# Washington University Math Circle: November 15, 2020

Presenter: Adeli Hutton, Mentors: Leda Liang, Moses Schindler, and Lily Xu

Welcome to the Math Circle lesson on the Mathematics of Gerrymandering!

In our first task, we'll act as partisan gerrymanders!

1) Please go to http://www.redistrictinggame.org/game.php, and select Mission 2: Partisan Gerrymander, Basic.
2) Select the party that you wish to act as a gerrymanderer for.
3) The state has four congressional seats which are currently evenly split; they are held by two Democrats and two Republicans. Work to redraw the districts to favor your chosen party to attempt to gain an additional congressional seat for them. Remember that you must retain population equality by having between 640,000 and 650,000 people in each district.
4) Once you've redrawn the districts, select "Get Feedback" and "Submit for Approval" on the left side to see if your plan gets approved by the State Legislature, Governor, and State Courts! If it doesn't pass, read their feedback, return to the map, and make some changes. Once your plan passes, select "Fast forward to the next election," and read what the editorialist has to say to say about your new plan!
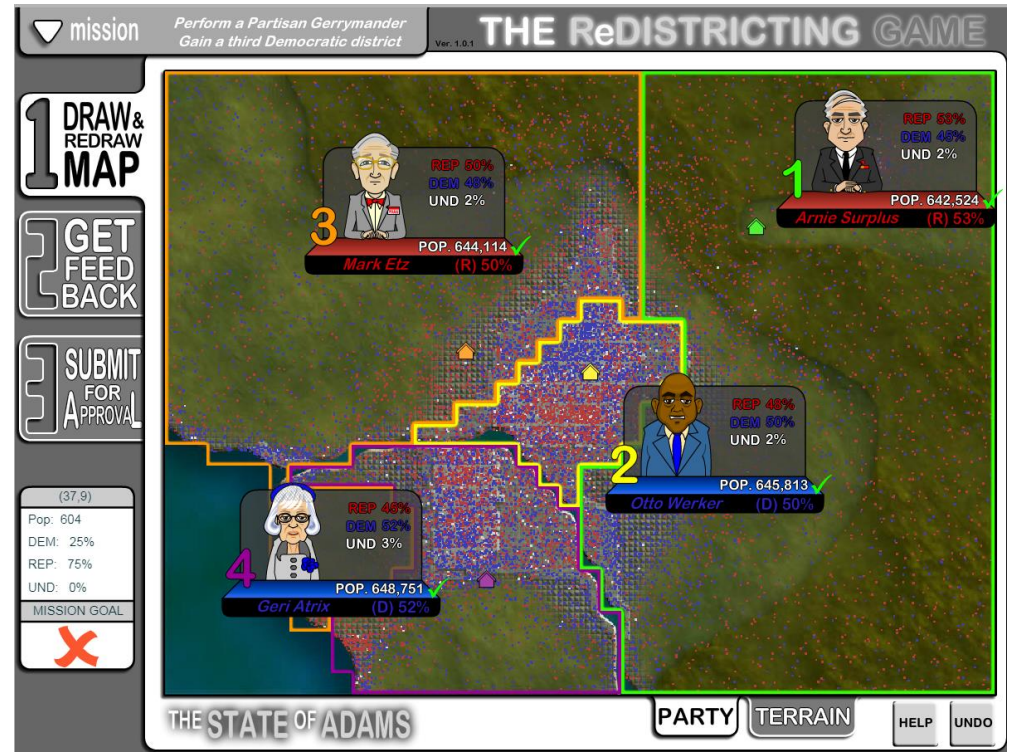
After retirement from a brief career gerrymandering districts, you became curious about the structure voting districts in Missouri. In our second task, we'll calculate the efficiently gaps of Missouri congressional districts based on the recent 2020 election data:

Missouri District	Democratic Votes	Republican Votes	Winner	Votes Needed to Win	Democratic Wasted Votes	Republican Wasted Votes
1	245,520	59,156	Cori Bush			
2	201,520	230,617	Ann Wagner			
3	115,909	282,424	Blaine Luetkemeyer			
4	107,528	245,064	Vicky Hartzler			
5	204,631	135,396	Emanuel Cleaver			
6	118,753	258,895	Sam Graves			
7	96,501	251,757	Billy Long			
8	70,504	253,646	Jason Smith			

1) Based on the 2020 Missouri US House election data above, calculate the

    (a) Votes needed for either candidate to win, for each district

    (b) Democratic wasted votes, for each district

    (c) Republican wasted votes, for each district

    (d) Efficiency gap of each district for Democrats, for each district

    (e) Efficiency gap of each district for Republicans, for each district

2) Add all of the data, and calculate

    (f) The overall efficiency gap of the state of Missouri for Democrats

    (g) The overall efficiency gap of the state of Missouri for Republicans

Based on your superb calculations analyzing voting districts in Missouri, you became nationally known as a mathematician specializing in voting district analysis! Election officials in Maryland have hired you to analyze their gerrymandered voting districts for your third task. Researchers at Towson University have gathered data for you to analyze!

1) Compute the Polsby-Popper Score of 2-4 districts of your choice. Recall that the Polsby-Popper score is the ratio between the area of the district and the area of a circle whose circumference is the same as the perimeter of the district.

2) Recall that the Reock score is the ratio between the area of the district and the area of the circumscribed circle. What additional information would you need to request from Maryland officials in order to calculate the Reock score?

3) Construct your own measure of voting district compactness. Apply it to some Maryland districts of your choice.

Maryland Congressional District Attributes

District	1	2	3	4	5	6	7	8
Area (sq. miles)	3,653	359	292	318	1,504	3,062	294	297
Perimeter (miles)	536	270	339	208	244	737	206	215
Longest Distance Across (miles)	158	52	44	40	74	138	42	58
Shortest Distance Across (miles)	1.36	0.28	0.1	0.4	5.3	3.1	1	0.45
Population (2017)	734,002	765,155	763,763	761,353	768,507	779,616	718,158	761,623
Median Income	$73,206	$68,204	$87,732	$81,151	$96,325	$79,247	$60,929	$100,953
Cook Partisan Voting Index**	R+14	D+11	D+13	D+28	D+16	D+6	D+26	D+14
Number of Counties Included	11	5	5	4	4	6	2	3