A win for society! Conquering barriers to fair elections

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Abstract

Social choice is a general framework used in the aggregation of agent preferences to make a collective decision, political elections whereby agents vote is a common example. It is often the case that society demands electoral systems which ensure, or election outcomes which satisfy, socially desirable outcomes such as representing large minorities and avoiding the 'tyranny of the majority'. Unfortunately, there are many natural barriers which may prevent desirable outcomes from being achieved. These barriers include the non-existence or computational intractability of achieving desirable outcomes, especially when combined with additional feasibility constraints, and the effect of strategic or manipulative agents. This thesis aims to improve our understanding of the scale of these barriers and if, or how, they can be overcome to provide socially desirable outcomes.

Introduction

Social choice is a general framework of preference aggregation in which voters express preferences over outcomes and a desirable outcome is selected based on the preferences of the voters (Aziz et al. 2017a; Conitzer 2010). It has also been motivated as being especially relevant to ethical and principled decision making in multi-agent settings (Conitzer et al. 2017). One particular principle which is often strived for by societies world-wide is that of proportional representation in multi-winner, or committee, elections (Dummett 1984). This principle captures the idea that election outcomes should represent the diverse preferences of voters, and avoid the 'tyranny of the majority'. Recently, a number of 'fairness' principles related to proportional representation have been the subject of intense research (Aziz et al. 2017b; Sánchez-Fernández et al. 2017; Aziz and Huang 2016).

This thesis aims to improve our understanding of when, and how, fair outcomes can be achieved in elections. The research is particularly focused on understanding what barriers naturally arise which may prevent a society from achieving a fair outcome and if, or how, these barriers can be overcome. A variety of 'fairness' principles, or axioms, are considered in my research and, where necessary, modified to suit the context of interest – all of these 'fairness' axioms relate to the well-known notion of proportional representation. However to avoid technical details this extended abstract will not distinguish between specific fairness axioms and instead will refer generically to 'fair outcomes' which should be understood to be appropriately adapted to the context of focus.

Three natural barriers to fair outcomes arise in election settings; firstly, computational barriers may render fair outcomes as computationally intractable for large elections; secondly, additional constraints on election outcomes may generate a barrier such as diversity quotas. Lastly, the strategic behaviour of self-interested voters may act as a substantial barrier to achieving fair outcomes. The two former barriers are explored in section 2 and the last barrier is explored in section 3. Throughout this paper I will highlight my existing contributions, and plans for further research.

Election constraints and computational concerns

When voters are assumed to vote sincerely (revealing their true preferences) there still may exist barriers which can prevent a fair outcome from being achieved. In particular, in some settings a fair outcome may not exist for certain compositions of voter preferences, in other settings a fair outcome may always exist but the task of calculating such an outcome may involve solving an NP-Hard problem effectively rendering it computationally intractable for large elections. This line of research has been extensively studied in recent years (Aziz et al. 2017b; Sánchez-Fernández et al. 2017; Aziz and Huang 2016).

My thesis question considers these same questions but when faced with additional constraints which naturally arise in social choice settings such as elections. For example in some multi-winner, or committee, voting instances diversity constraints may be present in the form of a quota, say on the number of male or female committee members.

Other, less concrete and more subjective, constraints can arise based on what is considered to be a 'good' electoral system. For example, a widely used[1] voting system called the Single Transferable Vote (STV) guarantees a fair election outcome, satisfying proportional representation, but is considered to be 'perverse' and hence undesirable due

[1] currently STV is used in national elections in Australia, India, Pakistan and Northern Ireland.

to a violation of what is known as a monotonicity property (Doron and Kronick 1977). Informally, this violation implies that a candidate may loose an election under STV due to receiving too many votes. Overcoming this monotonicity constraint, or barrier, and maintaining a fair election outcome has been termed a major open problem (Woodall 1997).

My research, to date, has contributed to the issue of achieving fair outcomes under the two constraints introduced in the preceding paragraphs. In the context of diversity constraints my joint work[2] (Aziz and Lee 2017b) has shown that diversity constraint can indeed prevent standard notions of fair outcomes from being achieved via non-existence results and also computational intractability results. However, by weakening the standard notions of 'fairness' a more appropriate axiom can be formulated for diversity constrained election whereby fair outcomes can be guaranteed to exist and computed via a computationally tractable algorithm. In the context of monotonicity constraints my joint work[3] (Aziz and Lee 2017a) has proposed a compelling solution to the 20 year old open problem of constructing a voting rule which maintains the desirable fairness features of STV, is computationally tractable, and also satisfies stronger notions of monotonicity.

Strategic concerns

In many settings it is dangerous to assume that voters will act sincerely when a manipulative but profitable action exists. Indeed this strategic and self-interested behaviour is the basis of microeconomic theory, and can present a substantial barrier to achieving fair outcomes. In particular, it has long been known that under very general conditions every voting rule can be manipulated by strategic voters (Gibbard 1977; Satterthwaite 1975).

My thesis considers a novel approach to achieving fair outcomes in the presence of strategic voters, by considering voting rules which are robust to strategic voters in the sense that they admit (possibly insincere) equilibria which are guaranteed to satisfy fairness axioms with respect to the true and unrevealed preferences of voters. In this pursuit, I have a number of promising results showing the existence of such a voting rule for a restricted setting of voter preferences. This is a continuing piece of work, in the future I would like to expand the results to a more general setting.

An additional contribution I have made to my thesis question is about the effect of an unorthodox electoral system used in Switzerland, in particular a restriction which is enforced on the number of candidates that a citizen can vote for. My work[4] (Lee 2017), among other results, shows that in an environment where voters are strategic, restricting the number of candidates that a citizen can vote for generates inequality by favouring certain groups of voters over others.

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[3] Submitted for journal publication.

[4] Submitted for journal publication.

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