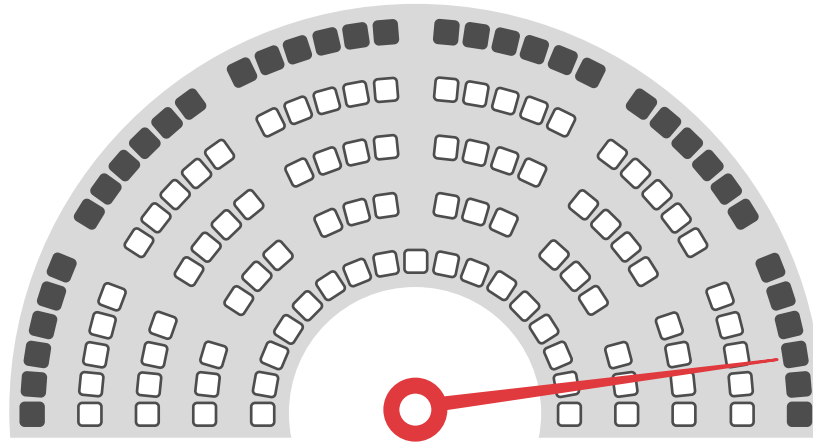




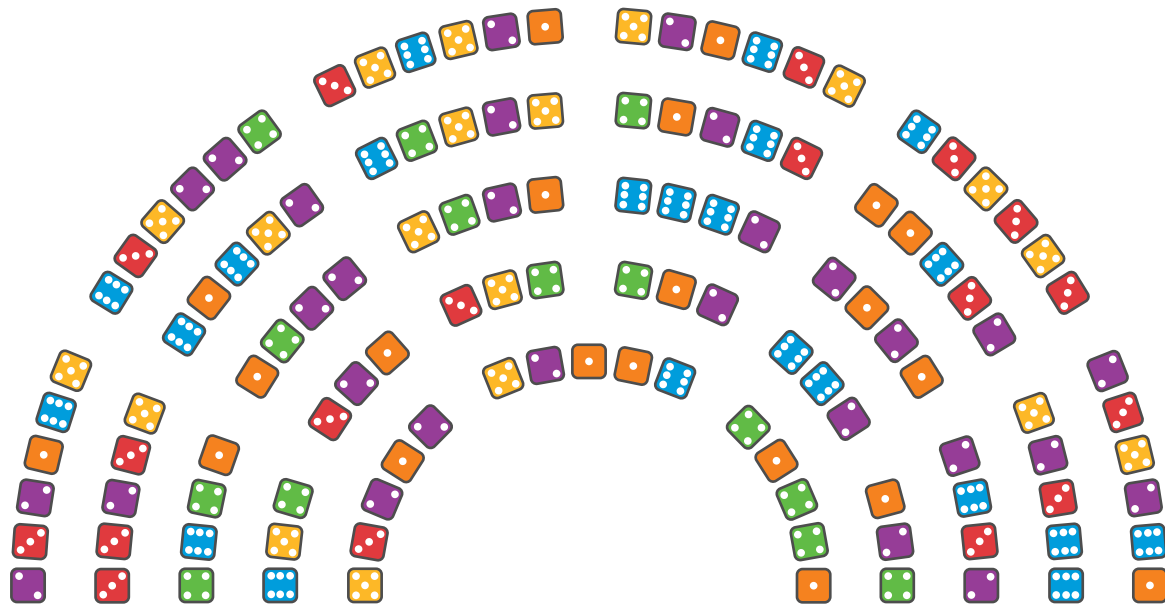
Optimized Democracy

Spring 2022 | Lecture 14

Sortition

Ariel Procaccia | Harvard University

THE PURSUIT OF RANDOMNESS



Sortition—democracy built on
lotteries instead of elections

A BRIEF HISTORY OF SORTITION

462-322 BC

Athens

Council of 500
and magistracies
chosen by lot

1328-1530

Florence

The government
and legislative
council chosen by
lot

1776-present

USA

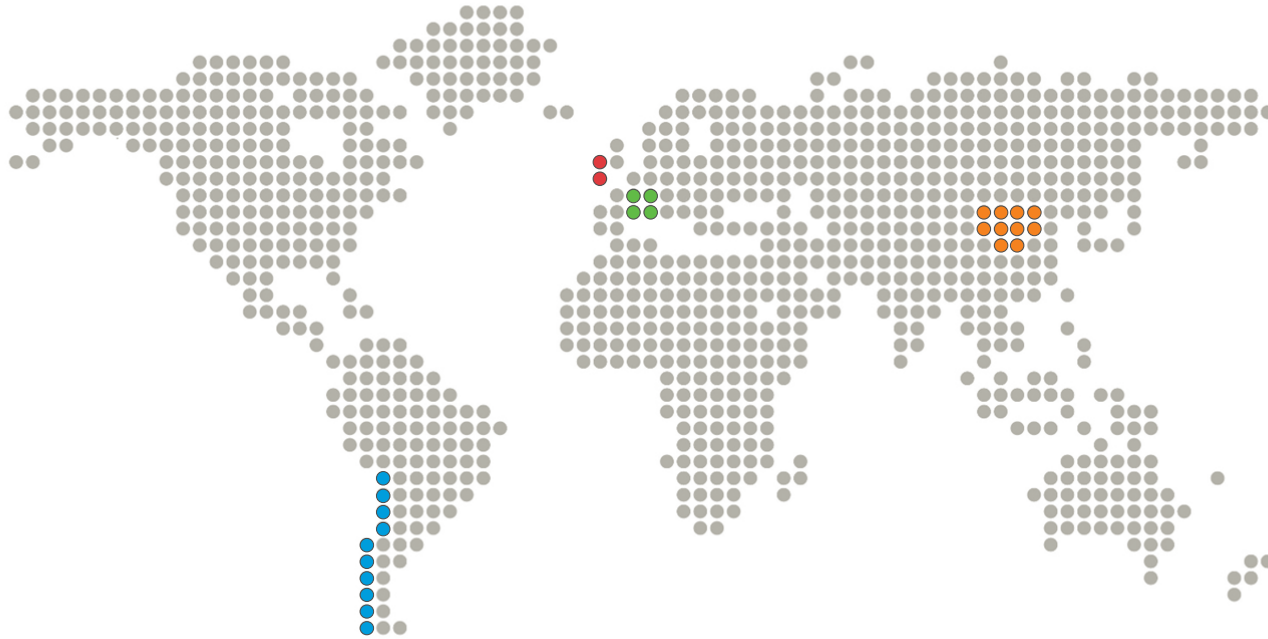
American and
French revolutions
make democracy
synonymous with
elections

21st Century

Worldwide

Citizens'
assemblies
organized by local
and national
governments

RANDOM ASSEMBLY REQUIRED



■ Ireland

Established: 2016

Participants: 99

Topic: constitution

■ France

Established: 2019

Participants: 150

Topic: climate

■ Mongolia

Established: 2017

Participants: 669

Topic: constitution

■ Chile

Established: 2020

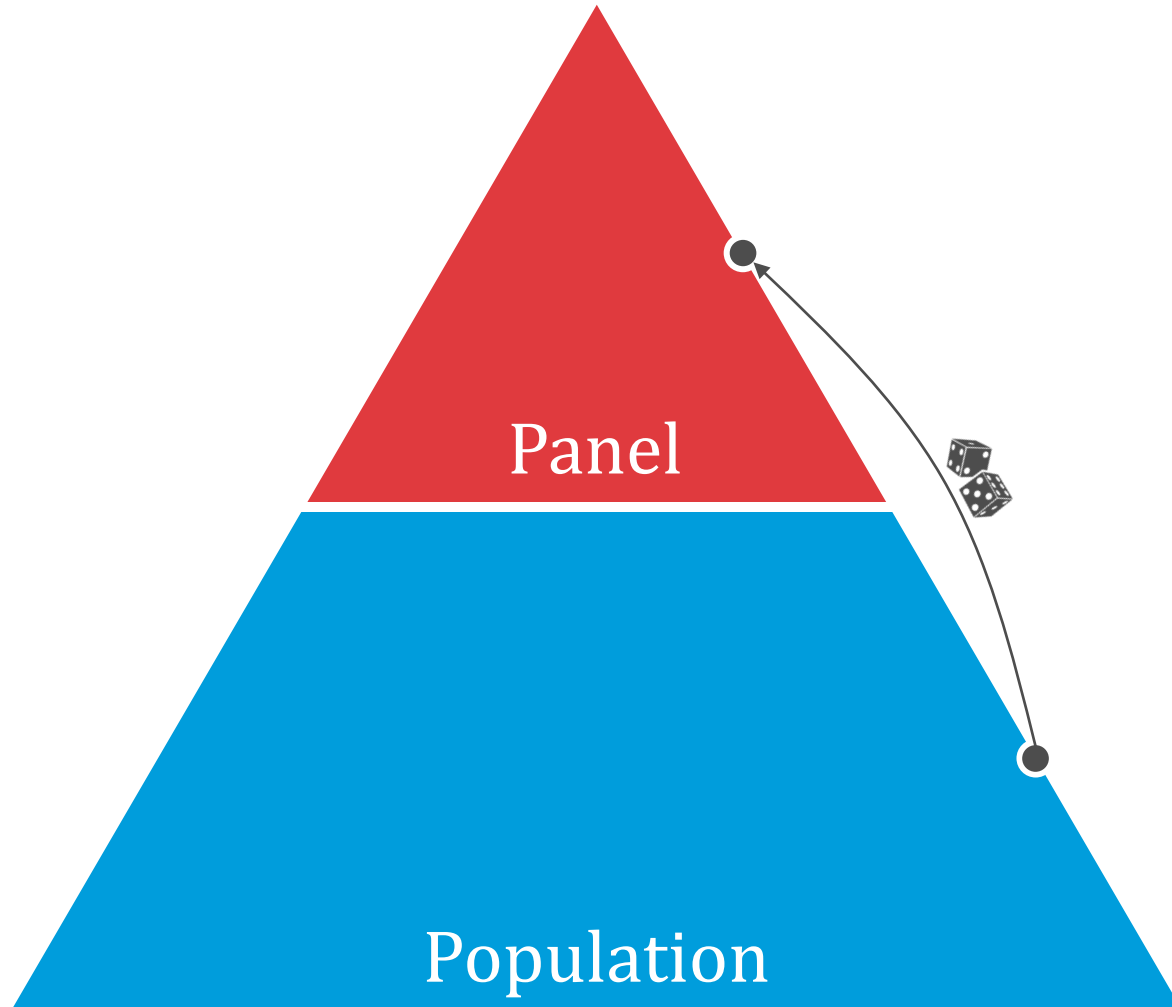
Participants: 400

Topic: pension, health

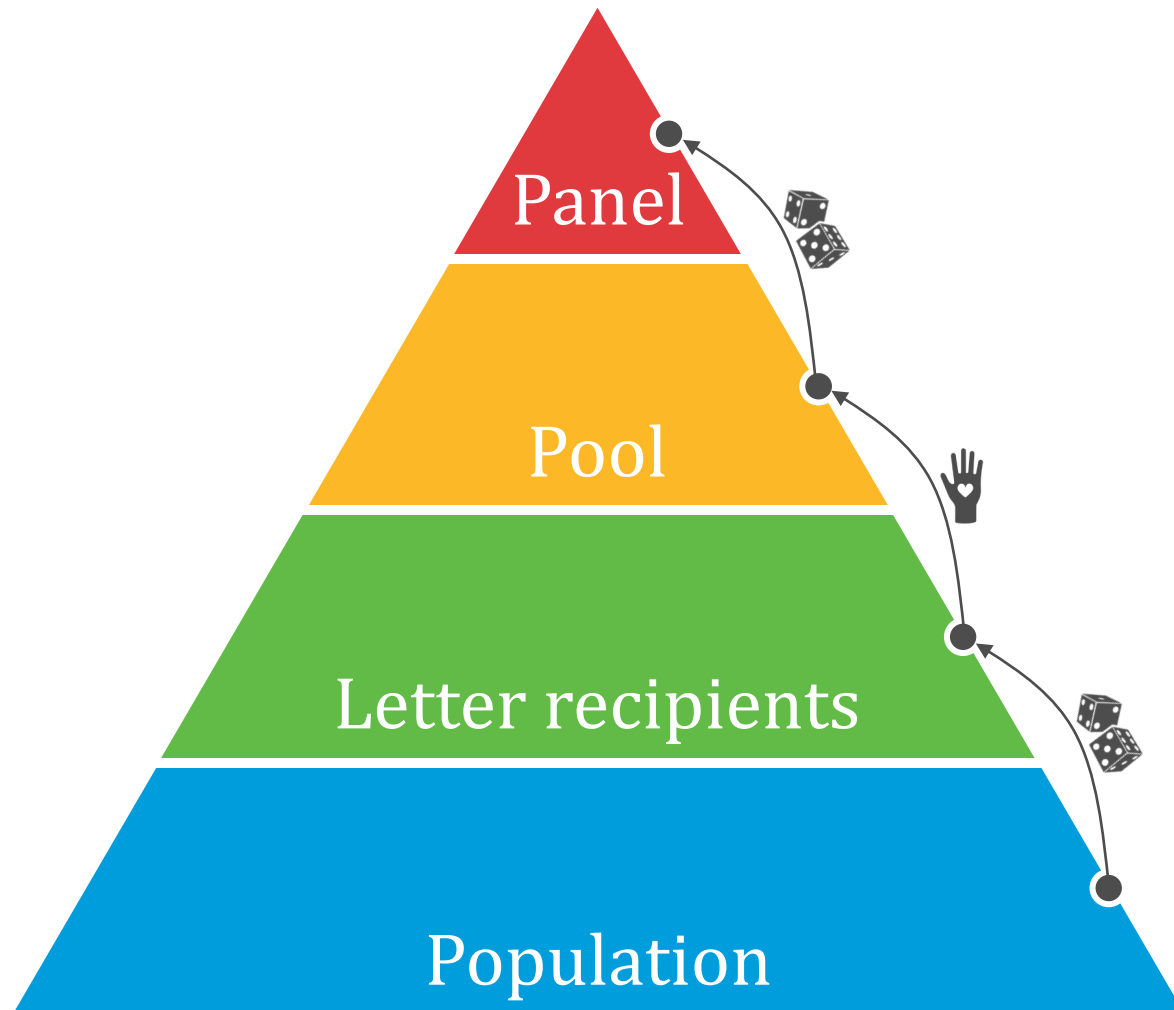


<https://www.youtube.com/watch?v=EDGp5eGnnxI>

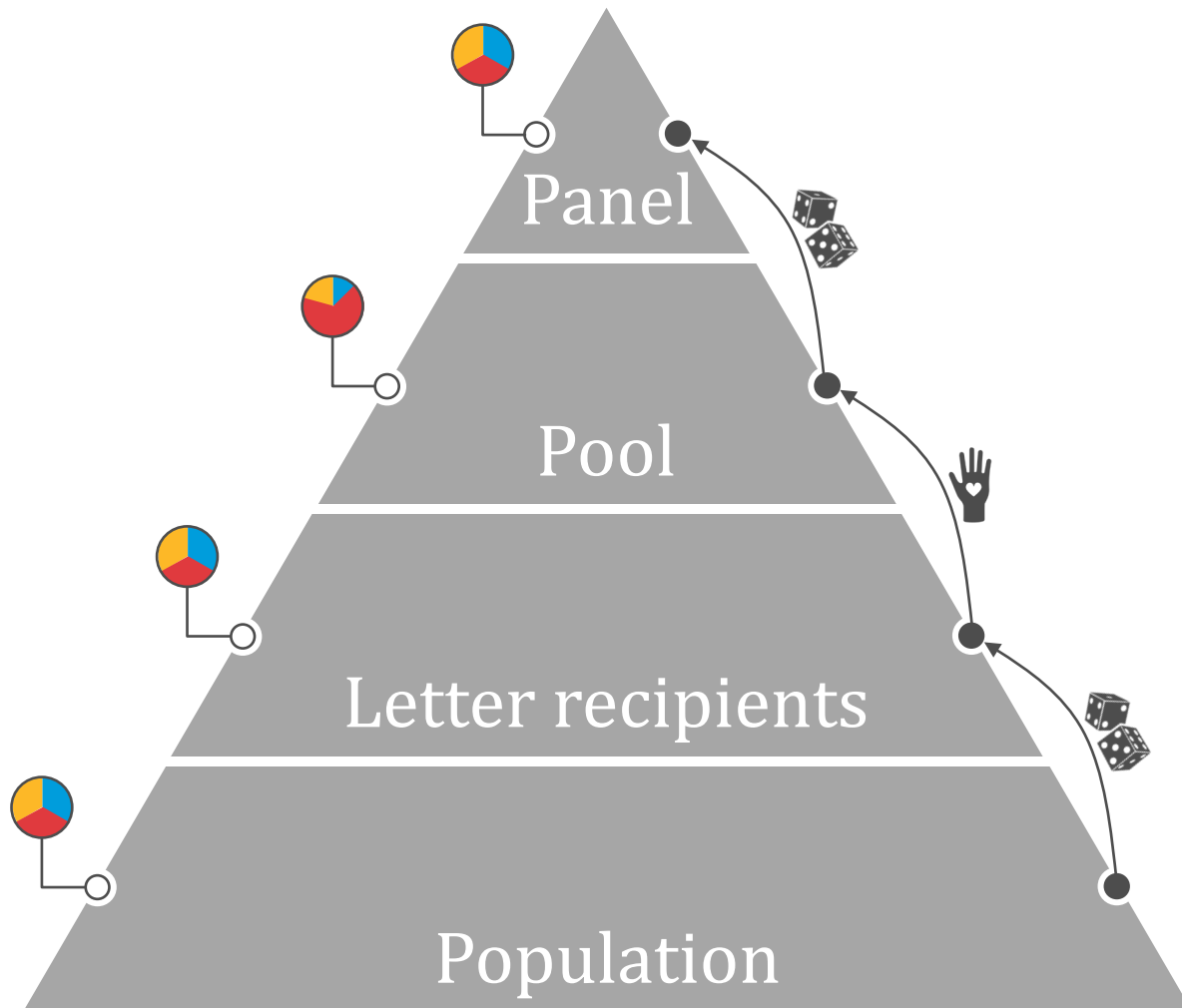
IDEAL SORTITION PIPELINE



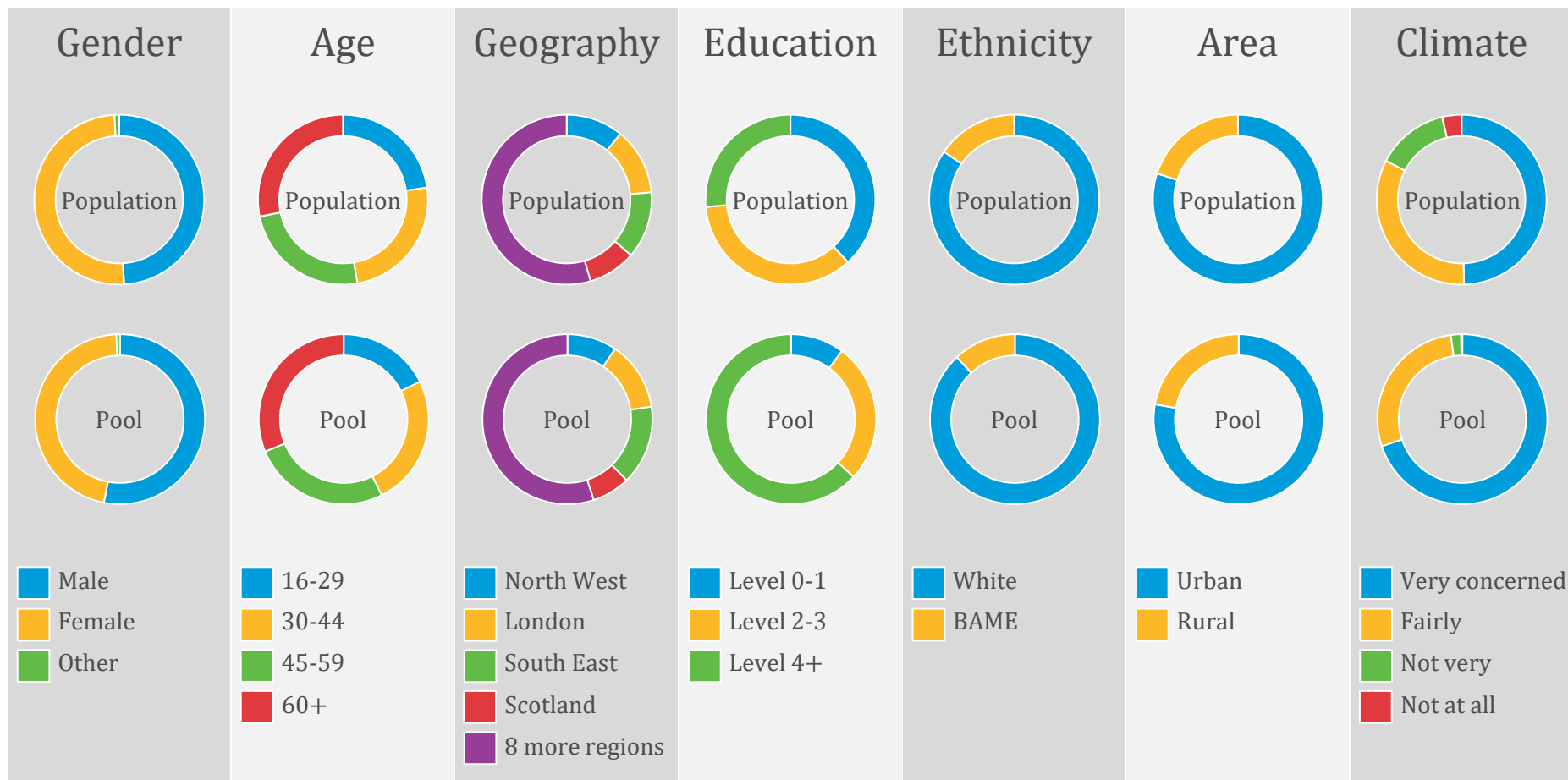
ACTUAL SORTITION PIPELINE



ACTUAL SORTITION PIPELINE

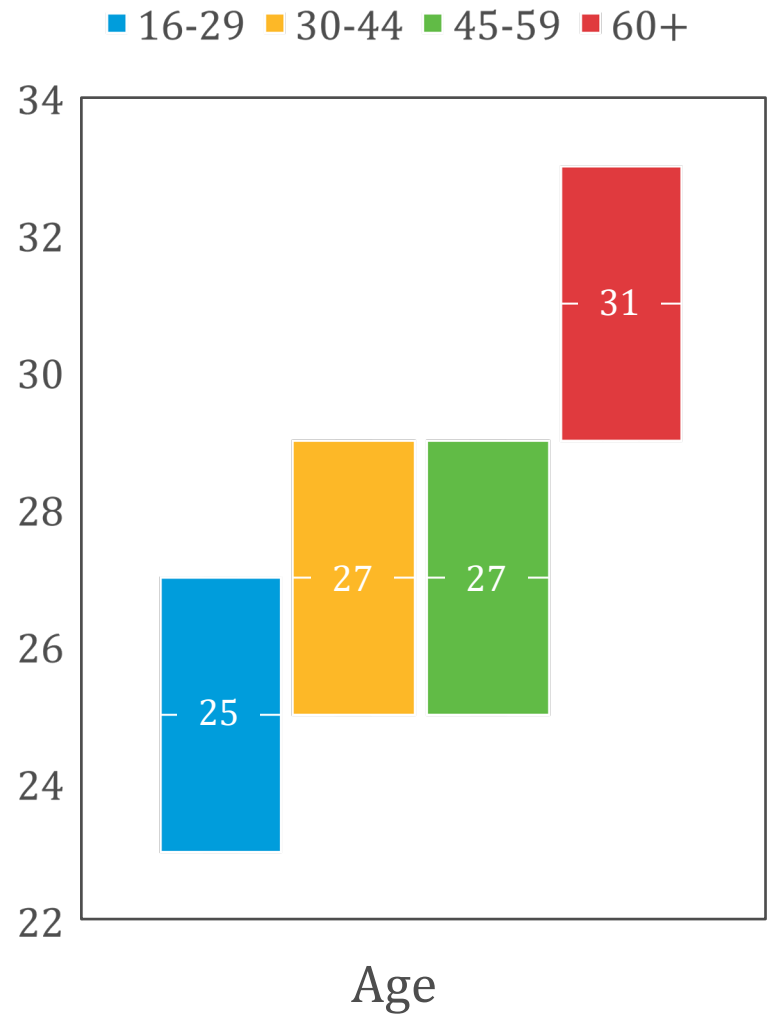
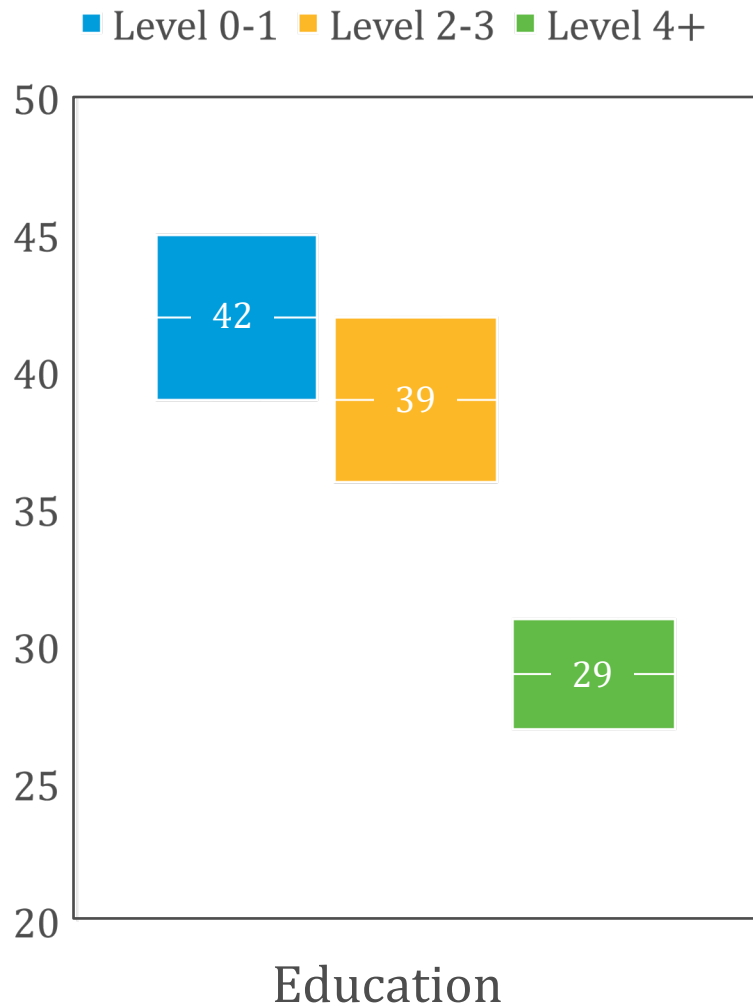


FEATURES



Climate Assembly UK (2020)
 Pool size is $n = 1727$, panel size is $k = 110$

QUOTAS



THE SORTITION MODEL

- Set of **features** F , where each $f \in F$ has a set of **values** V_f
- Multiset of n **volunteers** N where each $\mathbf{x} \in N$ is a vector of feature values
- For each $f \in F$ and $v \in V_f$ there is an **upper quota** $u_{f,v}$ and a **lower quota** $\ell_{f,v}$
- The goal is to choose a **panel** P of k volunteers such that for all $f \in F, v \in V_f$,
$$\ell_{f,v} \leq |\{\mathbf{x} \in P: x_f = v\}| \leq u_{f,v}$$
- Finding a quota-feasible panel is NP-hard

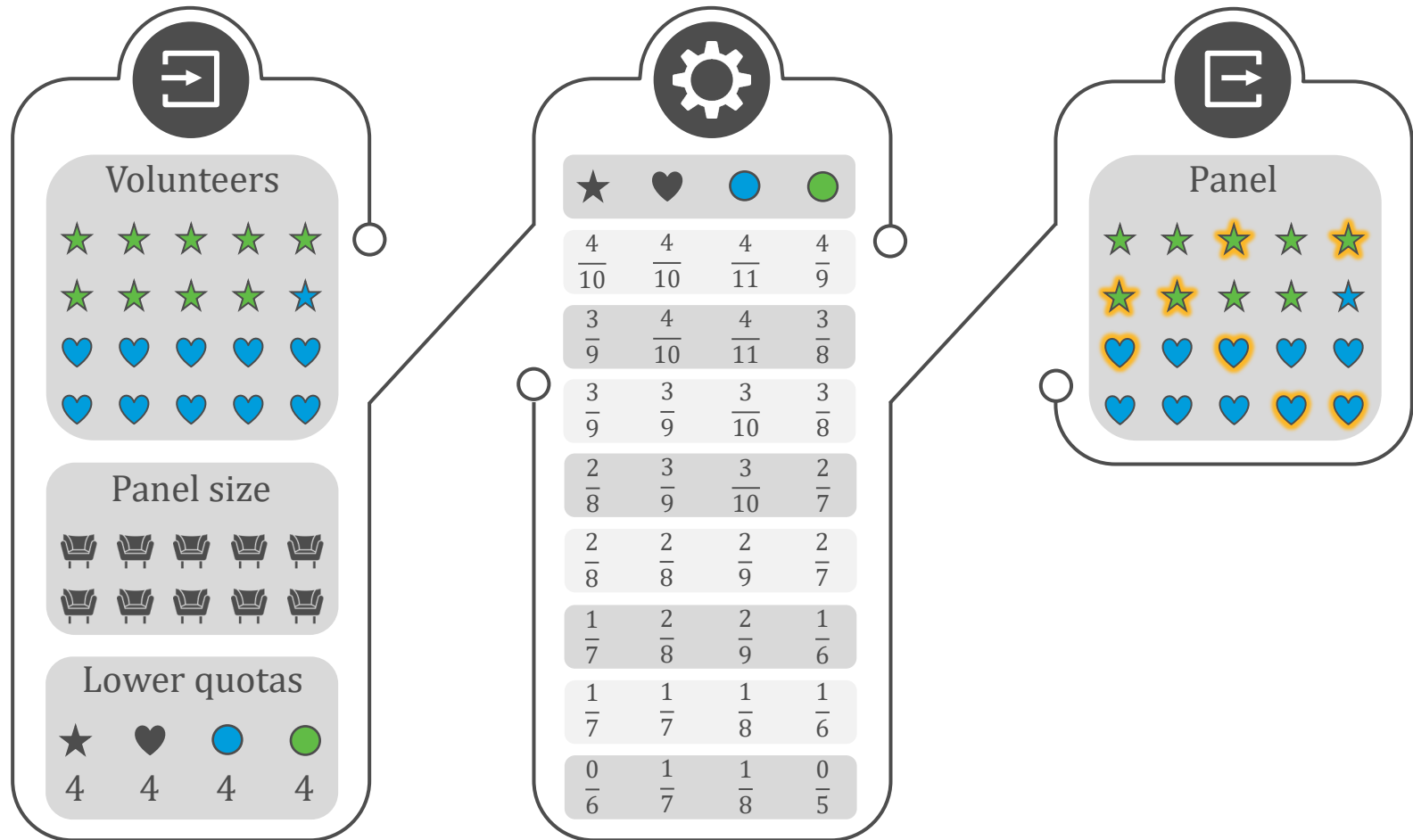
A GREEDY ALGORITHM

- At time t , a partial panel P_t has been selected ($P_0 = \emptyset$)
- For each $f \in F, v \in V_f$ define the score of v to be

$$\frac{\ell_{f,v} - |\{x \in P_t: x_f = v\}|}{|\{x \in N \setminus P_t: x_f = v\}|}$$

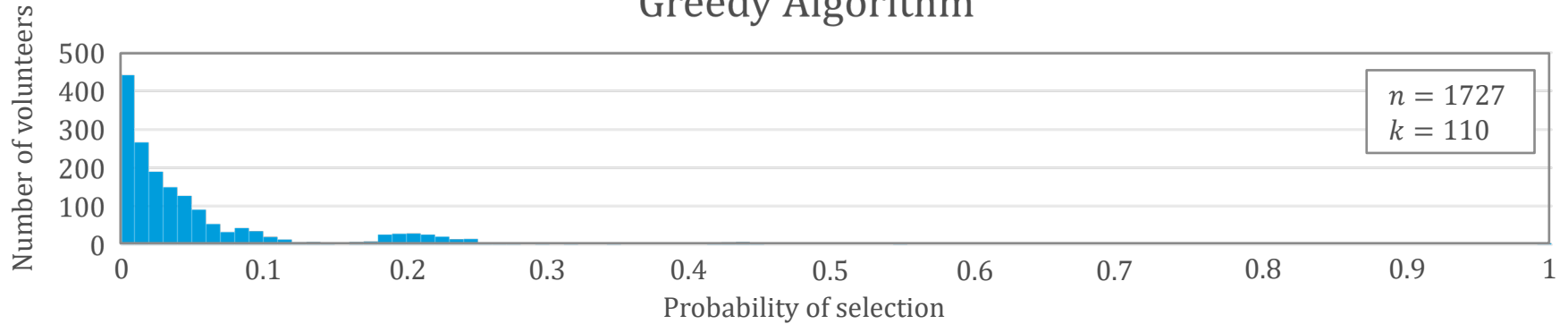
- For v with maximum score, select uniformly at random among $x \in N \setminus P_t$ such that $x_f = v$
- When all lower quotas have been filled, select uniformly at random among $N \setminus P_t$
- If any quotas cannot be satisfied, restart

A GREEDY ALGORITHM

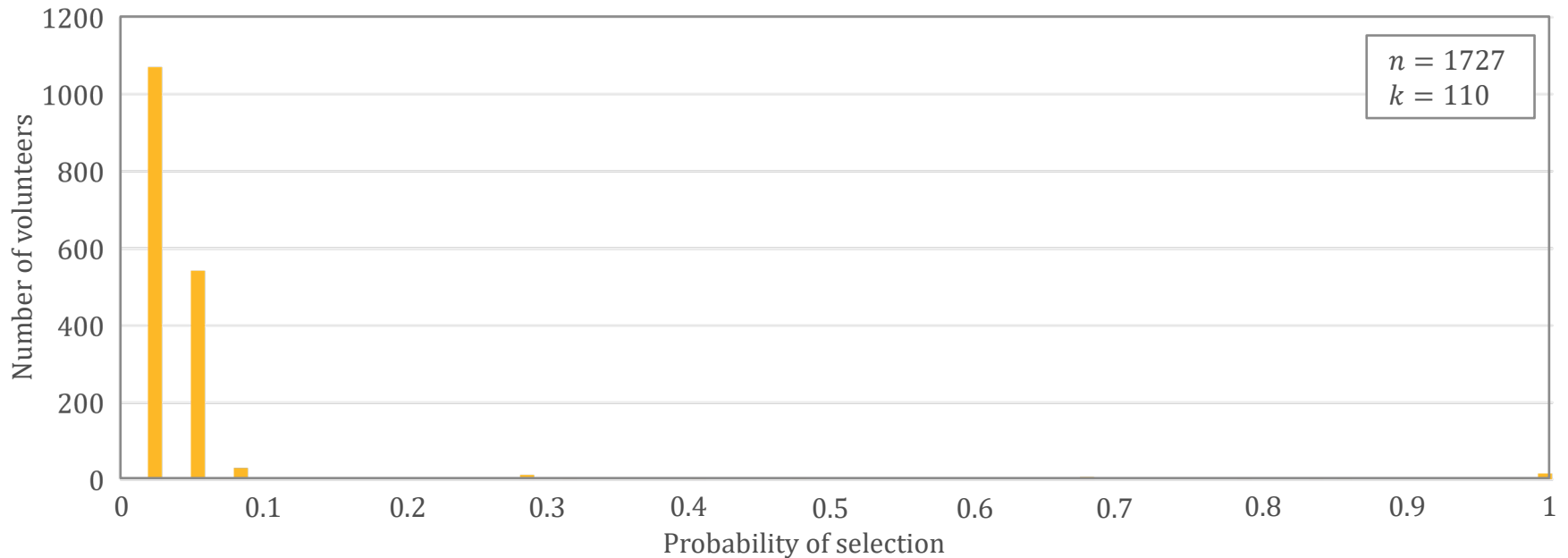


A GREEDY ALGORITHM

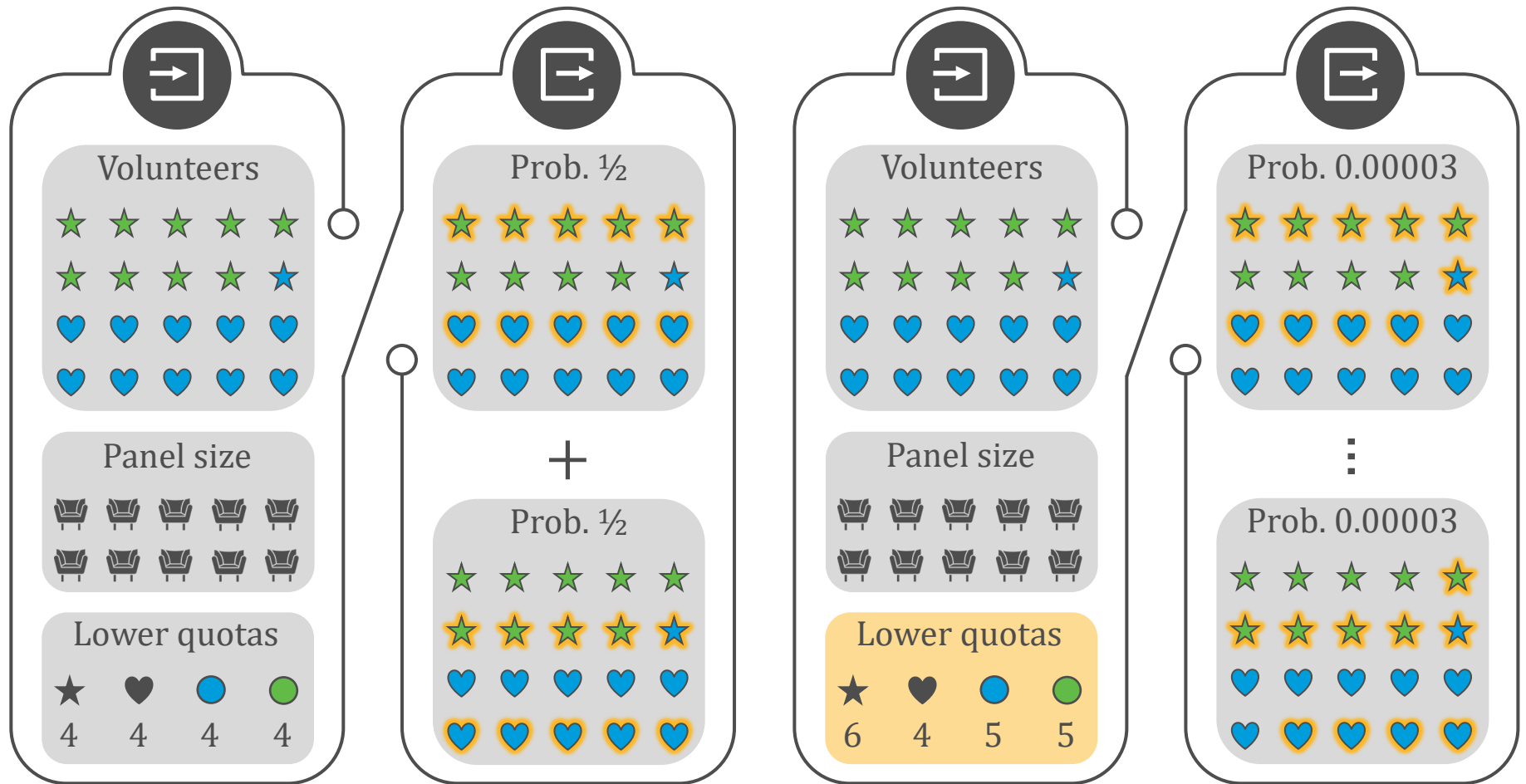
Greedy Algorithm



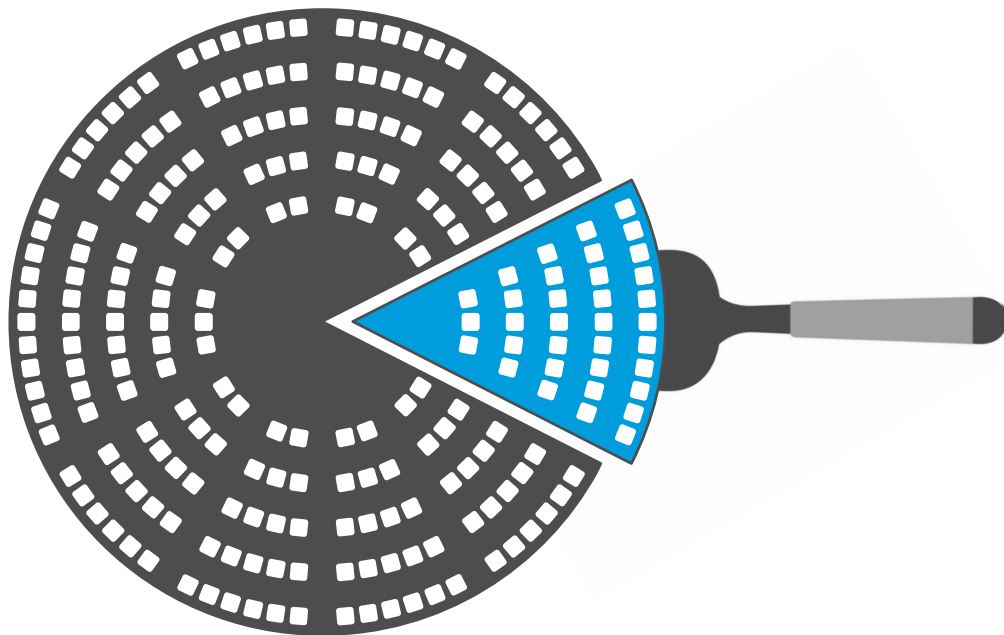
Mystery Challenger



DISTRIBUTIONS OVER PANELS



FROM SORTITION TO FAIR DIVISION



A distribution over panels of size k divides overall selection probability of k between pool members

ALLOCATION RULES

- An allocation rule outputs a distribution $\mathcal{D}$ over quota-feasible panels of size k
- **Maximum Nash Welfare** maximizes the product $\prod_{x \in N} \Pr_{P \sim \mathcal{D}} [x \in P]$
- **Leximin** maximizes $\min_{x \in N} \Pr_{P \sim \mathcal{D}} [x \in P]$, subject to that max the second lowest probability, etc.

Poll

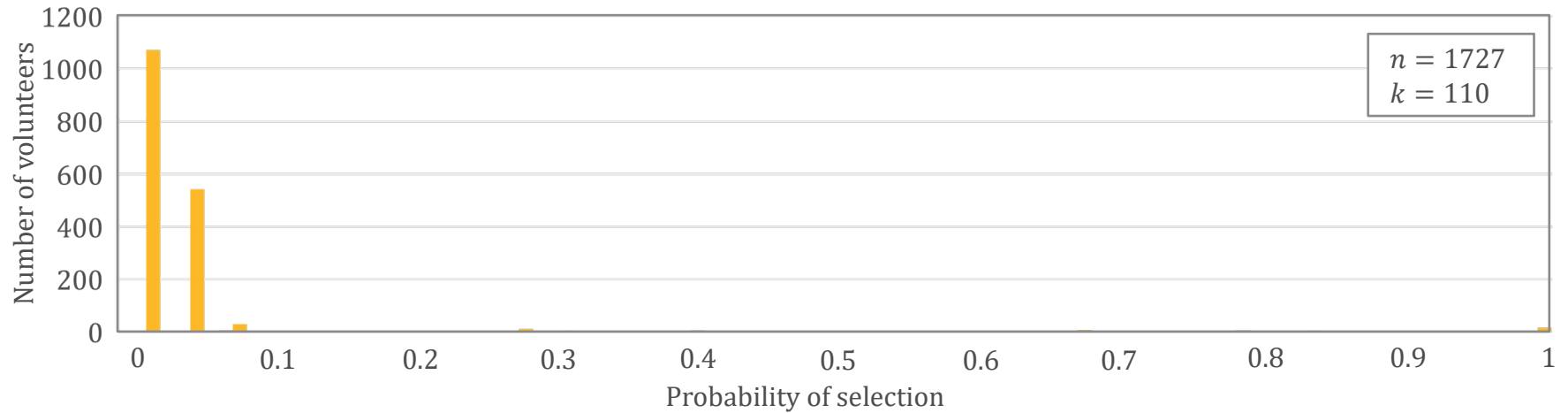
Which of the two rules equalizes volunteers' selection probabilities whenever the quotas make it feasible to do so?

- MNW • Leximin • Both rules • Neither one

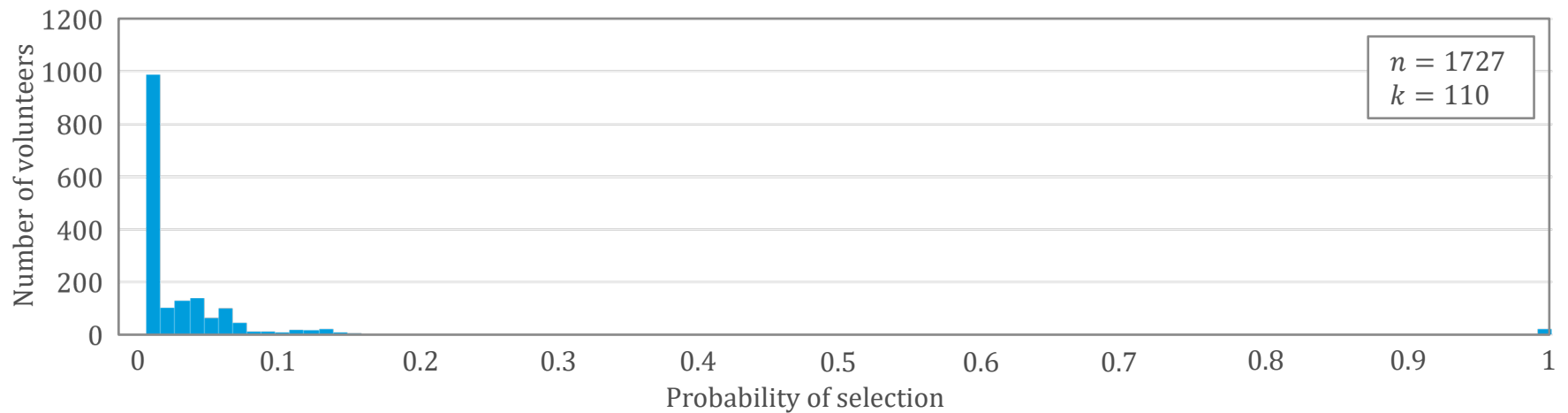


MYSTERY CHALLENGER UNMASKED

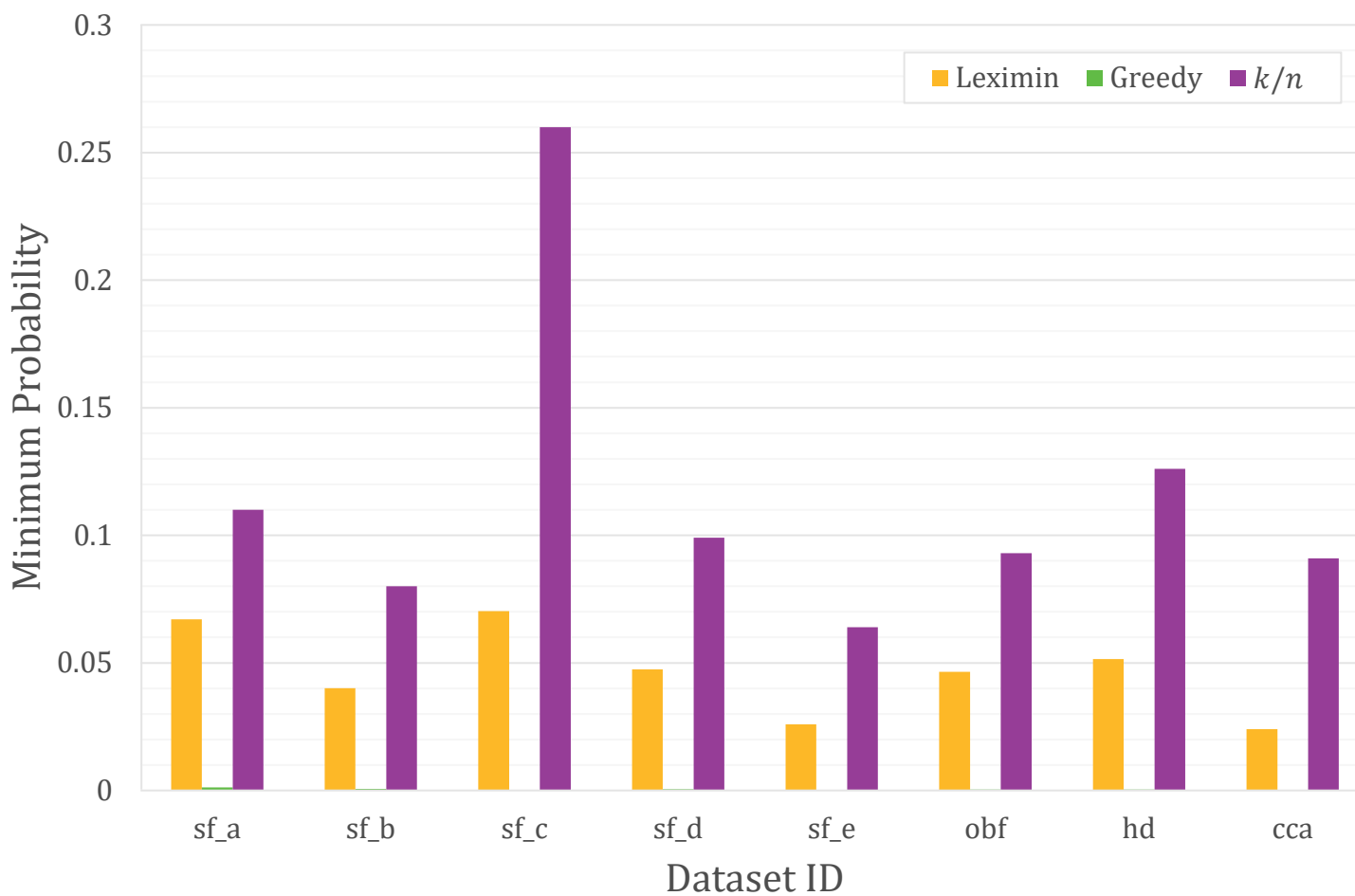
Leximin



Nash Welfare



EVERYONE DESERVES A FAIR CHANCE



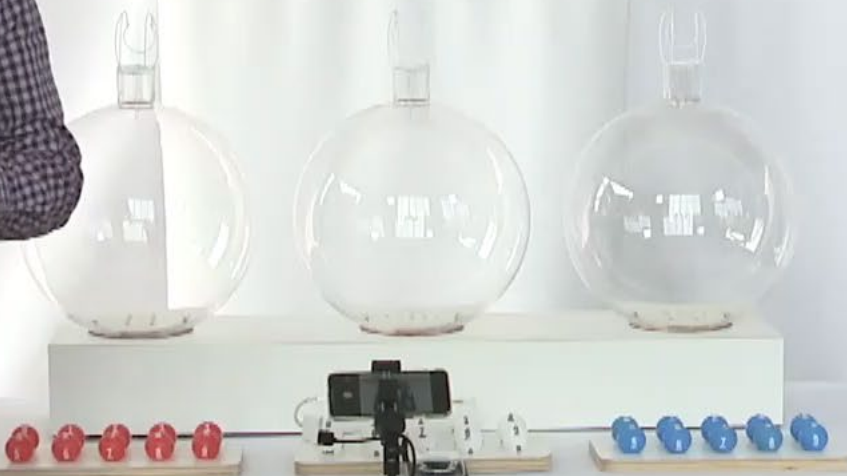


Panelot

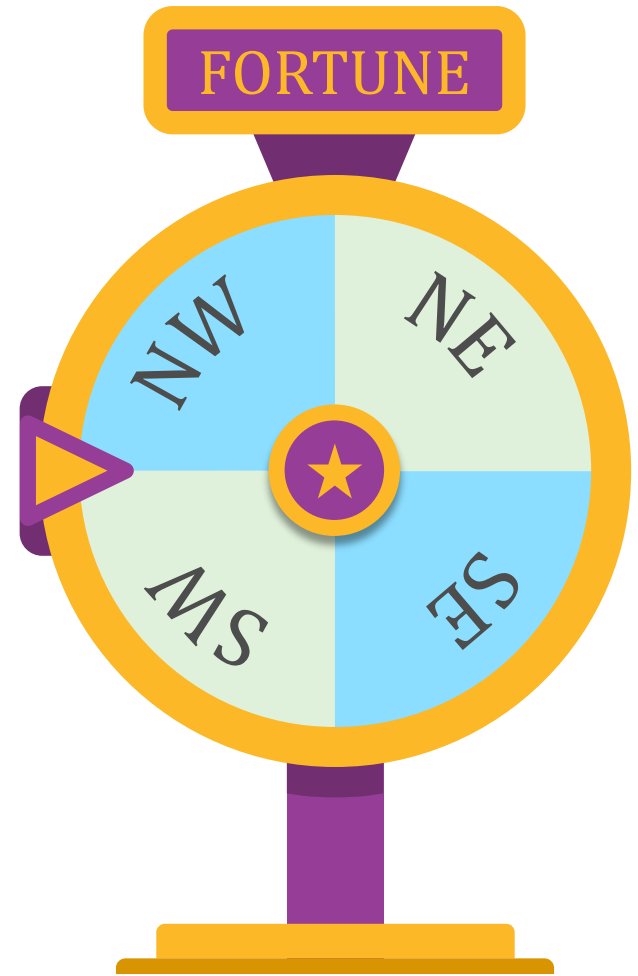
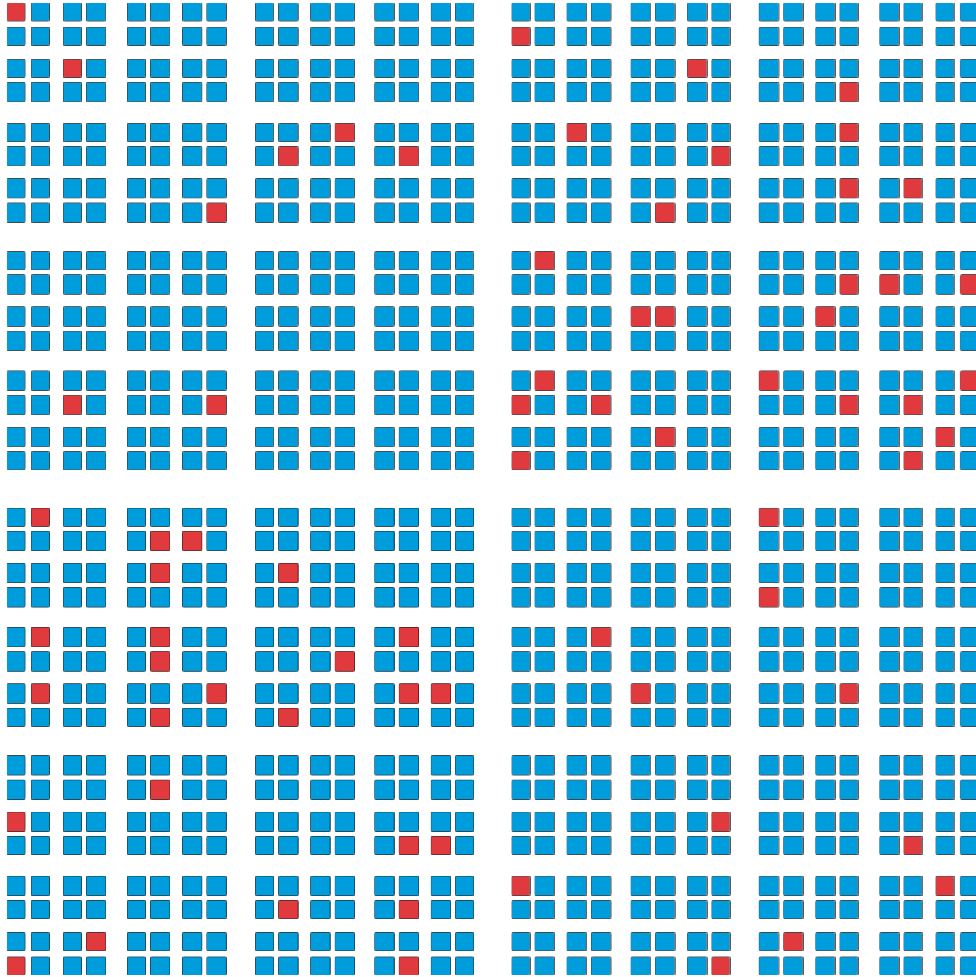
Now online at panelot.org

The
Citizens' Panel
on COVID-19

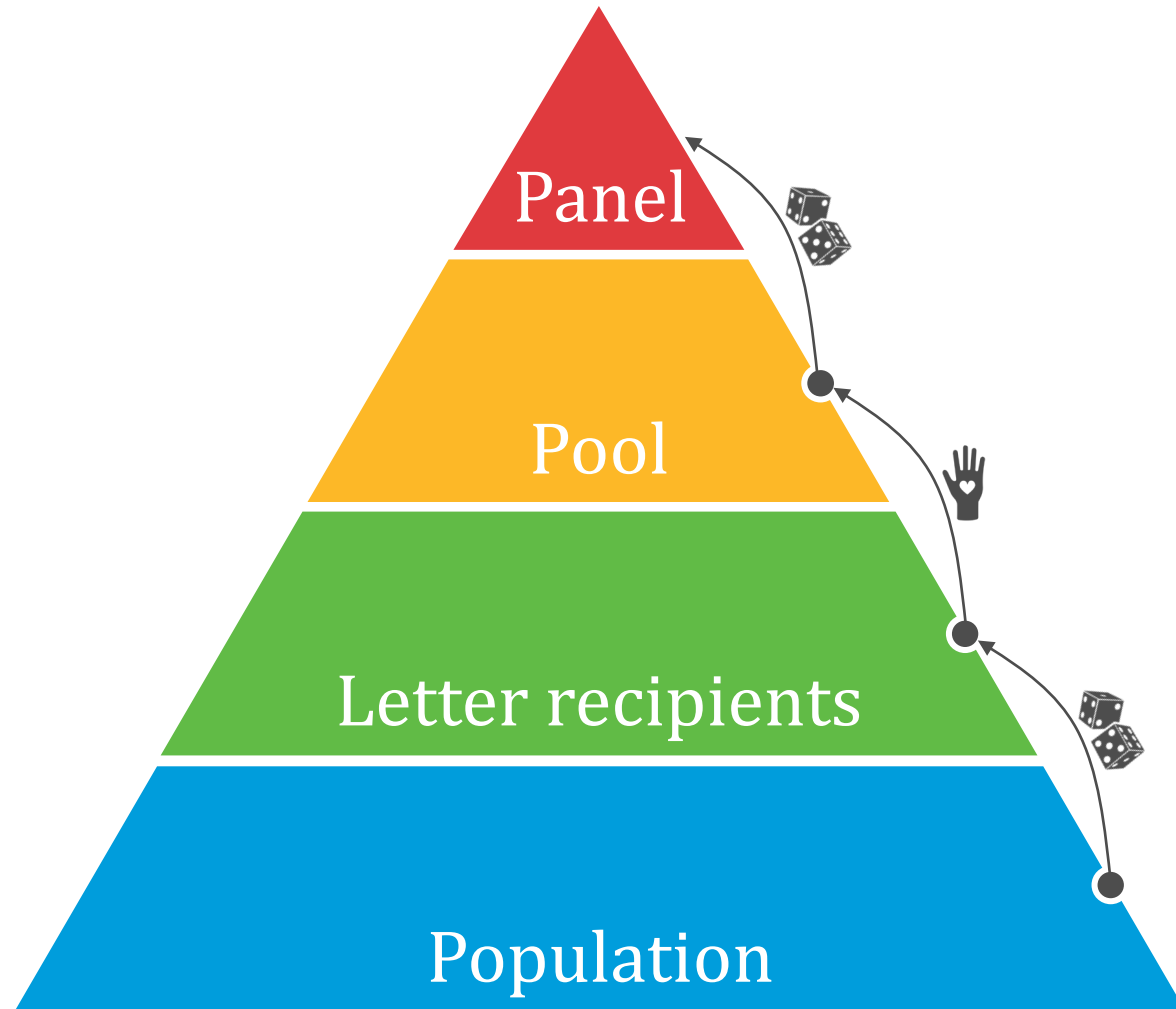
Democratic Lottery



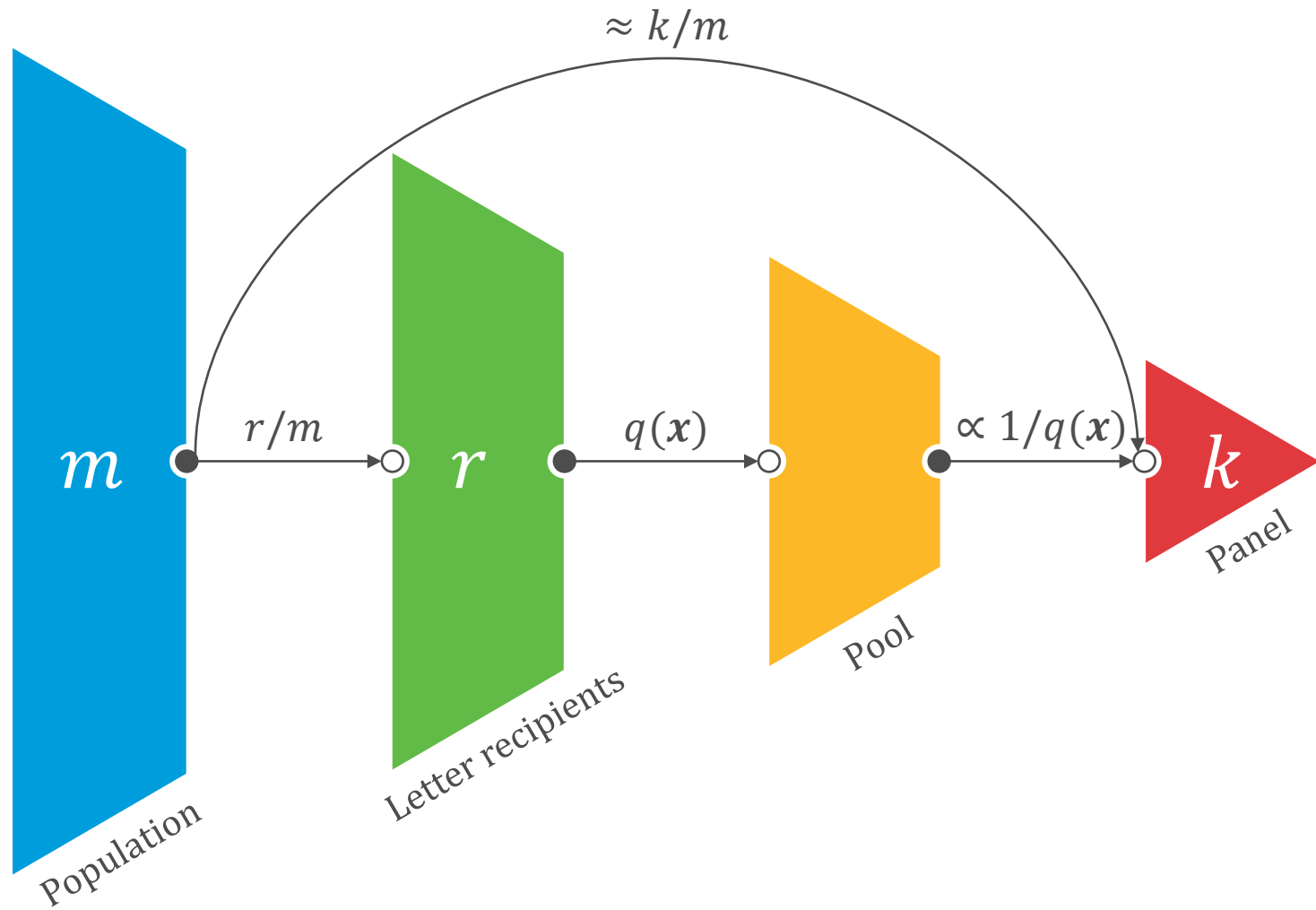
VISUAL SELECTION



SORTITION PIPELINE, REVISITED



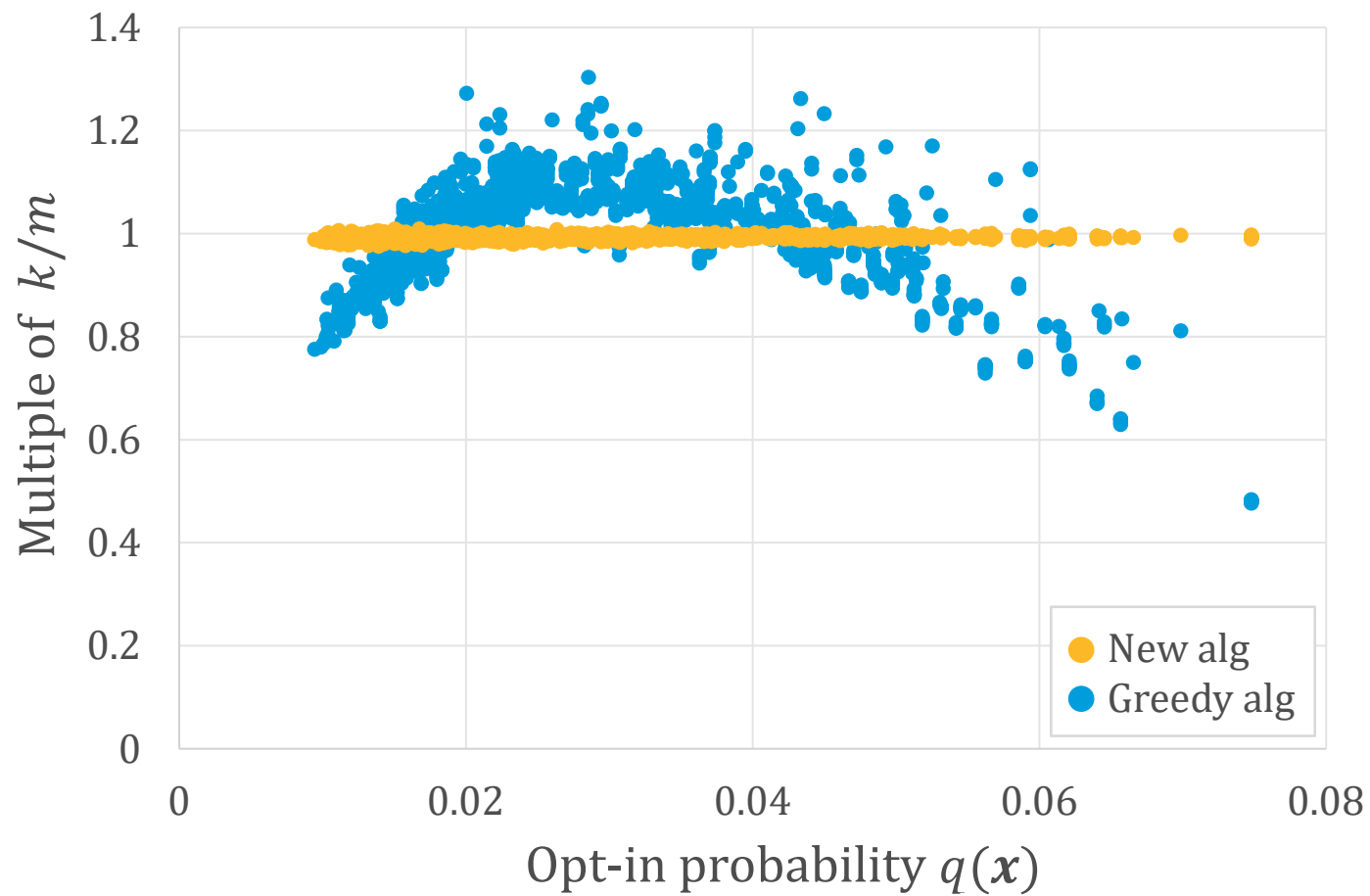
SORTITION PIPELINE, REVISITED



END-TO-END GUARANTEES

- Let M be the population, $|M| = m$, and let r be the number of letters sent
- Let $m_{f,v} = |\{\mathbf{x} \in M : x_f = v\}|$
- Let $q: \prod_{f \in F} V_f \rightarrow [0,1]$ give the opt-in probability of each $\mathbf{x} \in M$
- Let $\alpha = \min_{\mathbf{x} \in M} q(\mathbf{x}) \cdot r/k$
- **Theorem:** Suppose that $\alpha \rightarrow \infty$ and $m_{f,v} \geq m/k$ for all $f \in F, v \in V_f$, then there is an allocation rule such that:
 - $\Pr[\mathbf{x} \in P] \geq (1 - o(1))k/m$ for all $\mathbf{x} \in M$
 - W.h.p., the quotas $\ell_{f,v} = (1 - o(1))km_{f,v}/m - |F|$ and $u_{f,v} = (1 + o(1))km_{f,v}/m + |F|$ are satisfied for all $f \in F$ and $v \in V_f$

EMPIRICAL PROBABILITIES



BIBLIOGRAPHY

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Fair Selection of Citizens' Assemblies. Nature,
2021.

Flanigan, Gözl, Gupta, and Procaccia.
**Neutralizing Self-Selection Bias in Sampling
for Sortition.** NeurIPS 2020.

