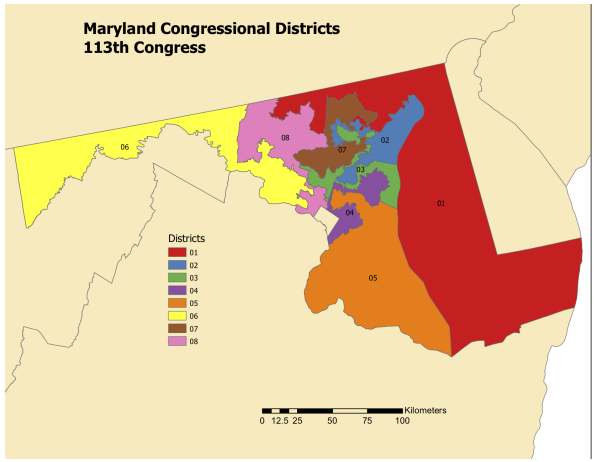
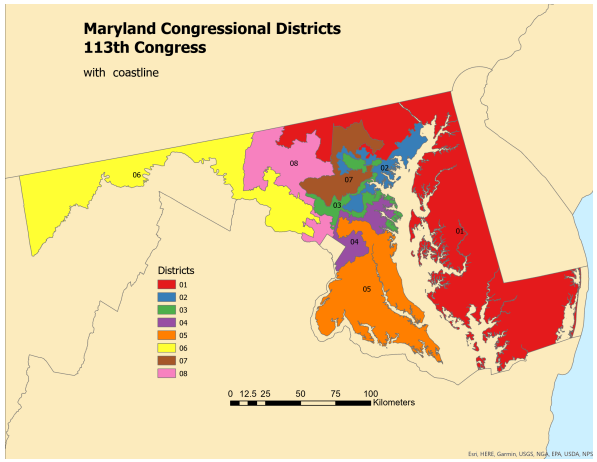
Gerrymandering and Compactness in Real Life

After completing this section, students should be able to;

- Calculate measures of compactness for actual districts
- Compare measures of compactness and their advantages and disadvantages
- Use compactness to argue that districts are or are not gerrymandered

Extra Question. Take these two maps of the congressional districts in Maryland for the 113th Congress. One map includes the water in each district (no coastline shown) and one does not include the water in the district (coastline is shown). The Schwarzberg score for District 1 (red) when the water is included (no coastline) is 0.25 and the score when the water is not included (with coastline) is 0.07.



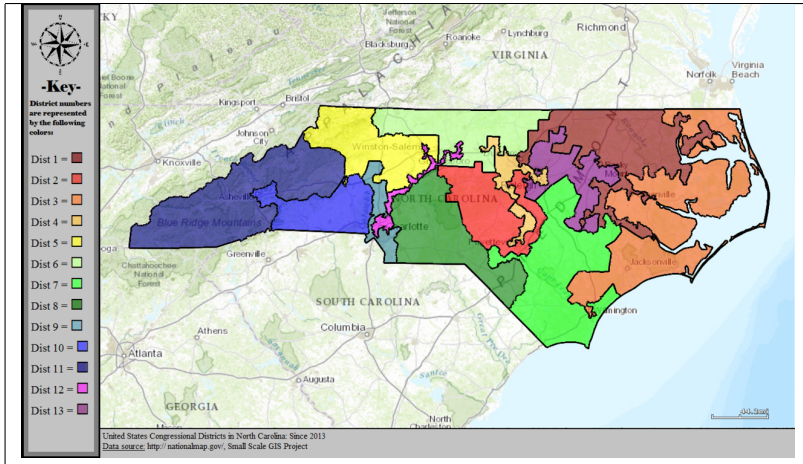


(a) Why is the Schwarzberg score larger when water is included (no coastline)?

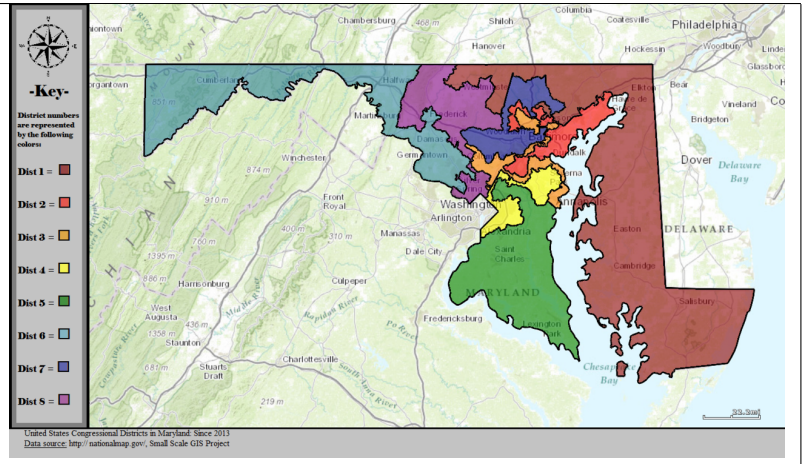
(b) Which compactness score seems like a more fair reflection of gerrymandering and why?

Compactness of real regions

- The area and perimeter of each US congressional district are available at US Census Data website `https://www.census.gov/cgi-bin/geo/shapefiles/index.php`
- Using this data, and spreadsheet formulas, we will compute the Polsby-Popper and Schwartzberg scores for all the districts, for several years.



North Carolina



Maryland

Calculate compactness in groups

- Choose a taskmaster, skeptic, explainer, and scribe.
- Locate the spreadsheet ”US Congressional Districts Geographic Data 2011 - 2019” in tinyurl.com/math115unc > week by week materials ¿ Week 3, and go to the tab for your group number, which corresponds to a particular election year.
- Compute compactness for all districts on your tab, using the Polsby-Popper and the Schwarzberg methods.
- Copy your scores for NC and MD to the summary spreadsheet linked to on canvas (or check yours against those if another group has already copied there and leave comments if you disagree).
- If time permits, discuss:
  - How do the compactness scores for NC and MD compare to the compactness scores of districts in other states?
  - How could you come up with a threshold score for Polsby-Popper or Schwartzberg scores, at which you would suspect that a district’s compactness score is suspicious? What threshold score would you pick and why?

Evaluate measures

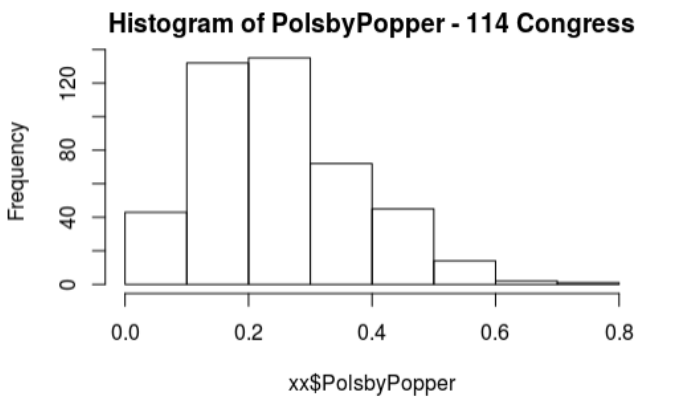
What pros and cons do you see in these methods for measuring compactness?

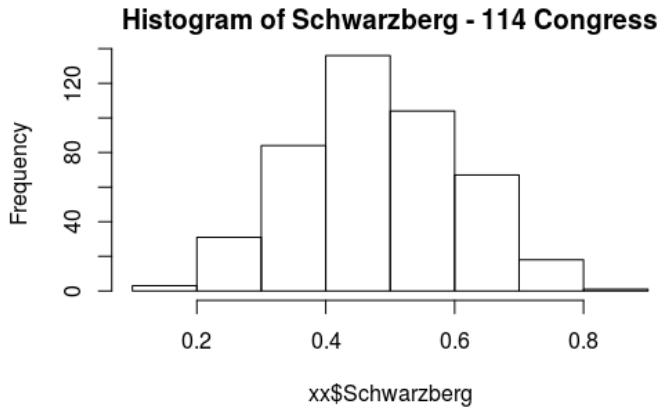
- **Polsby-Popper**: the area of a district divided by the area of a circle that has the same perimeter.

- **Schwarzberg** : the perimeter of a circle with the same area divided by the perimeter of the district.

- **Reock**: the ratio of the area of a district to the area of the smallest circle that encloses it.

- **Convex Hull**: the ratio of the area of a district to the area of its convex hull.


Histogram of PolsbyPopper - 114 Congress
Frequency
0
40
80
120
0.0
0.2
0.4
0.6
0.8
xx$PolsbyPopper


Histogram of Schwarzberg - 114 Congress
Frequency
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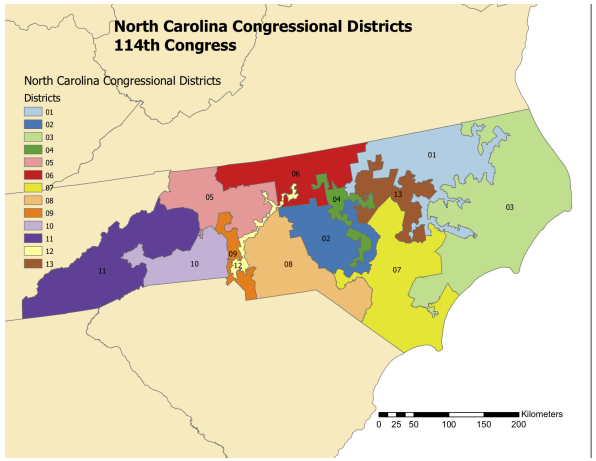
0.8
xx$Schwarzberg


North Carolina Congressional Districts
114th Congress
North Carolina Congressional Districts
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Kilometers
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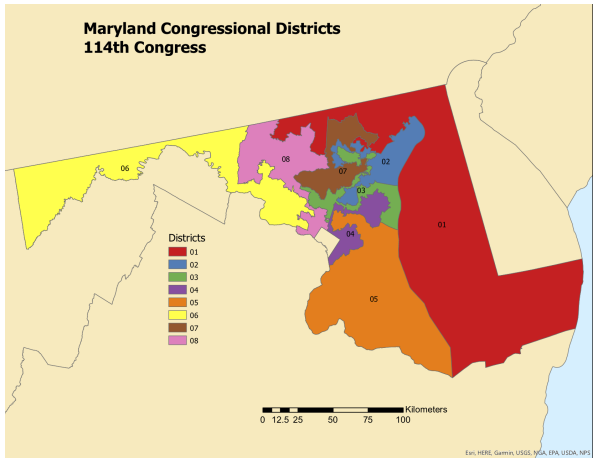
Maryland Congressional Districts
114th Congress
Districts
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Kilometers
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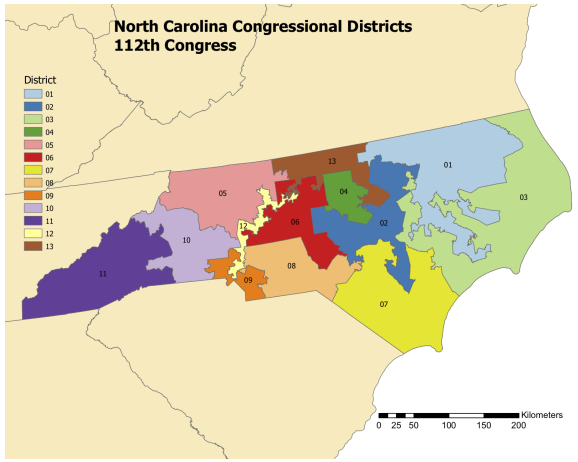
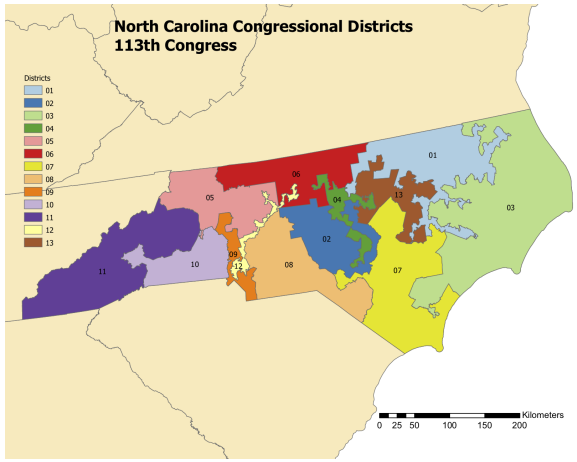
Question. If you were tasked to develop a mathematical criteria for detecting gerrymandering using compactness, what would you propose? On what basis might you pick a compactness method and a threshold score beyond which you would argue a district is gerrymandered?

Argue in court

Question. Imagine that there is a court case involving the congressional districts for either NC or MD (pick one) for the last congress (116th congress, elected 2018) and that you are called as a subject matter expert to help the judge weigh the argument for both sides. Make the case on the one hand that the districts in that state are gerrymandered. Then make the case on the other hand that they are not. You can use data on efficiency gaps and compactness, as well as bring in any additional considerations you think are relevant.


North Carolina Congressional Districts
112th Congress
District
Kilometers
0 25 50 100 150 200


North Carolina Congressional Districts
113th Congress
Districts
Kilometers
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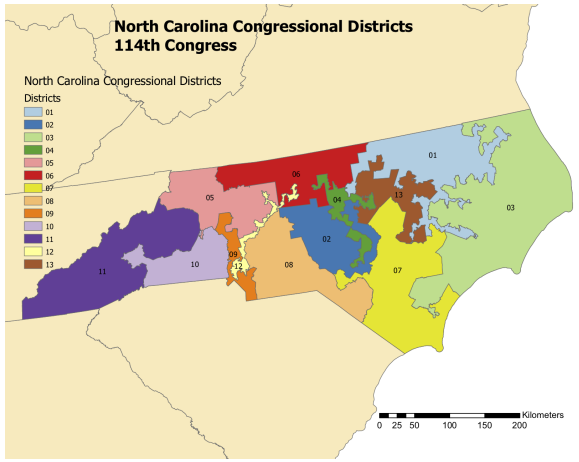
North Carolina Congressional Districts
114th Congress
North Carolina Congressional Districts
Districts
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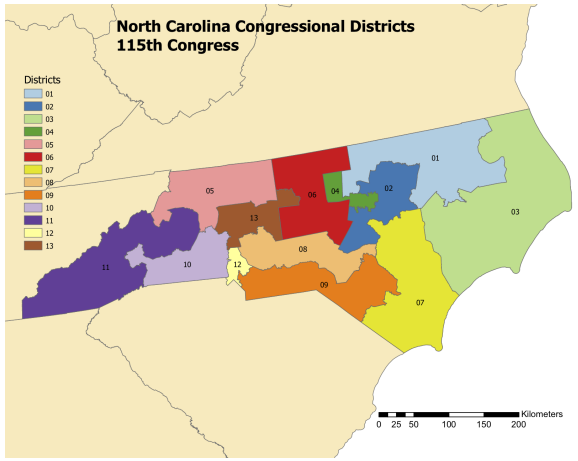
North Carolina Congressional Districts
115th Congress
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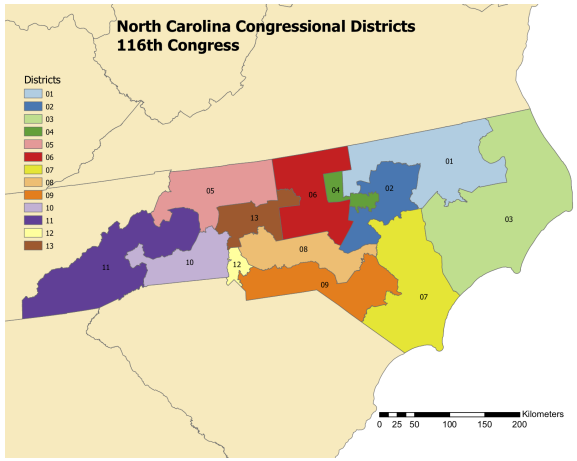
North Carolina Congressional Districts
116th Congress
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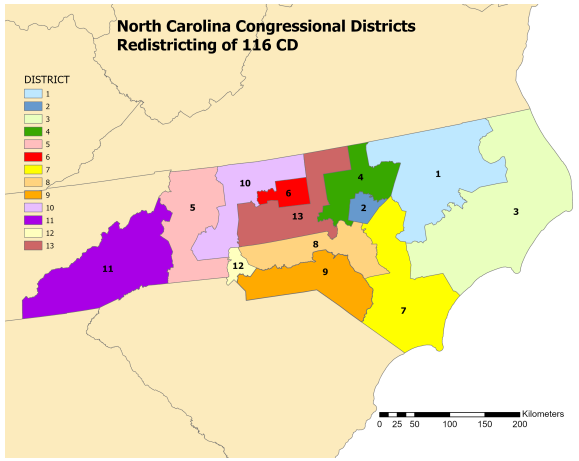
North Carolina Congressional Districts
Redistricting of 116 CD
DISTRICT
Kilometers
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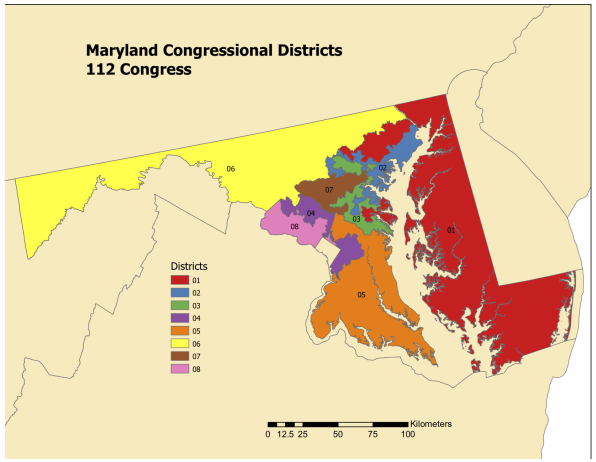
Maryland Congressional Districts
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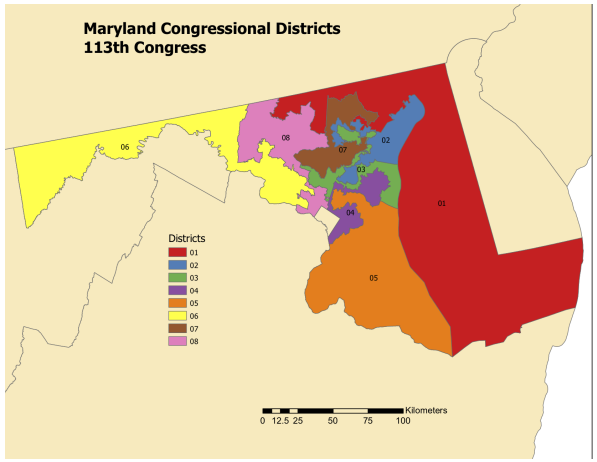
Maryland Congressional Districts
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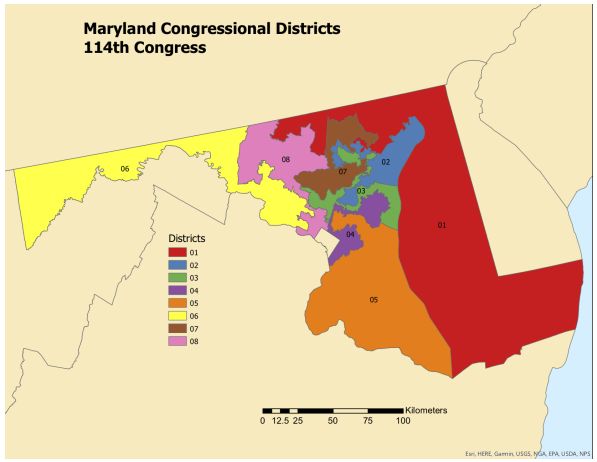
Maryland Congressional Districts
114th Congress
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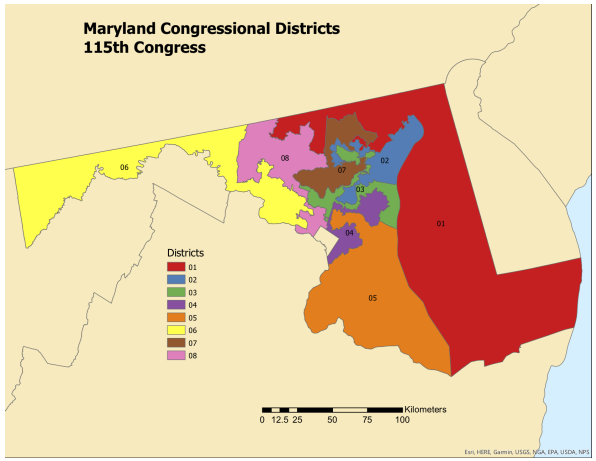
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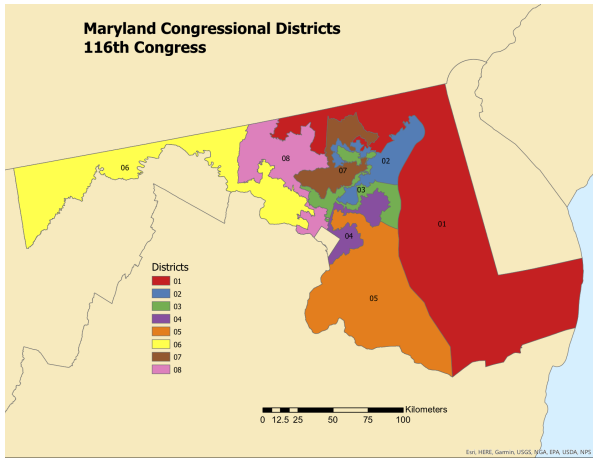
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116th Congress
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