

Efficiency Gap

A statistical measure of packing

It's all about counting "wasted votes"

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

Any vote for the loser counts as wasted
Any vote for the winner beyond the threshold counts as wasted.

Ex
In a district with 100 voters, if they vote:

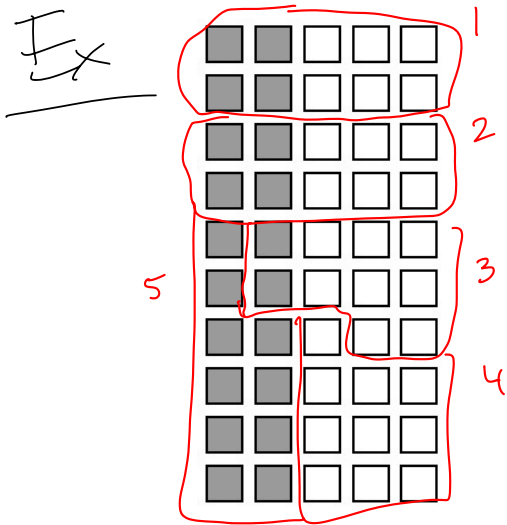
D: 47 ← all wasted D wasted 47
Ⓜ R: 53 ← 51 is the threshold, R's wasted 2.
R's got 2 extra

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

If it's packed:

D: 97 ← 46 extra votes beyond 51, so D wasted 46
R: 3 ← loser wastes all R wasted 3.

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



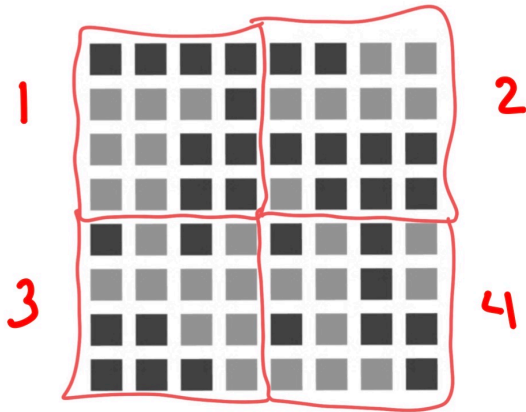
Count all wasted votes per district

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 is $\frac{14-6}{50} = \frac{8}{50} = 0.16 = 16\%$

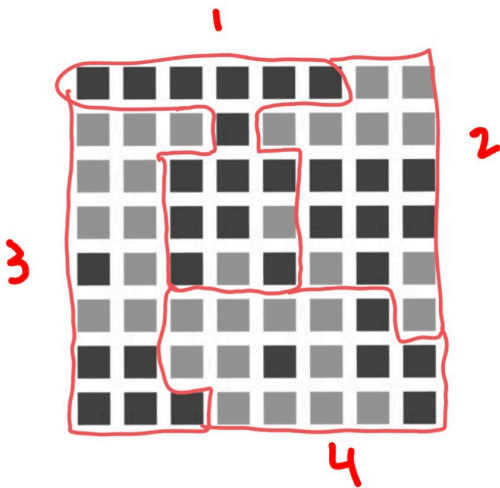
The answer is $\frac{(X \text{ wasted}) - (Y \text{ wasted})}{(\text{total total of votes})}$

In favor of L's (D's wasted more)



	D	L	total	flues	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

$$E6 = \frac{14 - 14}{64} = 0 \%$$



	D	L	total	thresh	D wasted	L wasted
1	(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
			<u>64</u>		<u>23</u>	<u>5</u>

EG is $\frac{23-5}{64} = \frac{18}{64}$ in favor of L

Find EG for CT reps in 2020

	D	R	Total	thresh	D wasted	R wasted
1	(223)	122	345	173	50	122
2	(218)	140	358	180	38	140
3	(203)	138	341	171	32	138
4	(224)	131	355	178	46	131
5	(192)	152	344	173	21	152
			<u>1743</u>		<u>187</u>	<u>683</u>

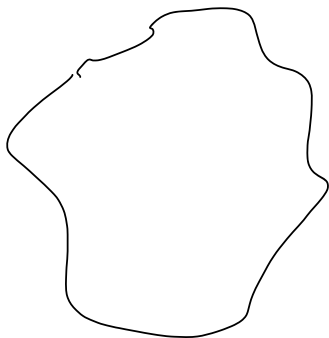
EG is: $\frac{683 - 187}{1743} = \frac{496}{1743} \sim 28\%$

EG is statistically useful when
there are many districts, and outcomes
per-district are varied

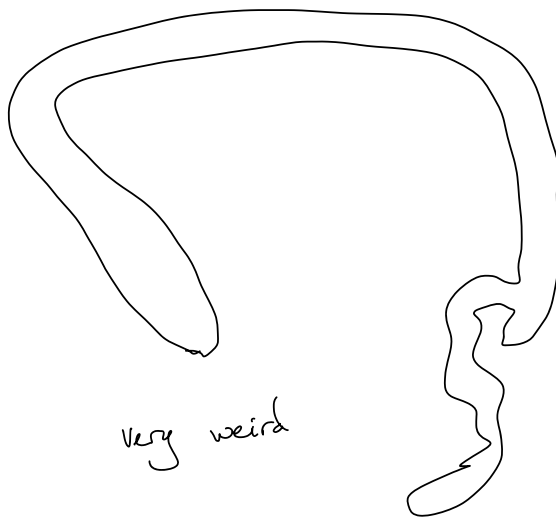
IG at the US Supreme Court

John Roberts: "gobbledigook"

2 geometric measures of
how weird the shapes are.



not so weird



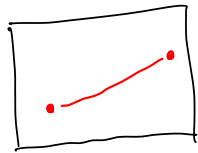
very weird

Mathematical measures of
weirdness or wigglyness

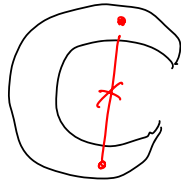
- convex hull ratio
- isoperimetric quotient.

Convex Hull Ratio

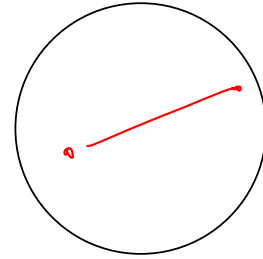
Convex: A set is convex when the straight line connecting any two points lies entirely within the set.



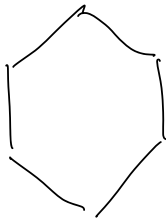
is convex



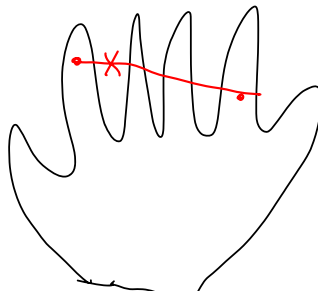
not convex.



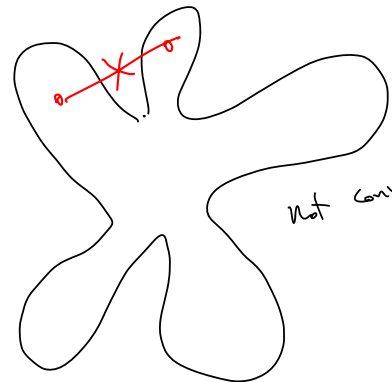
is convex



is

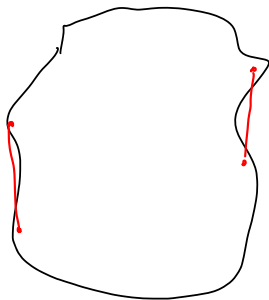


is not



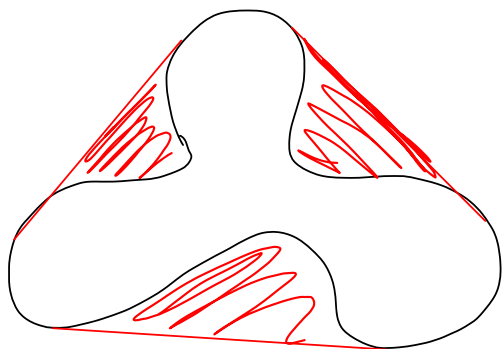
not convex.

Most real-world shapes are not convex



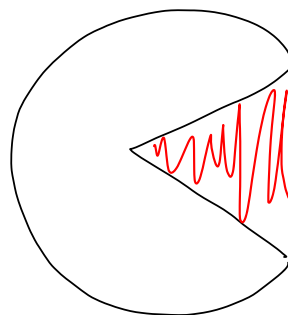
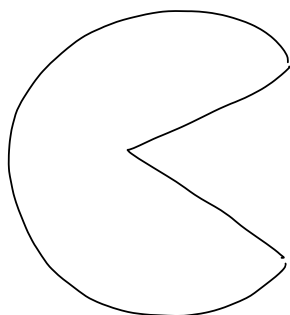
this is close to convex,

Any shape can be "filled in" to make it convex using straight line segments.

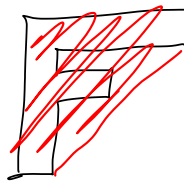


Now it is convex.
The new shape is
the convex hull
of the original.

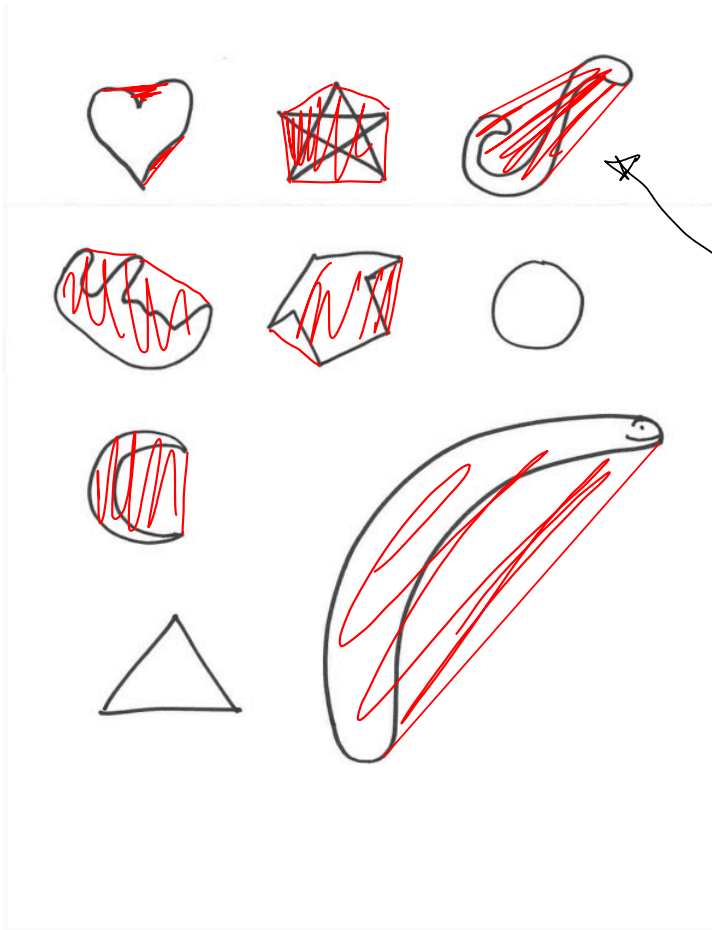
Same as if you wrap a rubber band around
the original shape.



convex hull



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For a nice shape,
the original is the
same as the hull.

For a wormy,
the hull is much
bigger.