FairyMander

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Our team

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Recorder

Meet Our Client

Dr. Bridget Bero, P.E.

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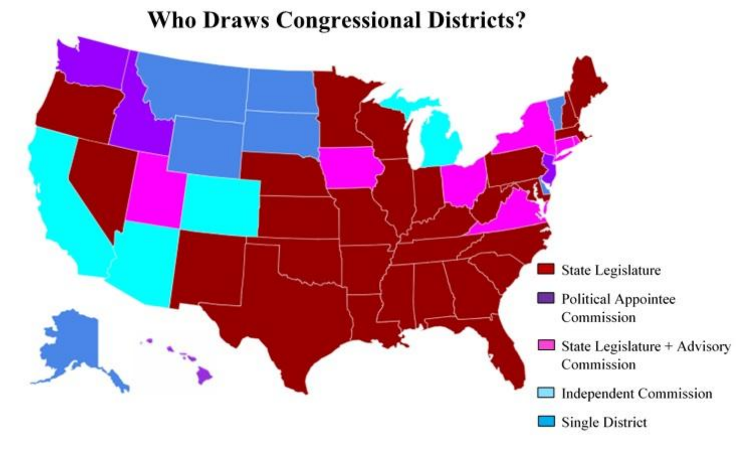
Problem Statement

Congressional districts are redrawn every ten years

- 39 states redistricting process is controlled by legislature
- Districts are Gerrymandered

Each district elects a state representative

- Representatives are members of Congress
- Congress creates and changes laws


Who Draws Congressional Districts?
State Legislature
Political Appointee Commission
State Legislature + Advisory Commission
Independent Commission
Single District

Problem Statement - cont.

Packing

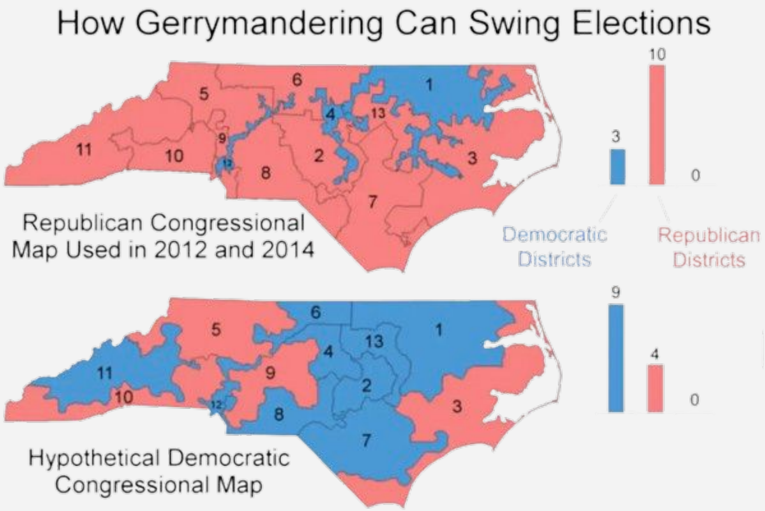
- Packing like-minded voters to as few districts as possible

Cracking

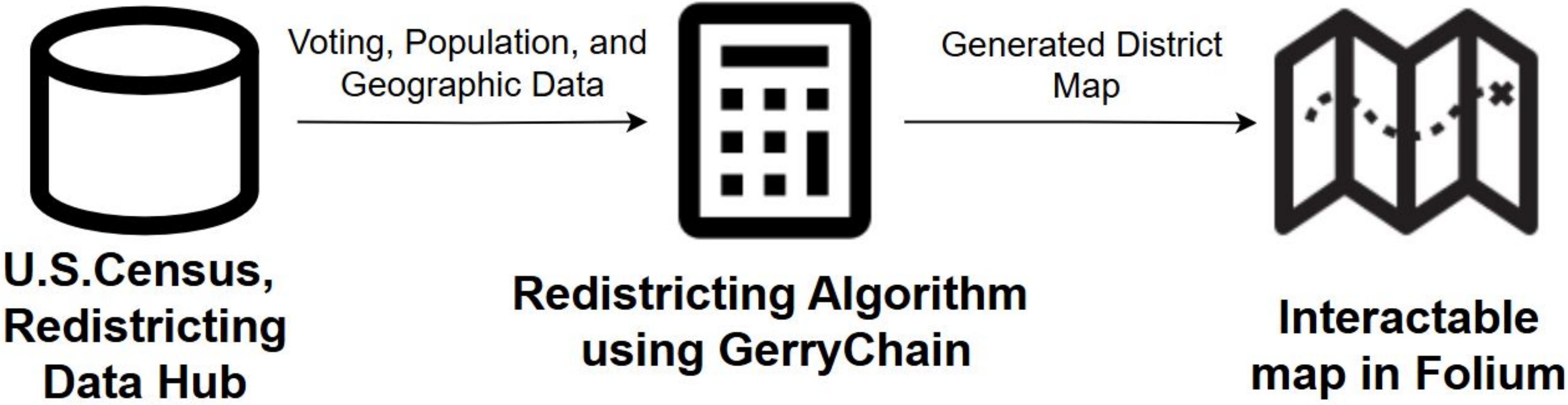
- Splitting like-minded voters across different districts

Underrepresentation

- Taking away the principle of fair representation


How Gerrymandering Can Swing Elections
1
2
3
4
5
6
7
8
9
10
11
12
13
10
3
0
Republican Congressional Map Used in 2012 and 2014
Democratic Districts
Republican Districts
1
2
3
4
5
6
7
8
9
10
11
12
13
9
4
0
Hypothetical Democratic Congressional Map

Solution Overview



U.S.Census, Redistricting Data Hub

Voting, Population, and Geographic Data

Redistricting Algorithm using GerryChain

Generated District Map

Interactable map in Folium

Requirements

Creating Fair Districts

- Using geographic, electoral, and demographic data

Visualize Results

- Display results using interactable district maps

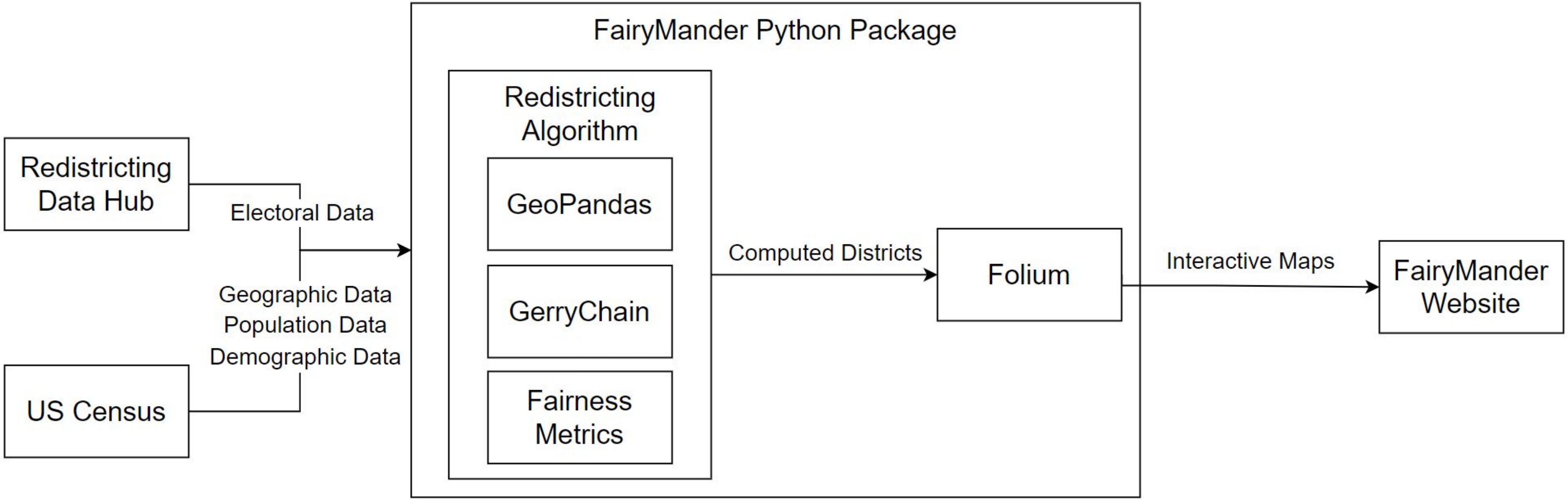
Web Application

- Results are viewable through responsive website

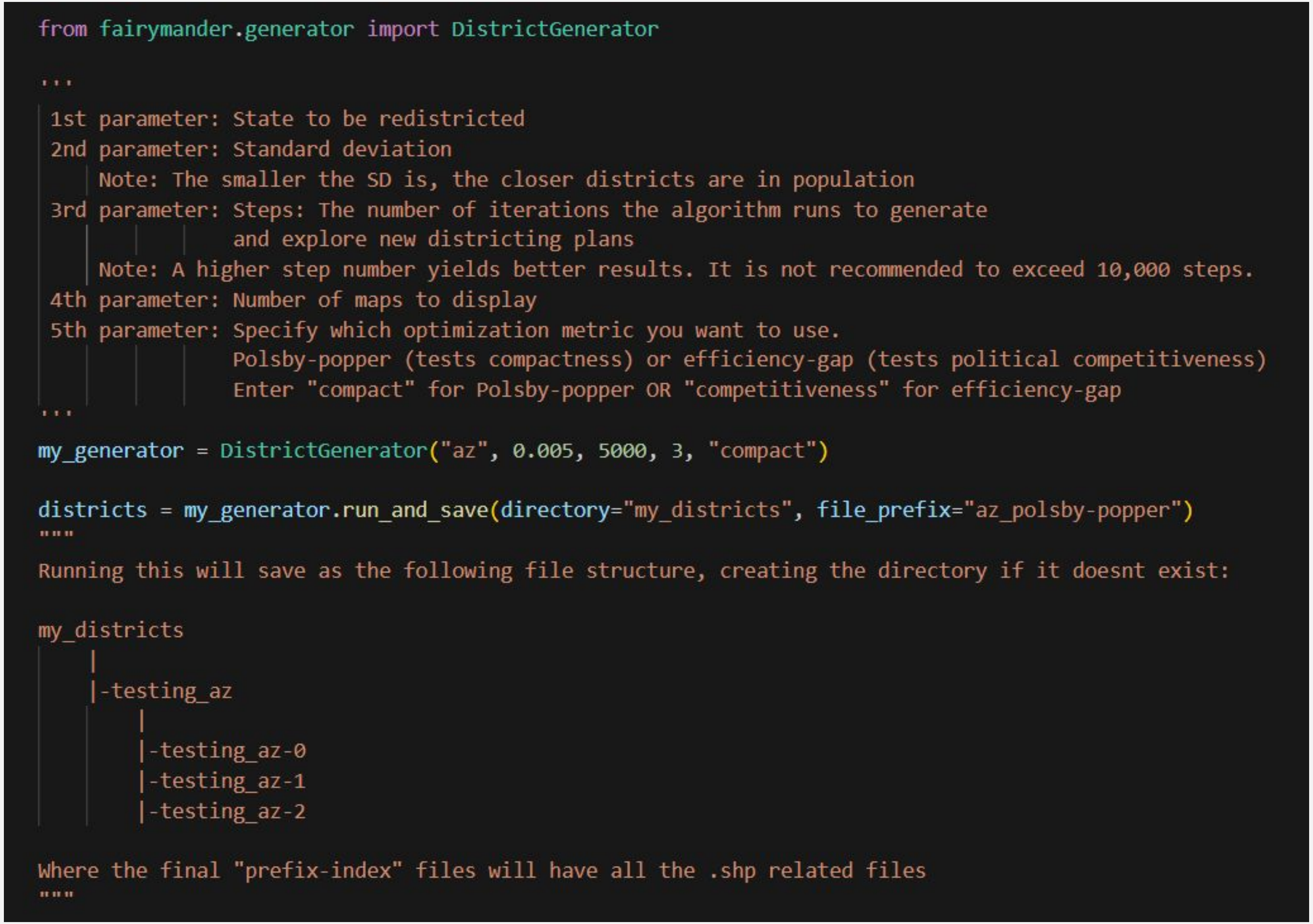
Redistricting Education

- Provide easy to understand insight into redistricting process

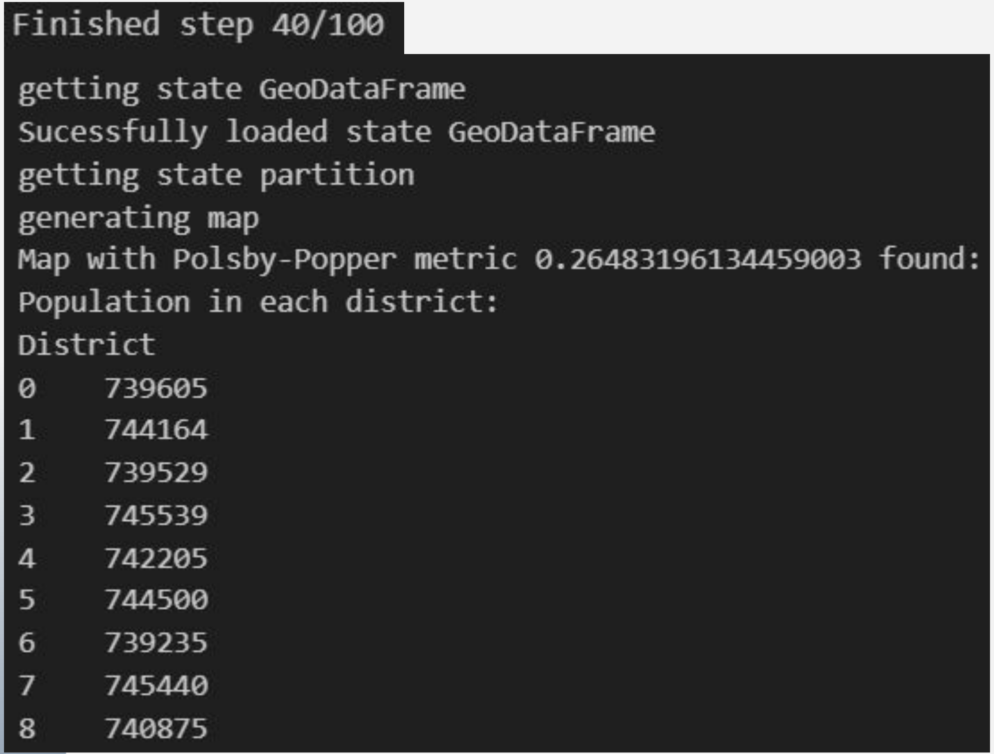
Implementation Overview



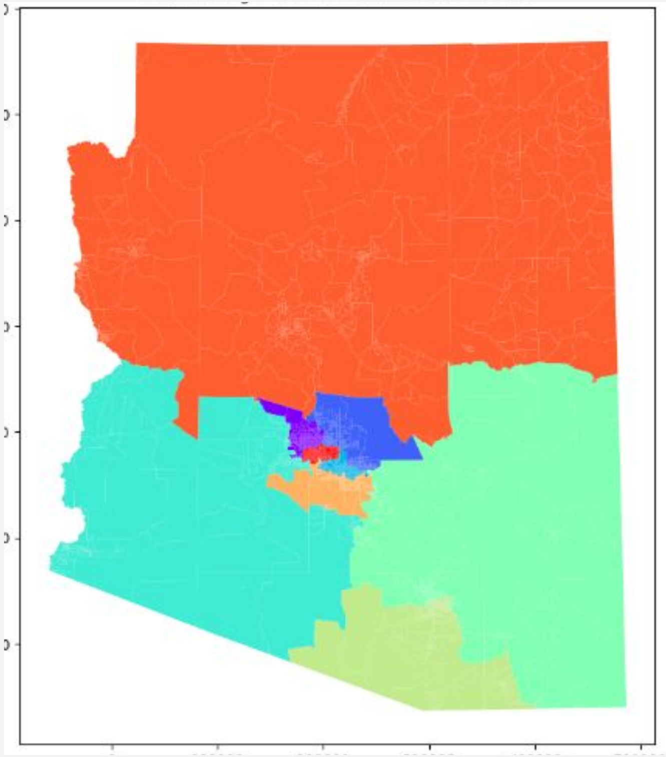
Prototype Review

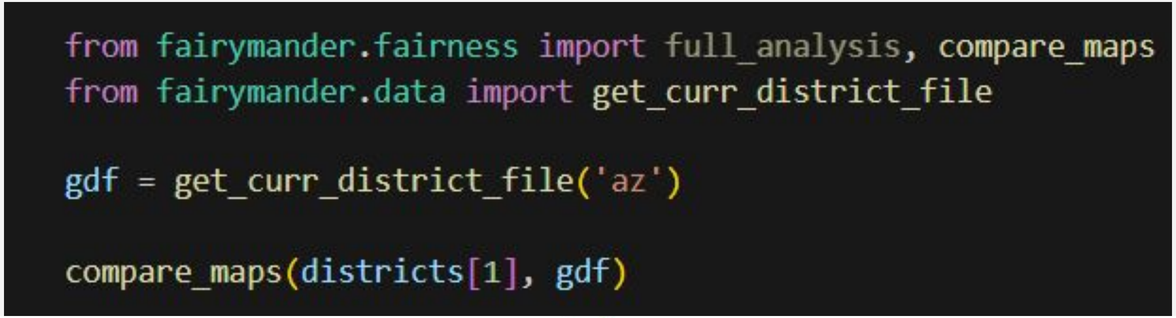


```
from fairymander.generator import DistrictGenerator

'''
 1st parameter: State to be redistricted
 2nd parameter: Standard deviation
     Note: The smaller the SD is, the closer districts are in population
 3rd parameter: Steps: The number of iterations the algorithm runs to generate
                and explore new districting plans
     Note: A higher step number yields better results. It is not recommended to exceed 10,000 steps.
 4th parameter: Number of maps to display
 5th parameter: Specify which optimization metric you want to use.
                Polsby-popper (tests compactness) or efficiency-gap (tests political competitiveness)
                Enter "compact" for Polsby-popper OR "competitiveness" for efficiency-gap
'''

my_generator = DistrictGenerator("az", 0.005, 5000, 3, "compact")

districts = my_generator.run_and_save(directory="my_districts", file_prefix="az_polsby-popper")
"""
Running this will save as the following file structure, creating the directory if it doesnt exist:

my_districts
    |
    |-testing_az
        |
        |-testing_az-0
        |-testing_az-1
        |-testing_az-2

Where the final "prefix-index" files will have all the .shp related files
"""
```

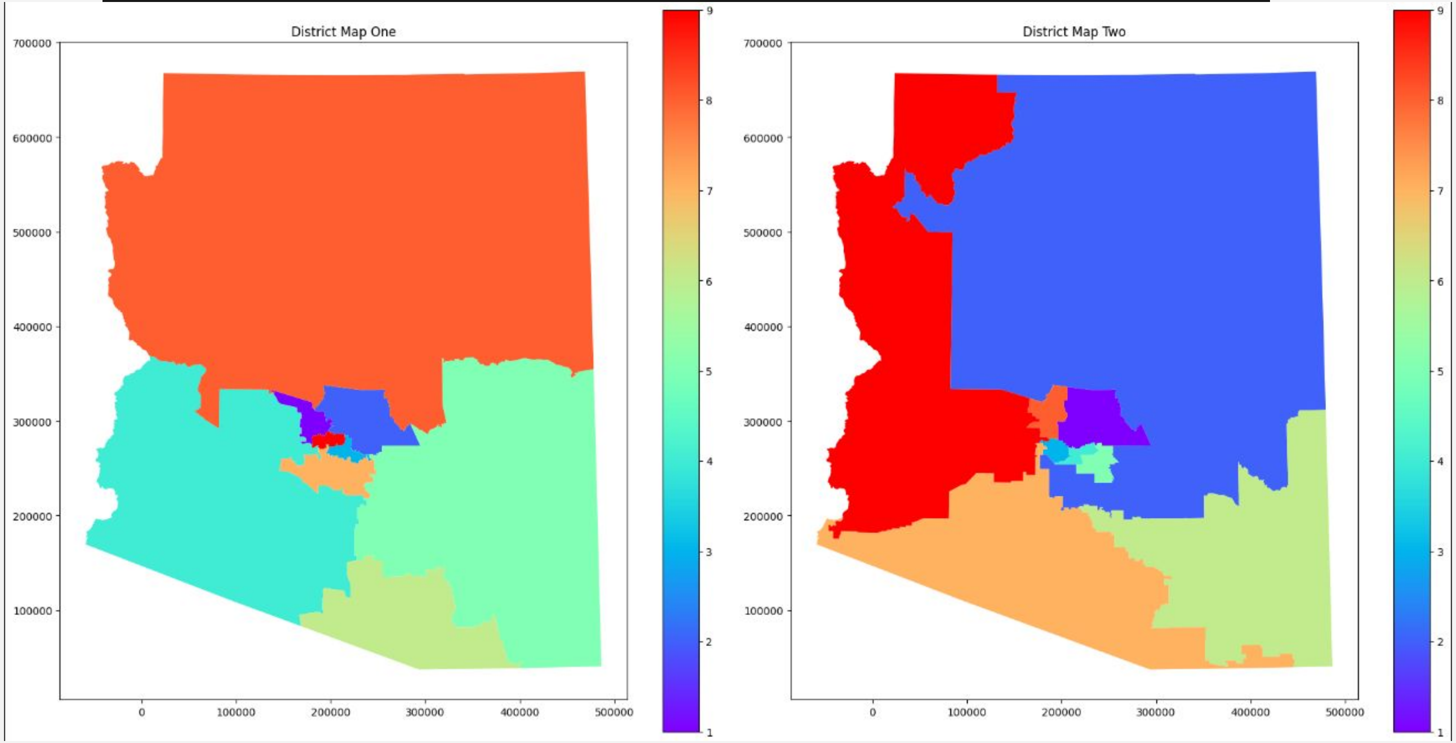


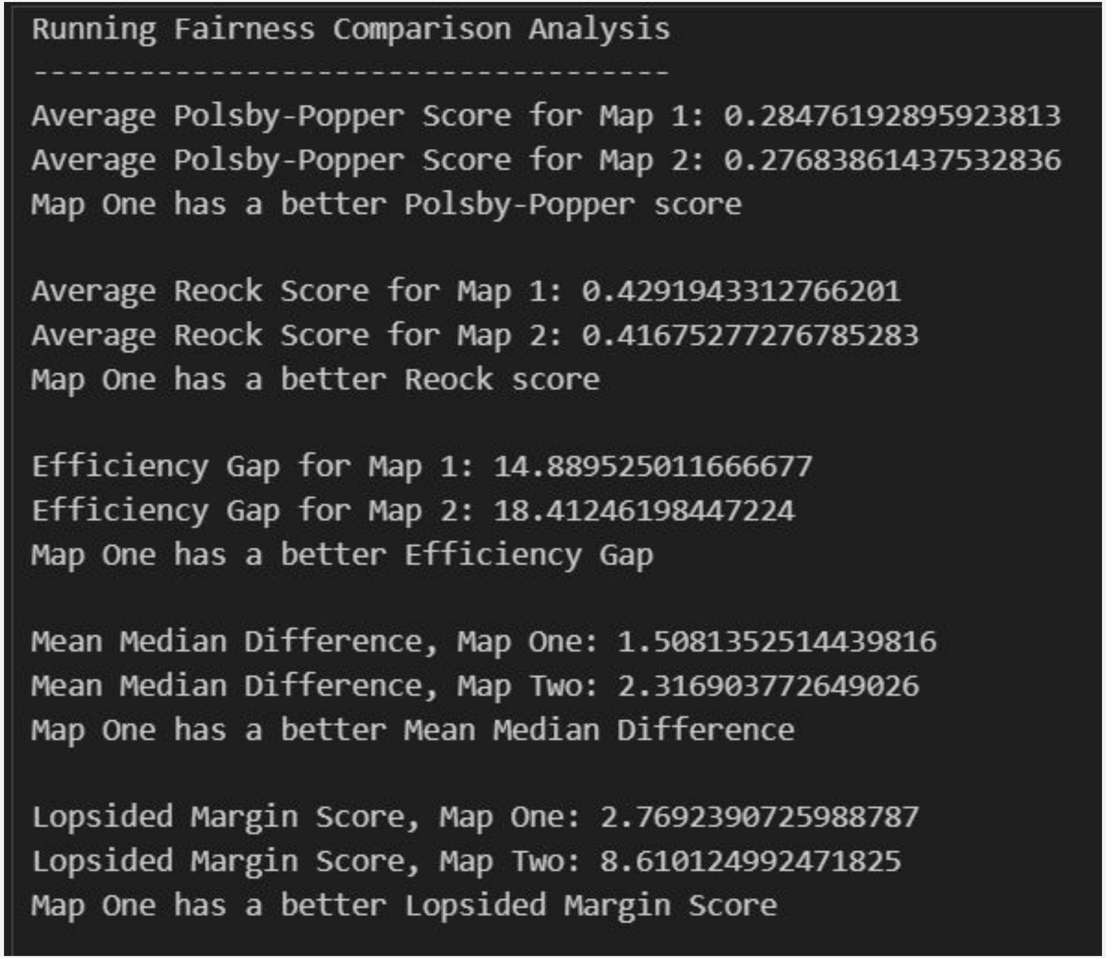
```
Finished step 40/100
getting state GeoDataFrame
Sucessfully loaded state GeoDataFrame
getting state partition
generating map
Map with Polsby-Popper metric 0.26483196134459003 found:
Population in each district:
District
0    739605
1    744164
2    739529
3    745539
4    742205
5    744500
6    739235
7    745440
8    740875
```



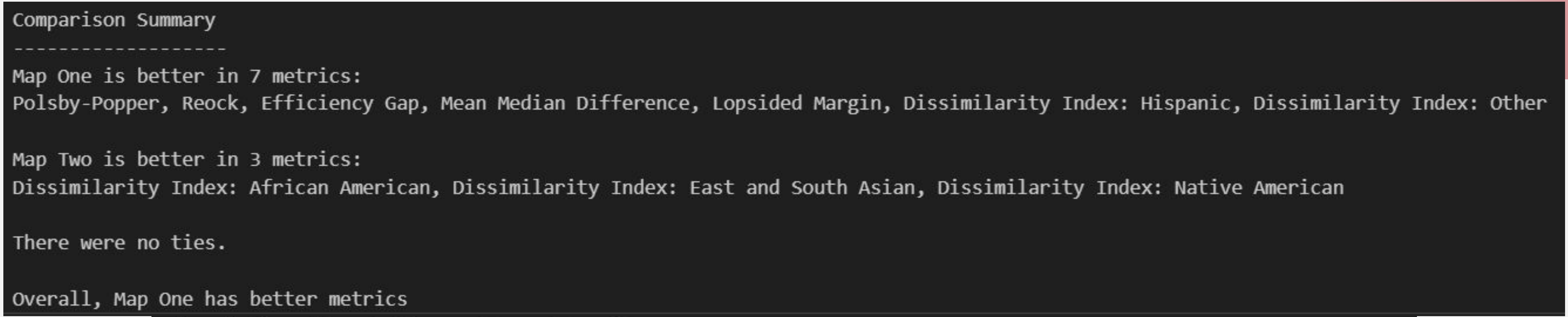


```
from fairymander.fairness import full_analysis, compare_maps
from fairymander.data import get_curr_district_file

gdf = get_curr_district_file('az')

compare_maps(districts[1], gdf)
```

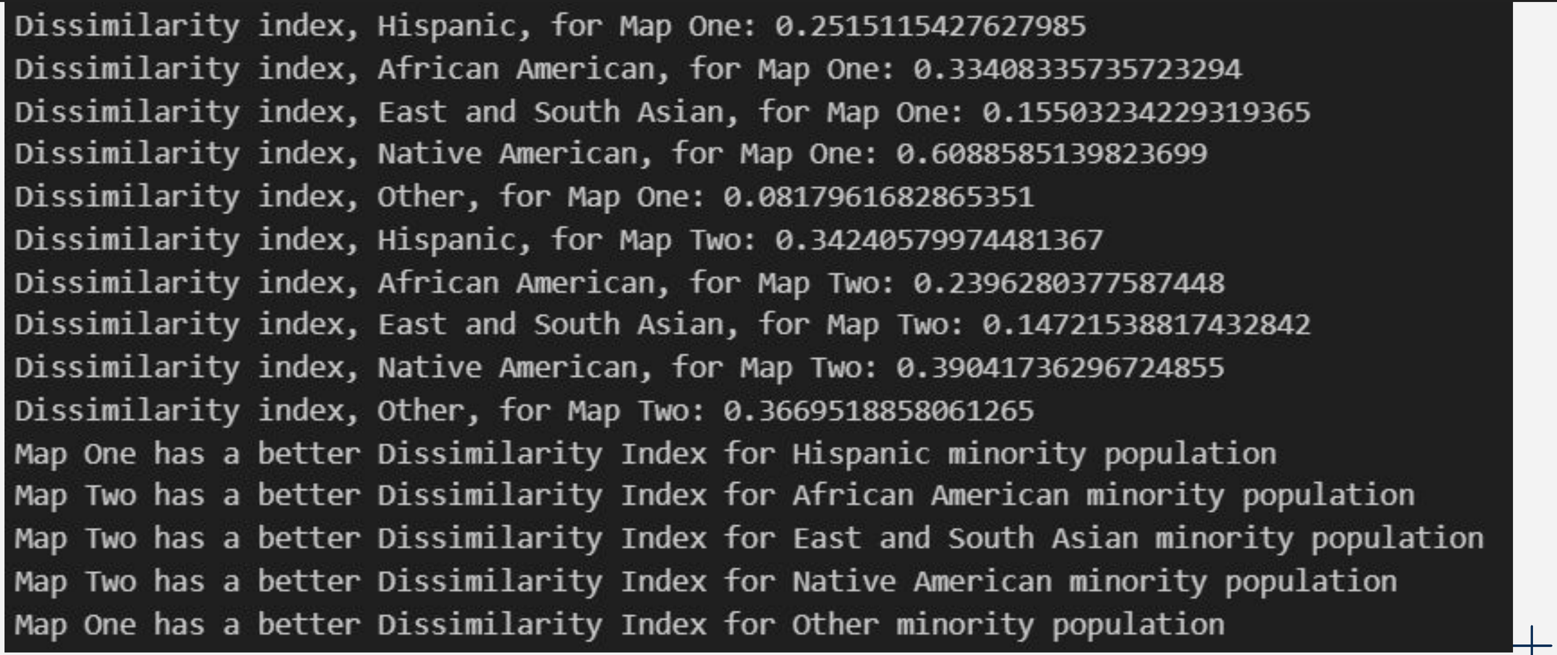




```
Running Fairness Comparison Analysis
------------------------------------
Average Polsby-Popper Score for Map 1: 0.28476192895923813
Average Polsby-Popper Score for Map 2: 0.27683861437532836
Map One has a better Polsby-Popper score

Average Reock Score for Map 1: 0.4291943312766201
Average Reock Score for Map 2: 0.41675277276785283
Map One has a better Reock score

Efficiency Gap for Map 1: 14.889525011666677
Efficiency Gap for Map 2: 18.41246198447224
Map One has a better Efficiency Gap

Mean Median Difference, Map One: 1.5081352514439816
Mean Median Difference, Map Two: 2.316903772649026
Map One has a better Mean Median Difference

Lopsided Margin Score, Map One: 2.7692390725988787
Lopsided Margin Score, Map Two: 8.610124992471825
Map One has a better Lopsided Margin Score
```



```
Comparison Summary
------------------
Map One is better in 7 metrics:
Polsby-Popper, Reock, Efficiency Gap, Mean Median Difference, Lopsided Margin, Dissimilarity Index: Hispanic, Dissimilarity Index: Other

Map Two is better in 3 metrics:
Dissimilarity Index: African American, Dissimilarity Index: East and South Asian, Dissimilarity Index: Native American

There were no ties.

Overall, Map One has better metrics
```

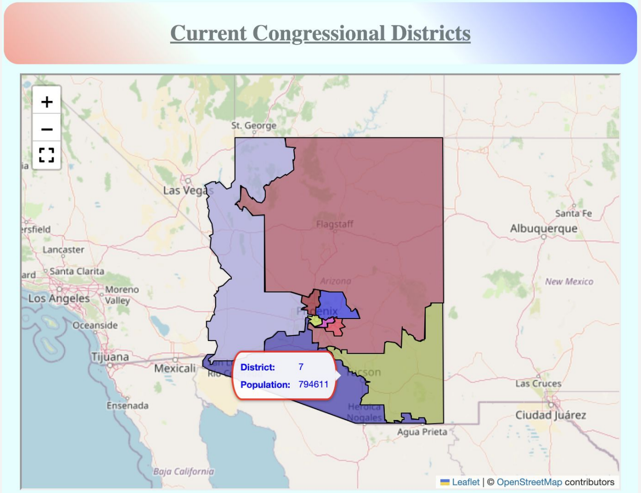


```
Dissimilarity index, Hispanic, for Map One: 0.2515115427627985
Dissimilarity index, African American, for Map One: 0.33408335735723294
Dissimilarity index, East and South Asian, for Map One: 0.15503234229319365
Dissimilarity index, Native American, for Map One: 0.6088585139823699
Dissimilarity index, Other, for Map One: 0.0817961682865351
Dissimilarity index, Hispanic, for Map Two: 0.34240579974481367
Dissimilarity index, African American, for Map Two: 0.2396280377587448
Dissimilarity index, East and South Asian, for Map Two: 0.14721538817432842
Dissimilarity index, Native American, for Map Two: 0.39041736296724855
Dissimilarity index, Other, for Map Two: 0.3669518858061265
Map One has a better Dissimilarity Index for Hispanic minority population
Map Two has a better Dissimilarity Index for African American minority population
Map Two has a better Dissimilarity Index for East and South Asian minority population
Map Two has a better Dissimilarity Index for Native American minority population
Map One has a better Dissimilarity Index for Other minority population
```

Folium and Website

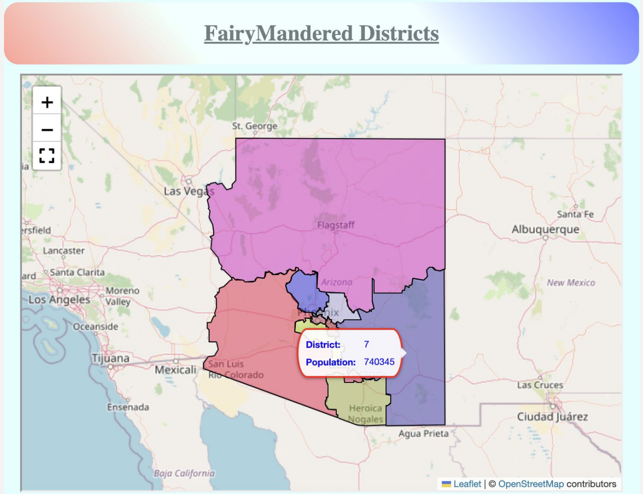
Folium

- Takes Computed Districts file



Current Congressional Districts

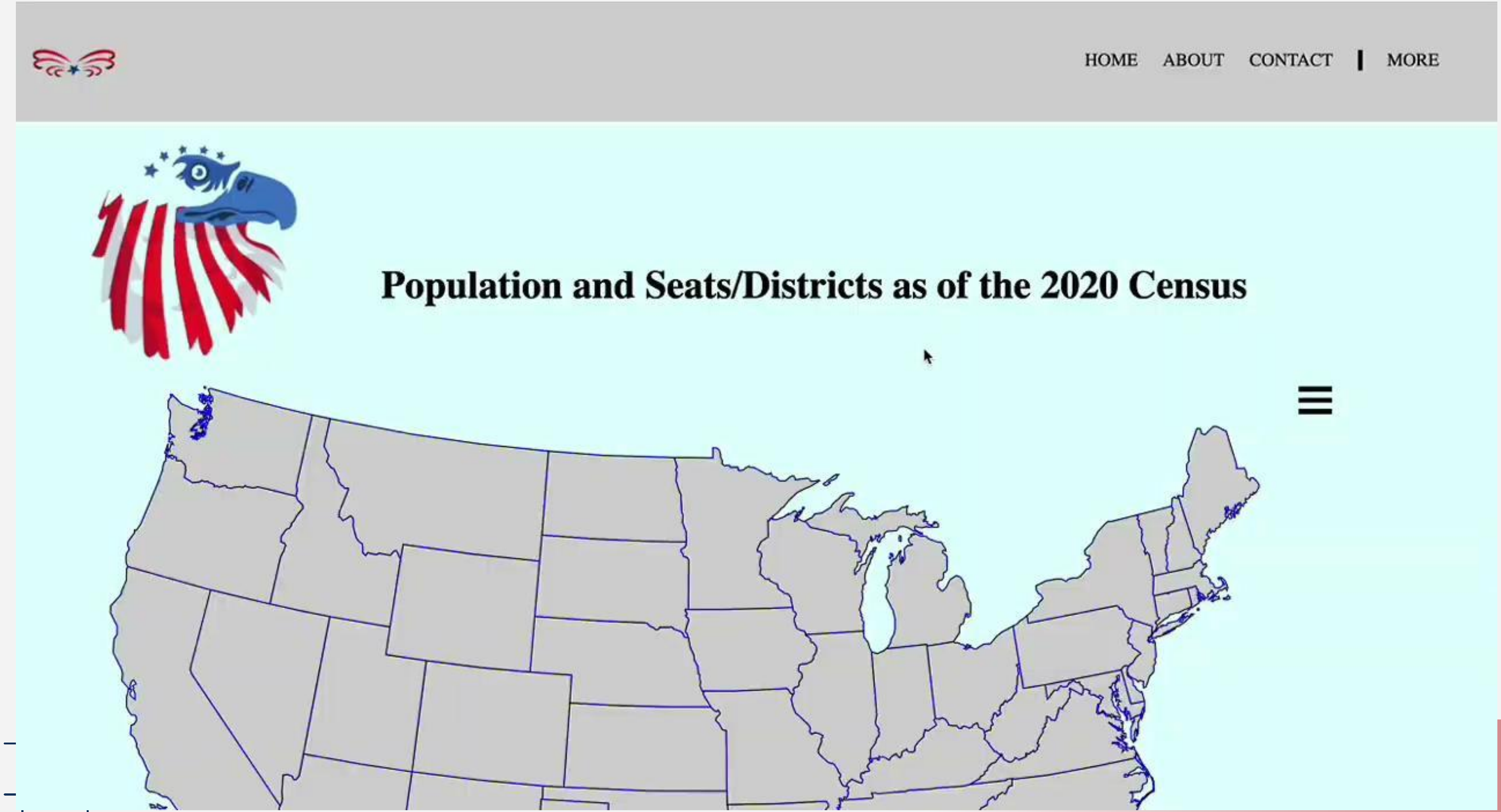
District: 7
Population: 794611



FairyMandered Districts

District: 7
Population: 740345

Website Cont.



Population and Seats/Districts as of the 2020 Census

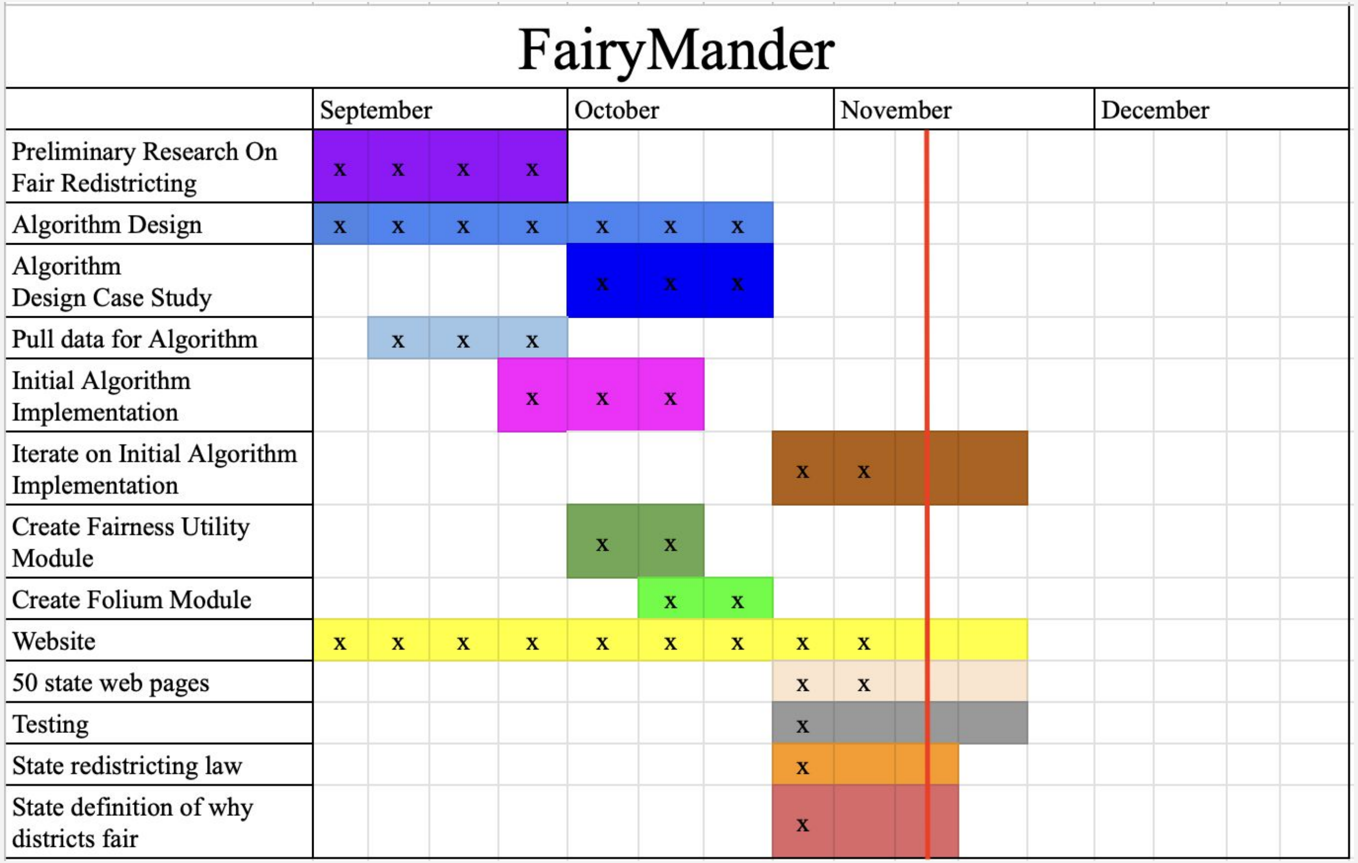
Challenges and Resolutions

- Algorithm Design - Acceptance
  - Excess criteria: Low acceptance rate
  - Minimal criteria: Low quality maps
- Representing “Fairness”
  - No composite score
- Islands
  - Connected island nodes to non-island nodes
  - Hawaii

Testing Plan

- Unit Testing
  - Generator, Fairness Metric, Folium Converter, and Data modules
- Integration Testing
  - System for generating, evaluating and visualizing district plan
- Usability Testing
  - Responsiveness and understandability through user acceptance testing

Schedule



FairyMander

	September				October				November				December			
Preliminary Research On Fair Redistricting	x	x	x	x												
Algorithm Design	x	x	x	x	x	x	x									
Algorithm Design Case Study					x	x	x									
Pull data for Algorithm		x	x	x												
Initial Algorithm Implementation				x	x	x										
Iterate on Initial Algorithm Implementation								x	x	▨	▨					
Create Fairness Utility Module					x	x										
Create Folium Module						x	x									
Website	x	x	x	x	x	x	x	x	x	▨	▨					
50 state web pages								x	x	▨	▨					
Testing								x	▨	▨	▨					
State redistricting law								x	▨	▨						
State definition of why districts fair								x	▨	▨						

Conclusion

Problem

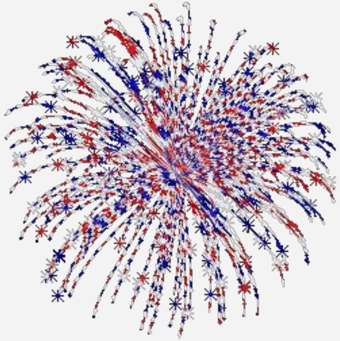
- Gerrymandering poses a serious threat to democracy

Solution

- We have developed a geospatial redistricting algorithm, presented using a web application.

Wrapping Up

- Testing and quality assurance



Thank You

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