Gerrymandering study finds fair districts can look strange, while symmetrical ones may be biased

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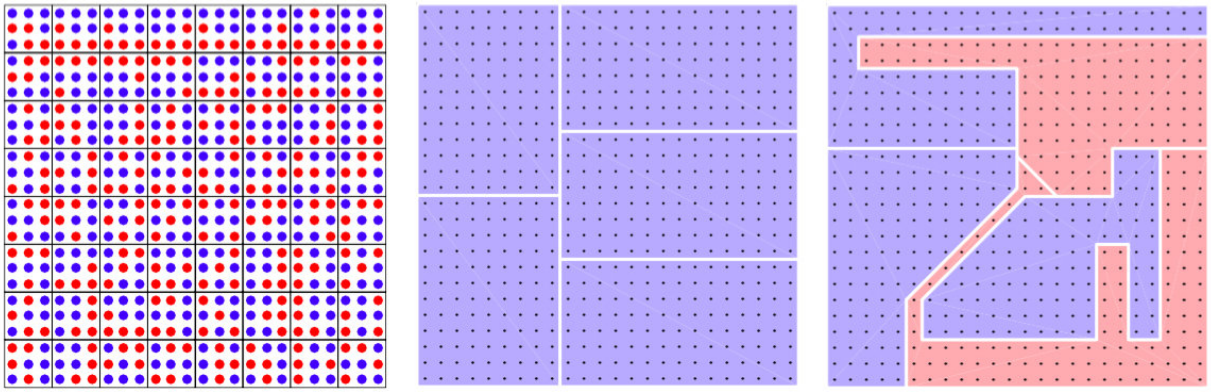

When a simulated neighborhood with roughly equal numbers of blue and red voters (left) is divided into symmetric districts, all the districts favor blue (center). But when districts in the same neighborhood are redrawn to reduce the Efficiency Gap statistic, the result is a more balanced representation of the two parties, but with oddly shaped districts. Credit: Dustin Mixon, The Ohio State University.

When it comes to judging the fairness of electoral districts, we can't believe our eyes.

That's the finding of two mathematicians who wrote a theorem to test whether the shape of a district is a good indicator of whether it's been

gerrymandered to favor votes for a particular political party.

As it turns out, districts that have been drawn in neatly symmetrical ways that are pleasing to the eye can actually be gerrymandered, while districts that have been drawn to assure balance between two parties can look distorted or downright wonky.

As the U.S. Supreme Court deliberates over whether a mathematical formula dubbed the "Efficiency Gap" should be used to detect unconstitutional partisan gerrymandering, this new theorem proves that in some cases, the Efficiency Gap will flag only bizarrely shaped districts as being constitutional.

"Our theorem shows that we need more robust metrics for determining the constitutionality of voting districts," said Dustin Mixon, assistant professor of mathematics at The Ohio State University.

With study co-author Boris Alexeev, Mixon composed the theorem and shared it on the science preprint server arXiv.org, where other mathematicians can review it and weigh in on its validity before they submit it to an academic journal for formal peer review.

The term "gerrymandering" originated in 1812, when Massachusetts Gov. Elbridge Gerry stacked the odds in favor of his party by redrawing state voting districts into a shape that the Boston Gazette likened to a salamander. Gerry lost his job over the incident, but the redistricting did enable his party to take over the state senate, and the name stuck.

In 1986, the Supreme Court ruled partisan gerrymandering to be unconstitutional, but even today there's no easy way to tell if districts have been gerrymandered. One factor cited by lower courts in the past has been the shape of the district, and oddly shaped districts are thought to be suspect. Now that the Supreme Court is trying to set a universal

standard for identifying partisan gerrymandering, mathematicians are asking a related question about geometry: Can shape be relied upon as an adequate indicator?

This is where the new theorem comes in.

Mixon specializes in the mathematics of geometric clustering. He's developed other theorems that aid data processing or help engineers boost the signal-to-noise ratio of electronic transmissions.

Like the environmental noise that can interfere with signal transmission, mathematicians can model voter preference as being randomly distributed, Mixon explained. So when the Supreme Court case brought gerrymandering to the forefront of mathematical discussions recently, he and Alexeev decided to see if they could analyze voting districts in a similar way.

The researchers pointed to three general criteria that are followed in the U.S. today for drawing the boundaries of districts. Only the first comes from the Supreme Court: Each district should contain roughly equal represented populations, a criterion known as "one person, one vote," which results from the Court's interpretation of the Equal Protection Clause to the Constitution.

The second criterion is a law in some states, but not all: Districts should be compact in shape. They shouldn't look weird to the eye, like the salamander-shaped district Elbridge Gerry drew in 1812.

There's no legal requirement for the third criterion, and the case currently before the Supreme Court asks the Court to make such a requirement: Districts should balance the votes of people belonging to different political parties in a way that's roughly equal.

The Efficiency Gap statistic is supposed to help measure whether a district is appropriately balanced. It counts the "wasted" votes of a political party in a particular district. If one party greatly outnumbers the other, then a high percentage of that party's votes are wasted—that is, they are not necessary for the party to win a majority vote in the district. In 2016, a federal court used the Efficiency Gap to decide a case on Wisconsin State Assembly election districts. That's why the Supreme Court is now considering whether the Efficiency Gap is a good measure of partisan gerrymandering or not.

In short, Mixon and Alexeev's new theorem proves that sometimes only two of these three criteria can be satisfied using the Efficiency Gap methodology. In those cases, when districts are drawn to contain equal numbers of voters and balance between the parties, the resulting shapes are highly asymmetrical. They look gerrymandered, but they're not.

"You can get a really weird-looking district that otherwise meets the criteria for 'one person, one vote' and partisan symmetry," Mixon said.

This new study has not gone through a formal peer-review process yet. But other researchers have weighed in on the work.

One of the theorem's informal reviewers was Mira Bernstein, a mathematician and founding member of the Metric Geometry and Gerrymandering Group at Tufts University. She said that, within its particular mathematical framework, the new theorem provides a rigorous demonstration of an intuitive fact: Voter geography matters.

"With geographically defined districts, the number of legislative seats that a party wins is going to depend not only on the number of votes it receives but also on where its voters live," Bernstein said. "A measure like the Efficiency Gap, which implicitly dictates a particular relationship between votes and seats, is therefore guaranteed to

erroneously detect 'gerrymandering' under some circumstances."

Judging by the recent oral arguments in front of the Supreme Court, she believes that the justices are aware of more sophisticated tools that can now distinguish between the effects of political geography and intentional partisan gerrymandering.

"My hope is that they will come up with a judicially manageable standard based not solely on the Efficiency Gap but on the more robust measurements now available," she added.

Mixon and Alexeev will continue to look at the problem, and await the court's ruling next year. In the meantime, Mixon has written a blog post to further explain the theorem to a general audience.

More information: An impossibility theorem for gerrymandering. arXiv. arxiv.org/abs/1710.04193

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