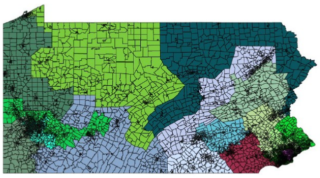
How Math Can Save Democracy

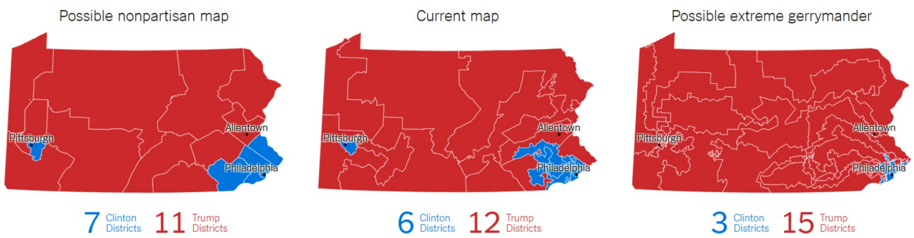
Can Math Solve the Gerrymandering Problem?



1. What kind of 2018 maps are you looking at?

a. Which state do they represent? Pennsylvania.

b. What is each map's relation to the gerrymandering problem? Justify.

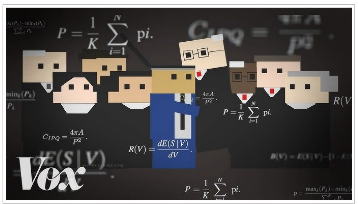


2. As a mathematician, what could you do to prove a case of partisan gerrymandering?

a. Which data, criteria or parameters would you study to evaluate the degree of partisan gerrymandering of a particular map and its impact on elections?

b. Would you imagine particular equations to prove or to account for the phenomenon of partisan gerrymandering?

3. Watch *Vox*'s video about "The algorithm that could help end partisan gerrymandering" (00:00-02:10) and answer the following questions.



a. Why is it so difficult for the Supreme Court to rule against gerrymandering? In other words, why do they need mathematicians? The Supreme Court has yet to settle on a standard or definition of political fairness. They just simply don't want to declare a partisan gerrymandering without some way to measure them. They need mathematicians to build a measurement tool to help the Court measure whether political parties have manipulated a map to gain an unfair advantage – a gerrymandering ruler. The court wants to be able to determine the intent behind the district maps that were drawn – they want to read the minds of the map drawers.

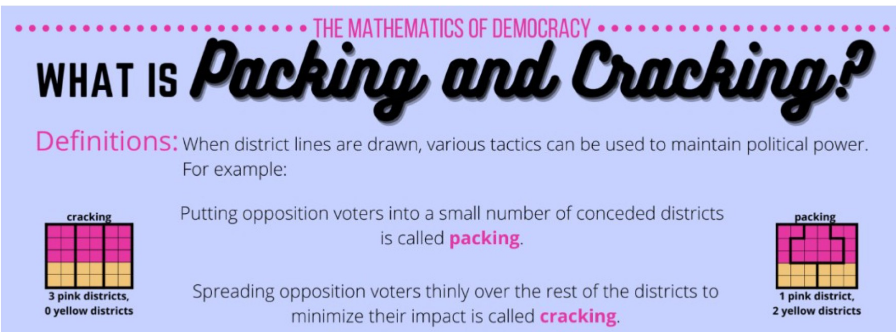
b. What is the mathematicians' strategy to prove a partisan gerrymandering? First mathematicians identified what criteria are important to the Court. Then they use a supercomputer to generate district maps based on those criteria. They create a billion maps using only the criteria required by law and the traditional districting principles – no political information (nonpartisan). If the current map doesn't look like any of the possibilities generated by the algorithm, that's a good indication a partisan gerrymander has occurred.

c. What criteria are they taking into account? The criteria are : population equity (about the same number of people in every district) ; contiguity and compactness (they can't be broken up into a bunch of pieces) ; traditional districting principles (political subdivisions, such as cities, counties, municipal boundaries or identifiable communities of like-minded individuals, should be preserved).

4. Now that you gathered more information, consider question 2 again.

a. What specific data and figures would you analyze to account for the various criteria? What relations would you pay attention to through equations?

b. To go further in your hypotheses and attempt to design a precise equation, you may have a look at the "GM-Clue" document on Célène.



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THE MATHEMATICS OF DEMOCRACY

WHAT IS *the Efficiency Gap?*

Wasted votes are those that do not affect an election: either votes above the 50% majority threshold for a winning candidate or any for a losing candidate. The **efficiency gap (EG)** is one method for measuring gerrymandering by adding up the wasted votes of each party's candidates over all electoral districts.

$$EG = \frac{|\text{(one party's wasted votes) - (other party's wasted votes)}|}{\text{total number of votes}}$$

THE MATHEMATICS OF DEMOCRACY

WHAT IS *Polsby-Popper Compactness Score?*

We can try to quantify gerrymandering by measuring how "reasonably shaped" a voting district is. The **Polsby-Popper Compactness Score** of district S, PP(S), measures how much "unnecessary" perimeter S has.

$$PP(S) = 4\pi \frac{\text{area enclosed by the district}}{(\text{perimeter of the district})^2}$$

If there is too much perimeter for the area, PP(S) is closer to 0.

If there is a small amount of perimeter for the area, PP(S) is closer to 1.

If PP(s) is close to 0, this indicates that the district might have been gerrymandered.

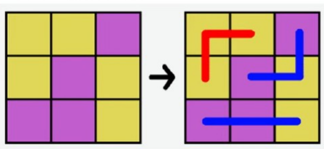
5. Do you think about other instances of data manipulation that math can help with (whether on the dark side or on the light side)?

6. Are you a genius at gerrymandering?

Try and solve Alex Bellos's gerrymandering puzzles.
If you are lost, your partner may look at the solution for the second puzzle on Célène and give you directions.

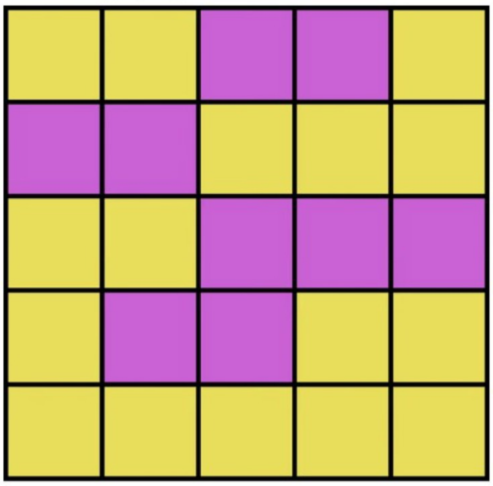
Example

Divide the grid into 3 regions of 3 cells each. Purple, the minority colour, must win the majority of the regions.



Puzzle 1: Easy

Divide the grid into 5 regions of 5 cells each. Purple, the minority colour, must win the majority of regions.



Puzzle 2: Medium

Divide the grid into 5 regions of 10 cells each. Purple, the minority colour, must win the majority of regions. No ties allowed in any region.