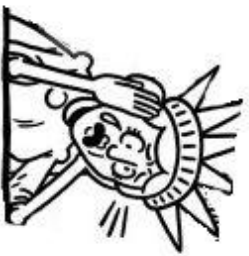# Three Tests to Detect Partisan Gerrymandering

Samuel S.-H. Wang, Princeton University

Presented by Julian Vanecek

Gov. Elbridge Gerry + Salamander = Gerrymander

- 1812 by the Boston Gazette
- Gov. Elbridge Gerry re-drew Massachusetts
- Favours Democrat-Republicans over Federalist party.
- District resembled Salamander
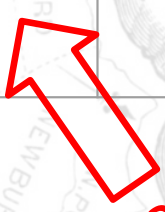- Process existed since 1705

Cartoon of South Essex

	Federalist	Democrat-Republicans
1812 State-Wide	51%	49%
1812 Seats Won	11	29
Support in Winning Districts	71%	56%
1813 State-Wide	56%	44%
1813 Seats Won	29	11

Gerry's Boys

This paper applies these methods to district seat results between 1812 - 2010
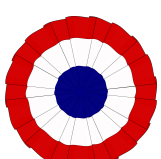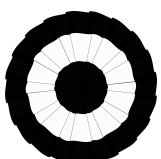
Violates Spirit of Constitution

"Packing voters into districts based on their partisan affiliation [infringes upon] the right to **public self-expression**, or **freedom of speech**. "

+ "chilling of partisan choice [infringes upon] **freedom of association**."

= **discrimination**.

- GM is judiciable since 1986 with Davis and Bandemer
- But there hasn't been a way to prove in court that Gerrymandering has occurred. (Except in Vieth vs. Jubelierer Supreme Court case 2004, showed GM unconstitutional)
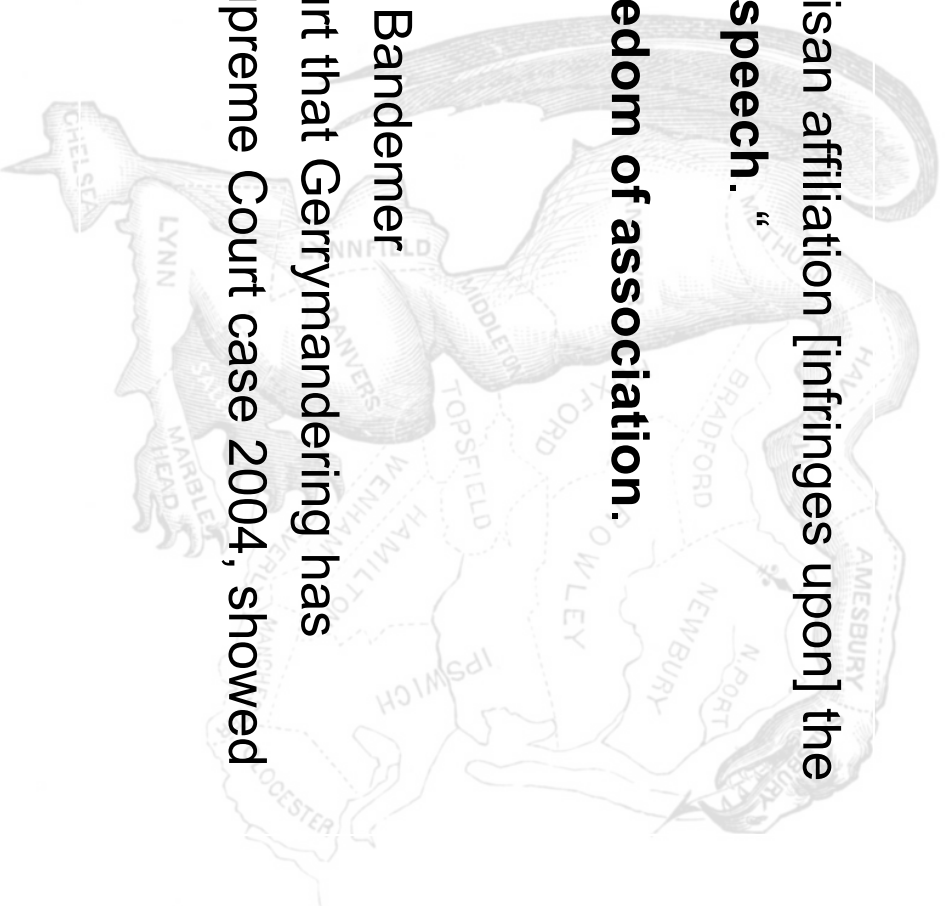
Easier than ever to gerrymander because:

- the Big Sort
  - Similar geographic region <=> Similar politics
  - Urban Concentration
- more detailed data
  - Good census data
- computer-based districting
  - Politicians don't have to do the math
  - Pretty optimal
- single-party rule
  - Party in power makes the choices
- X-treme Bipartisanship

Dave's Redistricting App

Software exists to gerrymander based on **your input parameters**, with **real census data**.
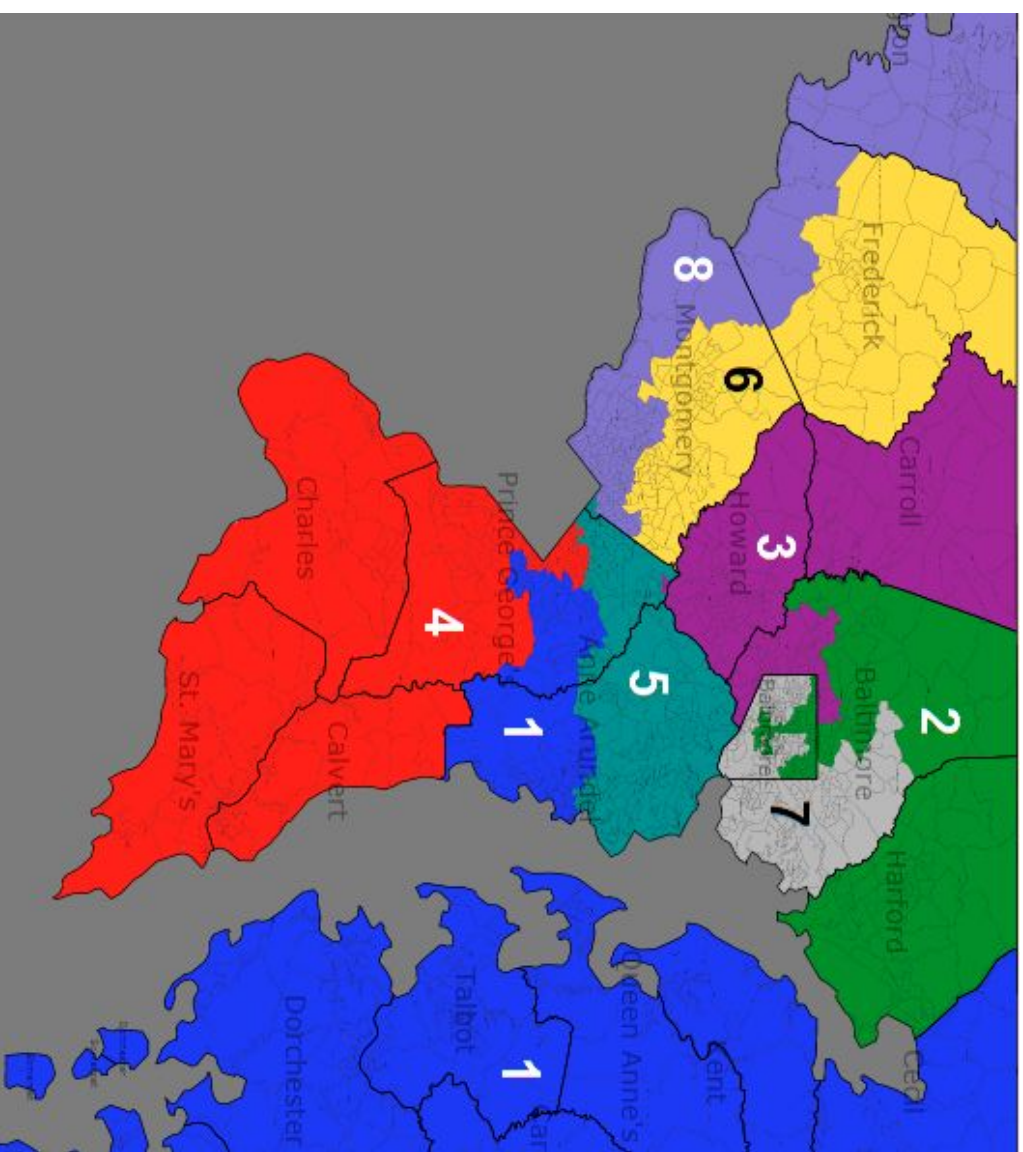
For all states but Alaska

This is an example Dem. Gerrymander (8 - 0)

Only works with **Internet Explorer** (Dave is a Microsoft guy)

http:// swing state project .com/

Proposed Minimum Qualities for a Standard to Avoid Crassly Anti-Majoritarian Outcomes

(1) be based on the general concept of partisan symmetry

(2) NOT lazily use geographic boundaries or districting procedures

(3) NOT use election results for offices other than the ones that are in dispute

(4) can clearly state without case-specific or mathematics-intensive assumptions, to allow courts to instruct experts on how and where to apply more detailed mathematical or other analysis.
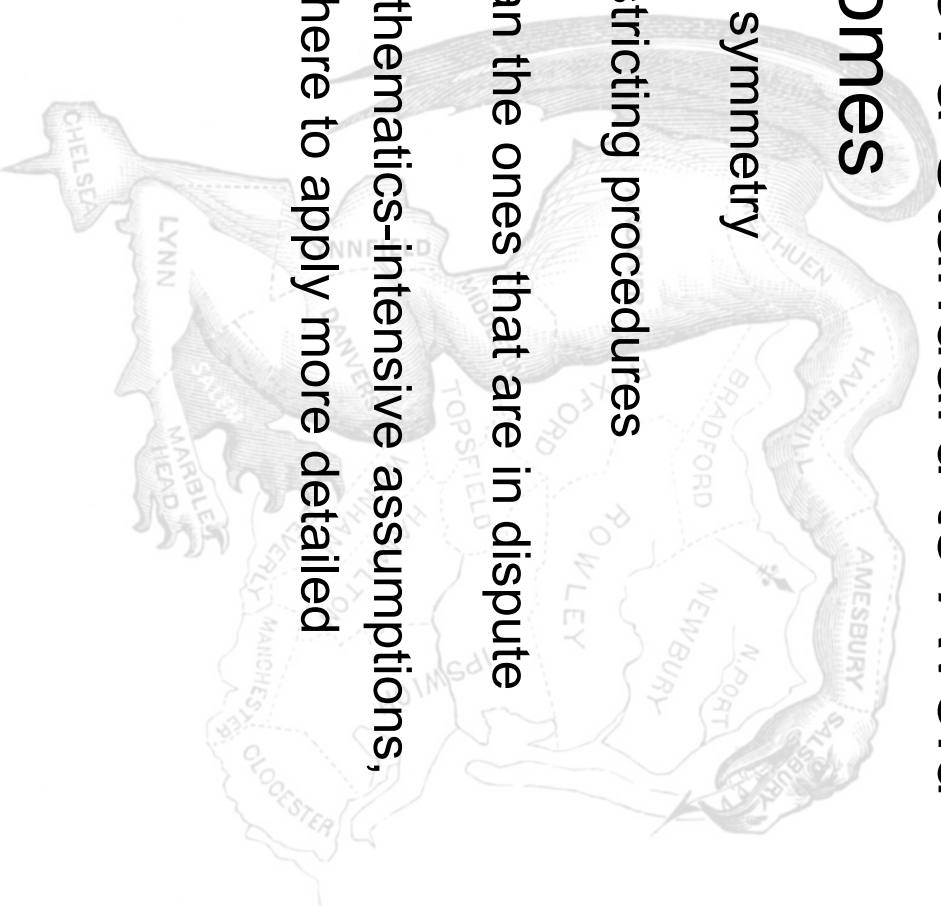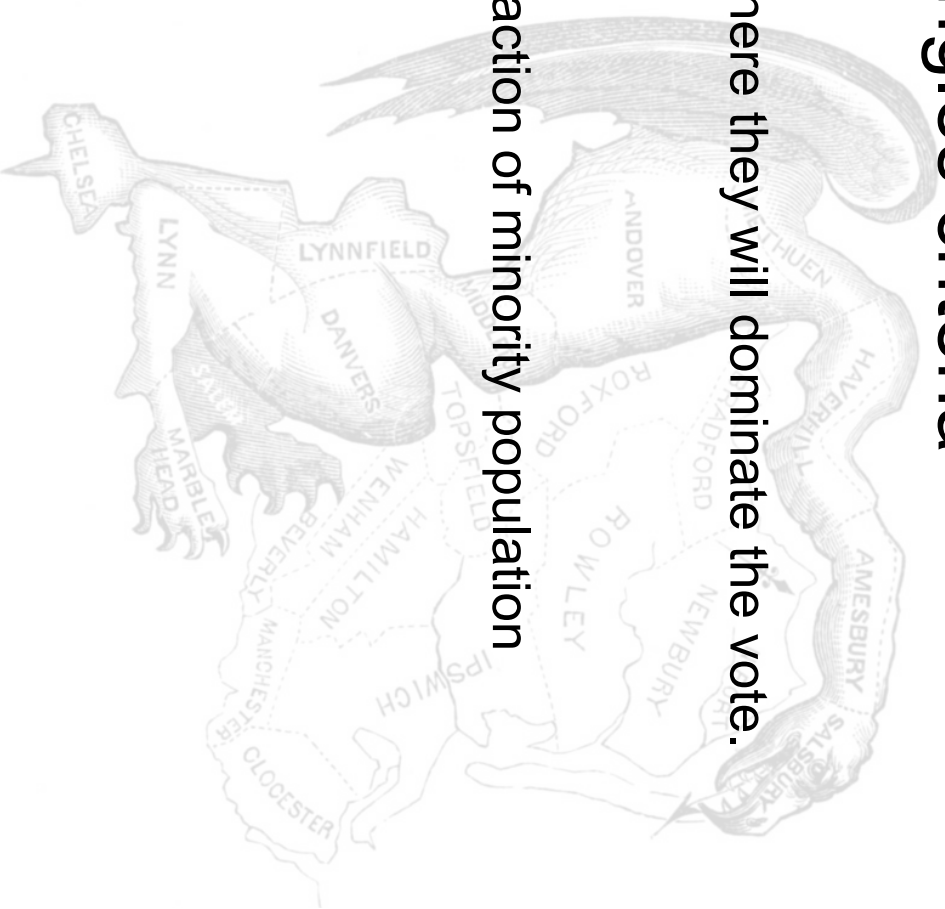
Majority-Minority Districts & Gingles criteria

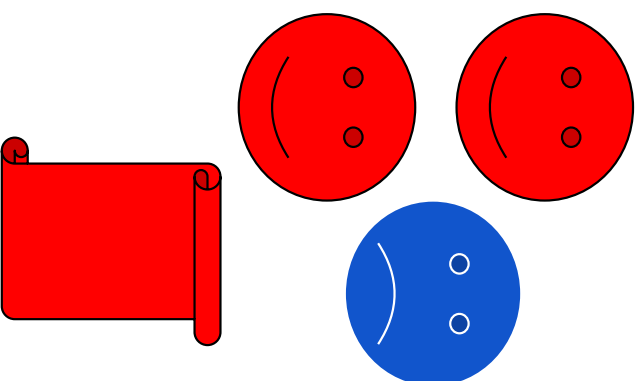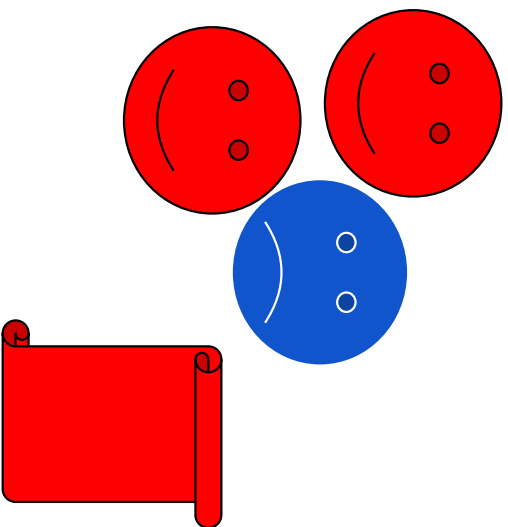Districts MUST be drawn for minority groups, where they will dominate the vote.

Guarantees minority voices are not suppressed

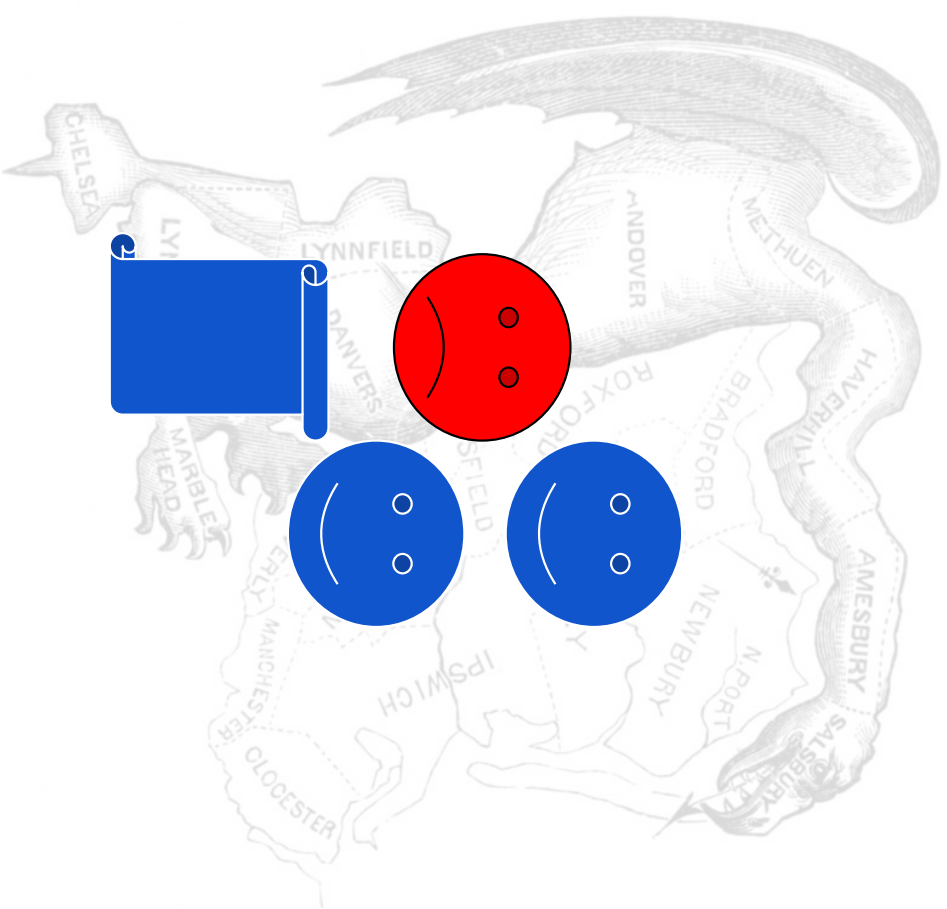The fraction of such districts does not exceed fraction of minority population

Other criteria include i.e. compactness

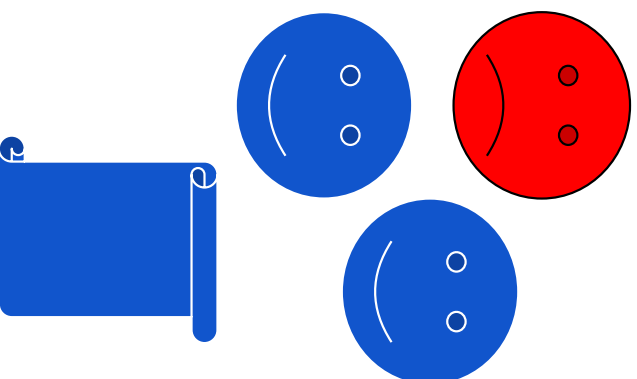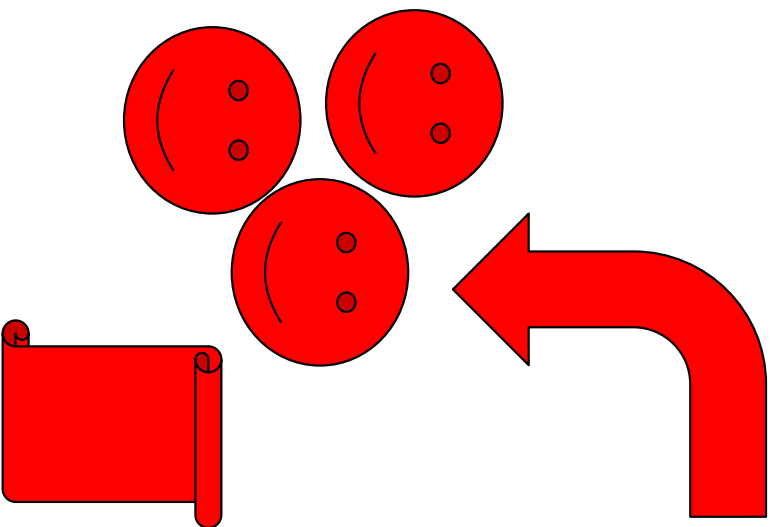# Packing (Before)

Packing (After)

Majority Minority
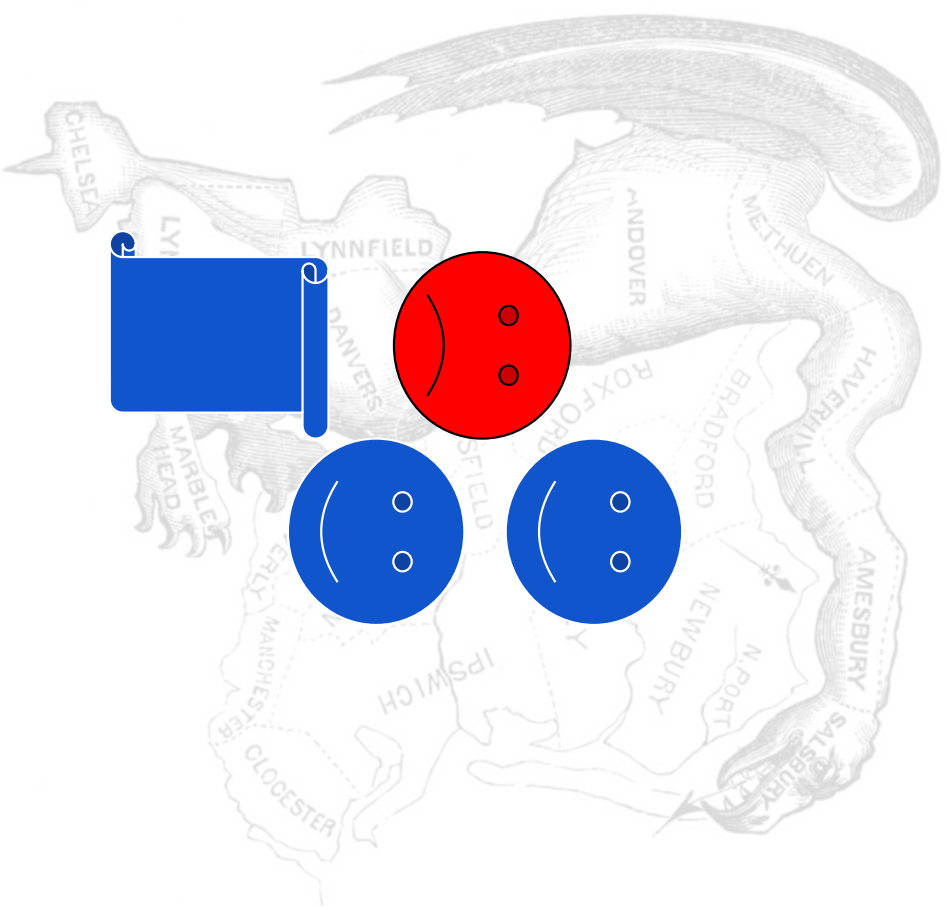
Cracking (Before)
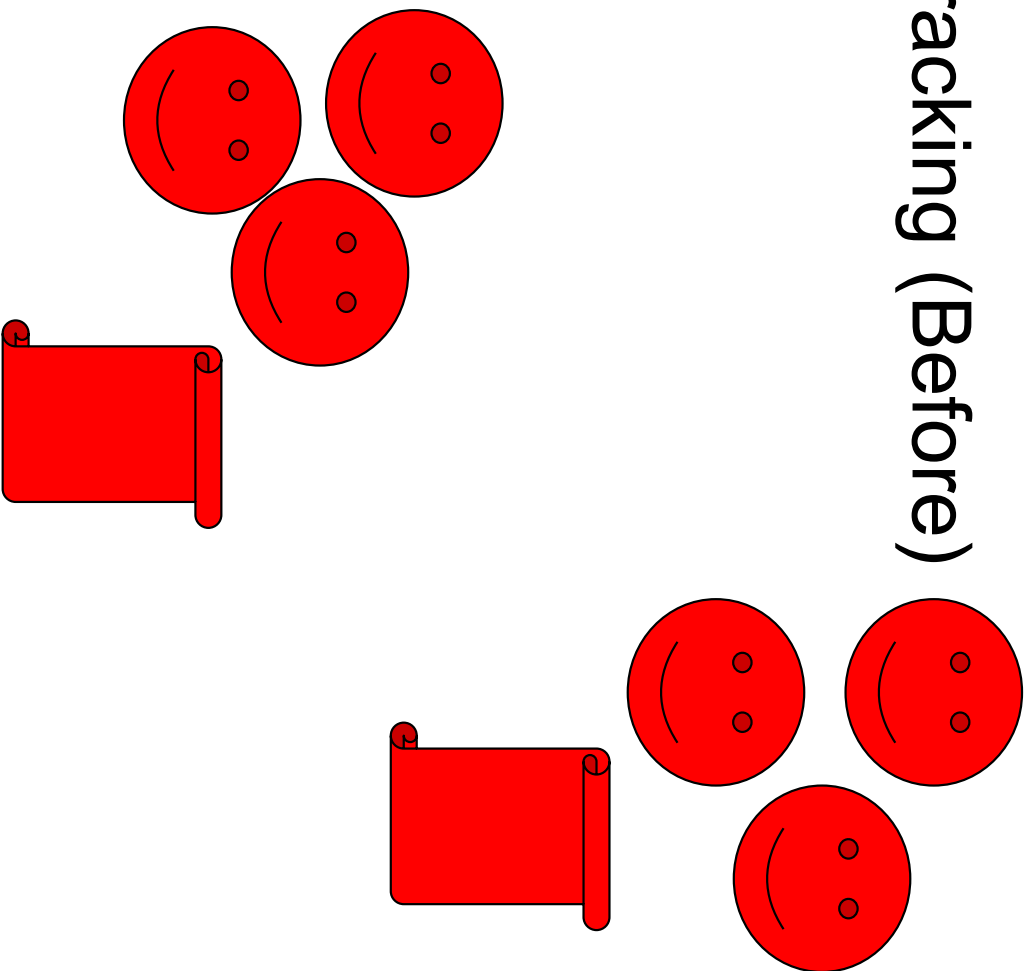
Majority Minority
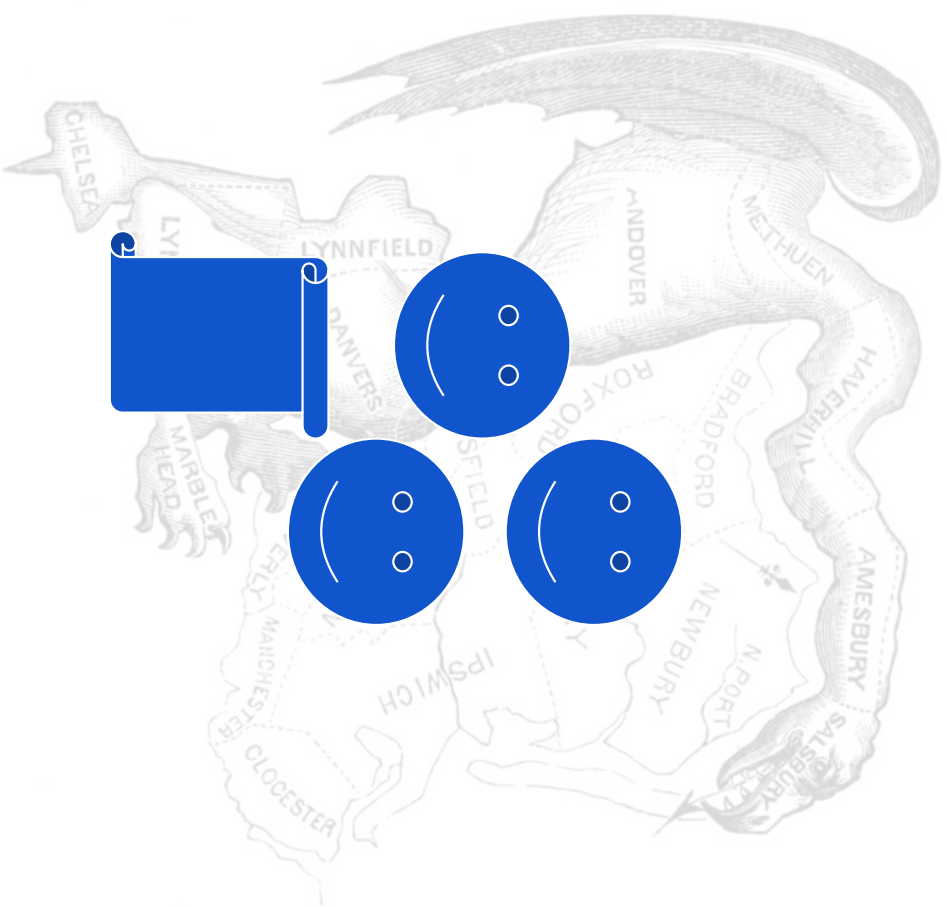
Cracking (After)
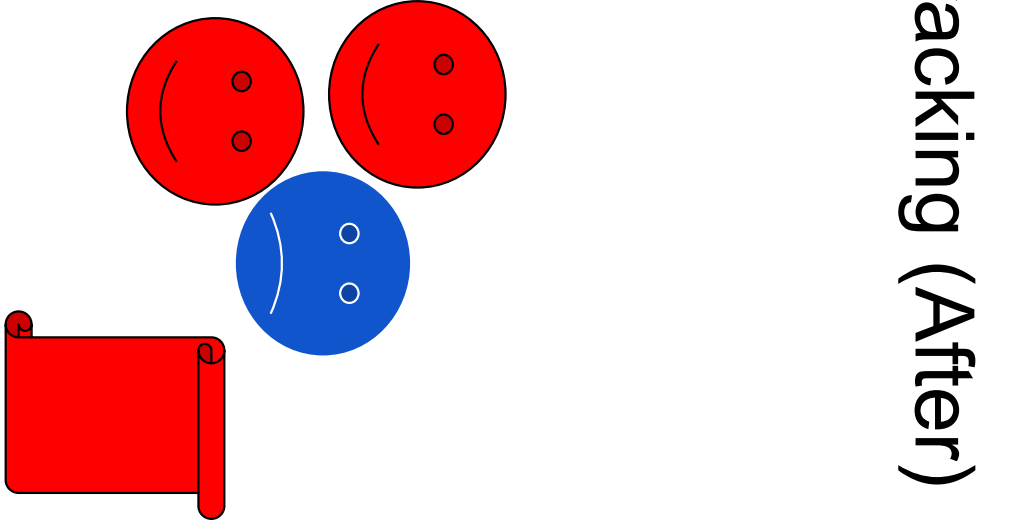
Majority Minority
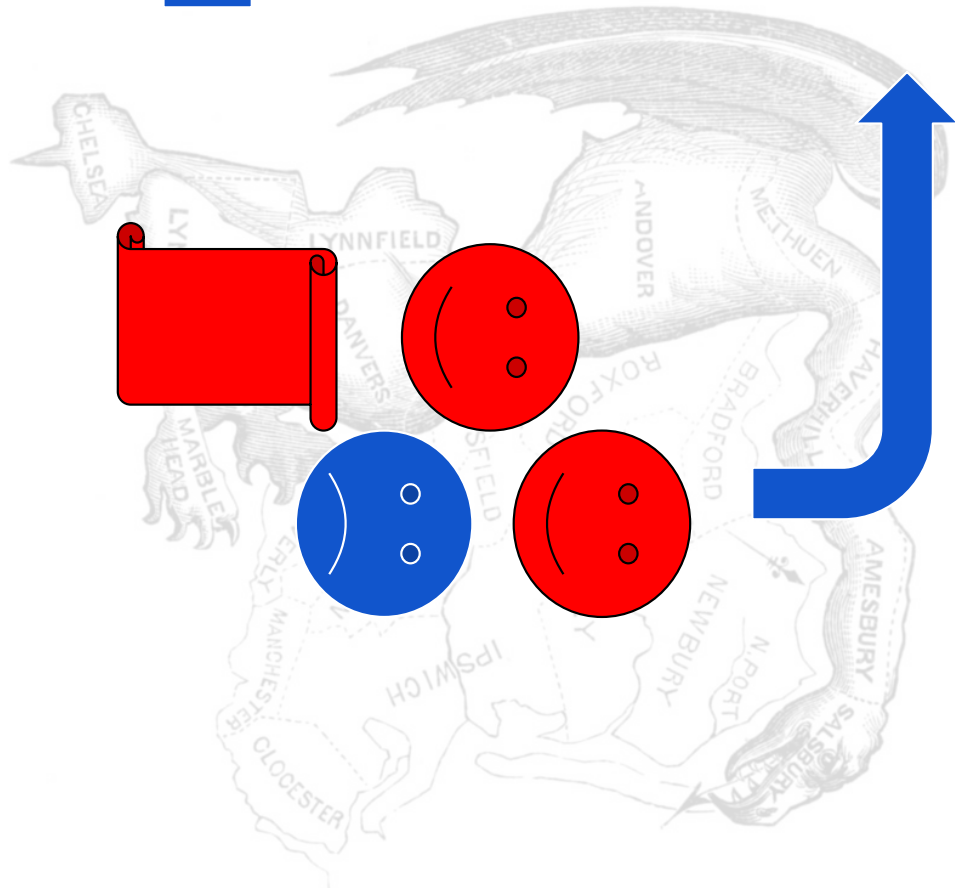
50 Precincts
60% Yellow
40% Green
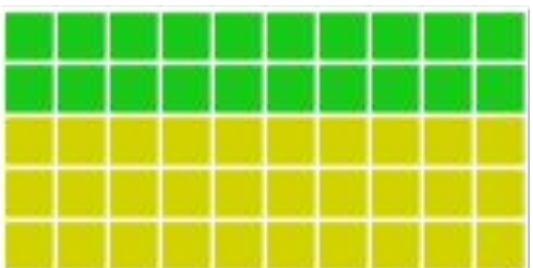
50 Precincts
are to be
apportioned
into 5
districts,
10 precincts
each district.

Proportionate Outcomes

FAIR

5 DISTRICTS
3 Yellow
2 Green

Green and yellow win in proportion to their voting

5 DISTRICTS
3 Yellow
2 Green

50 Precincts
60% Yellow
40% Green

50 Precincts are to be apportioned into 5 districts, 10 precincts each district.

Proportionate Outcomes
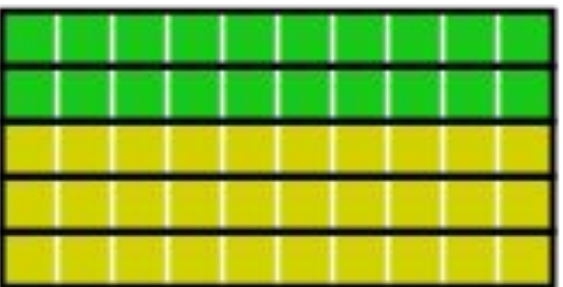
5 DISTRICTS
3 Yellow
2 Green
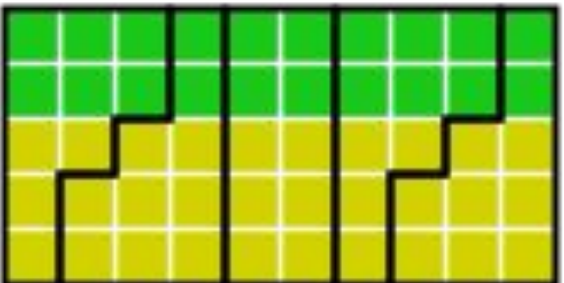
5 DISTRICTS
3 Yellow
2 Green

Green and yellow win in
proportion to their voting

FAIR

50 Precincts
60% Yellow
40% Green
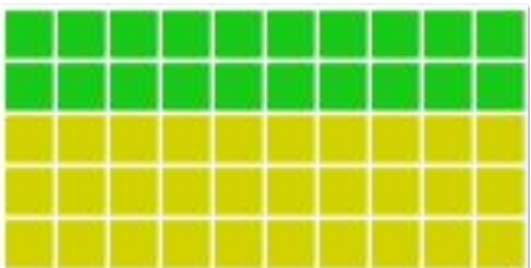
50 Precincts
are to be
apportioned
into 5
districts,
10 precincts
each district.

UNFAIR

Disproportionate Outcomes
"Gerrymandering"
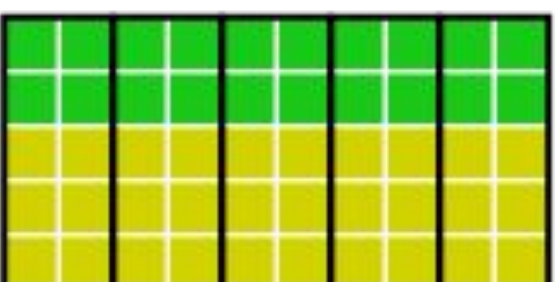
5 DISTRICTS
5 Yellow
0 Green
YELLOW
WINS ALL
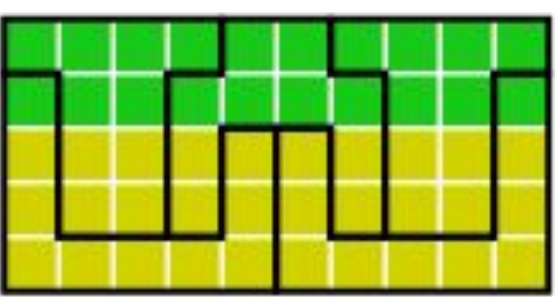
5 DISTRICTS
3 Green
2 Yellow
GREEN WINS
MAJORITY

"CORRECT" DISTRICTS?

Packing⇔Cracking

Voting Rights Act

- Majority-minority districts
- "Packing" required

Michigan

- Contiguous(ish)
- >50% D
- Reps: 5D, 9R
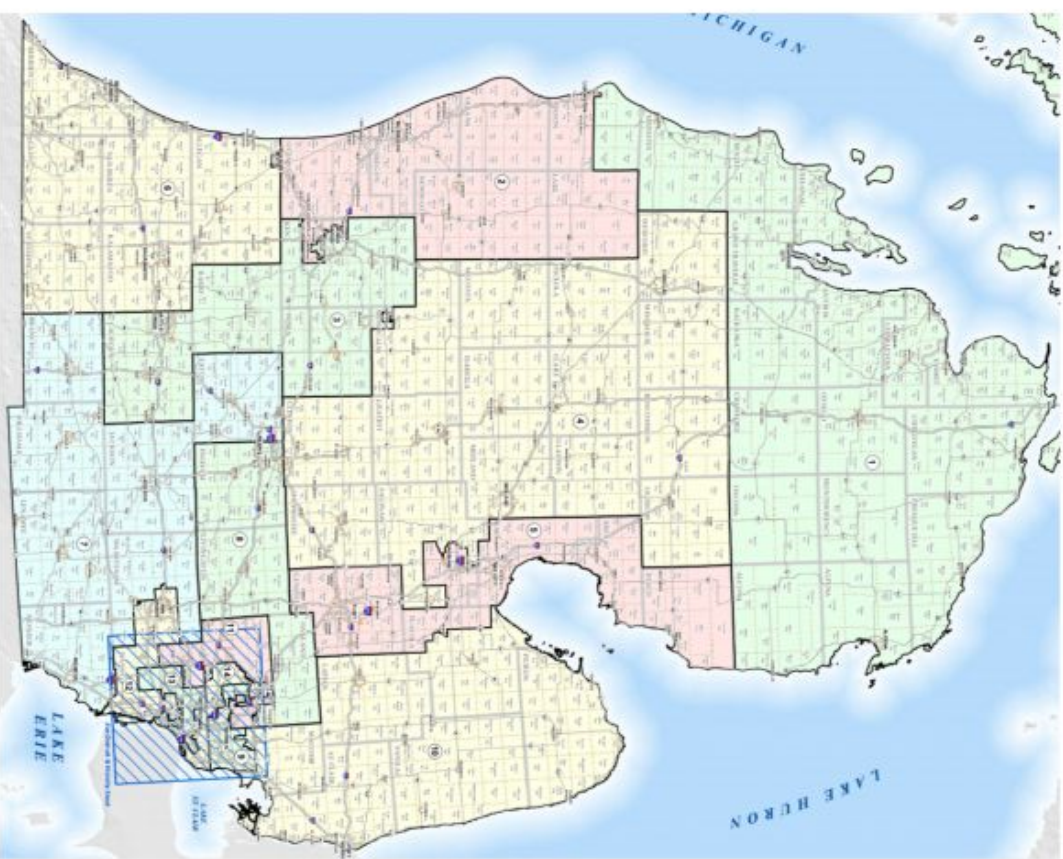
michigan.gov

Results

- Non proportional representation
- Maryland is one of worst in nation
- Maryland is gerrymandered, result of paper.
- Maryland 1973 - 82
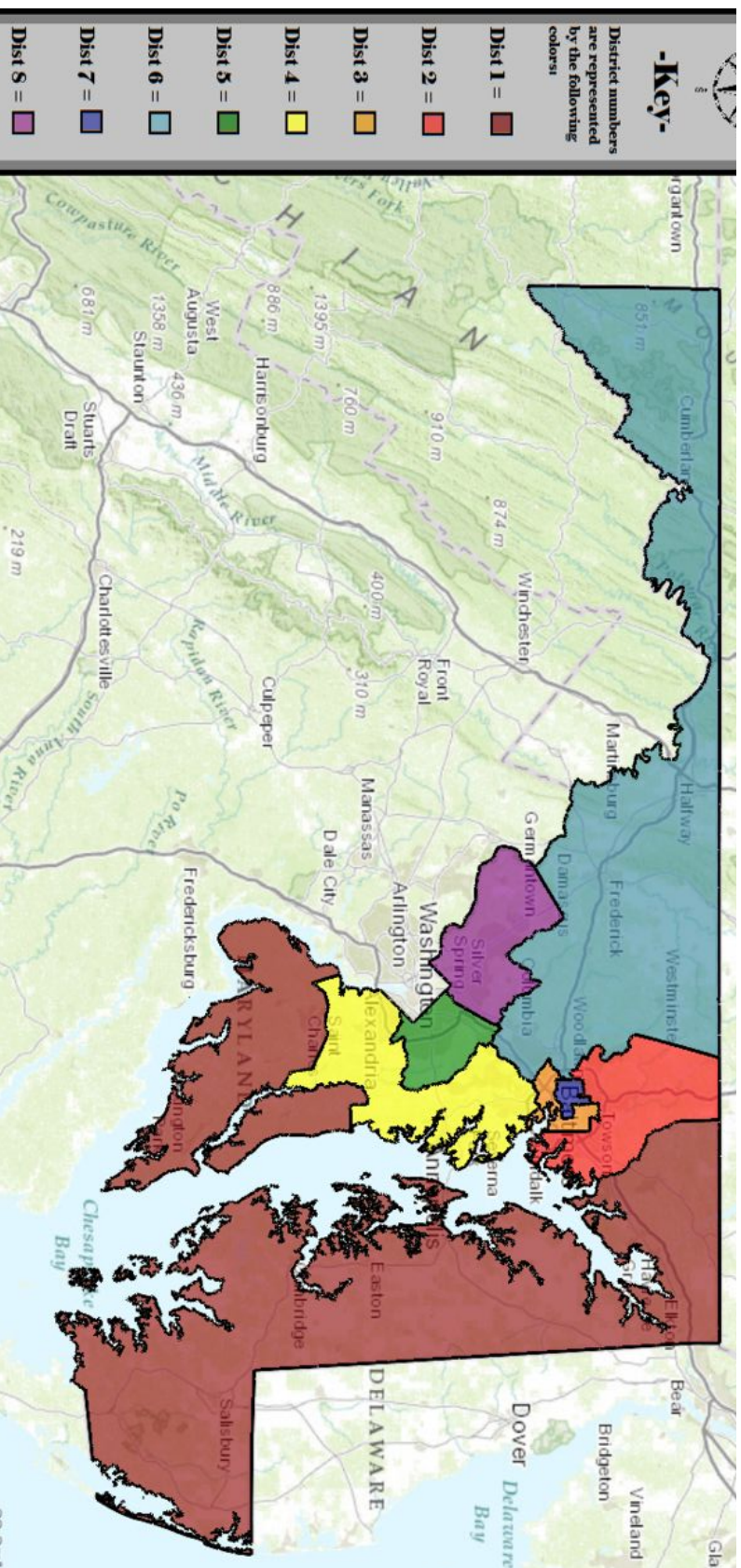
Results

- Non proportional representation
- Maryland is one of worst in nation
- Maryland is gerrymandered, result of paper.
- Maryland 2013 - today

-Key-

District numbers are represented by the following colors:

Dist 1 =
Dist 2 =
Dist 3 =
Dist 4 =
Dist 5 =
Dist 6 =
Dist 7 =
Dist 8 =
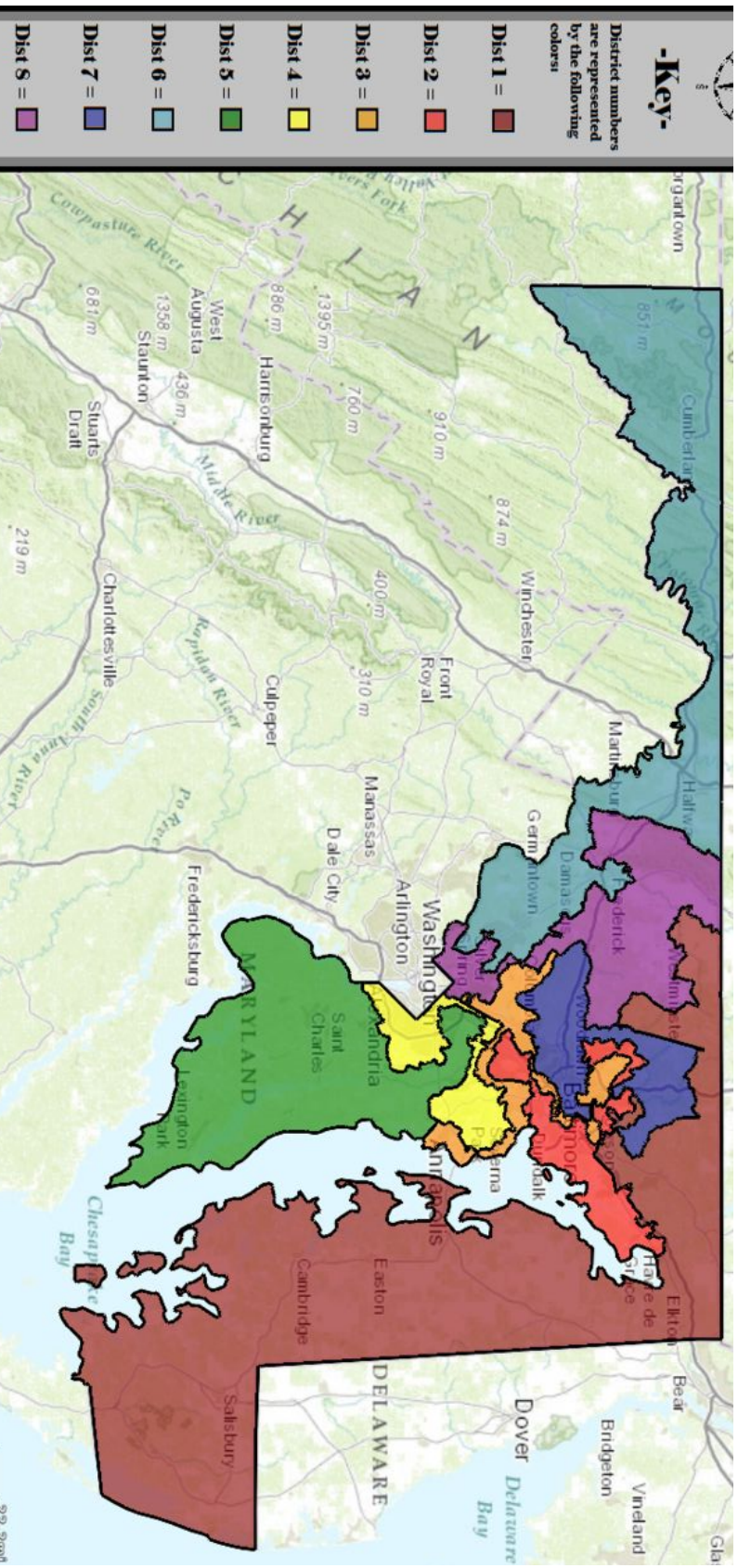
Arizona is not gerrymandered.

...by statistical review

Even though the LESS POPULAR party held more seats (2012)
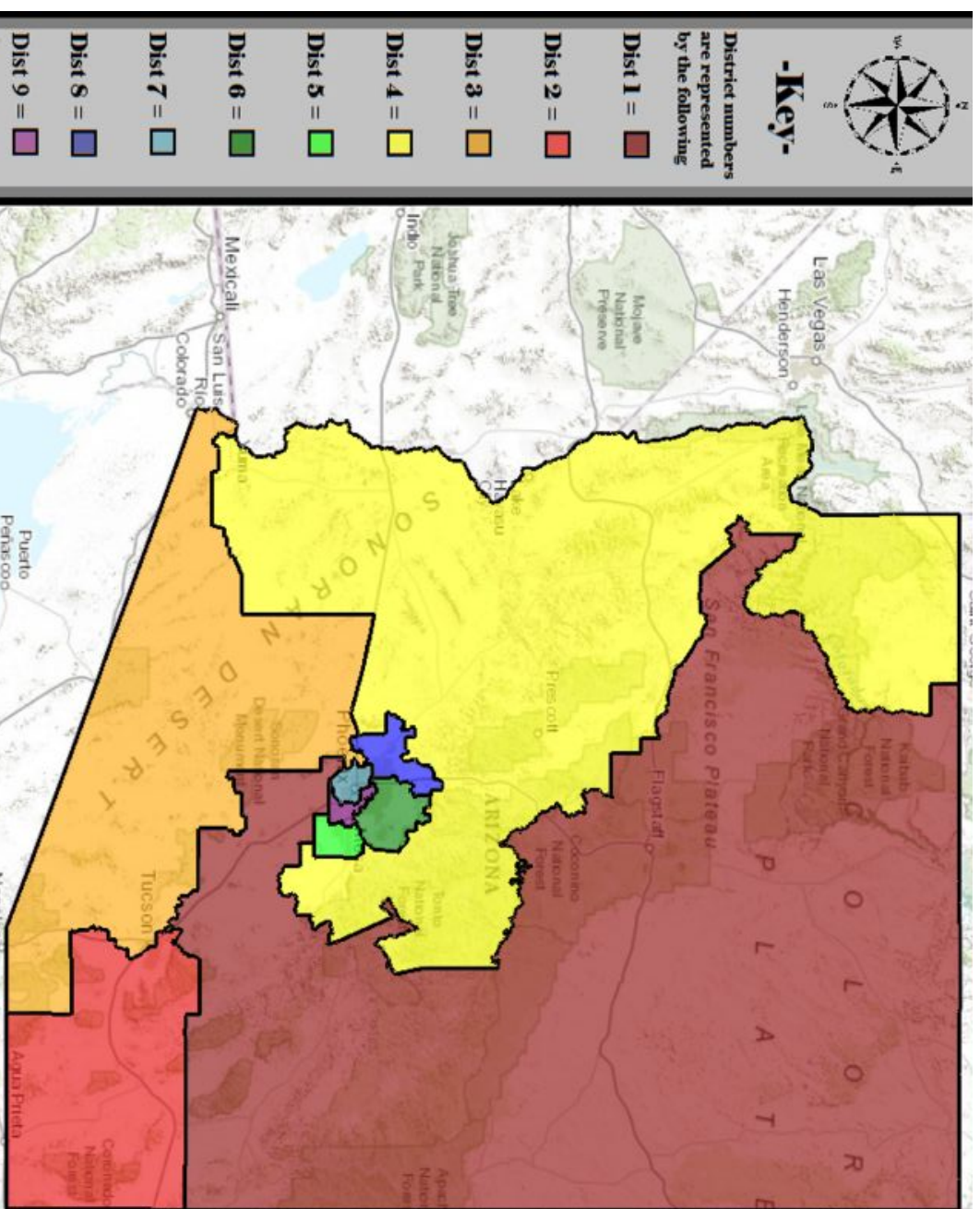
Court Request

1986 -- Supreme Court:

" a test for gerrymandering should demonstrate both **intents** and **effects**"

- "(1) intent—an established purpose to create a legislative districting map to disempower the voters of one party; and

- (2) effect—proof that an election based on the contested districting scheme led to a distorted outcome"

Spirit of the Three Statistical Tests

(1) Compare number of seats won vs. district expectations

– **WITH COMPUTER SIMULATION**

Spirit of the Three Statistical Tests

(1) Compare number of seats won vs. district expectations

– WITH COMPUTER SIMULATION

(2) a discrepancy in winning vote margins between the two parties

– WITH SIMPLE STATISTICS, T-Test

Are Dem. districts wins consistently close

but Rep. districts won by landslides?
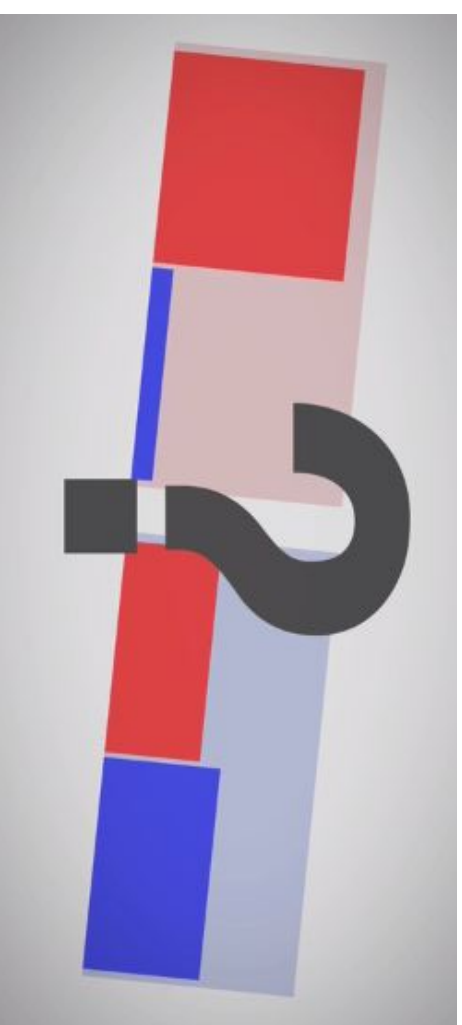
Spirit of the Three Statistical Tests

(1) Compare number of seats won vs. district expectations
-- **WITH COMPUTER SIMULATION**

(2) a discrepancy in winning vote margins between the two parties
-- **WITH SIMPLE STATISTICS**

(3) the construction of reliable wins for the party in charge of redistricting, as measured by either the difference between mean and median vote share, or an unusually even distribution of votes across districts.
-- **WITH SIMPLE STATISTICS**

Test 1: Excess Seats Test -- Analysis of Effects

Compare: **outcome** of an election after redistricting and **simulated** seats/votes curve. Does that outcome favor the redistricting party?

For a state containing N districts, calculate the difference between the actual seats and the simulated expected number and divide by the standard deviation to obtain the difference, Delta
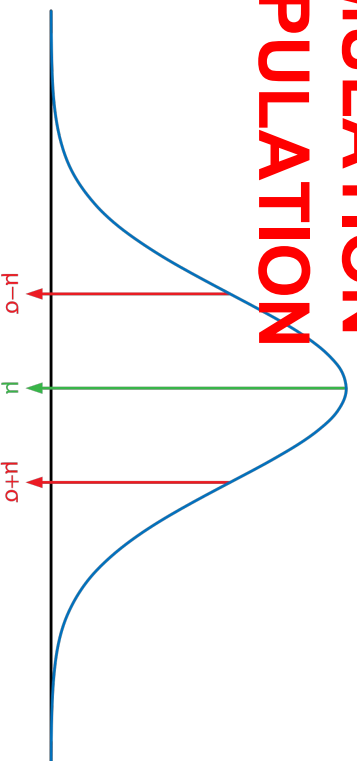
$$\frac{(\textbf{SEATS}_{\text{ACTUAL}} - \textbf{SEATS}_{\text{SIMULATED}})}{\sigma}$$

$$\frac{(18 - 10)}{0.5 * \sqrt{20}} = \textbf{3.577} \quad \textbf{T Score}$$

$$(0.001005 \quad \textbf{P Value})$$

SIMULATION POPULATION

μ−σ

μ

μ+σ

Fraction of Seats

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

35 40 45 50 55 60 65

Two-Party Vote Share (%)

dysproportional

dysproportional

seats-votes curve

eu-proportional
/Zone of Chance

x = y

95% range
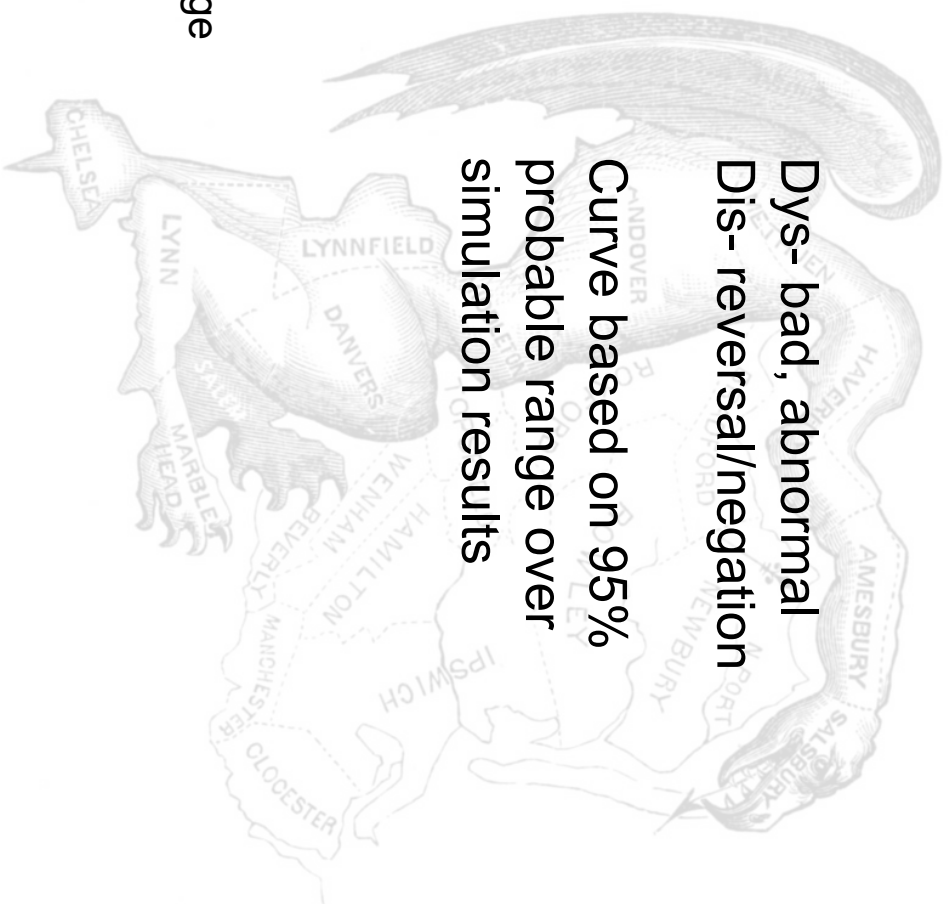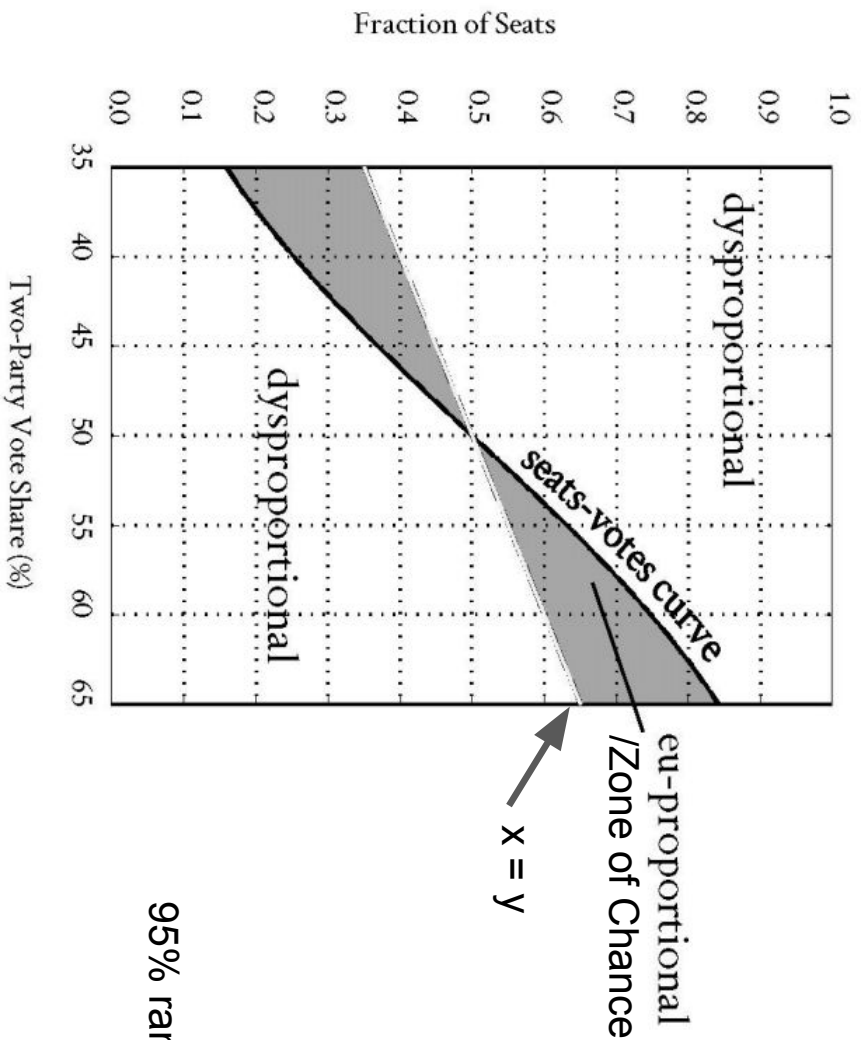
Dys- bad, abnormal
Dis- reversal/negation

Curve based on 95%
probable range over
simulation results

Test 2: Lopsided Outcomes Test - Analysis of Intents

Compare the **proportion** of votes in the districts that Democrats win, with proportion in Republican wins.

In GM, the opposition party wins landslide victories in few districts, but incumbents narrowly win in many .

Use grouped t-test
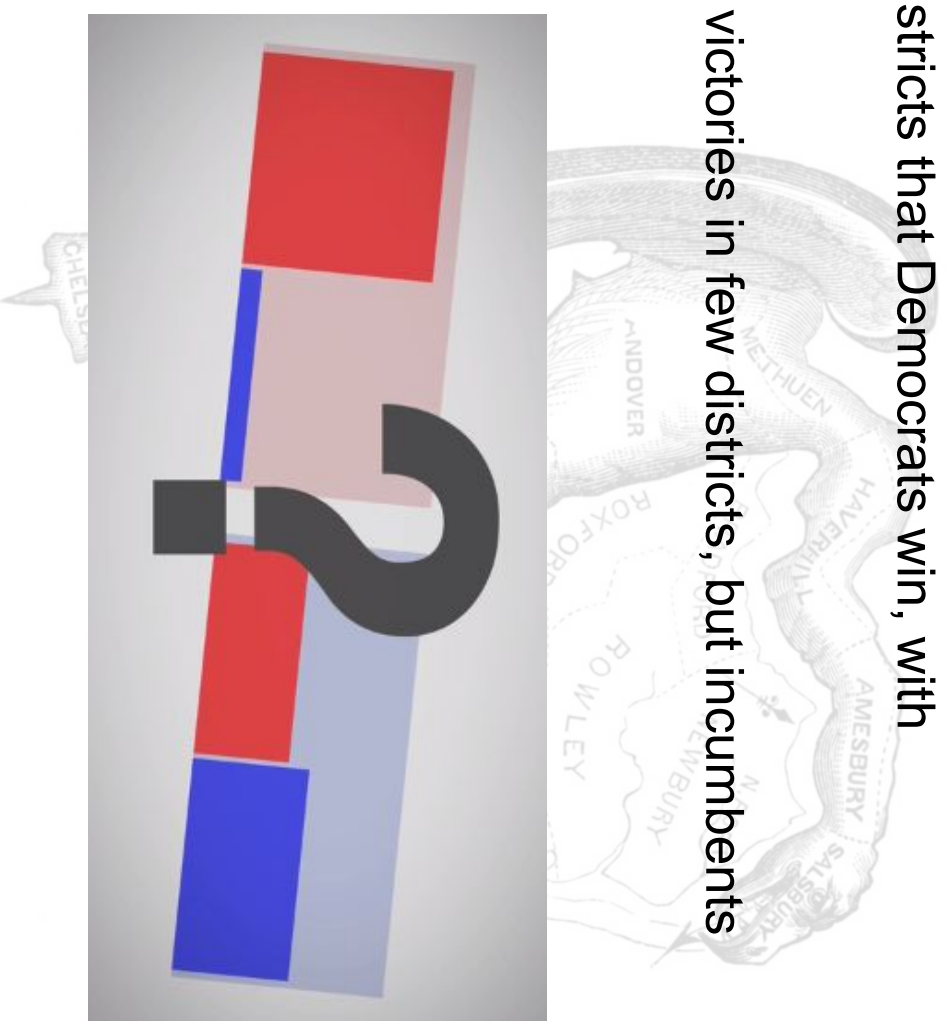
Test 3: Reliable Wins Test - Analysis of Intents

GMing offers secure wins for the incumbents with narrow, but **reliable** victories.

State's partisan vote:

Closely divided state,
reliable wins occur when the
average and median vote
differ from one another.
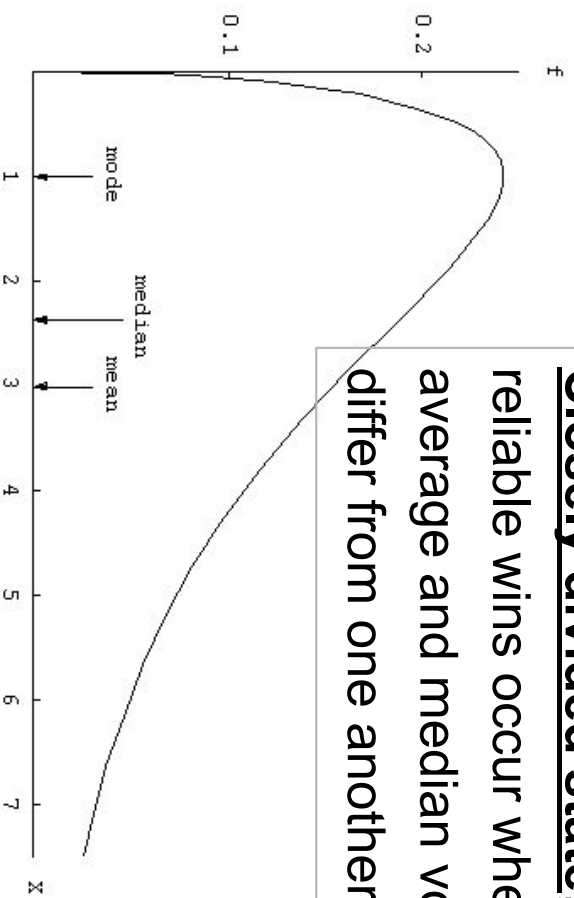
$$\frac{(\text{mean - median})}{\sigma}$$
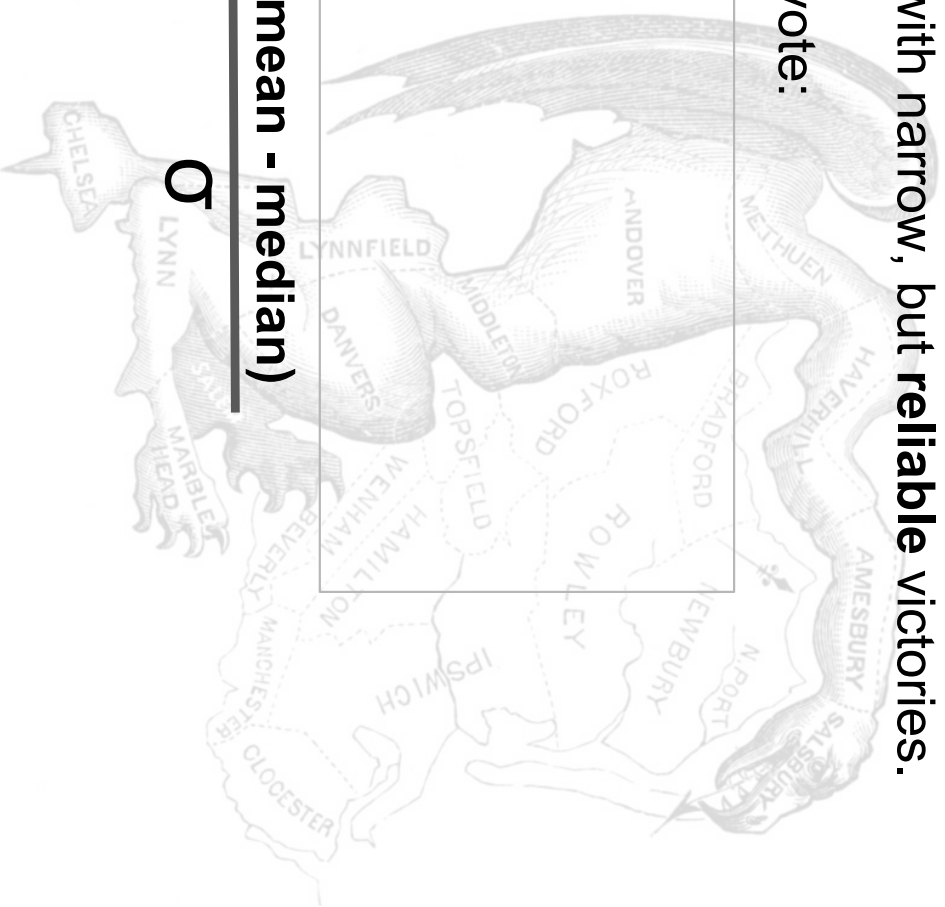
Test 3: Reliable Wins Test – Analysis of Intents

GMing offers secure wins for the incumbents with narrow, but **reliable** victories.

State's partisan vote:

Closely divided state,
reliable wins occur when the
average and median vote
differ from one another.

One party dominated state,
reliable wins occur when that
party's strength is spread
highly evenly across districts.

Compare **σ** of Winner's districts **in state vs. out of state/nationwide**
+ Chi-squared test

Table 2

Results of Three Tests for Partisan Asymmetry for the Congressional Elections of 2012

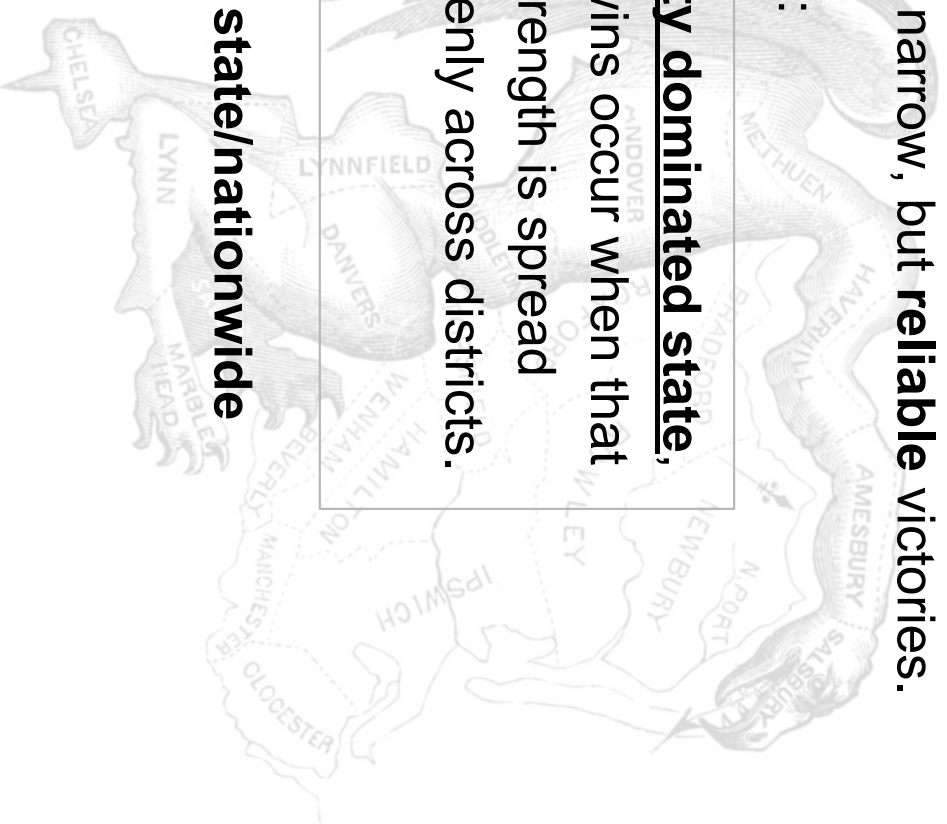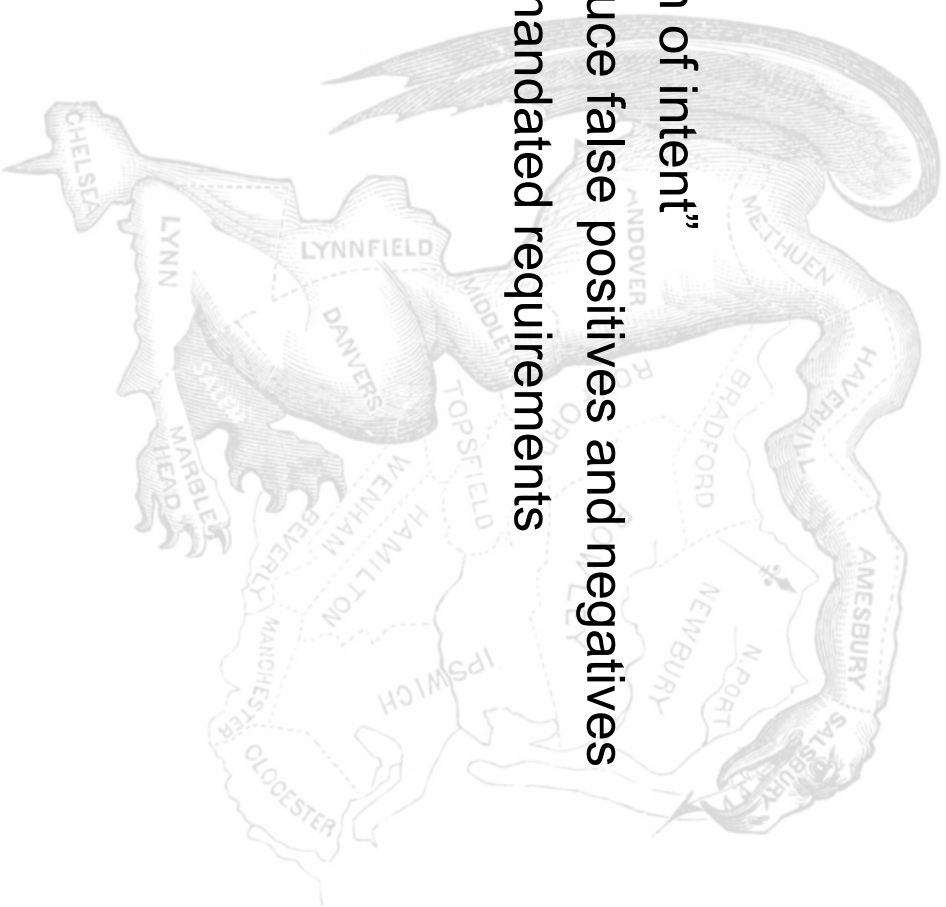|	Total Simulated seats	Test 1 (Simulation)			Test 2 (Lopsided Margins)					Test 3 (Skewed Districts)		
					Directly From Election Returns					Imputing Uncontested Races		
		Average	Δ (Difference Divided by Sigma)	Democratic Win %	Republican Win %	Sigma	Δ (Difference Divided by Sigma)	Average Minus Median Democratic Vote (%)	Sigma	Δ (Average-Median Divided By Sigma)	Average Minus Median Democratic Vote (%)	Sigma	Δ (Average-Median Divided By Sigma)
Arizona	9	2.96	**D by 2.7**	63.1%	66.6%	9.5%	D by 0.4	-0.5%	3.8%	D by 0.1	-3.3%	3.8%	D by 0.9
Florida	27	11.73	R by 1.3	73.0%	67.4%	7.4%	R by 0.8	4.8%	3.8%	R by 1.2	4.8%	2.4%	**R by 2.0**
Illinois	18	10.04	**D by 1.8**	66.2%	62.1%	4.9%	R by 0.8	2.1%	3.1%	R by 0.7			
Indiana	9	3.02	R by 1.3	65.1%	59.5%	3.1%	**R by 1.8**	1.4%	2.1%	R by 0.7			
Maryland	8	6.11	D by 1.2	70.4%	66.5%	-	-	-2.8%	3.9%	D by 0.7			
Michigan	14	6.97	**R by 2.0**	74.4%	58.9%	4.9%	**R by 3.2**	6.9%	3.7%	R by 1.9			
North Carolina	13	5.94	**R by 2.1**	70.2%	57.5%	6.9%	R by 1.9	7.8%	3.2%	**R by 2.5**	4.8%	3.8%	**R by 2.0**
Ohio	16	6.48	**R by 2.4**	80.2%	62.2%	7.5%	**R by 2.4**	6.8%	4.3%	R by 1.6	6.8%	3.0%	**R by 2.3**
Pennsylvania	18	8.14	**R by 2.9**	76.3%	59.5%	5.5%	**R by 3.1**	7.6%	3.2%	**R by 2.4**			
Texas	36	8.68	**D by 2.3**	71.4%	72.1%	4.5%	D by 0.2	4.9%	3.1%	R by 1.6	7.0%	2.4%	**R by 2.9**
Virginia	11	4.56	**R by 1.8**	70.9%	58.8%	5.6%	**R by 2.1**	6.3%	3.4%	R by 1.9			
Wisconsin	8	3.64	R by 0.9	68.9%	59.6%	3.8%	**R by 2.4**	7.0%	4.2%	**R by 1.7**			

In all cases, the last column gives the difference between expectations and actual results, expressed in units of sigma, the standard deviation, to give a measure that is comparable across the three tests. Test 3 starts from raw percentage results and the last column assumes voters in uncontested races are distributed 75%-25% for the winning party. The boldface underlined entries indicate statistically significant results. Test 2 could not be done for Maryland because the grouped t-test requires each group to include at least two wins.

3 Tests but 4 Good Things

- Don't use any maps
- "can be applied independently of evaluation of intent"
- can be used separately or combined to reduce false positives and negatives
- Combinable with other (geographic) state-mandated requirements

Run a Test   Explore U.S.   Data   Learn More   **Donate!**

U.S. Congressional Test Results
States failing more than one test: 5

Display test results for:

| U.S. Congress | State Legislatures |

2016 ‹›

Click on your state to see how it performs on our gerrymander detection tests. You can view the historical trends using the years selector above. You can also see **how the tests work**, or **run your own** with more detailed results.

Number of tests failed:

| 0 | 1 | 2 | 3 | Not enough districts |

Maryland 2016
Test 1: **Skipped**
Test 2: **Skipped**
Test 3: **Passed**
Maryland's partisanship prevents us from running 2/3 tests
Click for more information

U.S. Congressional Test Results

Maryland

◁ Back to Test Results

D: 63.4% (7 seats)
R: 36.6% (1 seats)
Efficiency Gap: **10.7% D**

View Detailed Results

Click on your state to see how it performs on our gerrymander detection tests. You can view the historical trends using the years selector above. You can also **see how the tests work**, or **run your own** with more detailed results.

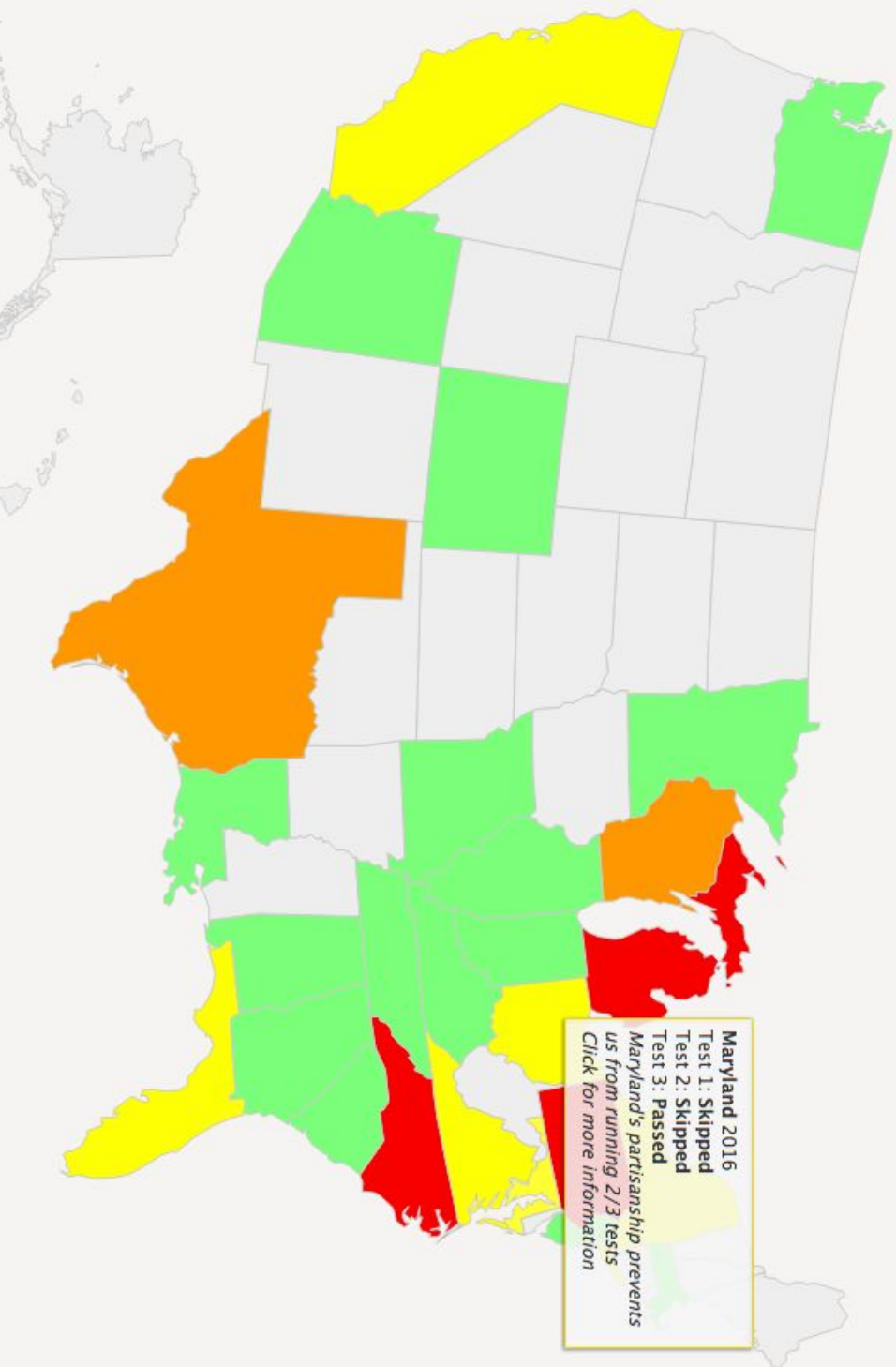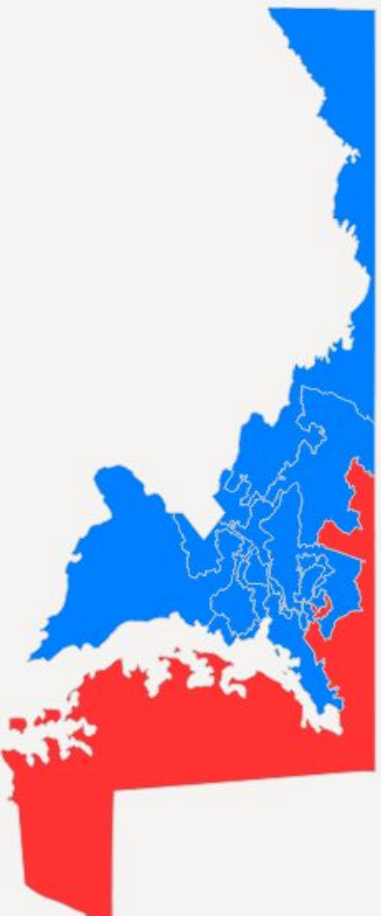Winning party in district:

Democratic   **Republican**

In heavily partisan states, the mean–median difference is not a reliable measure of gerrymandering. Instead, a chi-square test for variance is more sensitive. This is discussed further **here** as it relates to Maryland's *Shapiro v. McManus*.

Lopsided Wins

P-Value: **skipped**

Vote Share

● Democratic   ◆ Republican

Consistent Advantage

P-Value: **skipped**

Democratic vote share

— mean   — median

Simulated Elections

P-Value: 0.408

Actual Result: 7 seat(s)

Democratic seats won

Number of Simulations with Given Result