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Partisan Gerrymandering: the Culprit, a Proposed Solution, and Implications in Information Systems Education

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Abstract

Gerrymandering is the attempt to manipulate the map of voting districts for political gain. It did not do much harm when the manipulation could not make much political gain. Yet it is legal in order to protect the right of representation of minorities in the government. In the past several decades, since the use of Geographic Information System (GIS) has proliferated with easy access to information via the internet, gerrymandering creates a serious problem when the political party in power can manipulate redistricting to choose their voters. Much research effort in political structuring and technical study has gone to defend that, but success is limited at best and partisan gerrymandering continues to be a serious issue. We propose a solution. We suggest the redistricting plan to be selected by the voting public, taking the decision out of the governing political party. The suggested change has many ramifications, one of which is GIS education. The voting public, the politicians included, need to be educated in the use of GIS and some advanced analysis. The use of web accessible GIS will help to facilitate that.

Keywords: Gerrymandering, GIS, political redistricting, minority representation.

1. INTRODUCTION

Democracy originated in ancient Greece, circa 6th century B.C. The word represents the idea of granting the governing power (kratos) to the people (demos) (Raaflaub, Ober & Wallace, 2007). Modern democracies often divide the voting population into districts, not just for the ease of administration, but also to ensure that the minority groups have a fair representation in the government (Levitsky & Ziblatt, 2025; Nilsen, 2022). The Voting Rights Act (1965) prohibits practices or procedures that discriminate on the basis of race, color, or membership in one of the language minority groups. Therefore, drawing the map of the voting districts becomes important to observing that. To account for population growth and migration, the US Census Bureau performs a census every 10 years, and the voting districts will have to be updated accordingly. The authority to redistricting is vested in the state government in the United States. The political party in control of the government has the right to re-draw the map of voting districts.

Studies have shown in simplistic cases how the voting district map can seriously affect the results in the rights of representation. (Kirschenbaum & Li, 2023). Elaborate illustrations can also be found easily on the internet. Such as Wikipedia: "Gerrymandering in the United States" presents a succinct explanation and an updated history. Washington Post also offers a well-explained video titled "Gerrymandering 101" available in YouTube.

The first recorded effort of redistricting for political gain is reported in Section 2, digging up the origin of the word "gerrymander." But it was not a serious issue since the manipulation did not see evidence of much gain in political advantage. The advances of the GIS in the past decades,

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aided by the availability of relevant data, has made much difference. Section 3 sketches the steps of using the GIS, allowing the politicians to basically choose their voters in the process of re-drawing the voting districts. Extreme partisan gerrymandering therefore lays a threat to democracy. Section 4 then briefly surveys the history of various efforts to mitigate the threat. Unfortunately, these efforts do not seem to achieve good enough results. In Section 5, we describe our proposed solution: allowing redistricting plans to be accessible, with the choice to be selected by the voting electorate. The suggestion certainly has many ramifications. We briefly discuss some of them, but focus on GIS education of the voting public, and the issue of making GIS technology publicly accessible. Section 6 closes with the summary of the paper as the conclusion.

2. GERRYMANDERING

Elbridge Gerry (1744-1814) was among the founding fathers of the United States. He was the state governor of Massachusetts in 1812. Figure 1 shows a portrait of him, released in the public domain. Leading the Democratic-Republican Party, the governor re-drew the senate voting district map in an attempt to weaken the opposing Federalist Party. Boston Gazette then published a political cartoon depicting the new Essex district map in its strange shape as monstrous salamander (Tucker 2024). Figure 2 shows the cartoon illustrated by Elkanah Tisdale, available now in public domain.

Fig.1 Elbridge Gerry

Fig.2 Cartoon depicting Gerrymandering

The response in the media coined the word "gerrymander" to refer to manipulation of the voting district map for political gain (Griffith 1907). The authority to re-draw the voting district map was vested in the state government and thus the political party in power. However, the political intention of such manipulation was difficult to prove in the court of law, nor was its political gain readily evident. The new voting district map was signed into law. Although gerrymandering may be exploited to manipulate the fairness of representation rights, the problem was not serious at that time, nor was the intended political advantage easy to achieve. The next section will describe how information systems and technologies make an impact on the practice of gerrymandering, and on our politics.

3. GIS TECHNOLOGY IN USE

With the advances of GIS technology in the past decades, it begins to provide the means for the politicians or the political party to choose their voters with gerrymandering when drawing the voting district map, becoming a serious threat to democracy. In this section, we discuss how we may use the GIS for gerrymandering. We sketch the steps one may take to choose the voters in redistricting using the GIS.

(1) Collect favorable voter addresses
To learn where the supporters are, we collect the addresses of our favorable voters. Depending on the granularity of our map, we may just use the zip codes. To be much more accurate, we should use the complete resident address.

(2) Convert the addresses into a map
Geocoding is a foundational technology commonly provided in the GIS. Using the street maps of our voting area as the reference map, we can apply address geocoding to the collection of addresses, producing a point map of the address locations (Wu & Rathswohl, 2010; Goldberg, 2016). Figure 3 below illustrates the point map of resident locations on the reference street map.

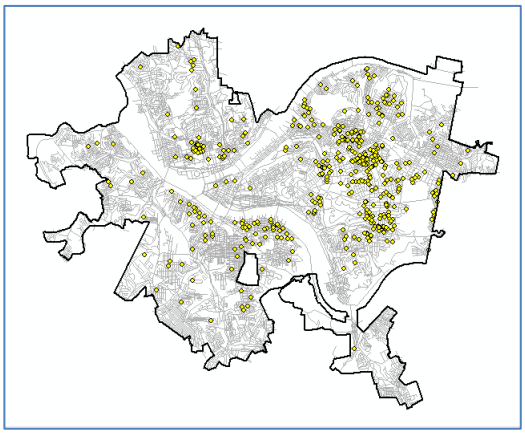

Fig.3 Address geocoded into points on street map

(3) Draw the district for our favorable voters
When we have the map visualizing where our favorable voters reside, we can conveniently use that as a guide to draw our voting district on the map. We can draw the map in any appropriate shape to just include these voters into our district. Figure 4 illustrates such a voting district drawn.

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One may suggest visualizing the locations of unfavorable voters and avoid them. That certainly is a possibility, although the resident addresses of unfavorable voters may be harder to obtain.

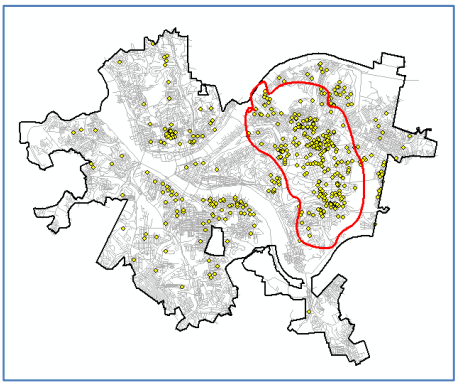

Fig.4 Voting District to Select Favorable Voters

(4) Verify the voting district drawn

The spatial join is a very common operation in the GIS (Wu, 2023). Once we have decided on one voting district, we may apply spatial join to evaluate the population as well as the number of favorable voters in the district, verifying our likelihood to win in the district. The spatial join and other spatial analyses will also help to make sure the voting district draw readily meets the specific requirements which may be there for the specific state.

(5) Re-do if not satisfactory

Perhaps the voting district we did is not satisfactory, or if we recognize that we need to have several favorable voting districts to win. We can go back to step (3) to try re-doing other shapes or additional districts for the voting districts. The try-and-verify approach guided by the visualized map becomes a very practicable way to do gerrymandering for political gain, effectively choosing our favorite voters. Figure 5 shows our desired result of 3 districts, practicing partisan gerrymandering.

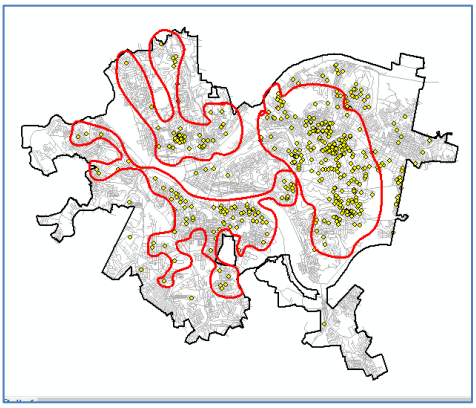

Fig.5 Three Voting Districts in Gerrymandering

4. ATTEMPTS TO SOLVE THE PROBLEM

When the GIS becomes a versatile tool for manipulating voting district boundaries, gerrymandering becomes a serious threat against democracy. Restricting the practice turns out to be a legally challenging proposition. There have been various attempts to mitigate the threat: some based on re-organizing the political infrastructure, and some others based on technical analysis of redistricting. We give a brief account of these attempts in this section, leading up to hopefully applying an information system solution (Wu, DePlato & Combs, 2022).

Non-partisan Commission

Redistricting is periodically necessary when the population distribution changes. In the United States, this is done every decade after the centennial census. Redistricting means redrawing the voting district map and that authority is vested in the state government. The political party in power will have the right to exercise gerrymandering to their advantage. To eliminate this conflict of interest, a suggested solution is to have a non-partisan commission in charge of redistricting, to alleviate the intention of political gain. The question becomes: who should then qualify to be on the commission? Currently 9 states practice this: Alaska, Arizona, California, Colorado, Idaho, Michigan, Montana, Utah and Washington. Each sets up requirements on who should be on the commission. All (except Utah) require non-legislators. Others also require equal number of Democrats and Republicans (Common Cause, 2025). Some other states also practice independent commission in redistricting of state and local level voting districts.

Legally Restrict Gerrymandering

The Voting Rights Act (1965) has a crucial piece of legislation to ban racial gerrymandering, aiming to protect the voting rights of everyone, regardless of race. Other than that, the federal courts have no jurisdiction over partisan gerrymandering (Oyez, 2019). But it can still be challenged at the state level, based on how the state legislation stipulates. Many states adopt criteria to limit gerrymandering: promotion of democracy in racial fairness, in preserving community of interest, and also the contiguity and compactness of the shape of a district. In Pennsylvania, redistricting has to promote democracy, and that has become the basis for legal challenge (Pubintlaw, 2018). Some of the law suits were successful. Yet, the legality of challenging partisan gerrymandering remains debatable.

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Popular Votes Only

Suppose we simply go back to the basics: winner in an election can only win by the majority of total popular votes count. The formation of voting districts is only for administration only; there is then no winner-take-all rule. In federal elections, winners win by total popular votes in the nation. In state elections, winners win by total popular votes in the state. The same applies to counties and cities and municipalities. Gerrymandering will become meaningless because redistricting is for administration only and there is no political gain. But this also goes against the intention in the constitution to protect the minority's right of representation in the government. The Voting Rights Act (1965) explicitly requires the state to ensure minority representation so that there is at least one district in which the minority becomes the majority. Ironically, that is gerrymandering in practice. In the U.S. presidential election, some states have dropped the winner-take-all rule to count only the total popular votes in the state. The Electoral College vote count is then divided proportionally among the candidates. Gerrymandering has no effect. On the other hand, swing states will lose their relevance to the candidates, losing the situation of a battle-ground state. That will be left for each state to consider. In similar ways, local governments often practice counting popular votes only. Gerrymandering is an issue more serious in federal elections, and political redistricting has to consider a proper channel for minority representation.

Identify Partisan Gerrymandering

Alluded to in the aforementioned, some states attempt to restrict partisan gerrymandering by requiring in the shape of a voting district certain contiguity and compactness in its neighborhood. Founded strongly in theoretical computer science, the field of computational geometry (Forrest 1971, Preparata & Shamos 1988) has spawned many algorithms for programming to process geometry in digital data. Much of the GIS functionality has been built on the results of the research work. Many sought to identify from the redistricting map that it is done with partisan gerrymandering (Flint, 2003; Chou & Li, 2006). Despite the effort, a technical objective definition of partisan gerrymandering remains an open question. Granted the difficulties involved, the fervency of the research effort apparently subsided. Alexeev and Mixon (2018) in a paper titled "An Impossibility Theorem of Gerrymandering" summed in definitive terms how inconclusive we may expect this very theoretic approach may do.

Automatic Redistricting

A definitive algorithm to identify partisan gerrymandering seems elusive. A practical approach may be to automate the redistricting process. If there is a computational process to generate political boundaries objectively based on acceptable criteria, such as population data only, we do not need to allow any attempt in gerrymandering.

Altman & McDonald (2011) released a public version of BARD - Better Automated Redistricting. While attempt to control the GIS software to do redistricting based on politically blind criteria has been complicatedly difficult, BARD significantly lowered the bar of required expertise. Yet it is still not generally practicable to apply it to automatic redistricting. Reported in The Washington Post (Ingraham, 2014), Brian Olsen, an avid programmer by trade, shared his automated solution of redistricting based on population data from census, requiring the voting district boundaries to basically follow census block boundaries. The algorithm also bypasses the issues of Voting Right Acts (1965) which, implemented in some states, requires majority-minority districts to be drawn. That makes it unacceptable in these states. Olsen is still working on adjusting the criteria to apply to his algorithm. Levin and Frideler (2019) published an experimental algorithm with a strategy to recursively sub-divide areas in triangulation to construct political district boundaries, based on various demographics criteria. The process does not have to follow census block boundaries. The algorithm seems promising, but it is almost computational prohibitively too expensive.

5. A PROPOSED SOLUTION

The fact seems to be that there is no effective means to prevent partisan gerrymandering, and it continues to be a threat to democracy. We propose to take the right of redistricting out of the state government, and give the right to the voting public to decide on the redistricting plan. Wu & Igoche (2022) suggested the idea, but did not expand on it further. An acceptable solution will have to observe the minority representation requirements in the Voting Rights Act (1965). In the course of campaigning for the election, the sponsor of a redistricting plan will have to face scrutiny, in the need to answer public questions. We hope that will disclose the partisan intention of gerrymandering. The GIS has to be generally accessible by the voting public. The voting public, particularly those involved in the discussion, will need to be educated in the basic use of, as well as analysis by, the GIS. Our suggestion most

certainly has many ramifications, and much will need to be debated. The following discusses some of these issues.

Minority Representation
The Voting Rights Act requires appropriate minority representation in the government. A redistricting proposal will need to be verified to observe that. This will become a fundamental requirement to a redistricting proposal, along with any other requirements stipulated in the state laws.

Public Scrutiny
One may set up initial requirements for one to sponsor a redistricting proposal. Generally, we may assume any citizen in the voting public can make a redistricting proposal, just as any citizen can sign up to be a candidate in an election. Once a proposal is made, the sponsor will have to face public questioning about the intention of the proposal. We believe the public scrutiny may then shed light on the intentions of partisan gerrymandering.

Popular Votes
In the state doing political redistricting, final adoption of a redistricting plan will be decided by popular votes within the state. When there are more than two redistricting proposals, we may set up Run-off Voting in case the winner does not have over 50% of the votes, or we may use Rank-Choice Voting to decide on the winner (Maloy, 2019). All of these will of course require the state legislature to adopt into the state law.

GIS Education
For the discussion, debate and voting about redistricting plans, the voting public will need to be educated about the use of the GIS for redistricting. To be engaged in discussion and debate, we perhaps also need more advanced knowledge in the analysis of redistricting plans how it may interact with the demographic information. We are indeed at the crossroads. We advocate teaching the basic use of the GIS in the middle school or high school levels. Some of the fundamentals in applying GIS analysis will need to be covered in the general education for high school completion, or at the college level, for an undergraduate diploma.

Apart from general GIS education, software vendors should pay attention to user education about using the GIS for political redistricting. At the time of this writing, only Esri has a product ready: Esri Redistricting, and has been promoting user education about it (Esri, 2025). It comes with a suite of application tools to create redistricting plan and to perform certain analyses. It brings clarity to the redistricting processes and government officers as well as citizen advocates should find it very helpful. Leveraging relevant resources to make it publicly available is possible but will be a challenge. We should be eagerly watching for the further development there.

Web-Based GIS
For GIS education and its use to become much more popularized, it is essential for the GIS functionalities to become web-based, so that the GIS is accessible via the internet. The GIS was originally developed as a stand-alone system for many decades. As the internet allows data to be much more easily available, the GIS also began its proliferation on the personal computer platform. But the past decade has seen many GIS software vendors pushing for their products to be web-based, allowing the GIS to become more and more accessible on the internet. This is a welcome trend. Esri Redistricting mentioned in the above paragraph, we are glad to learn, that it is web-based. However, higher education institutions today may still be using the stand-alone desktop system in their GIS courses. We would advocate switching sooner rather than later.

We propose letting the voting public decide on political redistricting, taking that right out of the state government and thus eliminating partisan gerrymandering. This may still be far from becoming reality. But the trends of GIS products and GIS education may facilitate that, keeping our hope alive.

6. SUMMARY

We briefly surveyed the history of gerrymandering, digging into the origin of the word. it was allowed because the provision in the constitution to protect minority representation in the democratic government. It was not a serious problem since there was not too much one could do to gain political advantage. But the proliferation of GIS technology and the availability of data changed that. Partisan gerrymandering is now a serious threat to democracy since the GIS allows the politicians to choose the voters in gerrymandering. We presented the sketch of a plan to do that using the GIS. We also accounted for the various ways we have been trying to mitigate the threat. Our conclusion is that none was quite effective enough for the task. We propose taking the right of political redistricting out of the government to let the voting public decide. We briefly discussed the ramifications of the proposal, but then focused on the need for promoting GIS education,

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and for the GIS technologies to become web-based. The goal may be far, but the trend is moving forward.

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