Strategic Voting and Social Networks

(Doctoral Consortium)

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ABSTRACT

The effects of social networks are pervasive in everyday life, from the subtle effects on mundane, moment-to-moment choices, to political revolutions driven through social media. The last few years have seen a rapid growth of interest in this area from researchers within artificial intelligence and multiagent systems communities. Until recently, relatively little attention has been paid on understanding the effects of these networks on the social aggregation of opinions. My main research question I wish to consider is the impact of social networks on social choice. Specifically, how does communication within social networks affect the strategic voting behavior of the population, and how does it affect the voting outcome?

Keywords

Behavioral game theory, Social choice theory, Social simulation, Agent-based Modeling, Graph theory, Iterative voting, Emergent behavior

1. INTRODUCTION

My current thesis work lays at the intersection of social network and social choice. Social networks have gained tremendous popularity in both research communities and popular media in the last decade. These networks capture the relationships and social structures that define communities both large and small. While early social network research produced theories on how information flows through such a network, and influence is exerted by the popular and powerful, relatively little is known about how this network structure might impact the way in which communities arrive at collective decisions.[1] A social network is typically represented as a graph $G = \{V, E\}$ on a set of vertices V. Each vertex represents an individual, and an edge $(i, j) \in E$ represents a connection between individuals i and j. The graph may be undirected, where $(i, j) \in E$ implies $(j, i) \in E$; or it may be directed. This latter case represents a community where influence (or flow of information) is asymmetric, where i may unilaterally influence j.

[1]With the notable exception of Sina et. al's 2015 paper on social network manipulation, which differs from my work in both the model used and the research question being investigated.

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Social choice theory is the study of collective decision making within a community. We focus on the topic of voting within social choice, where the community must rank a series of alternatives against each other. Each individual i within the community has her own subjective preferences on the alternatives, and submits a ballot b_i (which may or may not accurately reflect her preferences), and a social choice function maps the set of all ballots $\{b_i\}_{i \in V}$ to a final ordering of the alternatives. When an individual submits a ballot that does not accurately reflect her true preferences, she is voting strategically. One way to model strategic voting behavior is to allow voting to take place in successive rounds (which could be thought of as a series of advanced polls). In each round, the voters observe the results of the previous round and may revise their ballots accordingly. A number of papers have been published recently studying this form of *iterative voting* (such as [4] and [10]). This form of iterative voting makes the assumption that each voter receives complete information on the results of each round of voting; i.e. they see the ballots of all voters within the community. Instead of making this assumption, we assume that the visibility of information for each voter is limited to their social network, which may include not only friends and family, but frequent acquaintances, news outlets, and other forms of mass media. My thesis focuses on relaxing the assumption of information availability and examining the effects this has on strategic voting in the network domain.

2. CURRENT AND PLANNED WORK

My initial work [13] on this topic has been accepted to AAMAS 2016, and is based on Clough's early model [5, 6] in this area, using agent based modeling. While Clough's model was based on a simplistic grid based network, I utilize realistic graph models from random graph theory and opinion dynamics literature. In particular, we focus on networks that feature homophily – the tendency for connections to favor agents of similar opinions. This has a notable effect of reducing both the benefit and frequency of strategic voting behavior, and provides insight into the mechanisms behind the "Echo Chamber Effect" in popular media. We show that while voter dynamics are not guaranteed to converge, they often do so quickly in practice. We also show that these results are robust against variations in tie-breaking and update mechanisms. I plan to extend this paper by exploring additional graph models (see below) and different voting rules, which will require scaling up our simulation to run on more powerful architecture, or using maximum-likelihood methods to speed up computation.

It is clear that in iterative voting and in my social network simulations, voting strategies develop and evolve over time. A number of other papers also study the timing effects of voting. Zou, Meir and Parkes [14] have studied voting patterns in the popular social polling website Doodle, and found later ballots made use of information available from previous ballots. Alon et al. [2] examines a behavioral model of "herding" behavior where ballots can be entirely decided by the history of previous ballots, if agents derive utility having voted for the winner. As varied as these papers are, none of them address the ability for voters to control the time at which they commit their ballot. This is what I have called *strategizing along the time axis*, where a voter may choose when to cast their ballot, making it publicly visible, so as to maximize its influence on other voters, and is irreversible. This presents a set of interesting new dynamics to explore. In an environment where other voters are also strategic, an early commitment may help establish a favoured candidate as a "lead runner"; while a late commitment will avoid wasted a vote on a hopeless candidate.

I have done some preliminary analytical work in this area by defining a model of voter timing and studying several special cases in the absence of a social network. Consider a scenario where n agents $(1, \ldots n)$ must decide between k alternatives M, each agent having its over preference over the alternatives. Voting proceeds across T rounds. In each round, each voter who has not yet submitted a ballot yet may choose to cast their ballot. This decision is made simultaneously within each round, and their decision and ballot are revealed publicly. Alternatively, a voter may choose to refrain from casting a vote, and wait. In my basic analysis, I have shown that in a 3-player game with circular preferences, there is a subgame perfect Nash Equilibrium where it is in each agent's best interest to vote for their *second* preference with probability 0.2, and to wait with probability 0.8. I suspect this behavior is likely degenerate to small groups with complete knowledge of each others' preferences, and that this "first mover disadvantage" may disappear in larger groups. I hope to be able to extend this work to more general models using either analytical or empirical techniques.

Currently, I also am developing a new random graph model to accurately reflect the evolution of online networks. A central characteristic of human-made networks is that they feature a handful of very high-connected hubs and numerous sparsely connected nodes. This scale-free property was first characterized in the Barabasi-Albert model [1]. Recent work extends this model to directed graphs [3] where communication and influence between nodes may be one-directional, and separately, to feature high clustering coefficients [9] where the two agent sharing a common acquaintance are more likely to be connected to each other. My current work will be the first model to incorporate all three key properties that are found in social networks. I plan to produce both a theoretical analysis of this class of graphs, and to use these graphs to conduct future social choice simulations.

While not part of my thesis work, I have also worked on a related project investigating "should social network structure be taken into account in elections". This is a paper in response to the question posited by Conitzer in his 2012 paper of the same name. While his followup paper [7] answers this in the negative, we propose a more detailed model that answers in the positive. We show that under certain assumptions, we can improve the accuracy of aggregation protocols by up to 20% by using information from the social network of simulated voters. This is joint work with other researchers from my lab [12, 8], which we plan to submit as a journal paper.

In short, the crossroads of computational social choice and social computing is proving to be fruitful grounds for exploration by the AI community. My research has the potential to revolutionize our understanding of online environments, recommender systems, and strategic dynamics in both online and social environments.

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