Multivariate Analysis

Part 2: Visualizations

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Agenda

1. Why did the polls underestimate Trump support?

2. Rules of visualization

2020 polling

- Let's introduce a different dataset!
  - Download and open `Pres2020_PV.Rds`
  - Wrangle to get the popular vote margin, expressed in decimals

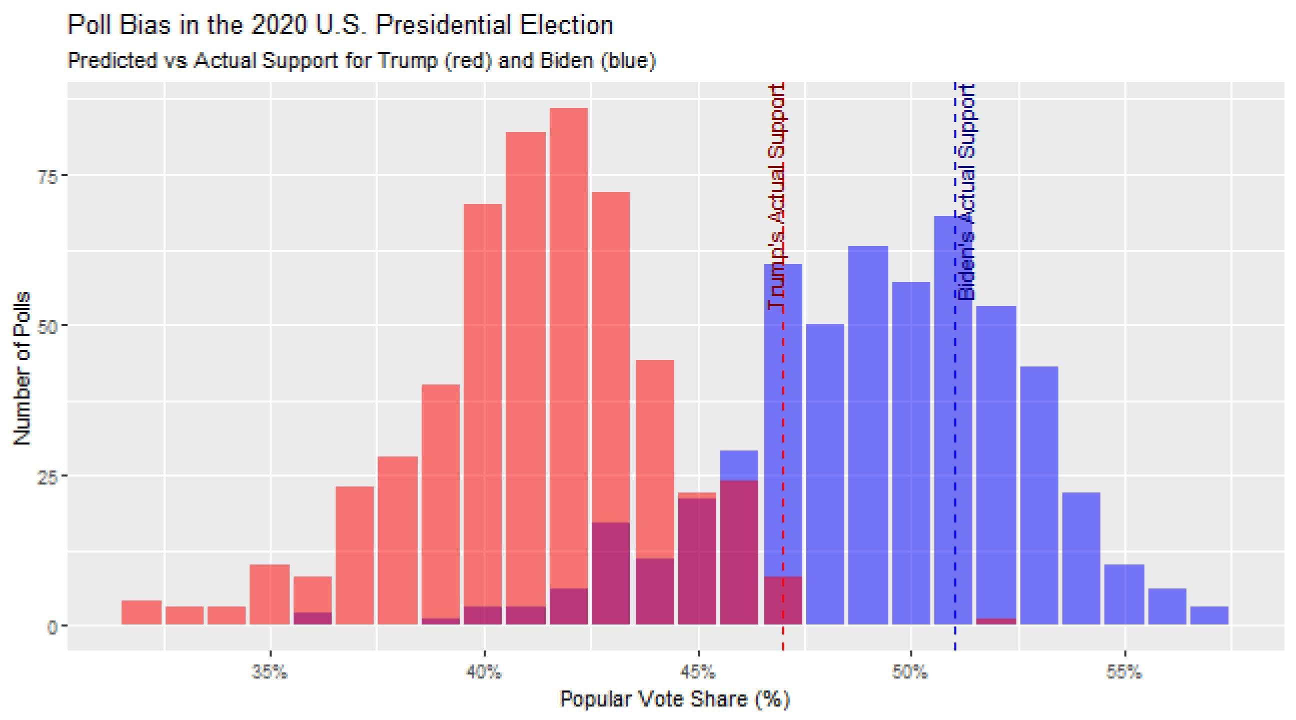
```
require(tidyverse)
poll <-
read_rds('https://github.com/jbisbee1/DS1000_F2024/raw/main/data/Pres20

poll <- poll %>%
  mutate(Trump = Trump/100,
         Biden = Biden/100,
         margin = Biden - Trump)
```

The Research Question

```
pRQ <- poll %>%
  ggplot() +
  geom_bar(aes(x = Biden*100),fill = 'blue',alpha = .5) +
  geom_bar(aes(x = Trump*100),fill = 'red',alpha = .5) +
  geom_vline(xintercept = 47,linetype = 'dashed',color= 'red') +
  geom_vline(xintercept = 51,linetype = 'dashed',color= 'blue')+
  annotate(geom = 'text',x = c(47),y = Inf,angle = 90,hjust = 1,vjust
= 0,label = c("Trump's Actual Support"),color = 'darkred') +
  annotate(geom = 'text',x = c(51),y = Inf,angle = 90,hjust = 1,vjust
= 1,label = c("Biden's Actual Support"),color = 'darkblue') +
  labs(title = 'Poll Bias in the 2020 U.S. Presidential Election',
       subtitle = 'Predicted vs Actual Support for Trump (red) and
Biden (blue)',
       x = 'Popular Vote Share (%)',
       y = 'Number of Polls') +
  scale_x_continuous(breaks = seq(30,60,by = 5),labels = function(x)
paste0(x,'%'))
```

The Research Question

pRQ



The Research Question

```r
poll %>% # Proportion that under-predict
  summarise(propBidenUP = mean(Biden < .51),
            propTrumpUP = mean(Trump < .47))
```

```
## # A tibble: 1 × 2
##   propBidenUP propTrumpUP
##         <dbl>       <dbl>
## 1       0.612       0.983
```

```r
poll %>% # Average under-prediction
  summarise(avgBidenErr = mean(.51 - Biden),
            avgTrumpErr = mean(.47 - Trump))
```

```
## # A tibble: 1 × 2
##   avgBidenErr avgTrumpErr
##         <dbl>       <dbl>
## 1      0.0175      0.0577
```

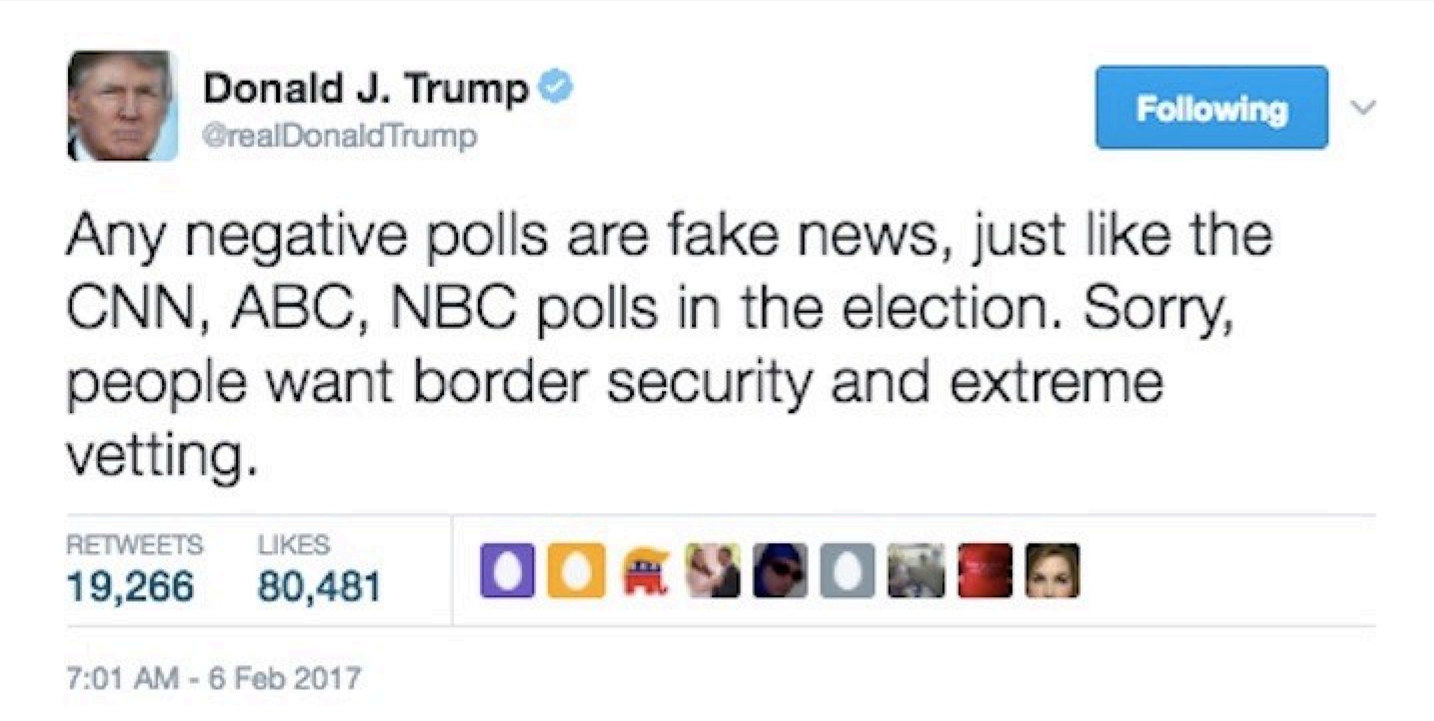
Theorizing

- Research Question: Why do polls under-predict Trump more than Biden?

    1. Unrepresentative samples (how were respondents contacted?)
    2. Small samples (how many respondents?)
    3. Shy Trump Voters / trolls (lying respondents)
    4. Timing (closer to the election → less biased)

Theorizing

- A fifth explanation?
- Anti-Trump media!



Donald J. Trump
@realDonaldTrump

Any negative polls are fake news, just like the CNN, ABC, NBC polls in the election. Sorry, people want border security and extreme vetting.

RETWEETS 19,266 LIKES 80,481

7:01 AM - 6 Feb 2017

Theorizing

- However...

Theorizing

- Theory #1: Does the "mode" of the survey matter?
    - I.e., if you only call people on landlines, who do you reach?
    - And how might they differ from the general population?
- Assumption 1: Younger people do not use landlines, meaning that surveys which rely on **r**andom **d**igit **d**ialing (RDD) will get disproportionately older respondents.
- Assumption 2: Younger voters are more progressive, making them less likely to support Trump.
- Theory: Surveys that use RDD will find more support for Trump than Biden.

Analyzing

- Plot the Biden-Trump vote margin by mode type

```
poll %>%
  count(Mode)
```

```
## # A tibble: 9 × 2
##   Mode                   n
##   <chr>              <int>
## 1 IVR                    1
## 2 IVR/Online            47
## 3 Live phone - RBS      13
## 4 Live phone - RDD      51
## 5 Online               366
## 6 Online/Text            1
## 7 Phone - unknown        1
## 8 Phone/Online          19
## 9 <NA>                  29
```

- So many modes of interviewing people!

(Soft) Rules of Visualization

- Variable `type` informs visualization

1. Univariate
   - Categorical data: `geom_bar()`
   - Continuous data: `geom_histogram()` or `geom_density()`
2. Bivariate
   - Categorical X Categorical: `geom_bar()`
   - Binary X Continuous: `geom_histogram()` or `geom_density()`
   - Categorical X Continuous: `geom_boxplot()` or `geom_violin()`
   - Continuous X Continuous: `geom_point()`

Beyond Bivariate

1. Trivariate
   - Categorical X Categorical X Continuous: `geom_tile()`
   - Continuous X Continuous X Categorical: `geom_point()` + `color`
   - Continuous X Continuous X Continuous: `geom_point()` + `color`/`size`
   - Latitude X Longitude X Categorical / Continuous: Maps!
   - Var X Var X Time: Animated!
   - (Beyond the scope of this course, but get creative!)

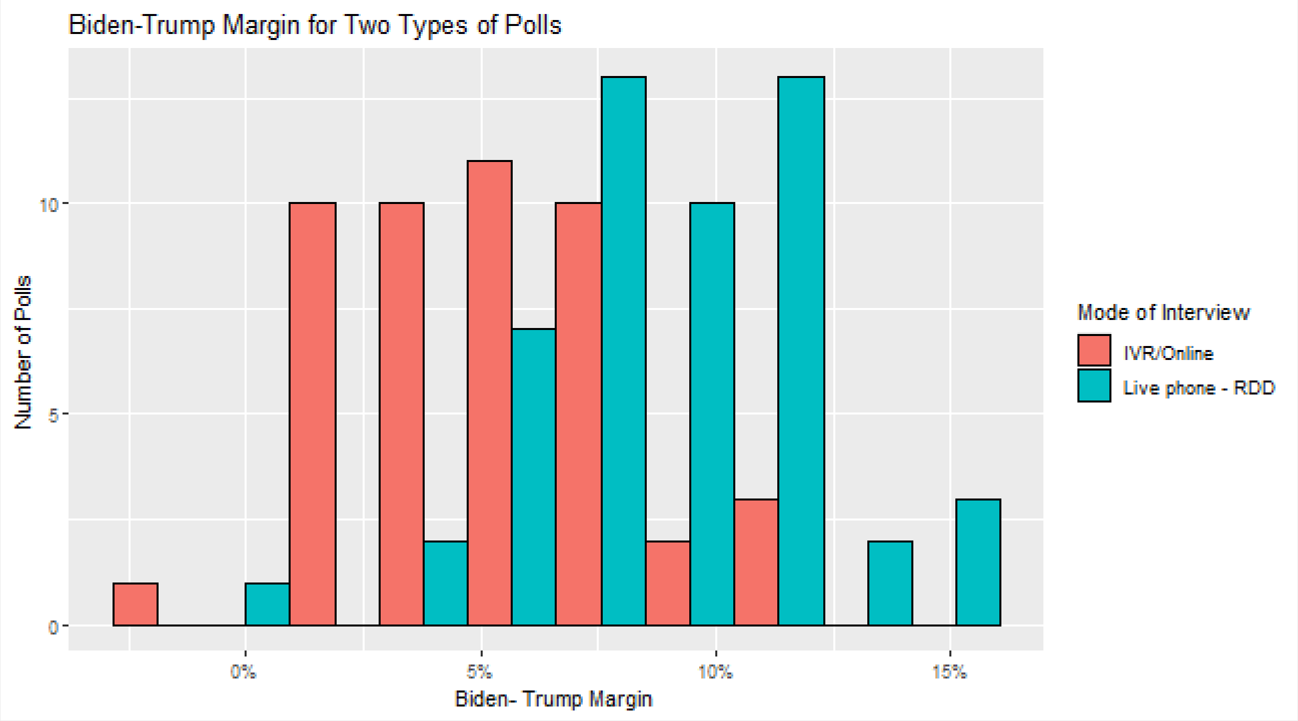
Analyzing

- For now, just focus on `IRV/Online` versus `Live phone - RDD`
- Since `margin` is a continuous variable, use `geom_histogram`

```r
pMode <- poll %>%
  filter(Mode == "IVR/Online" | Mode == "Live phone - RDD") %>%
    ggplot(aes(x= margin, fill = Mode)) +
  labs(y = "Number of Polls",
         x = "Biden- Trump Margin",
         title = "Biden-Trump Margin for Two Types of Polls",
        fill = "Mode of Interview") +
    geom_histogram(bins=10, color="black", position="dodge") +
    scale_x_continuous(breaks=seq(-.1,.2,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

Mode Matters!

```
pMode
```



- But results are **inconsistent** with our theory!

Visualization

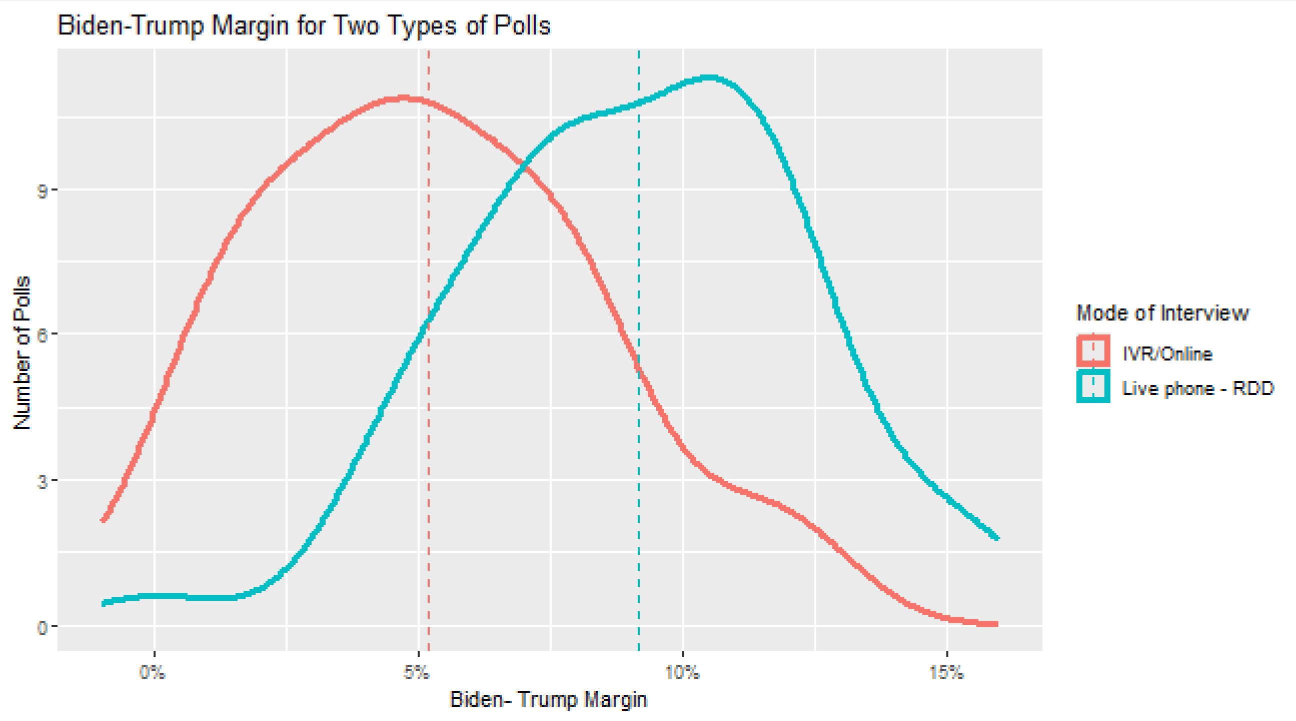
- How can we improve this? Perhaps `geom_density()` and `geom_vline()`?

```r
toplot <- poll %>%
  filter(Mode == "IVR/Online" | Mode == "Live phone - RDD")

pModeDens <- toplot %>%
  ggplot(aes(x= margin, color = Mode)) +
  labs(y = "Number of Polls",
       x = "Biden- Trump Margin",
       title = "Biden-Trump Margin for Two Types of Polls",
       color = "Mode of Interview") +
  geom_density(lwd = 1.2) +
  scale_x_continuous(breaks=seq(-.1,.2,by=.05),
                     labels= scales::percent_format(accuracy = 1)) +
  geom_vline(data = toplot %>%
               group_by(Mode) %>%
               summarise(margin = mean(margin)),aes(xintercept =
margin,color = Mode),linetype = 'dashed')
```

Visualization

- How can we improve this? Perhaps `geom_density()` and `geom_vline()`?

```
pModeDens
```



More Modes

- `geom_histogram()` and `geom_density()` less useful for more comparisons
- First, let's drop modes that were hardly used

```
(toKeep <- poll %>%
  count(Mode) %>%
  filter(n > 5,
         !is.na(Mode)))
```

```
## # A tibble: 5 × 2
##   Mode                   n
##   <chr>              <int>
## 1 IVR/Online            47
## 2 Live phone - RBS      13
## 3 Live phone - RDD      51
## 4 Online               366
## 5 Phone/Online          19
```

```
toplot <- poll %>% filter(Mode %in% toKeep$Mode)
```

More Modes

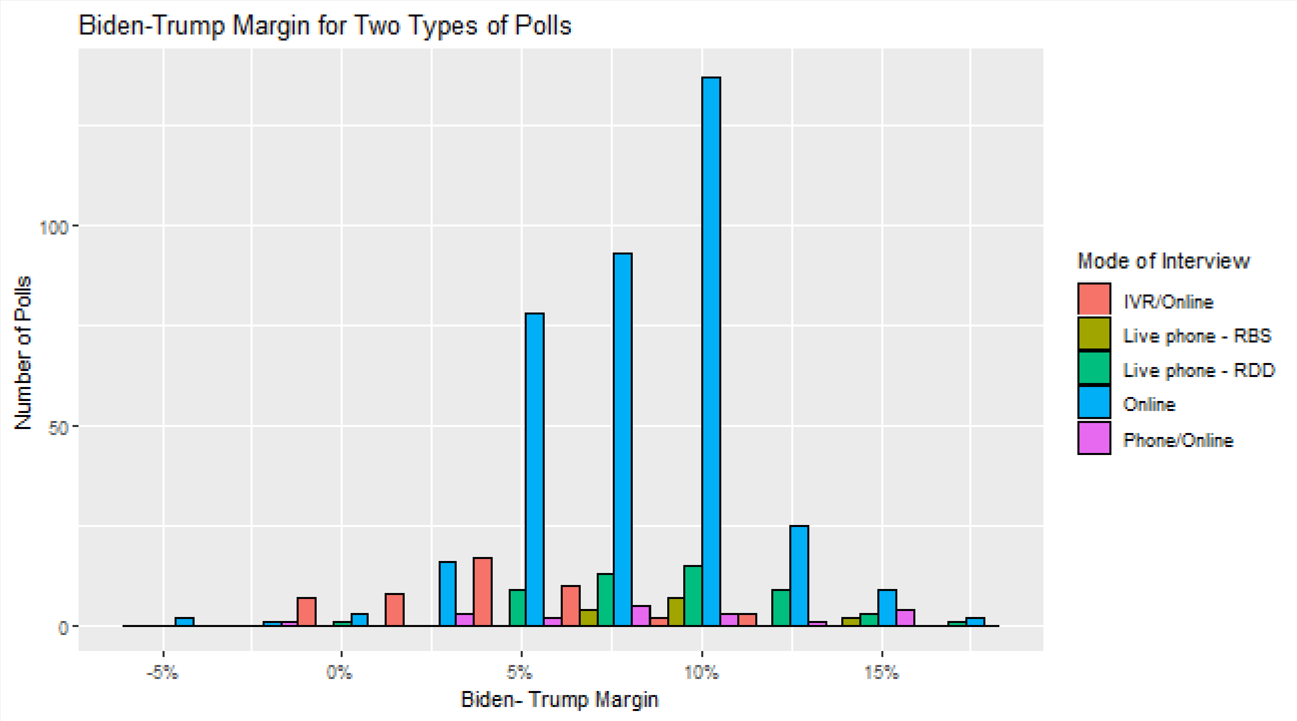
- How hard is `geom_histogram()` with more categories?

```
pModeHist <- toplot %>%
  ggplot(aes(x= margin, fill = Mode)) +
  labs(y = "Number of Polls",
       x = "Biden- Trump Margin",
       title = "Biden-Trump Margin for Two Types of Polls",
       fill = "Mode of Interview") +
  geom_histogram(color = 'black',position = 'dodge',bins = 10) +
  scale_x_continuous(breaks=seq(-.1,.2,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

More Modes

- How hard is `geom_histogram()` with more categories?

```
pModeHist
```



More Modes

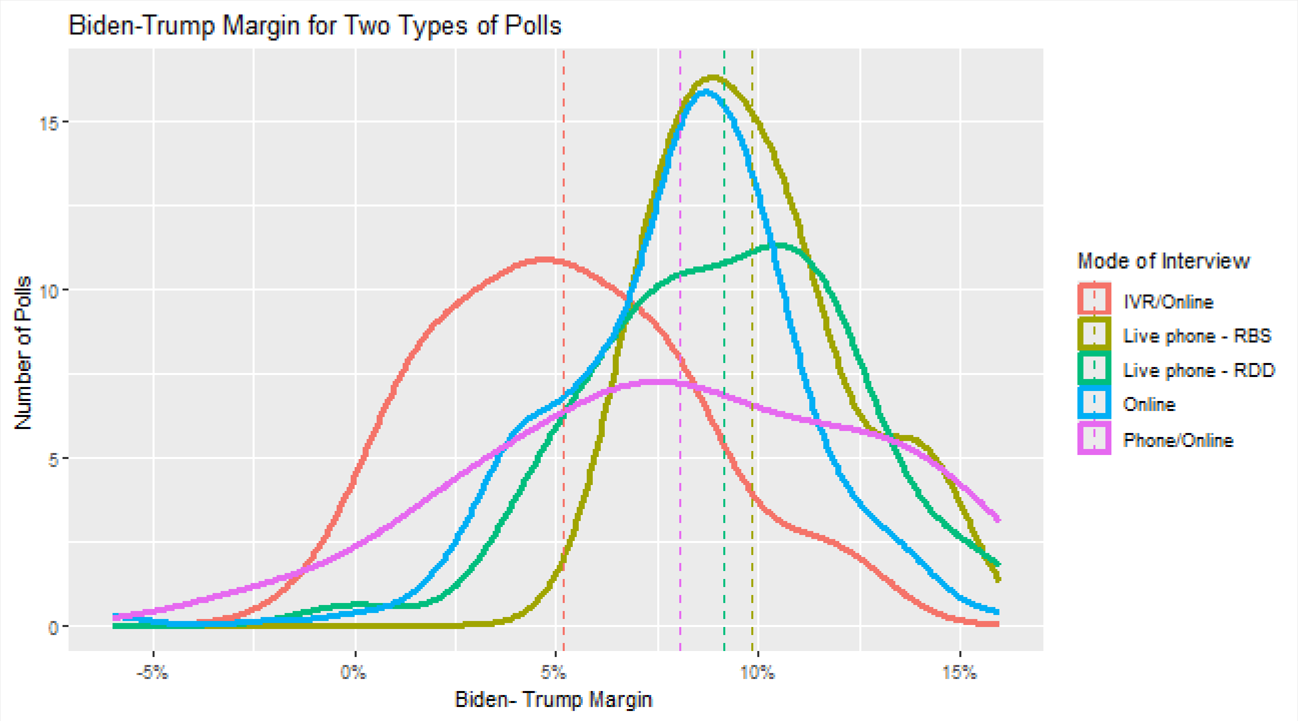
- How hard is `geom_density()` with more categories?

```
pModeDens <- toplot %>%
  ggplot(aes(x= margin, color = Mode)) +
  labs(y = "Number of Polls",
       x = "Biden- Trump Margin",
       title = "Biden-Trump Margin for Two Types of Polls",
       color = "Mode of Interview") +
  geom_density(lwd = 1.2) +
  scale_x_continuous(breaks=seq(-.1,.2,by=.05),
                     labels= scales::percent_format(accuracy = 1)) +
  geom_vline(data = toplot %>%
               group_by(Mode) %>%
               summarise(margin = mean(margin)),aes(xintercept =
margin,color = Mode),linetype = 'dashed')
```

More Modes

- How hard is `geom_density()` with more categories?

```
pModeDens
```



geom_boxplot()

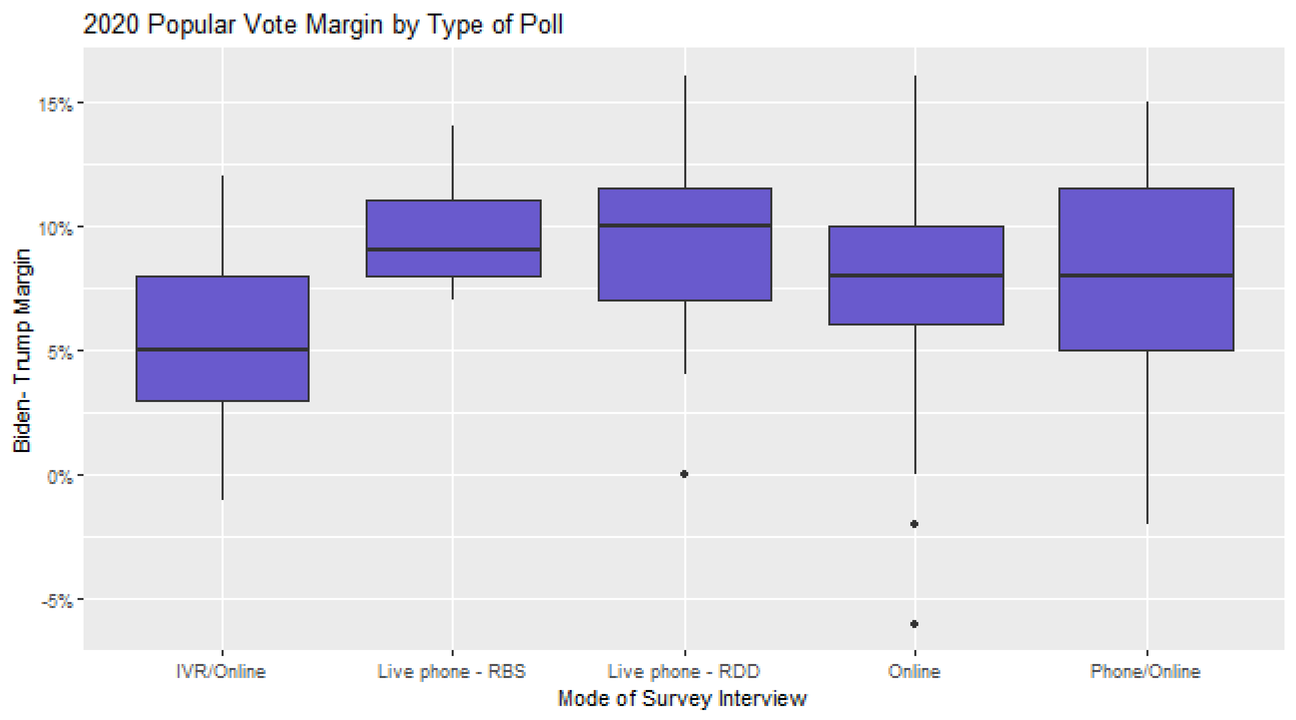
- More categories requires more compact ways of visualizing distributions

```r
pModeBox <- toplot %>%
  ggplot(aes(x = Mode, y = margin)) +
    labs(x = "Mode of Survey Interview",
         y = "Biden- Trump Margin",
         title = "2020 Popular Vote Margin by Type of Poll") +
    geom_boxplot(fill = "slateblue") +
    scale_y_continuous(breaks=seq(-.1,.2,by=.05),
                             labels= scales::percent_format(accuracy = 1))
```

geom_boxplot()

- More categories requires more compact ways of visualizing distributions

```
pModeBox
```



Ordering Unordered Categories

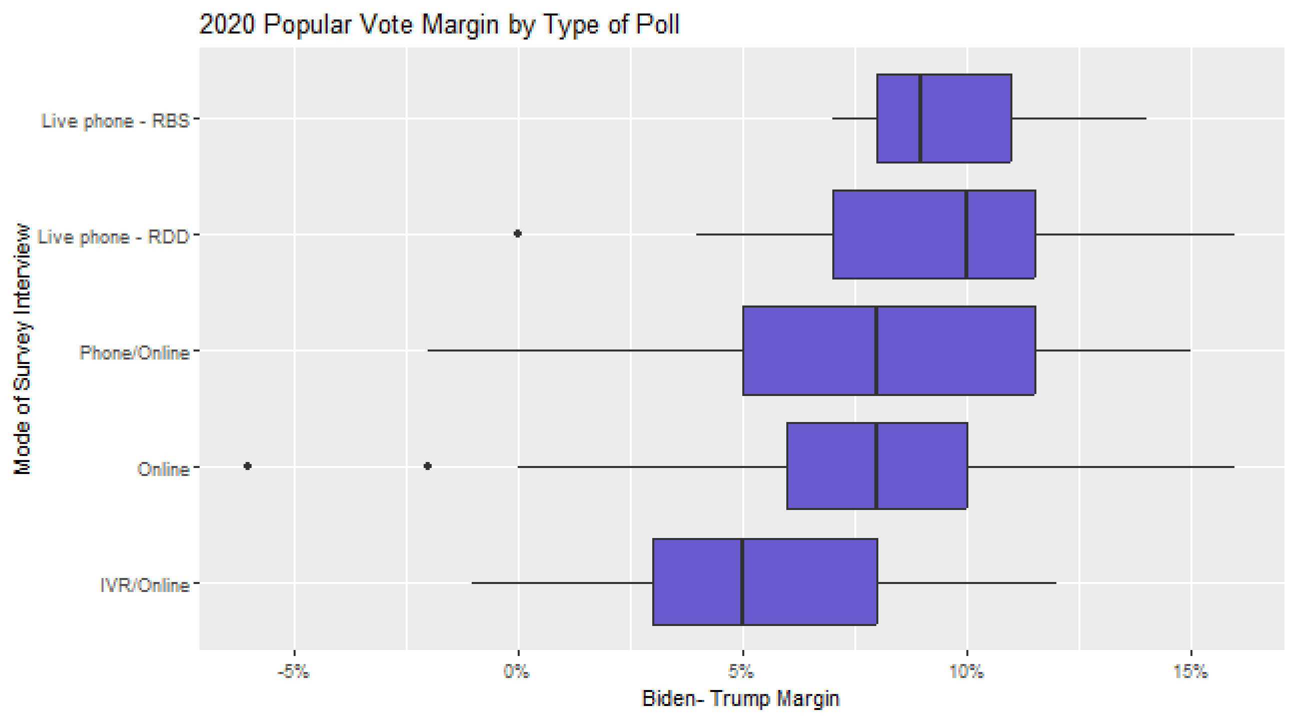
- We can use `reorder()` to arrange categories by the data

```
pModeBox <- toplot %>%
  ggplot(aes(x = reorder(Mode,margin), y = margin)) +
    labs(x = "Mode of Survey Interview",
         y = "Biden- Trump Margin",
         title = "2020 Popular Vote Margin by Type of Poll") +
    geom_boxplot(fill = "slateblue") +
    scale_y_continuous(breaks=seq(-.1,.2,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

Ordering Unordered Categories

- We can use `reorder()` to arrange categories by the data

```
pModeBox + coord_flip()
```



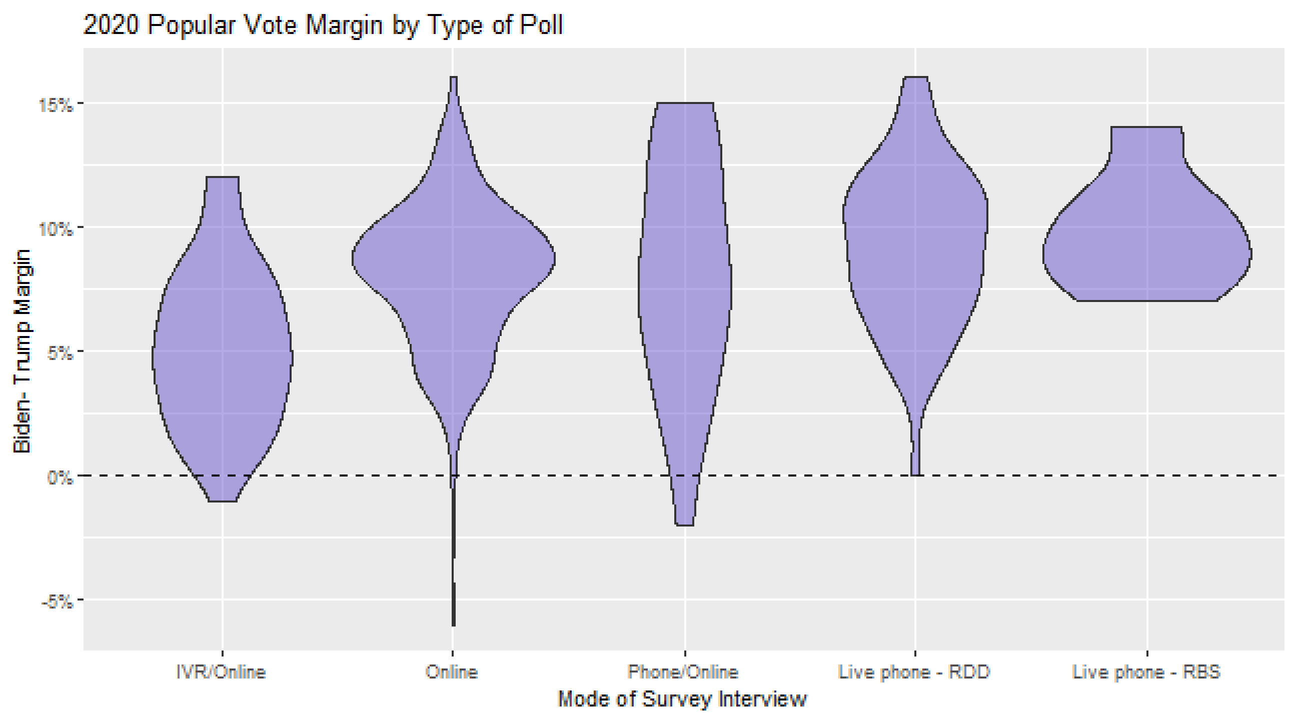
geom_violin()

- Boxplots are cleaner than densities and histograms for multiple categories
- But we lose ability to see distributions within the 80% box

```r
pModeViol <- toplot %>%
  ggplot(aes(x = reorder(Mode,margin), y = margin)) +
    labs(x = "Mode of Survey Interview",
         y = "Biden- Trump Margin",
         title = "2020 Popular Vote Margin by Type of Poll") +
    geom_violin(fill = "slateblue",alpha = .5) +
    scale_y_continuous(breaks=seq(-.1,.2,by=.05),
                       labels= scales::percent_format(accuracy = 1))
```

geom_violin()

```
pModeViol + geom_hline(yintercept = 0,linetype = 'dashed')
```



Continuous by Continuous

- For conditional relationships between two continuous variables, use `geom_point()`
- Theory: Are polls politically biased?
  - I.e., a Biden-friendly poll might **under**predict Trump support and **over**predict Biden support
- Data: Trump support conditional on Biden support

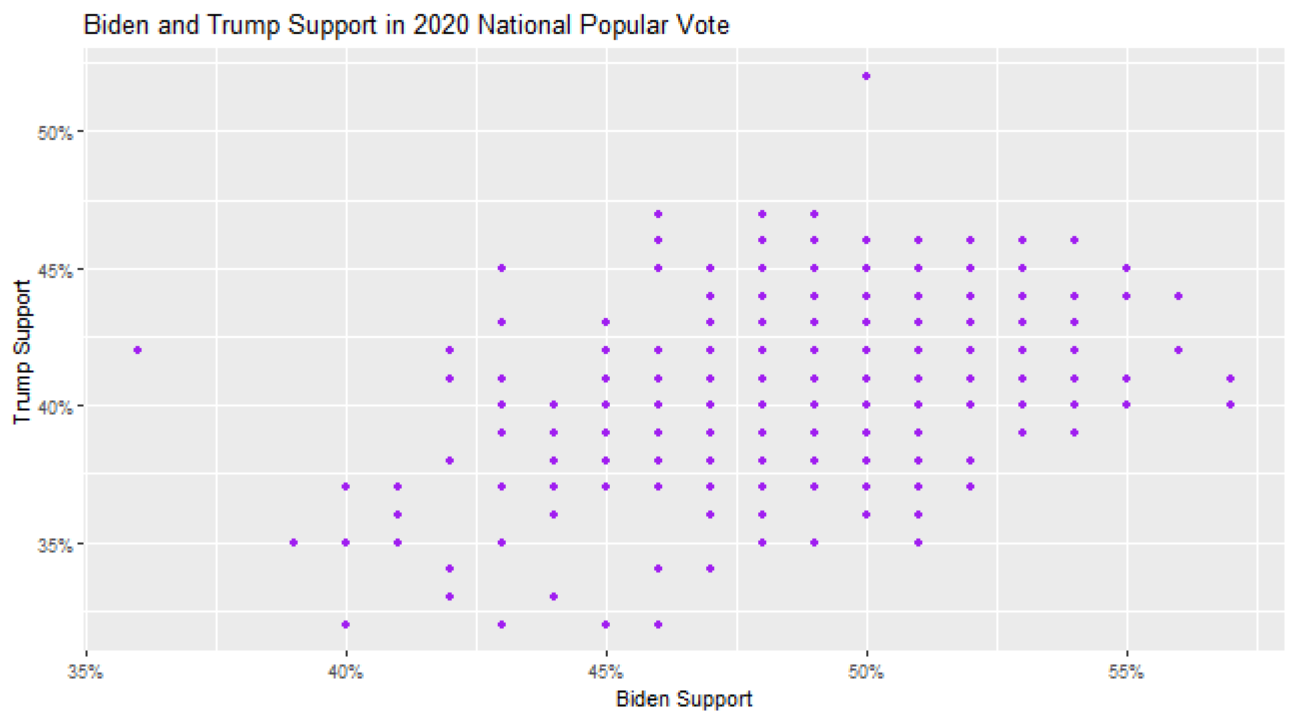
Analysis

- Plot Trump support versus Biden support

```r
pSupp <- poll %>%
  ggplot(aes(x = Biden, y = Trump)) +
  labs(title="Biden and Trump Support in 2020 National Popular Vote",
       y = "Trump Support",
       x = "Biden Support") +
  geom_point(color="purple") +
    scale_y_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1)) +
  scale_x_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

geom_scatter()

```
pSupp
```



- How many observations are at each point?

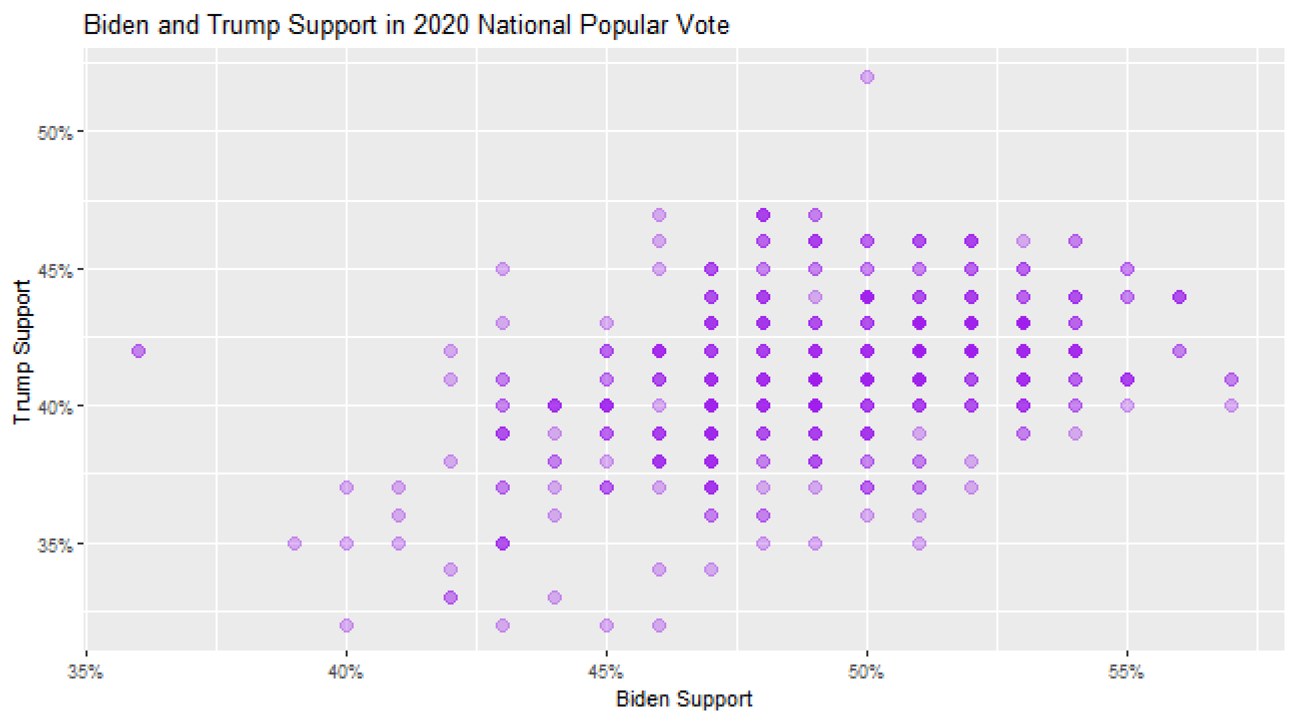
Tweaking `alpha`

- We can set the transparency of each point such that multiple points will show up darker
  - I.e., `alpha=.3` means that a single point will be 70% transparent, but 3 points on top of each other will be 10% transparent

```r
pSupp <- poll %>%
  ggplot(aes(x = Biden, y = Trump)) +
  labs(title="Biden and Trump Support in 2020 National Popular Vote",
       y = "Trump Support",
       x = "Biden Support") +
  geom_point(color="purple",alpha = .3,size = 3) +
    scale_y_continuous(breaks=seq(0,1,by=.05),
                       labels= scales::percent_format(accuracy = 1)) +
  scale_x_continuous(breaks=seq(0,1,by=.05),
                       labels= scales::percent_format(accuracy = 1))
```

Tweaking `alpha`

```
pSupp
```



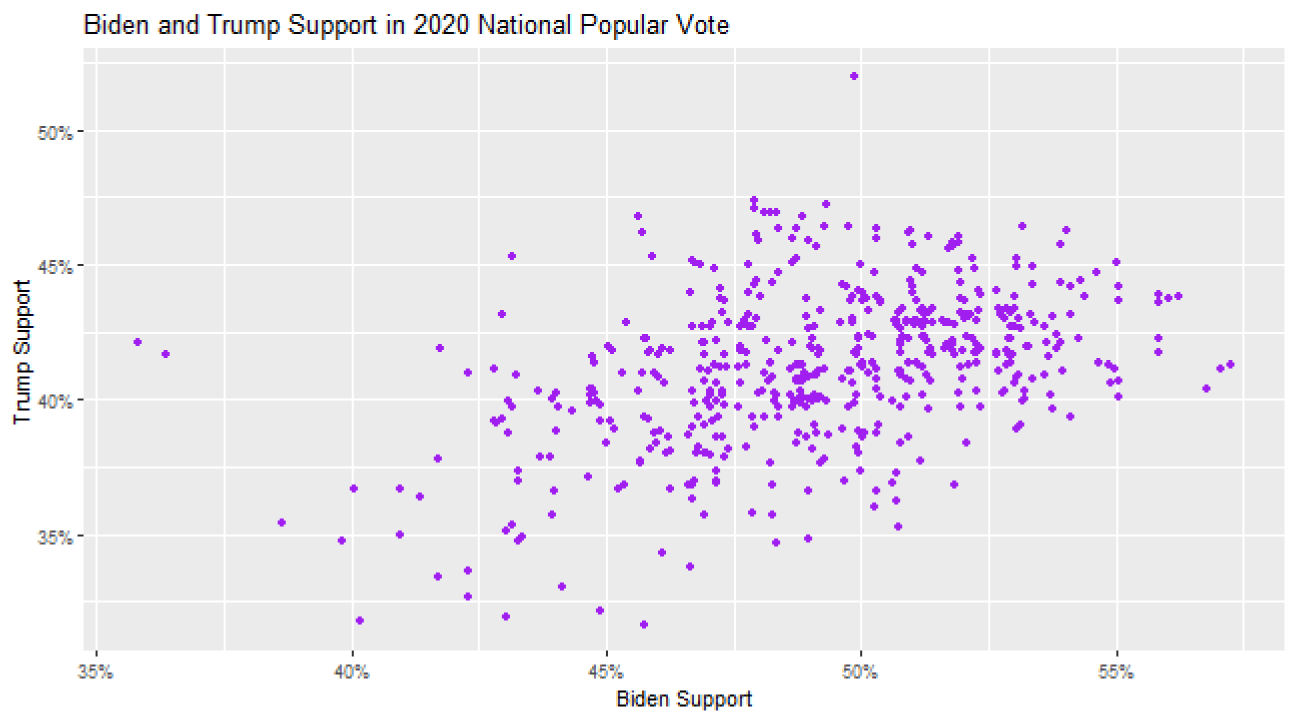
geom_jitter()

- Instead, we could "jitter" the points
  - This adds some random noise to each point to shake them off each other

```
pSupp <- poll %>%
  ggplot(aes(x = Biden, y = Trump)) +
  labs(title="Biden and Trump Support in 2020 National Popular Vote",
       y = "Trump Support",
       x = "Biden Support") +
  geom_jitter(color="purple") +
    scale_y_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1)) +
  scale_x_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

geom_jitter()

```
pSupp
```



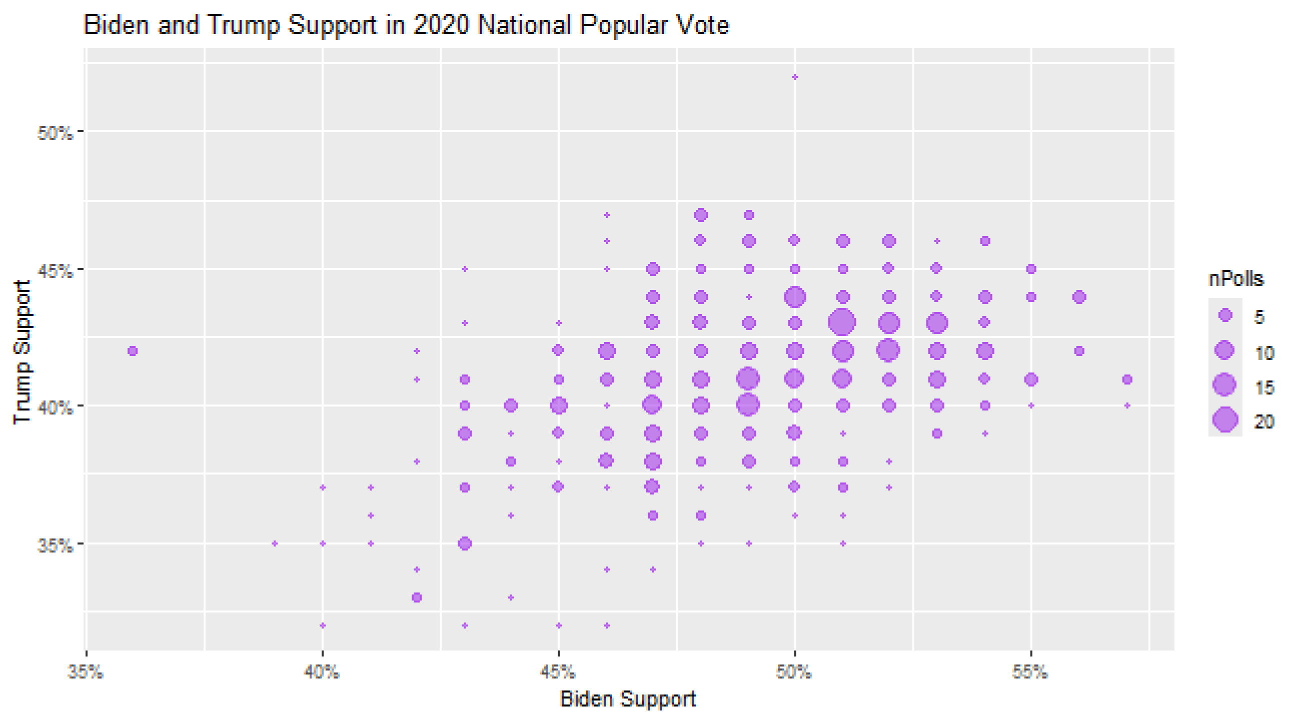
size

- Finally, we could simply count the number of polls at each x,y coordinate
  - Then size the points by the number of polls

```r
pSupp <- poll %>%
  group_by(Biden,Trump) %>%
  summarise(nPolls = n()) %>%
  ggplot(aes(x = Biden, y = Trump,size = nPolls)) +
  labs(title="Biden and Trump Support in 2020 National Popular Vote",
       y = "Trump Support",
       x = "Biden Support") +
  geom_point(color="purple",alpha = .5) +
    scale_y_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1)) +
  scale_x_continuous(breaks=seq(0,1,by=.05),
                     labels= scales::percent_format(accuracy = 1))
```

size

```
pSupp
```


Biden and Trump Support in 2020 National Popular Vote
Trump Support
50%
45%
40%
35%
Biden Support
35%
40%
45%
50%
55%
nPolls
5
10
15
20

Theory

- These results indicate that polls which predict greater support for Biden **also** predict greater support for Trump
  - Is this consistent with the theory?
  - Recall that **Biden-biased** polls should underpredict Trump support and overpredict Biden support
  - In the data, this would suggest a **negative** relationship
  - But we find a **positive** relationship
- **Inconsistent** with the theory, but raises another puzzle
- Why do polls that underpredict support for Biden also underpredict support for Trump?
  - Third party bias? Polls bias against 3rd party candidates
  - Timing of poll? Fewer uncertain responses closer to election
  - More next time!

Quiz & Homework

- Go to Brightspace and take the **7th** quiz
    - The password to take the quiz is ####
- **Homework:**
    1. Work through ds1000_hw_8.Rmd
    2. Problem Set 4 (Brightspace)