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* $0 \leq 400\frac{\pi A}{P^2} \leq 100$.

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".

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Talk 2:

Professor Professor Q Fictional *Zach Schutzman*

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Talk 3:

Professor Professor Q Fictional *Zach Schutzman*