Describing Categorical Variables

Stat 120

January 11 2023

Descriptive Statistics

- *In order to make sense of data, we need ways to **summarize** and **visualize** it*
- *Summarizing and visualizing variables and relationships between two variables is often known as descriptive statistics, also known as **exploratory data analysis (EDA)***
- *The type of summary statistics and visualization methods depend on the type of variable(s) being analyzed (categorical or quantitative)*

One Categorical Variable

A random sample of US adults in 2012 were surveyed regarding the type of cell phone owned

Android? iPhone? Blackberry? Non-smartphone? No cell phone?

Frequency Table

A frequency table shows the number of cases or counts that fall in each category:

Subset of Raw Data	
Case 1	Android
Case 2	none
Case 3	none
Case 4	iPhone
Case 5	Non Smartphone
Case 6	iPhone
Case 7	Blackberry
Case 8	Non Smartphone
Case 9	Android
Case 10	Android
...	(for 2253 cases ...)

Cell Phone Type	Frequency
Android	458
iPhone	437
Blackberry	141
Non Smartphone	924
No Cell Phone	293
Total	2253

Proportion

The proportion in a category is found by

$$\text{proportion} = \frac{\text{number in category}}{\text{total sample size}}$$

Percentages/proportions (relative frequencies)

- p = proportion for a **population** (parameter)
- $\hat{p}$ = proportion for a **sample** (statistic) ("p-hat")

What proportion of adults sampled do not own a cell phone?

Cell Phone Type	Frequency	Proportion
Android	458	0.203
iPhone	437	0.194
Blackberry	141	0.063
Non Smartphone	924	0.41
No Cell Phone	293	0.13
Total	2253	1.000

Proportions and percentages can be used interchangeably

Distribution of a variable

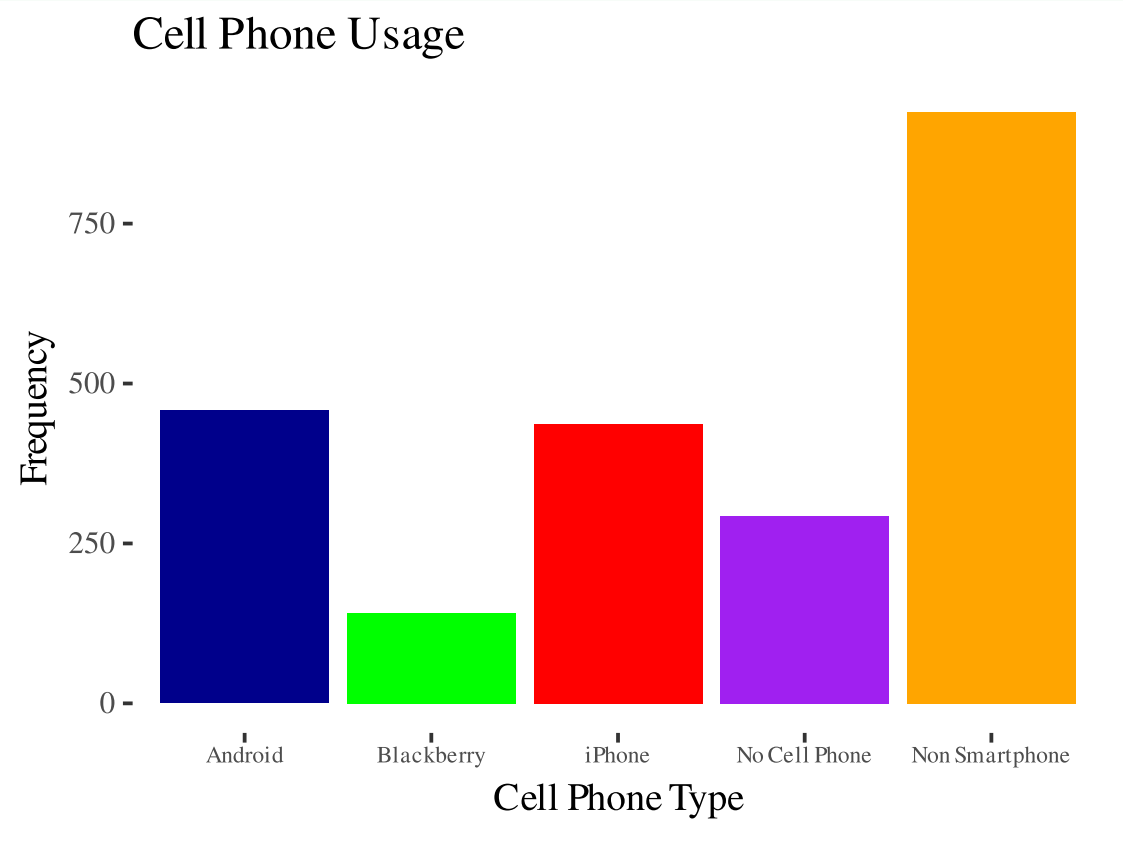
The "distribution of variable Y"

- describes the count or percent of observations that fall into each category of “variable Y”

- E.g. In the 2020 election, 51.3% of voters voted for Biden, 46.8% for Trump and 1.8% for third-party candidates

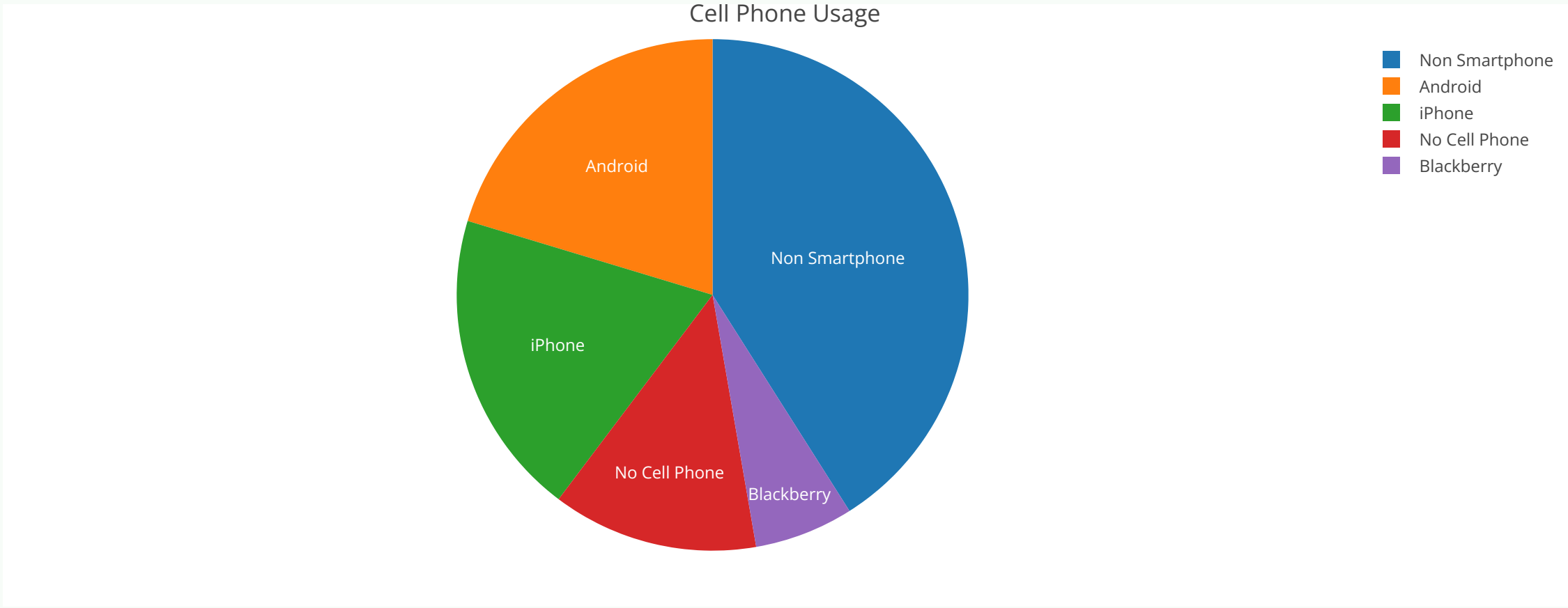
Bar Chart/Plot/Graph

In a barplot, the height of the bar corresponds to the number of cases falling in each category



Pie Chart

In a pie chart, the relative area of each slice of the pie corresponds to the proportion in each category



Two Categorical Variables

Look at the relationship between two categorical variables

- Relationship status
- Gender

	Female	Male	Total
In a Relationship	32	10	42
It's Complicated	12	7	19
Single	63	45	108
Total	107	62	169

We add a second dimension to a frequency table to account for the second categorical variable

Relationship status and Gender

Proportion of students that are in a relationship?

```
ans <- 42/169
round(ans,2)
[1] 0.25
```

Proportion of students in a relationship that are female?

```
ans <- 32/42
round(ans,2)
[1] 0.76
```

Proportion of students in a relationship that are male?

```
ans <- 10/42
round(ans,2)
[1] 0.24
```

Relationship status and Gender

Proportion of males that are in a relationship?

```
ans <- 10/62
round(ans,2)
[1] 0.16
```

Proportion of females that are in a relationship?

```
ans <- 32/107
round(ans,2)
[1] 0.3
```

Difference in proportions

A difference in proportions is a difference in proportions for one categorical variable calculated for different levels of the other categorical variable

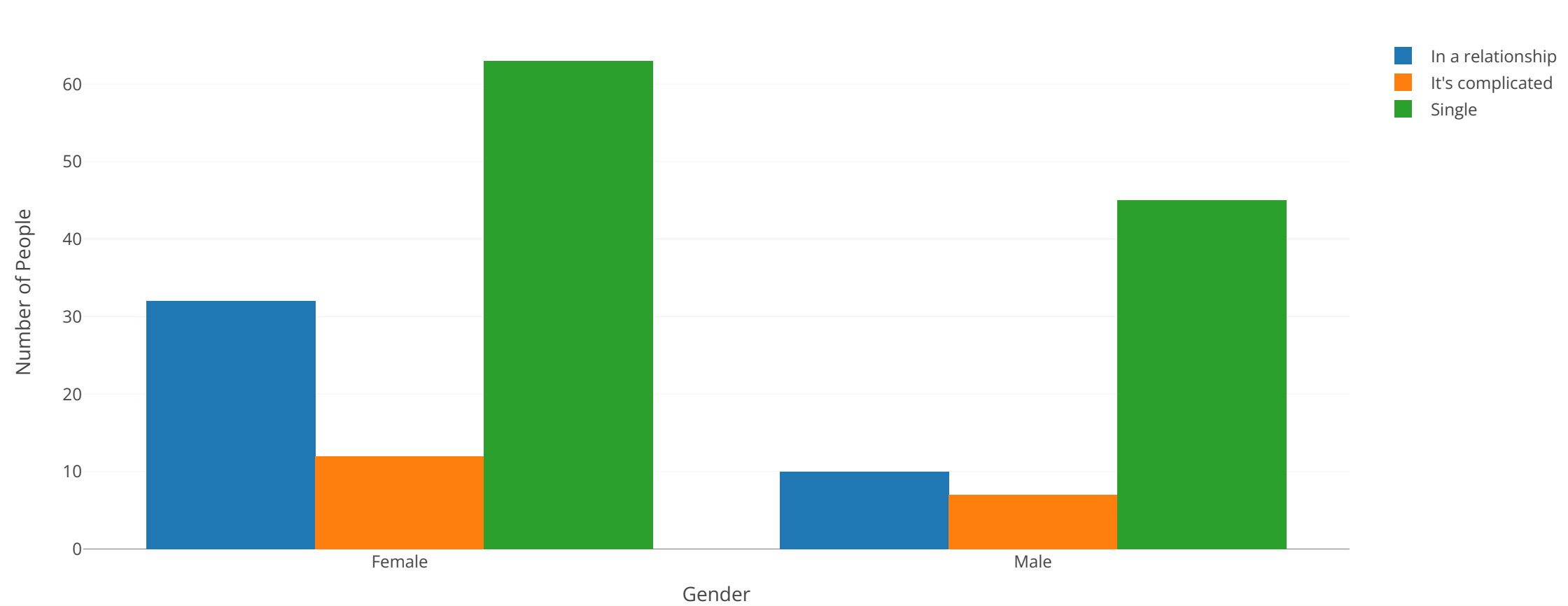
- Example: $\text{proportion}_{\text{Females}}$ - $\text{proportion}_{\text{Males}}$

$$\hat{p}_F - \hat{p}_M = \frac{32}{107} - \frac{10}{62} = 0.14$$

```
# R-code
prop.female <- 32/107
prop.male <- 10/62
prop.diff <- prop.female - prop.male
round(prop.diff,2)
[1] 0.14
```

Side-by-Side bar Chart

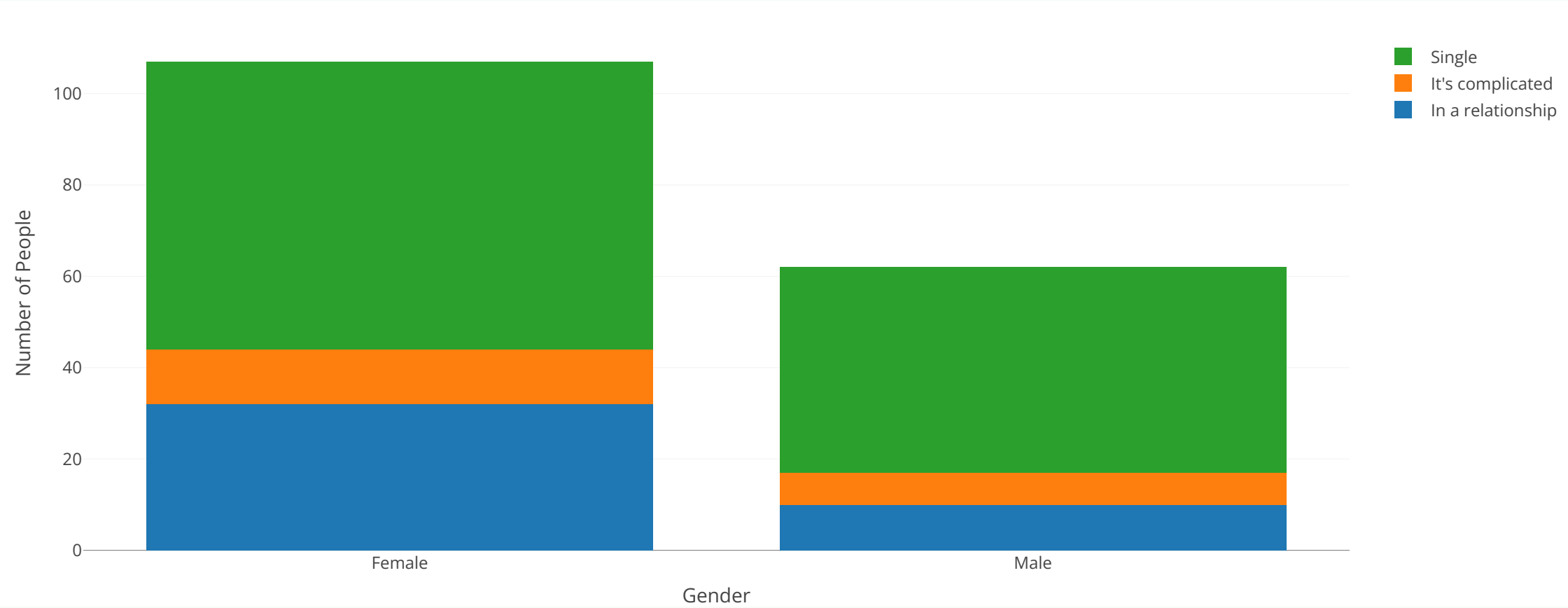
The height of each bar is the number of the corresponding cell in the two-way table



Source: https://www.lock5stat.com/StatKey/index.html

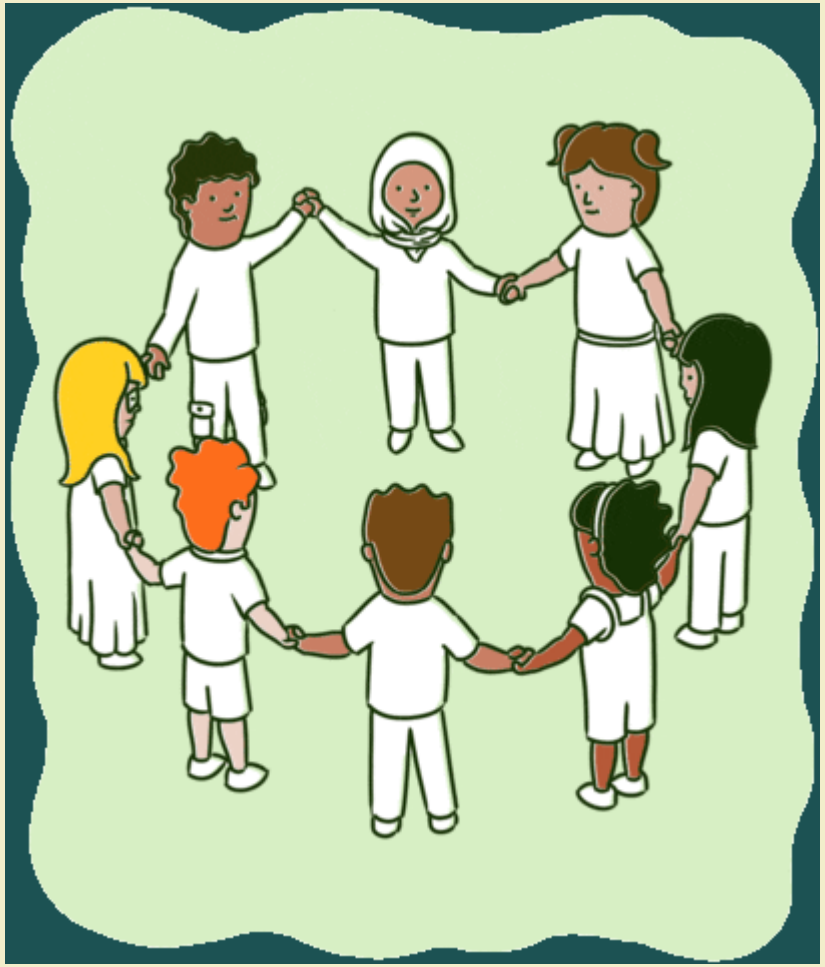
Segmented Bar Chart

A segmented bar chart is like a side-by-side bar chart, but the bars are stacked instead of side-by-side



Your Turn 1

05:00



- Let's go over this article
- Download the Class Activity .Rmd file for today and skim through the corresponding problems

Flowers v. Mississippi

2019 Supreme Court case:

- Has Mississippi prosecutor Doug Evans deliberately use "peremptory challenges" to strike black jurors from jury pools?

American Public Media journalist collected trial data from this district from 1992 to 2017 (Link)

The data set **APM_DougEvansCases.csv** contains data on 1517 jurors for cases which listed Doug Evans as the first prosecutor.

- Only looking at jurors with race listed as Black or White.
- These jurors are eligible for Evans to strike.

Source: Click here

Look at the data

```
jurors <- read.csv("https://raw.githubusercontent.com/deepbas/statdatasets/main/APM_
```

```
dim(jurors) # dimension of dataset
[1] 1517    6
```

Look at the first **three rows** of the data set

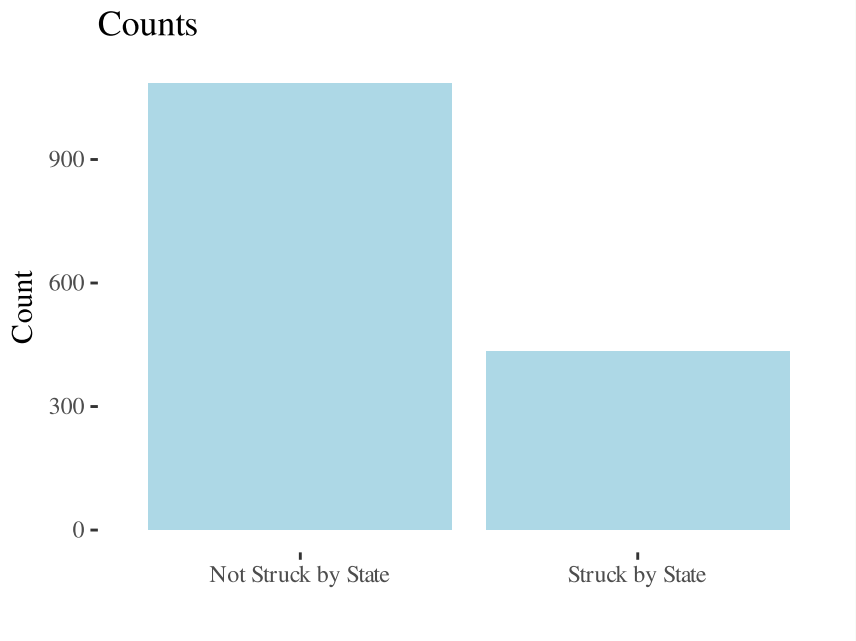
```
jurors[c(1,2,3), ]  #[rows, columns]
  trial__id  race        struck_state defendant_race      same_race
1         4 Black Not struck by State          White different race
2         4 Black     Struck by State          White different race
3         4 White Not struck by State          White      same race
                    struck_by
1 Juror chosen to serve on jury
2           Struck by the state
3 Juror chosen to serve on jury
```

Look at the data

```
jurors$struck_state[1:10] # first 10 entries in the `struck_state` variable
 [1] "Not struck by State" "Struck by State"     "Not struck by State"
 [4] "Not struck by State" "Struck by State"     "Not struck by State"
 [7] "Struck by State"     "Not struck by State" "Not struck by State"
[10] "Not struck by State"
```

Graphical summary: bar plot

```
library(ggplot2)  # load the library
counts_df <- data.frame(x=c("Not Struck by State
                            y=c(1084, 433))
ggplot(counts_df, aes(x=x, y=y)) +
  geom_col(fill="lightblue") +
  labs(x="", y="Count", title="Counts")
```



Associations between two categorical variables

How does state struck status vary by juror race? (How are race and state strikes associated?)

Numerically:

- summarize **counts** in a contingency/two-way table
- **conditional proportions:** "The conditional distribution of Y given variable X" describes how Y is distributed within each category of X (group by X).

Graphically:

- stacked bar graph of conditional proportions

Two-way (contingency) table

First 10 entries of `race` and `struck_state` variable is

```
jurors[(1:10), (2:3)]
    race        struck_state
1  Black Not struck by State
2  Black     Struck by State
3  White Not struck by State
4  White Not struck by State
5  Black     Struck by State
6  White Not struck by State
7  Black     Struck by State
8  White Not struck by State
9  White Not struck by State
10 White Not struck by State
```

`table` gives two-way tables when two variables are included.

```
(mytable <- table(jurors$race, jurors$struck_state))

        Not struck by State Struck by State
  Black                 225              310
  White                 859              123
```

Conditional proportions

`prop.table` gives conditional proportions grouped by the `row` variable when `margin=1`

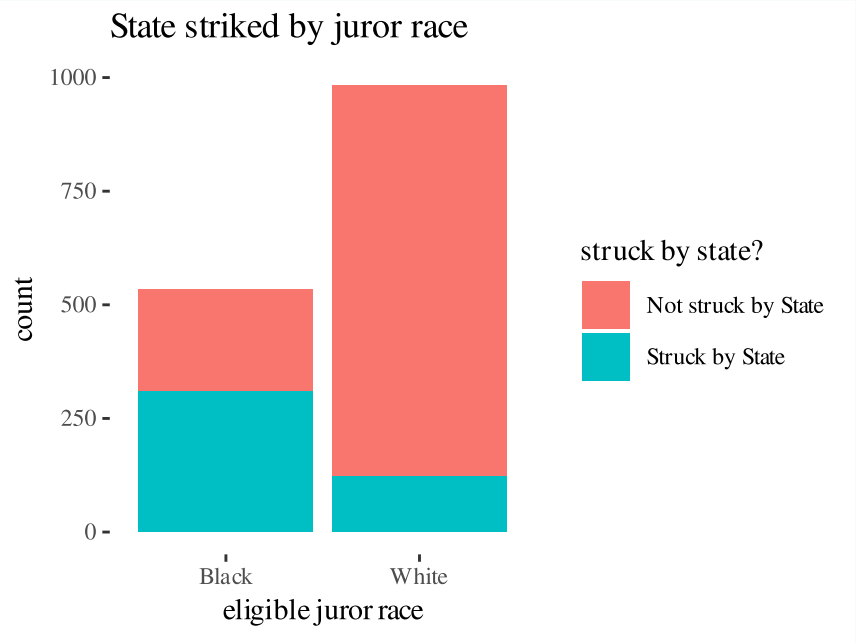
```
prop.table(mytable, margin = 1)

       Not struck by State Struck by State
  Black           0.4205607       0.5794393
  White           0.8747454       0.1252546
```

- Of all eligible black jurors, about 57.9% were struck by the state.
- What proportion of eligible white jurors were struck by the state?

Is there evidence of an association between juror race and state strikes?

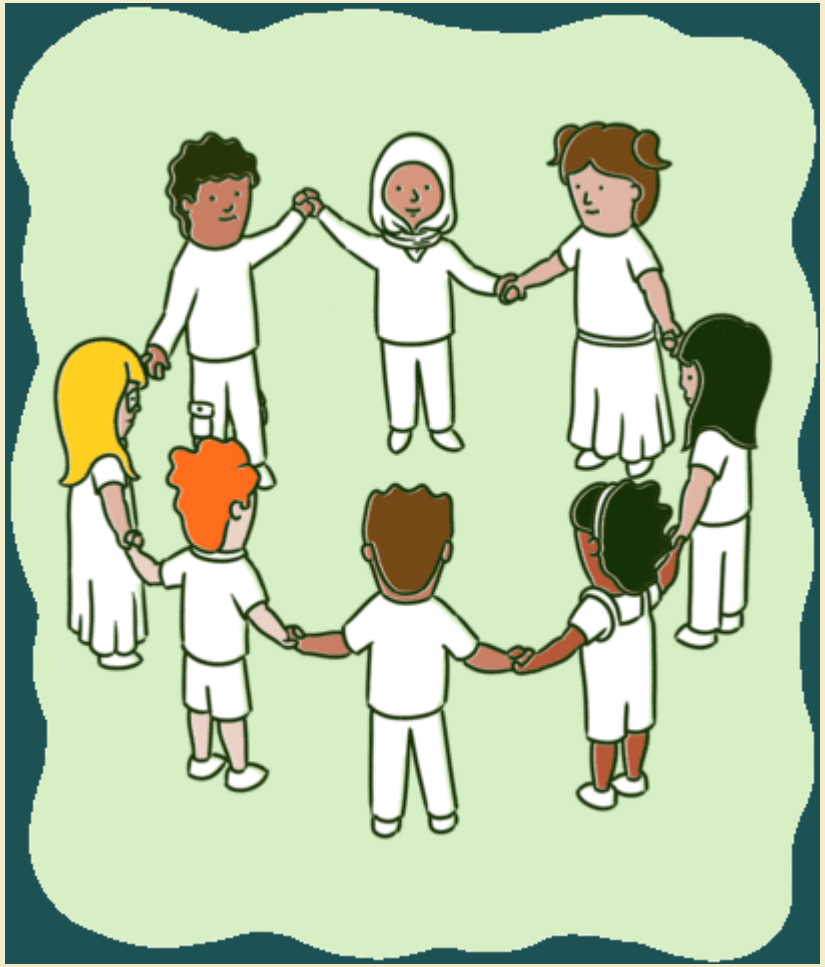
Stacked bar graph (counts)

```
# changes the `stuck_state` to a factor
jurors$struck_state <- factor(jurors$struck_stat
ggplot(jurors, aes(x = race, fill = struck_state
  geom_bar(stat="count") +
  labs(title = "State striked by juror race",
       y = "count",
       x = "eligible juror race",
       fill = "struck by state?")
```



Your Turn 2

05:00



- Please go over the rest of the in-class activity