GerrySim: A Markov Chain Monte Carlo Framework for Reducing Partisan and Racial Gerrymandering

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Gerrymandering is the process when congressional district maps are redrawn to benefit a certain political party. This process undermines democracy while giving disproportionate advantage to certain political and demographic groups. Currently, there are few neutral alternatives to clearly switch away from this process where voting districts are modeled with clearly defined constraints. Additionally, changes to electoral politics coming from Supreme Court precedence (Rucho v. Common Cause, Louisiana v. Callais) and midcycle redistricting in Texas and California, have updated the political situation to the point where previous research has largely become obsolete. Using redistricting simulations that utilize the Markov Chain Monte Carlo technique, congressional districts were modeled as an adjacency graph of precincts that are subject to real world regulations such as population size, contiguity, and compactness requirements. Additionally, a post-Callais framework was assumed where the majority-minority district requirement was not included. Moreover, to maintain representation across future mid-cycle redistricting, precinct demographic changes were simulated across a 10 year span for both legal and temporal resilience. This project used these metrics of population equality, district compactness, and district contiguity to optimize fair maps, as simulated elections, compactness scores and partisan distributions were tracked throughout the process. The results created statistically significant improvements and optimized and improved relative to current conditions. Simulated maps more closely reflect true vote distributions, improving electoral equity, and helping to solve this structural disparity across the United States.

Awards Won:
American Mathematical Society: Honorable Mention and One-Year Membership to AMS (for 5 projects with up to 3 team members per project)