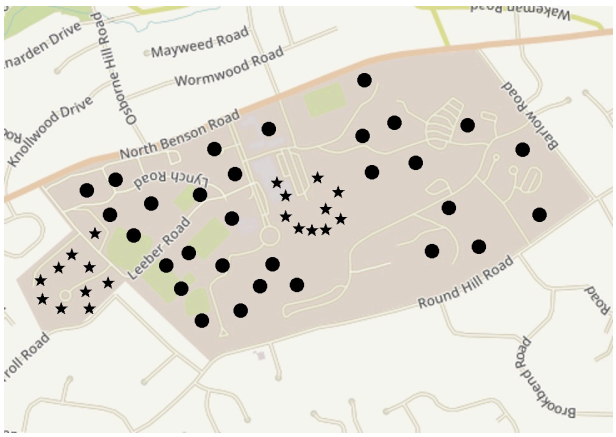


50 ★ & ●,

20 ★'s, 30 ●'s

Make 5 districts of 10 each.

What are the possible outcomes?

~~5 ★ / 0 ●~~

~~4 ★ / 1 0~~

3 ★ / 2 0 ← possible.

2 ★ / 3 0 } possible.

1 ★ / 4 0

0 ★ / 5 0

We have 30 ●s, 20 ★s, each district has 10 voters.

Threshold to win is 6 per district.

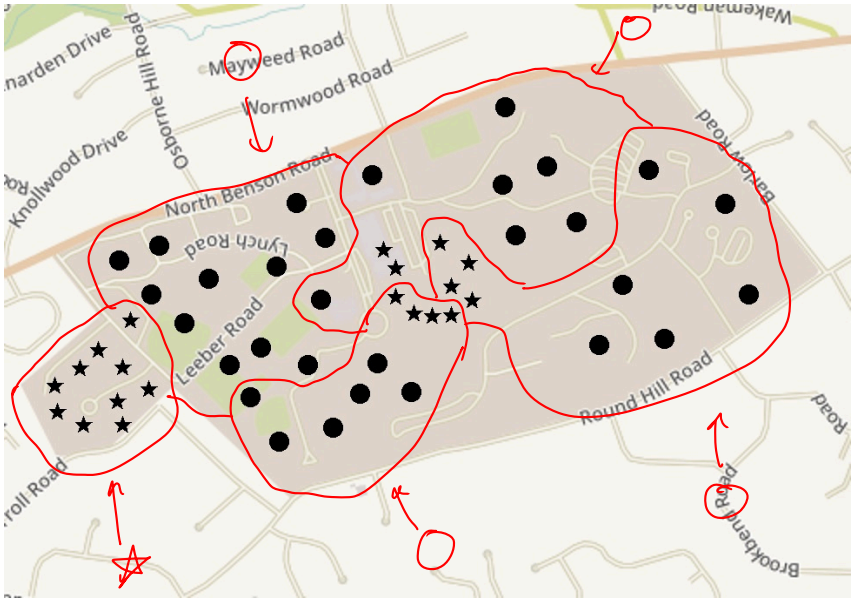
To win 5 districts, we'd need $6 \times 5 = 30$ voters.

So ★ can't win all 5.

To win 4, they need $6 \times 4 = 24$

So ★ can't win 4.

Draw the possible ones:

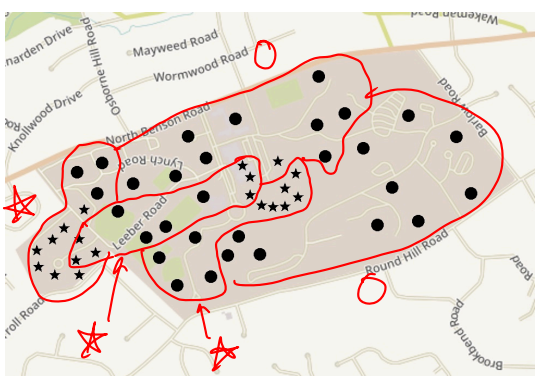


1★, 4●s.

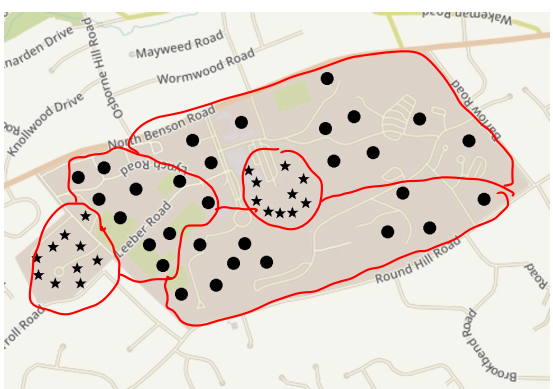
Pack the 1.

Crack the rest

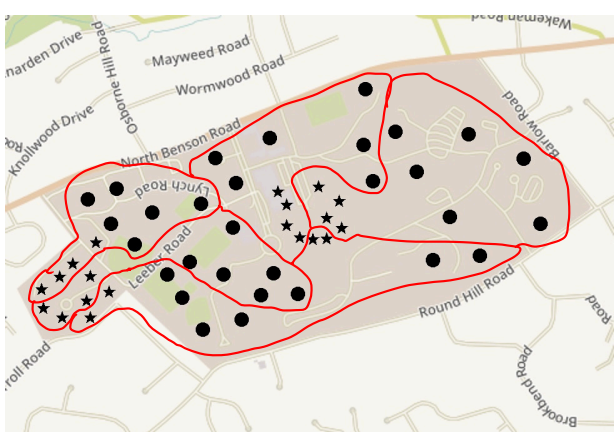
3★/20



2★/30



0★/50

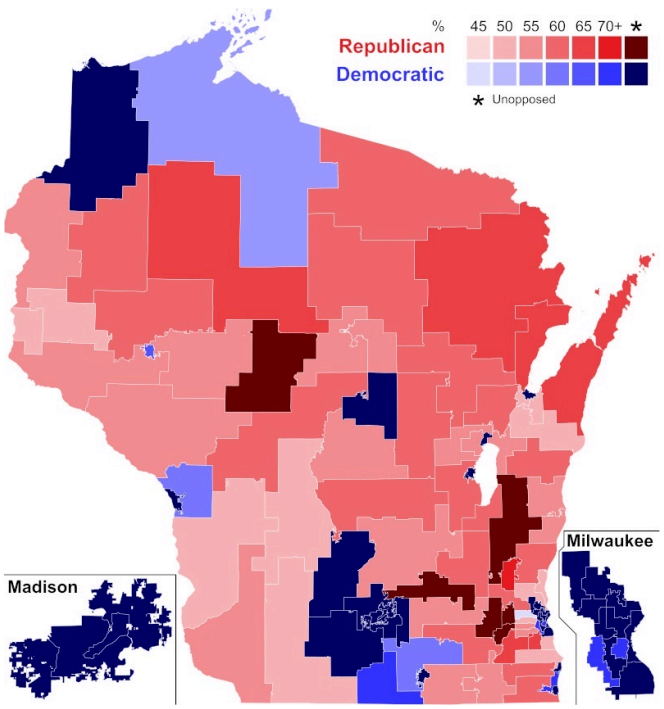


Drawing weird lines is very powerful.

How can we detect if the lines are being manipulated for partisan reasons?

mathematical measures of Gerrymandering.

- Try to measure geometrically how weird the shapes are.
- Try to numerically detect packing



2018 WI State Congress

Generally, blue districts are dark blue, red ones are light red.

53% of voters in WI voted for Dems. (blue)

The reps went:

63 R

33 D.

We have a way of measuring if many votes from one party are packed together

Lots of those votes are "wasted"

Counted by The Effiency Gap

Def A wasted vote is one which doesn't contribute to the winner's win.

Any vote for the loser is wasted.

Any vote for the winner beyond the threshold is wasted.

Ex1 In a district with 100 voters,

say D: 47 How many are wasted?

(R): 53.

D's all voted for loser, so they are all wasted.

D's wasted 47.

Threshold here is 51 ← (divide # of voters by 2, plus 1)

so R's wasted 2.

How about in

D: 97

R: 3

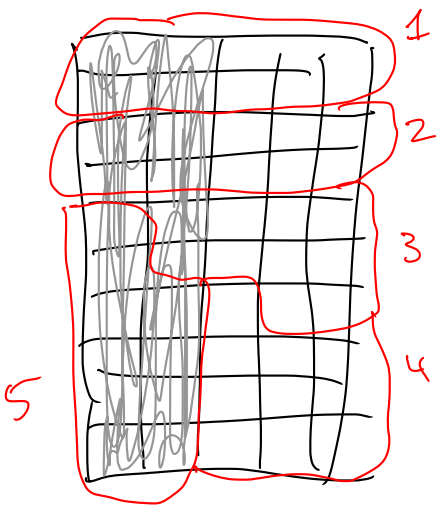
D's wasted : 46 ← 97 - 51

R's wasted : 3

In an even district, loser wastes a lot, winner wastes a little.

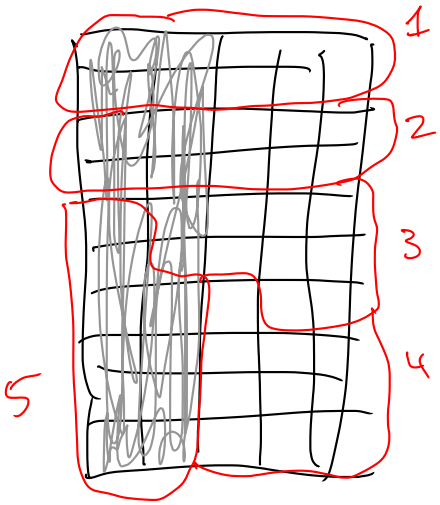
In a packed district, loser wastes a little, winner wastes a lot.

We can tell the difference by counting wasted votes!



In each district, count the wasted votes

D vs L



district	D	L	total	thresh	D wasted	L wasted
1	4	6	10	6	4	0
2	4	6	10	6	4	0
3	2	8	10	6	2	2
4	0	10	10	6	0	4
5	10	0	10	6	4	0
			50		14	6

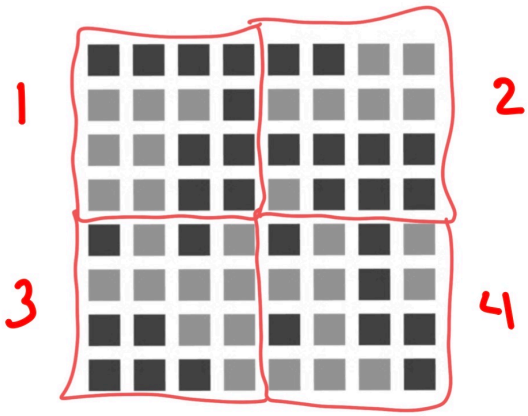
The Efficiency Gap (EG) is:

$$\frac{14-6}{50} = \frac{8}{50} = .16 = 16\%.$$

in favor of L's

Thursday 1PM Library

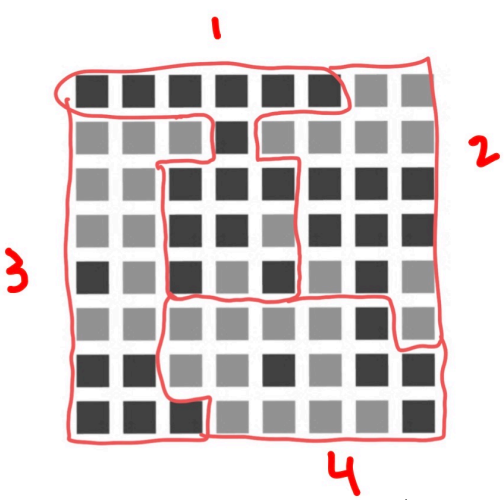
Lunch @ 12:45



Find the EG.

	D	L	Totals	thresh	D wasted	L wasted
1	9	7	16	9	0	7
2	9	7	16	9	0	7
3	7	9	16	9	7	0
4	7	9	16	9	7	0
			64		14	14

The EG is $\frac{14-14}{64} = 0$



	P	L	Total	thresh	D wasted	L wasted
	14	2	16	9	5	2
2	7	9	16	9	7	0

3	6	10	16	9	6	1
4	5	11	16	9	5	2
			64		23	5

The EG is $\frac{23-5}{64} = 28\%$

in favor of L.