You Know It When You See It:
Measuring Gerrymandering through Visual Perceptions

"Voters should choose their politicians; politicians shouldn't choose their voters." It seems troubling, then, that every 10 years, politicians redraw their district lines to suit their own reelection purposes. In some states, the majority party may draw the lines to strengthen incumbents and hurt opponents' abilities to gain election. In other states, incumbents from *both* parties conspire to keep themselves in office, effectively preventing newcomers from challenging their political dominance. This process is called Gerrymandering. It is completely legal, and sometimes results in abnormally-shaped districts, like Alabama's 16th State Assembly District:

Research in political science has attributed many adverse effects to Gerrymandering. For example, some say it contributes to polarization, which worsens legislative gridlock in both states and in Congress. Others say it extends the incumbency advantage, where leaders in office have a competitive advantage over newcomers, and thereby increases the amount of money in politics.

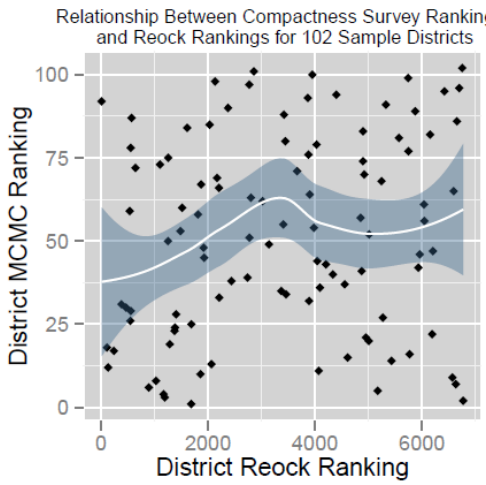
On the other hand, recent research argues that Gerrymandering has little effect on politics. Since many voters live in ideologically similar neighborhoods anyway, and if most voters in a county are Republican, those voters are best represented by a Republican regardless of the shape of the district. There is a thin line, however, between a district drawn to include like-minded voters and a district drawn to protect politicians from challengers.

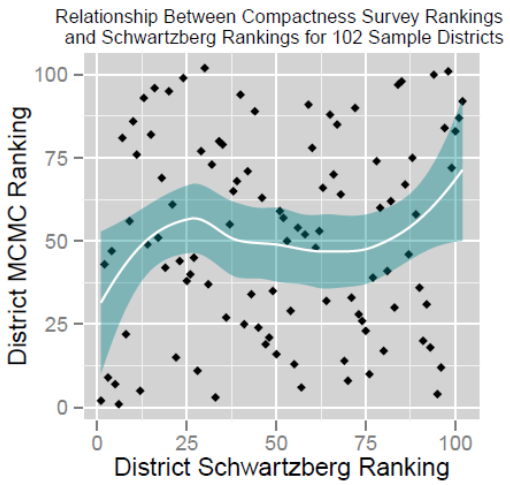
This line remains very unclear, but what we know about it comes from the Voting Rights Act (VRA). The VRA lists guidelines for how to legally redistrict cases to avoid Gerrymandering, and one of the key criteria is "compactness". Many political scientists have tried to mathematically define compactness, but none have been very successful. Today, the courts use any of several dozen academic and mathematical measures in trying to determine if a state's districts are Gerrymandered, many of which conflict with

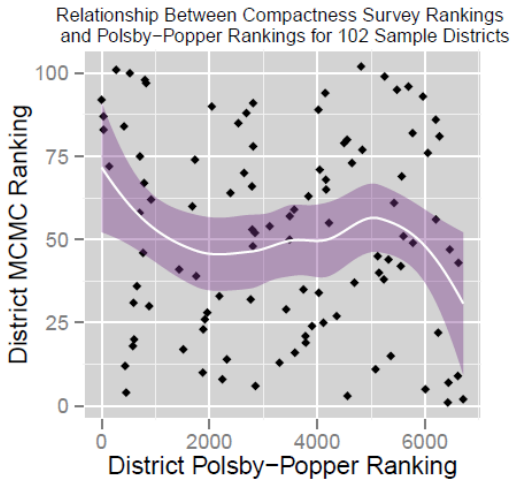
each other.All these measures start from a common ground: a district may be Gerrymandered if it is not compact, and we can measure compactness by measuring the population, size, and shape of a district.

In this project, we start from a different premise. Compactness cannot be formalized; rather, it is the kind of thing where you know it when you see it. So we do just that! Using the DLABSS, we show people pairs of districts, and ask them which district in each pair they think looks more compact, whatever that means to them. With enough responses, we can rank every district from least compact to most compact. Finally, once we have compactness ranks for every district, we can use cutting-edge sorting algorithms and machine learning to learn the relationship between the mathematical and academic measures of compactness, and what people consider to be truly compact. In summary, we are building a model to predict how Gerrymandered a district is!

Our major finding is that these traditional mathematical measures don't very well capture what people think compactness looks like. Below is a plot of the relationship between our DLABSS-based rank of districts and three major mathematical measures: the Polsby-Popper Test, the Reock Test, and the Schwartzberg Test. Each dot represents a real district. Its horizontal position refers to its rank along a mathematical measure of compactness; its vertical position represents its true compactness.







The plots are a complete mess! There is a very weak relationship between the two measures, indicating that the way judges and lawyers and lawmakers interpret the compactness criterion in the Voting Rights Act have little to do with the original meaning of the law. On the other hand, the tools we have developed are based on intuitive understandings of compact shapes. We hope that our research will set a new standard for identifying and correcting Gerrymandered districts.