Computational Complexity of Two Variants of the Possible Winner Problem

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Abstract

A possible winner of an election is a candidate that has, in some kind of incomplete-information election, the possibility to win in a complete extension of the election. The first type of problem we study is the Possible co-Winner with respect to the Addition of New Candidates (PcWNA) problem, which asks, given an election with strict preferences over the candidates, is it possible to make a designated candidate win the election by adding a limited number of new candidates to the election? In the case of unweighted voters we show NP-completeness of PcWNA for a broad class of pure scoring rules. We will also briefly study the case of weighted voters. The second type of possible winner problem we study is Possible Winner/co-Winner under Uncertain Voting System (PWUVS and PcWUVS). Here, uncertainty is present not in the votes but in the election rule itself. For example, PcWUVS is the problem of whether, given a set C of candidates, a list of votes over C, a distinguished candidate $c \in C$, and a class of election rules, there is at least one election rule from this class under which c wins the election. We study these two problems for a class of systems based on approval voting, the family of Copeland$^\alpha$ elections, and a certain class of scoring rules. Our main result is that it is NP-complete to determine whether there is a scoring vector that makes c win the election, if we restrict the set of possible scoring vectors for an m-candidate election to those of the form $(\alpha_1, \ldots, \alpha_{m-4}, x_1, x_2, x_3, 0)$, with $x_i = 1$ for at least one $i \in \{1, 2, 3\}$.

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