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# Analysis of Seat Occupation Phenomenon Based on Prisoner's Dilemma Model

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## Abstract

This paper analyzes the occupancy behavior of university libraries by establishing a game model of prisoner's dilemma, and gives corresponding solutions.

## Keywords

Occupation phenomenon; university library; prisoner's dilemma.

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## 1. Introduction

As a gathering place and resource platform for document information, the library is playing an increasingly important role in guiding the advancement of culture. It is a symbol of cultural spirit, and it is responsible for leading social and cultural trends and guiding core values. It affects the overall quality of the people subtly. However, there are always occupations in university libraries, and this phenomenon is becoming more and more popular. The problem of occupying seats has caused many students to "have seat but no use". The seats in the library are often occupied by fixed personnel but not the most people. It is undoubtedly a waste of resources and even affects the behavior of college students' values.

This is a typical example of collective irrationality caused by the pursuit of personal rationality. The "Prisoner's Dilemma" is a model for studying the game theory between police and criminals, which can provide a theoretical basis for this study.

## 2. Related literature review

As a symbol of the gathering place of college knowledge, the library has always been favored by college students. However, due to the continuous expansion of the major universities in recent years, the library's various hardware facilities can not be synchronized with the number of students who continue to grow, resulting in more and more serious problems of students occupying seats. The research on the issue of library occupancy has only developed in recent years, and domestic and foreign scholars have less research on the "occupation problem" in the perspective of "Prisoner's Dilemma". Some scholars use the theory of "Prisoner's Dilemma" to analyze the behavior of students' choice of occupying. Students choose "not to occupy the seat" as the best decision, but for the sake of self-interest, each student wants to maximize their own interests, so they will choose "occupy" as a dominant strategy. In addition, some scholars have analyzed the behavior of student occupation from the perspective of economics. They think that the seats of university library are public resource, from an economic point of view, public resources belong to items that are competitive but not exclusive. In addition, the library seats are competitive. When a student successfully takes up and uses a certain seat, the seats reserved for other students are correspondingly reduced, at the same time, the seat does not have an exclusive nature. When a student occupies and uses a certain seat, it does not prevent other students from occupying other seats. For self-interest, the students will choose a strategy that is most beneficial to themselves, that is "occupy". Guo Manhua, Fan Jianzhong and other scholars established a game model for two participants (students), and assigned specific utility values to the payment matrix, and analyzed the reasons why students would choose to occupy the seat as

their dominant strategy. There are also some scholars who, when establishing a model for analyzing the "Prisoner's Dilemma" in the library, generalize the utility value of the participants in various situations, that is, using letters instead of the specific values given by the subjective subject, making the model more persuasive. For example, Li Yingchun in the "Prisoner's Dilemma and University Library Occupation" assumes that the cost of occupying a seat is  $C_1$  (including the time of loss, the risk of losing property due to occupation), and the cost of finding someone else's seat is  $C_2$ . The probability of finding a seat is  $P$ , the utility of the seat is  $V$ , and the additional utility brought by the seat is  $A$ , because the utility of not being able to use the seat is  $-V$ [1], and then a more generalized occupation is established. The game model, respectively, derives the Pareto optimal solution under collective rational conditions and the final solution under the individual rational conditions, thus demonstrating the specific performance of the "Prisoner's Dilemma" on the issue of occupation. Most scholars generally analyze the problem from the perspective of the behavior of students occupying the seat, few scholars comprehensively analyze the occupation problem from the perspective of whether the librarian manages or not based on the analysis of the student's occupation. Li Xia, Liu Ze and others in the article "Analysis and Countermeasure of University Library Occupation Problem", from the perspective of readers and readers, readers and librarians, and politeness and impoliteness, through the payment matrix, give specific income values and analyze the occupancy of university libraries.

In summary, the research on the phenomenon of library occupancy is mainly focused on the analysis of the game between the students and the students so far, but there are few studies on game behavior of whether the management of the reading room is occupied by the administrator. Based on the study of student and student behavior, this paper analyzes the game behavior between administrators.

### 3. Research ideas in this paper

Due to the rich resources of the university library, the access to information is convenient and fast, and the environment is elegant and quiet. Therefore, many students have a special liking for the library, which makes the occupancy phenomenon more and more serious.

The occupancy of the library mainly has the following characteristics:

First, the occupancy phenomenon is phased and the occupancy period is relatively long. The peak period is often at the end of the semester, due to the proximity to the exam, most of the students will choose to go to the library to prepare for the exam. The seat will be in short supply, so the probability of occupying a seat is relatively large. However, at the beginning of the semester, due to the relatively lighter academic burden, there will be fewer students going to the library to study, so the probability of occupying a seat is relatively small.

Second, the occupancy phenomenon is universal. In colleges and universities, students will actively join the ranks of "occupation", on the other hand, students will be negatively affected by other people's occupation. In the library, students often use one or two books, a water glass, or even a roll of toilet paper to occupy a seat. This behavior causes the students who occupy the seat to "sit back and relax", as long as they or their classmates help to occupy the seat successfully, then they can use this seat at any time, but students who do not occupy a seat can only leave. This phenomenon reflects the growing need for "occupation", students have to get up early to line up, otherwise they will face the risk of being robbed.

Third, the phenomenon of "occupation" has been increasing year by year. The main reason is that in recent years, major universities have generally expanded their enrollment plans, but the hardware facilities such as libraries cannot keep up with them. In addition, due to the prevailing test habits of university students, they will review their homework near the test week. The time spent by students in using library resources is basically the same, which is the reason why the phenomenon of "occupation" is getting worse.

In view of the analysis of the characteristics of the "library occupancy" phenomenon, On the basis of the results of scholars' research that it is necessary to consider the phenomenon of "library

occupancy" in many aspects (not only from the perspective of library readers, but also from the perspective of librarians), This study establishes a game theory model. In addition, without loss of generality, when building a model, this article gives more generalized values of utility values for various situations, rather than specific values. Finally, this article gives the corresponding solution.

#### 4. Model establishment and interpretation

##### 4.1 "Prisoner's Dilemma" model

Game theory is a theory in which two participants in a balanced state take certain actions to analyze the behavior of themselves and their influence on each other and seek the best strategy. When it comes to game theory, we will think of the "Prisoner's Dilemma", which is a classic model in game theory, details as follows:

A rich man was killed at home and his property was stolen. During the detective process in this case, the police arrested two suspects and found stolen belongings f from their residence. However, both suspects denied that they had killed people, arguing that they first discovered that the rich man was killed, and then they stole some property by hands. The police then put the two men in isolation. The prosecutor said: "Your crime of theft is true, so you can sentence you to one year's sentence. However, I can make a deal with you. If you confess murder crimes alone, I will only sentence you to three months in prison, and your accomplices will be sentenced to ten years in prison. If you refuse to confess and are accused by your partner, you will be sentenced to ten years in prison and your partner will be sentenced to three months in prison. In addition, if both of you confess to the facts, each person is sentenced to five years in prison. "

The specific model is as follows:

Table 1: Prisoner Game Pattern Table

		Prisoner 1	
		frank	deny
Prisoner 2	frank	-5, -5	0, -10
	deny	-10, 0	-1, -1

According to the Prisoner Game Table, there are several situations: ① Prisoner 1 and Prisoner 2 both choose to repudiate, each side receives a one-year sentence. ②Prisoner 1 chooses to frank, Prisoner 2 chooses to repudiate, then Prisoner 2 is sentenced to 10 years in prison. ③Prisoner 2 chooses to frank, Prisoner 1 chooses to repudiate, then Prisoner 1 is sentenced to 10 years in prison. ④Both Prisoner 1 and Prisoner 2 chose to frank, and each one was sentenced to 5 years in prison.

Obviously, the best strategy for both one is to choose to deny at the same time.

In this way, each person can be sentenced to one year’s sentence. However, since the two participants are in a state of isolation from each other, it is not possible to reach an agreement through consultation. If you choose to deny, and the other party chooses to frank, you will face the danger of being sentenced to 10 years in prison. For the sake of self-interest, both prisoners will choose to confess in order to avoid the danger of being confessed to 10 years for their own refusal.

The above analysis shows that the “Prisoner's Dilemma” model reflects the contradictory result of collective irrationality due to personal reason.

Similarly, the issue of occupying in university library can also be explained by the “Prisoner's Dilemma”. Every student is like a “prisoner”, they understand that choosing not to occupy a seat is the best strategy, prisoners who choose to repudiate can make the best use of resources. However, for the sake of self-interest, every student wants to make the best use of it for themselves, so that each student chooses to occupy a seat instead of sharing seat resources with other students.

**4.2 Game Analysis between Students and Students**

The phenomenon of “occupation” is very common in major university libraries. With its elegant and quiet environment and convenient and quick access to information, it has become the preferred place for college students to study, which leads to a very serious occupation.

First, let's make the following assumptions:

- (1) There are N people who go to the library to study, and they are rational and homogeneous. There are M seats available, but  $N > M$ .
- (2) Participants are Student I and Student II, and each participant faces two choices: occupying and not occupying, and their payment function is known.
- (3) The cost of occupying is C1 (including the time of loss, the feeling of wasting, the risk that the occupied goods may be lost, etc.), the cost of temporarily finding a seat or letting someone else occupy the seat without occupying a seat is C2, and the probability of finding a seat P, The utility value of using this seat is V, and the additional benefit value brought by the seat is A. For the convenience of research, it is assumed that the negative utility value due to the inability to use the seat is -V. When the students are not seated, the cost of finding a seat can be regarded as 0, that is,  $C2=0$ .

Figure 2 below is the Occupancy Payment Matrix:

Table 2: Occupancy Payment Matrix

	Classmate II occupied	Classmate II don't occupy
Classmate I occupied	$V+A-C1, V+A-C1$	$V+A-C1, PV-(1-P)V-C2$
Classmate I don't occupy	$PV-(1-P)V-C2, V+A-C1$	$PV-(1-P)V, PV-(1-P)V$

Analysis according to the table 2 above:

- (1) As long as  $A > C1$  is satisfied, then  $V+A-C1 > PV-(1-P)V-C2$ , the extra utility value of the seat is greater than the cost of the seat, then the students tend to choose to occupy the seat. This situation occurs near the exam. most of the students want to go to the library to study. The probability of finding a seat available is relatively small. The extra utility brought by the seat is relatively large and is greater than the cost of occupying the seat. Therefore, all the student will choose to occupy the seat as their dominant strategy, thus forming a Nash equilibrium state (occupied, occupied).
- (2) When  $A < C1, C2=0$ , then  $V+A-C1 \leq PV-(1-P)V-C2, p \geq 1-(c1-a-c2)/2v$ , the additional utility value of occupying is not more than The cost of the seat, then the students tend to choose not to occupy. This situation occurs during the non-examination period such as the start of school, holidays, etc. At this time, there are fewer students studying in the library, the probability of finding a seat is very large, and the additional utility value of the seat is not more than the cost of occupying the seat. Therefore, students will choose not to occupy the seat as their own dominant strategy, thus forming a Nash equilibrium state (not occupying seats, not occupying seats).
- (3) When  $PV-(1-P)V > V+A-C1 > PV-(1-P)V-C2$ , according to the analysis result of (1), from the perspective of self-interest, both sides of the game will choose to occupy the seat as a dominant strategy. In this case, the participants choose not to occupy the seat, which is Pareto's optimal. At this time, the problem of “prisoner's dilemma” arises, that is, the conflict between individual rationality and collective rationality leads to the failure to make the best use of library seating resources.

**4.3 Game Analysis between Librarians and Librarians**

First, we assume that:

- (1) There are the phenomenon of student occupancy in the library reading room. There are two librarians in every reading room, and they are all rational people.
- (2) The two parties involved in the game are Administrator I and Administrator II. Each administrator faces two choices: management or no management of the reading room occupancy, and the respective payment functions are known.

(3) The basic salary utility value of the administrator is  $U$ , and the management cost under the management of both parties is  $C1$ , if one manages and the other one don't manage, the cost of the non-management is  $C2$ , and the management cost of the manager is  $C3$ , Compared with the mutual management, single-person management is time-consuming and labor-intensive, so  $C1 < C3$ , and the management cost  $C2$  of the non-manager in the case of single-person management can be regarded as 0, so  $C2 < C1 < C3$ ; In the case that neither administrator manages, due to the student's occupation, the library reading environment is deteriorated, the order is disordered, etc. As a punishment, the relevant departments will deduct the wages of the two administrators appropriately, and the negative effect of deducting wages to administrators is  $C4$ .

The specific payment matrix is shown in Table 3 below:

Table 3: Administrator Payment Matrix

	Administrator II manage	Administrator II don't manage
Administrator I manage	$U-C1, U-C1$	$U-C3, U-C2$
Administrator I don't manage	$U-C2, U-C3$	$U-C2-C4, U-C2-C4$

(1) If the two administrators do not manage the occupancy phenomenon, the relevant departments will severely punish them, then  $C4 > C3 > C1 > C2$ , one of the administrators from the perspective of dominant strategy Always knowing the decision of another administrator, choose a decision different from him, that is, the final result will appear (management, no management) or (not management, management).

(2) If the two administrators do not manage the occupancy, the relevant departments will punish them accordingly, then  $C3 > C4 > C1 > C2$ , so both administrators will choose not to manage as a dominant strategy. Thereby forming a Nash equilibrium state (not managed, not managed).

(3) If the two administrators do not take measures to manage the occupancy, the relevant departments will not punish them. That is: when  $C4=0$ , both administrators will choose not to manage as a dominant strategy, thus forming a Nash equilibrium state (not managed, not managed).

In the (2) and (3) cases above, it is the Pareto optimal thant the two administrators choose to manage, but for the sake of self-interest, both sides choose not to manage, thus forming a Nash equilibrium, which leads to the problem of "Prisoner's Dilemma", that is, individual rationality and collective Conflicts in rationality have contributed to the atmosphere of the library and further aggravated the issue of seating, which has made the library's seating resources not fully utilized.

### 5. Countermeasures and thinking

Through the specific study of the "Prisoner's Dilemma" theoretical model and the phenomenon of university library occupancy, this paper will propose a feasible plan for the library reading room.

(1) Punitive measures. One way to get out of the "prisoner's dilemma" is to impose punishment. If every prisoner who refuses to pay the refusal will be punished for the confession of the confessed prisoner after the release of the prisoner, then, because of the fear that the confession will have a punishment for the future, then both parties refuse to provide a repudiation and become a balanced solution, although this situation is not allowed by law in reality, but this idea can be applied to the occupation of university libraries. 1) Imposse appropriate and effective punishment on the students who occupy the seat. As long as a certain punishment is imposed on the students who occupy the seat, it is possible to prevent this behavior from happening again. 2) The incompetence of librarians is also a factor that makes the occupancy phenomenon popular. According to the analysis results of 4.2, in order to get out of the "prisoner's dilemma", it is necessary to appropriately increase the value of  $C4$  and increase the punishment for the administrator's non-management, that is, increase the amount of wage deduction when the occupation is not managed.

(2) Set a credible promise and be good at cooperation. Only through cooperation can we achieve win-win results. The problem of prisoner's dilemma lies in the conflict between individual interests and collective interests, and people tend to only value their own interests, so they get much less than they lose. All parties in the game must respect each other's legitimate interests, create win-win through profit sharing, and make cooperation long-term, and the key to cooperation is mutual trust. The way to achieve mutual trust between the players is to set third-party constraints. For students who go to the library to study, we can constrain the students through the management of the librarian, such as posting a notice of "civilized, not occupied" and other librarians. In addition, the librarian should also conduct a timely inspection. The occupying behavior is stopped and punished in time.

(3) Establish a seat card system. For example, the card is swiped once every half hour for the seat occupied, otherwise the seat is invalid. This can directly increase the occupancy cost  $C_1$ , thereby reducing the student's occupancy behavior, and getting out of the "prisoner's dilemma" problem, so that the university library seat resources can be optimally configured.

(4) Expand the self-study classroom. Due to the expansion of the study room, the number of self-study seats increased. According to the analysis of 4.1, the probability  $P$  of not occupying the seat but finding the seat is increased, and the additional benefit  $A$  of the seat is reduced to 0, but the seat cost  $C_1$  is unchanged. Under the premise of people, the occupancy phenomenon will be effectively solved, and the university seating resources will be optimally configured.

Of course, the above solution is based on some ideas and suggestions from the perspective of "Prisoner's Dilemma", and further research is needed.

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