Cooperation in Prisoners Dilemma Form Games

Abstract

A common subject of study in game theory is the prisoner's dilemma. The dilemma stems from the fact that when players act in their own interests, the best strategy is to defect. However, this outcome is not Pareto optimal, and is actually worse for both players. To maximize utility for both players, it would be desirable to find a solution that allows for cooperation between the players. This paper examines the emergence of cooperation in a repeated prisoner's dilemma game, in attempts to find environments that lend themselves to cooperative strategies.

Introduction

In an evolutionary iterated prisoner's dilemma, players repeatedly play the prisoner's dilemma game against the other players. Players may adjust their strategies over the course of the game. In this experiment, several parameters may be modified and monitored, to observe the emergence of cooperative behavior. These parameters include the agents knowledge of the effectiveness of their own or others strategies, the agents connections with the other agents, or an agent's utility function, especially its social utility.

Each of these parameters can be analyzed to examine prisoner's dilemma style situations in the real world. It can apply to the localization vs globalization debate, politics, the interactions of tightly knit groups, or social network interactions. By experimenting with these parameters, we can determine why cooperation emerges in some of these situations but not others.

Background Information

Typically, in evolutionary iterated prisoner's dilemma games, a tit-for-tat strategy will dominate after many generations of play. Tit-for-tat is a minimally cooperative strategy compared to an always-defect strategy. Of interest is situations that support the spread of more cooperative strategies such as tit-for-tat (Deshmukh and Srinivasa). In their experiment, Deshmukh and Srinivasa identify different ways to model the localization vs globalization debate with the prisoner's dilemma. In particular, they termed *entrenchment of acquaintance* and *entrenchment of knowledge*.

Entrenchment of acquaintance is the situation where an agent interacts mostly with a small, consistent group of other agents. For example, members of a small town where everybody is acquainted with everyone else in the town, or a small, tightly knit organization with their own unique and possibly extreme ideas. While agents that are entrenched in their acquaintances often foster cooperation between agents in their community, it often discourages cooperation amongst members outside of their entrenched community.

Entrenchment of knowledge is the propensity of an agent to find information from its own community, as opposed to outside sources. This means agents find strategic knowledge mostly from their social acquaintances, as opposed to books or the internet. According to Deshmukh and Srinivasa, disentrenchment, especially disentrenchment of knowledge, encourages the spread of cooperative strategies.

Another situation that effects cooperation is the expectation of cooperation in a community (Shibusawa, Otsuka and Sugawara). In this case, agents know that cooperative strategies will bring more shared utility in the long run, and thus will try to encourage cooperation. In their study, they gave each agent a parameter that measured their probability of cooperation, which would fluctuate after each game played. By modifying this parameter, it's effect on the rate of cooperation in a system could be measured.

Proposed Work

Deshmukh and Srinivasa's study modeled an evolutionary iterated prisoner's dilemma game, and observed that tit-for-tat strategy dominated an always-defect strategy over time. Thus, they observed how entrenchment would effect the rate at which tit-for-tat would spread in an environment. Every time an agent switches from an always-defect strategy to a tit-for-tat strategy, cooperation will spread. Every time an agent switches from a tit-for-tat strategy to an always-defect strategy, then the population is becoming more disillusioned with the idea of cooperation.

I propose to simulate an evolutionary iterated prisoner's dilemma game similar to the experiment run by Deshmukh and Srinivasa. I will also include parameters from other experiments, such as the study run by Shibusawa, Otsuka and Sugawara. I will also use the expectation of cooperation strategy to model the probability of cooperation in each strategy in the game. By running trials with different parameters, I can model the effects of each parameter on the system, and determine the environment that fosters cooperation the best, in attempts to apply the results to real-world scenarios and environments.

References

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