Abstract

Simple coalitional games are a fundamental class of cooperative games and voting games which are used to model coalition formation, resource allocation and decision making in computer science, artificial intelligence and multiagent systems. Although simple coalitional games are well studied in the domain of game theory and social choice, their algorithmic and computational complexity aspects have received less attention till recently. The computational aspects of simple coalitional games are of increased importance as these games are used by computer scientists to model distributed settings. This thesis fits in the wider setting of the interplay between economics and computer science which has led to the development of algorithmic game theory and computational social choice. A unified view of the computational aspects of simple coalitional games is presented here for the first time. Certain complexity results also apply to other coalitional games such as skill games and matching games. The following issues are given special consideration: influence of players, limit and complexity of ma-
Manipulations in the coalitional games and complexity of resource allocation on networks. The complexity of comparison of influence between players in simple games is characterized. The simple games considered are represented by winning coalitions, minimal winning coalitions, weighted voting games or multiple weighted voting games. A comprehensive classification of weighted voting games which can be solved in polynomial time is presented. An efficient algorithm which uses generating functions and interpolation to compute an integer weight vector for target power indices is proposed. Voting theory, especially the Penrose Square Root Law, is used to investigate the fairness of a real life voting model. Computational complexity of manipulation in social choice protocols can determine whether manipulation is computationally feasible or not. The computational complexity and bounds of manipulation are considered from various angles including control, false-name manipulation and bribery. Moreover, the computational complexity of computing various cooperative game solutions of simple games in different representations is studied. Certain structural results regarding least core payoffs extend to the general monotone cooperative game. The thesis also studies a coalitional game called the spanning connectivity game. It is proved that whereas computing the Banzhaf values and Shapley-Shubik indices of such games is \#P-complete, there is a polynomial time combinatorial algorithm to compute the nucleolus. The results have interesting significance for optimal strategies for the wiretapping game which is a noncooperative game defined on a network.

**Keywords:** Cooperative games, game theory, algorithms and complexity, multi-agent systems, network connectivity, network security, power indices, Shapley-Shubik index, Banzhaf index, Chow parameters, computational social choice, simple voting games, weighted voting games, nucleolus, least-core, cost of stability, resource allocation, preference aggregation, Nash equilibria, kernel, bargaining set, stable set, linear programming.
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