# Soft Grudger Strategy Implementation On Prisoner's Dilemma

Akhilesh Sakhare and Suraj Meshram
Scientific Computing Modelling and Simulation
Pune University
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## Abstract

*We explore how the Soft Grudger Strategy is used in the Prisoners' Dilemma in comparison to other game strategies and evaluate how well it performs. Soft Grudger - Co-operates until the opponent defects, in such case opponent is punished with four times defect and two times cooperate . Customised strategy 1 - default setting is always co-operate unless sucker (ie 0 points scored)*

## 1. Introduction

A prisoner's dilemma is a decision-making and game theory paradox illustrating that two rational individuals making decisions in their own self-interest cannot result in an optimal solution. The paradox was developed by mathematicians M. Flood and M. Dresher in 1950, and the modern interpretation was conceptualized by Canadian mathematician A.W. Tucker. The prisoner's dilemma may be expressed as an approach where individual parties seek their welfare at the expense of the other party. Generally, since both participants avoid cooperation in the decision-making process, they end up in a much worse condition. In the prisoner's dilemma theory, it is the responsibility of the two parties to choose whether to collaborate or not. Either party is given the chance to defect, despite the option of the other party. The outcomes of the prisoner's dilemma are either beneficial or injurious to society. Making better economic choices require cooperation between individuals.

### 1.1. What is a Prisoners' Dilemma?

A Prisoners' Dilemma is a situation in which two criminals are arrested and put in jail cells far apart from each other. They are allowed to communicate with each other through a window. Each prisoner has the option to cooperate with the other prisoner or not.

If they both cooperate, they can both get away with the crime and be released back into the community. However, if one prisoner cooperates and the other prisoner doesn't, then the cooperating prisoner will be charged with a crime and the other prisoner will go free.

### 1.2. How Does it Work?

The cooperating prisoner will first have to convince the other prisoner to trust them. Once the other prisoner trusts them, they will then have to decide what to do.

If the cooperating prisoner decides to betray the other prisoner, they will be charged with a crime and the other prisoner will go free.

- **What Are the Benefits of Cooperating?**

  If the cooperating prisoner cooperates, they will get away with the crime without getting caught. They will also have a better chance of getting released back into the community sooner.

- **What Are the Benefits of Not Cooperating?**

  If the cooperating prisoner decides not to cooperate, they will get caught and will likely be sentenced to more time in prison. They will also have a worse chance of getting released back into the community sooner.

- **What Are the Benefits of Not Cooperating?**

  If the cooperating prisoner decides not to cooperate, they will have a better chance of getting released back into the community sooner. They will also have a worse chance of getting caught.

- **Prisoners Dilemma In A Nutshell**

  In a prisoners' dilemma, it is in both prisoners' best interests to cooperate with each other. However, if one prisoner decides to betray the other, they can end up with a worse outcome.

## 1.3. Classic Examples of Prisoner's Dilemma

Prisoner's Dilemma is a thought experiment that illustrates the difficulties that may arise in situations where two individuals have a choice between two mutually exclusive actions, both of which will be beneficial to them individually. The dilemma stems from the possibility that if both individuals cooperate, they both benefit, but if one does not cooperate, he will benefit more than if he had both cooperated. Thus, the dilemma is for a rational individual to defect in the group. Over the last half-century, the Prisoner's Dilemma has been used to illustrate the challenges we face when making decisions with others.

A classic example of a Prisoner's Dilemma is a game between two prisoners, where the goal is to avoid getting caught by the guards. In the situation where that two prisoner questioned separately, what would happen if both tried to cooperate but discovered that the guards would turn them in, or if they both pretended to be criminals, thus putting them both behind bars?

The classic Prisoner's Dilemma (PD) problem, often depicted in academic and real-world contexts as "The game theory prisoners' dilemma," is a problem of strategic interaction between two players in which the players' best interests are in direct conflict with one another. The two players are "prisoners" who have been arrested and are confined in separate rooms. The goal of each prisoner is to convince the other to confess to the crime and thereby receive a reduced sentence. The game must not be played at the same time, or the conflicting interests of the prisoners may prevent the payer from confessing.

Prisoner's Dilemma is a game used to show the issue of Public Goods in economics, showing how cooperation is rarely achieved if the players can only benefit while the others lose. The game has been used to show that selfish and greedy players rarely succeed in achieving their goals – they never achieve any benefits for the group.

## 1.4. Instructions to Play Prisoner's Dilemma

Prisoner's dilemma is a fun game to play as long as you're with the right people as well as if you have the right setting and rules for this game. There are a lot of reasons for you to want to play iterated prisoner's dilemma, but the hard part can definitely be finding the right players as well as understanding the rules, setting as well as how all of the parties should act.

In order for you to play this game, you're going to have to learn the rules of this game so that you can play Iterated prisoner's dilemma properly and have fun. So, if you're looking for instructions for how to play Iterated prisoner's dilemma, then you've definitely come to the right place. Keep reading for you to find out and enjoy playing.

- **Find The Right People**

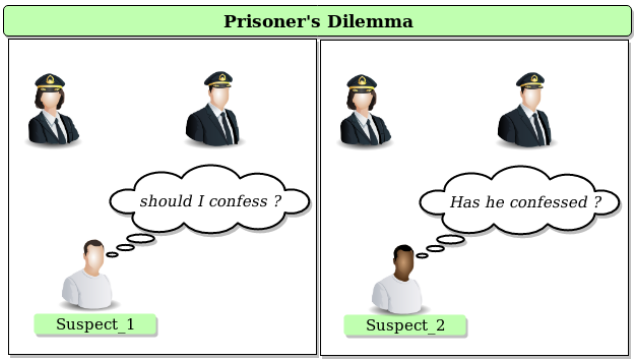


Figure 1

Normally, the minimum number of players that you can have for this game would be three, but the more, the merrier, right? Just as long as you have fun, you can definitely have more players in this game.

- **Know The Setting**

Knowing the setting is important as well. Know where you should hold this game, and it should be a reasonable and appropriate place—looking for a place that has two rooms that can separate two people, or at least a place where two people won't be able to communicate with each other. If you can't find a place available that at least has two rooms, you can definitely just separate the two in different ways by putting curtains or other similar items in order to separate them.

- **Get To Know The Rules**

Every game has a set of prisoner's dilemma rules that every player should follow. And iterated prisoner's dilemma also has those kinds of rules. Knowing and understanding the rules makes playing the game easier and definitely more fun. So, following the rules is definitely important, although some of the rules can be changed depending on what you want. But, you should definitely never change the rules of the game too much, since it might not even be recognizable without all of its rules being changed.

Two people are supposed to be separated, whether they would be separated into two rooms or any other way. They are to choose between cooperate or defect, and if both parties choose to cooperate, they are then rewarded with a R.

So, that's it about iterated prisoner's dilemma and how to play it. Hopefully, this does help you know what you should do if you ever want to play this game. This game is definitely fun, especially as long as you play, it will all of the right people.

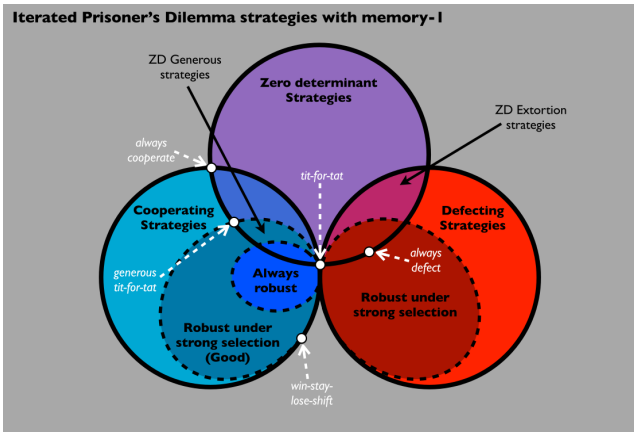


Figure 2

### 1.5. Types of Research from Prisoner's Dilemma Game

With how viral Prisoner's Dilemma has become, you can definitely expect that at least one type of research would be held from or because of it. Iterated Prisoner's Dilemma has definitely started many types of research all over the world. I'm sure that it would be almost impossible to list down all of the research or studies that have started because of this game theory.

This game theory has inspired people who are inspired to learn about philosophy or psychology, or even both. Since this is a game theory that started because of how people would react in this scenario, I'm pretty sure that it really isn't a surprise that Iterated Prisoner's dilemma has started being researched by people who study philosophy or psychology.

## 2. Algorithm details

- **Initialize counters of d-count and c-count to 0**
- **For d-count less than 4 iterations; increase d-count and return defect**
- **For next 2 iterations; increase c-count**
- **If c-count modulo 2 is 0; then set d-count to 0**
- **Return cooperate**
- **Repeat Step 1 and 4 until end of match**

## 3. Result and Discussion

Following plot shows a interpretation of average score of various functions within 10 matches.

From the graph, we can see that as the number of matches increases the average score of each function increases with different rate. In figure green colour line shows

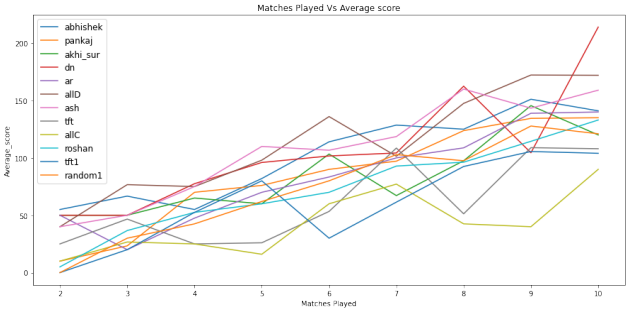


Figure 3. matches played

"akhi-sur" function. It shows the variation in the score is almost uniform as number of matches increases.

After playing nine matches "dn" score is increases above 80, after same matches playing "all d" score is constant after 150.

In our case after playing five matches avg score goes to 50-100 and decrease in seven upto seven matches and again increases after seven and continue increases upto avg score 130 till nine matches.

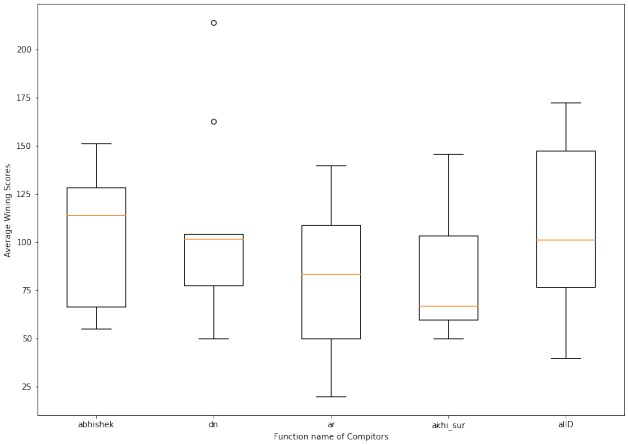


Figure 4. box plot

from the box plot we can see that "ar" and "all d" their box plot shows close to symmetric it means that their avg score data follows a normal distribution i.e (Q3 - Q2) = (Q2 - Q1)

Now comparing the box plot of "akhi-sur" with "dn" shows that our box plot shows positive skew i.e (Q3 - Q2) greater than (Q2 - Q1). In "dn" box plot we see that some points are outside the whiskers is consider as a outlier, because whisker are generally defined as interquartile range, already we shows this on previous plot.

In boxplot 2 we can see that the functions "allC" not perform well as compare to other functions and also we can see that whisker avg score is between five and hundred.

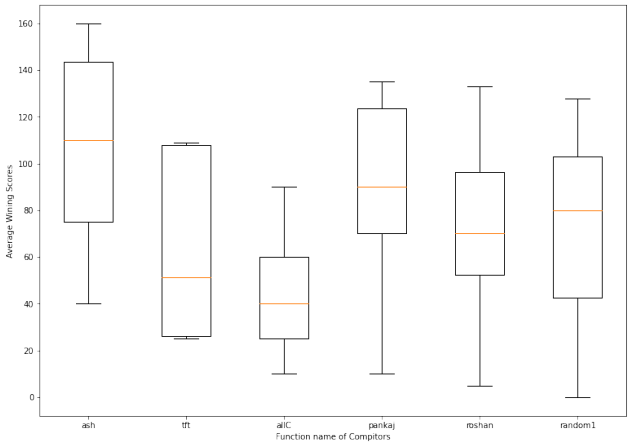


Figure 5. box plot 2

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In [10]: 1 data.describe()
Out[10]:
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| | Matches Played | abhishek | dn | ar | akhi_sur | allD | ash | tft | allC | pankaj | roshan | tft1 | random1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| count | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 | 9.000000 |
| mean | 6.000000 | 102.038889 | 106.711111 | 84.274444 | 84.281111 | 113.202222 | 106.952222 | 61.412222 | 43.034444 | 84.406667 | 73.413333 | 60.665556 | 73.737778 |
| std | 2.738613 | 37.712651 | 52.511969 | 41.529350 | 33.863847 | 46.312288 | 44.353441 | 36.978839 | 27.571380 | 45.206853 | 39.988806 | 38.115403 | 43.402288 |
| min | 2.000000 | 55.000000 | 50.000000 | 20.000000 | 50.000000 | 40.000000 | 40.000000 | 25.000000 | 10.000000 | 10.000000 | 5.000000 | 0.000000 | 0.000000 |
| 25% | 4.000000 | 66.670000 | 77.500000 | 50.000000 | 60.000000 | 76.670000 | 75.000000 | 26.000000 | 25.000000 | 70.000000 | 52.500000 | 30.000000 | 42.500000 |
| 50% | 6.000000 | 114.000000 | 101.670000 | 83.330000 | 67.140000 | 101.430000 | 110.000000 | 51.250000 | 40.000000 | 90.000000 | 70.000000 | 61.430000 | 80.000000 |
| 75% | 8.000000 | 128.570000 | 104.440000 | 108.750000 | 103.330000 | 147.500000 | 143.330000 | 108.000000 | 60.000000 | 123.750000 | 96.250000 | 92.500000 | 102.860000 |
| max | 10.000000 | 151.110000 | 214.000000 | 140.000000 | 145.560000 | 172.220000 | 160.000000 | 108.890000 | 90.000000 | 135.000000 | 133.000000 | 105.560000 | 127.780000 |

Figure 6. Statistical data table

In the above statistical data table, it shows that maximum winning score of ”dn” is 214. Then second maximum score is 172 is of ”alld” . And our maximum winning score i.e akhi-sur score is 145. that comes in 5th position.

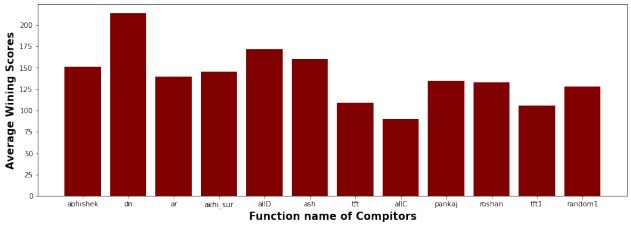


Figure 7. Barplot

A bar plot shows catergorical data as rectangular bars with the height of bars proportional to the value they represent. It is often used to compare between values of different categories in the data.In our bar plot it shows avg weight score vs function of competitors that function ”dn” have highest score above all after that ”alld” and so on.

## 4. Shortcomings

Most methods have in common one major shortcoming: they do not always narrow down what may happen in a game to a tractably small number of possibilities. For exam- ple, a game has an equilibrium in soft grudger strategies only if all players have a grudger strategy. If this is not the case, this solution concept is not very useful. Similarly, some games may not have any strategies that can be deleted via iterated deletion. Even among games that do have some dominated strategies, the remaining set of rationalize strategies may be very large and so the predictive power may not be precise enough to be useful. A drawback of the grudger strategy solution concept is, however, that it will often fail to exist. Hence if we wish to develop a predictive theory of behavior in games then we must consider alternative approaches that will apply to a wide variety of games.

## 5. Conclusion

- A player has a soft grudger if that strategy gives them a higher payoff than anything else they could do, no matter what the other players are doing. If a player has a soft grudger, expect them to use it!
- Grudgers would shun them after having helped once, but if the number of Suckers is large enough, Cheats will have an advantage. Moreover, back to the initial setting of Grudgers only - if a Cheat developed, he would be unlikely to meet the same Grudger twice, receiving the benefit all the time but never paying the cost.
- Soft Grudger is evolutionary stable strategy because they will be immediately penalised by lower chances of winning by giving opposite of opponent

## 6. References


- Prisoner dilemma
- Game theory
- CFI Team
- Strategy Game theory
- The Philosopher’s Stone
- Use full research paper.com