Can Math Help the Supreme Court Free Congress from Gerrymanders?

By Karen Saxe

In October the Supreme Court heard its first partisan gerrymandering case (Gill v. Whitford[1]) in more than a decade. Gerrymandering is the intentional manipulation of territory toward some desired electoral outcome. In 2012, Republicans won 60 out of 99 seats in the Wisconsin State Assembly while receiving only 48.6 percent of the statewide vote. In 2014 and 2016, Republicans extended their advantage as in Figure 1. Partisanship will be more carefully watched in the next round of redistricting, which will take place after the 2020 census.

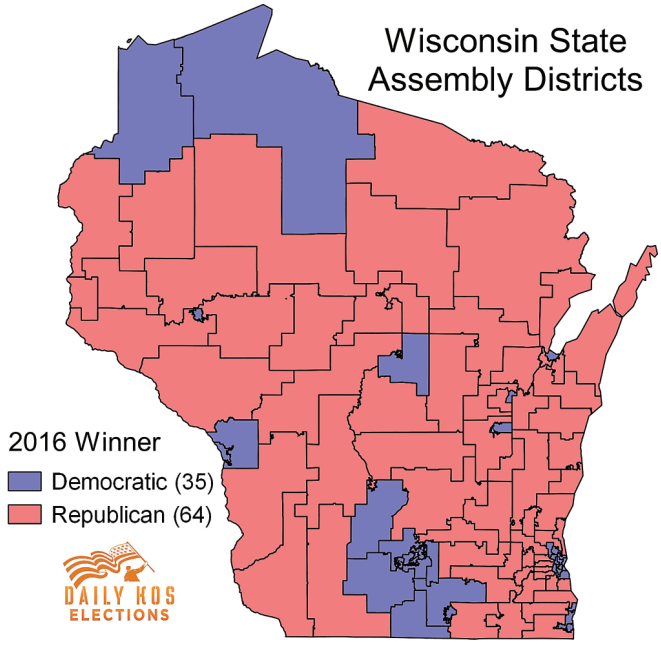

Figure 1. In 2016, Republicans won 64 of the 99 seats in the Wisconsin State Assembly while receiving only 53 percent of the statewide vote.

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A state legislature typically divides the state into election districts, one for each member of Congress. Map drawers usually build congressional districts using census blocks as the base unit. In Minnesota, for example, there are 259,777 census blocks, which need to be assembled into eight congressional districts. Minnesota will likely lose a seat after the 2020 census, which will make the upcoming redistricting even more difficult and contentious. With the current eight districts, there are approximately 5×10^{38} possible maps.

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Of course, there are many constraints on *how* the 259,777 blocks are put into the eight districts. Each district must contain the same number of people (and census blocks vary in population size), and each district must be "contiguous" (path connected). These two constraints alone reduce the number substantially, but to what sort of magnitude?

The pivotal Justice Kennedy has called for a "manageable standard" that can be used to detect whether or not a specific map is a partisan gerrymander. In a 1983 case (Karcher v. Daggett[2]) involving New Jersey's districting, Justice Stevens had written that "Substantial divergences from a mathematical standard of compactness may be symptoms of illegitimate gerrymandering." What exactly

[1] www.scotusblog.com/case-files/cases/gill-v-whitford/

[2] bit.ly/2wvK401

this means is an interesting question, but you can bet it has nothing to do with open covers. Measures often compare the district to some ideal geometric object such as a circle, a polygon, or the convex hull of the district, or require that the perimeter be relatively small compared to the area (a legislated isoperimetric inequality!). There are further guidelines arising from the Voting Rights Act. And there are other districting aspirations such as preserving communities of interest, incumbent protection, and creating competitive districts.[3] How can we detect whether there has been partisan intent or a partisan effect in the map-drawing process? There are social science measures that aim to identify partisan bias in districts, including the *efficiency gap,*[4] which is fairly new, central to the Wisconsin case, and getting a lot of attention from the press.

Take the line drawing out of the hands of those with ulterior motives.

While automated redistricting algorithms have been around for half a century, computational limitations have been a barrier. Due to vastly increased computational power, together with theoretical headway, we are currently seeing significant advances being made in the way we can utilize computer simulations to assess maps and help identify highly biased maps. In short, computers can generate a very large number of maps and for each of these maps partisan bias is measured using, for example, the efficiency gap. If the proposed map is an outlier in its partisan bias, as compared to the sample's distribution of the bias measure, then the proposed map can be considered biased. A new algorithm based on viewing redistricting as a graph-cut problem shows real promise; this algorithm generates maps that are contiguous and compact (as determined by a specified compactness measure) and further constraints (such as status quo bias) can be built in. This algorithm produces a representative sample from the space of all possible maps, subject to the constraints.

The power of such algorithms shows us that we are moving a long way toward being able to identify partisan gerrymanders. Unfortunately, sophisticated map-drawers with intention will be able to use the technology to draw maps that are biased but still legal. It seems that the only way out of this quagmire is to take the line drawing out of the hands of those with ulterior motives.

While there are federal laws, centrally the Voting Rights Act, that govern redistricting, the states[5] have substantial autonomy in how they draw their lines. And, for most states, this means that the maps are drawn by the party currently in power in the state. Some argue that change needs to happen up front, that redistricting should be taken out of the hands of state legislators who are—quite understandably—interested in seeing their own party stay in power. Americans across the political spectrum agree by wide margins that gerrymandering is bad. In 2013, a Harris poll[6] found that seven in ten Americans agreed that those who stand to benefit from drawing electoral lines should not have a say in the way those lines are drawn. This view cut across partisan lines, with 74 percent of Republicans, 73 percent of Democrats, and 71 percent of independents in agreement.

There are many civil rights organizations working on this. What about in Congress? In the current Congressional session there have been two bills introduced that, if adopted as law, would require non-partisan commissions in every state to draw congressional districts. Representative Don Beyer (Virginia) has introduced the Fair Representation Act, which includes an independent commission as part of a larger package of congressional election reforms. Representative Zoe Lofgren's (California) Redistricting Reform Act of 2017 also requires each state to establish an independent redistricting commission.

potential to positively impact the redistricting process

This past summer I participated in the Geometry of Redistricting Workshop. The workshop participants included many mathematicians, and also lawyers, political scientists, and computer scientists. The first three days were open to the public and consisted of talks preparing us in all relevant areas of math, computation, political science, and legal history. For the last two days small groups convened in three training tracks—information/technology, expert witness, and teaching. The teaching track introduced high-school and college teachers to the mathematical discipline of voting theory and offered concrete tools for incorporating mathematical topics related to voting, gerrymandering, and civil rights into their teaching. Information track folks engaged in a code-a-thon of sorts, creating databases, visualizations, apps, and other open-source tools for redistricting.

In my track, the expert witness track, we pored through witness testimonies and deposition transcripts, we talked about what we might ask a lawyer when initially contacted to potentially serve as a witness, and we discussed writing *amici curiae.* It was intense, and I know I speak for many in my track when I say that I now feel *much* more comfortable with the idea of being contacted to serve as an expert witness in a redistricting case.

We are two years away from our nation's next census and, following it, our next round of reapportionment of Congress and redistricting of the nation. Mathematicians

[3] *For more on constraints in redistricting by the states, see* redistricting.lls.edu/where-tablefed.php

[4] papers.ssrn.com/sol3/papers.cfm?abstract_id=2457468

[5] redistricting.lls.edu/who.php

[6] bit.ly/2rh3eWb

and statisticians have the potential to positively impact the redistricting process, and our community is increasingly ready to do so.

EDITOR'S NOTE. See Saxe's blog *Capital Currents* `blogs.ams.org/capitalcurrents/` and "A Formula Goes to Court: Partisan Gerrymandering and the Efficiency Gap" in the October 2017 *Notices*.

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ABOUT THE AUTHOR

Karen Saxe recently became one of the four experts comprising the Common Cause Minnesota Redistricting Leadership Circle.