Modeling Fair Redistricting Commissions

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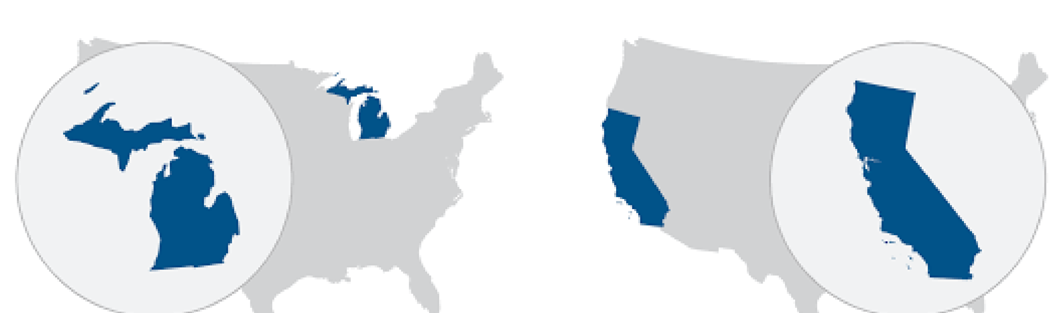
Gerrymandering

Every ten years, we redraw our voting maps. When these maps are drawn by politicians to maximize their electoral gains, this is known as *partisan gerrymandering*.

Elbridge Gerry's Original Gerry-mander.

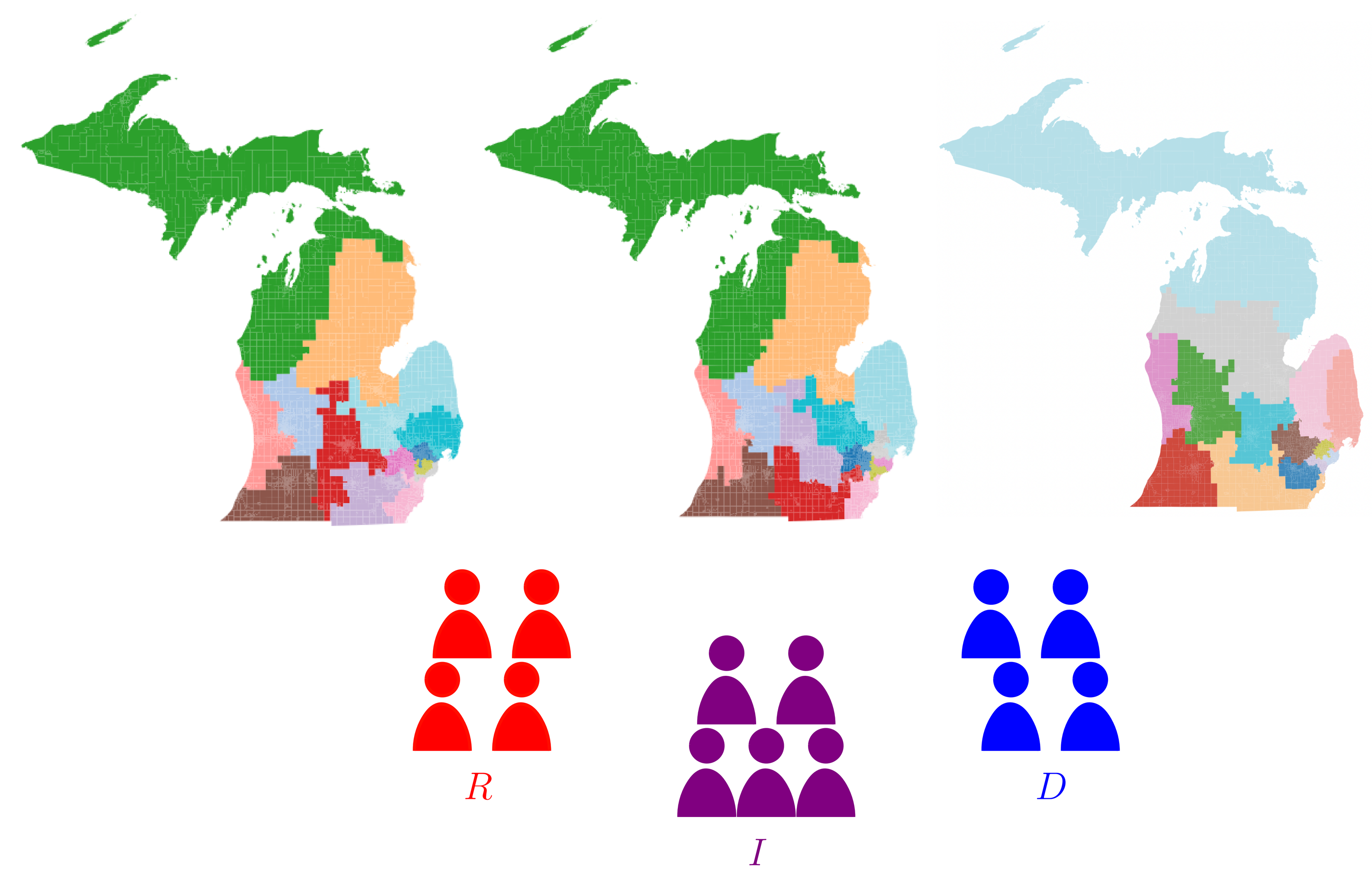
- In response to this anti-democratic process, fourteen states, including **Michigan** and **California**, have adopted a new redistricting protocol.



- Every redistricting cycle, a commission of volunteer citizens form to draw the maps without the input of elected politicians.

The state constitutions outline every aspect of these commissions. But, when the commissioners eventually choose a map to enact, *how can we be certain that they will actually choose a fair map*?

How can we ensure that independent redistricting commissions really work?

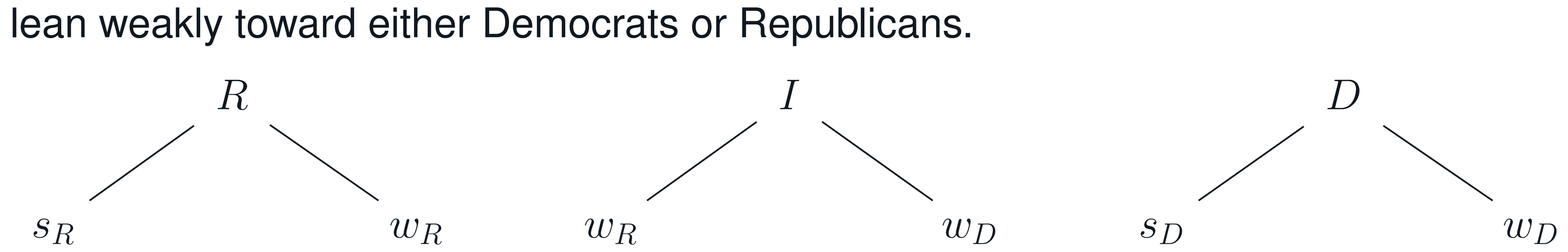


In our model, the commissioners decide between a Republican-biased, neutral, and Democrat-biased map. The true biases of the maps are known to the commissioners but unknown to the mechanism.

- The Michigan Independent Citizens Redistricting Commission is composed of **four** Republicans, **four** Democrats, and **five** Independents.
- After a year of learning about redistricting, the commission selects a voting map.
- Our mechanism leverages their acquired insight into the true biases of the maps to ensure the selection of a truly neutral map, even if partisan commissioners prefer biased maps and commissioners make mistakes.

Our Model

- Commissioner types: D for Democrats, R for Republicans, and I for Independents.
- Commissioner sub-types: partisans are either *weak* or *strong*, and independents lean weakly toward either Democrats or Republicans.



- All commissioners prefer a neutral map over a map biased toward the other party, but strong partisans prefer a biased map over a neutral map.
- The commissioners decide between three categories of maps: D (biased-Democrat), N (neutral), and R (Republican-biased). Their preferences are:

$$s_D : D \succ N \succ R, \quad w_D : N \succ D \succ R, \quad s_R : R \succ N \succ D, \quad w_R : N \succ R \succ D.$$

Results

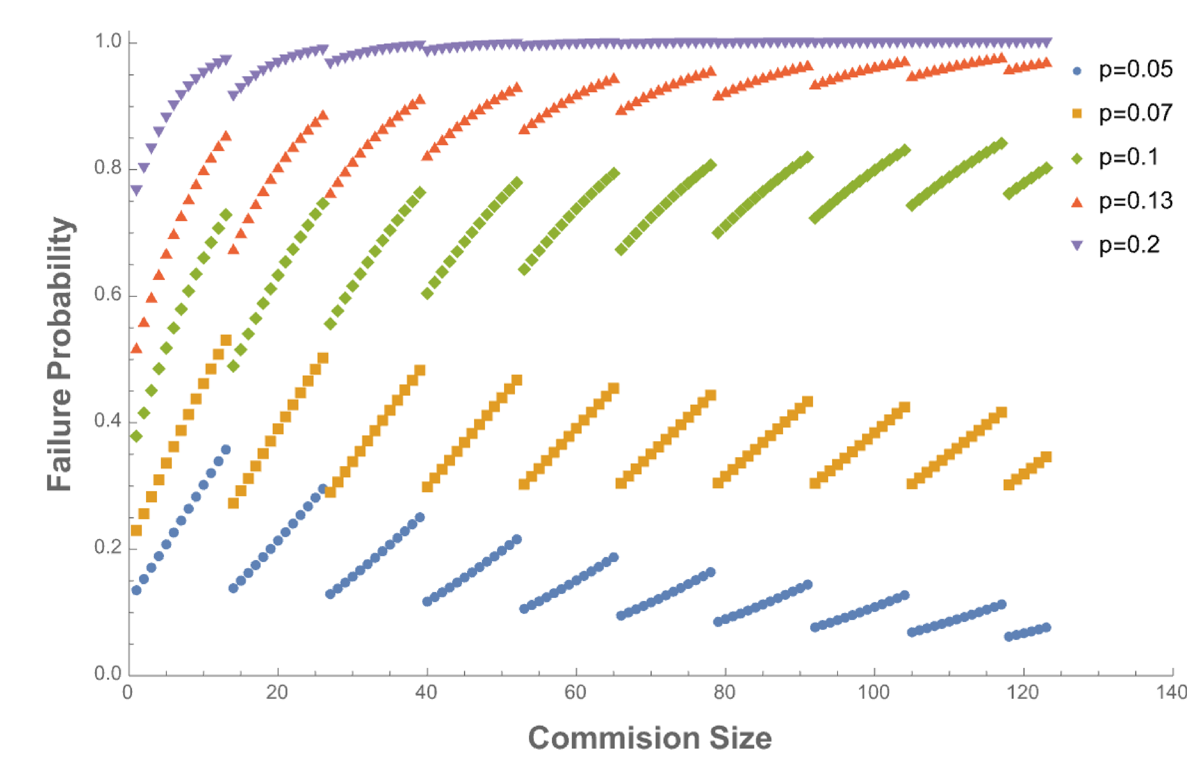
Theorem 1 (Balanced Mechanism)**.** *In commissions with equal numbers of partisans and some member preferring a neutral map, the positional-scoring voting rule with scores* $\langle 1, 0, -1 \rangle$ *is group strategy-proof and selects a neutral map.*

Theorem 2 (Unbalanced Mechanism)**.** *As long as some commissioner prefers a neutral map, the following group-dependent positional scoring rule is group strategy-proof and chooses a neutral map:*

$$D : \left\langle \frac{1}{n_D}, 0, -\frac{1}{n_D} \right\rangle, \ R : \left\langle \frac{1}{n_R}, 0, -\frac{1}{n_R} \right\rangle, \ I : \left\langle \frac{1}{n_R}, 0, -\frac{1}{n_R} \right\rangle.$$

Theorem 3 (Robustness to Misevaluations)**.** *Let x and y be the number of w_D Democratic commissioners and w_R Republican commissioners, respectively. If $n_D \geq n_R$, then Theorem 2 is robust up to $k \leq n_I/4 + \frac{n_R}{n_D} \cdot x + y$ commissioner misevaluations.*

In the below, p is the probability a commissioner misevaluates the maps.



For small enough p, it is better to have a big commission. For large p, it is better to limit the commission size.

Future Work

- The most well-known strategy-proof voting rule is the median voting rule on single-peaked domains.
- This voting rule can be generalized to restricted higher-dimensional domains.

Is there a reasonable function from the space of redistricting plans to a domain where the median rule applies?