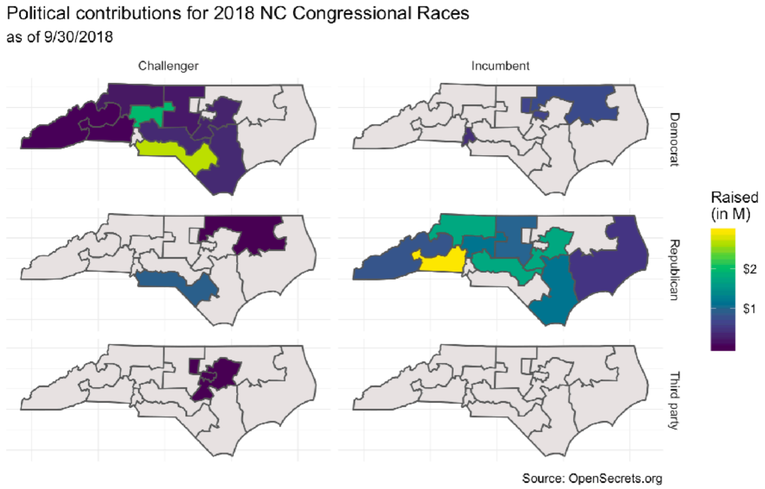
Ex 2: What other information do we need represented as variables to make this figure?



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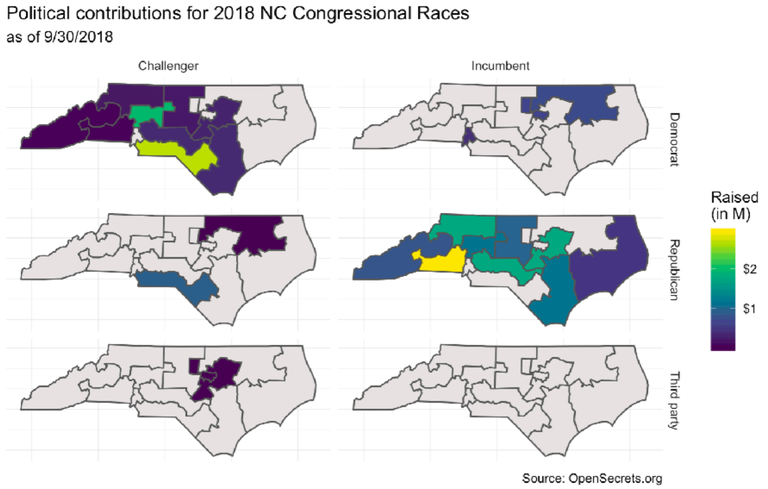
Lesson: "Just enough" regex

	candidate_info
1	G K Butterfield (D) • Incumbent
2	Roger Allison (R)

↓

	candidate_name	party	status
1	G K Butterfield	Democrat	Incumbent
2	Roger Allison	Republican	Challenger

Ex 2: What other information do we need represented as variables to make this figure?



If you are already taking a baking class, which will be easier to venture on to?

If you are already taking a baking class, which will be easier to venture on to?

leverage the ecosystem

5

leverage the
ecosystem
for your students

- Estimate the difference between the average evaluation score of male and female faculty.

	score	rank	ethnicity	gender	bty_avg
	<dbl>	<chr>	<chr>	<chr>	<dbl>
1	4.7	tenure track	minority	female	5
2	4.1	tenure track	minority	female	5
3	3.9	tenure track	minority	female	5
4	4.8	tenure track	minority	female	5
5	4.6	tenured	not minority	male	3
6	4.3	tenured	not minority	male	3
7	2.8	tenured	not minority	male	3
8	4.1	tenured	not minority	male	3.33
9	3.4	tenured	not minority	male	3.33
10	4.5	tenured	not minority	female	3.17
…	…	…	…	…	…
463	4.1	tenure track	minority	female	5.33

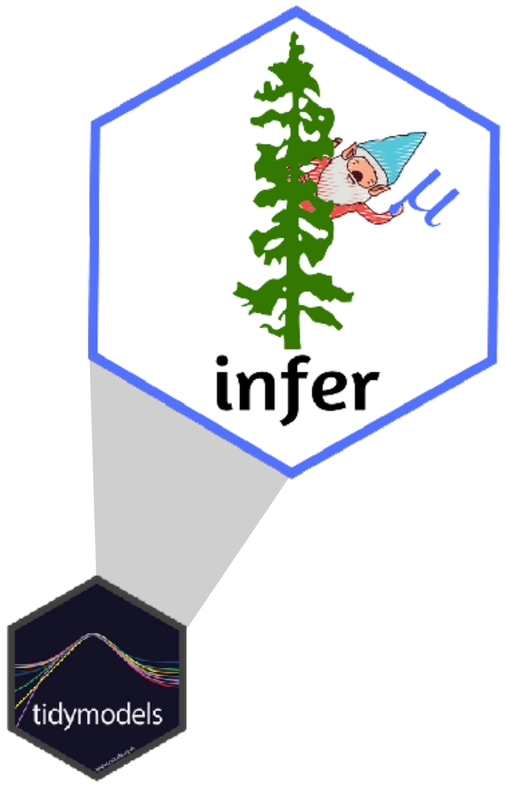
Hamermesh, Parker. “Beauty in the classroom: instructors pulchritude and putative pedagogical productivity”, Econ of Ed Review, Vol 24-4.

concise, but foreign

```
t.test(evals$score ~ evals$gender)

# Welch Two Sample t-test

# data:  evals$score by evals$gender
# t = -2.7507, df = 398.7, p-value = 0.006218
# alternative hypothesis: true difference in
# means is not equal to 0
# 95 percent confidence interval:
# -0.24264375 -0.04037194
# sample estimates:
# mean in group female   mean in group male
#             4.092821             4.234328
```

verbose, but familiar

```
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender) %>%
  generate(reps = 15000,
    type = "bootstrap") %>%
  calculate(stat = "diff in means",
    order = c("male", "female")) %>%
  summarise(
    l = quantile(stat, 0.025),
    u = quantile(stat, 0.975)
    )

#       l     u
# 0.0410 0.243
```



`infer`

The objective of this package is to perform statistical inference using an expressive statistical grammar that coheres with the `tidyverse` design framework.

Now part of the `tidymodels` suite of modeling packages.

```
library(tidyverse)
library(infer)

evals %>%
```

start with data

```
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender)
```

specify the model

generate bootstrap samples

```
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender) %>%
  generate(reps = 15000, type = "bootstrap")
```

calculate sample statistics

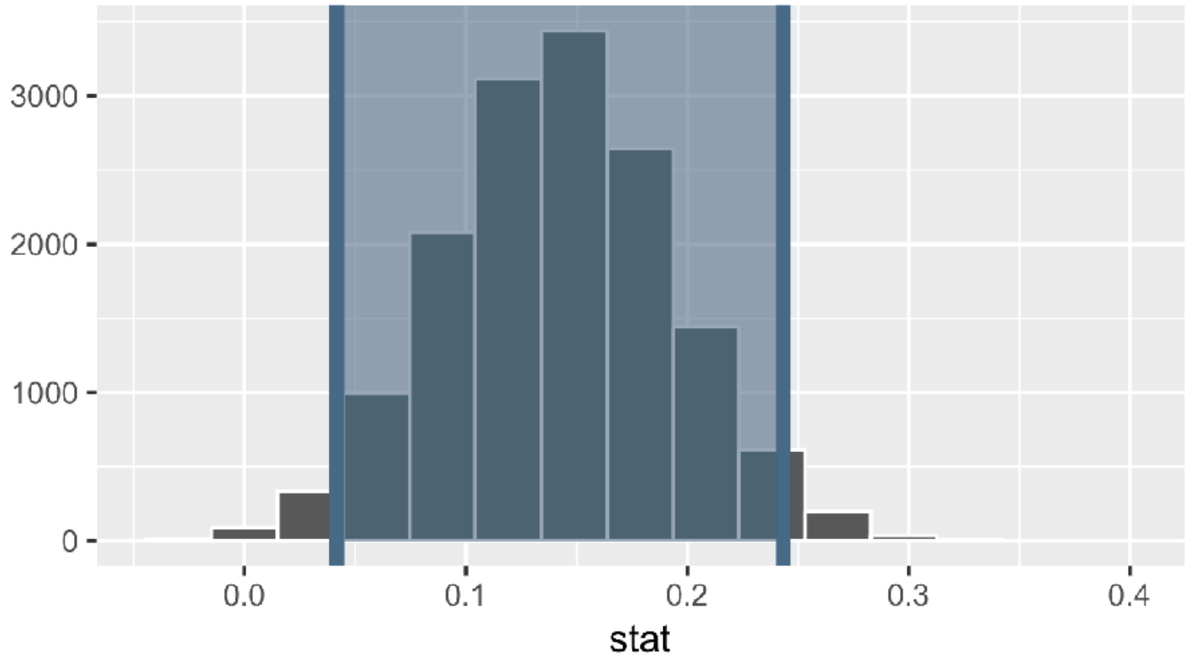
```
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender) %>%
  generate(reps = 15000, type = "bootstrap") %>%
  calculate(stat = "diff in means", order = c("male", "female"))
```

summarise CI bounds

```
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender) %>%
  generate(reps = 15000, type = "bootstrap") %>%
  calculate(stat = "diff in means", order = c("male", "female")) %>%
  summarise(l = quantile(stat, 0.025), u = quantile(stat, 0.975))
```

```r
library(tidyverse)
library(infer)

evals %>%
  specify(score ~ gender) %>%
  generate(reps = 15000, type = "bootstrap") %>%
  calculate(stat = "diff in means", order = c("male", "female")) %>%
  summarise(l = quantile(stat, 0.025), u = quantile(stat, 0.975))
```

```
#       l     u
# 0.0410 0.243
```



leverage the
ecosystem
for your students

leverage the
ecosystem
for yourself

student + instructor

instructor

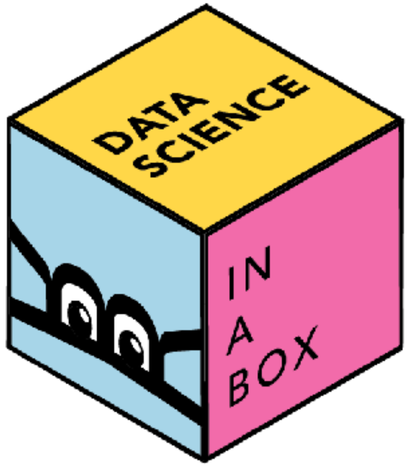
you’re not alone

Three questions that keep me up at night…

1. What should my students learn?
2. How will my students learn best?
3. What tools will enhance my students' learning?

Three questions that keep me up at night…

Content	1	What should my students learn?
Pedagogy	2	How will my students learn best?
Infrastructure	3	What tools will enhance my students' learning?



rstudio-education/datascience-box

Data Science Course in a Box https://datasciencebox.org/

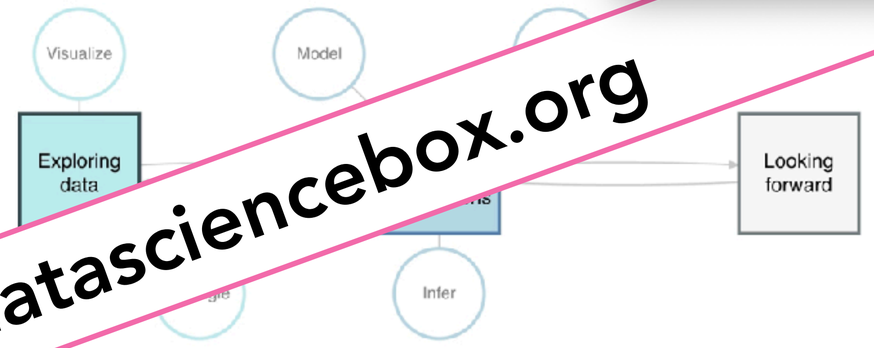
Topics :: Data Science in a Box

https://datasciencebox.org/hello/topics/

Data Science in a Box > Hello #dsbox > Topics

Topics

The course content is organized in three units:



Unit 2 - Making rigorous conclusions: In this part we introduce modeling and statistical inference for making data-based conclusions. We discuss building, interpreting, and selecting models, visualizing interaction effects, and prediction and model validity. Statistical inference is introduced from a simulation based perspective, and the Central Limit Theorem is discussed very briefly to lay the foundation for future coursework in statistics.

datasciencebox.org

27
slide
decks

10
application
exercises

10
computing
labs

6
homework
assignments

2
take-home
exams

1
open-ended
project

10
interactive
tutorials

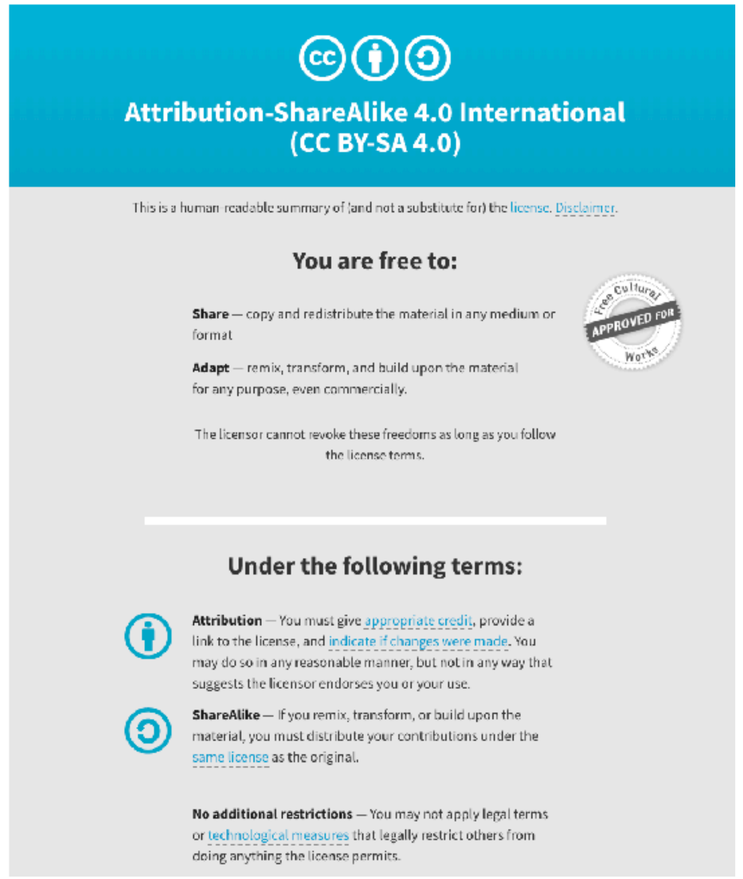
website

datasciencebox.org

repository

package

dsbox



TEACHING INTRO DATA SCIENCE & ASSESSING LEARNING

PREPARING TO TEACH
JSM 2019

🔗 bit.ly/ptt-repo

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