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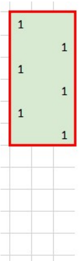
Ethics in Computer Science

11/5/20 – Homework

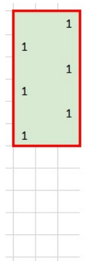
Gerrymandering Exploration

0) We spent some time experimenting with the excel file. As we explored, we determined that if 1/3 third of the voters were 1's, we can optimize the likelihood of giving them 0 districts (compared to 2 districts) by spreading them out as much as possible. We found that lining the 1's up on opposite sides, but alternating rows, was the configuration most likely to result in 0 districts. The second most likely configuration we found to result in 0 districts was to line the 1's up in diagonals. To illustrate this, we've included some examples from the spreadsheet below:



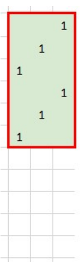
Number of plans in which 1 wins...		Percentage:
0 districts:	86	51%
1 districts:	66	39%
2 districts:	18	11%
3 districts:	0	0%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

Scenario 1



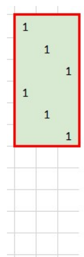
Number of plans in which 1 wins...		Percentage:
0 districts:	86	51%
1 districts:	66	39%
2 districts:	18	11%
3 districts:	0	0%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

Scenario 2



Number of plans in which 1 wins...		Percentage:
0 districts:	70	41%
1 districts:	78	46%
2 districts:	22	13%
3 districts:	0	0%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

Scenario 3

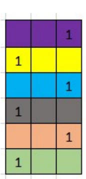


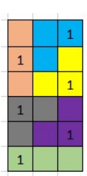
Number of plans in which 1 wins...		Percentage:
0 districts:	70	41%
1 districts:	78	46%
2 districts:	22	13%
3 districts:	0	0%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

Scenario 4

1) Each scenario above is an example in which 1/3 of the voters are 1's. So, any districting plan in which the 1's win no districts satisfies this condition. Given scenarios 1 or 2, there are 86 possible methods for ensuring that 1's win no districts.

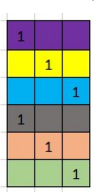
For example…

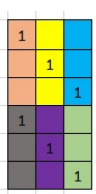




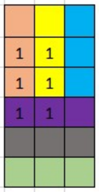
Similarly, given scenarios 3 or 4, there are 70 possible methods for ensuring that 1's win no districts.

For example…



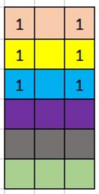


2) Before attempting this question, we first experimented to determine the configuration that maximized the likelihood of the 1's winning 3 districts. We found that grouping them in a rectangle located as close as possible to the center of the state led to 30 different scenarios in which the 1's could win 3 districts. We found it surprising that grouping the 1's in a rectangle made it more likely for them to win 3 districts. Intuitively, it seemed like grouping them in a rectangle should make it easier to pack them together when drawing district lines. We expected this would result in less configurations in which the 1's could win 3 districts. To illustrate this, we've included some examples from the spreadsheet below:



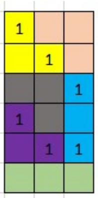
Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	34	20%
2 districts:	106	62%
3 districts:	30	18%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

UPDATE: We found a new configuration that maximizes the number of scenarios in which the 1's can win 3 districts:



Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	0	0%
2 districts:	109	64%
3 districts:	61	36%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

We also searched for a configuration and corresponding scenario in which the 1's win three districts despite it being very unlikely. The configuration and scenario below should raise some eyebrows:



Number of plans in which 1 wins...		Percentage:
0 districts:	44	26%
1 districts:	89	52%
2 districts:	36	21%
3 districts:	1	1%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

3) We determined that we can make it impossible for the 1's to win more than 1 district by grouping three 1's together (e.g. in a corner of the state), and dispersing the other 1's such that it is impossible for them to be part of any winning district. To illustrate this, we've included an example from the spreadsheet below:

1	1	
1		
		1
1		
		1

Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	170	100%
2 districts:	0	0%
3 districts:	0	0%
4 districts:	0	0%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

4) Given a 50/50 split of voters, we found that we found that it was most advantageous to either party to draw district lines that orphaned the opposing parties' cells to the greatest degree possible. To illustrate this, we've included an example from the spreadsheet below.

	1	1
1	1	
	1	1
	1	
	1	1

Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	0	0%
2 districts:	10	6%
3 districts:	64	38%
4 districts:	96	56%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

We have a working conjecture that configurations with more symmetry are harder to gerrymander, but we have not yet proven it. Some examples to illustrate this are included below:

1	1	1
1	1	1
1	1	1

Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	0	0%
2 districts:	30	18%
3 districts:	110	65%
4 districts:	30	18%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

1		
1		
1		
1	1	
1	1	
1	1	

Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	0	0%
2 districts:	25	15%
3 districts:	120	71%
4 districts:	25	15%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

The configuration we found hardest to gerrymander in either direction is shown below:

1	1	1
1	1	1
1	1	1

Number of plans in which 1 wins...		Percentage:
0 districts:	0	0%
1 districts:	0	0%
2 districts:	3	2%
3 districts:	164	96%
4 districts:	3	2%
5 districts:	0	0%
6 districts:	0	0%
TOTAL PLANS:	170	100%

Closing Thoughts:

-In the process of completing this activity, a lot of our exploration centered around adjusting the location of the 1's and 0's, significantly more than adjusting the district lines. However, in reality, the location of the 1's and 0's would be based on the locations in which voters live. Gerrymandering, on the other hand, is about how the district lines are drawn.

-We are still trying to figure out how to explore this with code. Some initial thoughts include…

Thought 1: First, generate a list containing all possible partitions in which the state is divided into groups of three cells. Next, run through each partition to check if there are any orphaned cells. If there are no orphaned cells in a given partition, that means all districts are contiguous, and we keep partition. If there are any orphaned cells, that means that there is at least one noncontiguous district, and we should throw out the partition.

Thought 2: Since there are only 170 partitions, manually generate a list of all possible partitions.

Thought 3: See KtS below: