

GERRYMANDERING

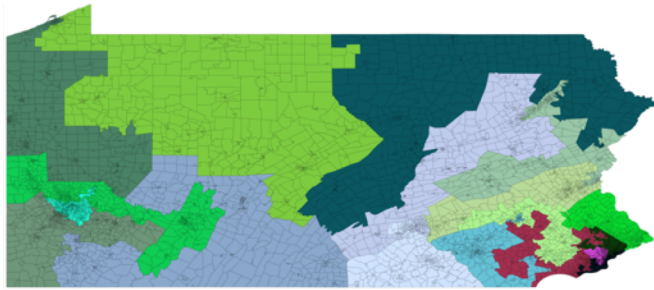
BRIAN ONDOV



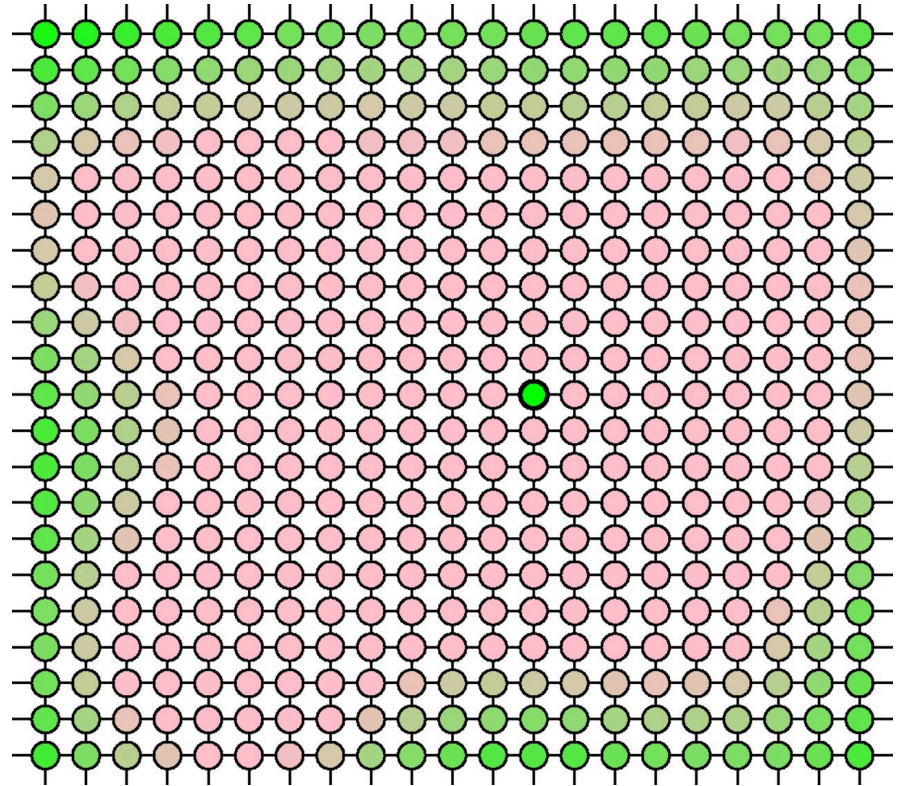
COMPUTER SCIENCE
UNIVERSITY OF MARYLAND



Chikina, Frieze & Pegden 2017



Markov chain sampling

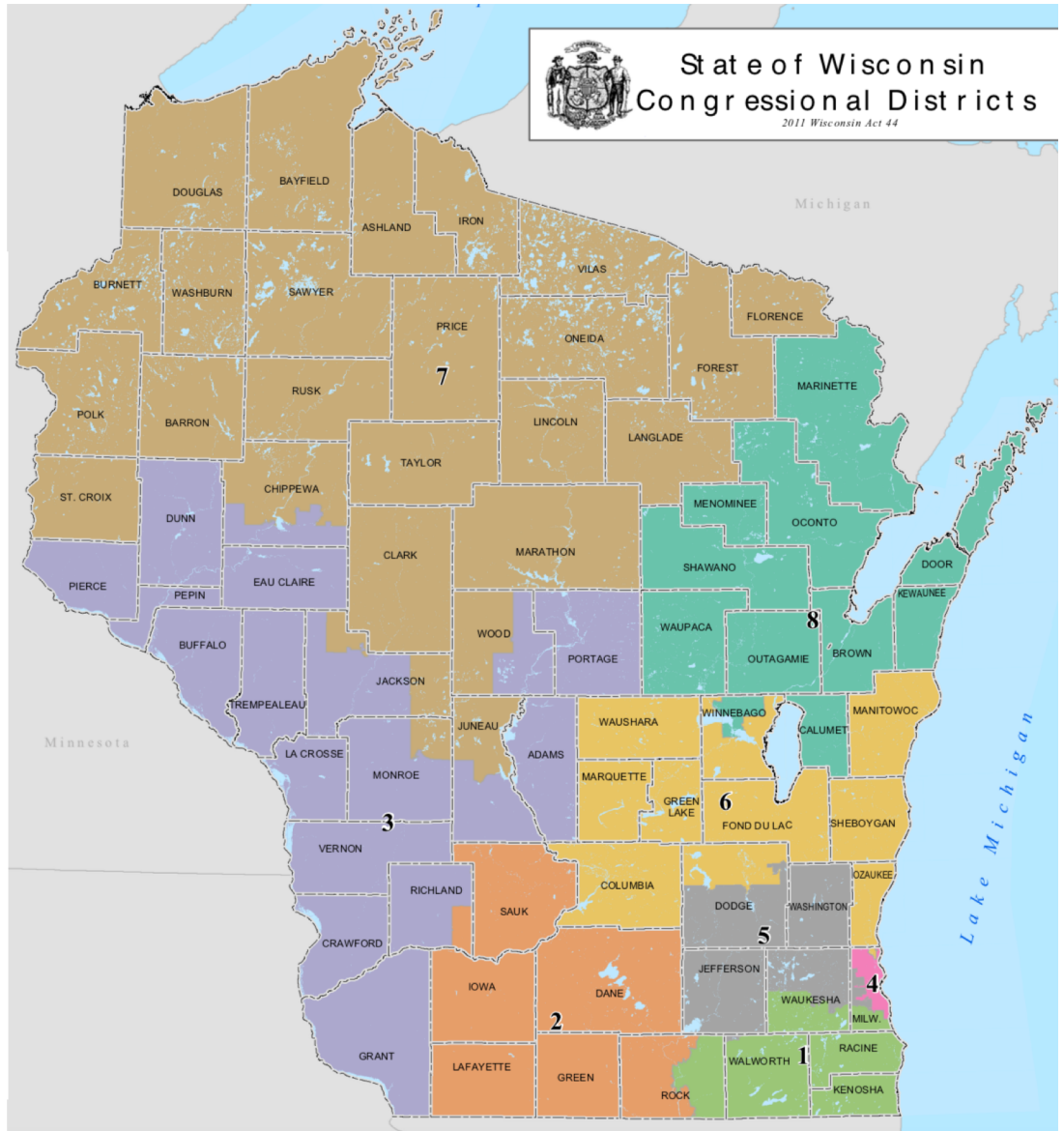


New test for outliers: $\sqrt{\epsilon}$

WISCONSIN

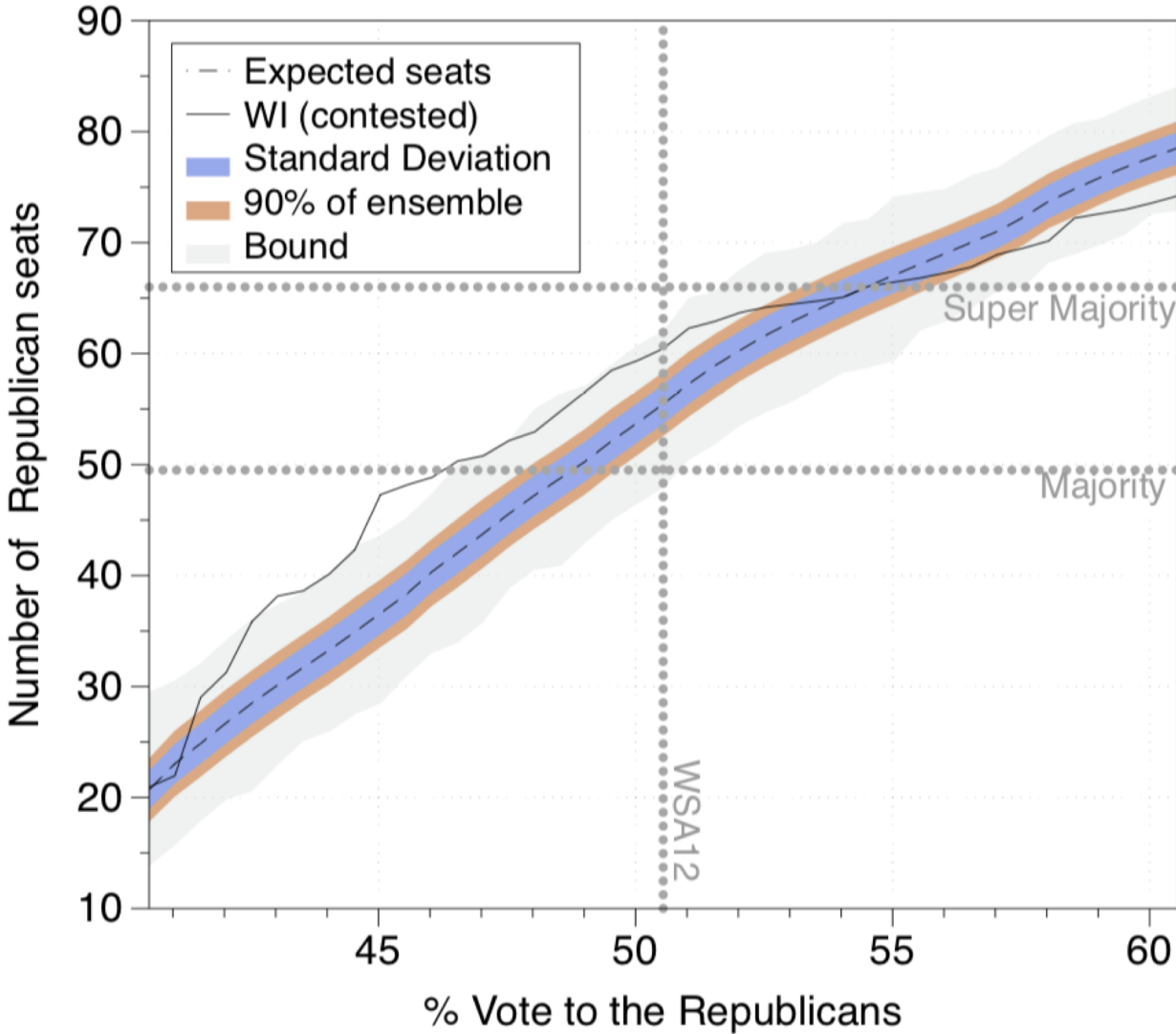


wisc.edu



wisconsin.gov

Herschlag, Ravier & Mattingly 2017



EFFICIENCY GAP

Stephanopoulos & McGhee, 2014

l := losing districts

w := winning districts

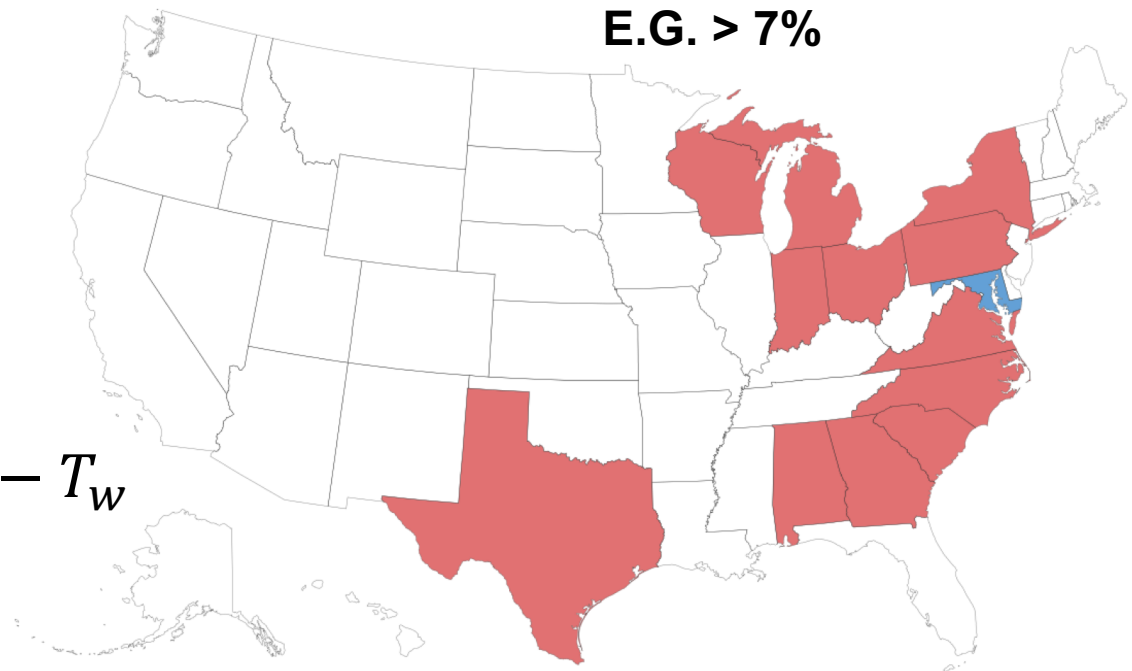
T_w := winning threshold

x := wasted votes

V := total votes

$$x_i = \sum_l v_{i,l} + \sum_w v_{i,w} - T_w$$

$$\text{E. G.} = \frac{x_1 - x_2}{V}$$



New York Times

Gill v. Whitford, Oct. 2017 (Wisconsin map)

13 CHIEF JUSTICE ROBERTS: It is just
14 not, it seems, a palatable answer to say the
15 ruling was based on the fact that EG was
16 greater than 7 percent. That doesn't sound
17 like language in the Constitution.

2 And the intelligent man on the street
3 is going to say that's a bunch of baloney. It

12 pursuant to, and it may be simply my
13 educational background, but I can only describe
14 as sociological gobbledygook.

FAIR DIVISION

“Zeus, most glorious and greatest of the eternal gods, take which ever of these portions your heart within you bids.”

- Prometheus, Hesiod's Theogony



MFA Boston

FAIR DIVISION

“A Partisan Districting Protocol with Provably Nonpartisan Outcomes”

- I cut, you freeze
- Serial dictatorship

Wesley
Pegden



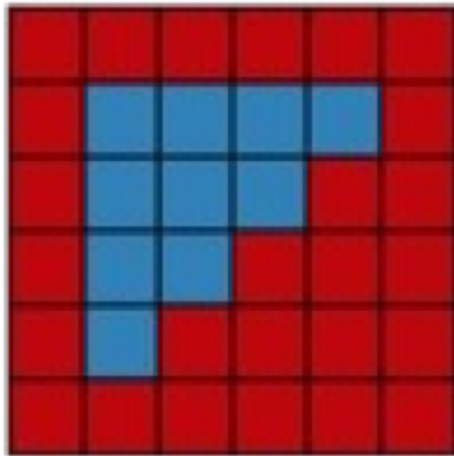
Ariel
Procaccia



Dingli
Yu



EXAMPLE

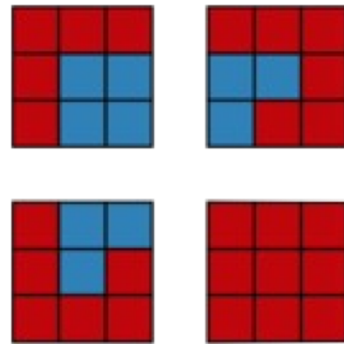


10 blue voters

26 red voters

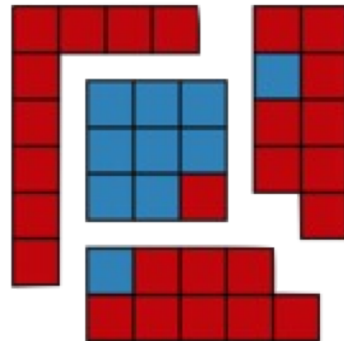
Slate

COMPETING OBJECTIVES



0 blue districts

4 red districts

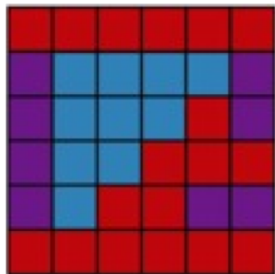


1 blue district

3 red districts

Slate

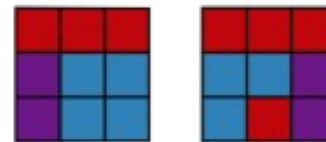
VARIED UTILITY



10 blue voters

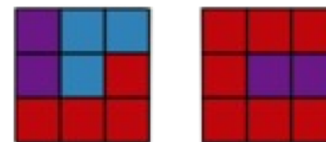
18 red voters

8 swing voters

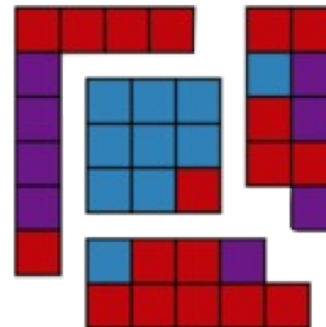


0 blue districts

1 red district



3 swing districts



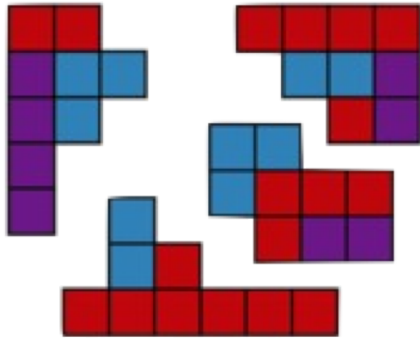
1 blue district

3 red districts

0 swing districts

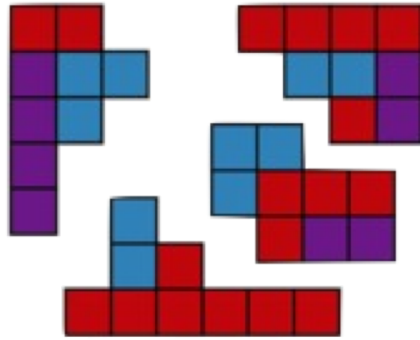
Slate

Red cuts

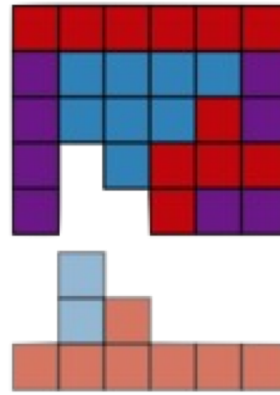


Slate

Red cuts

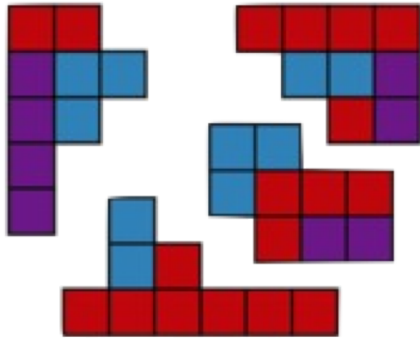


Blue freezes

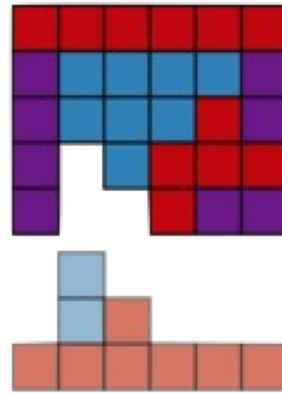


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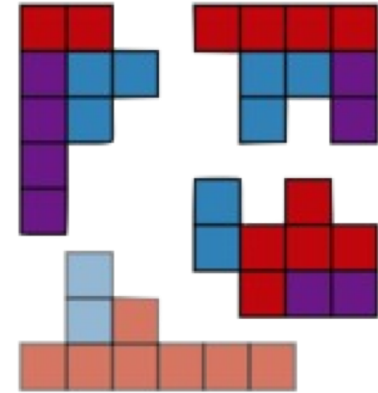
Red cuts



Blue freezes

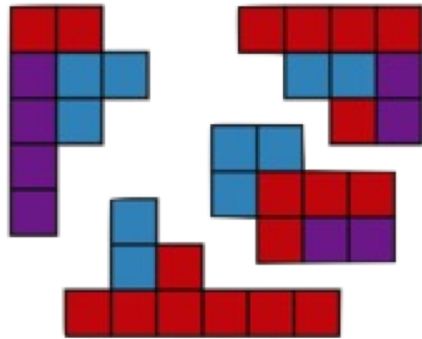


Blue cuts

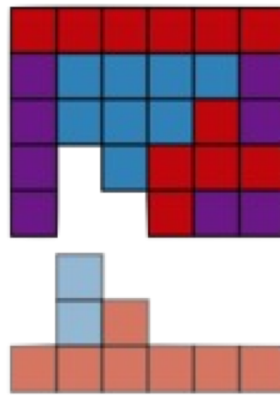


Slate

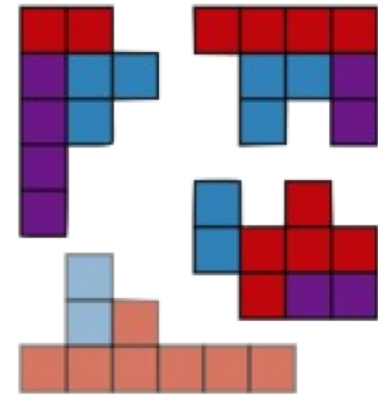
Red cuts



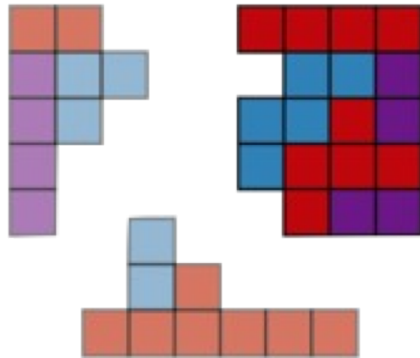
Blue freezes



Blue cuts

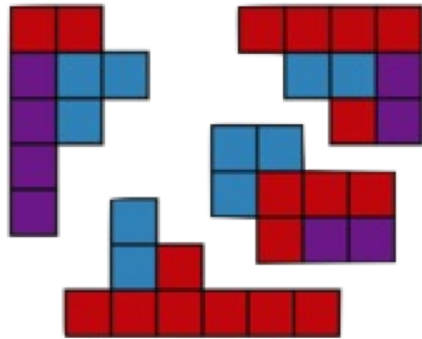


Red freezes

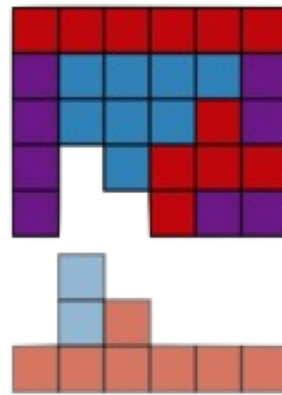


Slate

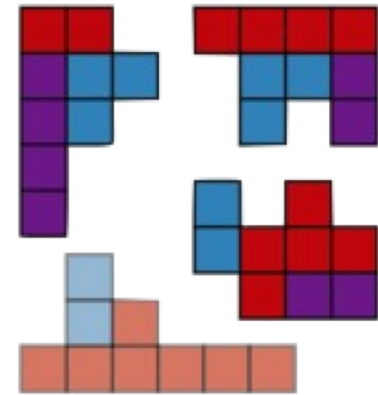
Red cuts



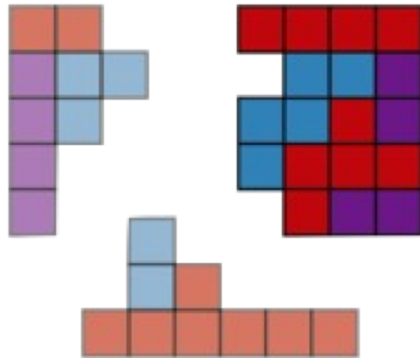
Blue freezes



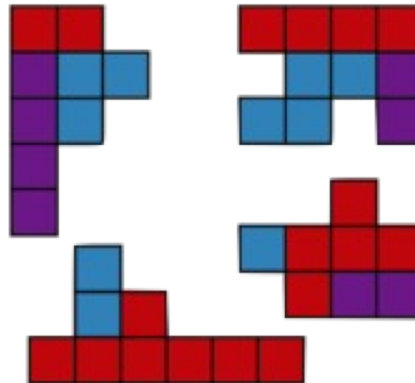
Blue cuts



Red freezes



Red cuts (end)



0 blue districts

2 red districts

2 swing districts

Slate

FORMAL PROCEDURE

- 1: **procedure** $\text{GAME}_1(k, s_1, A) \triangleright$ Player A divides first
- 2: Player A chooses k numbers in $[0, 1]$: $x_{k,1}, \dots, x_{k,k}$, such that

$$\sum_{i=1}^k x_{k,i} = s_1$$

- 3: Player B chooses an integer $i_k \in [k]$, where $\{A, B\} = \{1, 2\}$
- 4: **return** $\text{GAME}_1(k - 1, s_1 - x_{k,i_k}, B) + [x_{k,i_k} \geq \frac{1}{2}]$
- 5: **end procedure**

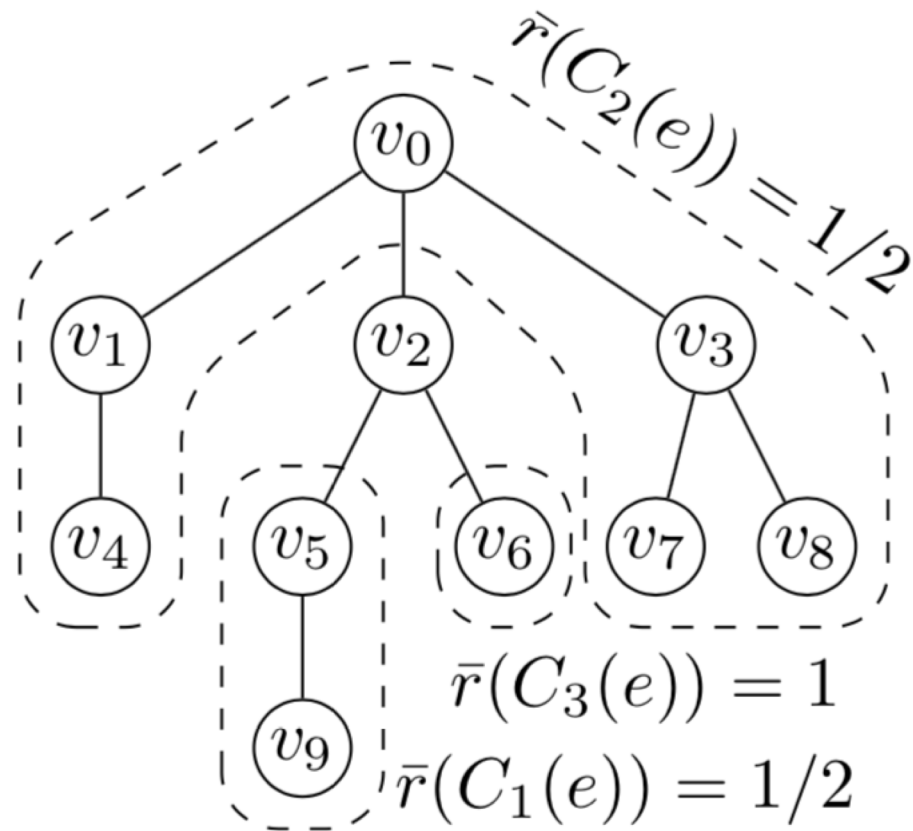
PROVING FAIRNESS

- **Step 1**
 - Prove non-geometric allocation
- **Step 2**
 - Generalize to geometric case
- **Step 3**
 - ???
- **Step 4**
 - Profit

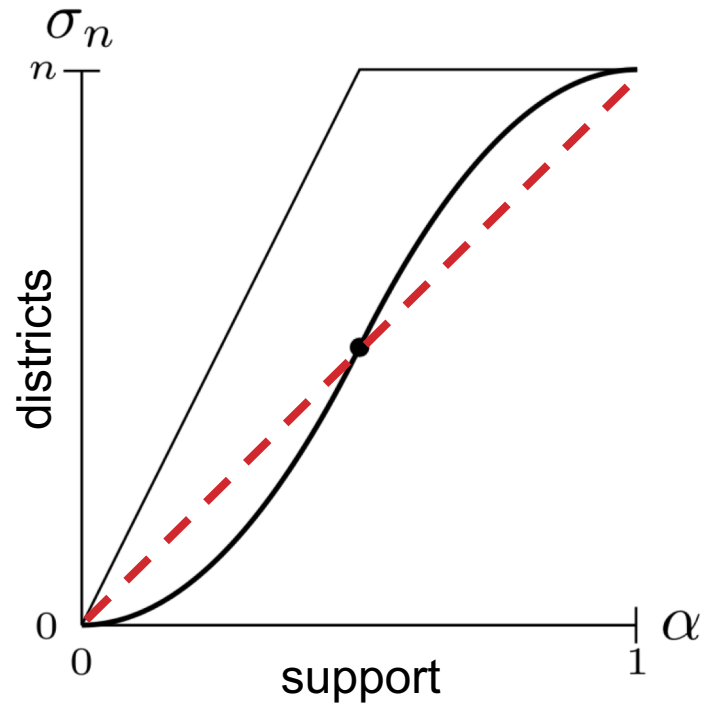
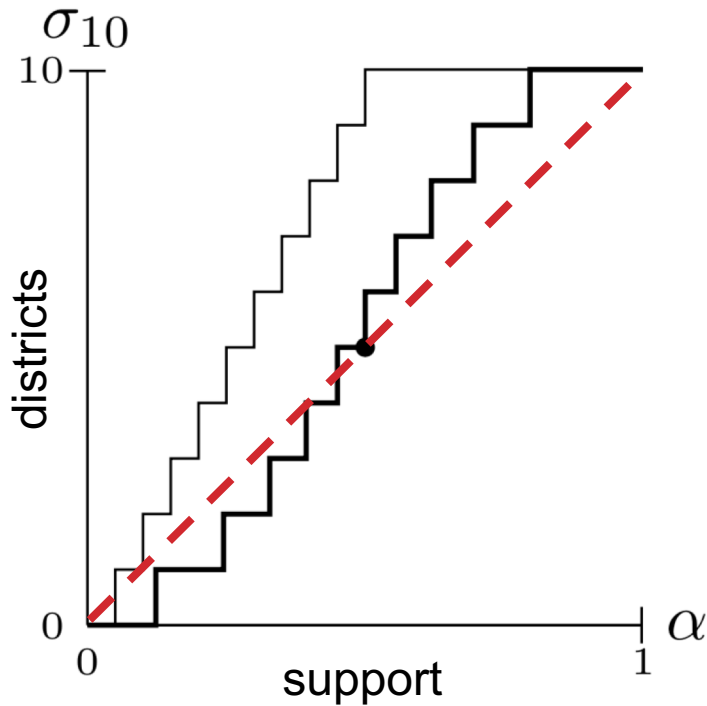
PROOF?

$$s \mid \gamma \begin{cases} \frac{(n-1)!!(2k + [2 \nmid n] - 2)!!}{2(2k + [2 \nmid n] - 3)!!(n-2)!!} & \text{for } k \leq n/2 \\ n - \frac{n!!(2(n-k) - [2 \nmid n] + 1)!!}{2(2(n-k) - [2 \nmid n])!!(n-1)!!} & \text{for } k > n/2. \end{cases}$$

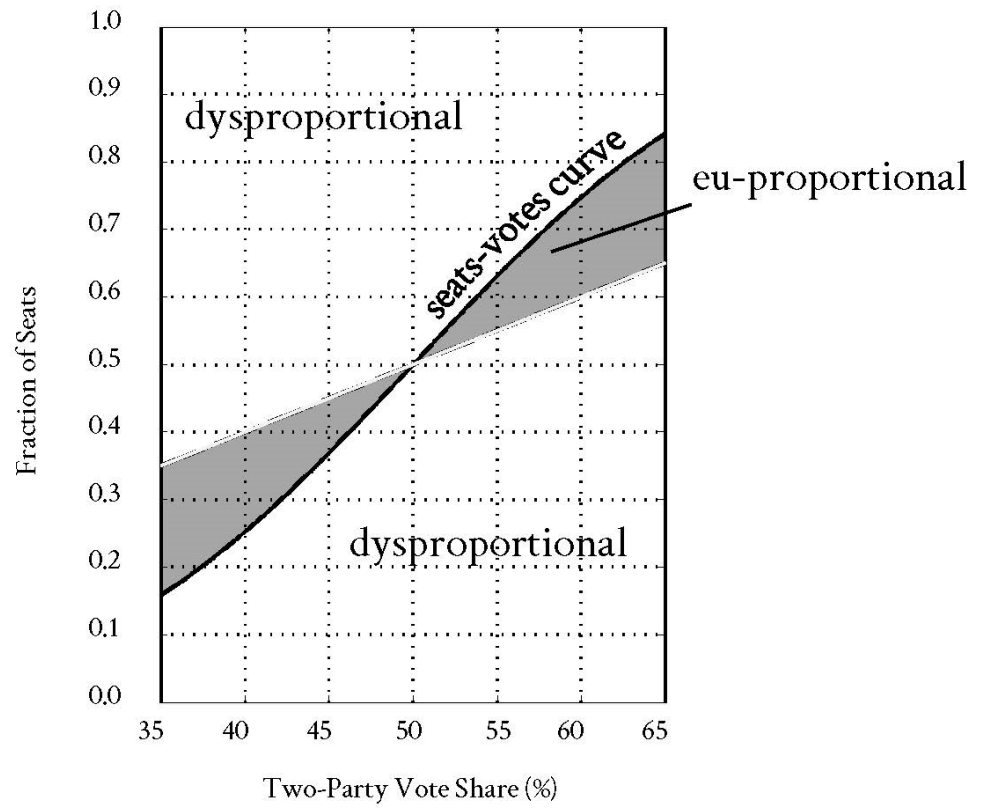
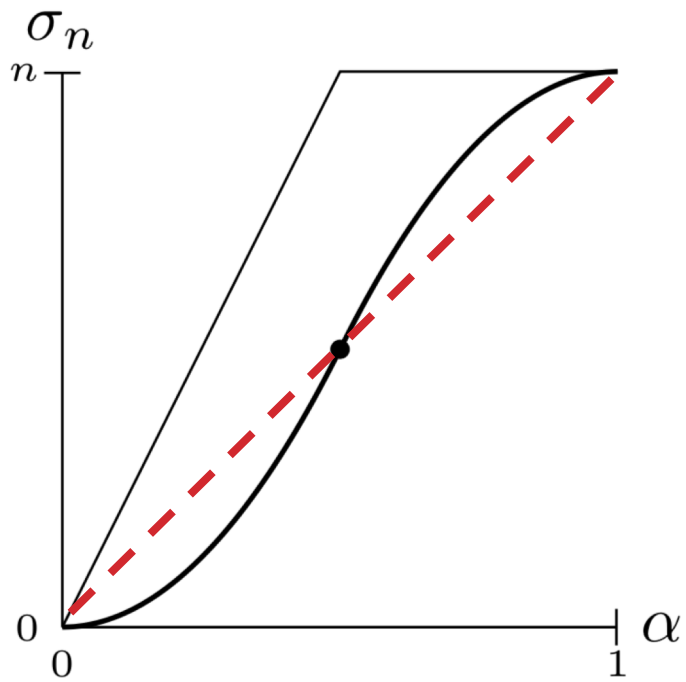
PROOF?



$\sigma(n, s)$: slate from optimal play (player 1)



$$\lim_{n \rightarrow \infty} \frac{\sigma(n, \alpha n)}{n} = \begin{cases} 2\alpha^2 & \text{for } \alpha \leq \frac{1}{2} \\ 1 - 2(1 - \alpha)^2 & \text{for } \alpha > \frac{1}{2}. \end{cases}$$



PROVABLE FAIRNESS: PIECE OF CAKE!



Amazon

