Investigation and Model checking of Algorithms of Eliminations in Game Theory based on Dynamic Epistemic Logic

ABSTRACT

The core of game theory is looking for the solution of game problems. Various algorithms of iterated elimination are significant for the rapid reduction of game models and seeking reasonable Nash equilibria. The traditional framework of game analysis assumes that game players are Bayesian rational, and that "every player is rational" is common knowledge among the players. However, game theory itself does not explicitly express the cognitive component of agents in a game, so it cannot precisely model the higher-order information changes of mutual knowledge among players. Accordingly, it induces paradoxes when some classic algorithms of iterated eliminations are used for solving games and seeking equilibria, so that these paradoxes are factors holding back game-theoretical development. Meanwhile, although automated verification of finite-state systems by means of model checking techniques is now a well-established area of research, and the success of model checking has led to a recent growth of interest in the applications of the techniques to the fields of Artificial Intelligence, such as Multi-Agent Systems(MAS), no studies has yet been made about verifying properties of the game epistemic systems and of the epistemic state of players in a game by means of a dynamic model checking tool. Thus, it barriers to the development of modeling techniques for MAS based on the research of game theory.

Firstly, we analyze the epistemic-logic foundations for various algorithms of iterated eliminations in strategic games, and systematically compare the strength of relations between some common algorithms of iterated eliminations. Furthermore, we explain the significance of logic research and epistemic analysis for IA (Iterated Admissibility), which has more obvious advantages in rapidly reducing game models, refining Nash equilibria, seeking more reasonable solutions of games and so on.

Secondly, inspired by [1] and [2], we build an axiomatic logic systems EL_G (Epistemic Game Logic), which is used to describe the epistemic framework of normal games with pure strategies. In this system, we define the new concept of rationality, which is a more intuitive and more realistic description of the players' rational decisions in a game. Furthermore, we proved the outcomes obtained by repeatly public announcing this rationality assertion are in line with the results

obtained by solving games with the IA algorithm. Thus we have given a novel epistemic foundation for the IA algorithm from a dynamic epistemic viewpoint., and effectively overcome the epistemic paradox in this algorithm.

Finally, we develop a tool of dynamic epistemic game checking named DEMOGAME, based on DEMO (Dynamic Epistemic Modeling). This tool can be used to verify the properties of epistemic systems of strategic games and of the players' epistemic state in a game. The validity of this tool is illustrated with some examples, and by successfully using it to verify the above-mentioned results and the achivements in [1]. Moveover，DEMOGAME is also used to solve finite two-player strategy-games with pure strategies.

Consequently, the research achievements of this dissertation not only promote and improve epistemic game theory, but also extend and enrich state-of-the-art model checking techniques for MAS (Multi-Agent Systems).

Main references

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