Logic and Game Theory for Social Mechanisms

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ABSTRACT

My research is focused on checking multi-agent protocols for their game theoretic properties, using logic and occasionally information theory. The main results involve computational complexity for several classes of properties, such as properties involving knowledge, assuming commonly known strategies, or nested preferences.

1. SUMMARY

A key assumption in the design of multi-agent systems is that agents are autonomous. This means that agents are free to choose their own actions, and typically agents will choose their actions according to their own best interest. Game theory can be used to predict how agents should or will choose their actions, how agents might coordinate their actions or whether agents should anticipate certain actions by other agents. Game theory is therefore widely used within artificial intelligence and multi-agent systems, for instance in the area of mechanism design.

A relatively simple class of games are extensive games with perfect information. In these games no simultaneous actions occur, and all agents are fully aware of all actions. Protocols with these properties are both easy to implement and to understand. Using logics one can express different properties of these games, involving for example fairness ('No single agent can block a proposal'), incentive compatibility ('agents cannot benefit from strategic voting') or coordination ('Agent A can help agent B achieving its goal'). An important question is whether one can efficiently test whether protocols have such properties. For several game logics this 'model checking' problem is tractable [3]. In certain cases one can even automatically construct protocols with given properties [1].

In other protocols agents are not aware of all actions that have been played or all the information that other agents have. These protocols thus have to be modeled as games with imperfect information. In these protocols it is important to consider what all agents know and learn exactly. Such situations can be modeled as knowledge condition games [4]. In general the computational complexity of determining whether protocols have certain properties is high, but luckily there are tractable special cases.

Using epistemic logic one can express whether something is known or unknown, but one cannot make finer distinctions. Using information theory one can precisely measure the amount of information or certainty that agents have, depending on the strategies that are used. In a recent paper, I have thus used information theory to calculate privacy optimising strategies [2].

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