Analyzing Multi-agent Systems by Iterated Continuous Prisoner's Dilemma Game

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July 9, 1999

Abstract

The purpose of this paper is to propose a new model of interactions between agents and to show its usefulness for analyzing multi-agent systems. This model is called *the iterated continuous prisoner's dilemma game*. It is an extended version of the usual iterated prisoner's dilemma game, and can deal with intermediate decisions. Using the iterated continuous prisoner's dilemma game, we analyze a dynamic behavior of multi-agent systems, especially for the process of invasion between two groups of agents. The analysis is done on a typical good strategy on the usual game, and the profitability of intermediate decisions is clarified. In a multi-agent system, each agent pursues his own interests through interactions with other agents. However, there is no supervisor which controls the whole system to resolve each conflict of interests among agents. For such systems, there are several results on the mechanism of computation for cooperation and the structure of a system in order to achieve it efficiently. For instance, T. Ishida proposed coordinator agents on a flat network that support people autonomously to make constructive agreements. On the other hand, there were researches on investigating natures of decisions in the interaction which is necessary to achieve robustness or stability, not restricted to cooperation, of the system. For instance, R. Axelrod investigated collectively stable strategies on the iterated prisoner's dilemma game. This research also approaches analytically to multi-agent systems just like that by Axelrod. In many researches, the prisoner's dilemma game was used as a model for analyzing interactions between agents in multi-agent systems. This game is a two-person non-zero-sum game. In this game, each player chooses an action between two alternatives called 'Cooperate' and 'Defect'. As a result, each player gains a payoff by a certain matrix. This game accurately represents the situation of a dilemma that a rational action taken by each agent does not result in the Pareto optimum. By such a characteristic, it is considered that this game is suitable for study on a reciprocal decision in interactions between agents in a dilemma. In recent years, this game has been also acknowledged as one of standard problems in the field of study on distributed artificial intelligence. Especially, the iterated prisoner's

dilemma game has been used in many related researches. This game is an iterated version of the prisoner's dilemma game. In the iterated prisoner's dilemma game, Tit for Tat strategy (TFT) is well-known as a typical good strategy. When considering multi-agent systems such as the general public or the cyberworld, it is also considered that there might be a case that a decision between two alternatives leaves something to be desired. Because people often take inexact stands against unknown opponents. The results of this research are concerning the profitability of intermediate decisions. They can contribute to designing the elastic decision mechanism of each agent in a multi-agent system.

Key Words: **distributed artificial intelligence, multi-agent, interaction between agents, game theory, prisoner's dilemma**