

Thesis Project Portfolio

Optimizing Electoral Boundaries: A Network Flow Approach to Political Districting

(Technical Report)

From Neutrality to Locality

(STS Research Paper)

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A Network Flow Approach to Political Districting

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From Neutrality to Locality

A Sociotechnical Synthesis

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“There are a lot of forces that feed cynicism. And there’s no dispute that our democracy is not working as well as it should... One [reason] is that we have set up a system for electing state legislatures and members of Congress that involves the drawing of district lines that are gerrymandered. For those of you who are unfamiliar with the phrase, it basically means that those who are already in power draw the maps in such a way that they can be assured that these are either going to be Democratic seats or Republican seats. And what that’s done is it’s made very few seats competitive.”

— Barack Obama, 2016

Virginia has had a long and fraught history of gerrymandering. Contemporary politics saw decades of partisan gerrymandering as control of the legislative body shifted between the two major parties. But the state’s most high-profile instances of gerrymandering are also the most recent. Following the 2011 redistricting cycle, several maps were legally challenged as racial gerrymanders, and Virginia’s House of Delegates and Congressional maps were ultimately redrawn by federal courts.

In 2020, Virginians voted to amend the state constitution to establish a bipartisan Redistricting Commission in the hopes of ending the practice of gerrymandering. But the Commission’s first attempt was marred with partisan disputes and never came close to an agreement on a set of maps, resulting in the Supreme Court of Virginia drawing the new districts. There were two notable reasons that led to the Commission’s deadlock. First, the Commission was unable to agree on a neutral entity to provide technical expertise in the redistricting process, and instead hired two sets of partisan mapmakers with the goal of melding their work. Second, the partisan mapmakers took different approaches to minority representation and compliance with the Voting Rights Act of 1965.

In this thesis, I explore the concept of neutrality in redistricting in two ways.

In my technical report, *Optimizing Electoral Boundaries: A Network Flow Approach to Redistricting*, I consider the neutrality of process through computational redistricting. In this paper, I describe a model for redistricting based on the capacitated clustering problem that leverages network flow to assign geographic units to district centers while optimizing for population equality and compactness. I then use the model to generate compact and contiguous example maps for Virginia's Congressional and General Assembly districts, and evaluate the generated districts on the basis of population equality and minority representation, comparing them against the maps drawn by the courts in the 2021 redistricting cycle. My results show that this approach is beneficial in that it can produce districts with low population deviations and strong minority representation opportunities. Furthermore, due to its foundation in network flow, the model can be extended to add additional constraints such as the consideration of political subdivisions and Communities of Interest.

In my STS research paper, *From Neutrality to Locality*, I explore neutrality in redistricting more abstractly with a focus on the Virginia Redistricting Commission, and ask the question of whether neutrality can exist in an inherently partisan process. I begin by analyzing the Virginia Redistricting Commission and its structure, as well as redistricting commissions in general. I then provide a brief technical and mathematical introduction to the redistricting problem. Tying in my technical report, I examine the neutrality of process through computational redistricting, as well as the shortcomings of a computational approach. I then assess the paradox that neutrality of process does not guarantee fairness of outcome, and detail why maps continue to be drawn by humans while highlighting some of the issues that exist with the current redistricting process. Finally, I argue in favor of a more localized and transparent approach to redistricting, proposing the formation of an independent redistricting lab in Virginia to provide technical expertise for future iterations of the Virginia Redistricting Commission.

Neutrality in redistricting is said to be a myth. Despite decades of research into computational methods that seek to depoliticize redistricting by automating the process, maps continue to be drawn by humans in a way that lacks transparency and reproducibility. Yet the first computational approach to redistricting in the 1960s saw computers as a means

to overcome legislative deadlock, and in New Zealand, computational redistricting was utilized alongside a commission to produce maps in an iterative manner. With the Virginia Redistricting Commission failing to produce maps due to partisan deadlock, computational redistricting has the potential to be an effective tool to help Virginians achieve their goal of a fair and equitable process.