Interactive Web Mapping for Multi-Criteria Assessment of Redistricting Plans

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Representation in redistricting

- Redistricting draws electoral boundaries
- Normatively, districts should be about representing groups of people with shared interests
- Preserving communities of interest (COI) is a traditional redistricting criterion
  - No clear definition!

How does a political scientist describe community?

- No clear definition of COI – use proxies:
  - Compactness
  - Heat maps (COIs)
  - Split municipalities count
  - Contiguous

- Countable! Meaningful?

How does a geographer describe community?

- Interactions in space/place and time
  - Human mobility flows
    - Quantitative!

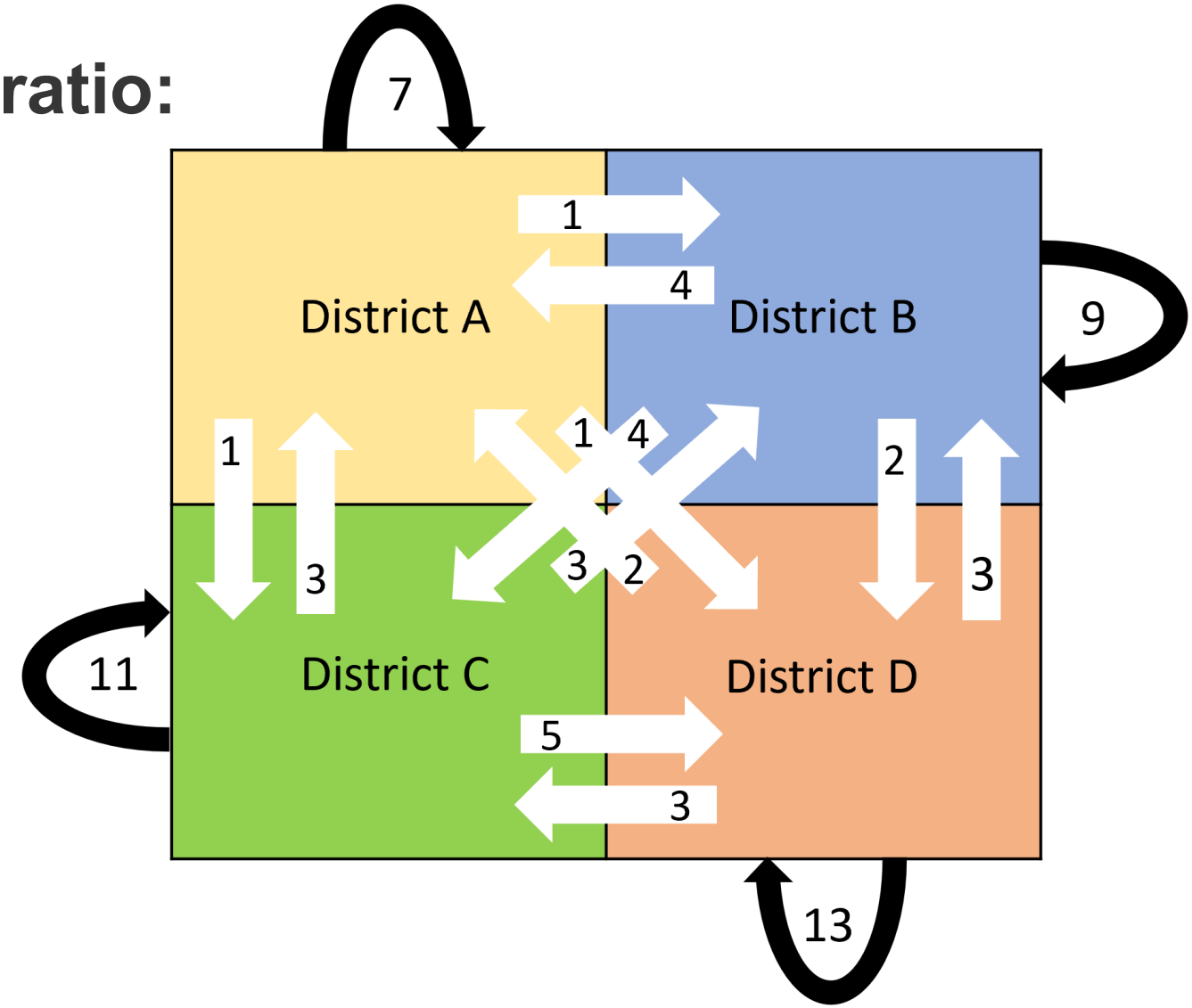
- Our claim:
  - districts that capture how people move are normatively better than districts that don't
    - New to poli-sci redistricting literature!

How to quantify community?

- Modularity ratio
  - Global metric
  - Sum of intra flows/sum inter flow

- Use pop-scaled human mobility flow data (SafeGraph)

Modularity ratio:



$$\frac{\textit{Sum of Intra Flows}}{\textit{Sum of Inter Flows}} = \frac{7_{AA}+9_{BB}+11_{CC}+13_{DD}}{1_{AB}+1_{AC}+1_{AD}+4_{BA}+4_{BC}+2_{BD}+3_{CA}+3_{CB}+5_{CD}+2_{DA}+3_{DB}+3_{DC}} = \frac{40}{32} = 1.25$$

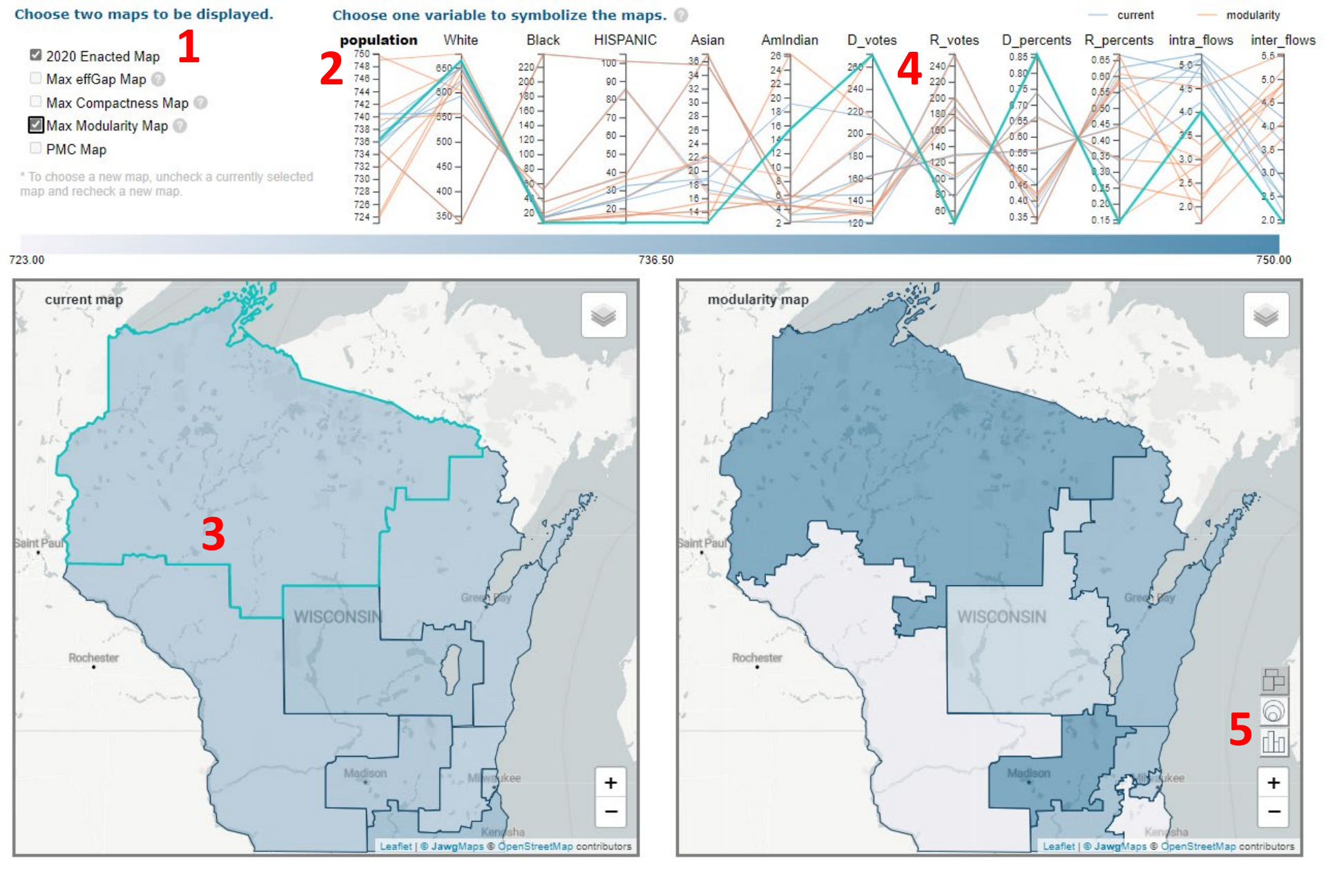
How to compare across potential maps?

- Too many potential maps to enumerate completely!
  - Get a representative sample instead
- Recombination (ReCom)[1]
  - Markov chain Monte Carlo (MCMC)
- Common to evaluate for compactness, fairness, and preservation of municipal units (i.e. not splitting counties)

[1]DeFord, Daryl, Moon Duchin, and Justin Solomon. "Recombination: A family of Markov chains for redistricting." arXiv preprint arXiv:1911.05725 (2019).

How to make sense of all these metrics???

- Interactive web map!
- Explore trade-offs between criteria

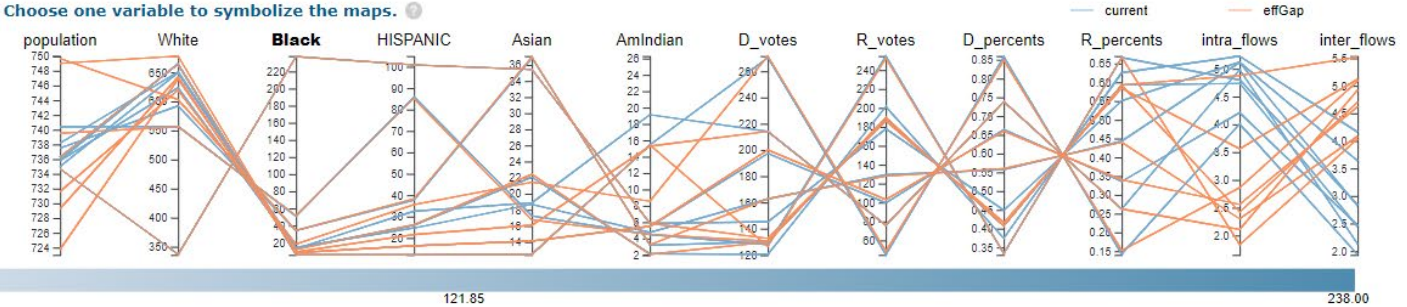

Choose two maps to be displayed.
1
2020 Enacted Map
Max effGap Map
Max Compactness Map
Max Modularity Map
PMC Map
* To choose a new map, uncheck a currently selected map and recheck a new map.
Choose one variable to symbolize the maps.
current
modularity
population
White
Black
HISPANIC
Asian
AmIndian
D_votes
R_votes
D_percents
R_percents
intra_flows
inter_flows
2
4
723.00
736.50
750.00
current map
3
modularity map
5
WISCONSIN
Saint Paul
Rochester
Madison
Milwaukee
Green Bay
Kenosha
Leaflet | © JawgMaps © OpenStreetMap contributors

Choose two maps to be displayed.

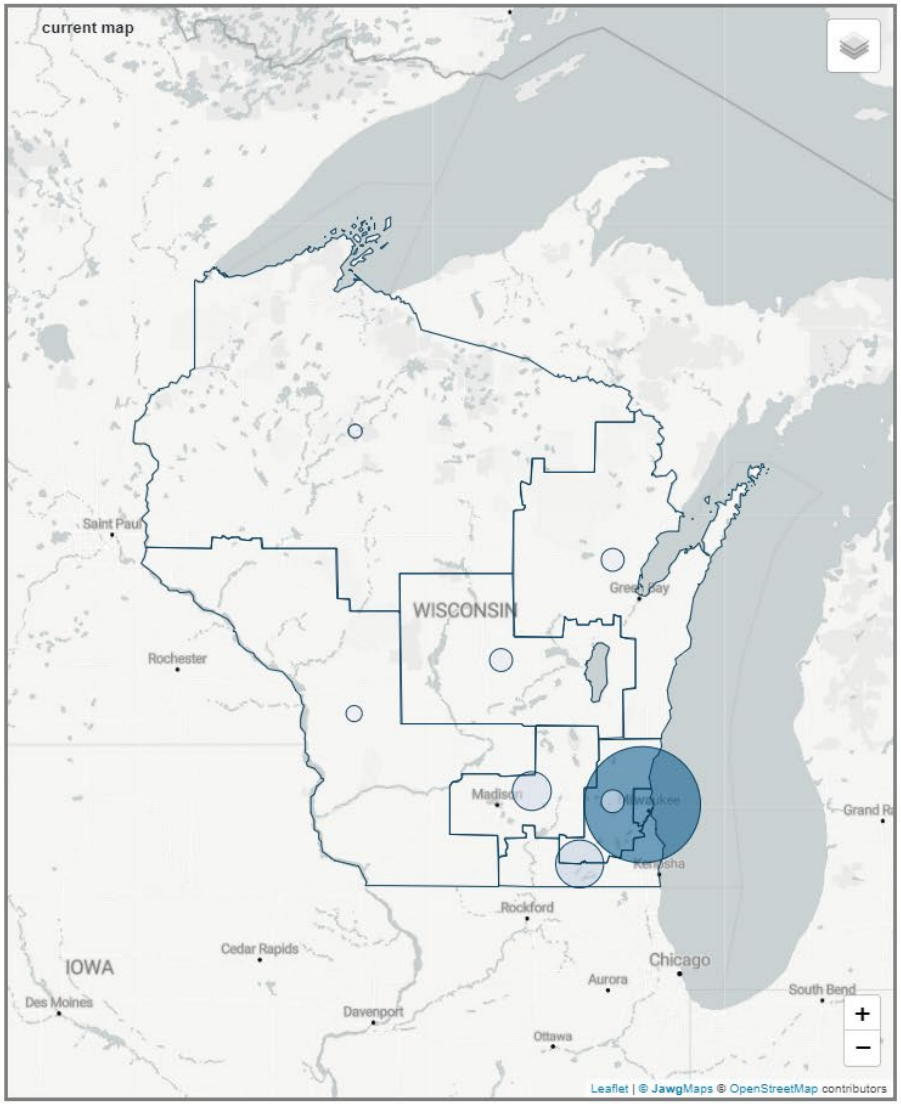
- [x] 2020 Enacted Map
- [x] Max effGap Map
- [ ] Max Compactness Map
- [ ] Max Modularity Map
- [ ] PMC Map

* To choose a new map, uncheck a currently selected map and recheck a new map.

Choose one variable to symbolize the maps.



5.70 121.85 238.00



Choose two maps to be displayed.

- [x] 2020 Enacted Map
- [x] Max effGap Map
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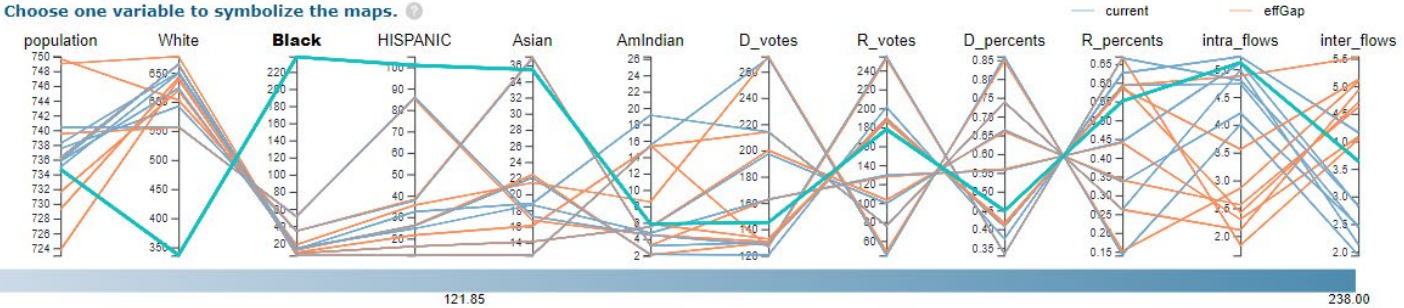
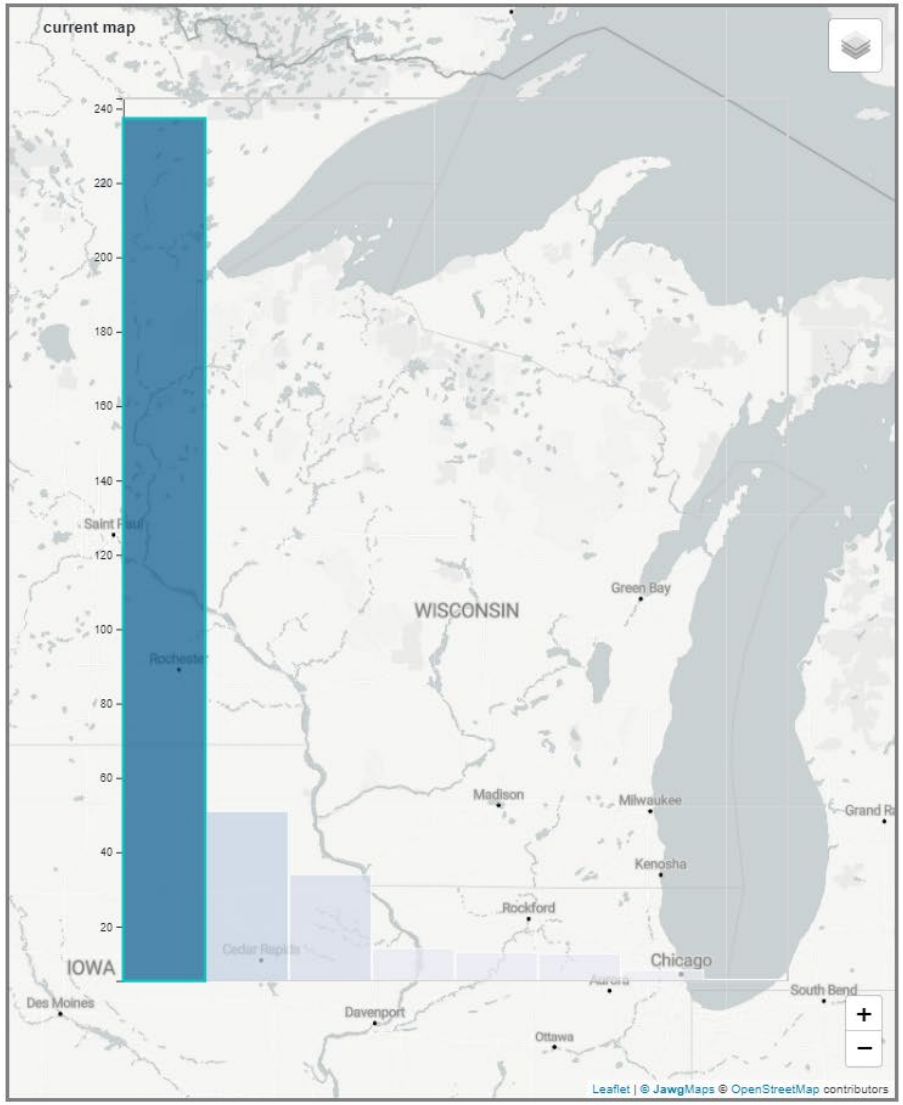
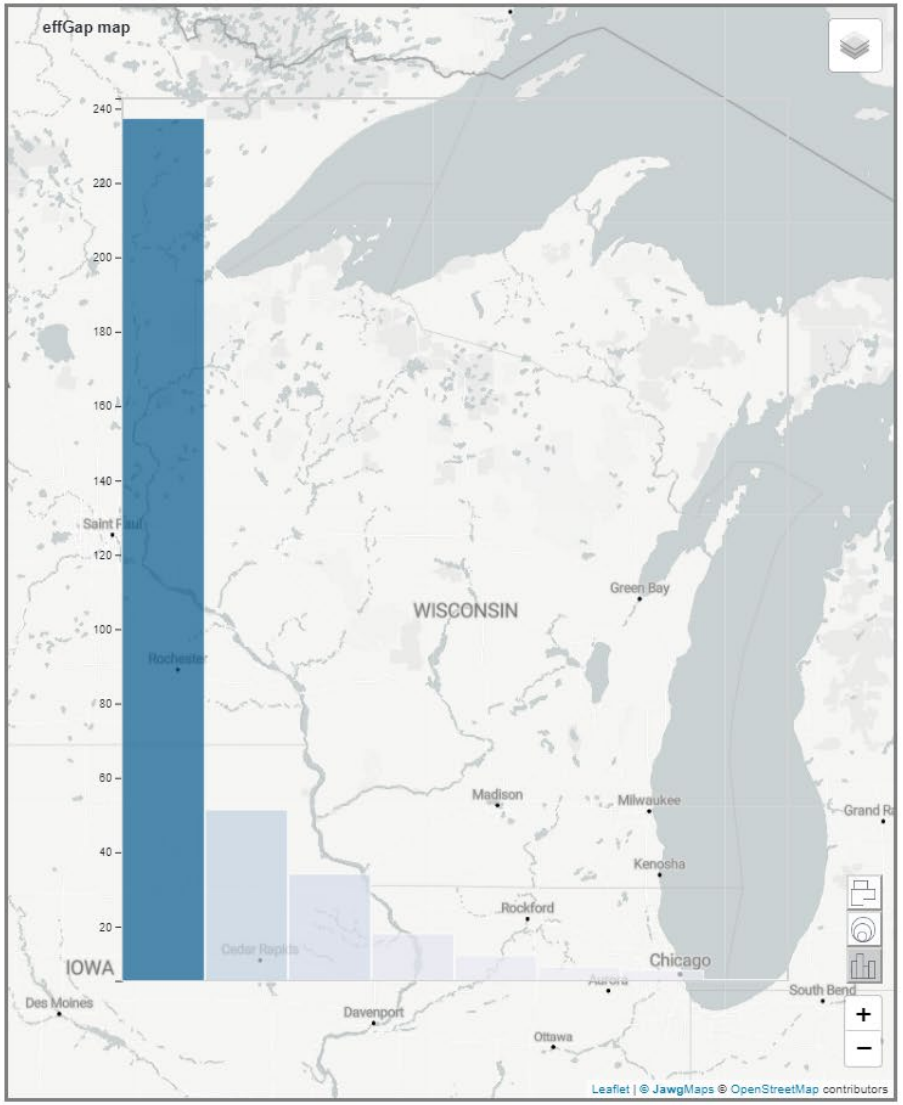
Choose one variable to symbolize the maps.







Gerrymandering

In the United States, political districts are redrawn every 10 years to reflect new Census data. When redrawing electoral district boundaries, legislators may try to create districts so as to create an advantage for their party: this is gerrymandering. Political gerrymandering is currently legal as long as it is not excessive, though what constitutes "excess" is difficult to define. While gerrymandering for the purpose of gaining partisan advantage is legal to some extent, gerrymandering to disenfranchise voters on a racial basis is illegal. In either case, gerrymandering seeks to give one party more representatives for the same number of votes, thus diluting the voting power of other parties.

Though political gerrymandering is legal and to some degree unavoidable, many scholars agree that it is harmful for our democracy: if voters feel like their vote doesn't count, they lose faith in our government.

Drawing of the salamander-like district shape that inspired the term 'gerrrymander'.

Metrics

The following sections describe each metric and how they are calculated.

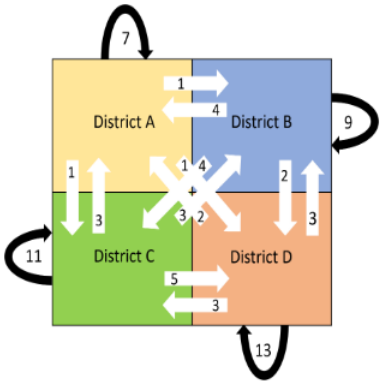
Modularity:

A communitiy is a group of people that have more in common with each other, on average, than they do with people from another group. Redistricting groups people across geographic space, and therefore can either split communities or keep them intact. Redistricting laws in many states have explicit preferences for redistricting plans that follow existing boundaries, such as county lines, which implicitly encourages communities to be kept intact. Frequently, in legal challenges to gerrymandered districts, split municipalities are shown as evidence that natural communities were split in order to gain partisan advantage.

Communities of interest and majority-minority districts are two explicit ways of keeping particular communities intact, and both function by keeping groups of people with common policy concerns in a single district. For communities of interest, people from such a group self identify and advocate for being kept in a single interest so that they can elect a representative that will represent their particular interests. Majority-minority districts are similar, though they are required by the Voting Rights Act so as to not "improperly dilute minorities voting power."

None of these community formations, however, attempt to maintain communities across all districts. Framed as an optimization problem, we might ask how we could make districts such that we maintain as many communities as possible within each district, such that we minimize community splitting across all districts. While optimization is redistricting is notoriously difficult, we attempt here to show at least what a range of possibilities might look like if such a metric were incorporated into redistricting law.

For such an optimization, we need both a formula for defining community strength, and a measurement to use in that formula. For the measurement, we employ human mobility flows from Safegraph. The mobility flows consist of anonymized cellphone counts that have moved from one census block group to another during a given time span. To quantify community strength, we use modularity, which is frequently used in community detection research. Modularity here is defined as the sum of district intra flow divided by the sum of district inter flows, where intra flows are mobility flows originating in one district and ending in that same district, while inter flows are mobility flows originating in one district and ending in another. By summing across all districts to calculate modularity, we can get a sense of how the districting plan, as a whole, keeps communities intact.



Example districts and flows.

$$Modularity = \frac{Sum\ of\ Intra\ Flows}{Sum\ of\ Inter\ Flows} = \frac{7_{AA}+9_{BB}+11_{CC}+13_{DD}}{1_{AB}+1_{AC}+1_{AD}+4_{BA}+4_{BC}+2_{BD}+3_{CA}+3_{CB}+5_{CD}+2_{DA}+3_{DB}+3_{DC}} = \frac{40}{32} = 1.25$$

Calculating modularity for the example districting plan.

Efficiency Gap

"[The efficiency gap] represents the difference between the parties' respective wasted votes in an election—where a vote is wasted if it is cast (1) for a losing cadidate, or (2) for a winning candidate but in excess of what she needed to prevail. Large numbers of votes commonly are cast for losing candidates as a result of the time-honored gerrymandering technique of "cracking." Likewise, excessive votes often are cast for winning candidates thanks to the equally age-old mechanism of "packing." The efficiency gap essentially aggregates all of a district plan's cracking and packing choices into a single, tidy number." (Stephanopoulos, McGhee, 2015). For more reading on the efficiency gap, you can visit ballotpedia.

To demonstrate how gerrymandering uses both packing and cracking to change election outcomes, we present the following example from the Washington Post: In this example, the Purple and Green parties are competing to win seats in 5 equal-population districts, and votes for a given party a represented by icons of the same color. The Green party receives 20/50 votes, yet is able to win 3/5 seats due to how the districts were arranged.

Questions?

- Funding:
  - Work is supported by a University of Wisconsin 2020 WARF Discovery Initiative funded project: Multidisciplinary approach for redistricting knowledge.

- Acknowledgments:
  - MGGG Redistricting Lab!
    - Metric Geometry and Gerrymandering Group

End Slide

Pop quiz!

- What is gerrymandering?

Pop quiz!

- What is gerrymandering?

How to “prove” a gerrymander?

- Outlier analysis
  - compare to sample distribution

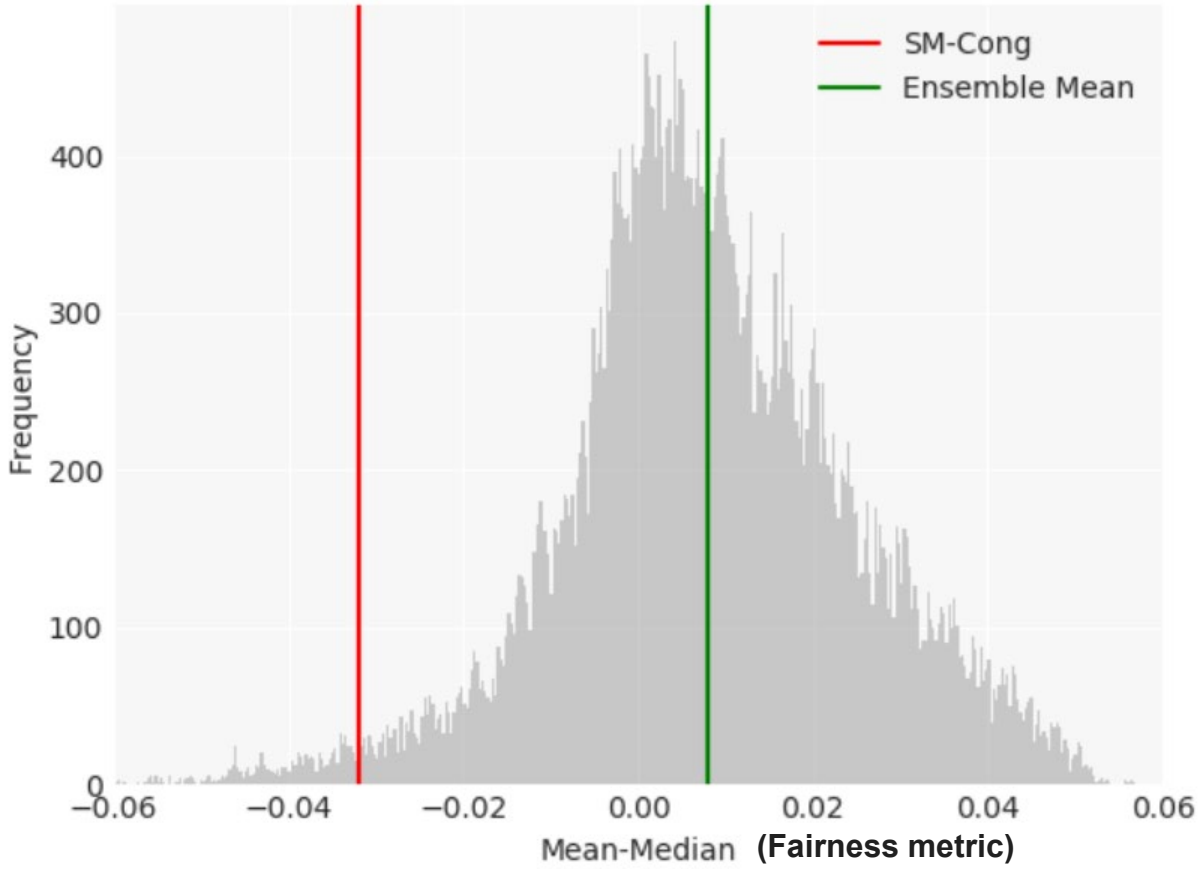
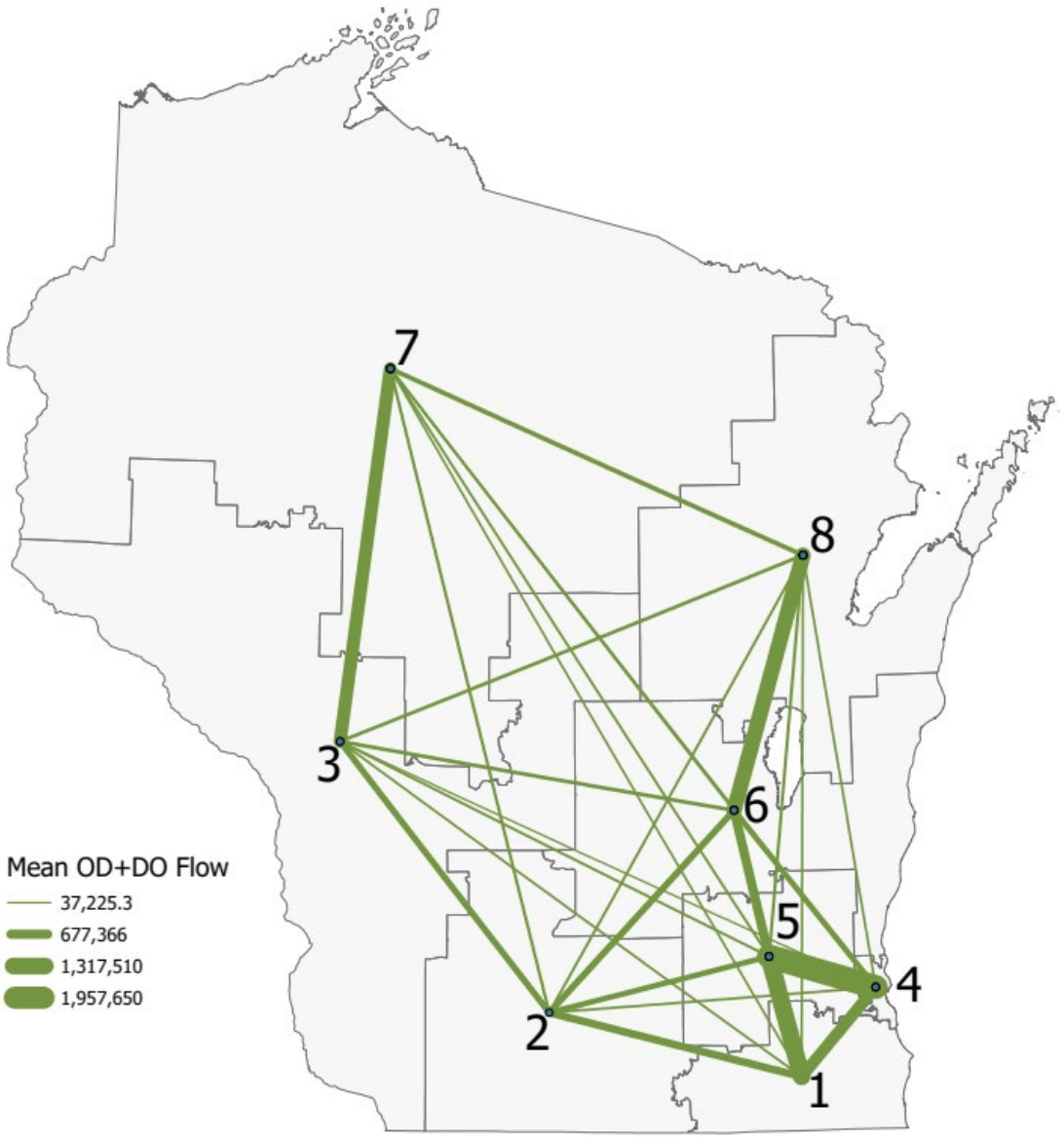
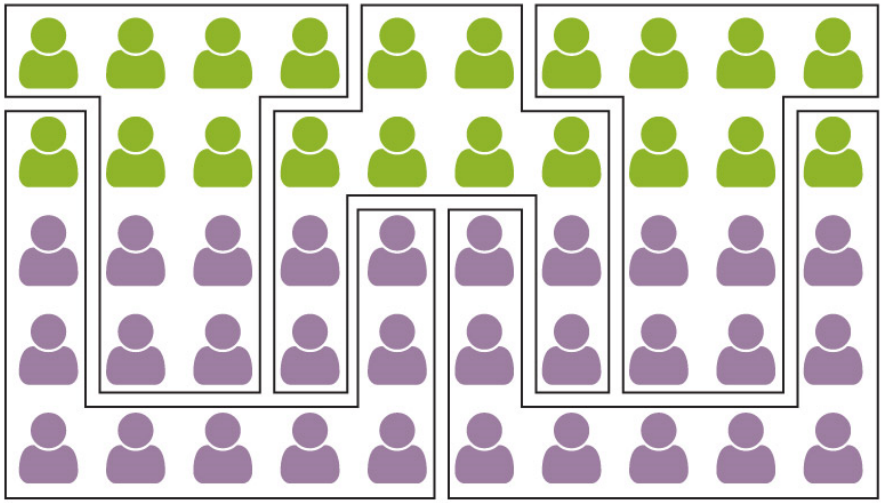


Figure from DeFord, Daryl, and Moon Duchin. "Redistricting reform in Virginia: Districting criteria in context." *Virginia Policy Review* 12.2 (2019): 120-146.


7
8
3
6
5
4
2
1
Mean OD+DO Flow
37,225.3
677,366
1,317,510
1,957,650

What is redistricting?



Imaginary state:
- 20 green voters
- 30 purple voters
- 5 districts

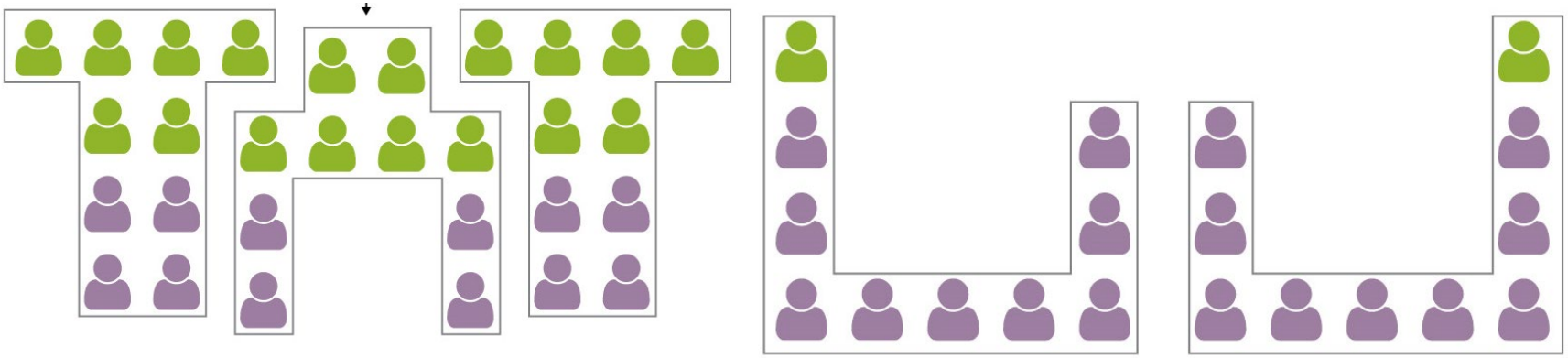


Figure: www.washingtonpost.com/graphics/2017/politics/courts-law/gerrymander/