With the August 12th release of 2020 Census results, redistricting can begin. Due to the size and complexity of Texas:

1. The number of possible ways to draw voting district plans is enormous.
2. It can be time-consuming to create even a single legally-valid plan that obeys constraints like population-balance and the county-line rule.

It is easier to draw and evaluate valid plans if you have examples to work from. However, it has not been feasible to create a large and representative **ensemble** of districting plans in prior redistricting cycles with the algorithms and computers available at the time.

Mathematicians and computer scientists solved this problem using Markov Chain Monte Carlo methods (MCMC). Developed during the Manhattan Project, MCMC methods are now used widely in science, engineering, statistic, finance, and more. Mathematicians like Moon Duchin (Tufts), Justin Solomon (MIT), Jonathan Mattingly (Duke), and Wes Pegden (Carnegie Mellon) created free, open-source software (**GerryChain**) that uses MCMC to create **ensembles** of millions of legally-valid plans.

Ensembles give redistricting committees examples to work from and baselines to compare against. Expert testimony based on MCMC ensembles played critical roles in Gill v. Whitford (2019), Rucho v. Common Cause (2019), and League of Women Voters v. Pennsylvania (2018). Since these cases, we have made further improvements to the mathematics, code, and geospatial resolution (**Census block level**), making MCMC ensembles a critical for redistricting in 2021.

We propose to apply these improved MCMC ensemble techniques to districting plans proposed by the Texas Legislature during the 2021 redistricting cycle. We are generating ensembles based on 2020 Census data and will be prepared to evaluate any new proposed plan along a variety of metrics.

Main Points

- MCMC ensemble sampling creates an **unbiased baseline** for districting plans by generating a large number of valid alternatives.
- Proposed plans can be compared to this ensemble to identify outliers that should be revised.
- MCMC ensemble sampling is reliable, replicable, and fast. It has been effective in expert testimony in court and is freely available as open-source software (GerryChain).
- Improvements like recombination MCMC, ecological inference, and Census block level granularity make MCMC even more powerful and efficient.
- Utilizes 2020 Census results released on August 12.

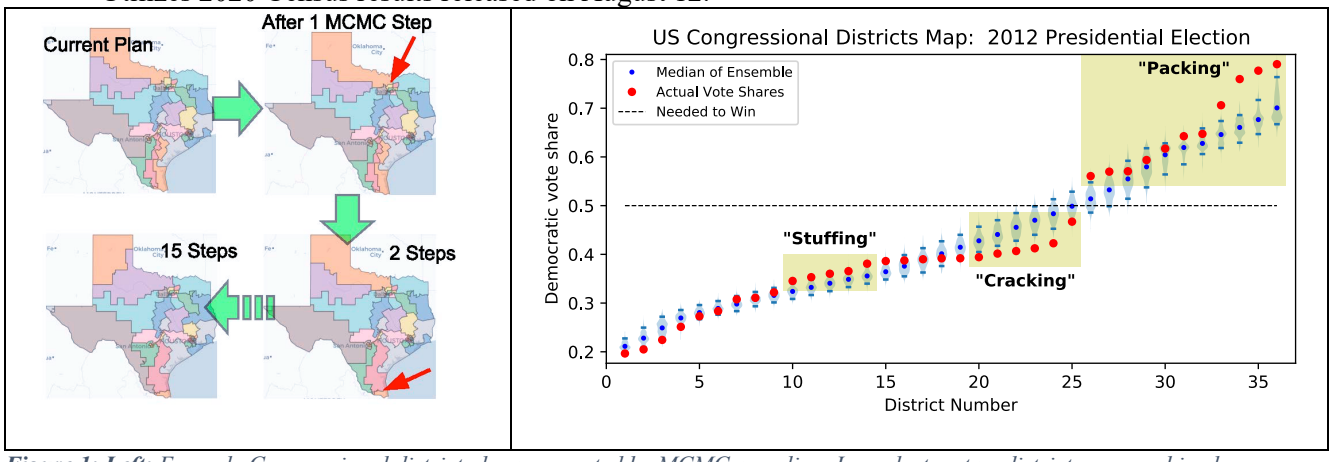

Figure 1: Left: *Example Congressional district plans generated by MCMC sampling. In each step, two districts are combined and re-split into two equal-population pieces (red arrows).* ***Clockwise from upper left:*** *Current plan; after 1 MCMC step (recombining districts 13 & 26); after 2 MCMC steps (recombining districts 15 & 34); after 15 MCMC steps.* ***Right:*** *Partisan gerrymandering is one phenomenon that can be illuminated using MCMC analysis. Here, the vote-share vector for the current US Congressional District (red dots), compared to an MCMC ensemble of alternative plans (blue violins). The results show a classic pattern called "Packing and Cracking".*

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