Cheating the Repeated Prisoner's Dilemma

Nathan Nickelson

Austin Peay State University Mathematics Department

Austin Peay State University Mathematics & Statistics

Abstract

It is generally accepted that one of the best strategies for handling a repeated Prisoner's Dilemma game with no known end is a Tit-For-Tat Method – one that employs copying your opponent's previous move. This tends to produce the highest payout overall, as it rewards mutual cooperation and punishes defection. Can a cheater's strategy win in a group of players trying to cooperate?

This project aims to look at a few strategies that were designed to try and exploit Tit-For-Tat and its varying degrees of forgiveness. While a cheater's strategy did not win out overall, permanent retaliation and conditional probability strategies were surprisingly effective

Introduction

The Game:

		Player Two	
Player One		Cooperate	Defect
	Cooperate	P1 = 3, P2 = 3	P1 = 0, P2 = 5
	Defect	P1 = 5, P2 = 0	P1 = 1, P2 = 1

The above payoff matrix is in standard form for a prisoner's dilemma. The Nash Equilibrium of the game has the best individual choice for each player as both defecting. Even though this is the best one game payoff, the overall best strategy for a long game tends to be one where mutual cooperation can be encouraged early on and maintained throughout the game. This ensures both players are guaranteed a payout of 3 every turn without risking unnecessary losses. The methods here will explore whether a player can occasionally cheat to steal points during a turn to gain an advantage over cooperating players.

Methodology

20 games were setup consisting of 100 turns and 100 players. Of the players, one player for each of the 11 strategies employed were included along with 89 players where the strategies were randomly selected. Each turn had every player play against every other play one time and the total points were tallied and the top five winning strategies were selected. The Alt Game has a (-15, 20) in place of the (0, 5) payout. The strategies were as follows:

Always Defect:	Defect every turn
Always Cooperate:	Cooperate every turn
Tit-For-Tat(N):	Cooperate unless opponent has defected N turns in a row
Cheater (N):	Try to cheat (N) times in a row without the opponent choosing defect. If it fails try fully cooperating, and if that fails then fully defect
Permanent Retaliation:	Cooperate until opponent defects, then always defect on that player
Conditional:	Use the probability of a player's choice following a defect to choose whether to defect or cooperate
Random:	Randomly choose cooperate or defect

Results

GAME TYPE	WINNER	% GAMES WON
All Players	Conditional	87.5%
Without Always Defect/Coop	Permanent Retaliation	99%
Alt. Payout (3, -15, 20, 1)	Cheater 1	90%
Alt. Payout Without Always	Cheater 1	85%
TFT vs Cheater (Normal Payout)	Tit-For-Tat 3	99%

Discussion

All Players: The Conditional Probability strategy handily won in this section largely due its ability to capitalize on Always Cooperate early on where it quickly chooses defect against this strategy.

Without Always Defect/Coop: Permanent Retaliation utilizes mutually assured destruction to ensure its victory here. It sacrifices enough points by punishing others for defecting and makes up for it with its Coop/Coop points gained from Tit-For-Tat. And without Always Cooperate, there are no easy points here.

Alt Payout: Cheater 1 wins this one. If Cheater 1 can do +20, +20, -15 in a set of 3 turns, it gains 25 points over the 9 points from 3 turns of mutual cooperation. It gains the majority of these points from Always Cooperate, Tit-For-Tat 2 and Tit-For-Tat 3.

Alt Payout Without Always Coop/Defect: Even though Cheater 1 scored about 10% less points without the easy points from Always Cooperate, it still manages to sneak more cheats without punishment than the rest.

TFT vs Cheater (95/100 players): Other TFT and cheater strategies get caught in a Defect-Cooperate loop that pays out only 5 points every two turns where TFT3 capitalizes on the more lucrative Cooperate-Cooperate 6 point payoffs.

Conclusion: Unless the Cooperate/Defect payoffs are extreme enough, it seems unlikely a cheating strategy will outperform a forgiving Tit-For-Tat strategy over a long repeated game.

References

Axelrod, R. (1984). *The Evolution of Cooperation.* New York, NY: Basic Books Inc.

Spaniel, W. (2013). *Game Theory 101: The Complete Textbook.*

Project Repository

https://github.com/nnickelson/PrisonersDilemmaProject/tree/master