About

These notes are from the Metric Geometry and Gerrymandering Group's (MGGG) workshop at Tufts University, August 7th-11th, 2017. For more information about the workshop itself, see `http://sites.tufts.edu/gerrymandr`.

As taking notes in LaTeX on-the-fly is not an easy task, I am sure this document is full of typos, sloppy notation, and small mathematical errors. If you find such an error, please send me an email at {`ianzach+notes[at]seas.upenn.edu`} *so I can correct it.*

MGGG Workshop at Tufts University **Tufts University**

Talk 1: Situating Redistricting

Professor Moon Duchin (Tufts) *Zach Schutzman*

Congressional Representation

Constitutionally mandated, allocations according to decennial Census.

There are issues:

- Census-taking isn't straightforward or perfect
- Apportionment isn't straightforward or perfect - how many reps should we have for each state?
- Drawing districts isn't straightforward or perfect - this is the topic of the week

Mathematically, we are interested in partitioning a population with attributes

We have a population of nodes, each with attributes

We want to partition the sets into blocks ("districts") and think about how the attribute patterns at the district level compare to that at the population model.

In practice, we also have geographic features to think about (S^2 embedding).

What are the goals?

We can think about proportionality - can we get the districts to "look like" the population at large?

We can gerrymander! - can we maximize/minimize the incidence of some attribute at the district level?

What are the constraints?

Districts must be (very nearly) equipopulous

Districts should be contiguous and non-punctured

Districts shouldn't be weirdly shaped (!)

Math v Politics

Any goal or constraint represents a mathematization of a normative ideal of politics

- Equal population - representational equality (one person - one vote)

Geographical division - bare majorities shouldn't dominate (appeal to the Law of Large Numbers - if people are assigned to a district randomly, a scant majority should make scant majorities in each district)

Shape - may indicate gerrymandering or some other extreme agenda

Proportionality - government should reflect the populace

Competitiveness - elections should be "fair"

Partisan favor - prevent government deadlock

The latter three of these are not encoded in the law.

How to Gerrymander

Packing and Cracking

Definition 1.1 ***Packing*** *is the act of creating a few districts with a strong majority of individuals with a certain attribute.*

Definition 1.2 ***Cracking*** *is the act of spreading out individuals with a certain attribute across several districts so as to make them a minority in those districts*

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Together, Packing and Cracking looks like taking members of one group and making a few districts where they have a strong majority and many where they are a scant minority so as to minimize that group's representation at the district level.

Evaluating Shapes

Intuitively, any weird agenda should make weird looking districts.

At the legal level, districts are usually only stipulated to be "reasonably compact". What does that mean?

Mathematically, there are numerous definitions for compactness.

Compactness

Isoperimetry

Definition 1.3 ***Isoperimetry*** *is a measure of how close to being circular a region is. The Poslby-Popper score is* $0 \leq 400\frac{\pi A}{P^2} \leq 100$ *and is one way to measure this.*

This is weak because "perimeter" isn't really a thing. We have a Coastline Paradox effect at play.

Convexity

We can look at the convex hull of a district and see how far the district deviates from this. Also not great, because there are some very good reasons for nonconvexity.

Dispersion

Look at things like moment of inertia or how spread the district is. The failings of this are a little more subtle, well-detailed in the literature.

All of this is based on old mathematics.

Courts have discarded maps based on "weird" shapes, but there is no standard. This is the "Eyeball Test".

Race as Issue

People of Color tend to vote for Democrats. We have to think about the issue of race proxying for partisan allegiance.

Large cities tend to vote for Democrats. Since cities are populous and dense, we need to think carefully about how we divide cities. There are strong correlations between method of commuting and Presidential vote in 2016. Three of the top 40 largest cities voted for Trump in 2016 (OKC, Mesa, AZ, Colorado Springs). Even cities in red states go blue.

The IL-4 has two neighborhoods joined by a highway (zero population, of course). The northern chunk is a Puerto Rican neighborhood and the southern chunk is a Mexican neighborhood. This might look like an instance of packing, but it was actually done in order to give these two Latino populations the ability to pick their own representative.

Density and Splittability

Density of population creates "natural gerrymandering (Chen and Rodden). How you draw the lines in and around cities decides how much packing and cracking you end up doing. In this sense, density and shape both contribute to how easy or hard it is to draw nice lines.

Thinking about District "Guts"

What abstraction should we be thinking about to capture the information we care about?

First, note that our data is discrete - we get block-level data from the census, and individual people are obviously discrete units.

We can think about Census units like vertices in a graph - but what are the edges?

Adjacency - the spatially obvious thing to do

Distance or travel time

Commonalities - edge between blocks that "look similar"

Curvature as an Approach to Compactness

Graphs have shape, which reveals something about both isoperimetry and dispersion. What if you try to build you district out of a sheet of paper, with a face for each block. This shape will have (discrete) **curvature** which tells us something about the geometry of the distric.

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Talk 2: Partisan Gerrymandering

Professor Steve Ansolabehere *Zach Schutzman*

How to Gerrymander (Revisited)

Suppose we have a square state where the Purple Party members all lives in a square in the center and the Yellow Party members all live in the surrounding region. You get hired to draw the districts (four of them) by the Yellow Party, how do you do it? Packing or cracking does the job here. If the Purples are a slight majority, draw one district that is all Purple, and the Yellow Party can win three districts. If the Purples are a minority, crack them across the four districts so that Yellow can win four.

Definition 2.4 *A **wasted vote** is a vote for the losing candidate or a vote for the winning candidate beyond the* $50\% + \epsilon$ *threshold for victory.*

At the base, packing puts "too many" people of one party into a district and "packing" puts too few, if we are thinking about how representative our districts are of the population. In our toy examples, we can think of drawing districts to waste as many Purple votes as possible. In the packing case, the Purple waste a lot of votes by winning unanimously in their district while the Yellow waste a smaller proportion of their votes in their winning districts, and waste none in the Purple district. In cracking, all of the Purple votes are wasted, while not all of the Yellow votes are.

How to Detect Gerrymandering (Revisited)

Definition 2.5 ***Distortion*** *is a quantification of how non-representative the legislature is of the voting populace.*

Definition 2.6 ***Partisan bias*** *is the difference between the proportion of the vote that a party wins and the number of seats that the party wins if the vote is split 50/50. An equivalent definition is that if one party earns x share of the vote statewide, they in half of the districts they earn more than x and half less than x share of the vote.*

For an example, think of FL, NC, or PA, where the Congressional vote is split fairly evenly, but Republicans won a majority of seats.

We can also think of *symmetry*, which considers how much one party wastes votes compared to the other.

Definition 2.7 *The **efficiency gap** is the ratio of the difference between the wasted votes for each party to the total votes.*

The efficiency gap concept gained traction in the current Wisconsin SCOTUS case. We have to ask whether this concept actually captures the notion of equal protection as enshrined in the Constitution and Voting

Rights Act. The case is notable because it was the first time a court found a violation of the 14th Amendment as a result of *partisan* (as opposed to racial or populational) gerrymandering.

One thing that has been measured is *historical gerrymandering*. Before the 1960s (particularly in the South), partisan gerrymandering was bad. In the 1960s and 1970s, that declined to the point that by the 1990s, partisan bias was minimal at the national level. We see an uptick in the 2010s

Making Good Maps

We see evidence of distortion when all three branches of a state government are controlled by the same party. The REDMAP effort in 2010 led to Republicans taking control of many states, which contributed to the partisan bias increase this decade.

Every 10 years, Congressional districts are up for being redrawn. Since *Reynolds v Sims*, this process is really strict, as zero population deviation is tolerated at the Congressional district level. This process is long and slow in buildup, but districts are drawn quickly, requiring lots of government bureaucracy, then they get the data, then they only have a few months to actually draw the lines.

Public mapping has been a powerful and important change in recent years. Now that data and GIS is available widely, public mapping will only become more important.

AZ and CA have removed the power of redistricting from their legislatures. CA used an independent commission with members not permitted to be themselves or relatives of State employees. While this sounds crazy, it did a a really good job making fair maps. In AZ, they had three Dems, three Reps, and one Independent member who was targeted by politicians and court cases, although she eventually succeeded. ("Fairness" here refers to partisan bias and efficiency metrics).

The VRA and its interpretation of the 14th Amendment present an "equal treatment" idea of representation, which may come into play when SCOTUS hears arguments later this year.

Going to Court

Compactness is an important tool, because it is a mathematical tool which is easy to understand, easy to understand, and easy to interpret. NC-12 got thrown out partially because of arguments of it being the least compact district in the US, and one of the least compact in history.

Courts care about equal treatment. Expert witnesses are employees of the court, and cannot be seen to be taking sides.

Historians have (unfortunately) been largely absent through these cases. Historians are good at evaluating how (un)equal treatment and intentionality has impacted people.

We also need to think about consequences. Stranding minorities isn't illegal, but it has profound implications on outcomes and is an important argument in a courtroom setting as potential evidence of gerrymandering.

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Talk 3: Voting Rights Litigation

Professor Kristen Clarke *Zach Schutzman*

The Voting Rights Act

Yesterday was the 52nd anniversary of the VRA (1965). The VRA is an important part of the context and history of the issues we'll talk about this week.

The VRA is one of the most important piece of civil rights legislation. It followed the incidents at the march from Selma to Montgomery and directly targeted racial discrimination in voting, banning literacy tests, grandfather clauses, and other tools of disenfranchisement. Certain states (mostly the South, but also NY and CA) were also required to get federal pre-clearance for passing voting legislation.

Section 2 of the VRA protects minority voters' equal opportunity to elect a representative of their choice, i.e. create "minority-majority" districts.

In 2006, Congress reauthorized the VRA for 25 years, including Sec. 5, by a wide majority. Things like packing and cracking of minorities and canceling a community election to prevent African-Americans from running for town council and mayor are examples of things struck down under the authority of Sec. 5.

Groups opposed to policies which attempt to correct historical wrongs, such as the VRA or race-conscious admissions policies, challenged the VRA. In 2009, SCOTUS (*Austin Municipal Util. Dist. No. 1 v Holder*), questioned, but did not strike down, Sec. 5. In *Shelby County v Holder* (2013) made a direct Constitutional challenge to Sec. 5. SCOTUS found that the coverage formula, used to determine which states were subject to Sec. 5, was unconstitutional, striking it down. This verdict opened the floodgates for a lot of the voter suppression we are seeing today, such as ID requirements.

Experts found that 600,000 people were disenfranchised the day this verdict passed, largely poor (disproportionately minorities). Costs of getting an ID are $20+, which is significant for people living below the poverty line. North Carolina cut early voting, eliminated pre-registration for teenagers, eliminated same-day registration, and made absentee voting more difficult, and this law would likely have been blocked by Sec. 5. A Court of Appeals found that this law discriminated against minorities with near "surgical precision" after examining how the State used data like Black voters huge participation in early voting to inform how it made its restrictions.

Today's Congress is fairly unproductive, and it does not look to be a fruitful avenue for protecting voting rights. Progress is being made case-by-case in court challenges. Unfortunately, in order to make a court case, you need evidence that the discrimination is occurring, which entails having to live under these repressive laws.

This doesn't just affect Congressional elections, but also state- and municipal-level elections which also use redistricting procedures. Over 8,000 jurisdictions will engage in redistricting for the first time without Sec. 5.

Fears of vote fraud are being used to justify implementing restrictive laws. Claims that undocumented Americans are voting illegally are an unfounded but powerful tool used to create support for these laws. Recently, the Election Integrity Commission (chaired by Kansas Secy. of State Kobach) is being used to

promote voter suppression laws. Cross Check, the process of checking if people are voting in more than one place, has been a big thing with Kobach, but the program has been found to have a 99% error rate in matching people registered in more than one place.

Redistricting

There is no cookie-cutter approach to redistricting that will solve all of the issues with discrimination simultaneously, and solutions must involve careful analysis of data, laws, and voting patters.

Typically, redistricting occurs decennially, following the Census. Recently, some states have been doing "mid-decade redistricting". A suit recently has been brought against Georgia for a 2015 redistricting plan which carves out minorities in places where there have been demographic shifts. As an example, State District 105 had a 550 vote margin in 2012, with the White incumbent barely edging out the Black challenger. The state redrew the lines to widen the margin protecting the incumbent.