Strategies Improve Social Welfare: An Empirical Study of Strategic Voting in Social Networks

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Abstract

In utilitarian social choice settings, voting systems are commonly used to approximate the optimal alternative, i.e. the one that maximizes *social welfare*, when each agent's ordinal preferences, transformed from its cardinal utility functions over candidates, are available. However, most work does not consider strategic play when using ordinal preferences as a proxy for cardinal preferences. In this paper, we present a decision-making model of strategic voting in iterative settings, where agents are allowed to successively update their vote. Experiment results show that adopting strategic voting can improve the social welfare of selected winners, and our model outperforms the other three models in large social networks. We also investigate Duverger's Law, showing that only the simple heuristic model can replicate the law.

Introduction

- What is utilitarian social choice?
  - selecting an outcome with **the maximal social welfare**, i.e. sum of utility of all agents,
  - using **voting system** to aggregate ordinal preferences when direct access to all agents' utilities is not feasible.
- Limitations of existing work
  - studying the distortion of voting rules via theoretical analysis, lacking empirical support.
  - assumes that all the agents always report the true ordinal preferences, and **do not consider strategic voting.**

Model

Assume agents are located in a social network, where they get incomplete information from their neighbors. The election proceeds in rounds. In each round, agents are allowed to update their votes to be better off.

1. Definition

Definition 1. Election

An Election consits of is a set of candidates $C = \{c_1, \dots, c_m\}$ and a set of agents $V = \{v_1, \dots, v_n\}$, and a total rounds rd that the election runs.

Definition 2. Social network

In social network $G(V, E)$, where $V = \{v_1, \dots, v_n\}$, E is a subset of $V \times V$. $N(v) = \{v_j \in V | (v, v_j) \in E\}$ is a set of neighbors for node v.

2. Euclidean model of elections

- Each agent v and candidate c are represented by **points** in a t-dimensional space, whose coordinates are $p_v = (y_1, \cdots y_t)$ and $p_c = (x_1, \cdots x_t)$.
- If c **is a winner** of the election, the **utility** an agent can get is:

$$u(p_c, p_v) = \frac{1}{\sqrt[2]{\sum_{i=1}^{t}(x_i - y_i)} + 1}$$

- **utilitarian social welfare** is the sum of utility from all agents:

$$SW(V) = \sum_{v \in V} u(p_c, p_v)$$

3. AURe model of strategic voting

- $S = (S_{c_1}, \cdots, S_{c_m})$ is **local information** agent v gets, and $s(c_m) = |b_{v_j} = c_m|$ for $v_j \in N(v)$,
- each agent attributes more weight, denoted by a parameter $\gamma = \frac{1}{1+e^{-rd}}$, to differences in candidates' score in S, as elections proceeds to round rd,
- In round rd, each agent vote for the candidate with the highest balanced value of the updated attainability and utility as :

$$M_{\alpha,\gamma}^{AURe}(u, S) = \arg max_{c \in C}\, u(c)^{\alpha} A_c^{\,2-\alpha}.$$

The α was proposed in [1] to emphasize a trade-off between the attainability and utility, And The attainability of candidate c, proposed in [2], is revised as

$$A_c = \frac{1}{\pi}\arctan\left(\beta_0(1+\gamma)\left(\frac{S(c)}{\sum_{c \in C} S(c)} - \frac{1}{m}\right)\right) + 0.5$$

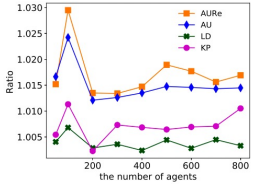
Experiment

1. Experimental settings

Settings	n	m	G	degree	α	β_0
1	63771	5	facebook-WOSN	25.6	[0,2]	4
2	{50,100,200,300,400, 500,600,700,800}	{4,5}	scale-free	20	[0,2]	4

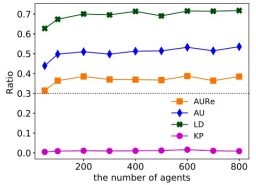
In real large social networks of facebook, the proposed model can still **improve the social welfare** of selected winners, with the ratio between social welfare of the strategic outcome and that of the outcome of the initial state (**Impro**) is 1.0147.

2. Experimental Results



Strategic voting can improve the quality of Plurality rule. And **the AURe model brings the highest amount of social welfare.**

Fig 2(a): **Impro** in 4-candidate elections.



Only KP models can replicate the rule.

Fig 3(a): the ratio of support between the second- and first-runner up candidates in 5-candidate elections.

Conclusions

This paper studies how strategic voting improves the quality of voting rule in a utilitarian setting and our proposed model brings the highest amount of social welfare compared with other three models.

[1] Fairstein, R., Lauz, A., Meir, R., Gal, K.: Modeling people's voting behavior with poll information. In: Proceedings of the 18th International Conference on Autonomous Agents and Multi-Agent Systems. pp. 1422{1430 (2019)

[2] Bowman, C., Hodge, J.K., Yu, A.: The potential of iterative voting to solve the separability problem in referendum elections. Theory and decision 77(1), 111-124(2014)