JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

Volume 15, Issue. 2
July 2022
ISSN: 1946-1836

In this issue:

iscap
Information Systems & Computing Academic Professionals

The **Journal of Information Systems Applied Research** (JISAR) is a double-blind peer reviewed academic journal published by ISCAP, Information Systems and Computing Academic Professionals. Publishing frequency is three to four issues a year. The first date of publication was December 1, 2008.

JISAR is published online (https://jisar.org) in connection with CONISAR, the Conference on Information Systems Applied Research, which is also double-blind peer reviewed. Our sister publication, the Proceedings of CONISAR, features all papers, panels, workshops, and presentations from the conference. (https://conisar.org)

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the JISAR journal. Currently the target acceptance rate for the journal is under 38%.

Questions should be addressed to the editor at editor@jisar.org or the publisher at publisher@jisar.org. Special thanks to members of ISCAP who perform the editorial and review processes for JISAR.

JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

Editors

2022 JISAR Editorial Board

GIS for Democracy: Toward A Solution Against Gerrymandering

Peter Y. Wu
wu@rmu.edu

Diane A. Igoche
igoche@rmu.edu

Department of Computer Information Systems
Robert Morris University
6001 University Blvd,
Moon, PA 15108

Abstract

Political redistricting is periodically necessary to maintain and promote democracy with population growth and migration. The United States constitution establishes majority rule for democracy, but it also protects minority rights. There is provision that a minority group may form a political district so that the group can have representation in the government. Each state has the right to political redistricting accordingly. Since 1812, this has been referred to as gerrymandering. It was not easy to do and was not considered a serious issue. However, the Geographic Information Systems (GIS) today have made the task much easier, leading to the practice of extreme gerrymandering in the past decade. The practice is detrimental to the health of democracy, but it is difficult to legally disallow. We propose a scheme in which the GIS becomes part of the solution. The proposed scheme is to make the process of political redistricting public, to be scrutinized and debated, and perhaps voted for or against by the voting population. The politicians as well as concerned citizens will need to use the GIS. The paper calls for the promotion of GIS education for democracy, with the need for relevant data in redistricting to be publicly available.

Keywords: Gerrymandering, Political Redistricting, GIS, Geographic Information System.

1. INTRODUCTION

Gerrymandering is the practice of manipulating voting district boundaries for political gain (Griffith, 1907). Political redistricting however is necessary to account for the changes in the population, such as those reflected in the decennial census. It is also required for the protection of minority rights so that a minority group may have representation in the government (US Dept of Justice, 1965). The Constitution granted the authority of political redistricting to the states. That allows the party in power in the state government the legal right of gerrymandering. In the past, it was rarely done because the task was difficult and there was inaccurate demographic data to make the process effective. With geographic information systems (GIS) now available, and data easily accessible, gerrymandering can be done with ease (Wu, Deplato & Combs, 2020). The past decade has seen extreme cases of partisan gerrymandering, re-drawing voting districts into strange shapes for political gain (Crane & Grove, 2018; Forest, 2018). It is generally understood to be bad for democracy because it allows politicians to choose favorable voters to secure their elected positions. There have been attempts to disallow partisan gerrymandering but legally it requires proof of intent in the court of law. We believe that the GIS

can be part of the solution in this effort. This paper presents our proposal using the GIS, as well as the public knowledge of the GIS, to be our approach toward a solution.

The next section will review a brief history of gerrymandering and will explain its basic strategies: cracking and packing, and how to gain political advantage in redistricting. The section presents a simple description of how to use the GIS to simplify the gerrymandering process. Section 3 follows with a review of the effort to prevent gerrymandering. Given the context, section 4 presents the draft of our approach toward a solution, requiring plans of political redistricting to be made public, for scrutiny and debate. It requires the voting public to have access to use the GIS knowledgeably. It is therefore pertinent to promote GIS education. The last section closes with a summary and our conclusion.

2. REVIEW OF THE PRACTICE

Gerrymandering is the practice of manipulating voting district boundaries to gain political advantage in democratic voting. The term was coined in 1812 when Massachusetts governor Elbridge Gerry signed into state law to create a voting district in the shape of a salamander to include most of his supporters as majority (Griffith, 1907). It is legal since the political party in power has the privilege of drawing the map for redistricting. However, it was not a serious issue because it was difficult to execute, and accurate demographic data was not readily available for use. In the past decade, very strange shapes of voting districts emerged in political redistricting. We believe the common use of the GIS today and the ease of access to data has made the task relatively simple. Below, we will briefly explain the two basic strategies in gerrymandering: cracking and packing. Then we will describe how it is made easy using the GIS today.

Cracking

The strategy of cracking attempts to dilute the votes of the opposing party to suppress them from winning in any voting district. Cracking is the approach when the party has the majority. The voters for the minority party may be cracked in the redistricting, keeping them as minority in many voting districts. A hypothetical case is illustrated below in Figure 1. Party A of 55% majority exploits cracking in drawing five districts (in the 5 horizontal strips), distributing the 45% voters of opposing Party B evenly to win all five districts, therefore suppressing the minority party.

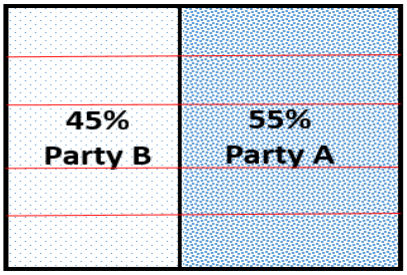

Fig.1 Cracking to Suppress the Minority

Packing

Packing attempts to concentrate the votes of the opposing party in one or a few districts to reduce the number of votes in the other districts. Packing is when the party in power is aware that they are in the minority. The redistricting will attempt to create one or a few districts packed with high percentage of voters for the opposing party. The voters not included in the packing are then distributed into the other districts so that they will not make majority, allowing the minority party to win these other districts. A hypothetical case is illustrated below in Figure 2. Party B has the 45% minority but is in power to do redistricting. One voting district shown as vertical to the right has Party A voters packed, of entirely Party A voters. The remaining Party A voters are distributed into the other four districts horizontal to the left. The result has the minority Party B winning these four districts.

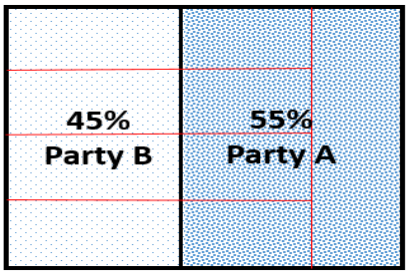

Fig.2 Packing to Limit the Majority

GIS For Gerrymandering

When data is available for use in the GIS, cracking and packing become much easier to do. Assume that we have gathered the addresses of the voters and which party they tend to vote. The GIS functionality known as *address geocoding,* uses an expert system to process the addresses to produce a point map (Wu & Rathswohl, 2010; Goldberg, 2016) as illustrated in Figure 3.

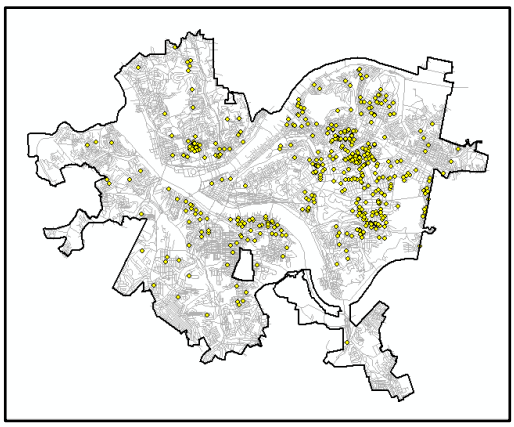

Fig.3 Point Map Showing Geocoded Locations

The map showing where the voters are located serves as our visual guide to draw the voting districts. With the point map as our base map, we can begin to draw voting districts one at a time, choosing to include or not to include areas where the voters are. Once we have drawn a district, the Spatial Join GIS function can readily verify the count of voters for or against the political party, verifying whether or not we are achieving our purpose in the effort. Figure 4 illustrates a voting district drawn to include where the voters are located.

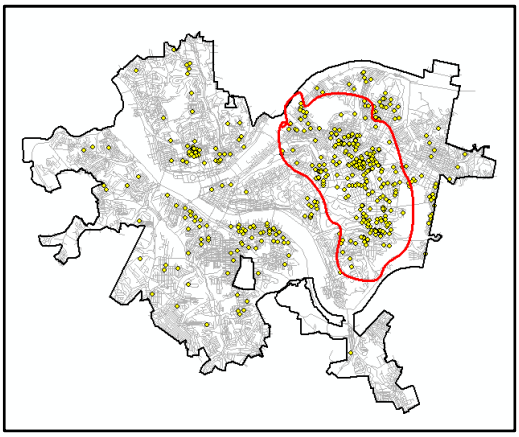

Fig.4 Drawing a Voting District

Thus, a redistricting plan can be constructed with relative ease, aided by the GIS. In the past decade, we have seen a rising number of cases of extreme gerrymandering (Crane & Grove 2018; Forest, 2018).

Wu, DePlato and Combs (2020) more thoroughly described cracking and packing, and the scheme of gerrymandering aided by a GIS. Noting the difficulties to objectively detect and therefore legally disallow gerrymandering, Wu et al called for further research in the area. This paper goes on to propose an approach toward a solution in which the GIS becomes essential.

3. TO PREVENT GERRYMANDERING

Gerrymandering is bad for democracy because it allows a politician to choose the voters by drawing the voting districts to his or her favor. This section presents the efforts attempted to prevent gerrymandering and the issues there.

To Count Total Popular Votes

Since 1824, the United States established the Winner-Take-all rule in having voting districts for presidential as well as local elections (McCarthy, 2012). The rule was originally designed to protect minority rights by allowing a minority population group to still have a voice in the democratic government. The Voting Rights Act of 1965 requires some states to have at least one district formed based on race, to ensure minority representation in the government (US Department of Justice 1965). Given that this Winner-Take-All Rule cannot be abolished, some states seek to revise it for appropriate adoption. Presently, Maine and Nebraska both practice a hybrid combination of statewide and district vote counts (McCarthy, 2012).

An Independent Commission

To prevent the political party in power from gerrymandering in redistricting, some have suggested to have a non-partisan commission in charge of redistricting. There would be no incentive to take political advantage for any party. But the problem is the same. The problem becomes: who should serve on the commission? The non-partisan commission will also have difficulty meeting the requirements of the 1965 Voting Rights Act. It is unlikely that the approach will remove gerrymandering since it only shifts the focus of the fight.

Computer Algorithms

From 1970s to 80s, founded strong in computer science, the field of computational geometry spawned many algorithms to process geometry represented in digital data (Forrest, 1971; Preparata & Shamos 1988). Much of the research work supplied for the GIS functionalities today. Using the GIS for gerrymandering became practicable and some attempted to automate the process (Li, Wang & Wang 2007; Yamada 2009; Siegel-Hawley 2013; Reitsma 2013). Yet automation of the process was hardly successful, though it might have become much easier when aided by the GIS. Realizing that partisan gerrymandering is unhealthy for democracy, many envisioned to identify it (Niemi, Grofman,

Carlucci & Hofeller 1990; Flint 2003; Chou & Li 2006; Ricca, Scozzari & Simeone 2008, Altman, Amos, McDonald & Smith 2015). If we can identify partisan gerrymandering objectively by a computer algorithm, we can contest it in court and disallow it legally. While many still call for research in the area (Crane & Grove, 2018; Grofman & Cervas, 2018; Forest, 2018), it proves to be more difficult than envisioned. A paper titled "An Impossibility Theorem for Gerrymandering" by two mathematicians (Alexeev & Mixon, 2018) perhaps was more telling in theoretical terms about the situation.

Automation of Redistricting

A definitive algorithmic solution to identify partisan gerrymandering may seem elusive. But that did not dampen the enthusiasm to automate the political 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 have to allow any attempt of gerrymandering, partisan or non-partisan. In 2014, Brian Olson, an avid programmer by trade, shared his automated solution to political redistricting, as reported in The Washington Post (Ingraham 2014). Olson's work was based on population data from census and required voting district boundaries to follow census block boundaries. Figures 5 and 6 respectively show the current congressional districts in Pennsylvania and those produced by Olson's algorithm. Also, the algorithm bypasses the issues of Voting Rights Act (US Dept of Justice 1965) which in some states requires majority-minority districts to be drawn. Olson then proceeded to start his Voting and Election Reform web site at bolson.org/voting/ to discuss possible adjustments to the criteria to apply to his algorithm.

Fig.5 Pennsylvania Congressional Districts

Without a satisfactory solution, the automated redistricting was also applied to produce redistricting maps as counter examples to argue against the cases of partisan gerrymandering in court (Magleby and Mosesson 2018; Krasno, Magelby, McDonald, Donahue and Best, 2019).

Fig.6 Pennsylvania Congressional Districts by Olson

Levin and Friedler (2019) published an experimental algorithm applying a divide-and-conquer strategy to recursively sub-divide an area in triangulation to construct political districts based on various demographic criteria. The process does need to follow census boundaries. The algorithm is much more promising, albeit computationally extremely expensive.

It was also noted that the application of artificial intelligence with machine learning may be applicable (Wu, DePlato & Combs, 2020). The suggested approach has not yet been explored.

4. GIS FOR DEMOCRACY

Our intention is that the GIS can be part of the solution against gerrymandering. In this section, we propose a potential solution. We trust that the people can determine what is good for democracy. If the GIS is available for everybody, the people will have a viable tool against gerrymandering. Our proposal has several facets. We discuss them in the following.

To Require Public Scrutiny

To prevent partisan gerrymandering, it is proposed that instead of allowing the majority party in the government, we should have an independent commission responsible for political redistricting. If the party in power decides who should be on the commission, the problem remains the same. The ideal of democracy should have the entire population serving in the commission. Our proposal therefore is to have any redistricting plan to be publicly scrutinized. A redistricting plan, along with all the relevant demographic data, has to be made available to the public. Reasons for redrawing a district must be stated to allow public discourse. We need to provide use of the GIS to the public so that anyone wanting to review the redistricting proposal may study and analyze it in detail.

Politicians and the citizens concerned about democracy will need to learn enough to use the GIS for the purpose. We put our trust in the people that they may have the discernment to see that a proposed redistricting plan is doing extreme gerrymandering, through public discourse and debate.

To Allow Alternative Proposals

If the GIS tool is made available to the public, we may also allow the minority party in the government to make opposing redistricting proposals which would have to face the same level of scrutiny. In fact, it is possible to set up appropriate regulations for other alternative redistricting proposals. Such a proposal may be sponsored by relevant elected members of the government. The feasibility of a proposal can be tested by the GIS and appropriate regulations may protect minority rights.

To Vote for The Right Proposal

When there are multiple legitimate redistricting proposals, voting can then be conducted to adopt one that is accepted by the majority of the electorate, not just the majority party in the government. This however will mean that sufficient knowledge and training need to be provided for the voting public.

Our conclusion, therefore, is that the GIS can be a critical part of the solution. To promote democracy, we need to promote GIS education. The call is for IS educators to make learning GIS accessible to a broader population, and for the GIS vendors to design the GIS with ease of use, and to provide reasonable learning tools to the public. The government can facilitate for the approach while providing the GIS learning and use along with relevant data for public use.

5. CONCLUSION AND SUMMARY

We presented our proposed approach to make political redistricting a public process, to be reviewed and debated by the voting public. Our approach can be implemented in three stages:

(1) To require the proposed redistricting plan to face public scrutiny.
(2) To allow alternative proposals by minority party, or any other individual or organization.
(3) To conduct voting by the public to decide which redistricting plan to be adopted.

The GIS is part of the solution since the politicians as well as the concerned citizens will need to be reasonably knowledgeable with using the GIS for redistricting. We believe that can be a viable solution against gerrymandering.

In summary, the paper began with the brief history of gerrymandering. The basic strategies of cracking and packing were illustrated. We also presented the steps of how using the GIS can make gerrymandering easy, leading us to the belief that the GIS has been the culprit of extreme gerrymandering. We then reviewed the various approaches attempted to possibly prevent gerrymandering. In the context that there seems to be no good solution, we propose to use the GIS to make the political redistricting process public. With the GIS available, any proposal for redistricting can be scrutinized and debated. The political party for the redistricting proposal will have to justify it publicly. We also suggest allowing opposing parties to make redistricting proposals. With appropriate regulations set up, legitimate proposals may be analyzed, debated, and finally voted for or against by voters. While the government needs to facilitate for the process, the GIS will require a better intuitive design for public use, and educators should be promoting GIS education, for democracy.

6. REFERENCES

Alexeev, B. and Mixon, D.G. (2018). An Impossibility Theorem for Gerrymandering. *The American Mathematical Monthly* 125(10), 878-884.
[https://doi.org/10.1080/00029890.2018.1517571]

Altman, M., Amos, B., McDonald, M.P. and Smith, D.A. (2015). Revealing Preferences: Why Gerrymanders Are Hard To Prove, And What To Do About It, Social Sciences Research Network (SSRN) Electronic Journal (Mar 22, 2015).
[https://dx.doi.org/10.2139/ssrn.2583528]

Chou, C.I. and Li, S.P. (2006). Taming the Gerrymander – Statistical Physics Approach to Political Districting Problem. *Physica A: Statistical Mechanics and Its Applications*, Elsevier.
[https://doi.org/10.1016/j.physa.2006.01.082]

Crane, N.J. and Grove, K. (2018). An Active Role For Political Geography In Our Current Conjuncture. *Geography Compass* 12(11). Wiley Online Library.
[https://doi.org/10.1111/gec3.12410]

Flint, C. (2003). Political Geography: Context and Agency in A Multiscalar Framework. *Progress in Human Geography* 27(5), 627-636.
[https://doi.org/10.1191/0309132503ph453pr]

Forest, B. (2018). Electoral Geography: From Mapping Votes to Representing Power. *Geography Compass* 12(1). Wiley Online Library.
[https://doi.org/10.1111/gec3.12352]

Forrest, A.R. (1971). Computational Geometry. *Proceedings of Royal Society London* 321(4), 187-195.

Goldberg, D.W. (2016). Geocoding. *The International Encyclopedia of Geography*, D. Richardson (eds. et al). John Wiley & Sons.
[https://doi.org/10.1002/9781118786352.wbieg1051]

Griffith, E.C. (1907). *The Rise and Development Of The Gerrymander*. Scott, Foresman and Company, Chicago, IL.

Grofman, B. and Cervas, J.R. (2018). Can State Courts Cure Partisan Gerrymandering: Lessons from League of Women Voters V. Commonwealth of Pennsylvania. *Election Law Journal: Rules, Politics, and Policy* 17(4), 264-285. Mary Ann Liebert, Inc., publishers.
[https://doi.org/10.1089/elj.2018.0496]

Ingraham, C. (2014). This Computer Programmer Solved Gerrymandering In His Spare Time. *The Washington Post* (June 3, 2014).
[https://www.washingtonpost.com/news/wonk/wp/2014/06/03/this-computer-programmer-solved-gerrymandering-in-his-spare-time/]

Krasno, J., Magelby, D.B., McDonald, M.D., Donahue, S. and Best, R.E. (2019). Can Gerrymandering Be Detected? An Examination of Wisconsin's State Assembly. American Politics Research 47(5), pp.1162-1201.
[https://doi.org/10.1177/1532673X18767890]

Levin, H.A. and Friedler, S.A. (2019). Automated Congressional Redistricting. *ACM Journal of Experimental Algorithms 24(1), Article 1.10*.
[https://doi.org/10.1145/3316513]

Li, Z., Wang, R-S. and Wang, Y. (2007). A Quadratic Programming Model For Political Districting Problem. *The First International Symposium on Optimization and Systems Biology* (OSB'07), Beijing, China.

Magleby, D.B. and Mosesson, D.B. (2018). A New Approach for Developing Neutral Redistricting Plans. Political Analysis 26(2), April 2018, pp.147-167.
[https://www.cambridge.org/core/journals/political-analysis/article/new-approach-for-developing-neutral-redistricting-plans/31F8EB3FFB7A8F5B3F7C2171BE016D47]

Mccarthy, D. (2012). How the Electoral College Became Winner-Take-All. Published online by FairVote, Takoma Park, MD.
[https://www.fairvote.org/how-the-electoral-college-became-winner-take-all]

Niemi, R.G., Grofman, B., Carlucci, C. and Hofeller, T. (1990). Measuring Compactness and The Role of a Compactness Standard in a Test For Partisan and Racial Gerrymandering. *The Journal of Politics* 52(4), 1155-1181. University of Chicago Press.
[https://doi.org/10.2307/2131686]

Preparata, F.P. and Shamos, M.I. (1985). *Computational Geometry – An Introduction*. Springer-Verlag. ISBN 0-387-96131-3.

Reitsma, F. (2013). Revisting The 'Is GIScience a science?' debate (or quite possibly scientific gerrymandering). *International Journal of Geographical Information Science* 27(2), 211-221.
[https://doi.org/10.1080/13658816.2012.674529]

Ricca, F., Scozzari, A. and Simeone, B. (2008). Weighted Voronoi Region Algorithms For Political Districting. *Mathematical and Computer Modeling* 48(9-10), 1468-1477.
[https://doi.org/10.1016/j.mcm.2008.05.041]

Siegel-Hawley, G. (2013). Educational Gerrymandering? Race and Attendance Boundaries in a Demographically Changing Suburb. *Harvard Educational Review* 83(4), 580-612.
[https://doi.org/10.17763/haer.83.4.k385375245677131]

United States Department of Justice (1965). History of federal Voting Rights Laws: The Voting Rights Act of 1965.
[http://justice.gov/crt/history-federal-voting-rights-laws]

Wu, P.Y. and Rathswohl, E.J. (2010). Address Matching: An Expert System and Decision Support Application for GIS. *Proceedings of Information Systems Education Conference* (ISECON 2010). ISSN: 1542-7382, #1339, Nashville, TN.
[http://proc.isecon.org/2010/pdf/1399.pdf]

Wu, P.Y., Deplato, J.P. and Combs, A.B. (2020). Geographic Information System and Gerrymandering. *Journal of Information Systems Applied Research* 13(3) pp 4-10. http://JISAR.org/2020-3/ ISSN: 1946-1836.

[http://jisar.org/2020-13/n3/JISARv13n3p4.html]

Yamada, T. (2009). A Mini-Max Spanning Forest Approach To The Political Districting Problem. *International Journal of System Science* 40(5), 471-477. [https://doi.org/10.1080/00207720802645246]