

Combatting Gerrymandering with Social Choice: the Design of Multi-member Districts



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Redistricting

Basics Following the census, voters are partitioned into contiguous equal-population districts, each of which elect a representative independently.

Objectives Draw districts which lead to globally representative outcomes (e.g. proportional) while preserving local representation (e.g. compactness).

Challenges Intentional and natural gerrymandering

1. Intentional: partisan manipulation to influence electoral outcomes
2. Natural: spatial distribution of voters make it impossible to draw representative maps.



This bill requires (1) that ranked choice voting ...be used for all elections for Members of the House of Representatives, (2) that states entitled to six or more Representatives establish districts such that three to five Representatives are elected from each district, and (3) that states entitled to fewer than six Representatives elect all Representatives on an at-large basis—**Fair Representation Act, H.R. 4000, 2019.**

Social Choice

Suppose we are electing N people.

Winner takes all: Each voter votes for N candidates. Top N vote-getters are elected.

STV: Candidates are not elected “independently.” Each voter submits a ranking, and candidates are selected sequentially.

Thiele rules: Parameterize decreasing marginal returns for individual voters in approval voting.

| Sample Multi-Winner RCV Election | | | | | |
|----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Candidate | Round 1 | Round 2 | Round 3 | Round 4 | Round 5 |
| Armando Perez Democrat | 27.2% 2,500 votes | 25.0% 2,300 votes | 25.0% 2,300 votes | 25.0% 2,300 votes | 25.0% 2,300 votes |
| Cathy Chan Democrat | 19.0% 1,750 votes | 20.1% 1,850 votes | 21.2% 1,950 votes | 34.8% 3,200 votes | 25.0% 2,300 votes |
| Hannah Murphy Republican | 14.1% 1,300 votes | 14.3% 1,320 votes | 20.7% 1,900 votes | 22.3% 2,050 votes | 27.2% 2,500 votes |
| Charles Lorenzo Republican | 14.1% 1,300 votes | 14.1% 1,300 votes | 17.4% 1,600 votes | 17.9% 1,650 votes | 18.9% 1,740 votes |
| Brad M. Jackson Democrat | 14.7% 1,350 votes | 15.5% 1,430 votes | 15.8% 1,450 votes | 0.0% 0 votes | 0.0% 0 votes |
| June Smith Republican | 10.9% 1,000 votes | 10.9% 1,000 votes | 0.0% 0 votes | 0.0% 0 votes | 0.0% 0 votes |

Our Work

Study the joint design space of districts and social choice rules.

Research Questions How do multiple multi-member districts (MMDs) affect the distribution of possible outcomes, under either adversarial gerrymanders or neutral re-districting? What is the role of the social choice function used? How big is “big enough”? How do MMDs affect intra-party measures, such as geographic and political diversity of winners?

Contributions

Methodologically, we provide a scalable methodology to algorithmically study partisan gerrymandering and fair redistricting under MMDs, and in particular under STV

Empirically, we show that 2- or 3-member districts with STV are enough to both inhibit partisan gerrymanders and eliminate natural gerrymanders, without sacrificing local representation.

Methods

Challenge: Need to generate maximally fair and unfair maps at scale for a wide range of states, voting rules, and district numbers. Very hard optimization and simulation problems!

Solution: Use stochastic hierarchical partitioning algorithm [1] to generate district ensembles.

1. Hierarchically generate districts in a tree structure
2. Calculate expected outcomes for districts in the leaf nodes using historical data.
3. Use a dynamic program (or an IP) to aggregate into maps

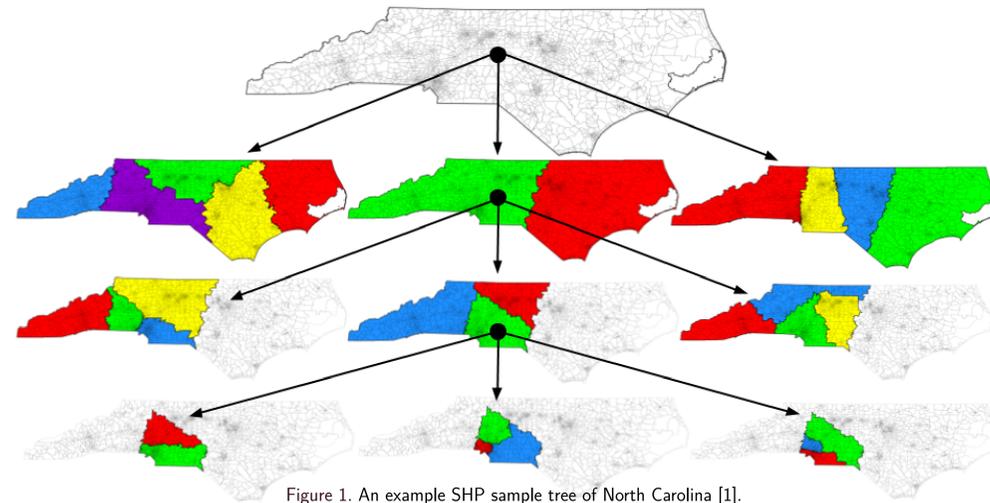


Figure 1. An example SHP sample tree of North Carolina [1].

Experiments

1. For each combination of state and number of districts, generate large ensemble.
2. For each voting rule, calculate
 1. Most gerrymandered map
 2. Most proportional map
 3. Neutral maps and the distribution of partisans outcomes
3. For each map, calculate outcomes of interest:
 1. (Without simulation): Proportionality, competitiveness, compactness
 2. (With simulation): Intra-party measures, such as geographic or opinion diversity

Results

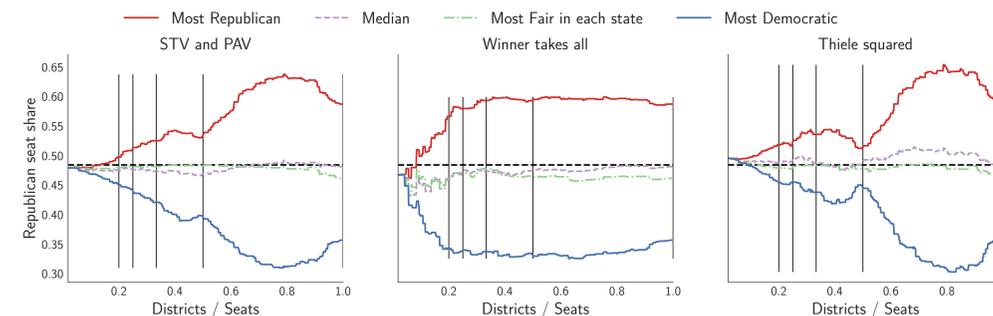


Figure 2. The Republican seat share over all states as the number of districts is varied in each state. This illustrates how effective STV is in blunting intentional gerrymandering with just small MMDs while winner take all has no effect on gerrymandering capacity.

Results Continued

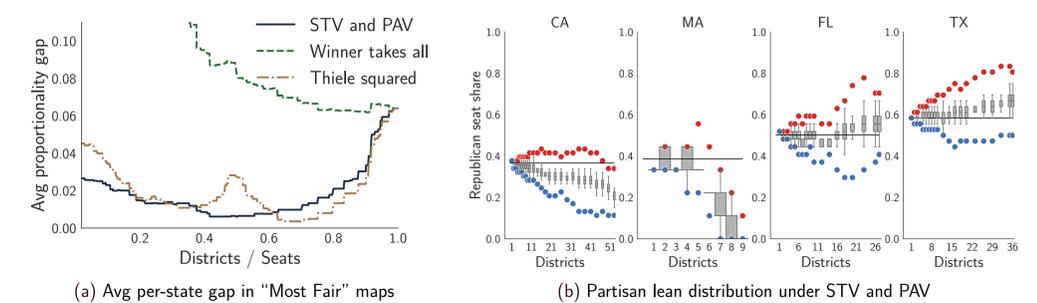


Figure 3. How the partisan lean and proportionality gap vary at the state level with voting method and the number of districts. Shows natural gerrymandering is virtually eliminated by using STV.

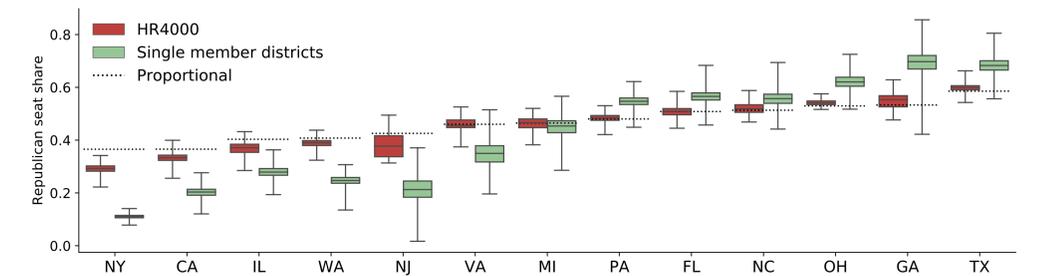


Figure 4. Comparison of Republican seat share distribution of H.R. 4000 compliant ensembles using STV/PAV voting rule to single-member district baseline for all states with 10 or more seats.

Conclusions

Design Recommendations

1. Two and three member districts are effective in most states in mitigating both intentional and natural gerrymandering.
2. MMDs with winner take all or using a mix of SMDs and MMDs do not help, and can enable worse gerrymandering.
3. Larger districts are needed in smaller and more partisan states.
4. H.R. 4000 is effective in promoting fair maps, while still allowing flexibility in MMD size.

Open Questions

1. How does the design of MMDs and voting rules interact with third parties?
2. What is the right way to think about the VRA in the context of MMDs?
3. What are the effects at the city level, where most candidates are in the same party?
4. Are there more data-driven or realistic but still tractable assumptions on voting behavior?

References

[1] Wes Gurnee and David B. Shmoys. Fairmandering: A column generation heuristic for fairness-optimized political districting. In *SIAM Conference on Applied and Computational Discrete Algorithms (ACDA21)*, pages 88–99. SIAM, 2021.