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Concept document of Automated Analysis of Nash Equilibria in Iterated Boolean Games

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1 Introduction

Nash equilibrium is a solution concept of a non-cooperative game involving two or more players in which each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy. If each player has chosen a strategy and no player can benefit by changing strategies while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitutes a Nash equilibrium.

Nash equilibrium is also a fundamental concept in the theory of games and the most widely used method of predicting the outcome of a strategic interaction in the social sciences. Agame consists of three elements : a set of players, set of actions available to each player and a payoff function for each player. The payoff fuctions represent each player's preferences over action profiles, where an action profile is simply a list of actions, one for each player.

2 Keywords

LTL - Linear Temporal Logic, MCMAS - Model Checker for Multi-Agent Systems, ISPL- Interpreted Systems Programming Language.

3 Background to the problem

Nash equilibrium concept makes misleading predictions (or fails to make a unique prediction) in certain circumstances. many related solution concepts have been proposed (also called 'refinements' of Nash equilibria) designed to overcome perceived flaws in the Nash concept. One particularly important issue is that some Nash equilibria may be based on threats that are not 'credible'. In 1965 Reinhard Selten proposed subgame perfect equilibrium as a refinement that eliminates equilibria which depend on non-credible threats. Other extensions of the Nash equilibrium concept have addressed what happens if a game is repeated, or what happens if a game is played in the absence of complete information. However, subsequent refinements and extensions of the Nash equilibrium concept share the main insight on which Nash's concept rests: all equilibrium concepts analyze what choices will be made when each player takes into account the decision-making of others.

Now consider the game that involves a repetition of the prisoners dilemma for n periods, where n is commonly known to the two players. A pure strategy in thisrepeated game is a plan that prescribes which action is to be taken at each stage, contingent on every possible history of the game to that point. Clearly the set of pure strategies is very large. Nevertheless, all Nash equilibria of this finitely repeated game involve defection at every stage. When the number of stages n is large, equilibrium payoffs lie far below the payoffs that could have been attained under mutual cooperation. It has sometimes been argued that the Nash prediction in the finitely repeated prisoners dilemma (and in many other environments) is counterintuitive and at odds with experimental evidence. However, experimental tests of the equilibrium hypothesis are typically conducted with monetary payoffs, which need not reflect the preferences of subjects over action profiles. In other words, individual preferences over the distribution of monetary payoffs may not be exclusively self-interested. Furthermore, the equilibrium prediction relies on the hypothesis that these preferences are commonly known to all subjects, which is also unlikely to hold in practice.

4 problem statement

The concept of Nash equilibrium has been generalized to allow for situations in which players are faced with incomplete information. If each player is drawn from some set of types, such that the probability distribution governing the likelihood of each type is itself commonly known to all players, then we have a Bayesian game. A pure strategy in this game is a function that associates with each type a particular action. A Bayes- Nash equilibrium is then a strategy profile such that no player can obtain greater expected utility by deviating to a different strategy, given his or her beliefs about the distribution of types from which other players are drawn. Allowing for incomplete information can have dramatic effects on the predictions of the Nash equilibrium concept. Consider, for example, the finitely repeated prisoners dilemma, and suppose that each player believes that there is some possibility, perhaps very small, that his or her opponent will cooperate in all periods provided that no defection has yet been observed, and defect otherwise. If the number of stages n is sufficiently large, it can be shown that mutual defection in all stages is inconsistent with equilibrium behavior, and that, in a well-defined sense, the players will cooperate in most periods. Hence, in applying the concept of Nash equilibrium to practical situations, it is important to pay close attention to the information that individuals have about the preferences, beliefs, and rationality of those with whom they are strategically interacting.

5 Aim and objectives

5.1 Aim or General Objective

To Automate the analysis of Nash equilibria in Boolean iterated games through implementing an algorithm (checking the existence of Nash equilibria in iterated Boolean games can be automatically solved using MCMAS, using a polynomial translation from iterated Boolean games to ISPL) and to check its performance so that Iterated Boolean Games can be solved in practice.

5.2 specific objectives

To check whether Multiplayer games can be solved in practice
To generate an Algorithm that will check the performance of Boolean iterated games.
To introduce a novel notion of expressiveness for temporal logics that is based on game theoretic properties of multi-agent systems.
To apply the standard game-theoretic concept of Nash equilibria.

6 Research scope

The scope of this project is between multiplayer games of only two players thus if the game includes one player of more than two it will be excluded in our research.
We study the problem of computing pure-strategy Nash equilibria in multiplayer

concurrent games.
The analysis of Nash equilibria will be concluded with a general approximation other than specifying an accurate formulae.(ie using their expressiveness powers)

In this model, each agent i exercises exclusive control over a subset of Boolean variables, and the game is played over an infinite number of rounds, where at each round each player chooses a valuation for their variables.

Each player is assumed to act strategically, taking into account the goals of other players, in order to try to bring about computations that will satisfy their goal.

7 Research Significance

To find out the running times (Analyse) and check whether Nash equilibria can be obtained in multiplayer games and to deduce their complexity. To check out whether artificial intelligence algorithms can be implemented in the multiplayer games.

8 References

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