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Application of mathematical modeling in probability theory and mathematical statistics

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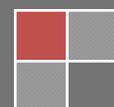
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ABSTRACT

In this paper, the mathematical modeling used in probability theory and mathematical statistics were studied. The idea of integration of mathematical modeling in probability theory and mathematical statistics in teaching is proposed. Students can cultivate creative thinking ability. Discussion is as below.

KEYWORDS

Mathematical modeling; Probability theory; Mathematical statistics.



INTRODUCTION

Probability theory and mathematical statistics belong to mathematics, but they are also used in many other related professional knowledge. In colleges, probability theory and mathematical statistics course are very difficult courses. The purpose of teaching probability theory and mathematical statistics is not only to allow students to grasp some of the important concepts, methods and conclusions, but also to achieve the goal of equipping students with the mathematical ideas and ways of thinking, and math skills applied in practice. Application of mathematical modeling in probability theory and mathematical statistics can well inspire students' creative thinking, as discussed below.

THE NECESSITY OF MATHEMATICAL MODELING IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS APPLICATIONS

Mathematical modeling is represented by a mathematical symbol or a set of mathematical expressions, as well as images, charts, graphs, and other characteristics. It describes features and internal relations of the real system, including simplifying a hypothetical question, the establishment and solution model, evaluation, analysis and application models and test models.

Models are everywhere in real life and production practice. Probability models are the majority.

We can say that the probability models are from the practice. One mathematics branch of statistical regularity of random phenomena is probability theory and mathematical statistics which are basic math courses in many institutions, and also the follow-up courses. However, because many students in application-oriented colleges and universities have a poor mathematical basis and they seldom learn probability theory and mathematical statistics courses. It is difficult to arouse students' interest in learning and achieve high marks. Realistic sources of theoretical models needs to be introduced, thus the theory from the practice goes back to the practice. Students get interested in learning. From this respect mathematical modeling used in probability theory and mathematical statistics is very necessary.

The brain activity is thinking, which is the initial impression of objective things, analysis of objective things, comparison, summarization of the reaction process. Thinking can be divided into low-level thinking and higher-order thinking. The latter one can be summed up and improved, then forms the ideological formation. The purpose of probability theory and mathematical statistics is to solve the problems in the real world. In another word, the biggest feature of probability theory and mathematical statistics courses lies in real life applications. In university education, the traditional way of teaching pay more attention to the theoretical and systematic knowledge structure, and often neglects mathematical theory in solving practical problems. In recent years, relevant agencies organized this National Mathematical Contest in Modeling activities, which improved the situation to some extent. With the Mathematical Contest in Modeling quality gradually improved and expanded year by year, its guiding ideology of training students to apply their mathematical knowledge to solve practical problems affects the in Probability Theory and Mathematical Statistics Teaching in universities.

Under this circumstance, this article discusses the use of mathematical modeling used in probability theory and mathematical statistics, so that all aspects of daily teaching has penetration of mathematical modeling. Mathematical modeling used in probability theory and mathematical statistics reflects not only the role of mathematical thinking in solving practical problems and the connection of everyday life and mathematics, but also enables the students to learn to face problems through the use of comprehensive knowledge and methods. In recent years, many problems in the National Mathematical Contest in Modeling are related to the probability theory and mathematical statistics, such as electricity transmission congestion management market, the 2008 Beijing Olympic Games, the flow distribution, reasonable arrangements for hospital beds, etc., but many students in the National mathematical contest in Modeling rarely consider random nature of the data and attributes of practical problems. They were more willing to directly use the software model to solve the problem when performing, and also ignored the identification of the model, the estimated realistic data and parameters, etc.. Few students are able to conduct a full and comprehensive analysis and their models are rarely tested. So we can see that, to enable students to grasp the basic methods of probability theory and mathematical statistics and the basic concepts, it is very necessary to enhance their ability to solve problems and apply the mathematical modeling in probability theory and mathematical statistics. We can have a more thorough understanding of the various types of mathematical modeling through some diagrams as Figure 1, 2, and 3.

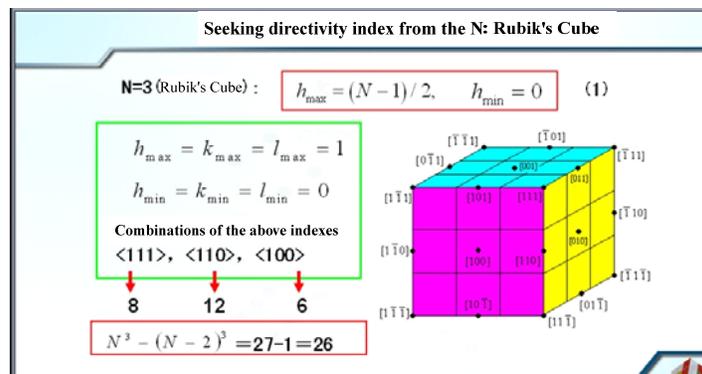


Figure 1 : Mathematical modeling diagram

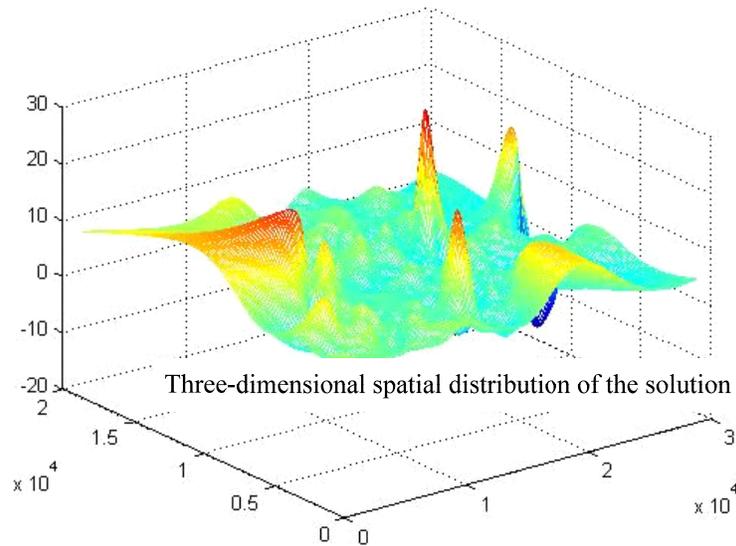


Figure 2 : Mathematical modeling diagram

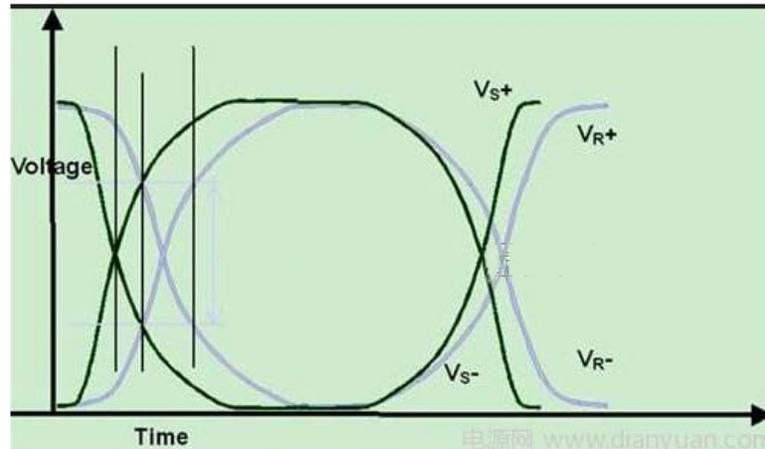


Figure 3 : Mathematical modeling diagram

APPLICATION OF MATHEMATICAL MODELING IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS

Probability theory and mathematical statistics introduced by the mathematical model

In real life, there are many examples of randomized trials. The teacher can be introduced in the first lesson, which may arouse students' interest in the probability model. In the one door and three sheep question, at this time the teacher is the host, with A, B, C to be labeled doors. The teacher labels the real door and hands over the answer note to a student in advance. Then let class students to participate and experiment for 10 trials. Let some students randomly select two doors and let the rest of the students choose to change a door. This allows students to experience the probability theory and mathematical statistics course being a subject researching a large number of random events statistical regularity. This teaching method also allows students to feel their presence, make students feel they are the focus in class. The teacher plays the leading role. The emergence of probability theory is mainly related to distribution of gambling money. A proper introduction of the historical background of the statistical probability can improve student learning efficiency to a certain extent. We give a scenario: two people gamble and toss an even coin, to guess positive and negative speculation. Each one takes 100 yuan, so the total sum is 200 yuan. Whoever wins three innings wins 200 yuan. But for some reason during the course the gambling is interrupted. Then one wins two times and lose once. Then how to allocate these 200 yuan bet to make it fair? This problem can be left for further thinking. After analyzing the equally probability model and the total probability formula, students are given two kinds of calculation methods. For the full probability formula, if two participants have the 4th inning, one participant's chance of winning and losing constitutes a complete set. If one wins, he will win all the money for gambling. If not, he has half chance to win in the fifth innings. The probability for one to win all the gambling money is $1/2 \times 1 + 1/2 \times 1/4 = 3/4$. As a result, one wins 150 yuan, the other one wins 50 yuan.

As for equity possibility events probability model, one of the two men will win the money for gambling after five innings of gambling. After 3 innings, there are four possible outcomes after two innings. In all the results, there are three ways for one of them to win and one way for the other one to win, so the money should be allocated following the 3 : 1 ratio. That means one man will get 150 yuan, the other one will get 50 yuan. The result will be the same as that calculated though full probability formula.

The whole process of putting mathematical modeling idea into probability theory and mathematical statistics teaching

Integrating the idea of mathematical modeling in the classroom means a lot to students’ ability of application. Case teaching methodology can be used to integrate mathematical modeling into the whole process of probability theory and mathematical statistics teaching. After the use of the case teaching method is determined, the content of each chapter of the textbook should be inserted with appropriate cases. When organizing teaching, we should use mathematical modeling to give description, assumptions, modeling and solving practical problems in order to introduce the basic concepts and method theory of this chapter. After explaining a chapter, we should hand over the understanding reports of groups, and particularly sum up the knowledge points that are needed.

Birthday problem

The birthday problem is a typical problem in classical probability. Through the analysis of the birthday problem, we can deepen students’ understanding of classical probability of relevant knowledge and methods. The designing of birthday problem is as follows: In a 30-person classroom, seek the probability of at least two persons having the same birthday.

Under normal circumstances, there are usually about 120 people in a large class of probability theory and mathematical statistics class. Students will write on a piece of paper their birthdays of gregorian calender in an anonymous way. Extract 30 randomly and 50 continuously. Through years of this experiment in eight large classes, we get the experimental data (TABLE 1).

TABLE 1 : Times of at least two students having the same birthdays

| Project | Class | | | | | | | |
|--|--------|--------|--------|--------|--------|--------|--------|--------|
| | 200901 | 200902 | 201001 | 201002 | 201101 | 201102 | 201201 | 201202 |
| Times of at least two students having the same birthdays | 33 | 36 | 34 | 37 | 35 | 33 | 38 | 34 |

As can be seen from TABLE 1, the probability of at least two students having the same birthday is around 70%, which is relatively close to the result of classical probability calculations $1 - 365 \times 364 \times \dots \times 336 / 36530 \approx 0.706$. Then we can raise new questions: after random selection of 50 groups, what the probability of finding all students having the same birthday is. Leave the issue as student’s homework, and it is good for deepening students’ general understanding of classical probability and application of knowledge.

Problem of economic benefit

In real life, we can use probabilistic knowledge to solve simple economy problems. We have designed a simple economic problem: in order to predict the occurrence of a natural disaster, there are A, B, C, D four independent prediction methods can be used. After using A, B, C, D forecasting methods, we can successfully predict the probability and cost of natural disasters as in TABLE 2. The predicting program can use an individual prediction method and also combination of using several forecasting methods. If the total cost is not more than 1.2 million as the premise, then what kind of prediction scheme should be used so that natural disasters can be predicted with a maximum probability.

TABLE 2 : Predicting the probability of success and the costs

| Project | Prediction method | | | |
|--------------------------------|-------------------|-----|-----|-----|
| | A | B | C | D |
| Ratio of successful prediction | 0.9 | 0.8 | 0.7 | 0.6 |
| Costs / ten thousand yuan | 90 | 60 | 30 | 10 |

Calculating the probability of independent event, we can obtain three predictions. The corresponding predicted probability of success are shown in TABLE 3. Through TABLE 3 we can see that if the total cost is not more than 1.2 million yuan, we can make the greatest probability of successful prediction which is 0.976 after combining B, C, D three programs. Students can do further research by writing their own set of data, so that they can make the problem better solved, and summarize their experience. They can learn under what circumstances it is better to take one or two kinds of prediction

methods, or even take combination of three predictions. Leave it to students as homework. In human resource management, marketing and other directions we can also use this case to allow students to think on their own.

TABLE 3 : Prediction scheme and predict the probability of success

| Project | Scheme | | |
|-------------------------|--------|-------------------------|---------------------------------|
| | A | Jointing A, B | Jointing B, C and D |
| Prediction success rate | 0.9 | $1-(1-0.9)(1-0.7)=0.97$ | $1-(1-0.8)(1-0.7)(1-0.6)=0.976$ |

METHOD OF STRENGTHENING MATHEMATICAL MODELING USED IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS

Strengthening the construction of materials

Teaching and learning together constitute the educating activity. Teaching activities revolve around teaching content and teaching materials are the teaching mediation. In order to enhance the practicality of university mathematics and increase setting up and solving mathematical models, we should abide the principle of "to apply and to be enough for the degree", learn from the data, and reform probability theory and mathematical statistics textbook. In order to meet the teaching syllabus requirements, and allowing the students to have practical application of knowledge of each chapter, we can appropriately reduce the difficulty of teaching materials.

Encourage and train students to participate in mathematical contest in modeling

American held in 1985 for the first time college students modeling contest, with a competition team of three students to solve practical problems. During the game, students need to conduct the topic and finish the papers in three days. Since 1992, China began to organize their own Mathematical Contest in Modeling. In recent years, many problems are related to the probability and statistical knowledge, which is also needed in conducting model parameter estimation and testing.

Students in application-oriented colleges and universities have relatively weak mathematical foundations, but some students have a very strong interest for mathematical modeling. Teacher can give brief introduction of mathematical modeling to freshmen and have them find information about it. Teachers can also pick some students to learn mathematical modeling, and organize students to participate in provincial mathematical Contest in Modeling. In this way, teachers can select outstanding students to participate in the National students' contest in Modeling which can also be a good exercise for students.

Reform testing method

Assessment in the teaching process is a very important aspect. It can assess students' learning and can also evaluate the quality of teaching. In general, institutions of higher education only have investigation lesson for probability theory and mathematical statistics course. In the evaluation mechanism of higher mathematics curriculum, the average grades accounts for 30% and the final exam accounts for 70%. While in the probability theory and mathematical statistics courses evaluation mechanism, the usual closed-book exam results and final assessment results both account for 50%. The average score is usually divided into four parts, including classroom performance, homework, and attendance, each accounting for 10% and mathematical modeling homework accounting for 20 percent. This can not only reflect the students' enthusiasm for probability theory and mathematical statistics courses, but also reflect students' ability of application of probability and statistics knowledge. All the flexible evaluation mechanisms reflect students' true ability, and also very beneficial for students to develop practical ability.

CONCLUSION

In this paper, the mathematical modeling used in probability theory and mathematical statistics are studied. First comes the discussion of the necessity of mathematical modeling of probability theory and mathematical statistics application. Then the application of mathematical modeling in probability theory and mathematical statistics is discussed, including probability theory introduced by mathematical models and mathematical statistics courses, the whole process of integrating mathematical model thought with Probability Theory and Mathematical Statistics. The final are the ways to strengthen mathematical modeling in Probability Theory and Mathematical Statistics, including strengthening the construction of teaching materials, encourage and train students to participate in mathematical modeling contest, and reform assessment methods. All these ways can help to achieve good results in probability and mathematical statistics contest, stimulate students' interest in learning, and inspire students' creative thinking.

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