Bayesian Group Decisions: Algorithms and Complexity

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We model the interactions of rational agents in a group, where they receive private information and act based upon that information while also observing other agents' recommendations. In this work, we are interested in the computations that the Bayesian agent should undertake in order to realize her optimal recommendations at every decision epoch. We use the framework of iterative eliminations to model the thinking process of the Bayesian agent, as she recursively refines her belief about the private signals of others, given her observations and subject to their rationality. The iterative elimination algorithm runs in exponential time; however, we show that when the group structure is a POSET the Bayesian calculations simplify and an efficient computation of the Bayesian recommendations is possible. We next shift attention to the case where agents reveal their beliefs at every decision epoch. We thus analyze the computational complexity of the Bayesian belief formation in groups and show that it is NP-hard. We also investigate the factors underlying this computational complexity and show how belief calculations simplify in special network structures or cases with strong inherent symmetries. We finally investigate how network structure determines statistical efficiency (optimality) of beliefs and their relation to computational efficiency.

Additional Key Words and Phrases: Rational Choice Theory, Observational Learning, Bayesian Decision Theory, Computational Complexity, Group Decision Making, Computational Social Choice, Inference over Graphs;

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