Modeling Multi-Winner Approval Voting

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Introduction

Approval voting is a common approach to aggregating preferences from multiple participants.

- Allows people to vote for multiple candidates.
- The candidate with the most votes wins a single-winner election.
- In multi-winner elections, the top X candidates receiving the most votes win the election.

Candidates:	A	B	C	D	E
Utility:	0.05	0.10	0.01	0.25	0

Table 1. Example of a voter's preference distribution

Sincerity in Approval Voting:
When a voter submits a ballot, it is considered a sincere "if and only if whenever he votes for some candidate, he votes for all candidates preferred to that candidate" (Brams 1982). Given the preference distribution in Table 1, a sincere vote could be **[D]**, **[B,D]**, **[A,B,D]**, **[A,B,C,D]** or **[A,B,C,D,E],** but not, for example, **[B].**

Goal:
Model voting behavior in approval voting scenarios with varying degrees of uncertainty and number of winners.

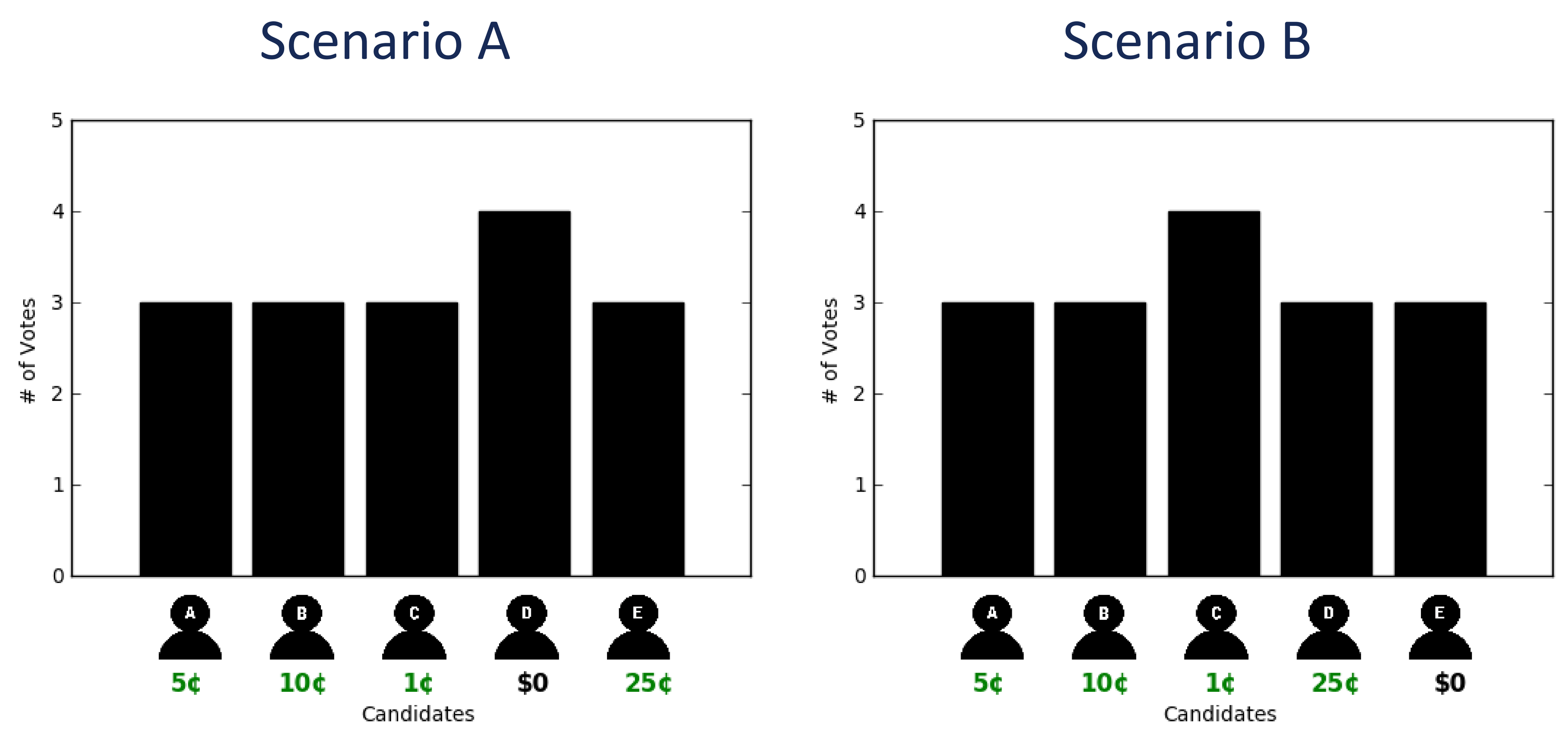
Methods

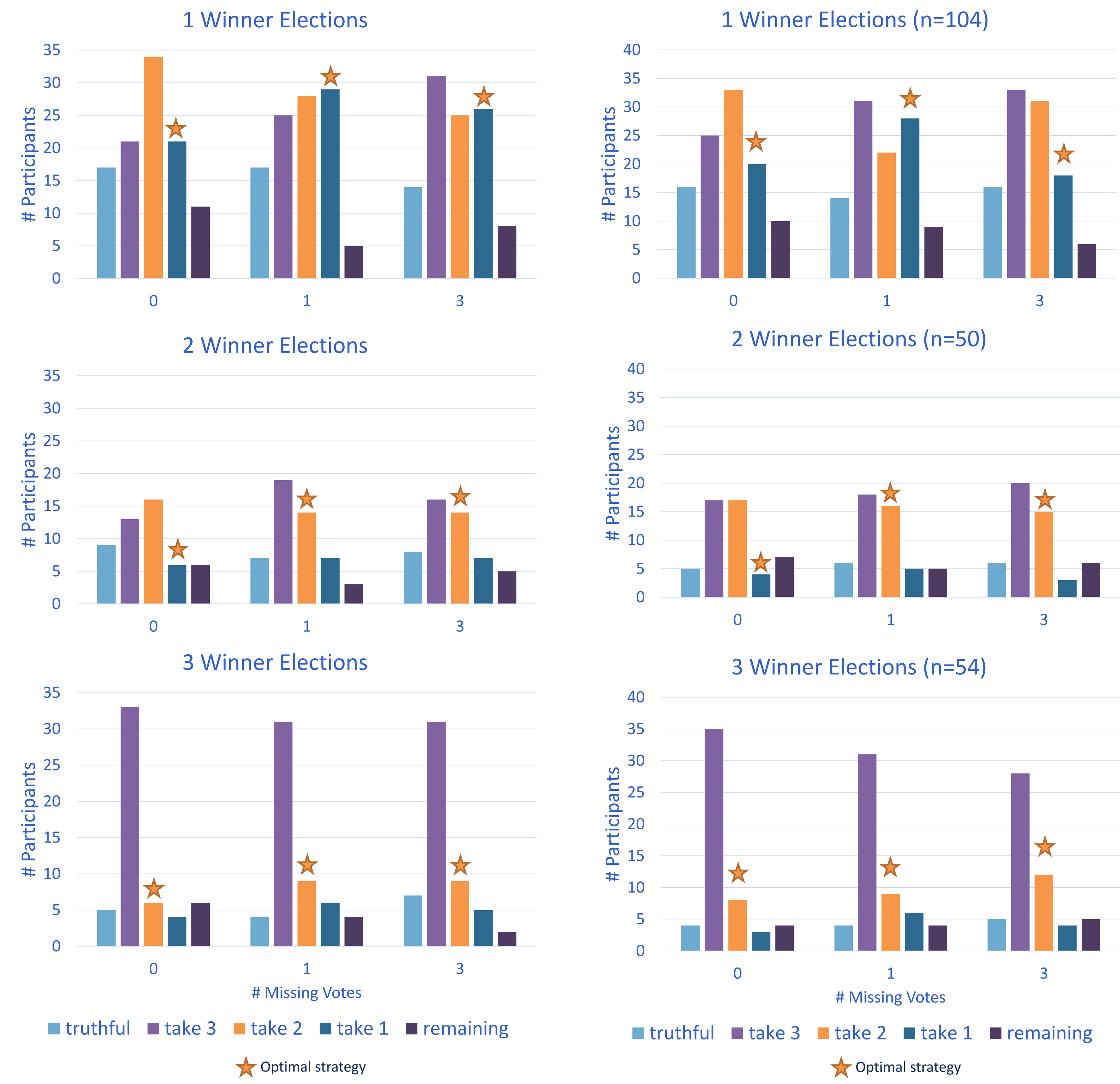
Experimental design.

- 104 participants recruited on Mechanical Turk.
  - *Condition 1*: 1-winner elections (n=104).
  - *Condition 2*: 2-winner elections (n=50).
  - *Condition 3*: 3-winner elections (n=54).
- Participants voted in a series of hypothetical approval elections.
- They were compensated between $1-$8, depending on the outcome of the elections.
- For each condition, participants voted in scenarios A and B with 0, 1 and 3 missing ballots.

Heuristics for Approval Voting:

- *Complete:*
  Vote for all candidates with positive utility.
- *Take the X Best:*
  Vote for the top X candidates.
- *Attainability-Utility (AU):*
  Consider the attainability and the utility of each possible ballot and approve the ballot that maximizes these (Fairstein et al, 2019).
- *Attainability-Utility with Threshold (AUT):*
  Consider the attainability and utility of each candidate and vote for those that exceed a certain threshold.





- 90.9% of participants voted sincerely.
- Voting behavior did not change significantly between scenarios or as uncertainty increased.

Modeling Attainability-Utility and Attainability with Threshold

Attainability-Utility score: Calculated as a tradeoff between attainability and utility. α, β parameters are fit from behavioral data. *b* can represent a ballot or a single candidate. More formal details can be found in Scheuerman et al, 2020.

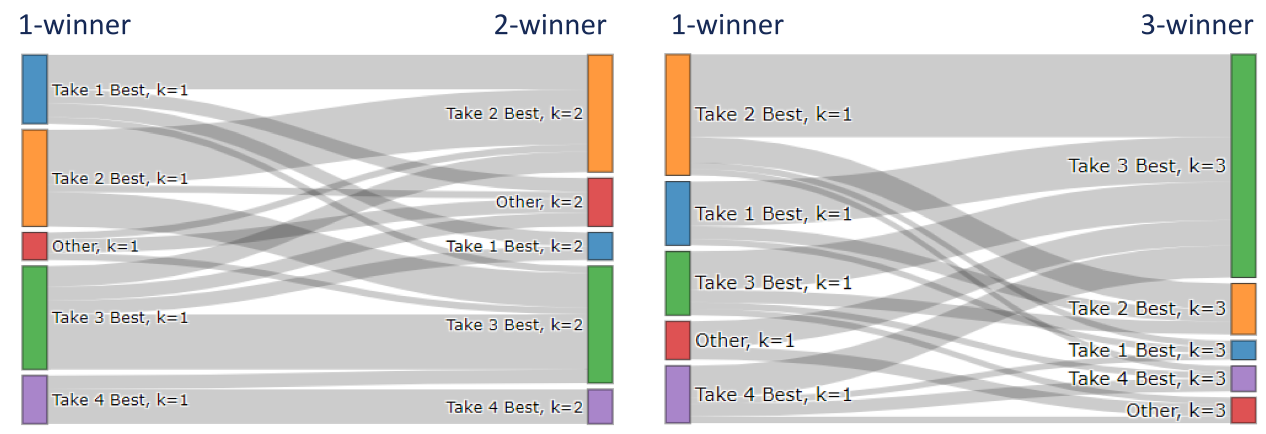
$$s = \boldsymbol{utility(b)^{\alpha} \cdot attainability(b, \beta)^{2-\alpha}}$$

AU: Score is calculated for every possible ballot. Voter approves the ballot that maximizes AU.

AUT: Score is for each candidate. Voter approves only the candidates with a score that exceeds the threshold *t* that is learned from the data.

Behavior changed significantly ($P < 0.0005$) as the # of winners increased.

Scenario B, 0 missing ballots



Model Evaluation

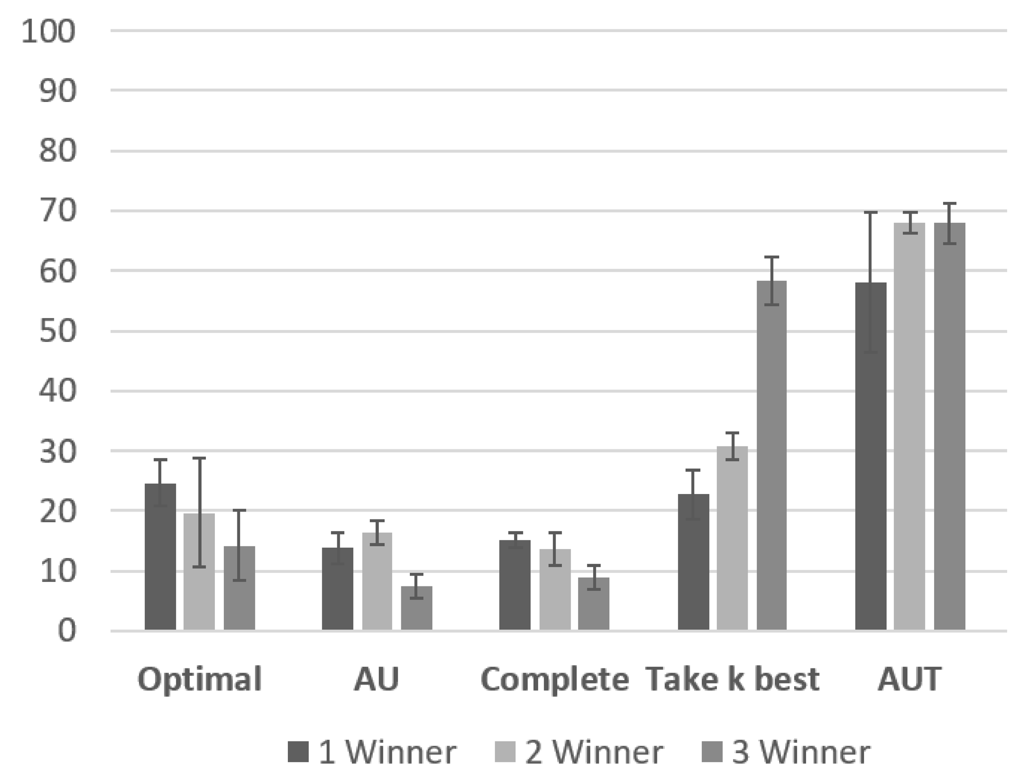
We trained the parameters of AU and AUT for each participant, using the behavioral data from Scenarios A and B, for 0, 1 or 3 missing ballots (6 total examples). Using a Leave One Out approach, we predicted the voting behavior for each participant in each scenario and condition.

We compared the results of *AU* and *AUT* against several other baselines:

- *Optimal Baseline***:** Assumes people vote optimally, approving ballots that maximize their utility.
- *Complete:* Assumes that people vote for all candidates with positive utility.
- *Take the k best:* Assumes that people vote for their top X candidates, where X is equal to the k number of winners in the election.

Evaluation Results

Mean and standard deviation of prediction accuracy for each model across conditions.



References

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Fairstein, R.; Lauz, A.; Meir, R.; and Gal, K. 2019. Modeling People's Voting Behavior with Poll Information. In *Proceedings of the 18th International Joint Conference on Autonomous Agents and Mullti-Agent Systems.*

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