

The Application of Game Theory to the Selection of Postgraduate Dissertation Topics

Yunke Guo

School of Business Administration, Henan Polytechnic University, Jiaozuo, China

Abstract: Nowadays, games exist everywhere in people's daily life, and game theory methods should not be just formulas and words in books, but also brought into people's daily life, helping people to solve many practical problems in life. This paper selects the most common problem in the life of postgraduate students - the choice of thesis direction between postgraduate students and their supervisors, takes Nash equilibrium as the theoretical support point, analyses the "prisoner's dilemma" model in game theory, combines with the payment matrix, and finds the solution to the problem. The solution to the problem is the application of game theory in daily life, which demonstrates the close connection between games and life.

Keywords: Game theory, Prisoner's dilemma, Payment matrix, Postgraduate student, Supervisor, Thesis topic selection.

1. Introduction

Across the globe, the idea of gaming has been used skillfully in ancient times. For example, in the 6th century BC (Spring and Autumn Period), the famous "Sun Tzu's Art of War" was a brilliant masterpiece of countermeasures, which is still shining with the light of human wisdom and is used by the world today. The application of game theory has penetrated into various fields of human life, such as politics, economy, military, sports, culture and law, etc. This paper briefly analyses and explains the application of game theory in life mainly from the aspect of postgraduate thesis selection.

2. Literature Review

2.1. The main ideas of game theory

Game theory, also known as response theory, is a quantitative analysis theory that describes these problems in a rigorous mathematical model, analyzes them mathematically in a unified framework, seeks a reasonable choice of strategy for the parties to the game and the outcome of the game when the strategy is chosen rationally, and analyses the economic and efficiency implications of the outcome [1]. This discipline, founded by the father of computing, von Neumann, and the economist Oscar Morgenstern, has become an important branch of modern mathematics. In today's increasingly globalised society, games permeate every aspect of people's lives and our daily work and life is a constant process of choice, decision making and gaming. Every rational economic person tries to get the maximum payment in the game to maximise their own interests [2].

2.2. The main idea of Nash equilibrium

A Nash equilibrium is a situation that develops in a non-cooperative game in which, for each participant, he cannot improve his situation as long as the others do not change their strategies.

It is generally accepted that the economic definition of a Nash equilibrium refers to such a combination of strategies of the participants where no participant alone would benefit from changing his strategy. In other words, a strategy combination is a Nash equilibrium if no one will change his

or her strategy when all others do not [3].

3. The Gaming Relationship Between Teachers and Students

The student-teacher relationship at the graduate level is a special kind of interpersonal relationship formed by the mutual influence and interaction between supervisors and students, and graduate students need to work with their supervisors throughout the graduate stage, so the relationship between students and supervisors becomes the focus of close attention of all students and supervisors.

From the student's point of view, postgraduate studies can broaden one's knowledge and professional ability in one's field of specialisation, while a postgraduate diploma can provide one with more and better employment options in one's future life. From the supervisor's point of view, recruiting students is a necessary condition to maintain their status as a postgraduate supervisor, but sometimes this status can bring other effects such as social reputation or welfare benefits, and some supervisors who have research projects also hope to help complete their research tasks by recruiting postgraduates [4]. As a result, a situation may arise between supervisors and students regarding the selection of topics for postgraduate students: students want their dissertation topic to be one that interests them and is easier to complete, while supervisors want their students' dissertation topic to be one that is related to their own research projects. The conflicting needs of students and supervisors, if not handled properly, will have a significant negative impact on both the students and their supervisors, which can be analysed using game theory.

4. Game Analysis

4.1. The original model of the Prisoner's Dilemma

The Prisoner's Dilemma, a common and typical explanation of the Nash equilibrium, is a classic case in game theory and is illustrated by the following model: two prisoners are taken to separate rooms for interrogation, and their strategy sets are both {Confession, No confession.} If both choose to confess and the evidence is overwhelming, each is

sentenced to 8 years in prison; if only one chooses to confess and reveal, and the other chooses to deny, i.e. not to confess, he is released on merit and the other is sentenced to 10 years in prison; if both choose not to confess, they are both charged with a crime, but each is sentenced to only 1 year in prison due to insufficient evidence. Before the trial, the two prisoners are informed of all the consequences that will result from their actions, and both understand that their companion has the same information as they do [1].

The model was developed as follows:

Table 1. Prisoner's dilemma payment matrix

		Prisoner 2	
		Confession	No confession
Prisoner 1	Confession	-8, -8	0, -10
	No confession	-10, 0	-1, -1

The above matrix is analyzed: for Prisoner 1, no matter whether Prisoner 2 confesses or not, Prisoner 1 will get higher returns from confessing than not confessing, so Prisoner 1 will choose to confess. For Prisoner 2, whether Prisoner 1 confesses, Prisoner 2 will get a higher payoff for confessing than for not confessing, so Prisoner 2 will confess. No matter what the other person chooses, the best option for everyone is to confess. Therefore, the model's Nash equilibrium would be (Confession, Confession).

4.2. Game analysis between graduate students and supervisors

4.2.1. Model Establishment

Setting up the situation:

the graduate student and the supervisor jointly choose the topic. The supervisor wants to choose the research project, while the student wants to choose the interest. At this time, the conflict between supervisors and students occurs.

Establishing five hypotheses:

Hypothesis 1: Both the supervisor and the student are perfectly rational people;

Hypothesis 2: The supervisor agrees that the student chooses interest related, and the student actively completes the paper, which increases the gratitude and satisfaction to the supervisor, and the return is 2; Although it is not of great help to the scientific research project of the supervisor, the supervisor guides the students to complete the thesis smoothly, and his reputation is improved, with a profit of 1.

Hypothesis 3: The students listen to the supervisor to choose the research project, the supervisor's research project is promoted, the income is 2; Although students are not interested in the topic selection, but get the supervisor's active help, the benefit is 1;

Hypothesis 4: The supervisor and the student do not give in to each other, the supervisor does not agree with the students to choose the topic of interest, does not actively help the students to complete the thesis, the students are under great pressure to graduate, the scientific research project of the supervisor has not been promoted, the reputation of the supervisor among the students has deteriorated, and the relationship between supervisors and students has deteriorated, so the income of both sides is -1.

Hypothesis 5: Considering that there is no actual situation in which the supervisor actively selects the interest related of the student and the student actively selects the research

project related to the supervisor, the return of both parties is -1.

According to the above assumptions, the model is established as follows:

Table 2. Game payment matrix between supervisors and students

The game between supervisors and students on topic selection		Student	
		Research project correlation	Student interest correlation
Supervisor	Research project correlation	2, 1	-1, -1
	Student interest correlation	0, 0	1, 2

4.2.2. Gain and loss analysis

Using mixed strategy Nash equilibrium to solve the above problems.

Suppose that the probability of students choosing the thesis topic they are interested in is p , and the probability of choosing the thesis topic related to the supervisor's research project is $1-p$. The probability that supervisors choose students' interests is q , and the probability that supervisors choose scientific research projects is $1-q$.

When the income related to the selection of scientific research project by the supervisor is equal to the income related to the selection of students' interests, the following requirements should be met:

$$2(1-p) - p = p$$

When students choose the benefits related to their interests equal to the benefits related to their research projects, they need to meet the following requirements:

$$1 - q = -(1 - q) + 2q$$

From the above two formulas: $p=1/2$, $q=1/2$

Therefore, the Nash equilibrium for the above problem is:

Student (Research project correlation, Student interest correlation) = (1/2, 1/2)

Supervisor (Research project correlation, Student interest correlation) = (1/2, 1/2)

4.2.3. Solution

In practice, what people demand is often the maximization of the interests of both sides. When it comes to communication, the best way to solve differences or conflicts is to resolve conflicts through negotiation in order to maximize the interests of both parties. For example, when there is a conflict in communication with the supervisor, we should first calm down, analyze the gains and losses of the decision, and then select the optimal strategy. Under normal circumstances, students are in a weak position and choose to make concessions to maximize their interests for the sake of successful graduation. However, students do not blindly obey the requirements of supervisors in every case, but need comprehensive analysis to get the optimal strategy. At the same time, the supervisor should give the students some choice, not blindly ask the students to comply with the requirements of the teacher, fully understand the ideas of the students, and more communication between the two sides, so as to select the optimal strategy to ensure the maximum benefits.

5. Conclusion

Life is full of prisoner's dilemma games, such as between bosses and subordinates, drivers on the same road, dating games between couples, etc. In many cases, individual rationality is likely to bring collective irrationality, if everyone only acts in accordance with the principle of self-interest, such as: Bosses who don't trust their subordinates and don't delegate power, drivers who don't obey traffic rules for their own sake, and couples who don't agree with each other often end up losing out.

The Prisoner's dilemma mentioned above are one-time games. If it is multiple games, people are likely to cooperate and the Prisoner's dilemma can be solved. Game theory studies show that in order for cooperation to become an equilibrium solution in multiple games, one party of the game (preferably the stronger party) must actively express the goodwill of cooperation to the other party through a credible commitment, and strive to express and convey this goodwill clearly. Only in this way can both sides cooperate, so that both sides can maximize their interests and get the optimal strategy.

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