第三届"ScienceWord 杯"数学中国

数学建模网络挑战赛

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题　　目　　　　　高校图书馆的智能服务

关 键 词　　图书馆预约系统　二项分布　误期发生率 图书利用率

摘　　　要：

本文在考虑图书馆实际运行情况下，基于概率论与初等函数等相关知识，建立了两个模型：**预约效用评价模型**与**基于误期发生率与图书流通率的图书优化管理模型**，合理的解决了高校预约系统的效应评价与图书管理方案的制定问题。

针对问题一，本文建立模型 V——**预约效用评价模型**。本模型巧妙的将预约系统对图书流通率的影响转化为对图书流通增长次数的影响。对于第 i 类预约的书，在没有预约系统的情况下，假设学生按时还书的人数 k 服从二项分布，而在预约系统的积极影响下，对于第 i 类书，在假设学生按时还书的概率为 0.3 的情况下，可以求出它的图书流通增长次数的数学期望，然后再将 22 类书的图书流通增长次数的期望相加起来，就是总的增长期望。考虑到预约系统的失败率高达 60% 以上， 大部分预约图书都在书架存放 5 天，影响了图书的流通率。因此，在前面的总增长期望的基础上，还要减去预约失败影响的流通次数。基于题目给出的数据，通过模型求解得到最终结论：预约系统增长流通次数，增长的次数为：185 次。

针对问题二，本文建立模型 VI——**基于误期发生率与图书流通率的图书优化管理模型**。本模型的建模思路为：先考虑影响误期发生率与图书发生率的因素有：1、对误期读者的惩罚力度；2、预约读者可以保存书的天数；3、预约读者误期的惩罚额数；4、续借期限；5、预约人数；6、失约人数等。

在这些因素之中，预约人数对预约读者保留书天数、预约读者误期的惩罚额数也有一定的影响。考虑了上述影响因素后，分别建立了以上各因素对误期发生率、图书利用率的影响函数（主要为三类指数函数）。然后以这些影响函数作为约束条件，以图书利用率与误期发生率之差最大作为目标函数建立最优化模型。用 MATLAB 求解出最优解：最优的预借书人数为 **6** 人，预约读者每人保留书的天数为 **18** 天，预约读者发生误期的惩罚额数为 **0.27**，续借的期限为 **60** 天，即可以两次续借，一次 **30** 天。图书利用率为：**0.7481**，误期发生率为：**0.4822**。并得出一套图书管理方案。

本文的亮点有：

1、**转移角度解决问题**。模型 V 巧妙地将预约系统对图书流通率的影响转化为预约系统对图书流通增长次数的影响，使问题的求解更简洁容易。

2、**善于运用前面模型的结论**。模型 VI 很好的利用前面模型 I 数据字典模型、模型 II 的 SOM 神经网络模型、模型 IV 的惩罚函数，来验证本次建模中的假设函数是否合理、正确。

3、**创造性的构造初等函数**。模型 VI 构造了 13 个初等函数，这些构造函数虽然存在一定的主观性，但是也能较好的描述各种因素对误期发生率、图书利用率的影响。体现了本文的大胆创新，勇于实践。

Abstract

Based on the probability theory and the knowledge of primary function knowledge，we have built two models: The Model of the Effection of Book Reservation and the Book Optimal Management Model based on the Error rate and the Flow rate.With the help of these two models ,we have solved the problem of evaluating the booking system of the college and the established issues of the management of the library.

Modle V—The Model of the Effection of Book Reservation .

The model translated the effection of the booking system into growth of the number of books in circulation. Appointment book for the first category, there is no booking system in the case, assuming that the number of students to return books on time and obey the binomial distribution, and in the reservation system of positive influence, for the first books, on the assumption that the probability of students to return books on time in order to circumstances under which the books can be found in circulation growth of the number of mathematical expectation, and then 22 books in the library circulation growth in the number of expected aggregated overall growth is expected. Taking into account the reservation system of more than 60% failure rate, most of the appointment books are stored in the shelves 5 days, affecting the flow rate of books. Therefore, the total growth in the previous expectations, based on even less influence the flow of the number of failed appointments. Based on the data subject is given by solving the model to get the final conclusion: the number of reservation systems has grown in circulation, an increase of the number is: 185 times.

Model VI — Book Optimal Management Model based on the Error rate and the Flow rate.

The modeling idea is: Firstly consider the impact of error on the incidence and books incidence of factors: 1, the punishment of readers' error; 2, booking readers can save the book of days; 3, number of pentalty amount; 4, renewal deadline; 5, reservation number; 6, the number of missed appointments and so on.

Among these factors, the number of reservations on the appointment book readers keep the number of days, make an appointment, readers might be the amount of punishment has a certain impact on the number. After considering the above factors, were established on the above factors on the incidence of errors, utilization of library functions (mainly three types of exponential function). Then the influence function as constraints to book availability and misuse of the biggest difference between the incidence of objective functions as the optimization model. Using MATLAB to solve the optimal solution: the optimal number of people:6 appointment book readers keep the number of days per person for 18 days, appointment delays occurred readers the amount

of the penalty number of 0.27, renew the period of 60 days, that can renew twice, once for 30 days. Books Flow rate: 0.7481, error rate of occurrence: 0.4822.

This paper include three highlights:

1 ,**Solved the the problem 1 in another point of effectively and simply view .**

2, **Used the conclusions of the previous models**. Model VI is good use in of the model I (data dictionary model), model II(SOM neural network model)and model IV of the penalty function, to verify the assumptions of this modeling function is reasonable and correct.

3, **Creative construction of elementary functions.** Model VI have creatived 13 elementary functions, although these structures function is subjectivity, can be used to describe the various factors on the incidence of delays, library utilization. This reflects the bold innovation of this article,and the courage to practice

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