

Thesis Title

Thesis Subtitle

Author Name

B.Sc. Final Year Dissertation

Cardiff School of Mathematics

Acknowledgments

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Chapter 1

Introduction

The Prisoner's Dilemma (PD) is a classical model in Game Theory. It is a simple two player game where the agents must make a binary decision without communicating. This is often presented as two suspects who have been arrested, are being interrogated separately and have the option of whether to cooperate with each other or defect. Each player receives an individual payoff that depends on the actions that have been taken.

Now, consider the situation that both prisoners return to their cells each night, to be presented with the same choice the next day. Furthermore, allow this process to continue repeatedly. This is called the Iterated Prisoner's Dilemma (IPD) and has been an object of interest ever since the 1950's but became more popular after Robert Axelrod's large amount of work in the 1980's.

1.1 Prisoner's Dilemma

The first formal definition of PD was presented by Albert W. Tucker during a seminar at Stanford University [Gass2005]. However, the idea was first formulated by the Merrills [Flood1958] in 1950 whilst working for the RAND cooperation.

A description of the PD - Two players simultaneously decide whether to Cooperate (C) or Defect (D), without exchanging information. They receive payoffs as follows:

- They both choose C (mutual cooperation) and receive a payoff R (Reward)
- They both choose D (mutual defection) and receive a payoff P (Punish)
- One player chooses C and the other chooses D . The cooperator receives a payoff S (Sucker) and the defector receives a payoff T (Temptation).

Figure 1.1 shows the payoff matrix.

$$P = \begin{array}{c} C \\ D \end{array} \begin{array}{cc} C & D \\ \left(\begin{array}{cc} (R, R) & (T, S) \\ (S, T) & (P, P) \end{array} \right) \end{array} \quad (1.1)$$

There are also two assumptions that need to be stated. Firstly, both players are rational. Secondly, there is no communication between them. It is then easy to see that regardless of the choice of one player, the other will always obtain a higher payoff by defecting instead of cooperating. Therefore we have a pure Nash Equilibrium where both players defect, despite the fact that both players would do better if they were to cooperate with each other. Additionally, to ensure this behaviour occurs, the payoffs must satisfy the following inequalities:

$$S < D < C < T \quad (1.2)$$

and

$$(S + T) < 2C \quad (1.3)$$

Equation 1.2 merely fixes the payoffs in their intuitive order. Equation 1.3 ensures that alternating between cooperating and defecting (players take it in turns to stab each other in the back) performs no better than mutual cooperation. These inequalities allow for many different payoff matrices to be formulated, but values of $(R, S, T, P) = (3, 0, 5, 1)$ are commonly used in literature (find references). We can now formulate the new payoff matrix, as shown in Figure 1.4 A more detailed explanation of the Prisoner's Dilemma is given in [Gotts2003].

$$P = \begin{array}{c} C \\ D \end{array} \begin{array}{cc} C & D \\ \left(\begin{array}{cc} (3, 3) & (5, 0) \\ (0, 5) & (1, 1) \end{array} \right) \end{array} \quad (1.4)$$

	0.0	0.2	0.4	0.6	0.8
0.0	(C, C): (1.00, nan)	(C, C): (0.04, 0.00)	(C, C): (0.02, 0.00)	(C, C): (0.01, 0.00)	(C, C): (0.00, 0.00)
	(C, D): (0.00, nan)	(C, D): (0.35, 0.36)	(C, D): (0.39, 0.38)	(C, D): (0.42, 0.42)	(C, D): (0.46, 0.45)
	(D, C): (0.00, nan)	(D, C): (0.27, 0.29)	(D, C): (0.22, 0.23)	(D, C): (0.16, 0.17)	(D, C): (0.09, 0.09)
	(D, D): (0.00, nan)	(D, D): (0.34, 0.36)	(D, D): (0.38, 0.38)	(D, D): (0.41, 0.42)	(D, D): (0.45, 0.45)
0.2	(C, C): (1.00, 1.00)	(C, C): (0.27, 0.25)	(C, C): (0.17, 0.15)	(C, C): (0.13, 0.12)	(C, C): (0.10, 0.10)
	(C, D): (0.00, 0.00)	(C, D): (0.24, 0.25)	(C, D): (0.31, 0.31)	(C, D): (0.35, 0.35)	(C, D): (0.40, 0.40)
	(D, C): (0.00, 0.00)	(D, C): (0.24, 0.25)	(D, C): (0.22, 0.23)	(D, C): (0.17, 0.18)	(D, C): (0.10, 0.10)
	(D, D): (0.00, 0.00)	(D, D): (0.24, 0.25)	(D, D): (0.30, 0.31)	(D, D): (0.35, 0.35)	(D, D): (0.39, 0.40)
0.4	(C, C): (1.00, 1.00)	(C, C): (0.40, 0.38)	(C, C): (0.22, 0.25)	(C, C): (0.19, 0.20)	(C, C): (0.15, 0.18)
	(C, D): (0.00, 0.00)	(C, D): (0.18, 0.19)	(C, D): (0.25, 0.25)	(C, D): (0.31, 0.30)	(C, D): (0.34, 0.35)
	(D, C): (0.00, 0.00)	(D, C): (0.24, 0.25)	(D, C): (0.27, 0.25)	(D, C): (0.20, 0.20)	(D, C): (0.17, 0.12)
	(D, D): (0.00, 0.00)	(D, D): (0.18, 0.19)	(D, D): (0.25, 0.25)	(D, D): (0.30, 0.30)	(D, D): (0.33, 0.35)
0.6	(C, C): (1.00, 1.00)	(C, C): (0.45, 0.43)	(C, C): (0.30, 0.30)	(C, C): (0.25, 0.25)	(C, C): (0.21, 0.23)
	(C, D): (0.00, 0.00)	(C, D): (0.13, 0.14)	(C, D): (0.20, 0.20)	(C, D): (0.25, 0.25)	(C, D): (0.29, 0.31)
	(D, C): (0.00, 0.00)	(D, C): (0.30, 0.29)	(D, C): (0.31, 0.30)	(D, C): (0.26, 0.25)	(D, C): (0.22, 0.15)
	(D, D): (0.00, 0.00)	(D, D): (0.13, 0.14)	(D, D): (0.19, 0.20)	(D, D): (0.24, 0.25)	(D, D): (0.28, 0.31)
0.8	(C, C): (1.00, 1.00)	(C, C): (0.42, 0.40)	(C, C): (0.35, 0.29)	(C, C): (0.30, 0.25)	(C, C): (0.25, 0.25)
	(C, D): (0.00, 0.00)	(C, D): (0.09, 0.10)	(C, D): (0.16, 0.14)	(C, D): (0.21, 0.19)	(C, D): (0.25, 0.25)
	(D, C): (0.00, 0.00)	(D, C): (0.40, 0.40)	(D, C): (0.33, 0.43)	(D, C): (0.29, 0.38)	(D, C): (0.26, 0.25)
	(D, D): (0.00, 0.00)	(D, D): (0.09, 0.10)	(D, D): (0.15, 0.14)	(D, D): (0.21, 0.19)	(D, D): (0.24, 0.25)

Chapter 2

Awesome theorems and stuff

2.1 Introduction

Note that I can refer to other chapters: see Chapter 1 and even specific equations in each chapter, this is an equation (??).

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Chapter 3

Conclusion

3.1 Introduction

This chapter will just show you a picture drawn in tikz shown in Figure 3.1.

3.2 Conclusion

The end.

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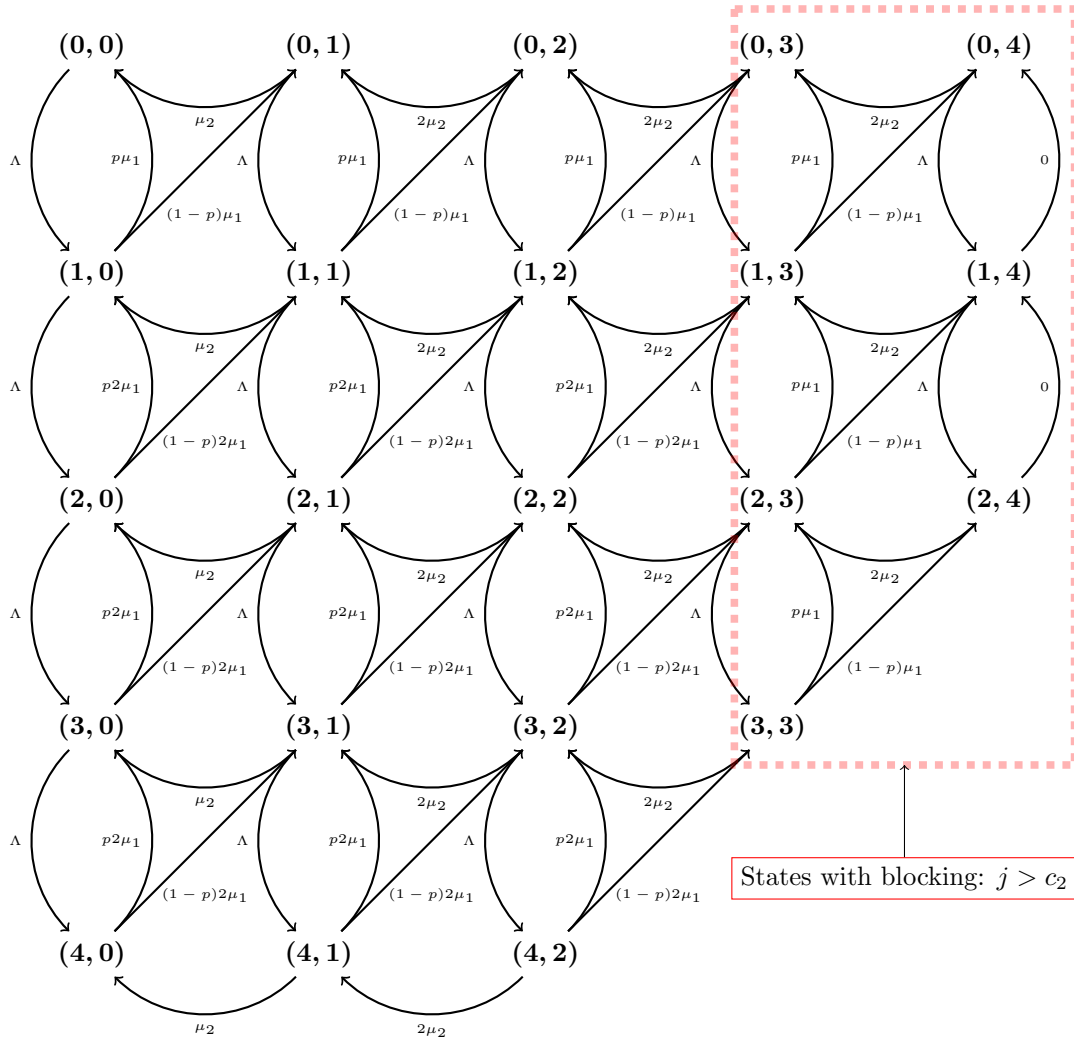


Figure 3.1: A Markov chain

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