Topic 5. Visualization and Univariate Graphics

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Today's Agenda

- Introduction to data visualization!
- Guiding principles
- The glorious world of `ggplot`
- Bargraphs and histograms

Motivation: Communicating Data is Essential

- Data does not exist in a vacuum – it is always interpreted in relationship to something.
- All data-science should be question driven! What is the question you are asking?
- What is the answer that your visualization is providing?
- Does your visualization communicate the relationship cleanly and accurately?
- Humans infer causality (much too quickly!).

CHALLENGER EXAMPLE

Your visuals must tell an accurate story

- Tables and graphs are essential for visualization.
- Visualizations must be stand-alone (if possible).
- Visualizations must be well-labeled!

NOTE: Rule of thumb: show it to someone without explanation. If they are confused, re-do!

Dimensions of Visualization

You have several “dimensions” to use when presenting information

- Horizontal (x-axis) location
- Vertical (y-axis) location
- Size of data points
- Shape of data points
- Color

Dimensions of Visualization

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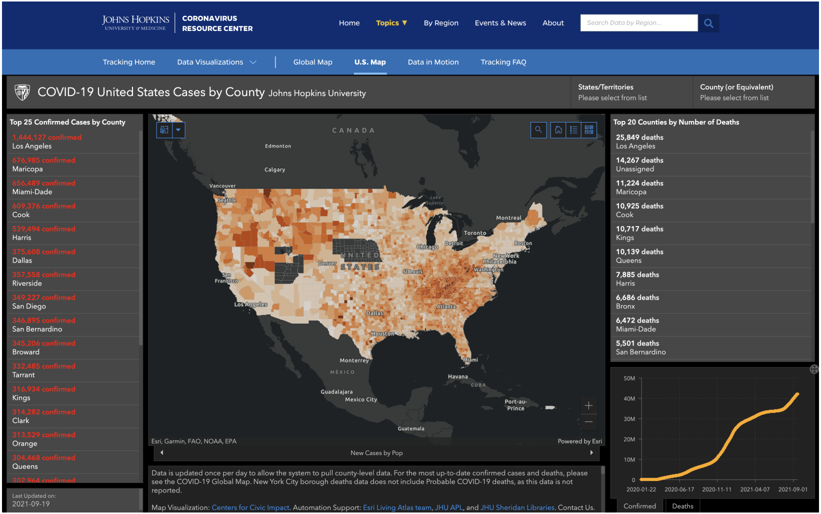
- Color
- Map each variable to at most one dimension.
- Be intuitive – don't assign small numbers large dots, etc.
- Don't be misleading.

MORE EXAMPLES

So is this a good visualization of the pandemic in the US?



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COVID-19 United States Cases by County Johns Hopkins University

States/Territories
Please select from list

County (or Equivalent)
Please select from list

Top 25 Confirmed Cases by County

1,444,127 confirmed	Los Angeles
676,985 confirmed	Maricopa
656,489 confirmed	Miami-Dade
609,376 confirmed	Cook
539,494 confirmed	Harris
375,608 confirmed	Dallas
357,558 confirmed	Riverside
349,227 confirmed	San Diego
346,895 confirmed	San Bernardino
345,206 confirmed	Broward
332,485 confirmed	Tarrant
316,934 confirmed	Kings
314,282 confirmed	Clark
313,529 confirmed	Orange
304,468 confirmed	Queens
302,964 confirmed	

Last Updated on:
2021-09-19

Top 20 Counties by Number of Deaths

25,849 deaths	Los Angeles
14,267 deaths	Unassigned
11,224 deaths	Maricopa
10,925 deaths	Cook
10,717 deaths	Kings
10,139 deaths	Queens
7,885 deaths	Harris
6,686 deaths	Bronx
6,472 deaths	Miami-Dade
5,501 deaths	San Bernardino

Esri, Garmin, FAO, NOAA, EPA · Powered by Esri

New Cases by Pop

Data is updated once per day to allow the system to pull county-level data. For the most up-to-date confirmed cases and deaths, please see the COVID-19 Global Map. New York City borough deaths data does not include Probable COVID-19 deaths, as this data is not reported.

Map Visualization: Centers for Civic Impact. Automation Support: Esri Living Atlas team, JHU APL, and JHU Sheridan Libraries. Contact Us.

https://coronavirus.jhu.edu/us-map

Visualization using ‘ggplot

- Everything in an R visualization can be controlled.
- Graphs themselves are an object that can be saved and altered.
- Start with a blank “canvass” and then you add the visuals.
- Actually, you start with the question you want the visualization to answer.

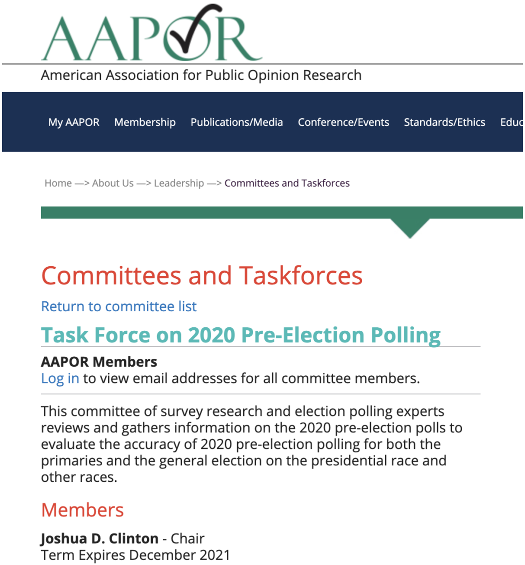
Visualization First Steps

First graph is usually a summary of the data: what does it look like?

- Central tendency? (Where is most data located?)
- Variation? (Range? Dispersion? Skew?)

Application: 2020 Election

Data We Are Using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Task Force on 2020 Pre-Election Polling

AAPOR Members
Log in to view email addresses for all committee members.

This committee of survey research and election polling experts reviews and gathers information on the 2020 pre-election polls to evaluate the accuracy of 2020 pre-election polling for both the primaries and the general election on the presidential race and other races.

Members

Joshua D. Clinton - Chair
Term Expires December 2021

Loading Polling Data

```r
library(tidyverse)
load(file="data/Pres2020.PV.Rdata")
```

What do we have here. . . .

```
glimpse(Pres2020.PV)
```

```
## Rows: 528
## Columns: 16
## $ poll.id     <dbl> 1942, 1941, 1940, 1939, 1938, 1937, 1936,
## $ Geography   <chr> "NAT", "NAT", "NAT", "NAT", "NAT", "NAT",
## $ Poll        <chr> "Economist/YouGov", "Research Co.", "Ipso
## $ StartDate   <chr> "10/31/2020", "10/31/2020", "10/29/2020",
## $ EndDate     <chr> "11/2/2020", "11/2/2020", "11/2/2020", "1
## $ DaysinField <dbl> 3, 3, 5, 1, 1, 3, 3, 3, 4, 4, 2, 5, 5, 14
## $ MoE         <dbl> NA, 3.10, 3.70, 1.70, 3.20, NA, 1.00, NA,
## $ Mode        <chr> "Online", "Online", "Online", "Online", N
## $ SampleSize  <dbl> 1363, 974, 914, 5174, 1008, 1360, 799401,
## $ Biden       <dbl> 53, 53, 52, 52, 48, 53, 52, 53, 52, 52, 4
## $ Trump       <dbl> 43, 44, 45, 46, 42, 43, 46, 41, 41, 42, 4
## $ DemCertVote <dbl> 51, 51, 51, 51, 51, 51, 51, 51, 51, 51, 5
## $ RepCertVote <dbl> 47, 47, 47, 47, 47, 47, 47, 47, 47, 47, 4
## $ Winner      <chr> "Dem", "Dem", "Dem", "Dem", "Dem", "Dem",
## $ Funded      <chr> "Economist", "Research Co.", "Reuters", "
## $ Conducted   <chr> "YouGov", "Research Co.", "Ipsos", "Swaya
```

What is our question?

How did public polling on the 2020 presidential election vary over the course of the election?

So the relationship of interest how *polling results* vary over *time*

But what do we mean by _"*polling results*?

- National Popular Vote vs. State specific support?
- Support for Biden and Trump? Difference in support between Biden and Trump?

And also, What do we mean by *time*?

- Day of the year? Proximity to Election Day?
- Results by day? week? month?

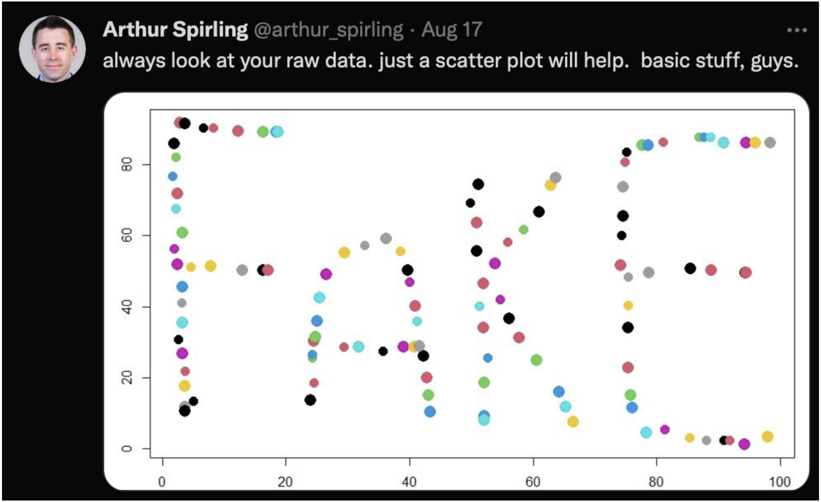
Start by defining some variables we need

```
Pres2020.PV <- Pres2020.PV %>%
  mutate(margin = Biden - Trump)
```

```
summary(Pres2020.PV$margin)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  -6.000   6.000   8.000   8.021  10.000  17.000
```

Don't just glimpse, Visualize!



Arthur Spirling @arthur_spirling · Aug 17

always look at your raw data. just a scatter plot will help. basic stuff, guys.

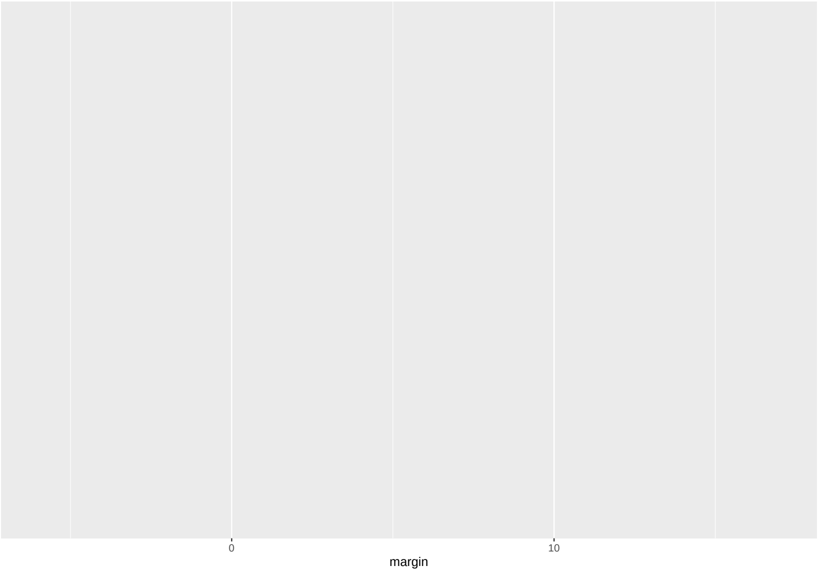
Visualizing `margin`

```r
g <- Pres2020.PV %>%
    ggplot(aes(x = margin))
```

- plots can be objects
- `data` defines the dataframe being used
- aesthetics define the variables being used

The Canvass

```
g
```



What do we want to convey about `margin`

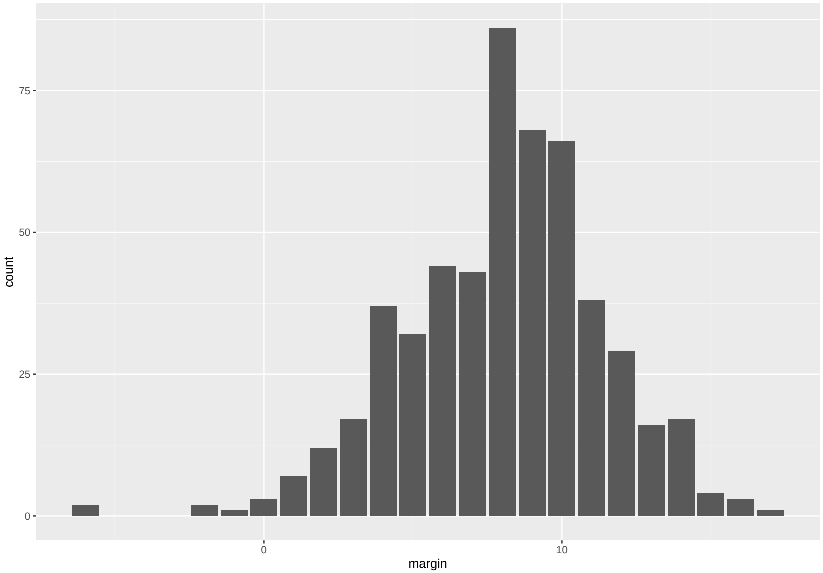
We only have 1 variable (x-axis), but 2 options depending on whether categorical/discrete or continuous!

- `geom_barplot` - discrete
- `geom_histogram` - continuous

NOTE: No pie-graphs!

Barplot

```
g + geom_bar()
```



Barplot

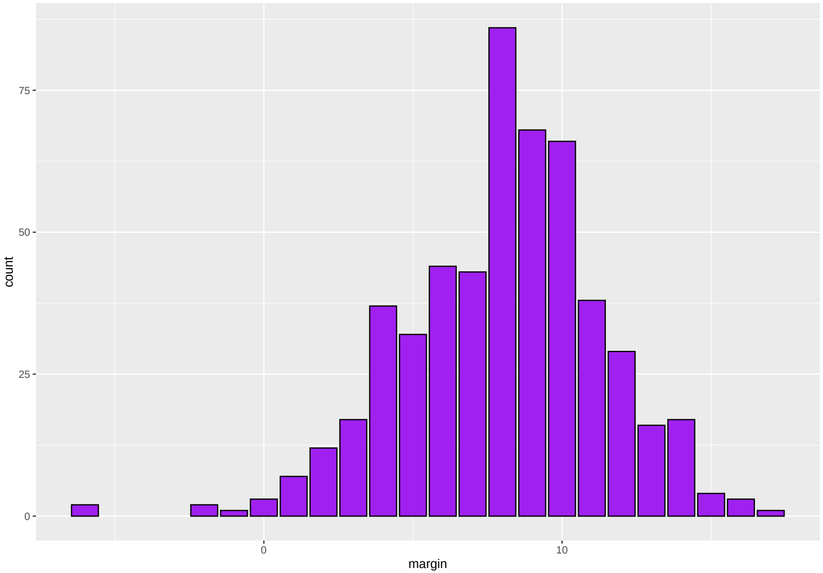
Used for discrete variables - one “bar” for each value

```
g + geom_bar(fill = "purple", color = "black")
```

- `fill` is the color of the bars
- `color` is the border of the bars

Barplot

```
g + geom_bar(fill = "purple", color = "black")
```



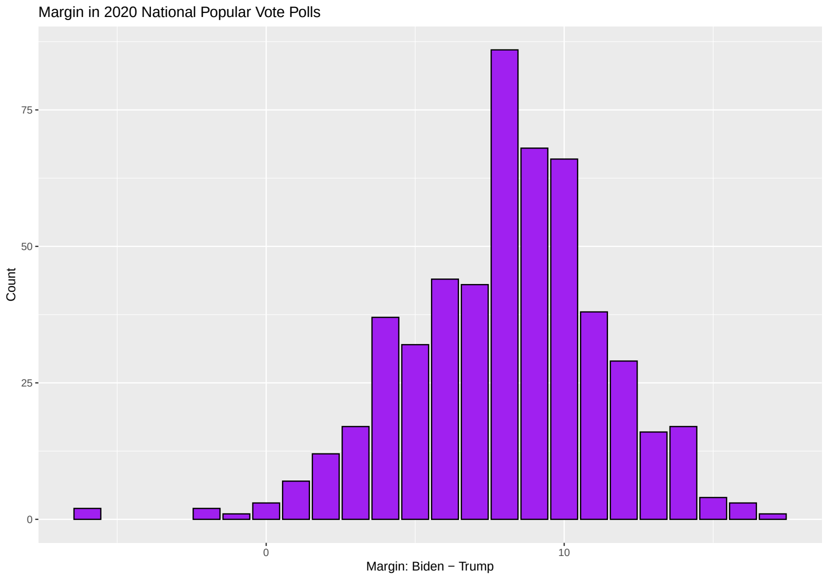
Adding `labs`

```
g <- g + geom_bar(fill = "purple", color = "black") +
  labs(title = "Margin in 2020 National Popular Vote Polls") +
  labs(x = "Margin: Biden - Trump") +
  labs(y = "Count")
```

- Note can add multiple layers at the same time
- Never label using variable names!

Adding `labs`

```
g
```



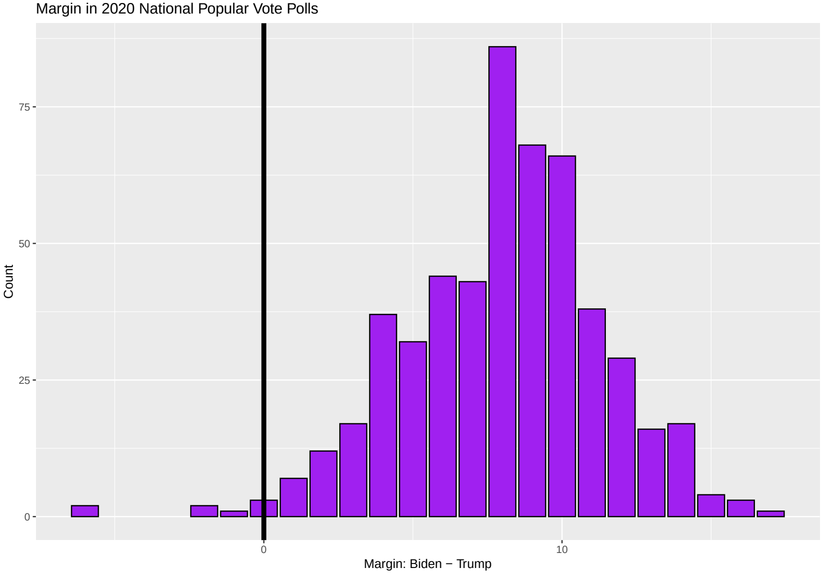
Adding a (linear) line to the plot

```r
g + geom_vline(xintercept = 0, lwd=2)
```

- `+ geom_abline(intercept = A , slope = B)`: add a line with y-intercept A and slope B
- `+ geom_vline(xintercept = A)`: add a vertical line with x-intercept A
- `+ geom_hline(yintercept = A)`: add a horizontal line with y-intercept A

Adding a line

```
g + geom_vline(xintercept = 0, lwd=2)
```



Saving graphs

- Can save manually using R-Studio (bad).
- Can save using a graphical device.

```
pdf(file="2020MarginBarplot.pdf")
g
dev.off()
```

Histogram

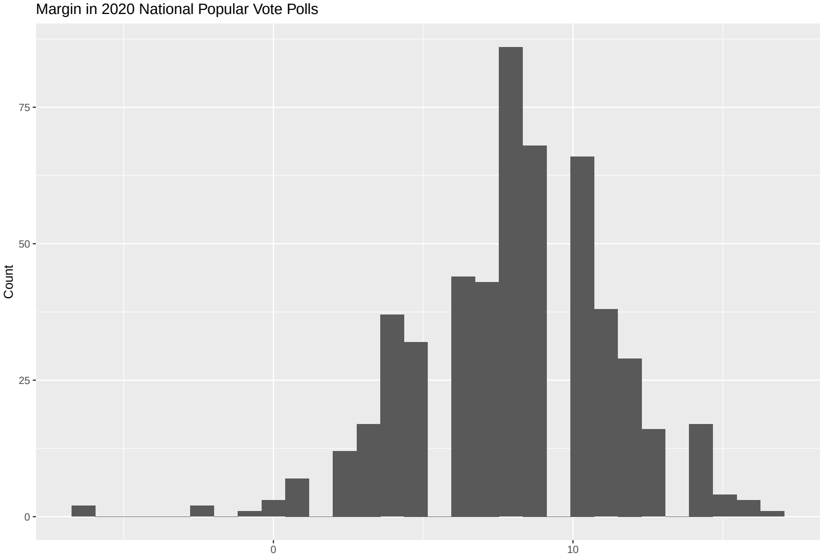
Used for continuous variables - divide values into “bins” and plot bins.

```r
h <- Pres2020.PV %>%
  ggplot(aes(x = margin)) +
  labs(title = "Margin in 2020 National Popular Vote Polls") +
  labs(x = "Margin: Biden - Trump") +
  labs(y = "Count")
```

Take a look at default

```
h + geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwi
```



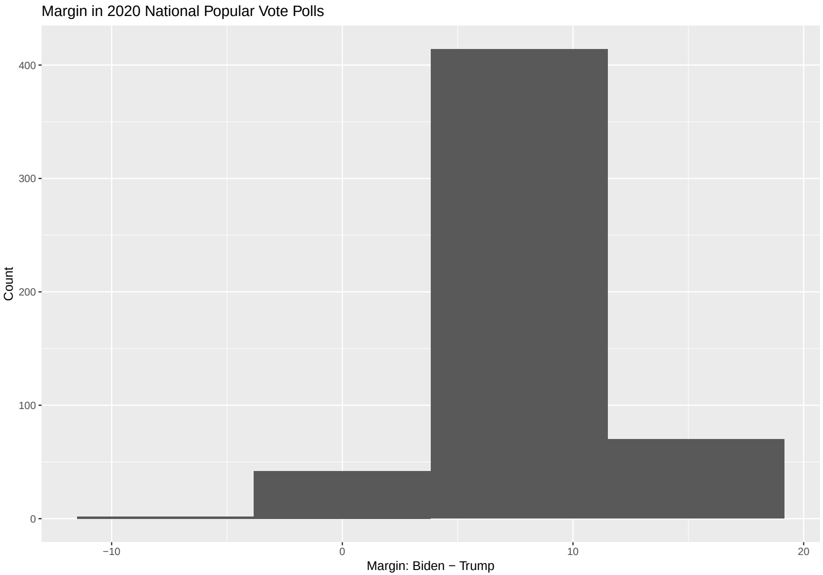
Let's fix..

```
h + geom_histogram(bins = 10)
```

- `bins` defines how many bars you want
- Default is the count of how many observations fall into each bin.
- Can also plot the density by including `aes(y = ..density..)`

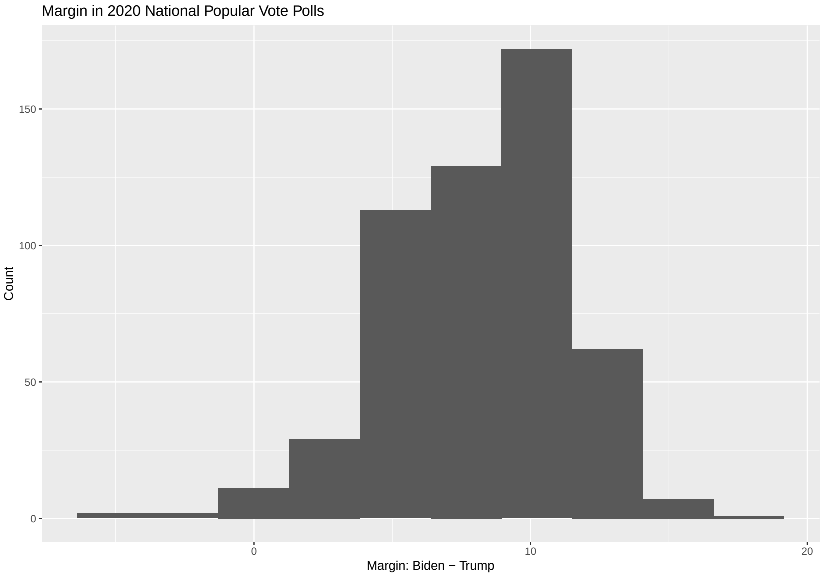
Histogram (Count)

```
h + geom_histogram(bins = 4)
```



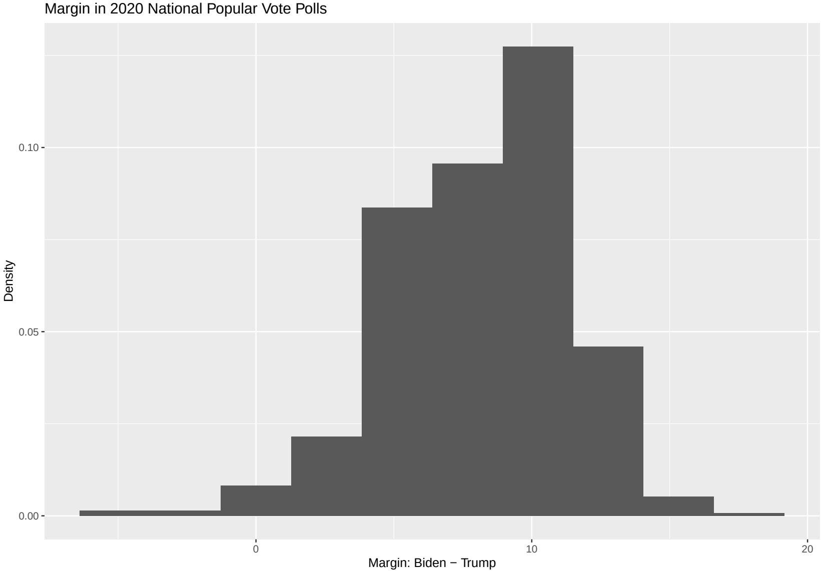
Histogram (Count)

```
h + geom_histogram(bins = 10)
```



Histogram (Density)

```
h + geom_histogram(bins = 10, aes(y = ..density..)) +
  labs(y = "Density")
```



Density? What is that?

- Density is not a proportion – it is the “area under the curve”. (Integrals!)
- So the proportion is: width x height
- Primarily used when comparing distributions of different variables: densities always integrate/sum to 1.

Plotting Single Variables

- If discrete: `geom_bargraph`
- If continuous: `geom_histogram`
- If want to compare variation across variables (on same ggplot) - density.
- Always label!
- Next Steps: Try plotting the distribution of `Trump` and `Biden` to make sure you can do it.
- Next time: plotting bivariate relations!