

Test 2A, Math of Democracy

Dr. Adam Graham-Squire, Fall 2018

Name: _____

I pledge that I have neither given nor received any unauthorized assistance on this exam.

(signature)

DIRECTIONS

1. Don't panic.
2. **Show/explain all of your work.** A correct answer with insufficient work will lose points.
3. Read each question carefully, and make sure you answer the the question that is asked. If the question asks for an explanation, make sure you give one.
4. Clearly indicate your answer.
5. Calculators are allowed on this test, but any other technology (cell phones, computers, etc) is NOT allowed.
6. Make sure you sign the pledge.
7. Number of questions = 5. Total Points = 25.

1. (5 points) Consider the following table of data from a recent election in a state, and answer the questions below.

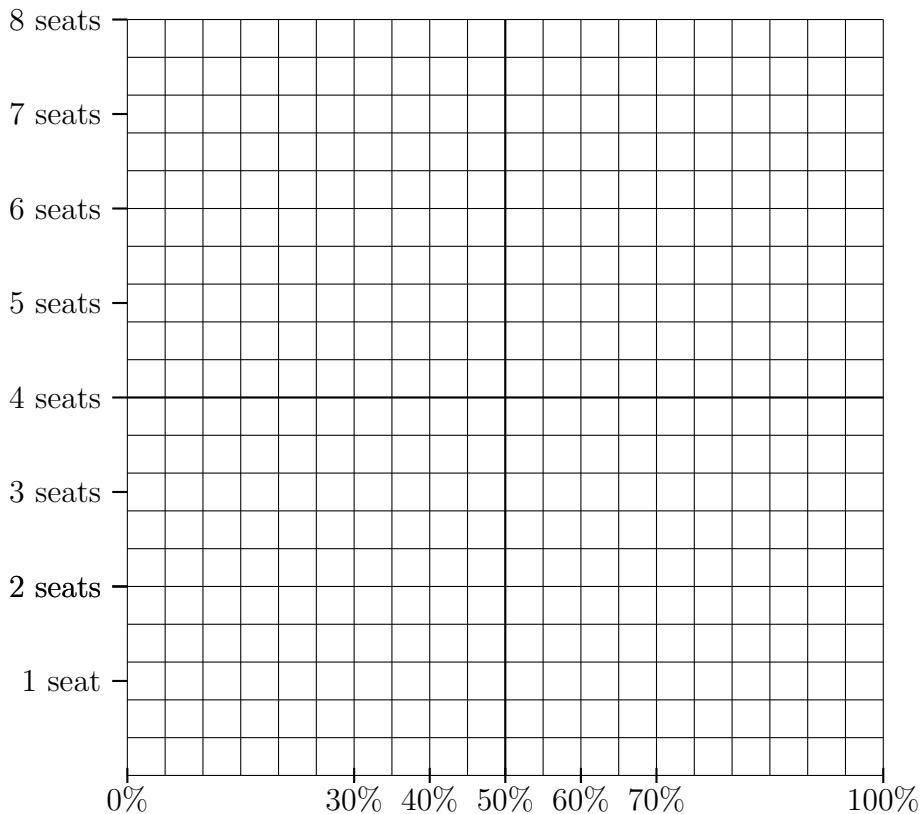
District	% Democrat	% Republican
1	49	51
2	25	75
3	57	43
4	47	53
5	59	41
6	62	38
7	44	56
8	18	82

- (a) What is the percentage of Democrats, overall, in the state (assume that each district has an equal population)? How many districts did Democrats win in the election?
- (b) What is the uniform partisan shift (from Republicans to Democrats) that would need to occur for Democrats to *win* one more district? If that shift occurred, what would be the new percentage, overall, for Democrats in the state? Explain/show your work.
- (c) What is the uniform partisan shift (from Democrats to Republicans) that would need to occur for Democrats to *lose* one more district? If that shift occurred, what would be the new percentage, overall, for Democrats in the state? Explain/show your work.

2. (5 points) In question 1 you effectively calculated three points for a partisan symmetry graph for the state. The remaining points are below (you do NOT have to calculate these):

- When the Democrats have 38.2% of the overall vote, they drop from winning 2 districts to only win 1 district.
- When the Democrats have 36.4% of the overall vote, they drop from winning 1 district to winning no districts.
- When the Democrats have 48.2% of the overall vote, they increase from winning 4 districts to winning 5 districts.
- When the Democrats have 51% of the overall vote, they increase from winning 5 districts to winning 6 districts.
- When the Democrats have 63.4% of the overall vote, they increase from winning 6 districts to winning 7 districts.
- When the Democrats have 66.5% of the overall vote, they increase from winning 7 districts to winning 8 districts.

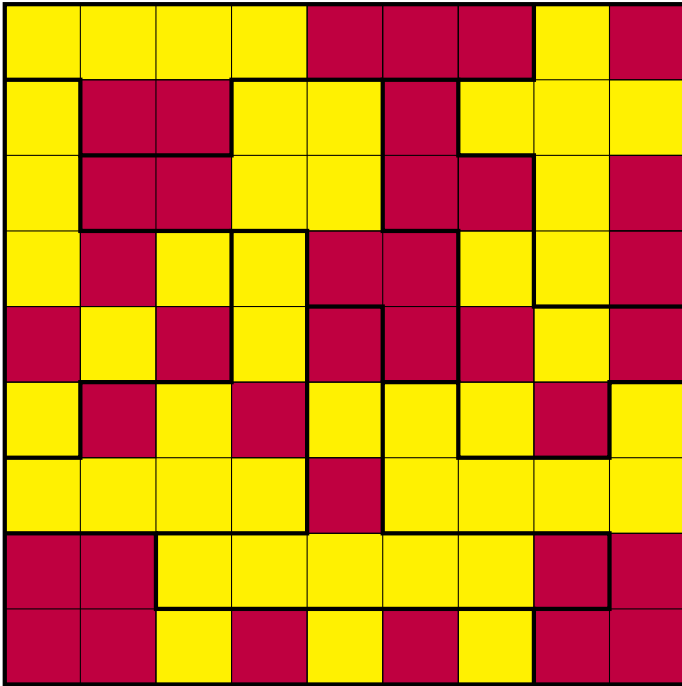
Plot the data above, and the data from question 1, to draw the partisan symmetry graph with Democrat vote % on the x -axis and Democrat seats on the y -axis.



Answer the question about the partisan symmetry graph on the next page.

Does your partisan symmetry graph indicate that the state has been gerrymandered? If so, in favor of which party? Use information from the graph to support your conclusions.

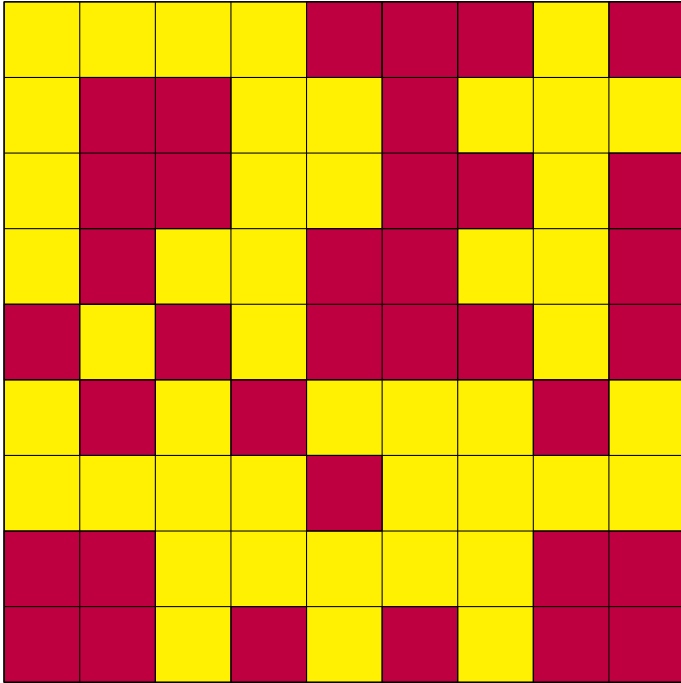
3. (5 points) Consider the following state of Squaretopia below, with 36 Red squares and 45 yellow squares. Suppose that the state has been districted into the 9 districts on the map.



- (a) Do the districts seem fair? Why or why not?

This question is continued on the next page.

- (b) Below is the same squaretopia as in question 3. Choose one party (either red or yellow) and try to draw relatively compact districts that favor your chosen party (at least, favor them *more* than the districts given above). In other words, try to gerrymander the state in favor of one party, but do it in a way where you are trying to draw districts that are relatively compact.



4. (5 points) (a) Calculate the efficiency gap for the district map you drew (assume there are 100 voters in each square).

(b) Choose the two districts in the original map that you consider to be the *least* compact, and calculate the Isoperimetric (Square Polsyb-Popper) score for one of them and the Square Reock score for the other.

(c) Compare your results from questions (a) and (b). What do your answers above indicate about how useful compactness and efficiency gap are at detecting gerrymandering?

5. (5 points) At the heart of gerrymandering may be an “impossibility” theorem, in the sense that some desirable traits for a district map may not be compatible with another. That is, it may be impossible to create a perfect district map for a given state.

(a) Choose two of the aspects below and explain why they may be incompatible.

(b) Choose two of the aspects below and explain why they CAN be compatible.

- Compactness
- Efficiency Gap
- Proportionality (of votes to seats)
- Partisan symmetry
- Competitiveness of districts
- Ensuring that minority populations have some representation
- Having a map that is not an Outlier.

Your answer should be thorough and (if possible) use examples to illustrate your argument.

Extra Credit(1 point) Outlier methods are not just used in regard to gerrymandering and redistricting. Give another example where an outlier method is used to ascribe validity (or lack thereof) to something.

Formulas:

1 Compactness measures in Squaretopia

- Skew measure: W/L
- Isoperimetric (Square Polsby-Popper) measure: $16A/P^2$
- Square Reock measure: A/S

2 Real-world Compactness Measures

- Harris: W/L
- Polsby-Popper: $4\pi A/P^2$
- Reock: A/C

3 Efficiency Gap Formulas

- $EG = \frac{W_A - W_B}{\text{total votes}}$
- $EG = 2V - S - \frac{1}{2}$