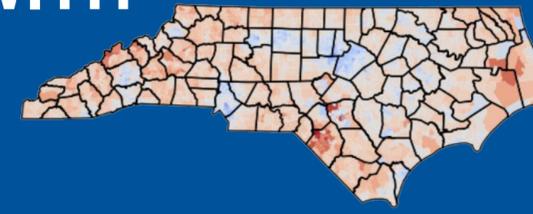


# UNDERSTANDING VOTING PATTERNS & INTERACTIONS WITH GERRYMANDERING

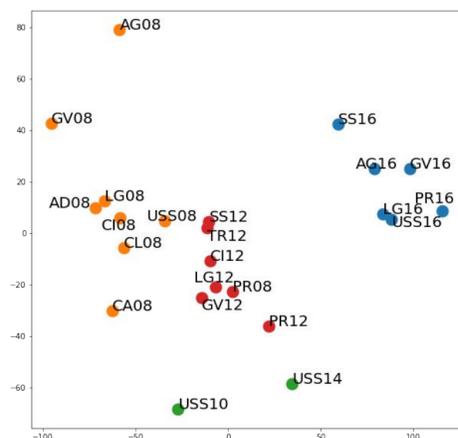
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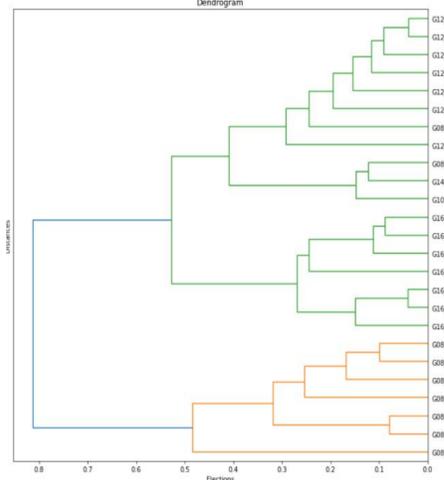
## Goals

- Understand voting patterns in North Carolina
- Examine election data from 2008-2016
- Test redistricting plans against large ensembles of non-partisan maps to identify gerrymandering

## Dimension Reduction and Clustering



- For each precinct, computed its contribution to the statewide Democratic vote total.
- Used PCA to extract important features.
- Ran K-means to cluster the elections based on PCA results (shown on the left).

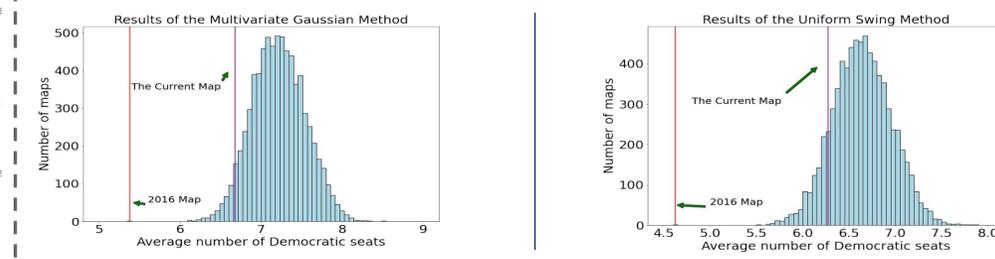
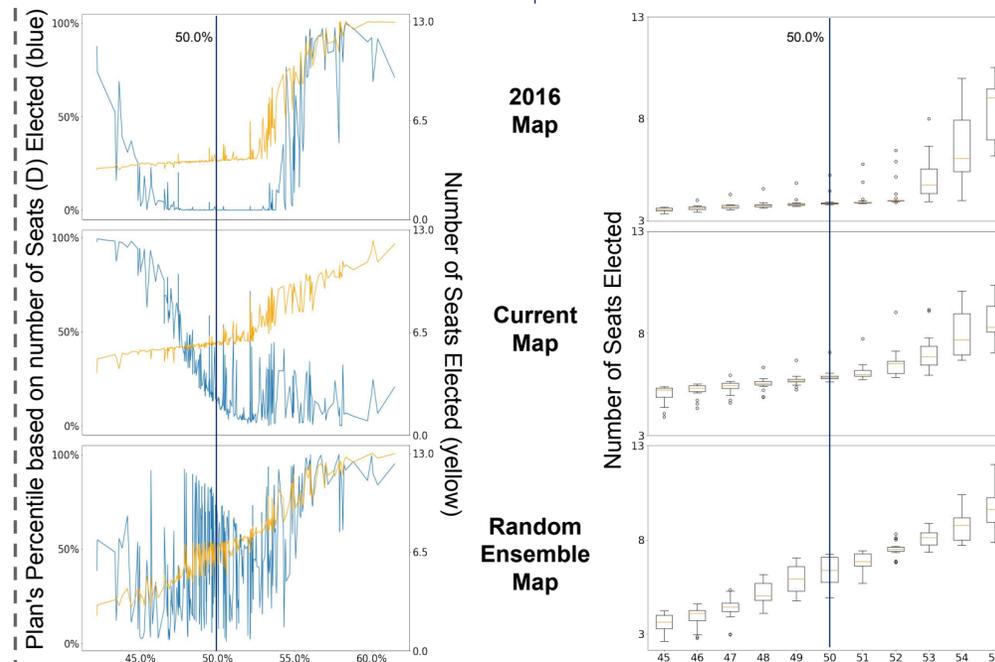


- Applied a Uniform Swing to historic elections and calculated the distance between every pair based on distribution of Democratic seats elected.
- Performed agglomerative clustering on the distance matrix (shown on the right).
- The clusters from these two very different techniques were nearly identical, with elections from the same year usually assigned to the same cluster.

## Generating Synthetic Elections

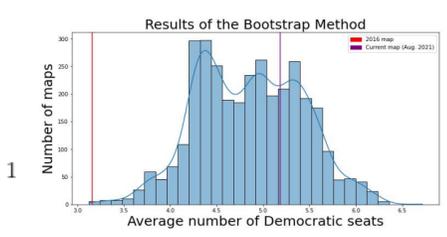
Create synthetic elections and analyze an ensemble of districting maps.

- Fit a multivariate Gaussian model to each set of historic elections corresponding to a specific election year.
- Draw 300 synthetic elections from the resulting models.
- Swing all Democratic vote shares by the same amount for each precinct.
- Generate synthetic elections by uniformly swinging historic elections from 45% to 55%.



Generate synthetic elections by mixing several different historic elections in random proportions:

$$Election_{new} = \sum_{i=1}^m \alpha_i * Election_i \quad \alpha_i \in (0,1), \sum_{i=1}^m \alpha_i = 1$$

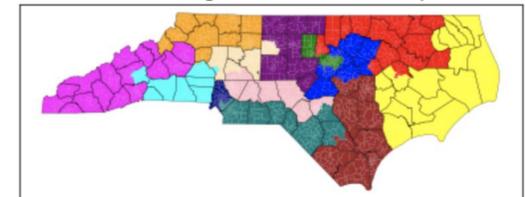


## Swing Methods

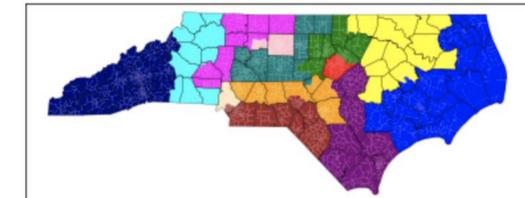
- Uniform absolute swing factors in voter turnout data and vote share within a precinct.
- We plan to compare elections generated by uniform absolute swing to those generated by uniform shift (the standard swing) to see if patterns are preserved.
- This alternative swing is generated for each precinct using the following equation:

$$(Diff. \text{ Vote Counts}) \times (1 \pm (\text{Needed Swing Share}))$$

2016 Congressional District Map



The Current Congressional Map (As of August 2021)



## Discussion and Future Work

- We found that the 2016 map was an outlier, electing only 3 Democrats even when they won statewide majority vote.
- The current map consistently elected more Democratic seats, but further analysis is needed to determine if gerrymandering is present.
- For the future, we want to rigorously test the validity of our current generative methods and develop other generative methods, such as interpolating the vote fraction and voter turnout between existing elections.