

Let them  
eat cake  
(first)!



@minebocek



mine-cetinkaya-rundel



cetinkaya.mine@gmail.com



[bit.ly/eat-cake-diz](http://bit.ly/eat-cake-diz)





Imagine you're new to baking,  
and you're in a baking class.  
I'm going to present two  
options for starting the class.  
Which one gives you **better**  
**sense** of the final product?

# Pineapple and coconut sandwich cake



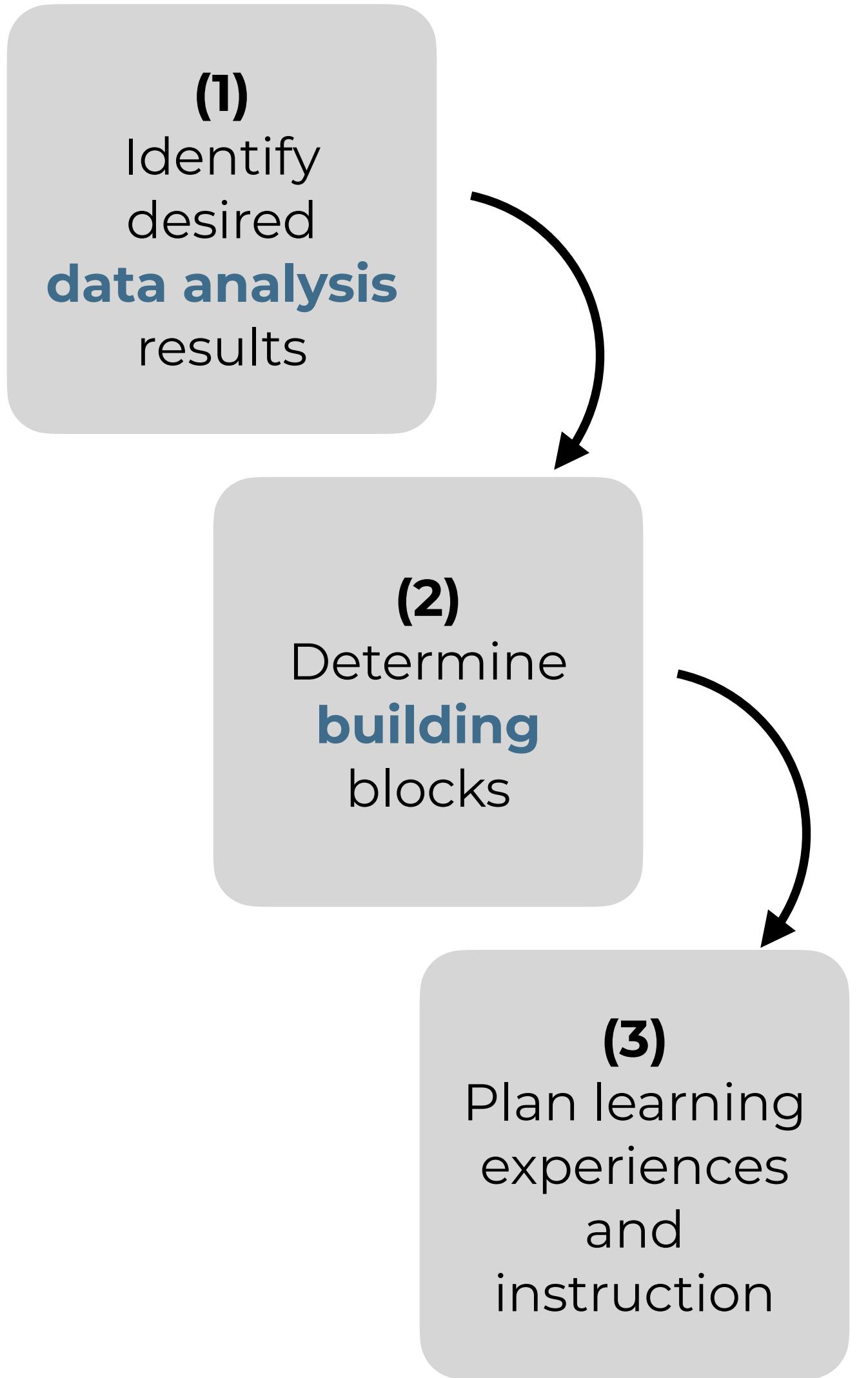
# Pineapple and coconut sandwich cake



# design foundations



# 1 backwards design



# 2 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.

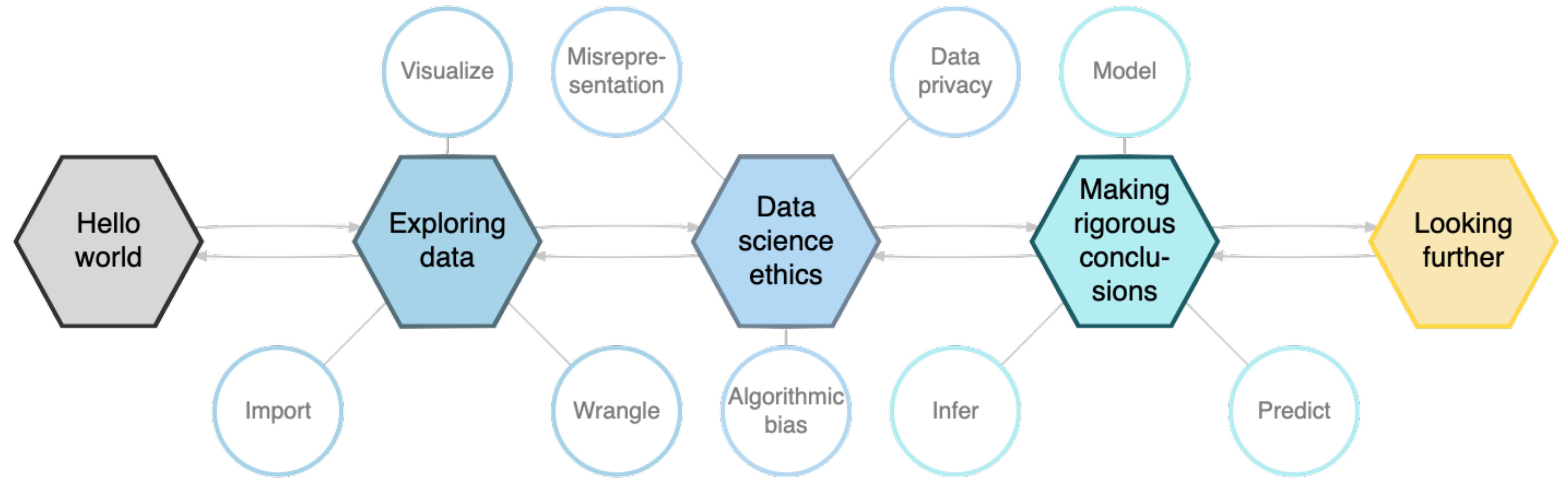
## 6. Use assessments to improve and evaluate student learning.

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 Not just inference & modeling, also data importing, cleaning, preparation, exploration, & visualization



First data viz  
+  
Introduction to computational toolkit:  
R, RStudio,  
R Markdown,  
simple git

Fundamentals of data, visualization, and tidying, recoding, transforming, summarizing, and importing from files and scraping from the web + collaboration on GitHub

Ethics of working and communicating with data, algorithmic bias and what to keep in mind to minimize the risk of bias creeping in

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

Varies:  
Bayesian inference,  
interactive reporting and visualization, text analysis, machine learning, ...

# design principles



# Q

Which kitchen would you  
rather bake a cake?

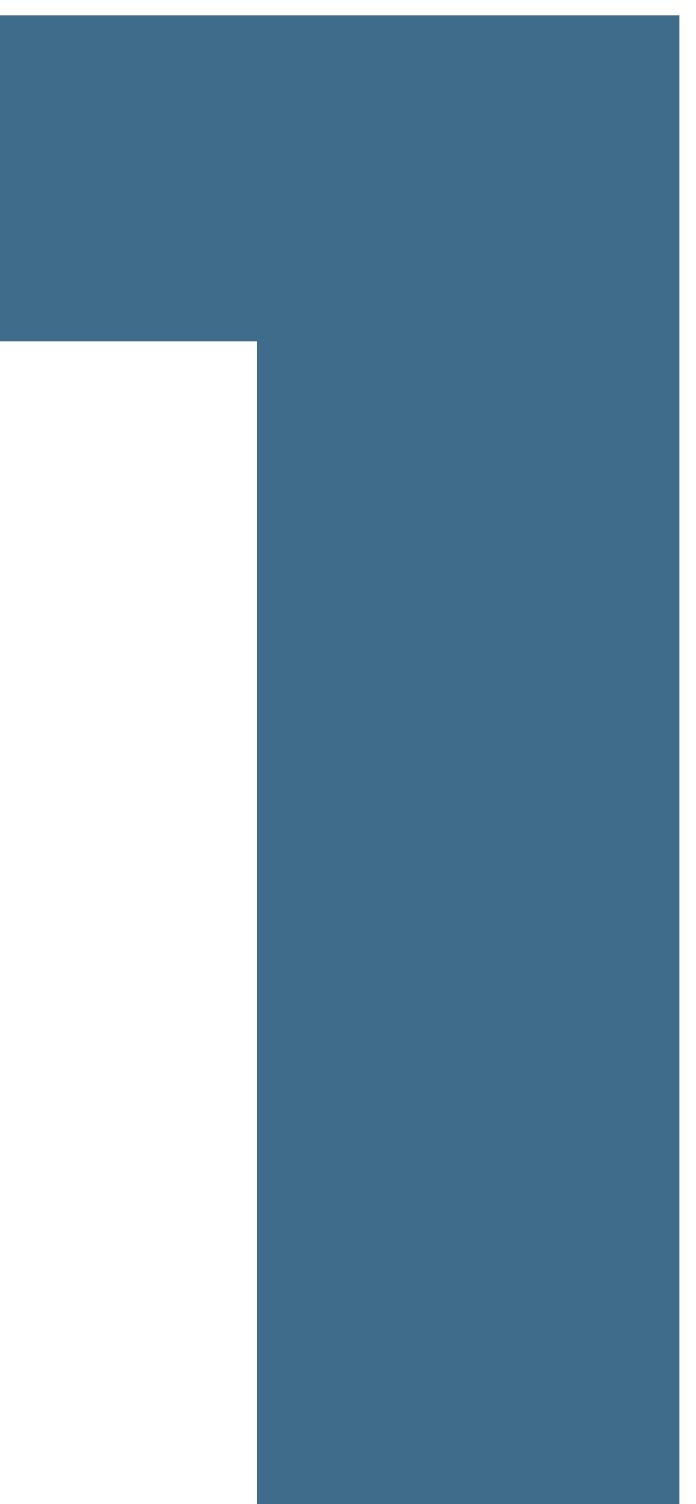


# Q

Which kitchen would you  
rather bake a cake?



cherish  
day  
one

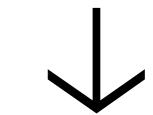
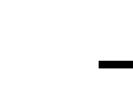
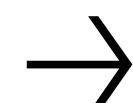




- ❑ Install R
- ❑ Install RStudio
- ❑ Install the following packages:
  - ❑ tidyverse
  - ❑ rmarkdown
  - ❑ ...
- ❑ Load these packages
- ❑ Install git



- ❑ Go to [rstudio.cloud](https://rstudio.cloud) (or some other server based solution)
  - ❑ Log in with your ID & pass
- > hello R!



Data  
Analysis  
References  
Appendix

## UN Votes

Mine Çetinkaya-Rundel

2018-09-26

Let's take a look at the voting history of countries in the United Nations General Assembly. We will be using data from the `unvotes` package. Additionally, we will make use of the `tidyverse` and `lubridate` packages for the analysis, and the `DT` package for interactive display of tabular output.

### Data

The `unvotes` package provides three datasets we can work with: `un_roll_calls`, `un_roll_call_issues`, and `un_votes`. Each of these datasets contains a variable called `roid`, the roll call id, which can be used as a unique identifier to join them with each other.

- The `un_votes` dataset provides information on the voting history of the United Nations General Assembly. It contains one row for each country-vote pair.

`un_votes`

```
## # A tibble: 738,764 x 4
##   roid country      country_code vote
##   <int> <chr>        <chr>     <fct>
## 1 3 United States of America US      yes
## 2 3 Canada          CA      no
## 3 3 Cuba            CU      yes
## 4 3 Haiti           HT      yes
## 5 3 Dominican Republic DO      yes
## 6 3 Mexico          MX      yes
## 7 3 Guatemala       GT      yes
## 8 3 Honduras         HN      yes
## 9 3 El Salvador      SV      yes
## 10 3 Nicaragua        NI      yes
## # ... with 738,754 more rows
```

- The `un_roll_calls` dataset contains information on each roll call vote of the United Nations General Assembly.

`un_roll_calls`

```
## # A tibble: 5,429 x 9
##   roid session importantvote date      unres amend para short descr
##   <int> <dttm>    <dttm> <dttm> <dbl> <dttm> <dttm> <dttm>
## 1 3 1946-01-01 0 1946 1 0 0 AMEN. TO ADD.
## 2 4 1946-01-02 0 1946 0 0 0 SEC'D. TO ADD.
## 3 5 1946-01-04 0 1946 0 0 0 VOT'L. "TO ADD."
```

# Q

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

## 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 (15 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



# Q

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**start  
with  
cake**



Ingredients	Directions
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16 ounces plain or <b>toasted sugar</b> (about 2 1/4 cups; 455g)	1. <b>For the Cake:</b> 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 <a href="#">here</a> ). 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.
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16 ounces all-purpose flour (about 3 1/2 cups, spooned; 455g)	



- Declare the following variables
- Then, determine the class of each variable

```
# Declare variables
x <- 8
y <- "monkey"
z <- FALSE

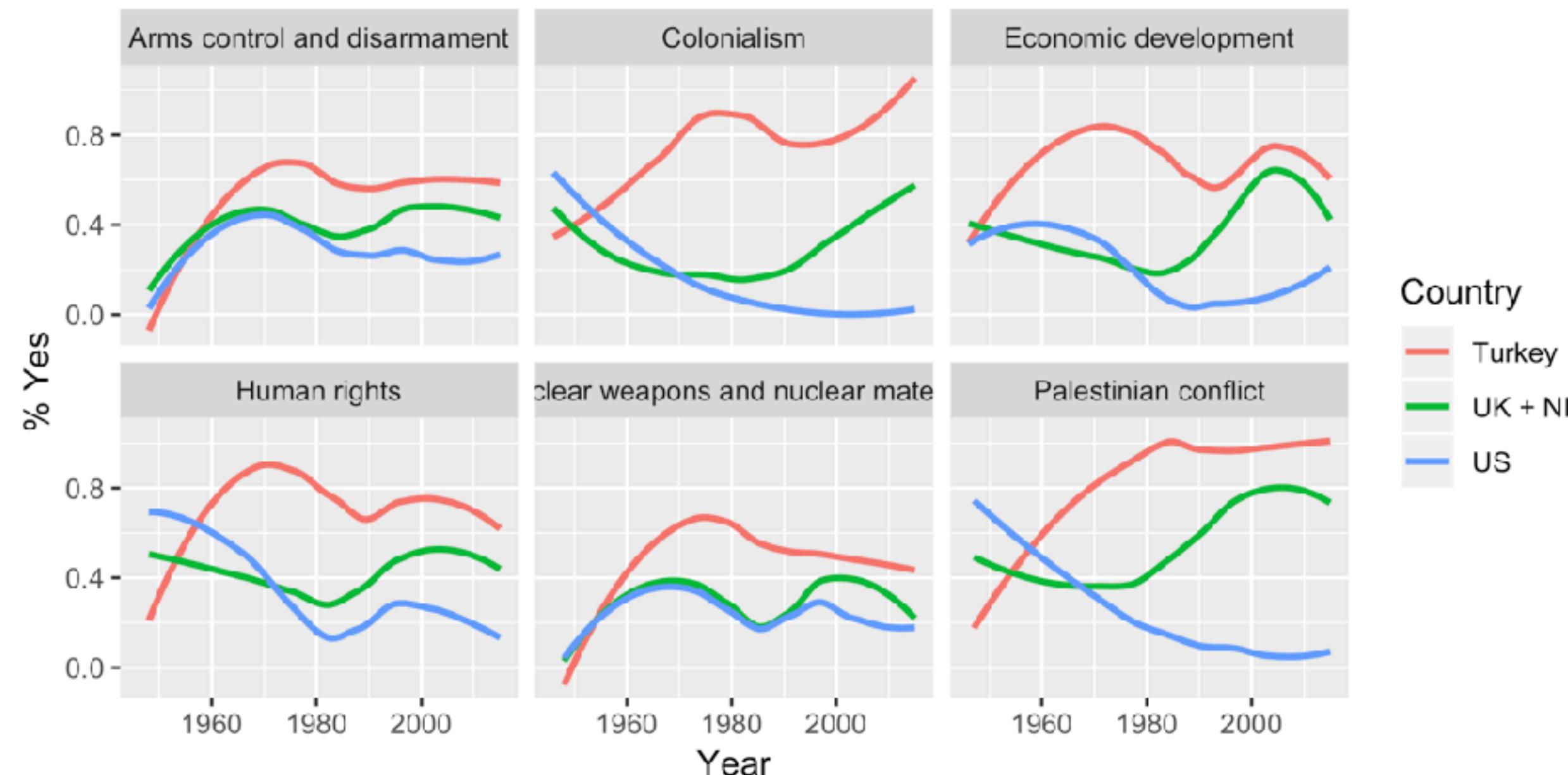
class(x)
#> [1] "numeric"

class(y)
#> [1] "character"

class(z)
#> [1] "logical"
```

- Open today's demo project
- Knit the document and discuss the results with your neighbor

Percentage of Yes votes in the UN General Assembly  
1946 to 2015



- Then, change Turkey to a different country, and plot again

with great examples,  
comes a great amount of code...

but let's focus on the task at hand...

- Open today's demo project
- Knit the document and discuss the results with your neighbor
- Then, change Turkey to a different country, and plot again

```
un_votes %>%  
  filter(country %in% c("UK & NI", "US", "Turkey")) %>%  
  inner_join(un_roll_calls, by = "rcid") %>%  
  inner_join(un_roll_call_issues, by = "rcid") %>%  
  group_by(country, year = year(date), issue) %>%  
  summarize(  
    votes = n(),  
    percent_yes = mean(vote == "yes")  
  ) %>%  
  filter(votes > 5) %>% # only use records where there are more than 5 votes  
  ggplot(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"  
)
```

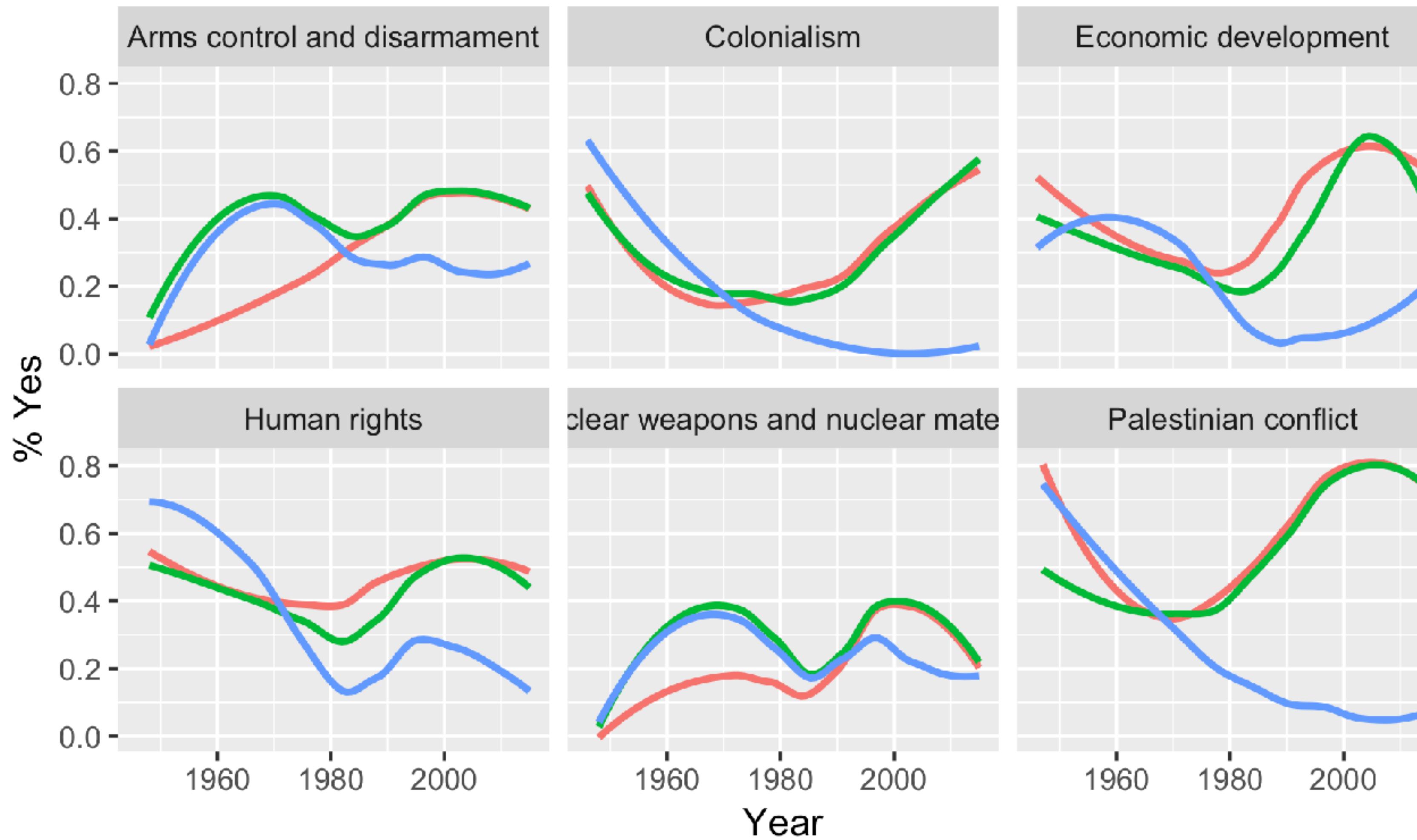
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  facet_wrap(~ issue) +
  labs(
    title = "Percentage of Yes votes in the UN General Assembly",
    subtitle = "1946 to 2015",
    y = "% Yes",
    x = "Year",
    color = "Country"
  )

```

```
un_votes %>%
  filter(country %in% c("UK & NI", "US", "France")) %>%
  inner_join(un_roll_calls, by = "rcid") %>%
  inner_join(un_roll_call_issues, by = "rcid") %>%
  group_by(country, year = year(date), issue) %>%
  summarize(
    votes = n(),
    percent_yes = mean(vote == "yes")
  ) %>%
  filter(votes > 5) %>% # only use records where there are more than 5 votes
  ggplot(mapping = aes(x = year, y = percent_yes, color = country)) +
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  facet_wrap(~ issue) +
  labs(
    title = "Percentage of Yes votes in the UN General Assembly",
    subtitle = "1946 to 2015",
    y = "% Yes",
    x = "Year",
    color = "Country"
  )

```

# Percentage of Yes votes in the UN General Assembly 1946 to 2015



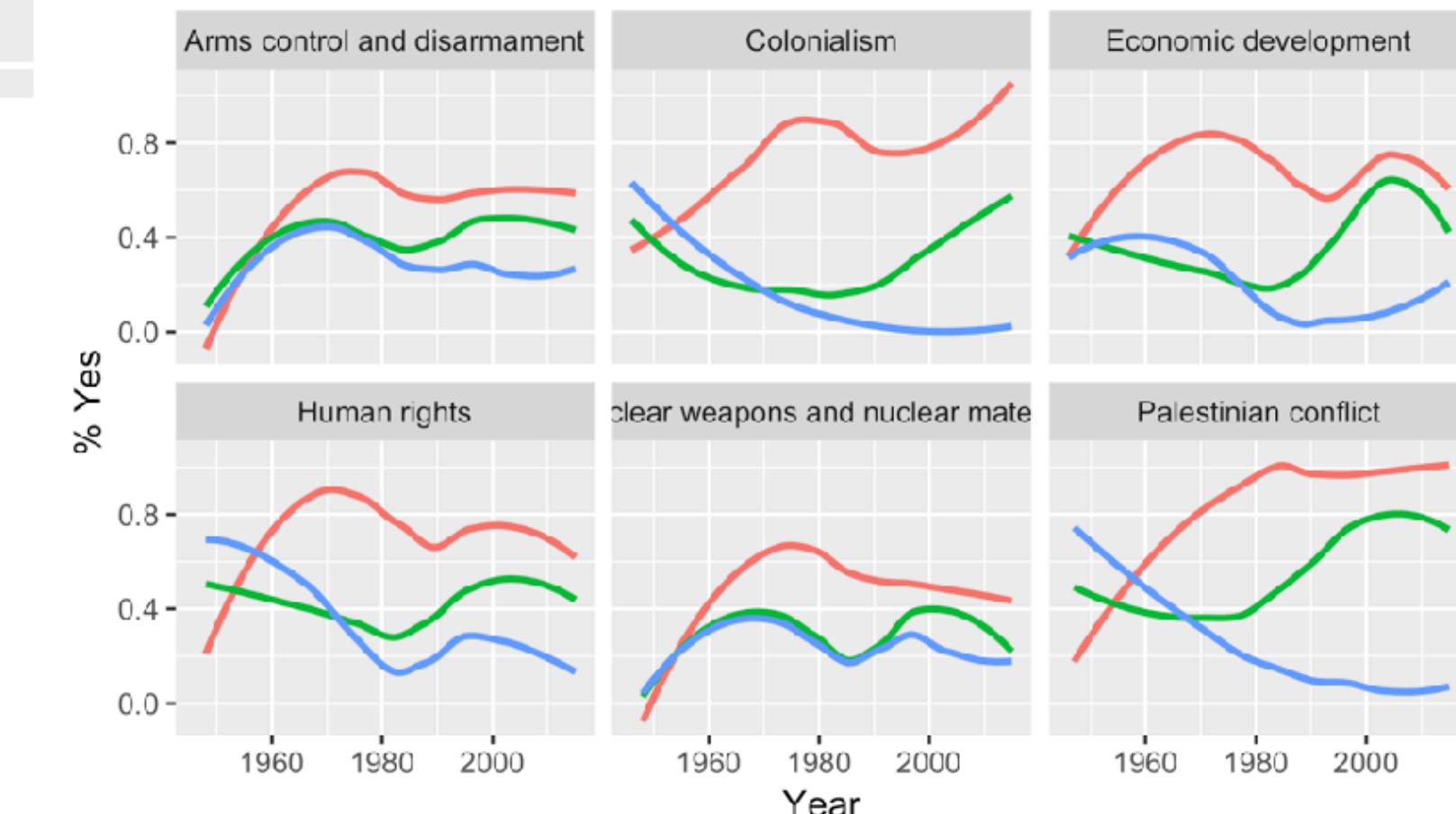
Country

- France
- UK + NI
- US

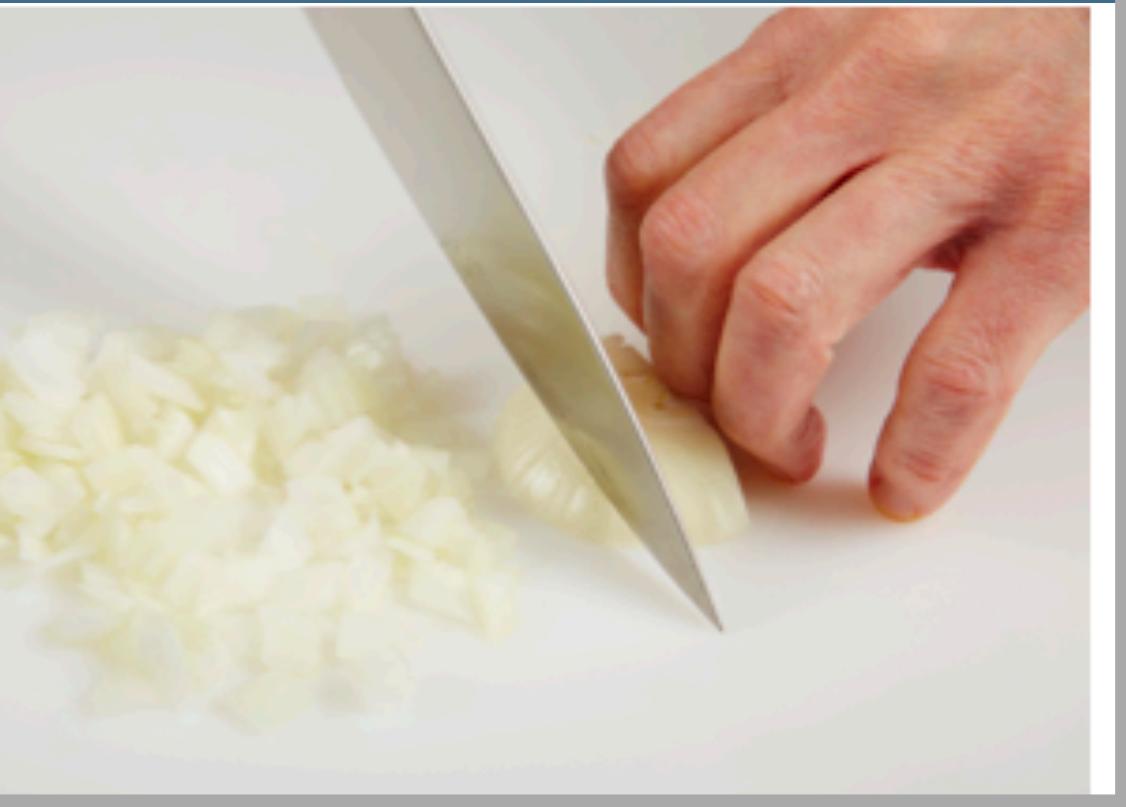
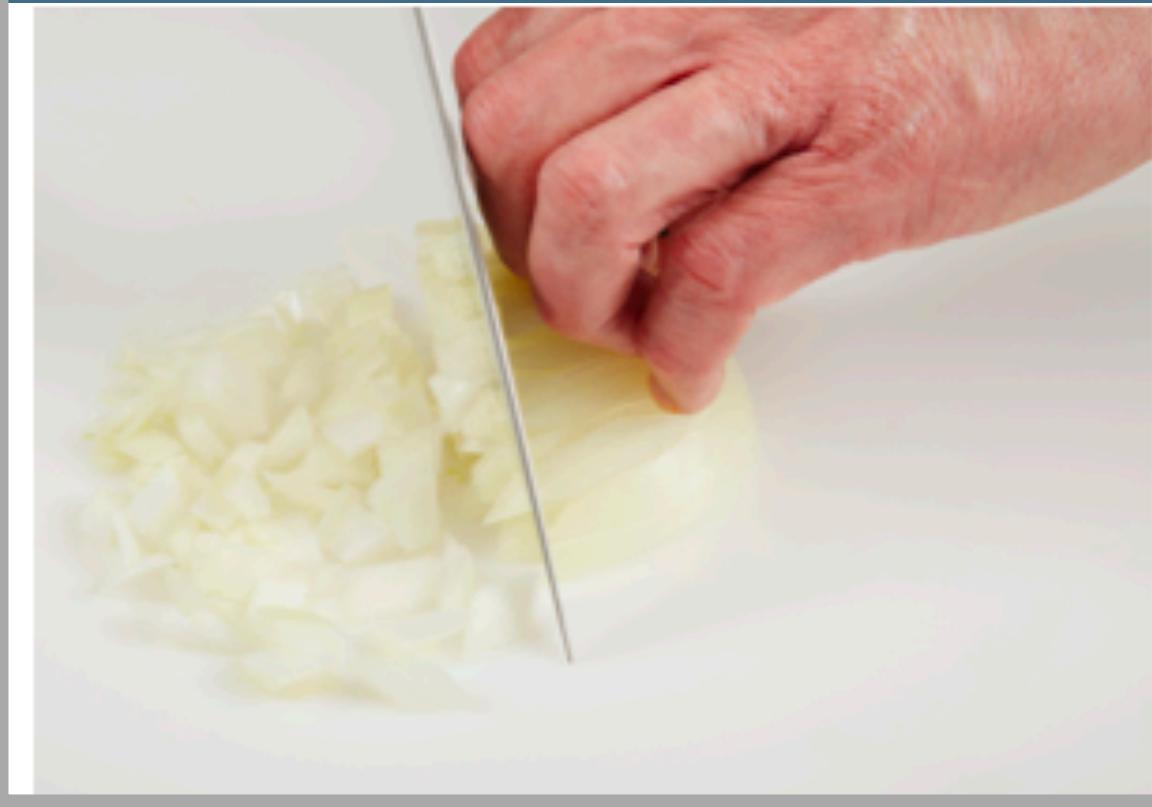
Country

- Turkey
- UK + NI
- US

Percentage of Yes votes in the UN General Assembly  
1946 to 2015



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



# Q

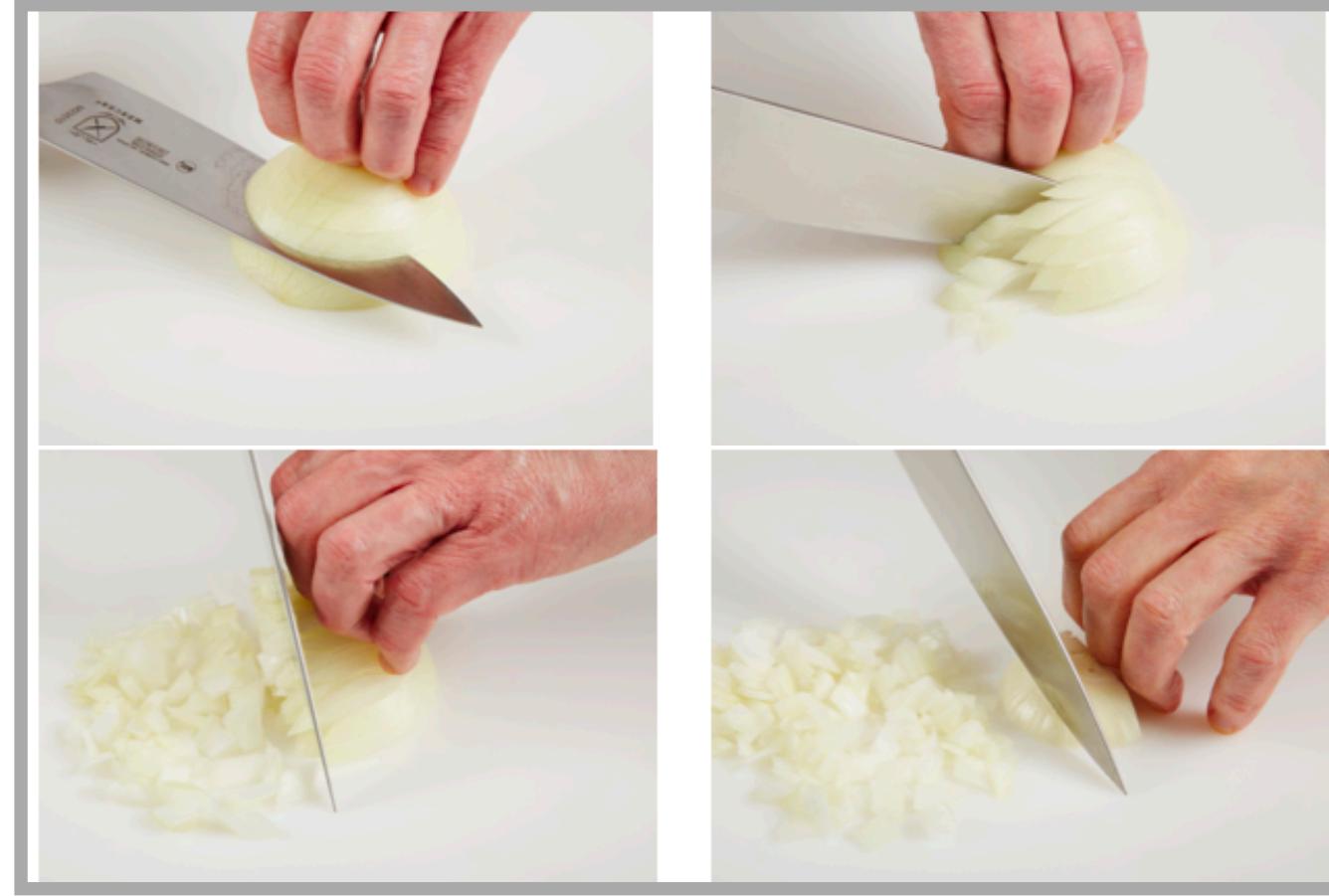


Which motivates you more to learn how to cook: perfectly chopped onions or ratatouille?

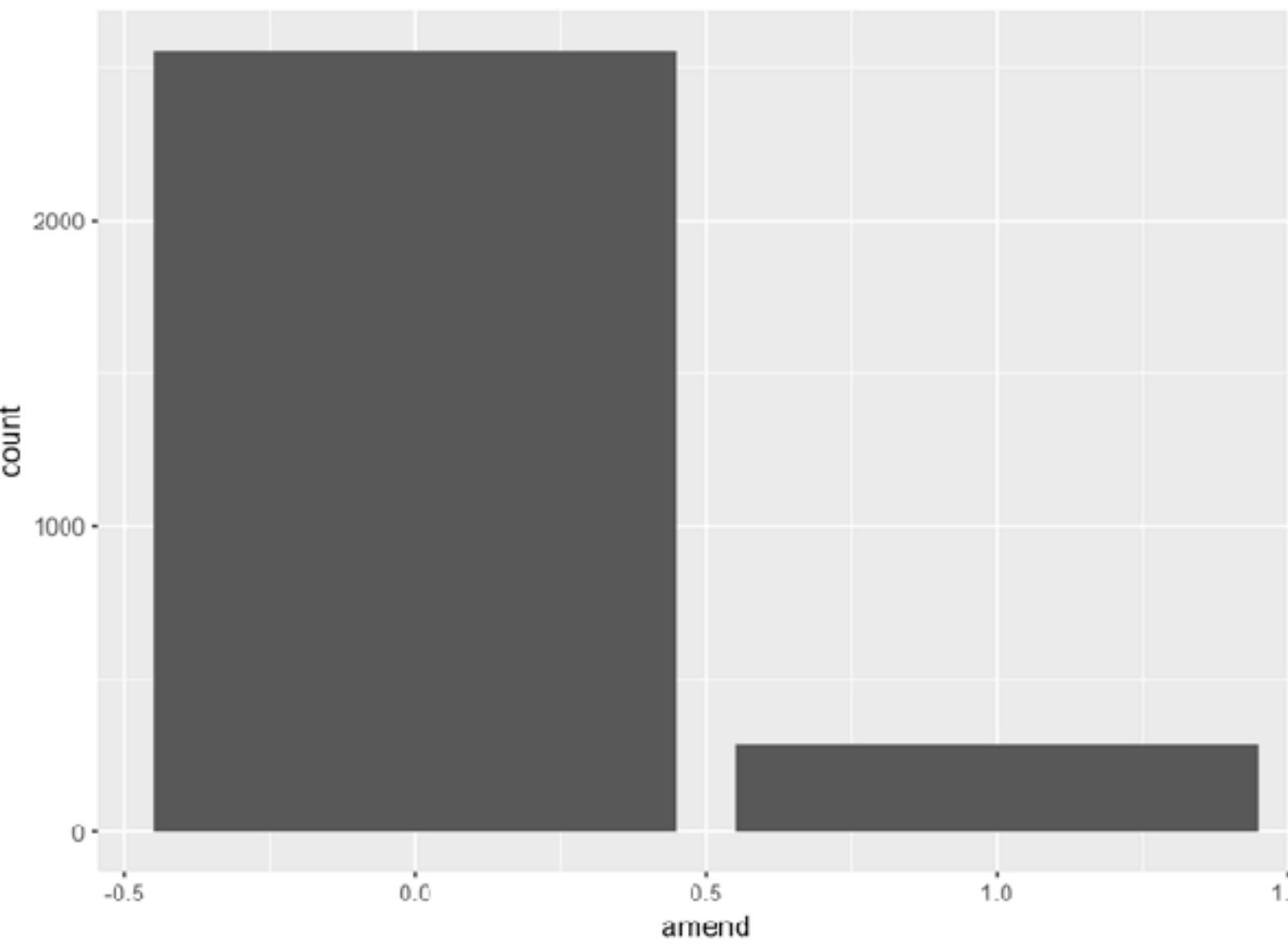


**skip  
baby  
steps**

**73**



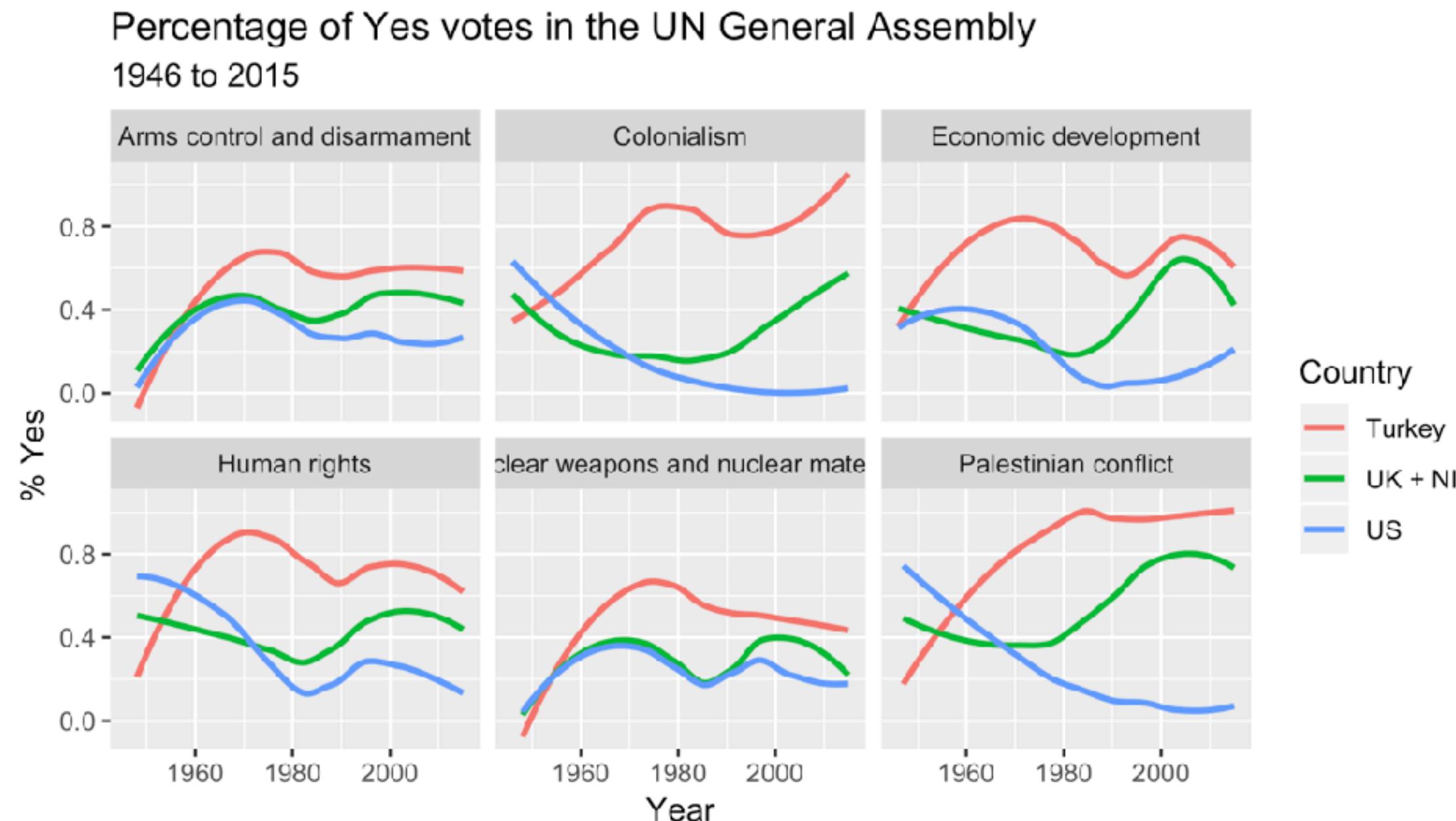
Create a visualization displaying whether the vote was on an amendment.



[bit.ly/eat-cake-diz](http://bit.ly/eat-cake-diz)



Create a visualization displaying how US, UK, and Turkey voted over the years on issues of arms control and disarmament, colonialism, economic development, human rights, nuclear weapons, and Palestinian conflict.



non-trivial examples can be motivating,  
but need to avoid !

How to draw an owl

1.



2.



1. Draw some circles

2. Draw the rest of the  owl

## How to draw an owl

1.



scaffold + layer

2.



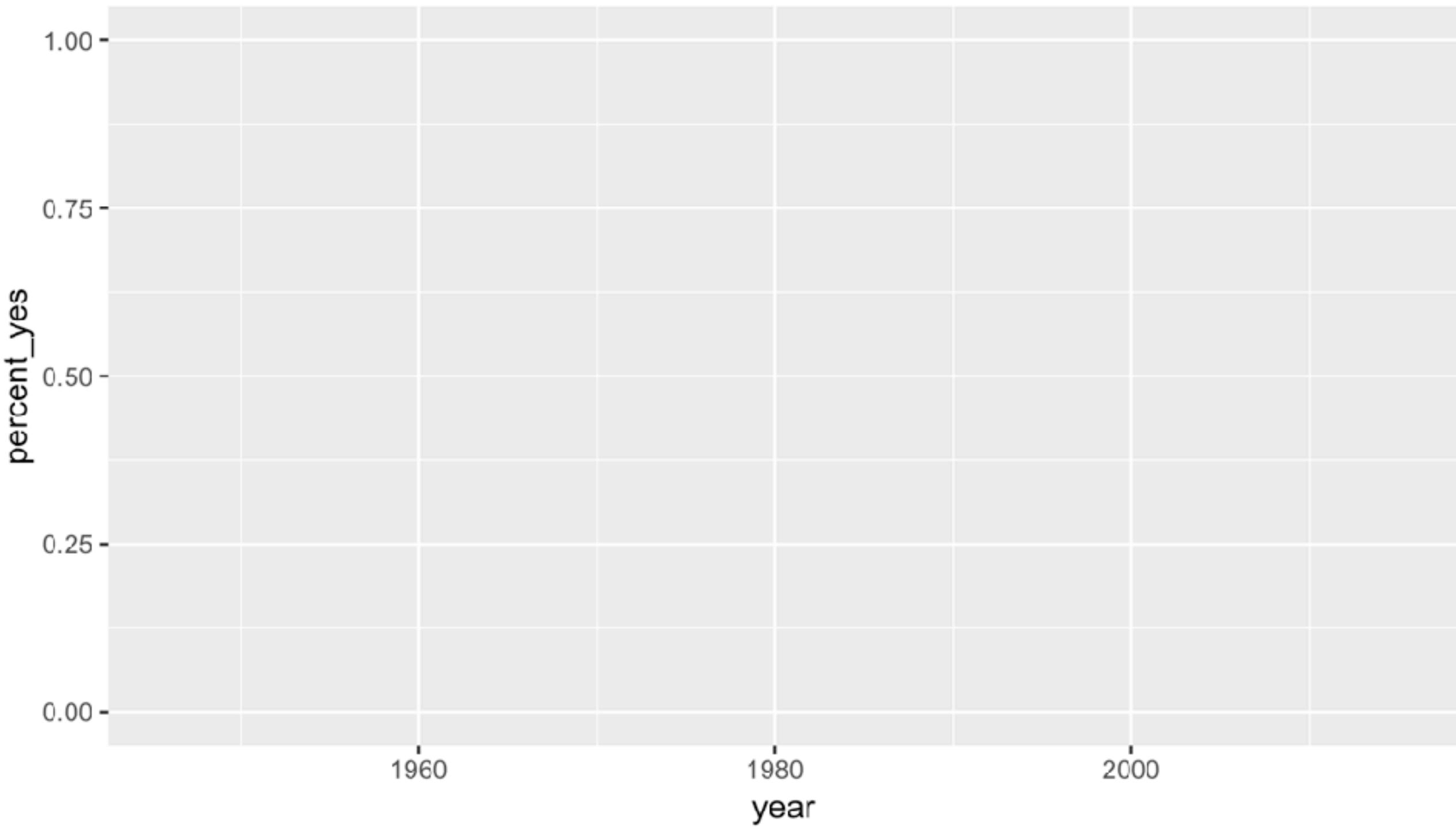
1. Draw some circles

2. Draw the rest of the owl

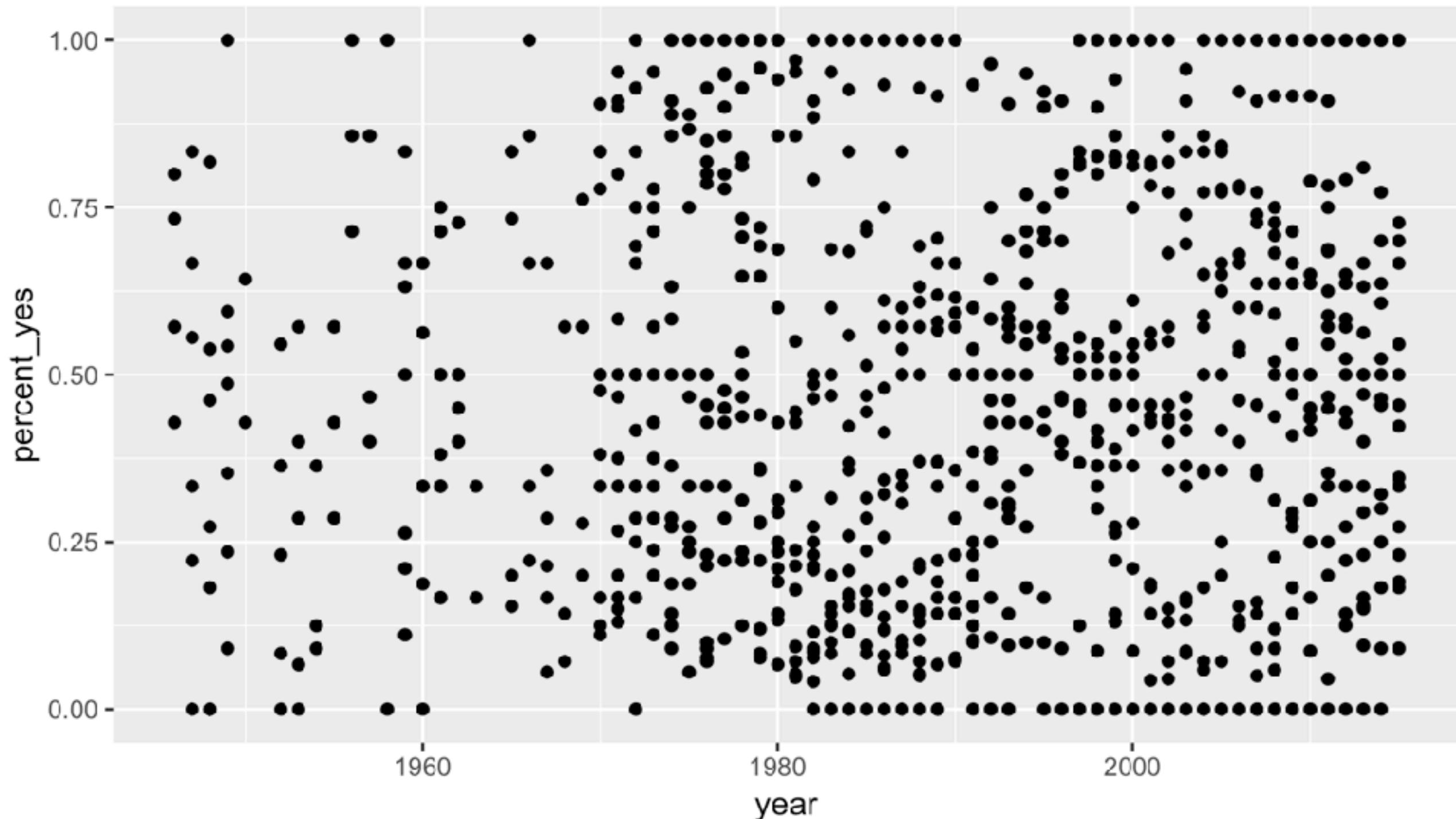
@#\$%

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

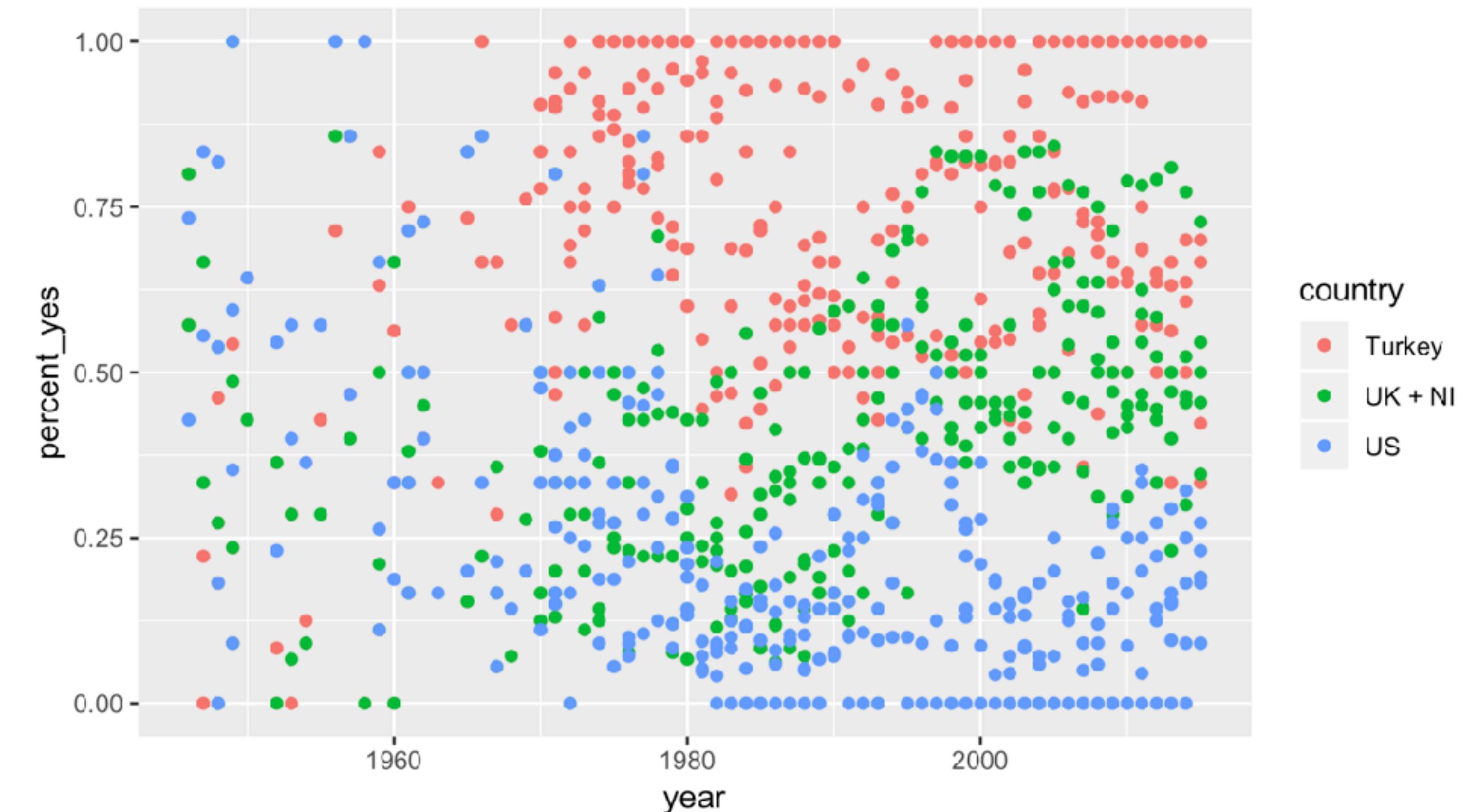
```
ggplot(data = un_votes_joined,  
       mapping = aes(x = year, y = percent_yes))
```



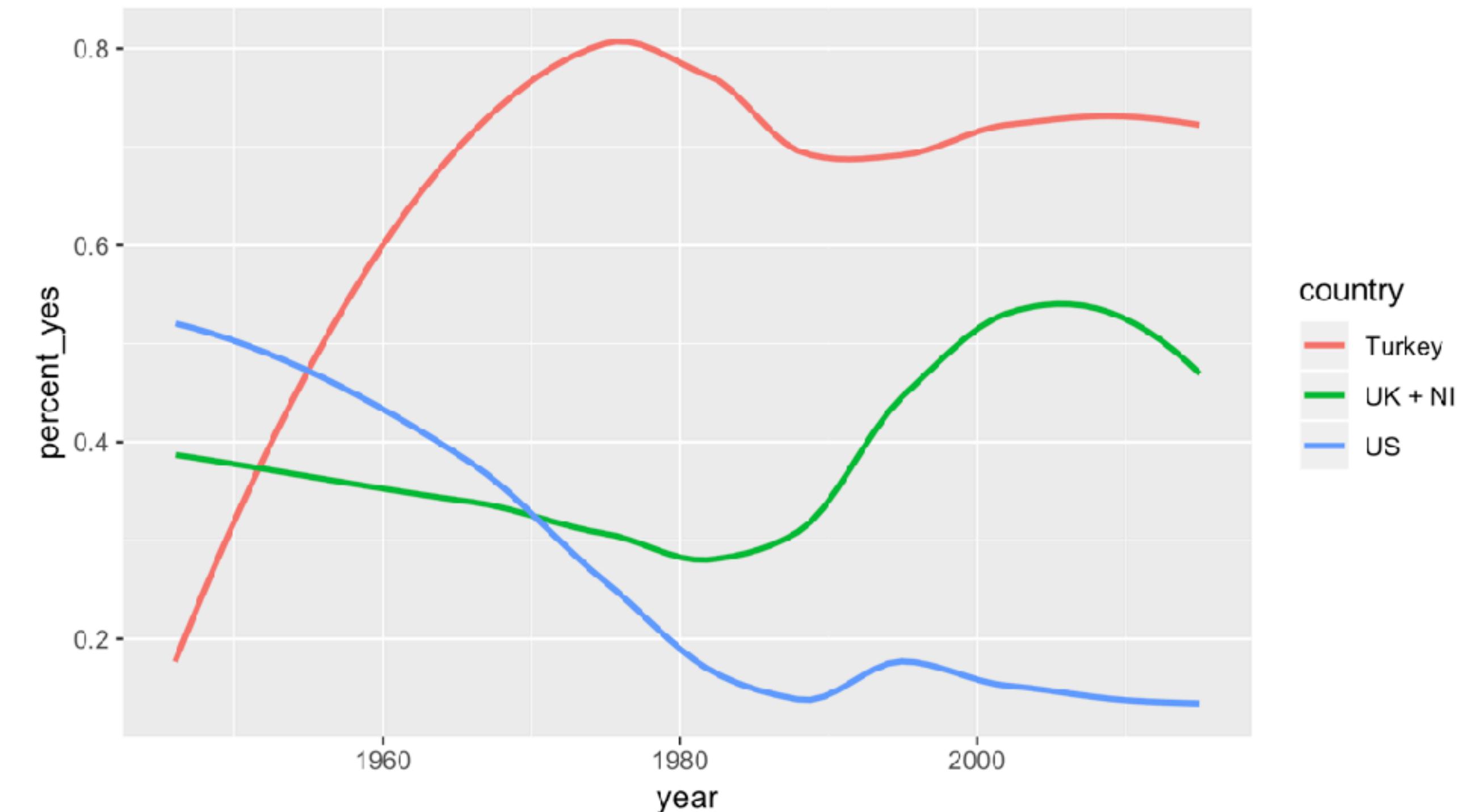
```
ggplot(data = un_votes_joined,  
       mapping = aes(x = year, y = percent_yes)) +  
  geom_point()
```



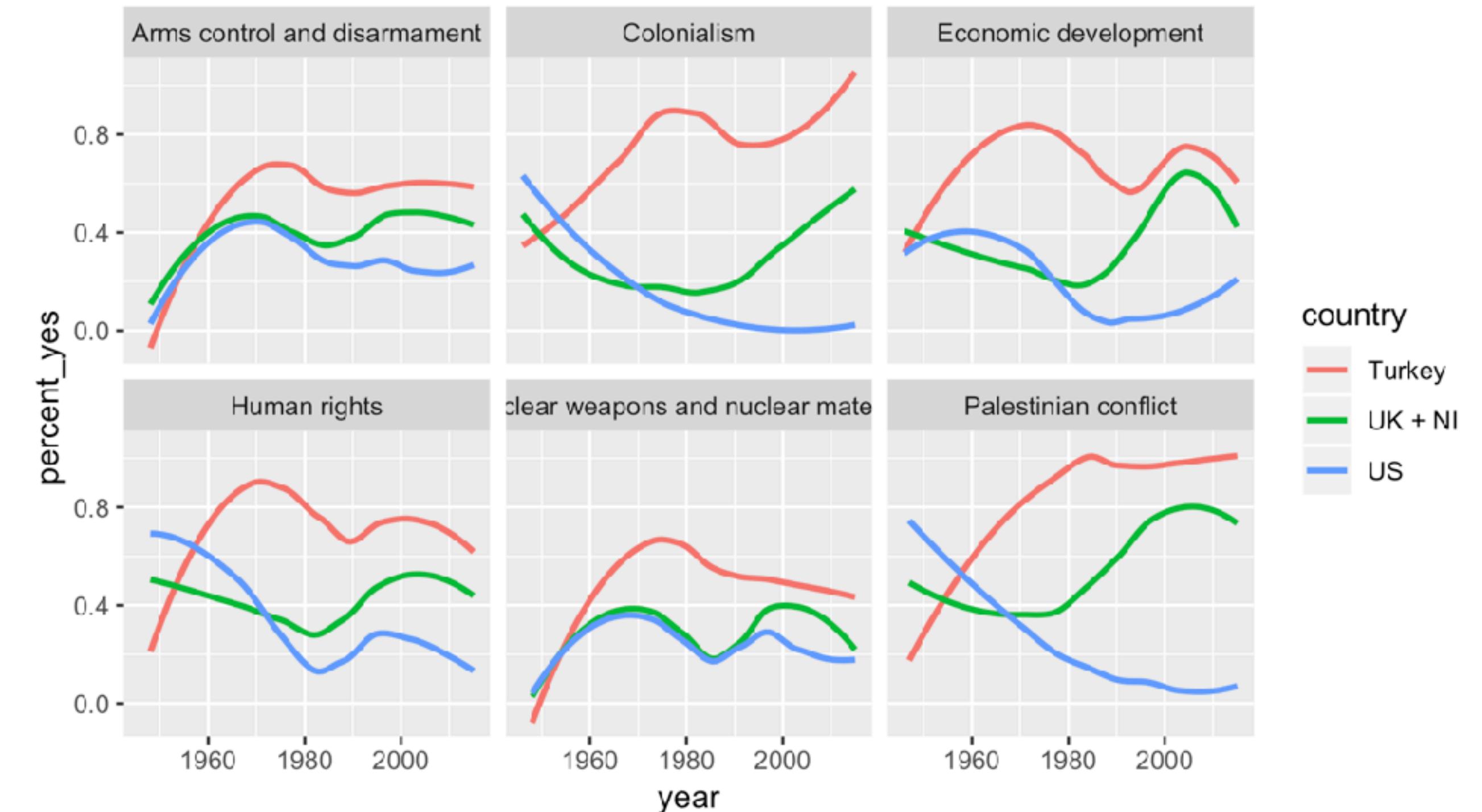
```
ggplot(data = un_votes_joined,  
       mapping = aes(x = year, y = percent_yes, color = country)) +  
geom_point()
```



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



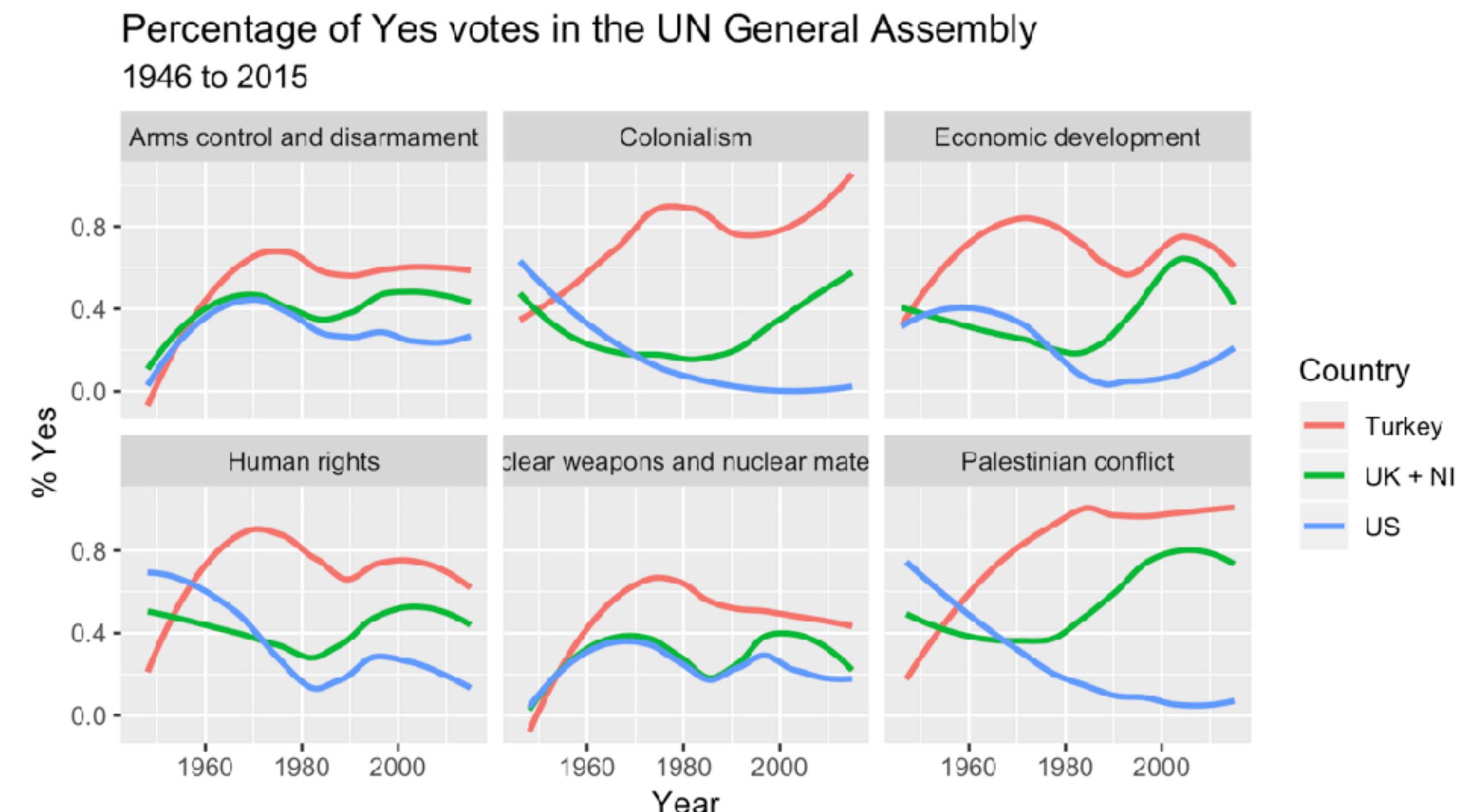
```
ggplot(data = un_votes_joined,
       mapping = aes(x = year, y = percent_yes, color = country)) +
  geom_smooth(method = "loess", se = FALSE) +
  facet_wrap(~ issue)
```



```

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"
  )

```



re-insert  
~~skip~~  
**baby**  
**steps**

## Visualizing data

Data visualization with ggplot2

The data: Star Wars

Scatterplots

Setting aesthetic features

Faceting your visualizations

Data types

Univariate analysis

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

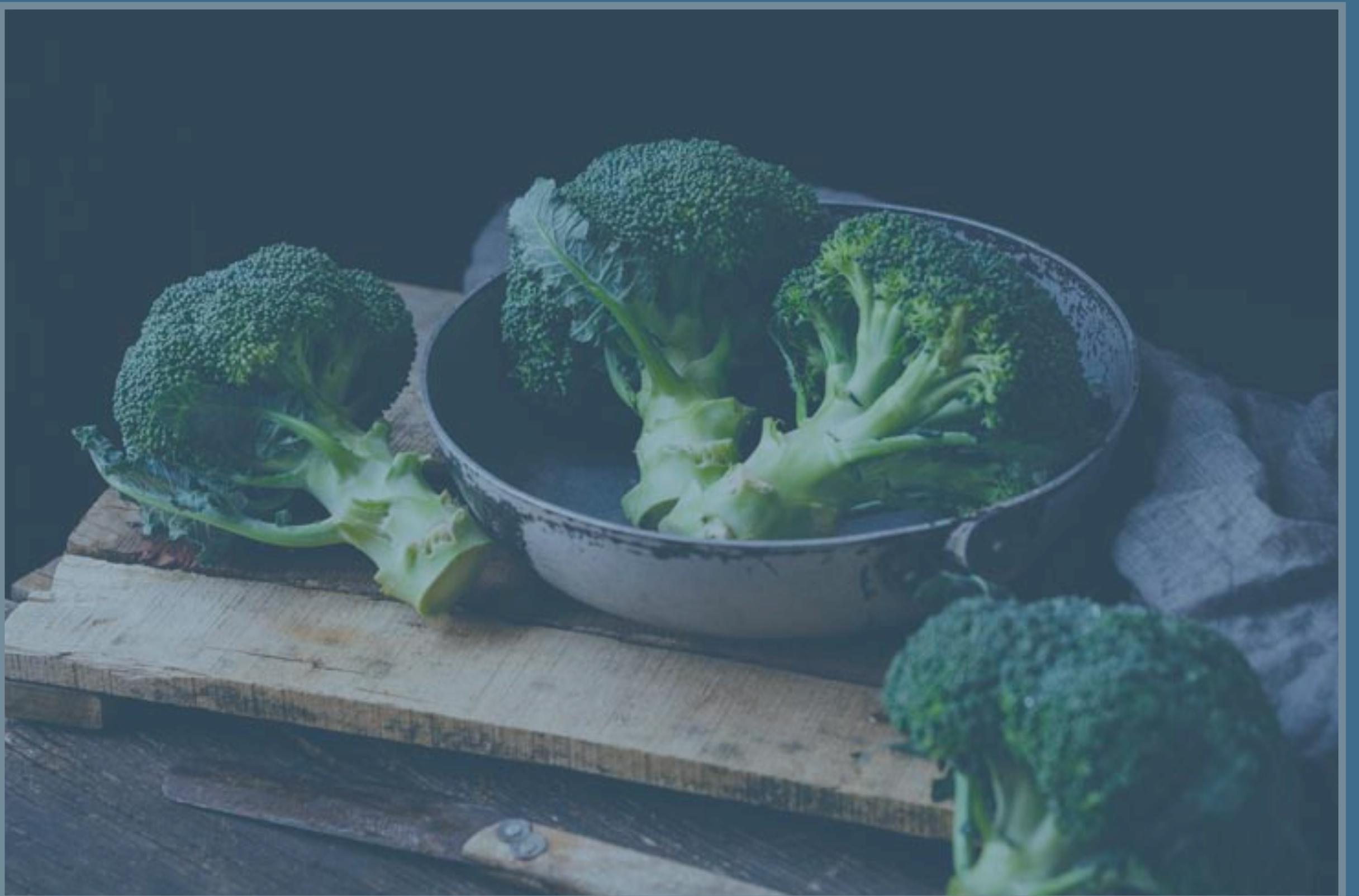
# Q

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



# Q

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



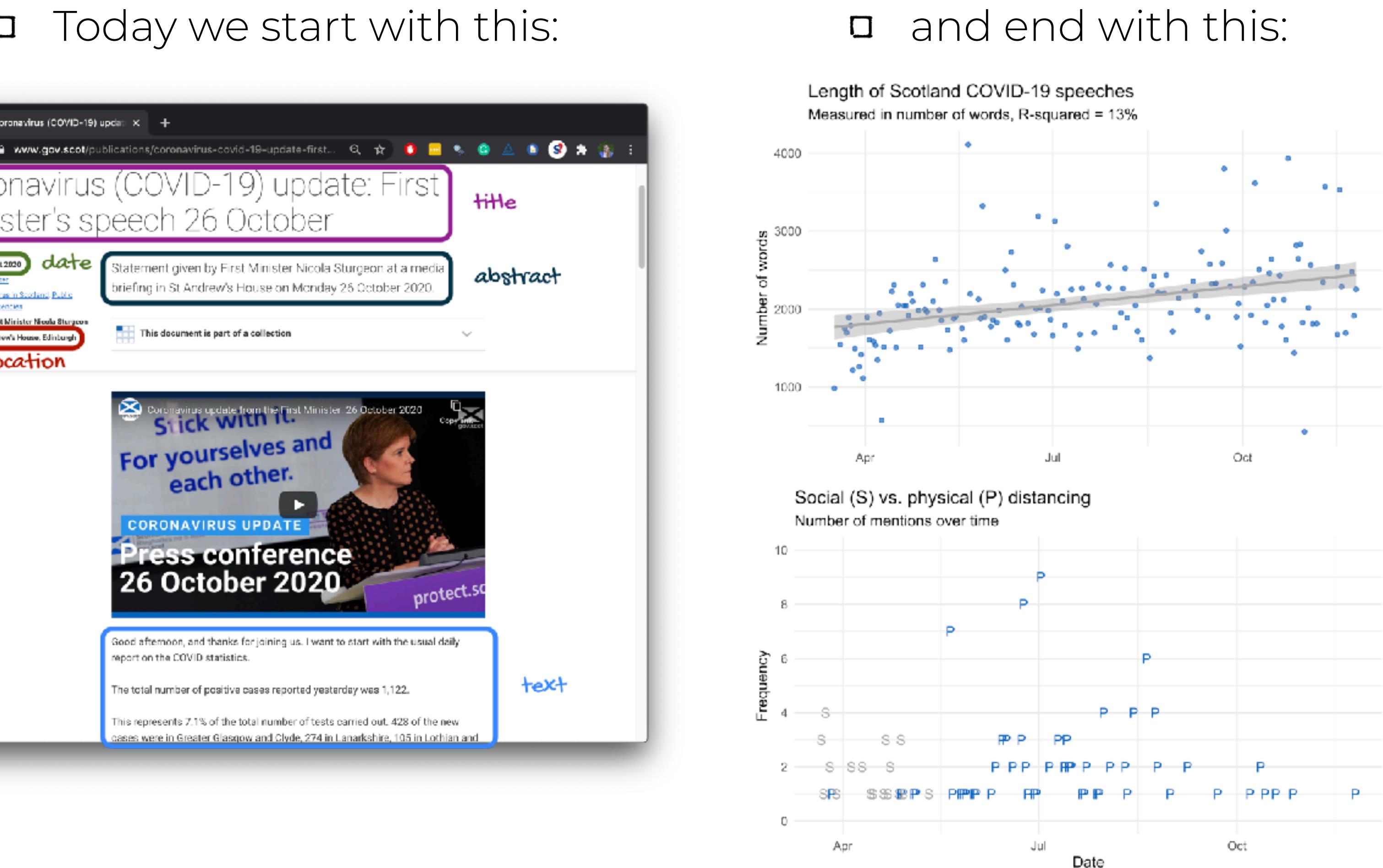
hide  
the  
veggies





- Topic: Web scraping
- Tools:
  - **rvest**
  - **purr**
  - regular expressions
  - iteration

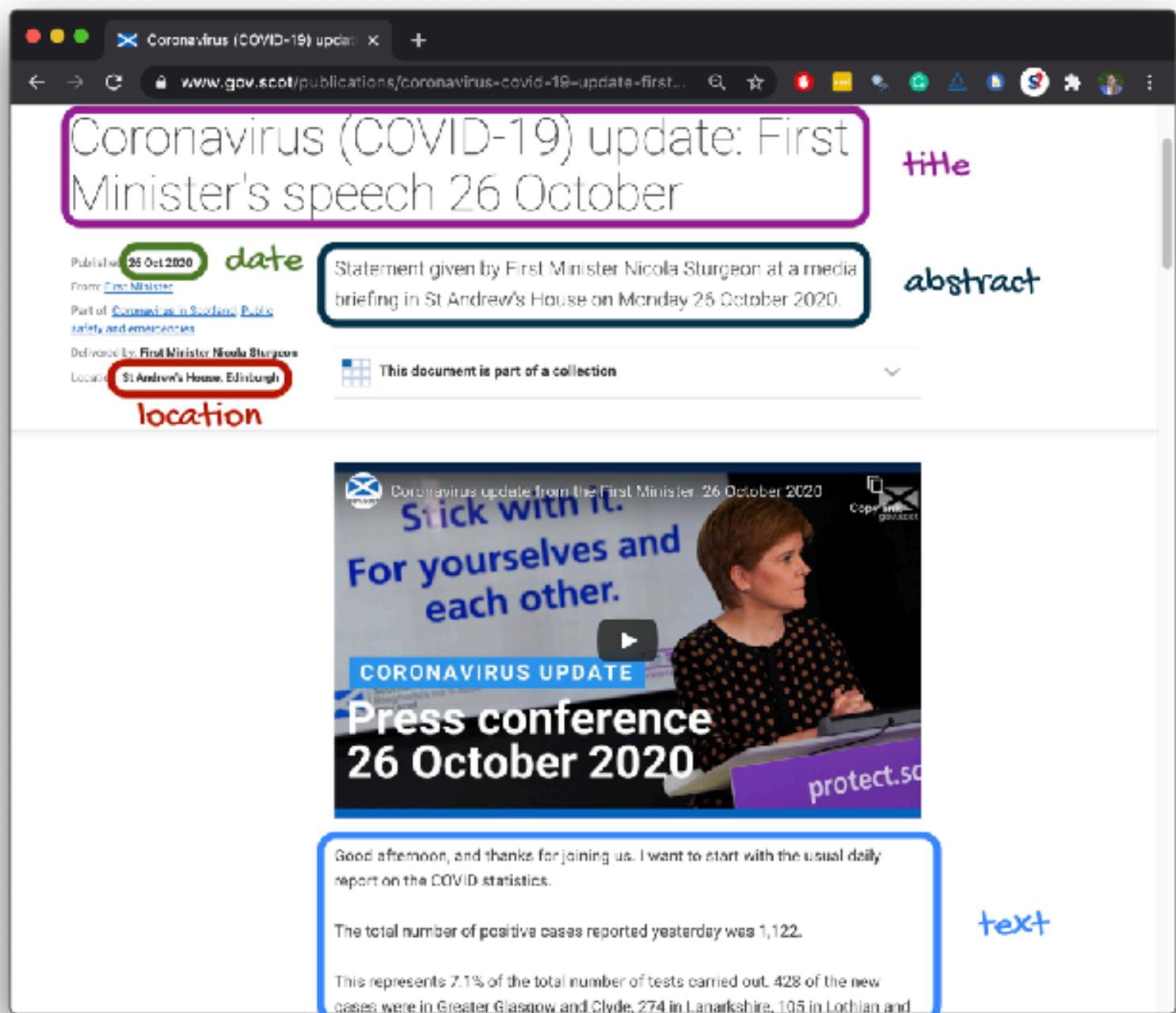
A screenshot of a web browser displaying a government publication page. The title is "Coronavirus (COVID-19) update: First Minister's speech 26 October". The page includes metadata: "Published 26 Oct 2020", "From First Minister", "Part of Coronavirus in Scotland: Public safety and emergencies", "Delivered by First Minister Nicola Sturgeon", and "Location: St Andrew's House, Edinburgh". A video player shows a speech by Nicola Sturgeon with the text "Stick with it. For yourselves and each other. CORONAVIRUS UPDATE Press conference 26 October 2020". Handwritten annotations on the right side of the screen label parts of the page: "title", "abstract", "date", "location", and "text".



students will encounter lots of new challenges along the way — let that happen, and then provide a solution

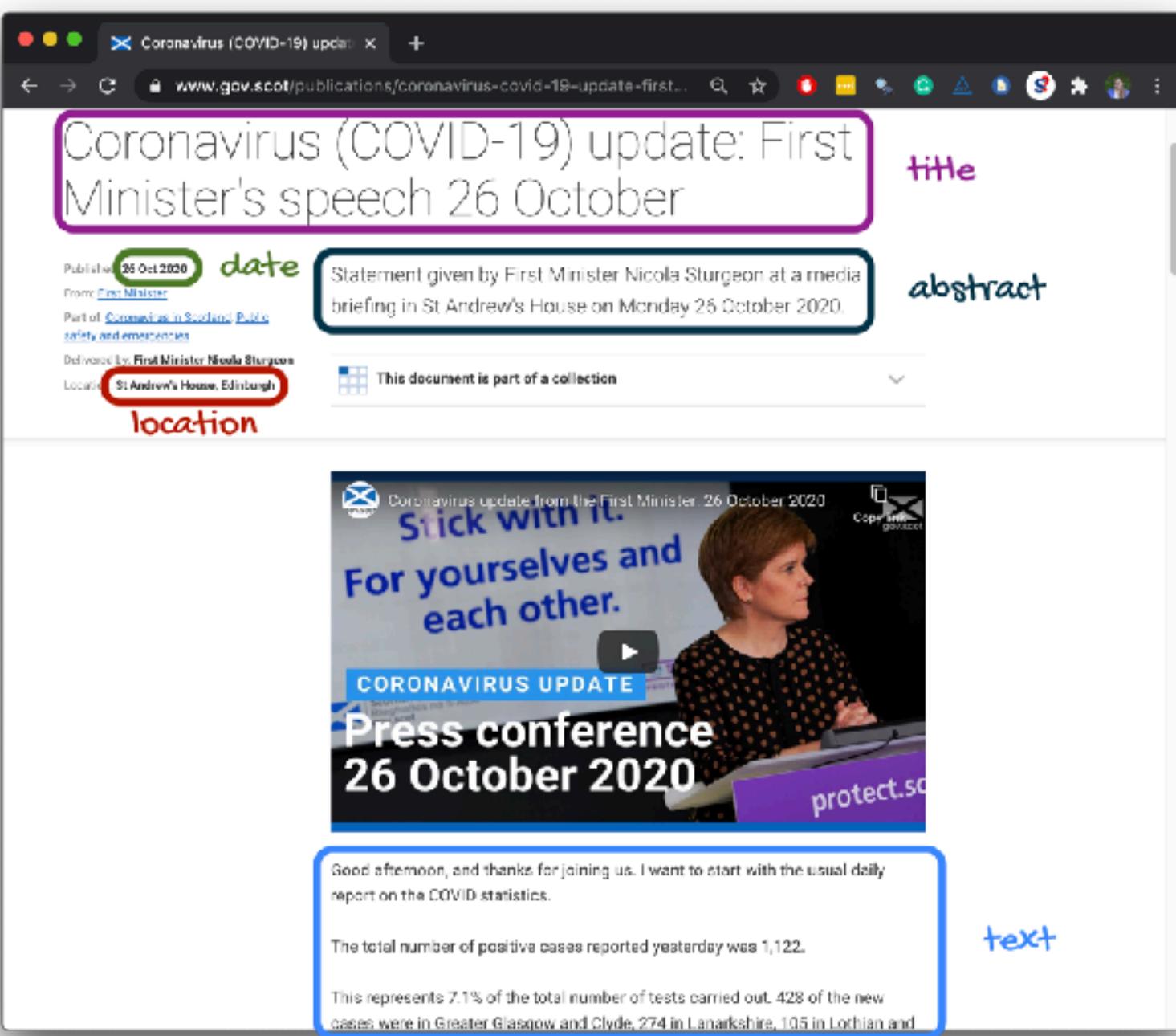
- **Lesson:** Web scraping essentials  
for turning a structured table into  
a data frame in R.

- **Lesson:** Web scraping essentials for turning a structured table into a data frame in R.
- **Ex 1:** Scrape the data off the web and save as a row of a data frame.

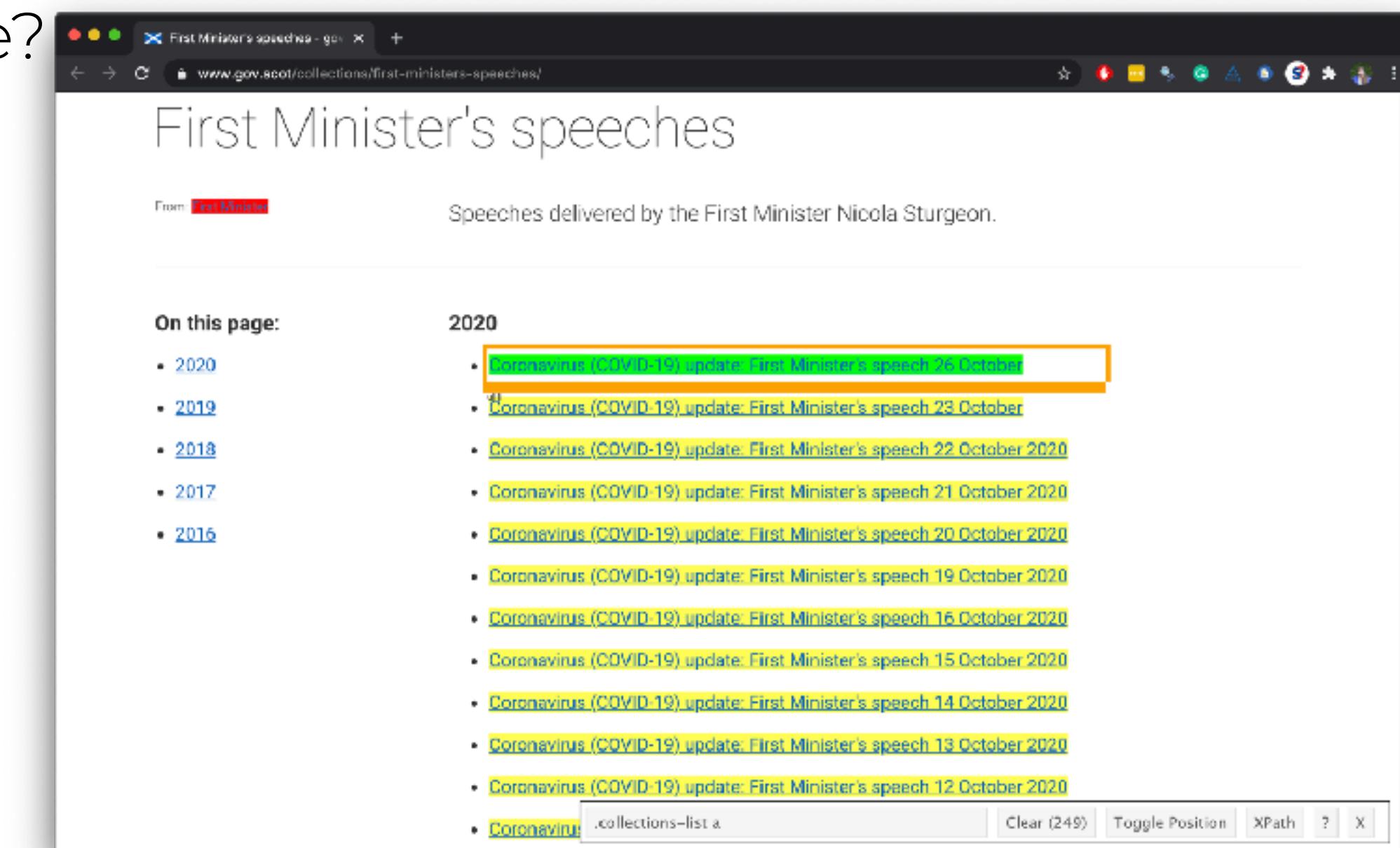


- **Lesson:** Web scraping essentials for turning a structured table into a data frame in R.

- **Ex 1:** Scrape the data off the web and save as a row of a data frame.

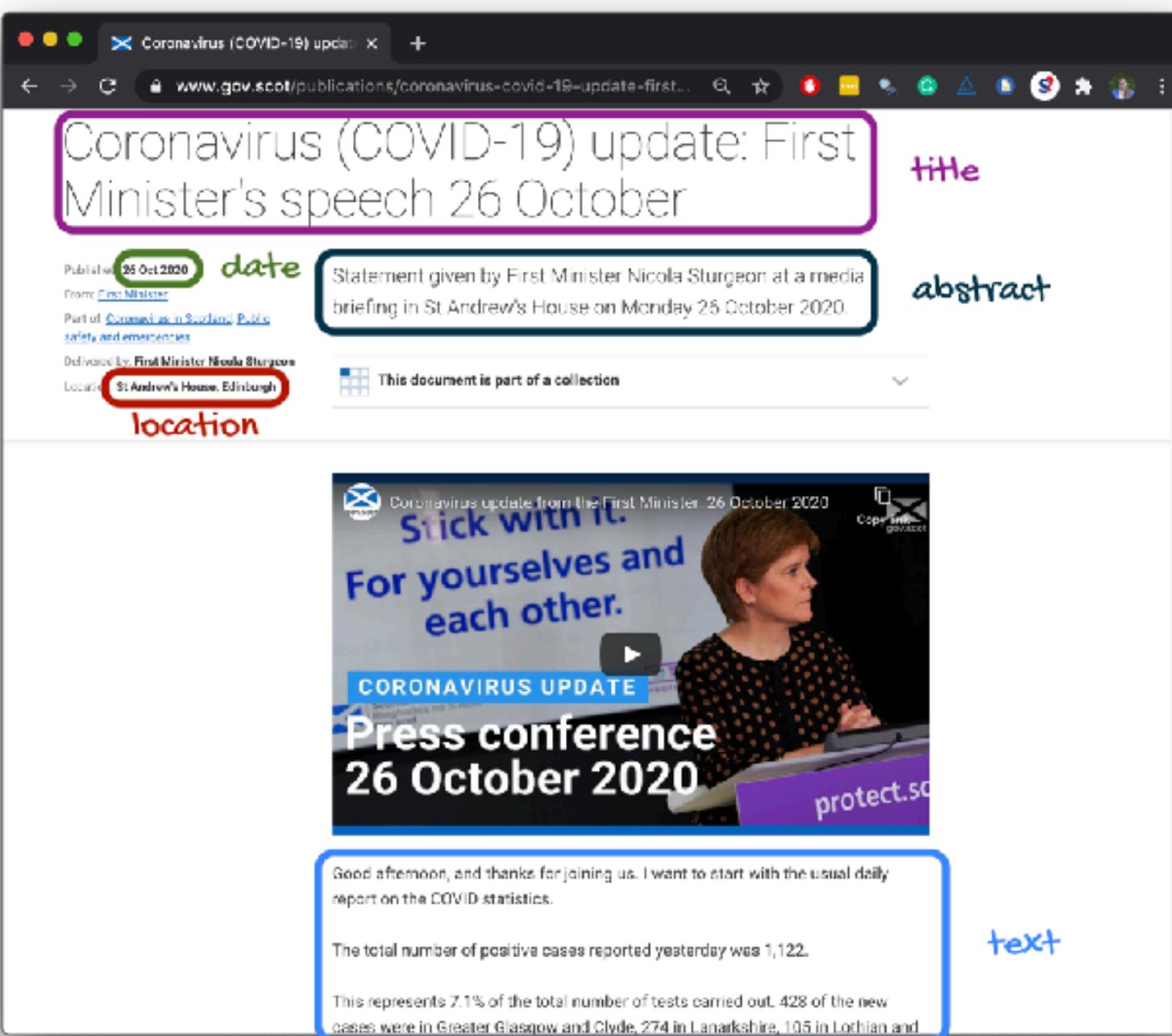


- **Ex 2:** How do we get the same information from each speech's webpage and combine all information in a data frame?



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

- **Ex 1:** Scrape the data off the web and save as a row of a data frame.



- **Lesson:** “Just enough” string parsing, regular expressions, and iteration

- **Ex 2:** How do we get the same information from each speech’s webpage and combine all information in a data frame?

First Minister's speeches

From First Minister

Speeches delivered by the First Minister Nicola Sturgeon.

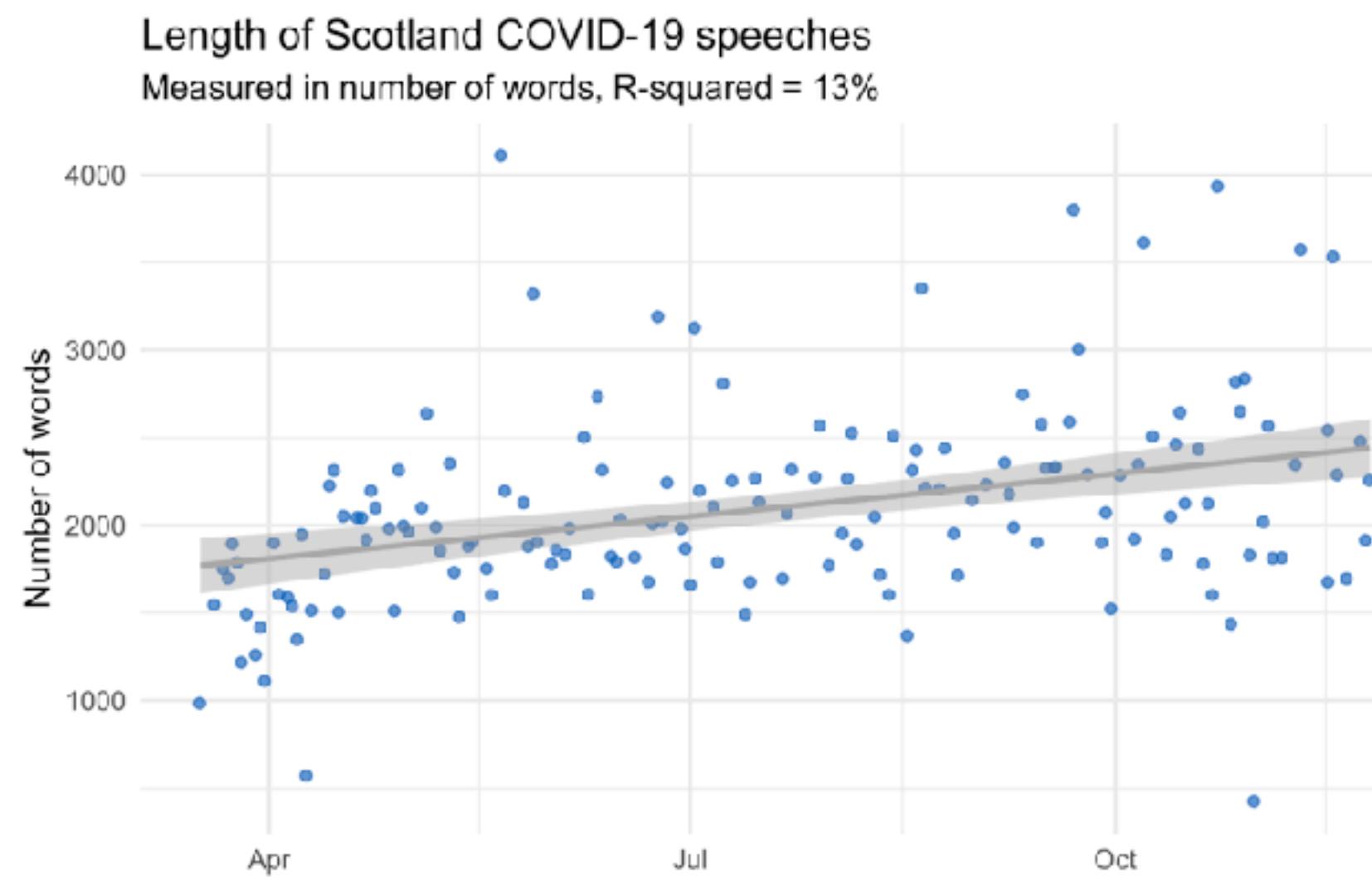
On this page:

2020

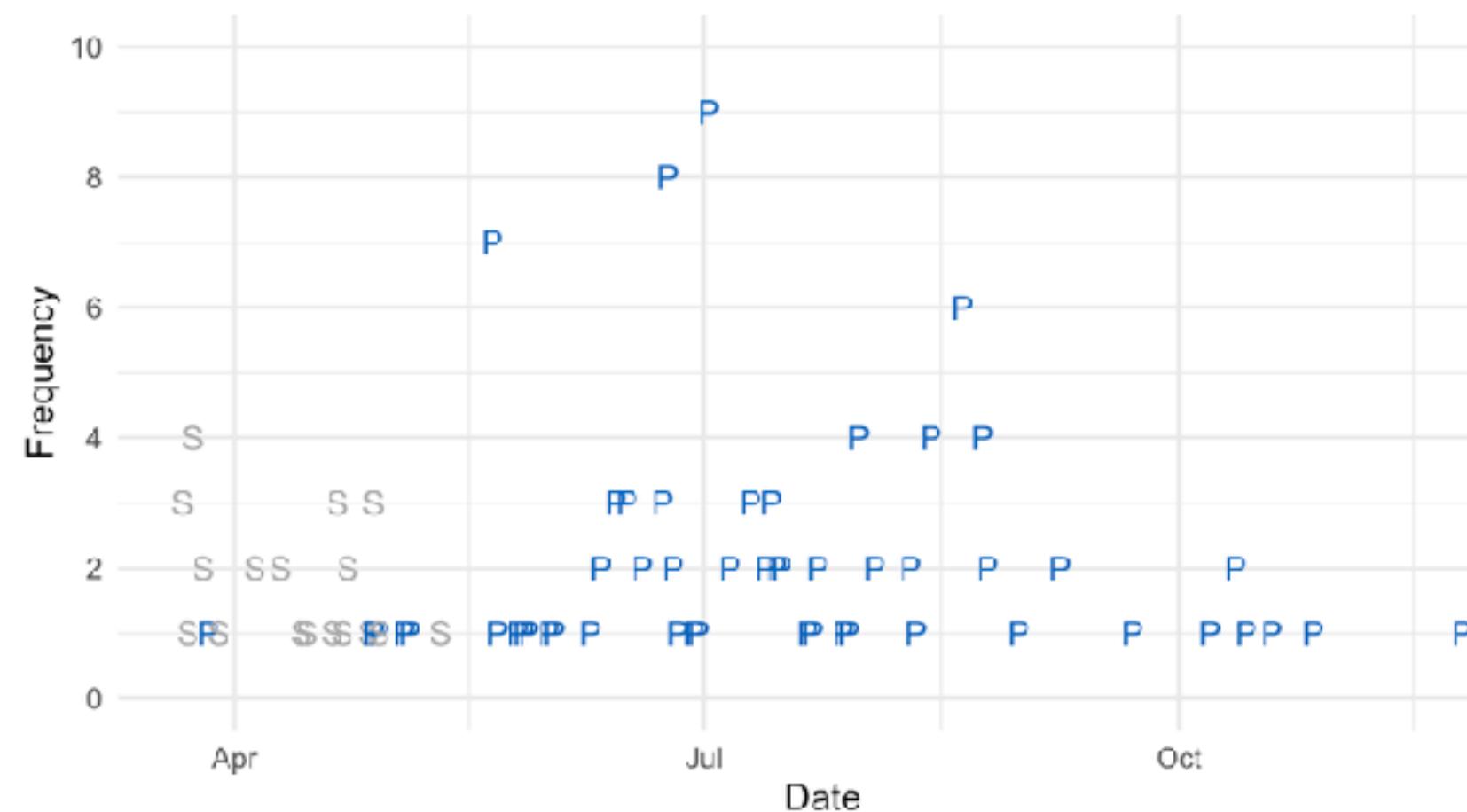
- [Coronavirus \(COVID-19\) update: First Minister's speech 26 October](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 23 October](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 22 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 21 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 20 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 19 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 16 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 15 October 2020](#)
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- [Coronavirus \(COVID-19\) update: First Minister's speech 12 October 2020](#)
- [Coronavirus \(COVID-19\) update: First Minister's speech 11 October 2020](#)



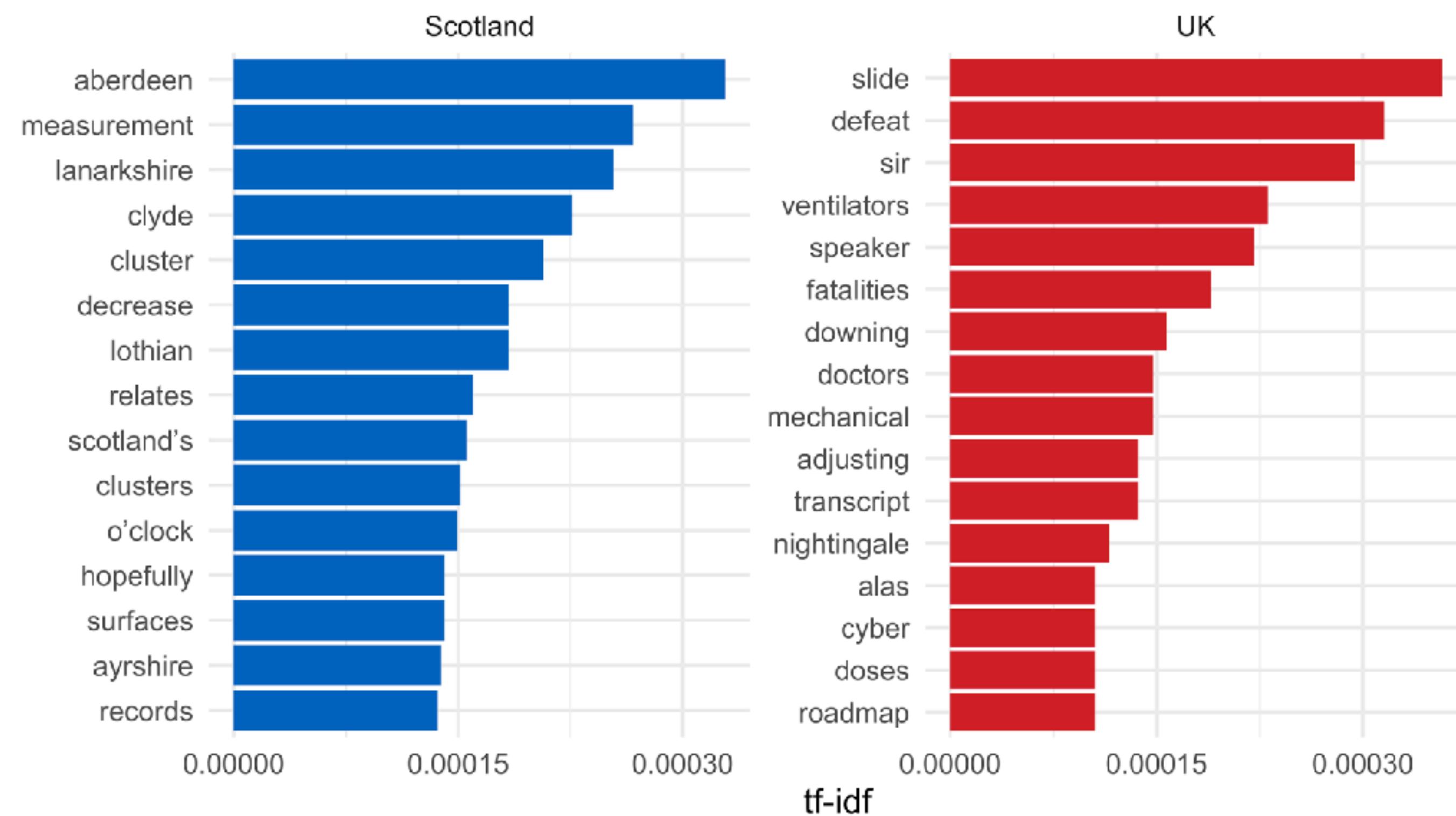
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## Social (S) vs. physical (P) distancing Number of mentions over time



## Common words in COVID briefings



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



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

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



```
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
```

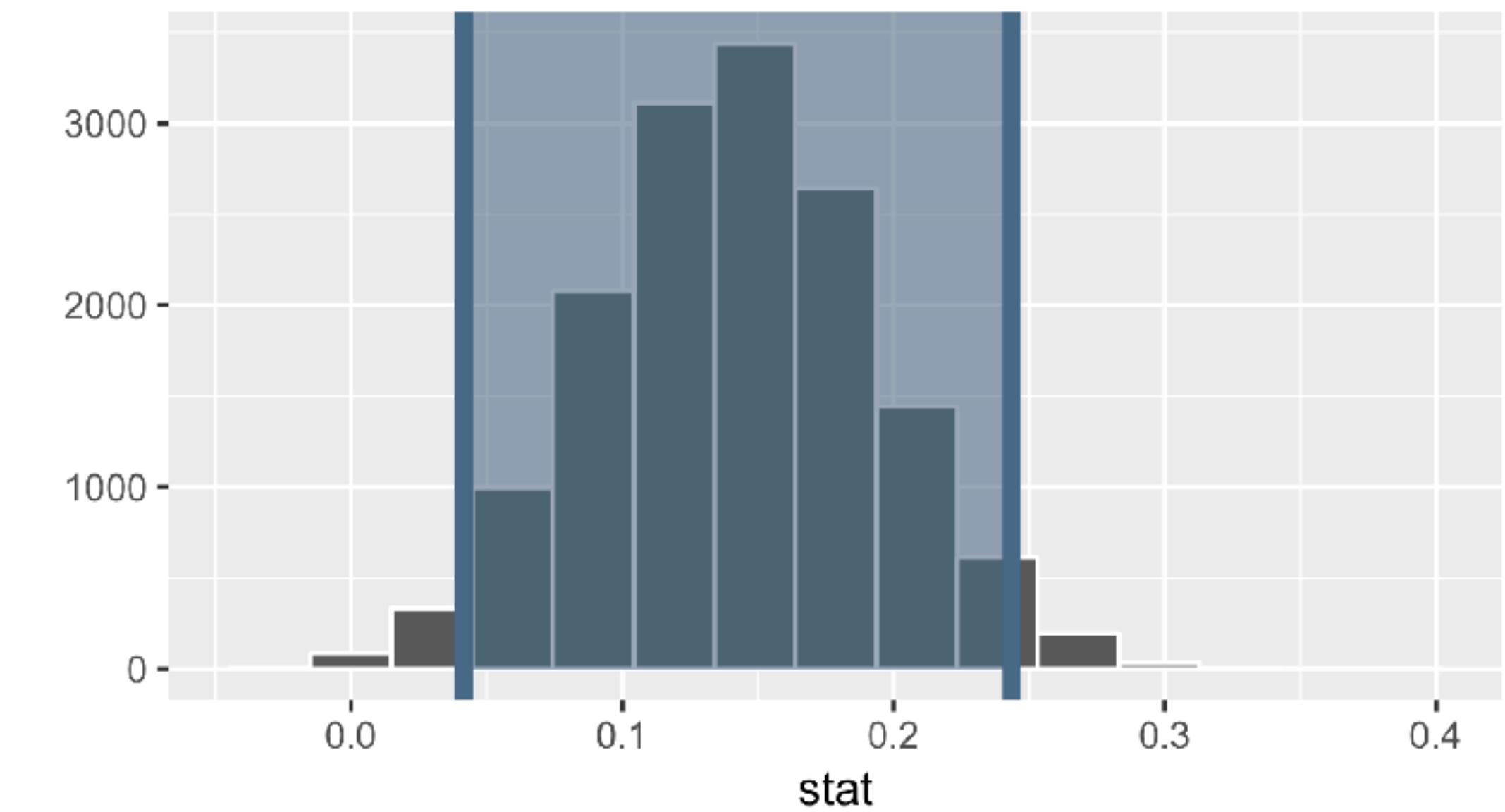


```
library(tidyverse)  
library(infer)  
  
evals %>%  
  specify(score ~ gender) %>%  
  generate(reps = 15000,  
           type = "bootstrap") %>%  
  calculate(stat = "diff in means",  
            order = c("male", "female")) %>%  
  summarise(  
    l = quantile(stat, 0.025),  
    u = quantile(stat,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

```
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
```



**the  
full  
curriculum**

Welcome | Data Science in a Box

datasciencebox.org

## Data Science in a Box

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Hello #dsbox!

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Infrastructure

14 Accessing R

15 Version control

16 Discussion

## Chapter 7 Exploring data | Data Science in a Box

### 7.1.2 Wrangling and tidying data

#### Unit 2 - Deck 5: Tidy data

Slides

Source

Video

Reading: JSS :: Tidy data

#### Unit 2 - Deck 6: Grammar of data wrangling

Slides

Source

Video

#### Unit 2 - Deck 7: Working with a single data frame

Slides

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Video

On this page

7 Exploring data

7.1 Slides, videos, and application exercises

7.1.1 Visualising data

7.1.2 Wrangling and tidying data

7.1.3 Importing and recoding data

7.1.4 Communicating data science results effectively

7.1.5 Web scraping and programming

7.2 Labs

7.3 Homework assignments

[View source](#)

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Designing the Data Science Classroom

https://rstd.io/design-ds-class

Day 1 - Monday, Jan 27

Time	Activity
09:00 - 10:30	Welcome + Curriculum design
10:30 - 11:00	Coffee break
11:00 - 12:30	Teaching the tidyverse
12:30 - 13:30	Lunch break
13:30 - 15:00	Computing infrastructure with RStudio Cloud
15:00 - 15:30	Coffee break
15:30 - 17:00	Case study: Design your assignment on RStudio Cloud

Day 2 - Tuesday, Jan 28

Materials for the Designing the Data Science Classroom workshop by Mine Çetinkaya-Rundel at rstudio::conf(2020)

View the Project on GitHub  
rstudio-conf-2020/design-ds-classroom

Download ZIP File   Download TAR Ball   View On GitHub

This project is maintained by [rstudio-conf-2020](#)

Hosted on GitHub Pages — Theme by [orderedlist](#)

Day 2 - Tuesday, Jan 28

Materials for Day 2 will be posted in the morning of Day 2

Time	Activity
09:00 - 10:30	Reproducible workflows: R Markdown, Git, GitHub
10:30 - 11:00	Coffee break
11:00 - 12:30	Getting more out of GitHub
12:30 - 13:30	Lunch break
13:30 - 15:00	Interactivity and immediate feedback
15:00 - 15:30	Coffee break
15:30 - 17:00	#rstats lifehacks for instructors + Wrap up

Let them eat cake (first)!\*

↳ [bit.ly/eat-cake-diz](http://bit.ly/eat-cake-diz)

</> [bit.ly/repo-eat-cake](http://bit.ly/repo-eat-cake)

\* You can tell them all about  
the ingredients later!



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