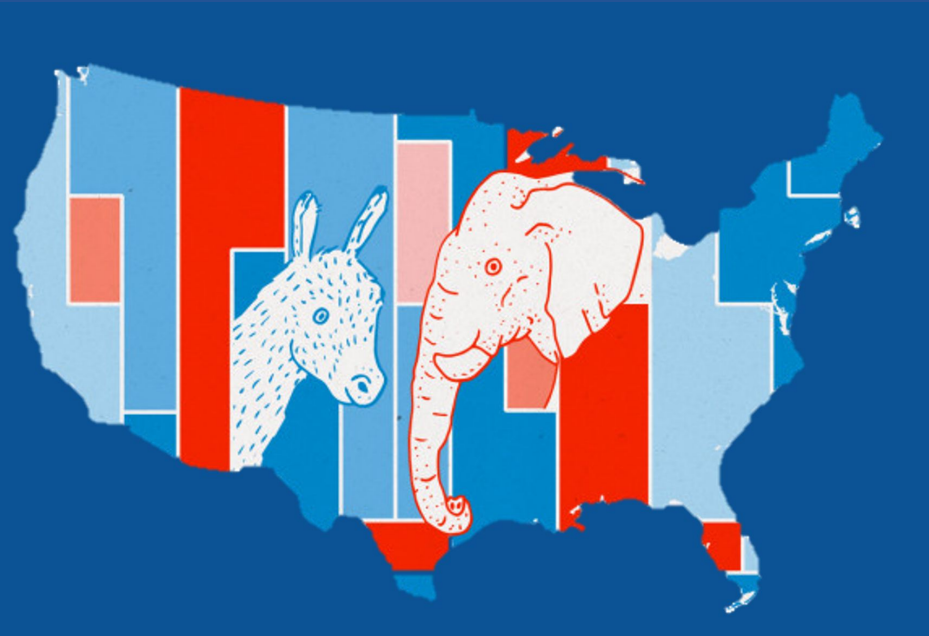


# Mathematical Modeling of U.S. Elections

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ES\_APPM 399 Spring Quarter

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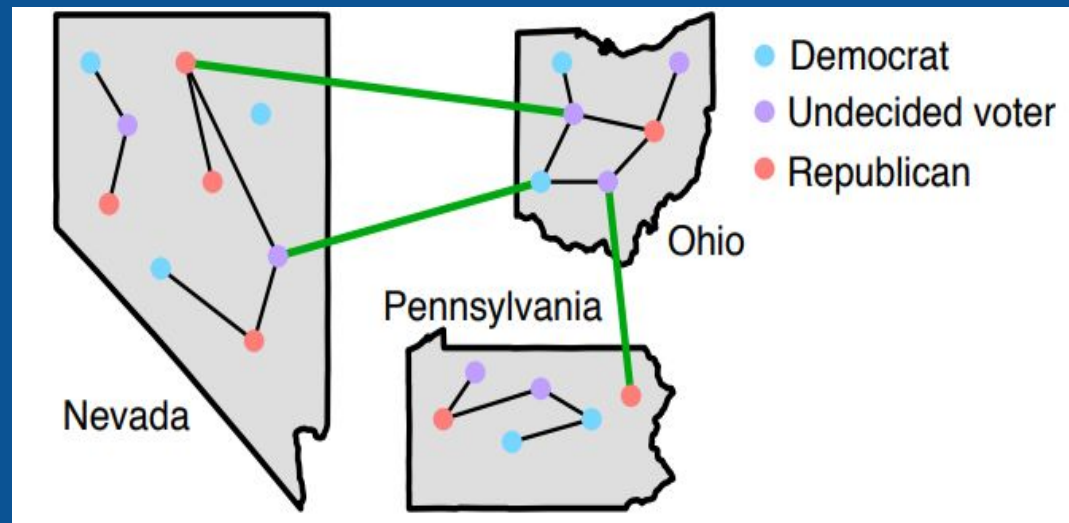
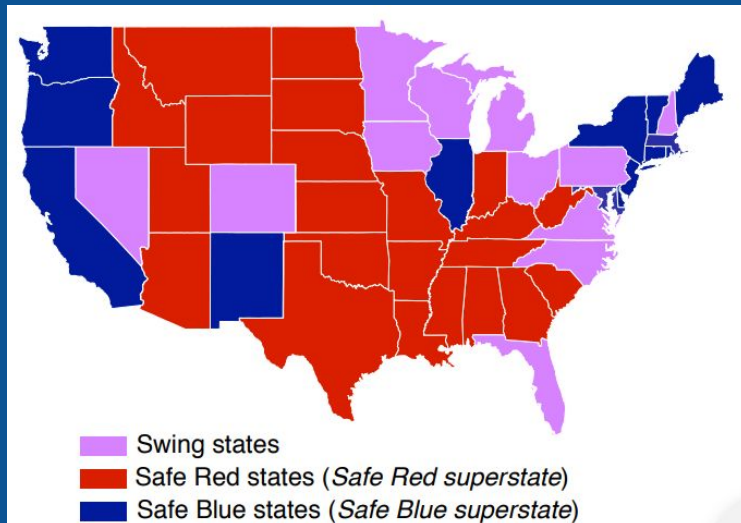


# Motivation

Questions:

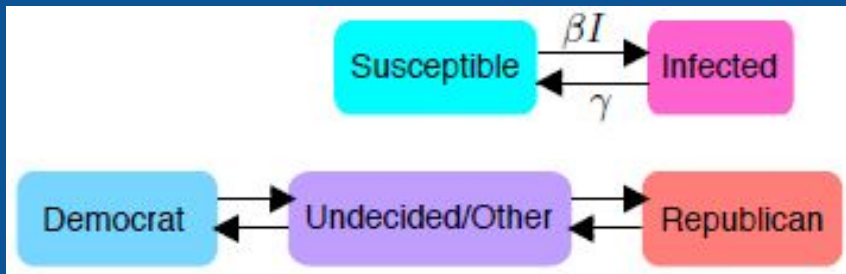
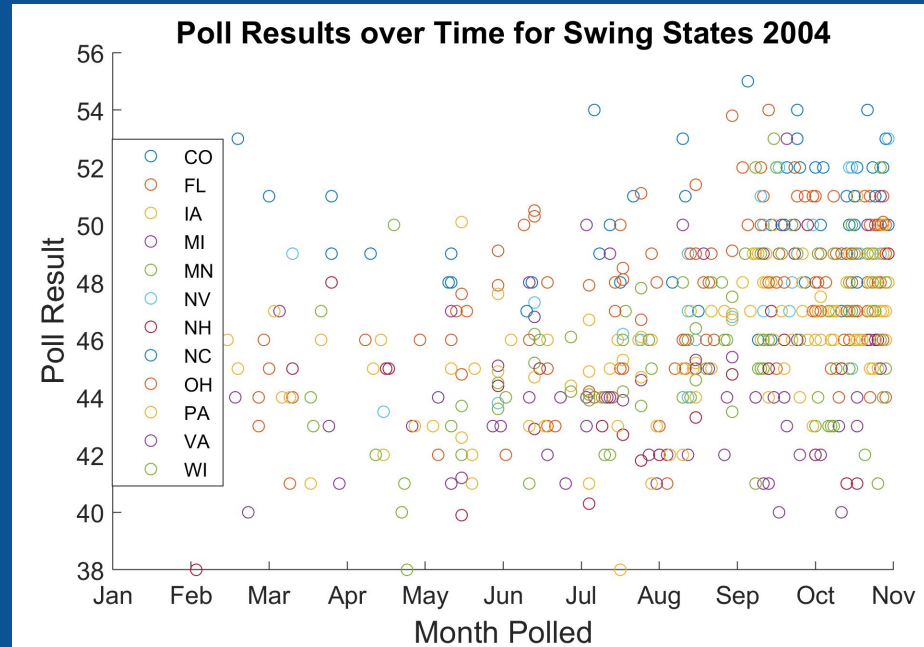
- Can we use mathematical modeling to forecast elections?
- How do different states influence each other?
- How early can we make accurate forecasts?

Goal: Analyze the accuracy of our 2004 and 2008 forecasts



# Mathematical Methods

1. Formatting polling data
2. Fitting parameters for state influence in R
3. Simulating elections using differential equation model

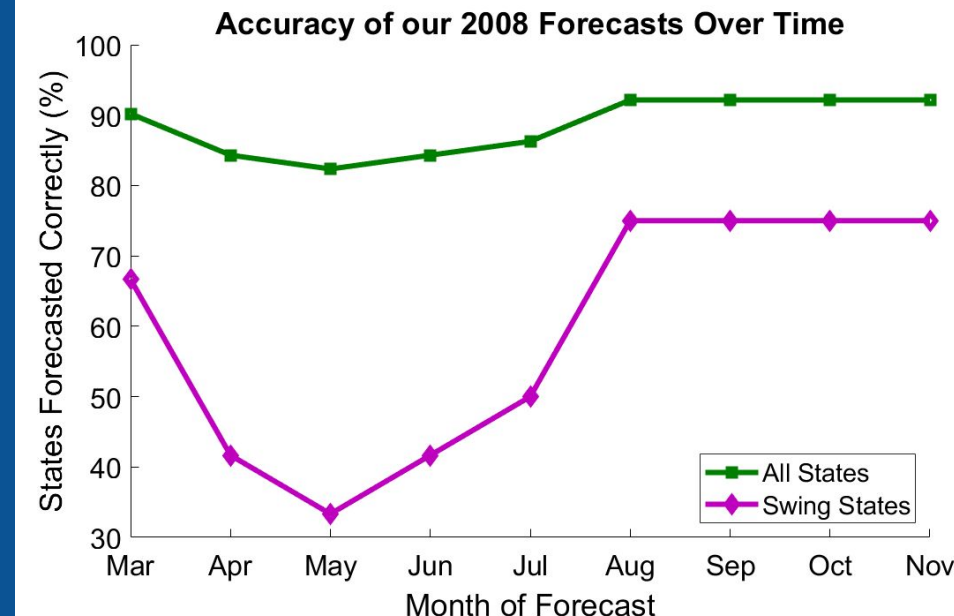
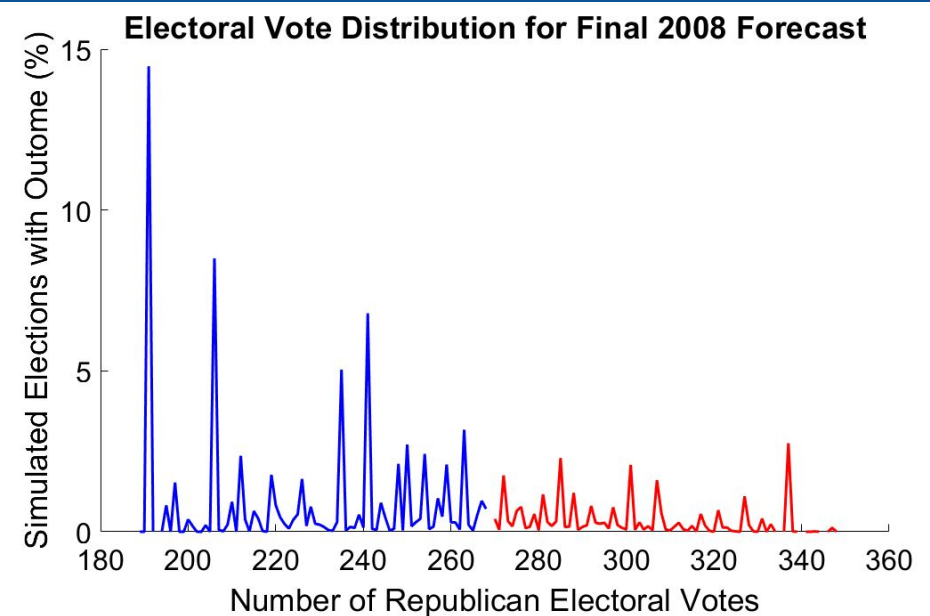


$$\frac{dI_D^i}{dt}(t) = \underbrace{-\gamma_D^i I_D^i}_{\text{Dem. loss}} + \underbrace{\sum_{j=1}^M \beta_D^{ij} \frac{N^j}{N} S^i I_D^j}_{\text{Dem. influence}},$$

$$\frac{dI_R^i}{dt}(t) = \underbrace{-\gamma_R^i I_R^i}_{\text{Rep. loss}} + \underbrace{\sum_{j=1}^M \beta_R^{ij} \frac{N^j}{N} S^i I_R^j}_{\text{Rep. influence}},$$

$$\frac{dS^i}{dt}(t) = \gamma_D^i I_D^i + \gamma_R^i I_R^i - \sum_{j=1}^M \beta_D^{ij} \frac{N^j}{N} S^i I_D^j - \sum_{j=1}^M \beta_R^{ij} \frac{N^j}{N} S^i I_R^j,$$

# Sample Results



- Ran 10,000 simulations of 2004 and 2008 presidential elections to obtain our forecasts
- Wrote code to handle states with varying amounts of polling data
- Considered uncertainty related to state demographics with the introduction of noise

# Outlook: 2020 Election

Next steps:

1. Handling and formatting polling data for the upcoming election
2. Using the accuracy of our 2004 and 2008 forecasts to better understand the 2020 results

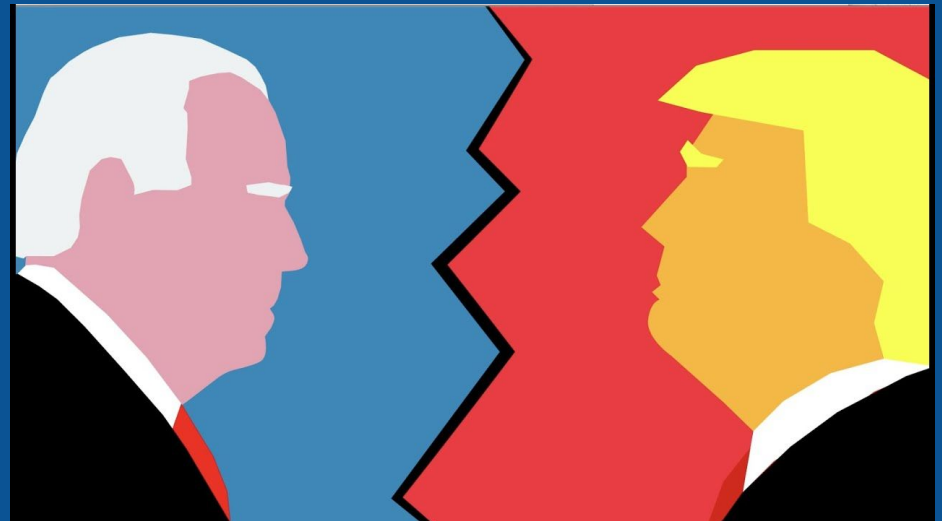
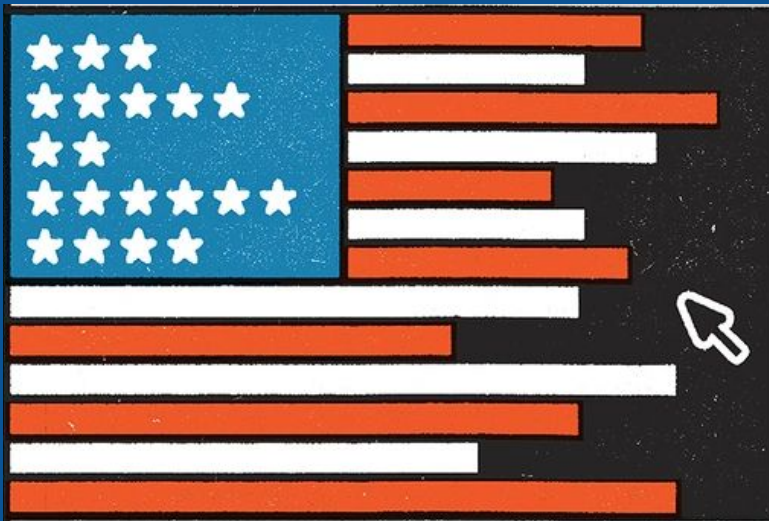


Image source: UNSW Business School <https://i.ytimg.com/vi/pDSq6bkYBbw/maxresdefault.jpg>, Accessed May 18 2020

Image source: Burton <https://www.theatlantic.com/magazine/archive/2013/03/a-more-perfect-poll/309219/>, Accessed May 18 2020