

# Gerrymandering and Political Gridlock in the US

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## ABSTRACT

In the recent decades gerrymandering became one of the effective tactics to guarantee the outcomes of general elections. Since elected officials know that they are safe in the next election cycle, they only are to appeal to one partisan interest group. This discourages congressmen from working across party lines and leads to congressional gridlock.

In this paper we discuss our approach to measuring gerrymandering of a congressional district. Starting with the ratio of the shape's area to its perimeter as compactness we analyzed which congressional districts are gerrymandered. Furthermore, we deployed Partisan Voting Index data to identify Swing districts and districts with one-party leaning. Comparing mean compactness of all three groups we concluded that the Swing districts are less gerrymandered compared to party-aligned ones. We discuss the challenges, results and future work in analyzing congressional data to understand the impact of gerrymandering.

## Categories and Subject Descriptors

G.3 [Probability And Statistics]: Experimental design;  
J.1 [Administrative Data Processing]: Government

## General Terms

Application of Compactness

## Keywords

Compactness, gerrymandering

## 1. INTRODUCTION

In the recent aftermath of the government shutdown one can wonder how much the partisanship contributed to gridlock in Congress. Are the congressmen who have a greater certainty of reelection within the congressional districts more prone to take a partisan stance when it comes to voting patterns?

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KDD'14 August 24-27, 2014 New York, NY USA

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Based on the recent polls [11] congress has one of the lowest job approvals. Nevertheless, 90% the incumbents [10] were reelected into the House of Representatives in 2012. One of the factors that could have contributed to this phenomenon is gerrymandering.

Gerrymandering has been making national news on the several occasions [13, 7, 12]. Several papers have been written about gerrymandering [6, 8]. Even the Supreme Court acknowledged the issue and is open to bringing it before judges. There have been many attempts to quantify gerrymandering beyond anecdotal observational evidence. Scientists used measures of dispersion, perimeter, area, or both via compactness to argue about validity and even sanity of congressional districts boundaries.

When it comes to measuring the performance of the House Representatives, several agencies provide performance scores on both, liberal and democratic scale. Combining that information with the geospatial data from the US Census bureau can shed a light on whether partisanship can be attributed to gerrymandering.

This paper describes the attempt at quantifying congressional districts by their geospatial attributes and performance of their representatives to explain the relationship between gerrymandering and partisanship. In the next section we go over definitions of gerrymandering and compactness of a congressional district, and then discuss data and methodological approach to transforming and exploring it in Section 3. Section 4 discusses the results of the analysis. Proposed future work is then described in Section 5.

## 2. OVERVIEW OF GERRYMANDERING AND COMPACTNESS

The term gerrymander was first introduced by the *Boston Gazette* in 1812 as a response to the redistricting in Massachusetts under then-governor Elbridge Gerry. One of the newly drawn districts from the infamous redistricting bill signed by Gerry resembled the shape of a salamander. By combining the governor's name with salamander, one arrived at the term *gerrymander*.

According to *Black's Law Dictionary* political gerrymandering is the process of dividing a geographical area into electoral districts to give one political party an unfair advantage by diluting the opposition's voting strength. Based on how districts are drawn, each party can guarantee the majority of seats within the House of Representatives even though they might have a minority of the popular vote [6]. Take, for example, the 2012 elections. Even though the Republican party won a majority seats in the House of Representative,

they received less popular votes than the Democrats.

Congressional districts are the 435 areas from which people are elected to the U.S. House of Representatives. Each state has at least one representative in the U.S. House of Representatives. Each individual state is responsible for establishing the boundaries of the congressional districts based on the results of the decennial census. Based on two U.S. Supreme Court decisions, *Wesberry v. Sanders*, 376 U.S. 1 (1964) and *Reynolds v. Sims*, 377 U.S. 533 (1964), it was established that each congressional district must maintain approximately the same population counts across redistricting efforts. Thus, since the 1960s redistricting is performed every ten years soon after the decennial census.

Overall, there is no law prohibiting division of counties and cities across the congressional districts. The only unit that has to be preserved is the census block, which is a statistical area bounded by visible features, such as roads, rivers, and shorelines, as well as by property lines, city, county and similar. This allows redistricting authorities to manipulate the boundaries of the districts to include or exclude certain census blocks of interest.

Over the course of the last 50 years state jurisdictions found a way to manipulate the borders of each congressional districts. One example of such was the construction of majority-minority districts or in other words, engage into racial gerrymandering. This practice was later struck down by the Supreme Court in *Shaw v. Reno*, 509 U.S. 630 (1993). On the other hand when it comes to political gerrymandering, no plaintiff was successful at claiming that the redistricting was unconstitutional since it denied a political party its constitutional rights. The reason is that political gerrymandering falls outside of the courts' jurisdiction as it is a political question.

There are two well-defined approaches to district gerrymandering: *packing* and *cracking*. Packing is the process of placing as many homogeneous voters as possible into one district to reduce their effect in the other. This will allow a party to have a very strong presence in one district, but offer virtually no opposition in others. The cracking method, on the other hand, spreads opposition voters across several districts to avoid strong competition. The methods are most effective when deployed together.

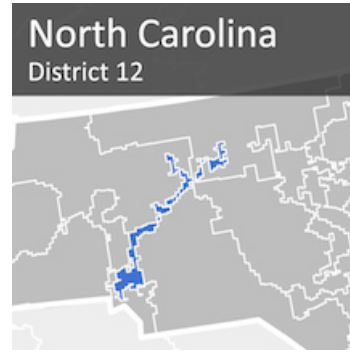
How does one decide if a district is gerrymandered? In the past there have been several attempts to quantify this phenomenon. One of the measures proposed is district compactness. The compactness metric quantifies how tightly the area of the shape is packed into its boundary or perimeter. A common compactness measure is the ratio of the area of the shape,  $A$  to the area of a circle having the same perimeter  $P$  [4].

$$C = \frac{4\pi \cdot A}{P^2} \cdot 100 \quad (1)$$

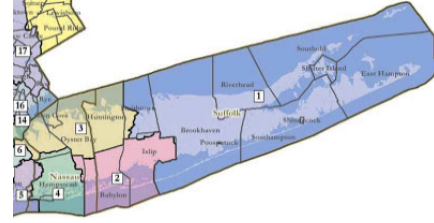
Given this metric, the most compact shape would be a circle, with score of 100.

Figure 1 shows the least compact district in the US in the 113th Congress.

There has been great debate over the last several decades about the best measure of congressional district's compactness [8]. Driven by the desire to find optimum the district boundaries within the state, compactness was thought to be a quantifiable measure to aid in doing so. However, given complexity of a redistricting process based on population density, racial distribution, and geographies, compactness



**Figure 1: The Least Compact District in The US. Compactness Score is 2.9.**



**Figure 2: Congressional Districts in The State of New York After Redistricting in 2011[2]**

alone could not serve as a proxy for optimal redistricting. On the other hand, it's a very interesting metric, which in general could help the public to understand the relationship between gerrymandering and partisanship that caused recent government gridlock.

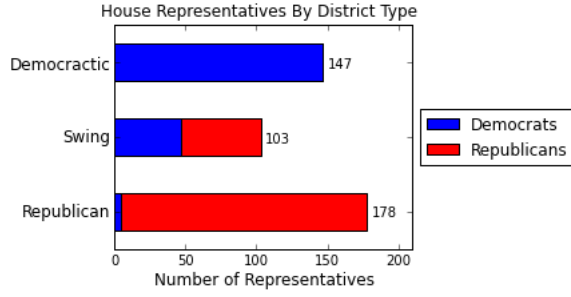
### 3. DATA AND METHODOLOGY

#### 3.1 Data Sources

After each redistricting initiative the US Census Bureau releases shape files of each congressional district organized by state. Based on the fact that the geospatial data for a district is defined by each individual state, the district boundaries are subject to generalization. For example, in 2011 New York state version of redistricting boarder of the 1st Congressional District (Figure 2) is generalized by including shore into the district outline instead of limiting it by the coastal outline. After examining the districts of the 113th Congress in detail and overlaying their boundaries with the coastal boundaries of the US, we concluded that the approach described above involves sufficient smoothing of the boundaries, minimizing variability in district compactness due to a natural coastal landscape. This allows us to distinguish between districts whose borders are complex due to shoreline profiles vs. districts which have been carved out through the gerrymandering process.

Given that Alaska, Delaware, Montana, North Dakota, South Dakota, Vermont, and Wyoming have only one congressional district we excluded them from our analysis. This leaves us with 428 districts for examination.

In order to understand the performance of each individual district and its congressman, we used a measure of partisanship. There are several public agencies that score each congressman's performance according to various criteria (e.g.,



**Figure 3: Distribution of House Representatives by District Type**

voting record). After careful considerations of at least three sources, *Heritage Action For America Score Card* [5], *U.S. House Scorecard* [3] and *Partisan Voting Index* by The Cook Political Report [9], we decided to use The Cook Political Report to quantify the partisan polarity of each district and its representative. The reason behind this decision lies within the methodology by which each Partisan Voting Index (PVI) is assigned. Both Heritage and U.S. House Scorecard based their decisions on opinions about each representative, whereas the Cook Report focuses solely on the outcomes of the presidential elections in each district. Based on the PVI, we then identified three possible categories for classifying congressional districts:

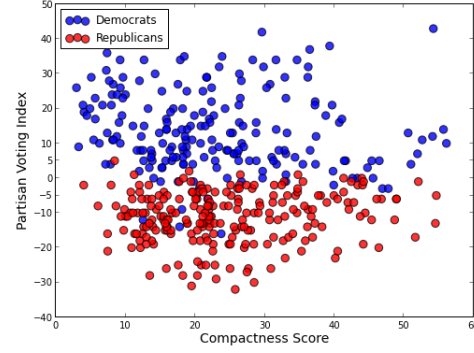
1. Democratic districts, with scores above 5 on the democratic scale
2. Republican districts, with scores above 5 on the republican scale
3. Moderate or Swing districts, with scores between 5 on the democratic and 5 on the republican scales

Rescaling PVI within the range from -50 to 50, where 50 means the most partisan democrat, we can now compare the PVI and district compactness scores to determine if there is a relationship between them and how could it contribute to a better understanding of the impact of gerrymandering on the House Representatives' records

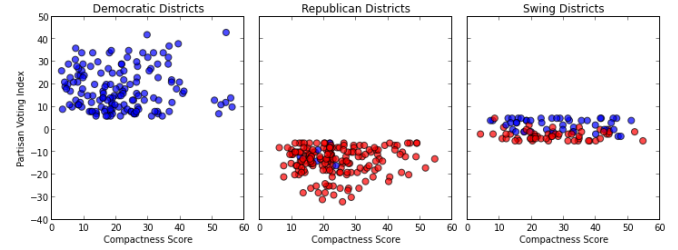
### 3.2 Exploratory Analysis

In order to study the relationships between Compactness Scores (CS) and PVI for each congressional district we combined compactness scores (1) with partisan voting indices obtained from the Cook Report for each congressional district. Plotting CS against PVI (Figure 4) it's clear that there is no linear relationship between two. Splitting congressional districts according to each individual category described in section 3.1 (Figure 5) we can see that the CS of *Swing* districts are more uniformly distributed compare to both *Democratic* and *Republican* districts. Furthermore, the CS of both *Republican* and *Democratic* districts are located in the lower range, i.e. more gerrymandered.

Running simple five-number summaries (Table 1) we can observe that the mean CS for all three types of district are not the same. Moreover, it seems that *Swing* districts are more compact compared to *Democratic* and *Republican* ones. This comes as no surprise given the definition of gerrymandering itself. Our next step would be to support this claim with appropriate hypothesis testing.



**Figure 4: Congressional Districts by Compactness Score and PVI**



**Figure 5: Distribution of Congressional Districts Split by Representatives by District Type**

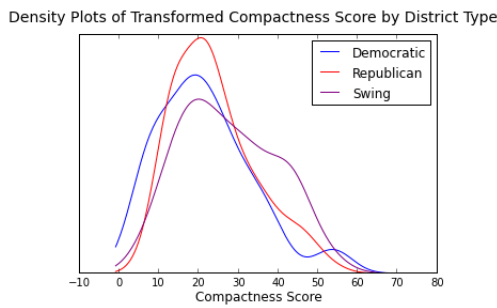
Since we are working with three groups of districts, the most appropriate method would be the analysis of variance. Given slight right skew in the density of compactness scores (Figure 6) we deployed Box-Cox squared-root transformation to normalize the distribution of the compactness scores (Figure 7). Performing *normality tests* on all three groups confirmed that after the transformation the data is normally distributed.

## 4. RESULTS

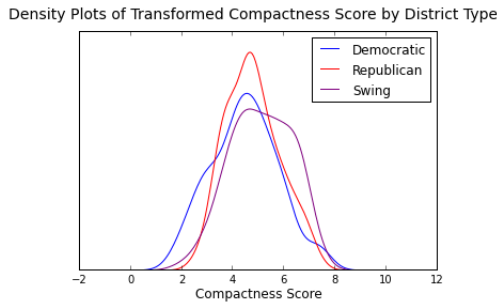
Based on the results of our analysis of variance, we rejected the hypothesis that the average CS in all three districts are the same with p-value of 0.00013. Furthermore, pairwise t-tests adjusted for multiple testing [1] showed that the average compactness of the Swing districts is the largest compared to Democratic and Republican ones with p-values of 0.0001 and 0.023 respectively. Interestingly, Democratic districts had on average smaller compactness compare to

**Table 1: Summary of Compactness Score by District Type**

	Democratic	Republican	Swing
count	147	178	103
mean	21.499810	23.788090	27.361563
std	11.959828	10.431241	11.990965
min	2.907000	6.001000	3.950000
25%	12.541500	15.699000	18.283500
50%	19.531000	21.916500	26.308000
75%	27.595000	29.265000	36.369000
max	56.086000	54.502000	54.632000



**Figure 6: Density Plots of Compactness Scores for Three District Types**



**Figure 7: Density Plots of Transformed Compactness Scores for Three District Types**

Republican ones with a p-value of 0.023.

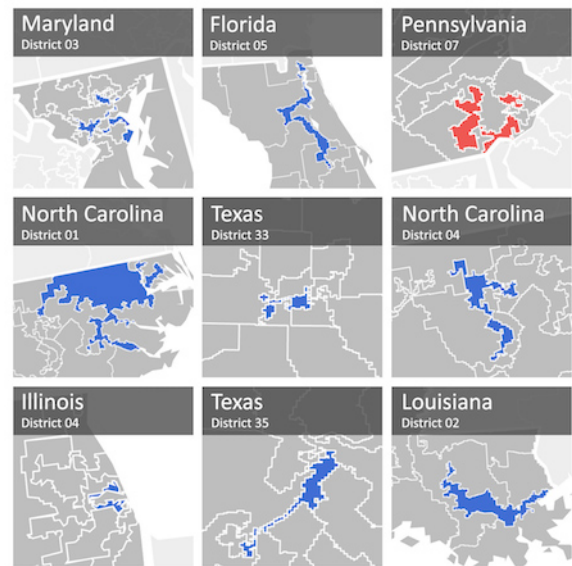
This means that districts which are less compact have larger deviation of Partisan Voting Index from the moderate (or zero). As demonstrated on the Figure 8 out of nine districts with very low compactness, only one is Republican, which comes with no surprise given that Democratic districts have lower average compactness.

## 5. DISCUSSION AND FUTURE WORK

Political gridlock happens usually when two political sides are not willing to compromise on the pressing issues. In the case with the House of Representatives, having secure congressional districts that guarantee a reelection for each individual congressman helps to create political agendas, which do not represent district constituents.

We were able to show that there is a relationship between the gerrymandering (compactness) and the party-leaning districts, meaning that on average Democratic and Republican districts are more gerrymandered. However, future analysis is necessary to link government gridlock to the gerrymandering of the congressional districts. In order to do so we first have to come up with better score for measuring how polarized each representative is. After researching the potential data sources we realized the following approach to engineer the features for designing a score:

1. Examine text of legislatures, both proposed and signed to laws;
2. Examine voting patterns of each representative;
3. Deploy PVI to represent presidential voting in each district;



**Figure 8: Nine Least Compact Districts in The US**

4. Examine campaign contribution data;

Based on the information derived we would like to create a partisan score for each congressman. Additional work has to be performed to identify gerrymandering. To do so we would like to study how rural versus urban characteristic affects the measure. In addition we would like to study the relationship between the distribution of registered voters in congressional districts and overall distribution across the state and its effect on the shape of the district. After construction of these metrics we then would like to examine the connection between the gerrymandering and the partisanship, deriving better understanding of its contribution to the political gridlock.

## 6. ACKNOWLEDGMENTS

The authors would like to thank Scott Kurth of Silicon Valley Data Science for his help in editing this paper, and Susie Lu of Silicon Valley Data Science for help with district visualizations.

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