NORTHERN ARIZONA UNIVERSITY

School of Informatics, Computing, and Cyber Systems

Requirements Specification

Version 1

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Team Name: FairyMander
Sponsor: Bridget Bero
Professor: Michael Leverington
Mentor: Vahid Nikoonejad Fard

Team Members:
Izaac Molina (Team Lead)
Dylan Franco
Jeysen Angous
Sophia Ingram
Ceanna Jarrett

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1 Introduction

Congressional district lines are redrawn following the release of the census, a survey that is taken every ten years. The census provides information on population, demographics, economics, geography, etc. The number of seats each state gets in the US House of Representatives is determined by the state's population, thus determining the state's number of congressional districts. Congressional districts are the voting districts for state representatives, which are members of Congress. These districts must comply with state and federal laws, and represent the population. Every two years, people within each district vote for their representative in Congress. This is an important decision since Congress holds all legislative power; it is the only part of the government that can make and change laws.

Currently, thirty-nine state's redistricting processes are controlled by their state's legislative body. In these states, district lines are manipulated and approved by their members of Congress. The first draft of the proposed district lines is drawn by a legislative committee. Members of the legislative committee are chosen by the legislature. Some of their responsibilities include: monitoring government operations, recommending courses of action to the Senate, etc. The draft of the proposed districts may be vetoed by the governor, but this veto can be overridden by a ⅔ legislative vote. Final approval of the proposed districts varies by state, but it is most commonly approved by legislature with a ⅔ vote. However, the legislature holding all the power to create new districts causes a problem to arise.

Gerrymandering is the act of drawing district lines in a way that benefits certain political parties; this leads to underrepresentation and political manipulation. Representatives have the power to manipulate electoral outcomes during redistricting, thus guaranteeing their electoral success. This power poses a threat to our democracy, having the potential to make voting obsolete. Gerrymandering is done through packing and cracking; these concepts are introduced in Section 2.3. There are active solutions in place for gerrymandering, but they are not as widespread as they should be. One solution against gerrymandering is for voting districts to be drawn by the Independent Redistricting Commission (IRC). The IRC is separate from the legislature, meaning that politicians do not have the opportunity to manipulate voting districts. This makes the redistricting process fair and transparent. The IRC must adhere to certain criteria when creating districts, such as equal population, protecting racial minorities, and making districts compact. However, only eight state's districts are currently being drawn using this system. This means the other 42 states' voters are being gerrymandered and suppressed. In search of a more widespread solution, our client, Dr. Bero, reached out to us to create an open-source, non-biased redistricting algorithm. Dr. Bero, of NAU's Department of Civil Engineering, Construction Management, and Environmental Engineering, has the goal of creating a user-friendly tool to educate citizens on how congressional districts can be created fairly.

2 Problem Statement

To establish new voting districts, congressional boundaries are redrawn every ten years following the completion of the decennial census, which the United States Census Bureau does. Gerrymandering, however, is an issue that can occur during redistricting and can be used to favor a certain political party, group, or individual over another.

2.1 Updating the Population

The redistricting process is typically controlled by the state legislature, which relies on the United States Census Bureau to provide an updated population. The updated population comes from the decennial census, which is used to count the population every ten years, along with several other relevant surveys. Since 1970, the decennial census has been used to count every resident living in the United States using demographic data like age, gender, race, and other relevant information.

2.2 Manipulating District Lines

The two types of redistricting are congressional and state legislative. Both congressional and state legislative redistricting are used to redraw boundaries; the only difference is that one is used for federal while the other is used for state. Gerrymandering is the act of manipulating district lines in a way that benefits certain political parties. The term gerrymandering dates back to as early as the 19th century when the Massachusetts governor signed into law a state senate district map. The map was used to favor the Democratic-Republicans over the Federalist Party voters as they were “thrown” into smaller districts, which reduced their say. Up until the 1960s, some states did change their districts, which gave voting power to white, rural, and non-immigrant Americans rather than Black Americans and immigrants. Due to this, the U.S Supreme Court made the ruling known as the "redistricting revolution". This ruling ensured that the populations of all state voting districts must be roughly equal, which was known as “one person, one vote”. This meant that the vote of one person should not count towards more or less than the vote of another person, regardless of where they live. Moreover, the decision mandates that states adjust their federal congressional districts after every ten years' census. Unfortunately, despite all of these efforts to change, to this day, gerrymandering remains an issue in U.S politics with the term "fairness” as it is not used properly as it should be. The result of gerrymandering is that it can have districts that are shaped oddly, which dilutes the voting power of a certain community and even gives an unfair advantage to one political party over the other.

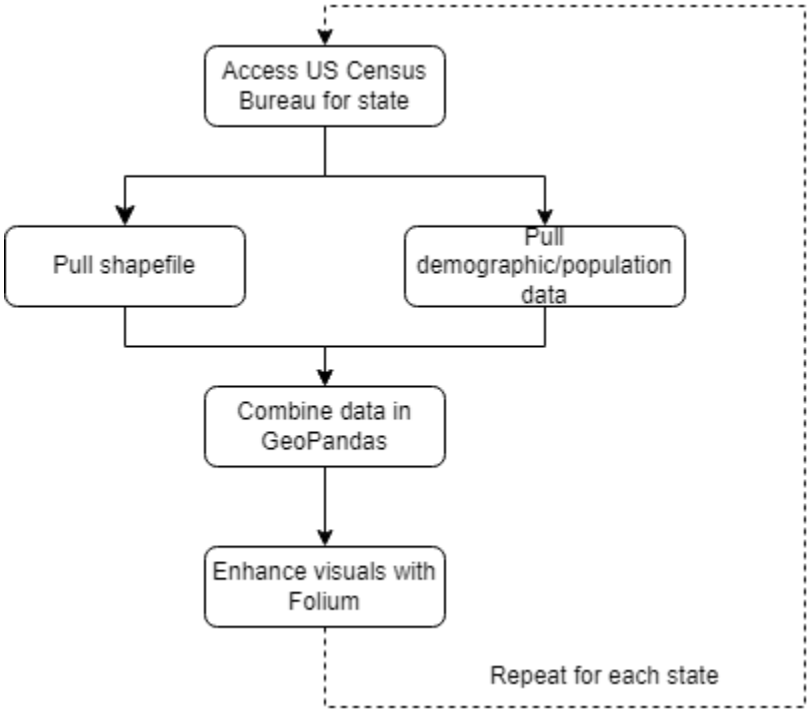
2.3 Packing and Cracking Technique

Gerrymandering is done using two popular manipulating strategies: packing and cracking. Packing packs like-minded voters into as few districts as possible, whereas cracking splits like-minded voters with similar characteristics across different districts, thus diluting their votes.

North Carolina is an example of where gerrymandering strategies are used, which include both packing and cracking techniques. The state packs minority voters into one district while cracking like-minded minority populations among several districts, which results in their vote being fragmented. These strategies give a particular political party a district majority, giving them the upper hand, power, and advantage over the others. This can also be used to silence minority groups, preventing them from having political representation. Ultimately, both packing and cracking strategies are troublesome in the sense that they break the rule of fair representation and the meaning of the word "fairness".

3 Solution Vision

Our system leverages data provided directly from the United States Census Bureau, ensuring that the algorithms utilize the most accurate and publicly available data. This data is used to generate a density plot, which is then visually represented on a map to facilitate user interpretation. The computational process involves several steps:



Despite the availability of other free-to-use district mapping options, our system distinguishes itself by being more user-friendly and educational. This decision was driven by our goal to make the system accessible and informative for the general public, enabling them to better understand the political dynamics that impact their daily lives. We hope this system will empower the public with knowledge, potentially altering public engagement with politics.

4 Project Requirements

In order for our project to be successful, the requirements will be split up into three categories. Functional requirements are tasks that our application must be able to perform. Performance requirements are the focus of how the listed functional requirements will be expected to perform. Lastly, environmental requirements are non-functional requirements related to constraints imposed on our project. Below is a more thorough assessment of each of these requirements.

4.1 Functional Requirements

4.1.1 Creating the Districts

Our algorithm must accurately create districts that are contiguous, compact, and have an equal population. In order to be accurate, every person will be put into a district; there will be no outliers. Furthermore, the number of districts created must be the number of specified districts that each state has. Geographic data will be considered when districts are made in order to support compactness, and census data will be utilized to ensure that minority communities are accurately represented.

4.1.2 District Meeting Fairness Requirements

When creating the districts, they have to meet the following requirements of fairness that we have defined; As of right now, the requirements for our districts are equal population, no discrimination, and benign unbiased. Each district must have an equal population. Ensuring an equal population in each district of that state will give citizens a fair chance. The next requirement is that there will be no discrimination in each district. When creating the districts, we realized that certain groups live in certain areas. We cannot break them up just to make a quota. We have taken into account that we must not discriminate when creating districts. We have to figure out how to make sure that we show no discrimination on a map. The last requirement, and the most important one, is to be unbiased. We cannot favor one group over the other. The best route to take here is to go the mathematical way. When creating our algorithm we will need to be honest with the data. We will be unbiased through the data.

4.1.3 Displaying Created Districts on State Map

A central aspect of our website will be displaying our interactive maps for the users. These maps will be generated using GeoPandas and Folium. The maps themselves will be populated with a combination of shapefiles and other numeric data gathered from the United States Census Bureau. Because the census data these maps are based on only comes out once every ten years, the data in these maps will be generated beforehand to prevent unnecessary loading times.

4.1.4 Produce Interactive Map

The interactive map that must be produced on the website needs to ensure that users can hover over a particular state, and when you hover over a state on the interactive map, you are able to see the boundaries of that state along with the state name, population, and districts or seats in that state. Moreover, when users click on a certain state it will take them to a different webpage where they are able to see a side-by-side comparison of how that state's districts are drawn currently compared to our "fairymandered" algorithm. The webpage will also provide users with information about gerrymandering in that state, mainly focusing on the educational aspect. This concludes that in addition to being clickable, all fifty states must have the hover effect and must display the state's boundaries when hovering over that certain state.

4.1.5 Education on State Redistricting Laws

Our website must encompass an educational aspect. To achieve this, we will educate users on the different redistricting procedures. Each state follows different procedures in order to adhere to state redistricting laws. The user will choose a state that they would like to see "fairymandered". Upon doing so, they will be presented with information on the chosen state's redistricting laws. Our goal is to make the information clear and easily understandable, that way both fifth graders and members of a committee will be able to understand the laws.

4.1.6 Educational Reasoning of Why Our District is Fair

On our website, each state will have an explanation as to why our redrawn districts are fair, which will further explain the reasons behind the district's appearance. A user might view the "FairyMander" map and question, "why are these the better districts?". We will therefore provide reasoning for why our map is more fair than the current districts. Our goal is to provide information on why it is fair for the user to fully understand and learn more about civil problems.

4.1.7 Pulling Accurate and Up-to-Date Demographic and Population Data

To enable a quality redistricting algorithm, the application will need to pull data relevant to drawing voting districts. This includes population data as well as geographic information that will allow the algorithm to discriminate between different locations in deciding which locations should be included in a given district. This could be counties, zip codes, census blocks, etc., or some combination thereof, along with data on their respective populations. Additionally, we will need additional data to be used for evaluating our districts' fairness. This includes racial demographic information to ensure minority groups are properly represented within a state, as well as previous electoral data to evaluate whether the drawn districts provide an unfair partisan advantage. The source(s)used for these purposes must both be highly reputable. A source will be considered reputable if it has an established reputation through usage in other applications, or some other clear method of verification, such as previous use in redistricting practices. It is also important that the data pulled from the source(s) is up-to-date with the most recent census and electoral data available and shows evidence that such data will be updated when necessary.

4.2 Performance Requirements

4.2.1 User Interface

Because the website is to be designed with the general public in mind, the UI must be intuitive and understandable. There should not be any hidden features. A user should be able to easily access any state's information with ease. This means that navigation should be straightforward, employing clear labels and common icons that communicate function and content without ambiguity. The design should facilitate quick learning and easy recall of how to perform tasks, making it possible for users from various backgrounds to interact with the system without frustration. This approach will ensure the platform is inclusive, enhancing user engagement and satisfaction.

4.2.2 Interactive Map Responsiveness

Map responsiveness is a feature that must be considered with the implementation of an interactive map. The map should be responsive across various devices and platforms, adapting the layout of the interactive map to different screen sizes and resolutions. Finally, when implementing the interactive map, it is crucial to keep in mind that it should load quickly and function smoothly. This includes fast loading speeds without any delays when a user hovers over or clicks on a state.

4.2.3 Understandable to Both the General Public and Redistricting Officials

FairyMander should promote civil engagement in the redistricting process. Therefore, the information that is provided in FairyMander must be easily understandable by the general public. This means that, in general, the majority of the application's written content should not exceed the fifth-grade reading level. This would not only help current voters understand redistricting, gerrymandering, and how our algorithm addresses these problems, but it would also make the application useful in an educational context, enabling young people to learn about our democracy. However, we must also provide specific reasoning for our drawn districts so that its legitimacy as a redistricting tool is clear to any user that is willing to "dig deeper", whether it be a voter or someone more directly involved in the redistricting process. As a result, we must strike a balance between these two levels of understanding by providing an initial simplified interface with the option to "dig deeper" if the user chooses to do so. All in all, the application must accommodate users of all understanding levels, making it understandable and useful regardless of how acquainted the user is with redistricting.

4.3 Environmental Requirements

4.3.1 User Friendly Website

When implementing the website, we must ensure that it is user-friendly. It is also important to ensure the information displayed on the website is clear and easily understood. Additionally, if users don't want to hover over a state, the website will have a hamburger-style drop-down menu that users can click on, and a list of all fifty states will be displayed alphabetically. Upon that, users can then click on a state, which will provide them with information on that particular state's redistricting laws. Moreover, the website will have a contact form where users will have the ability to send any feedback they would like about the website, such as likes and dislikes, any improvements, or something that they want to see implemented in the future. Lastly, the website must focus on the education aspect as per the client.

4.3.2 Created Districts Follow Federal Redistricting Laws

Our created districts must follow federal redistricting laws to support fairness. These laws are as follows: equal population, compactness and contiguity, minority protection, and consideration of communities of interest and political subdivisions. Each district in a state must have an equal population in order to support the "one person, one vote" standard. Compactness and contiguity must be upheld to accurately reflect a community's geographic and demographic data. The protection of minority groups and consideration of political subdivisions must be implemented in our algorithm to help prevent packing and cracking.

5 Potential Risks

While this project can potentially revolutionize the way congressional districts are drawn, this responsibility comes with a significant set of risks. In this section, we acknowledge these risks and their impact on our development process.

5.1 Failure to Deliver Fair Redistricting Plans

Redistricting has a significant impact on political outcomes and can seriously affect people's lives. If we are to construct an algorithm that would be used to enable civic engagement, failure to deliver a fair redistricting plan would be a massive disservice to voters across America. We have previously discussed how Gerrymandering can negatively impact the redistricting process, but if not executed properly, our algorithm could lead to the same if not worse outcomes. This risk emphasizes how critical it will be to develop quality evaluation criteria for the districts we generate, as failure to meet these criteria has the potential to silence the same voices we aim to uplift. Ultimately, we must be hypervigilant in ensuring our algorithm provides a definitively fair redistricting framework, as failure to do so would be detrimental to American democracy if our maps are used as a redistricting reference.

5.2 Failure to Update Redistricting Data

Even if we are to develop a fair redistricting algorithm, it is imperative that this algorithm uses data that is as up-to-date as possible. To be used in a real redistricting context, our algorithm should provide a redistricting plan that best reflects the most current conditions in each state. If the data we use in our algorithm is not up-to-date, this could lead to redistricting outcomes that do not accurately represent the people in a given state, cascading into problem 5.1. As a result, we must ensure that our algorithm uses the most recent data available and has the capability to update this data if needed.

5.3 Low Understandability

In general, the goal of any programmer is to create software that is easy to understand and use. However, we have a particular interest in ensuring the usability of our product if we aim to have it usable in a real redistricting setting. Whether it be due to a poor user interface or low code readability, if our application is not easy to understand, it has a very slim chance of being used in a real redistricting setting due to its impracticality. Additionally, it is important that we make our algorithm as understandable as possible so that it can be built upon in the future if necessary. This is also important to build the credibility of our algorithm, as the criteria we use to evaluate fairness should be as clear as possible to ensure transparency. In summary, we must ensure that our project is transparent in both its function and its use, as failure to do so will severely limit the practical application of our algorithm.

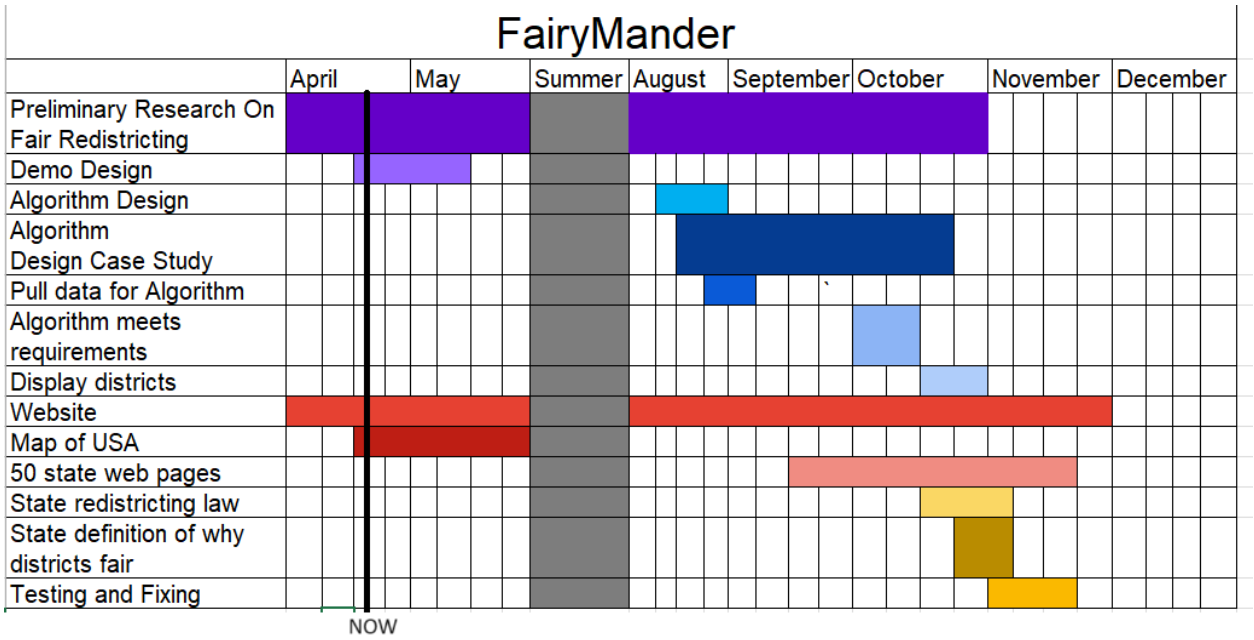
6 Project Plan

For the project plan, the first thing that will happen throughout this project is research. Research will be the basic foundation of this project. Our end product will be a website for someone to understand the concept of Gerrymandering, and to see a new way to look at districts. The website is an educational civil website for citizens to get more information about their own state's politics on voting districts. The research will happen from April through September.

We are separating projects into different portions of the project. The first thing that we need to do is the algorithm. We will do the algorithm design, which will take about three weeks, to understand how we want to set up the algorithm. Once we have the design of the algorithm, we are going to do a case study with one state to make sure that our algorithm works, keeping in mind that we are working with all fifty states in the United States of America. Then, we can change the algorithm when needed. The next milestone is that we need to make sure that we collect all the data that we have gathered together throughout our research and apply it to the algorithm. Then, at the end of the case study, we will make sure that the algorithm meets the requirements of what it means to be fair in our eyes. After it meets the requirements, we can create and draw the district lines where the case study and the algorithm are projected to be in.

The second part of the project is an educational website. We have created an interactive map of the United States of America where you can hover over a state. That action will show the state name, the population, and the number of districts. The interactive map will only take a week, as it is mostly completed. Once you click the state, it leads to the state's own webpage. The longest milestone will be the creation of a website, which will take four months to complete. This is a lot of time for it to get completed, but we have to do a lot of research for each state. On one of those web pages, we will implement the state redistricting laws and a reason why "FairyMander" voting district is fair. Finding and uploading all the research will take around two weeks for all fifty states. By October, we will have an algorithm for all fifty states, and by November, we will have an educational website about gerrymandering.

6.1 Fairy Mander Scheduler



7 Conclusion

FairyMander aims to democratize the redistricting process through the power of data science. Census data and GIS will be used to generate unbiased, equitable voting districts that meet the fairness requirements we will outline through research. This project not only targets the corrupt manipulation inherent in current redistricting practices but also proposes a tangible solution that champions fairness and transparency.

In this document, we have outlined the necessary requirements for such an application, laying the groundwork for our development process. We have defined how our algorithm must be constructed as well as the expected redistricting outcomes. This algorithm must also be

supplemented by extensive research on fair redistricting. Then, to translate this algorithm into a useful tool for civic engagement and propose real redistricting alternatives by providing a web-based interface. This interface will include an interactive U.S. map for displaying the "FairyMandered" state districts, allowing users to compare our generated maps to current district maps. Additionally, the interface will also provide educational content on the redistricting process as well as insight into the fairness metrics used to design these maps. By defining these requirements, we have clearly defined a set of goals that we must complete by the end of our project. This has led to a well-defined schedule that will enable our success in the development phase of this project.

8 Glossaries and Appendices (if needed)

9 References

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