Analysis of Prisoner's Dilemma Facebook game

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6.853 Project Proposal

Introduction

A Facebook game modeling the Prisoner's Dilemma was set up by Brodrick Childs, Sunny Long and Sam Sinai. Users logged in with their Facebook accounts, and had the goal of escaping prison by earning points playing an Iterated Prisoner's Dilemma. Users were given the opportunity to escape from prison, opting to either "Cooperate" or "Defect". The players thus had a global goal of trying to escape from prison that was reached by gaining points from multiple minigames played throughout.

Game Theory has analyzed the Prisoner's Dilemma game extensively, and the trade-offs between the potential benefits both players receive from cooperating, and the individual incentives to each player to defect. Data on how players played, and more information on each player's demographics, was gathered by the authors of the project. The authors have carried out some preliminary statistical analysis of players' strategies. We will make further statistical analysis as well as an economic analysis of the dataset, both described below. The main goal is to study any interesting similarities between statistical modeling of the behavior and what an economic study might uncover to compare and contrast the power of both.

Machine Learning Analysis

The first goal of our project is to analyze the data using standard machine learning techniques such as neural networks, nonlinear regressions, and the online learning algorithms we saw in class. The idea is to fit a behavioral model to predict what a player might do in the next game that he/she plays, taking into account a set of features such as gender, time of day, history of past 5 games played, among other possible factors. Here, our initial experiment will be to train a neural network to determine the weighting between the layers of the network using machine learning methods such as stochastic gradient descent. Naturally, this will occur after we split our dataset into a training set, validation set, and testing set.

Economic Analysis

After carrying out a statistical/machine learning analysis, we will move on to examine the data from a more game theoretic point of view. Namely, we will address the following:

- **Equilibrium Concepts:** a standard economic study can be carried out to model the behavior of the individual players, according to what might be expected in a game theoretic setting. Possible areas of exploration include uncovering nash equilibria,

bayesian nash equilibria, subgame perfect nash equilibria, as well as strategies found in repeated games (tit-for-tat, grim trigger, etc.)

- **No-Regret Learning:** We will use a No-regret learning algorithm to predict a player's chance of Defecting. The algorithm will play against players statistically identical to the dataset's, and will arrive at a strategy. By feeding the algorithm our training set, we will judge if the algorithm simulates user play, or if it beats the Machine Learning techniques.

- **Quantal Response Equilibrium:** A quantal response equilibrium is yet another game theoretic solution concept. It provides an interesting framework to analyze games where players might err when choosing which strategies to play. This solution concept offers a more realistic analysis of what constitutes a real-life game setting, as players might not always act rationally.

Conclusion

In doing this project, we hope to demonstrate the power of the used economic learning algorithms on the famous Prisoner's Dilemma game. Doing so, we hope to find new insights into how these algorithms should best be implemented, and how they are appropriately used. Most importantly, our analysis will determine whether equilibrium concepts in game theory have the same predictive power as standard statistical methods when modeling the behavior of economic agents.

Note: we are submitting the project proposal after the deadline with the consent of Professor Vasilis and Professor Daskalakis since we changed the topic of our project after the project office hours were over. We had to meet Professor Vasilis on Thursday April 13, and we are scheduled to meet Professor Daskalakis on Tuesday April 18 to discuss the work to be done for the project.