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2020
MCM/ICM
Summary Sheet

Course Arrangement System Design

Summary

Due to the backward configuration of the teaching building, a university hopes to update the classroom configuration, make reasonable arrangements for classrooms and arrange reasonable lessons, which is conducive to improving university teachers' resources and teaching standards. Therefore, we study the transformation of teaching buildings and curriculum arrangements.

For the first question, We calculate the classroom demand under three usage rates and check whether it meets the curriculum requirements. First, we sorted out the data in Forms 1 and 2, and classified the classrooms according to the teaching area, classroom type, and classroom capacity. For students, we sort out 5 types of data: class number, class hours, class size, class and classroom requirements;For the classroom, we sorted out the classroom scheduling capacity, classroom type, total class hours, and 4 types of data in the teaching building to reduce the amount of data redundancy. Paradigm type changed from 1NF to BCNF. And according to the classroom matching function (see Figure 2 for details), the course requests are processed one by one. When the utilization rate is 40%, the demand for three types of classrooms is 17, 56, and 38 (see Table 1 for the other two utilization rates).

For the second question, based on the known data in Appendix 2, we can calculate the classroom utilization in 2020 and bring it into the classroom matching function in the first question. The utilization rate of the first teaching building is 34.17%, and the utilization rate of the second teaching building is 37.41%. See Table 2 for the classroom requirements.

For the third question, we obtained the lessons for each class and each class based on the constraints of the total class hours taken by each class. The average utilization rate, the continuous use of the classroom scores, and the number of people use scores were used to define the best use plan. Class matching function. The conclusions are shown in Figure 4. Compared to the conclusion of the second question, the lesson scheduling plan of this question increases the average utilization rate between classrooms, reduces the possibility of equipment overload, and increases the classroom full capacity.

For the fourth question, Based on the conclusions of the above questions, we put forward rewriting proposals and transformation plans for the problems existing in university classrooms. Such as: strengthening the overall layout and planning to integrate classroom resources as much as possible; appropriately reducing the use of classroom time; and improving the construction of modern classrooms.

Finally, we evaluate the advantages and disadvantages of the model, and propose the generalization and application of the model.

Kew words: preprocessing, class classification, classroom matching algorithm, class scheduling algorithm

Content

1. Introduction

1.1. Background

With the continuous expansion of universities, the increase in the number of students and the relative shortage of resources, the efficiency of the use of classroom resources in universities has become a matter of great concern. Due to the backward configuration of the teaching building, a university hopes to transform it into a classroom type, make the classroom size more standardized, optimize the structure, and make full use of classroom resources. For this reason, it is necessary to evaluate the needs of the classroom, and to meet the needs of the students and teachers to the maximum extent, and complete the problem of class scheduling. Among them, the problem of class scheduling is a complete NP problem. Each university cannot be separated from the problem of classroom arrangement. Being able to arrange courses reasonably and efficiently is of great significance for improving the quality of the school and the efficiency of the use of classroom resources.

1.2. Literature review

At home, Safeai D and Sigero O proposed the genetic algorithm combined with the idea of control constraints; Yu Chengjie took the classroom resources of Nantong University's main campus as the perspective, and from the current situation of classroom resources, he proposed solutions based on the problems that often occur in the management process. The methods of these problems make classroom resources better serve teachers and students; Fan Huijun uses Nantong Shipping Vocational and Technical College as an example to analyze school classroom resources, and analyzes the current situation of classroom resources in the new campus of the school to find out classroom resource management. Problems. Some improvement measures for classroom resource management in higher vocational colleges are proposed to provide reference for classroom resource management in higher vocational colleges.

In foreign countries, Arbainad tripathy arranges the curriculum for the situation of "people". He uses the Glange's relaxation method and branch and bound technology to solve the problem, and artificially causes conflicts between courses to reduce the number of variables; Jean Aubin and Jacques Ferland of Montreal University of Canada and others divided the scheduling problem into two sub-problem schedule problems and grouping problems.

1.3. Overview of our work

Based on the data provided using mathematical modeling methods, we solved the following problems:

For question one: Calculate the number of demand for the three classrooms in the three classroom usage rate, and check whether it meets the demand for all courses in the fall of 2020. We have classified the data and simplified the redundant data. We set the classroom utilization rate from the perspective of class hours, and then match the student's curriculum with the relevant situation of the classroom so that the conditions are one-to-one. If the conditions are met, the number of three types of classrooms that meet the needs of the curriculum .

For question two: Calculate the utilization rate of classrooms in Teaching Buildings 1 and 2 in 2020, and then find the demand and judge whether it is appropriate. On the premise of question 1, we calculated the utilization rate of the classroom, calculated the demand for three classrooms based on this utilization rate, and analyzed the rationality of the utilization rate based on the distribution of the different types of classrooms and the results.

For question three: In the teaching week is 16 weeks, 8 days a day, 5 days a week, students have less than 6 lessons per day, and based on this, the best classroom utilization model is established. We build a model from three aspects of utilization rate, and use lingo to solve it based on class hours, classroom types, and classroom numbers as constraints.

Forquestion four: In response to the above situation, rewrite proposals for the university's classroom and propose a suitable transformation plan. We mainly put forward suggestions to increase more small-capacity classrooms, improve classroom utilization, and improve school teaching standards.

2. Symbol Description

Symbol	Symbol Description
η_k	Utilization of the kth classroom
P_{ij}	Number of students in class i in class j
L_{kp}	k classroom can accommodate class p size
C_{ijnm}	Class i in class n in classroom building m with class number j
D_{knm}	Class m classroom of the nth school building
T_j	The number of class hours required for class number j
R_k	Class k remaining hours
F_{ijq}	Class i course number is the qth time

Note: Other symbols are described in the text.

3. Assumptions and Justifications

●Hypothesis 1: The multimedia equipment in the classroom and the seats in the classroom are not damaged.

Reason: Most of the current teaching is multimedia teaching. If the multimedia teaching equipment in the classroom is damaged, it may lead to the failure of normal teaching and problems in the classroom arrangement of the class.

●Hypothesis 2: Holidays cannot be scheduled during class hours (such as National Day).

Reason: When there are holidays during the scheduled class hours, the teaching plan will be disrupted, which will lead to smooth class hours, which may lead to classroom conflicts.

●Hypothesis 3: There are no major disasters, such as earthquakes and infectious diseases.

●Hypothesis 4: Each course is equipped with enough teachers.

Reason: For the model we built, we need enough teachers for each course to meet the teaching needs.

●Hypothesis 5: The teaching plan needs to be strictly implemented, and the class hours cannot be increased suddenly.

Reason: When the class time in a classroom is just right, the classroom needs to be changed suddenly to increase the class time to disrupt the teaching process.

●Hypothesis 6: There is not much difference between the hours of study in each class.

Reason: Only when there is a small gap in the hours of study in each class, can you use it as a basis for classifying and classifying courses.

4. Task 1: Matching the curriculum with the classroom

4.1. Definition of related concepts

●Classroom utilization rate = (actual class hours of the classroom / full hours of the classroom) * 100%

●Classroom scheduling capacity represents the maximum capacity of the classroom.

●Full lesson a day: 8 lessons per day is full.

● Types of classrooms: Different classrooms have different functions, and the school divides them into multimedia classrooms, seminar rooms, smart classrooms, drawing rooms, and professional studios according to the teaching arrangements.

4.2. Problem analysis

Based on the data provided, classroom utilization was specified. First of all, we classify the type of classroom, the area code of the teaching building, the capacity of classroom scheduling, and the number of hours per week. Classroom utilization is 40%, 50%, and 60%. Figure it out. Then arrange the class for the student's class timetable, determine the number of the course by both the course number and the class number, and determine the appropriate classroom type. Classrooms are arranged by the number of students until the maximum number of hours in the classroom is reached. Finally, under these three kinds of utilization rates, check whether it meets the needs of all courses in the fall of 2020.

4.3. Prerequisites for model building

4.3.1. Data preprocessing

(1) We pre-processed the data of the class schedules of the teaching buildings 1 and 2 in the autumn of 2020 in Table 1 to remove the unique attributes. The only attributes are usually those that cannot describe the distribution of the sample itself. For example, theoretical class hours and experimental class hours, the total class hours can be represented without the need for specific class hours description. So organize it into course number, total course hours, class size, class number, teaching building.

(2) Similarly, we pre-processed the data in Table 2 and deleted some irrelevant attributes, sorting them into classroom scheduling capacity, school semester, total class hours, teaching building.

(3) We understand the lesson number as the number of lessons in the course. We delete the repeated lesson number.

Note: Only the teaching areas 1 and 2 are mentioned in the question. Teaching areas 3 and 8 appear in the data. After comparing and analyzing other data, we changed teaching areas 3 and 8 to teaching areas 1 and 2. 2 and deleted the location of 6 teaching area in Table 1.

(4) For students, we sort out 5 types of data: class numbers, class hours, class sizes, and classes and classrooms. For classrooms, we sort out 4 types of data: classroom scheduling capacity, classroom types, total class hours, and classroom buildings. , Sort the data paradigm type in the table in Appendix I from 1NF to BCNF, and change the data paradigm type in the table in Appendix II from 1NF to BCNF.

4.3.2. Related regulations

Classroom capacity: Class 1 classrooms can accommodate 40 people, Class 2 classrooms can accommodate 70 people, and Class 3 classrooms can accommodate 90 people. In addition, the number of seats in the original classroom, which accommodated more than 120 people, remained unchanged.

4.4. Model establishment

4.4.1. Introduction to variables

η_k : Utilization of the kth classroom;

P_{ij} : The number of students in class i in class i;

L_{kp} : The k-th classroom can accommodate the number of people in class p classrooms;

C_{ijnm} : Class i in class i is classroom m in classroom n;

D_{knm} : Class m classrooms of the nth teaching building belonging to the kth classroom;

T_j : The number of class hours required for class number j;

R_k : The remaining class hours in classroom k;

F_{ijq} : The class number of class i is j time;

A_l : The number of classroom needs in the first l.

Among them, i is the class; j is the class number; n is the teaching building number n; k is the classroom number; p is the size of the classroom, including the first class can accommodate 40 people, the second class can accommodate 70 people, Class classrooms can accommodate 90 people, and Class IV classrooms can accommodate more than 120 people; q represents the number of classes.

4.4.2. Constraints:

1. The number of people in the course does not exceed the maximum capacity of the k classroom. Therefore, there are restrictions on the number of people:

$$P_{ij} \le L_{kp}$$

2. The classroom type of the student j course number matches the classroom type. Therefore, there are classroom type constraints:

$$C_{ijnm} = D_{knm}$$

3. The total class hours of the eligible courses must be less than or equal to the number of hours in the corresponding classroom. Therefore, the class hours are restricted by:

$$T_j \le R_k$$

4.Class time constraints:

$$F_{ijq_1} \ne F_{ijq_2} (q_1 \ne q_2)$$

Due to the same course, there may be a time conflict problem, that is, the same class in the same class in different classrooms at the same time. For this reason, we have the following corollary, as long as the class hours of all courses are less than n hours (n is the sum of available hours of each classroom in 1-19 weeks), there will be no conflicts between courses. Here is a simple proof:

Assume that in the same classroom set (teacher type, the same number of people in the classroom, and the same location), remember that all courses are $x_1, x_2, \cdots, x_n$, distributed in 1-19 weeks, there may be conflicting courses. Then there is a distribution scheme so that the courses do not conflict. The plan is: put $x_1, x_2, \cdots, x_n$ in order in the classroom allocation set of 1-19 weeks, that is, the lesson is arranged as shown below.

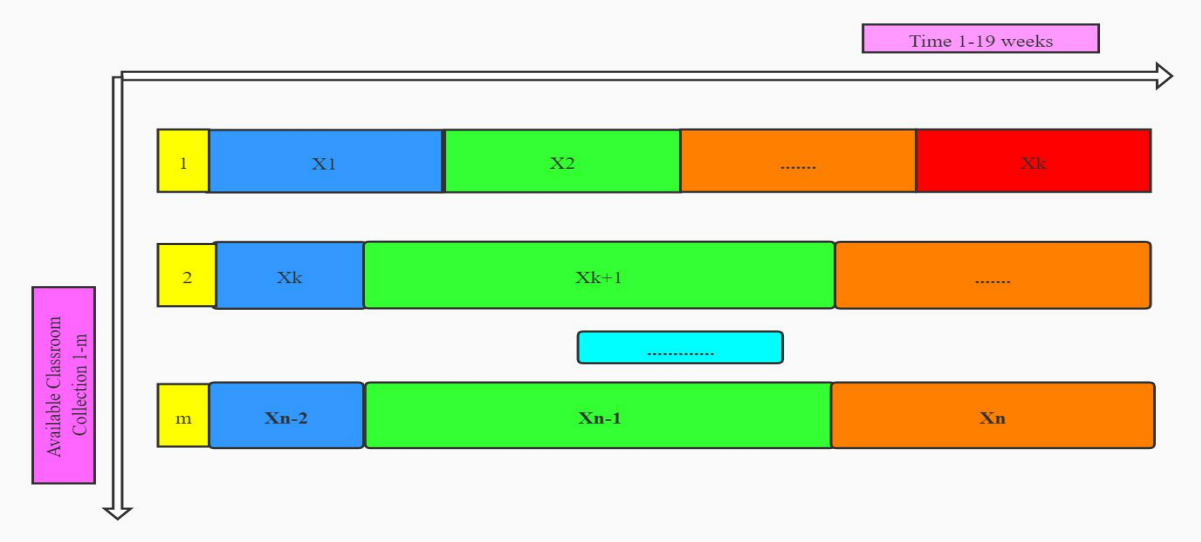

Figure 1: Schematic depicting time conflicts

As can be seen from the above figure, when there is a conflict in the courses arranged in the classroom, it can be exchanged with the already scheduled courses, and there is a certain scheme to meet the time without conflict.

4.4.3. Algorithm Design

*Step*1: Classify the weekly use of the classroom in Table 2 according to the type of classroom, the area code of the classroom, and the capacity of the classroom schedule. Based on the classification results and the utilization formula, calculate the utilization rates under the conditions of 40%, 50%, and 60%, respectively. Calculate the maximum number of class hours from 1 to 19 in each classroom.

*Step*2: The number of students for the course in the 2020 fall class schedule of Table 1 is determined by both the course number and the class number. The matching algorithm is used to match the area code of the teaching building, the type of classroom, and the situation of the classroom. Large-to-small order, and arrange the lessons that are less than the maximum class hours of the total course to the corresponding classroom area and classroom type.

*Step*3: According to the logical relationship of the flowchart in Figure 1, the specific description of the logic includes the number of people, the type of classroom, the requirements of the course time, and the class time. These relationships need to be matched. Finally, the demand for the three classrooms under each usage rate.

*Step*4: In the case of not exceeding the total class hours of the classroom, see whether the needs of various classrooms can be calculated, and test whether the demand for the courses can be met under the three utilization rates.

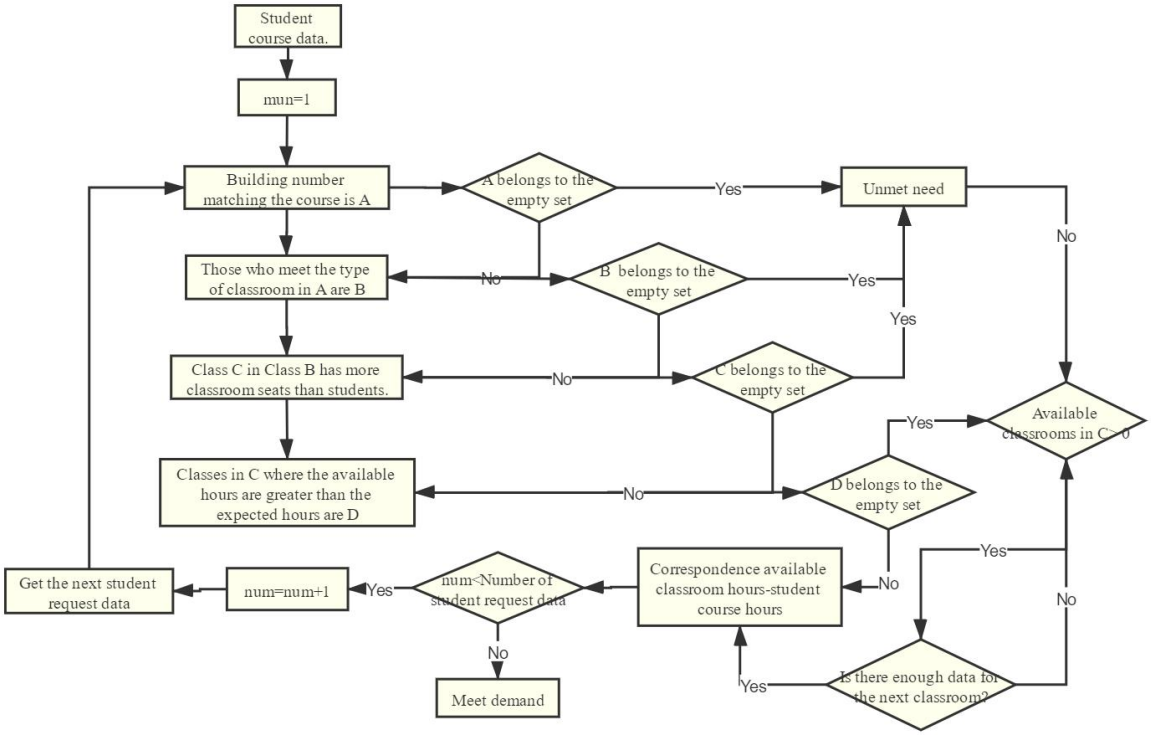

Figure 2: Course matching algorithm

4.5. Results Analysis

According to the logic of matching the distribution of courses and classrooms, the needs of the three classrooms are as follows:

Table 1: Demand for three types of classrooms

Classroom utilization	Class 1 classroom demand / room	Class 1 classroom demand / room	Class 1 classroom demand / room
40%	17	56	38
50%	13	43	31
60%	12	34	27

As can be seen from the above table, the higher the utilization rate of the classroom, the less the demand for each type of classroom. The process will be carried out because the classroom meets the requirements of the course, otherwise it will break. Therefore, the utilization rate in the classroom is 40%, 50%, and 60%. Under the conditions, the corresponding classroom needs have been found, so they all meet the needs of all courses in the fall of 2020.

4.6. Sensitivity test

We take every 5% of the 35% -65% utilization to make this graph:

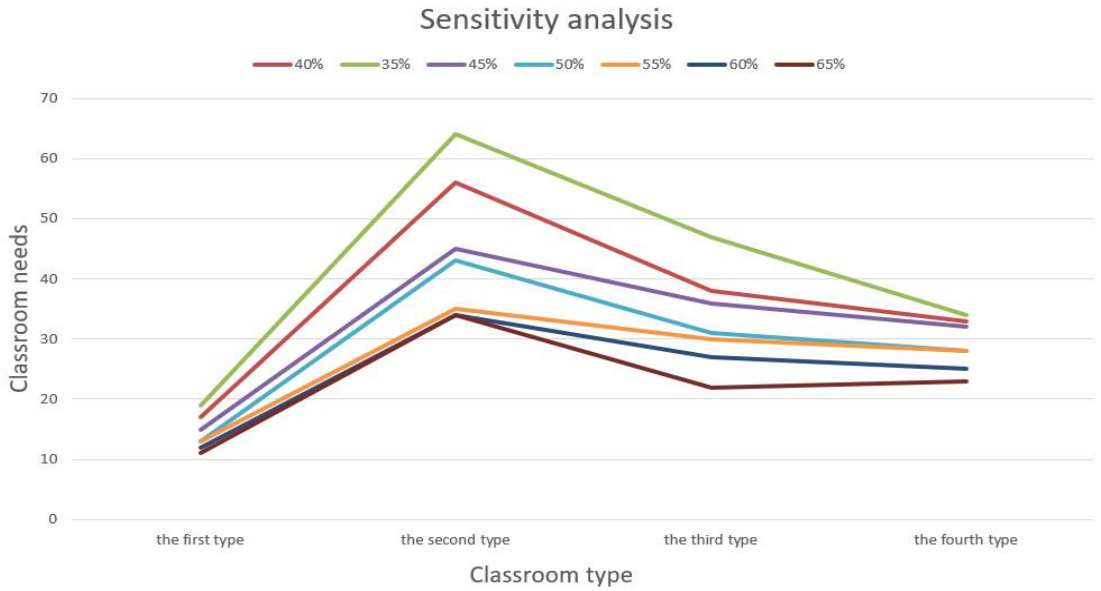

Figure 3: Problem-sensitivity analysis

It can be seen that as the utilization rate decreases, the demand for teachers has also increased. The second type of classrooms have increased the most, and the demand for the other three types has increased by 30. The number of demand does not fluctuate much, and each line changes The trends are the same, and the sensitivity analysis results can be considered good.

5. Task 2: Classroom Utilization and Demand

5.1. Problem Analysis

Calculate the utilization rate of classrooms 1 and 2 of the teaching building, and find the corresponding three types of classroom needs. According to the data provided in Table 2, the number of class hours to be met each week, and using the classroom utilization rate of Question 1, the classroom utilization rate of Building 1 and Building 2 in 2020 is η. According to the procedures of Question 1 and the students' curriculum situation in the fall, input the corresponding utilization rate to match the number of courses, teaching location, and class hours to the classroom situation, and draw three types of classroom needs. Rate statistics to analyze whether the utilization rate is reasonable.

5.2. Model establishment

By the definition of the utilization rate formula, the utilization rate of the classroom hours = (the actual number of class hours of the classroom / the number of full hours of the classroom) * 100%, according to the available classroom hours per week in Table 2, we can get the numbers 1 and 2. The utilization rate of the teaching building, combined with the thinking of problem 1, and changing the utilization rate with other constraints and the same logical relationship, calculated the three types of classroom needs.

5.3. Results analysis

According to the formula of utilization rate, that is, the utilization rate of the classroom = (the actual class hours of the classroom / the number of full hours of the classroom) * 100%, the utilization rate of Building 1 is 34.17%, and the utilization rate of Building 2 is 37.41% .

The specific usage of Classes 1 and 2 classrooms is as follows:

Table 2: Classroom usage of buildings 1, 2

Area code of teaching building	Utilization Rate	Demand for Class 1 classrooms / room	Demand for Class 2 classrooms / room	Demand for Class 3 classrooms / room
number 1	34.17%	20	67	47
number 2	37.41%	18	56	46

In order to more intuitively analyze whether this utilization rate is appropriate, we use three different types of classrooms and classrooms with a capacity of more than 120 people (including multimedia classrooms, seminar rooms, smart classrooms, drawing rooms, and professional studios) Rate statistics, the results are as follows:

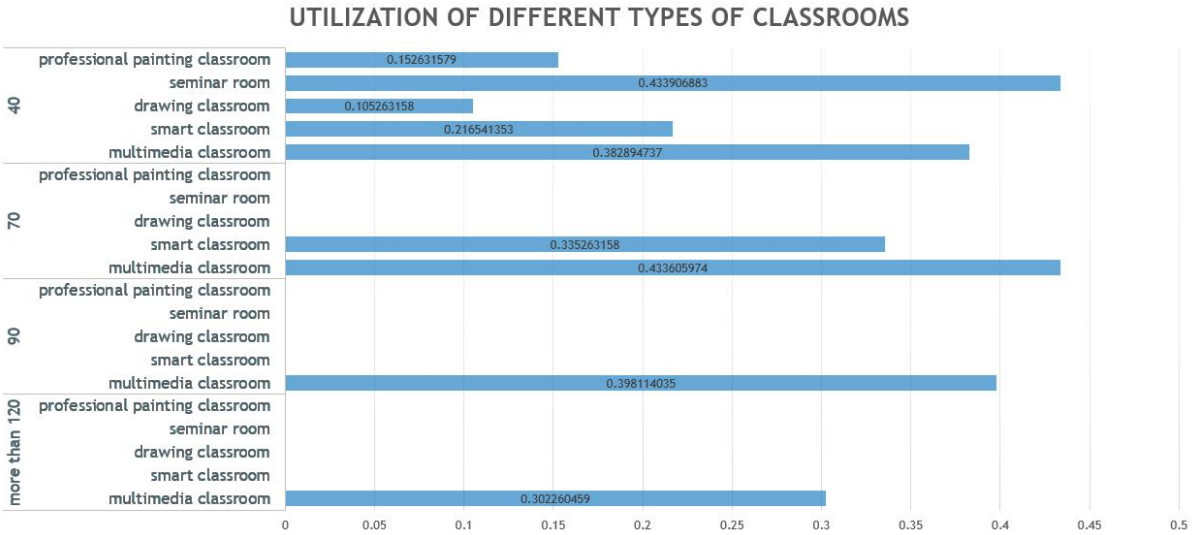

Figure 4: Different types of classroom utilization

Conclusion 1: According to different teaching classrooms of different sizes, we analyze the utilization rate of Building 1 and Building 2. In classrooms with a capacity of more than 120 people and large classrooms with a capacity of 90 people, There is only a multimedia classroom. Among the classrooms with a capacity of 40 people, the professional painting classroom and draming class courses account for only a few of them, and most of them are the other three types of classrooms.

Conclusion 2: Under the condition that the utilization rates of buildings 1 and 2 are 34.17% and 37.41% respectively, the number of three types of classrooms is obtained. The capacity of the first type of classrooms is 38 and the capacity of the second type of classrooms. There are 123 classrooms, and the capacity of the second class classrooms is 93. From the capacity of the three types of classrooms, it can be seen that there is a greater demand for classrooms with a larger capacity, and a smaller demand for small classrooms. However, for professional classrooms, all classrooms have small capacity, so for teaching multimedia classrooms, There are fewer capacity classrooms, but they are all large classrooms. For teaching, the classroom learning efficiency of large classrooms may be relatively low, and most teachers cannot take care of them, because the temptations of various types in universities are very large. The self-discipline of students alone is the most important factor for most people. It is very difficult, so we should transform some first-class classrooms for teaching, improve class efficiency, reduce the scope of teacher management, and then improve the overall school level. Therefore, the utilization rate is not very reasonable.

Conclusion 3: The utilization rate of buildings 1 and 2 is relatively low. Although it is said that the need for free classrooms can provide self-study, too many classrooms are idle, which is a waste of resources. It is necessary to make fuller use of classroom resources. So this utilization is not very suitable.

6. Task 3: Establish the best classroom utilization model

6.1. Analysis of the problem

For question three, we can find that the number of teaching weeks has changed from 19 weeks to 16 weeks, and it clearly shows that there are 8 lessons a day, 5 days a week. At the same time, compared with the problem one or two, this problem has two new constraints. It can be understood that each class has a maximum of 5 lessons a day, and each class has a maximum of 4 lessons. We take each class as a discussion unit, and plan for each day of each class. We make assumptions about the meaning of course numbers, and assuming that each department has one class, and we classify the courses by department.

6.2. Model establishment

6.2.1. Introduction of decision variables

$$S_{ijkmn}=\begin{cases}1 & \text{Class i of the jth course in the nth classroom of the mth section.}\\ 0 & \text{Class i of class j of class k is not in class m.}\end{cases}$$

M_s : s Classroom capacity.

6.2.2. Objective function

According to the data provided, to establish the best classroom utilization model, we consider from three perspectives, namely the average utilization rate of classroom hours, the continuous utilization rate, and the utilization rate of the people. From these three aspects, the optimal classroom utilization Rate optimal solution.

6.2.2.1. Average hourly utilization equation

The average utilization rate of a class with or without a class. The higher the utilization rate, the better. It helps to improve the resources of the classroom. The average utilization rate calculation formula is:

$$A_1=\sum_i\sum_j\sum_k\sum_m S_{ijkmn_1}$$

6.2.2.2. Continuous utilization equation

If the classroom has been in continuous class, for example, when the first few days of the week are full, and the next few days are idle, it may cause equipment overload and increase the burden on the classroom. Therefore, the lower the utilization rate of continuous classrooms, the better. The continuous utilization rate calculation formula is :

$$A_2=\sum_i\sum_j\sum_m\sum_n find\left[S_{ijk_1mn}=1\,\&\,\&(S_{ij(k_1+1)}==1\,||\,S_{ij(k_1-1)}==1)\right]$$

6.2.2.3. Headcount utilization equation

Crowd utilization rate = (the number of people in the course / the number of people in the classroom) * 100%, which reflects the utilization of classroom resources. The better the classroom and the number of people attending, the better. Of students not only waste teaching resources, but also affect teachers' teaching passion, so the higher the utilization rate of classrooms, the better.

If $S_{i_s jkmn_1}=1$, there is:

$$sum=sum+\frac{\sum_j\sum_k\sum_m S_{i_1 jkmn_s}}{M_s}$$

among them, M_s represents the number of people in the classroom.

Therefore, the headcount utilization rate is:

$$A_3 = \frac{sum}{k}$$

$$\max f = \frac{A_1 A_3}{A_2}$$

6.2.3. Constraints

(1) **Classroom constraints:** Only one class can be in a classroom at a time:

$$\sum_{n=1}^{l} S_{ijkmn} = 1, l = len(classroom)$$

(2) **Constraint on single day:** According to the requirement of task three, the number of class hours per day for this class should be less than or equal to 6 hours. Then there are:

$$\sum_{m=1}^{8} S_{ijkmn} \le 6$$

(3) **Constraint on total class hours:** Within 16 weeks, there are five days a week, no classes are scheduled on Saturdays and Sundays, and there is a maximum of 8 class hours per day, so the total class hours of this classroom is 640. The total class hours of a student's course must not exceed the total class hours that can be scheduled in the classroom, so that the classroom can be reasonably allocated, so there are the following total class hours constraints:

$$\sum_{i=1}^{161}\sum_{j=1}^{599}\sum_{k=1}^{80}\sum_{m=1}^{8} S_{ijkmn} \le 640$$

(4) **Classroom constraints:**

① If $i = s, i = 1,2,\cdots,161$, then

$$S_{ij_s kmn} = 0, j_s \in \left(a_{j_s}\right)_{x_s}$$

Among them, j_s is the set of no classes in class s; $\left(a_{j_s}\right)_{x_s}$ is the course number of no classes in class s.

②If $j = t, t = 1,2,\cdots,599$, then

$$S_{ijkmn_t} = 0, n_t \in \left(a_{n_t}\right)_{x_t}$$

Among them, n_t is the set of classrooms in which classes cannot be taught in j; $\left(a_{n_t}\right)_{x_t}$ is the classroom number of classes in which j cannot be taught in the classroom.

● Model summary:

$$\max f = \frac{A_1 A_3}{A_2}$$

$$A_1 = \sum_i \sum_j \sum_k \sum_m S_{ijkmn_1}$$

$$A_2 = \sum_i \sum_j \sum_m \sum_n find\left[S_{ijk_1 mn} = 1 \,\&\&\, (S_{ij(k_1+1)} == 1 \,||\, S_{ij(k_1-1)} == 1)\right]$$

$$A_3 = \frac{sum}{k}$$

$$s.t. \begin{cases} \sum_{n=1}^{l} S_{ijkmn} = 1, l = len(classroom) \\ \sum_{m=1}^{8} S_{ijkmn} \le 6 \\ i = s, i = 1,2,\cdots,161, S_{ij_s kmn} = 0, j_s \in \left(a_{j_s}\right)_{x_s} \\ j = t, t = 1,2,\cdots,599, S_{ijkmn_t} = 0, n_t \in \left(a_{n_t}\right)_{x_t} \end{cases}$$

6.2.4. Algorithm Design

Assume that the first two courses represent the college, the third represents the department, and the last few are the course numbers. It is also assumed that each department has a class, and the courses are classified by department.

*Step*1: Randomly select a class that can still take lessons. If you can't take a lesson, go to the next lesson selection.

*Step*2: Determine whether the class in the class schedule is still available on the day of the class. If it can, a section is selected randomly. If not, the class is reselected.

*Step*3: Find a matching classroom according to the type of classroom required for the course and the class size requirements. If there is, arrange a class, if not, do not attend.

*Step*4: Repeat steps 2-3 until all classes have judged.

*Step*5: Repeat steps 1-3 until 8 lessons are judged on that day.

*Step*6: Repeat this cycle 80 times, and judge the class schedule of each day.

The detailed algorithm is shown in the following flowchart:

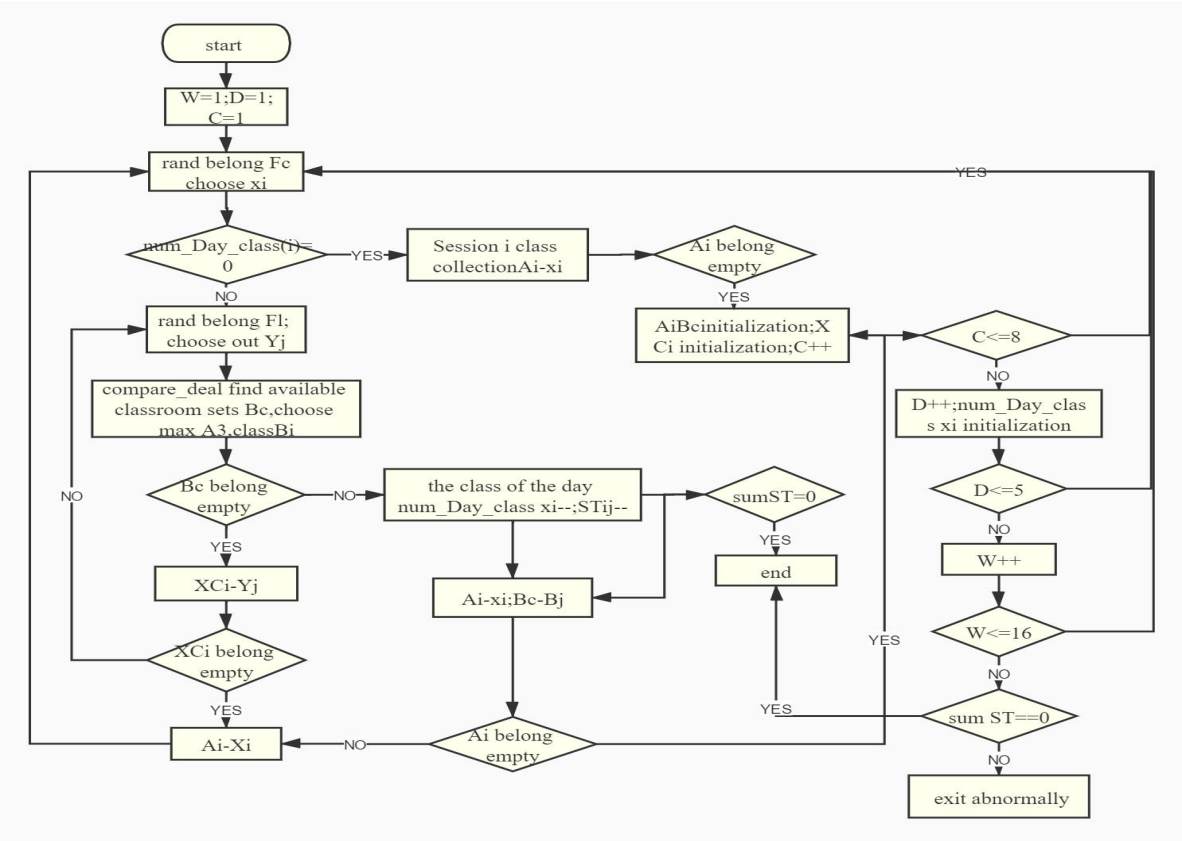

Figure 5: Classroom utilization optimization model

The related symbols of the flowchart are explained as follows:

W: number of weeks; D: number of days; C: first class class; A: class assembly; x_i : class; XC_i : section C class x_i class curriculum set; Y_j : a course number; $num\_Day\_class_i$: the number of courses that can be taken on the same day when the class is changed; ST_{ij} : x_i class and Y_j lessons remaining; B_c : section C available classroom set; B_i : one classroom; F_c = total remaining hours of class / total remaining hours; F_l = remaining hours of class / total remaining hours.

6.3. Results display

According to the utilization situation, the following figure is obtained:

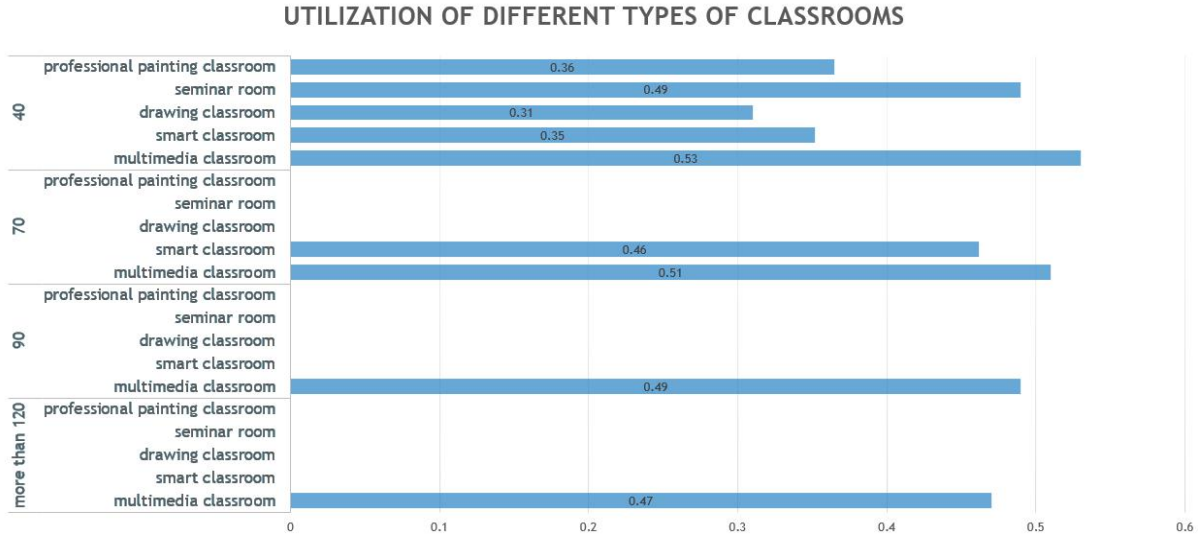

Figure 6: Utilization of optimized multi-class classrooms

Based on the figure above and the model, we draw the following conclusions:

(1)We can see that the utilization rate of each type of classroom has increased compared to Figure 2 due to the reduction in the number of weeks. At the same time, we can find that the utilization rate of classrooms of 40 and 70 people is higher, and the utilization rate of classrooms of 120 people or more is the lowest.

(2) Seminar rooms and multimedia classrooms have higher utilization rates, as these two classrooms are the classrooms most frequently used in class.

(3) The drawing room and professional drawing room have the lowest utilization rate. There are not many courses for daily use of this classroom. You can consider opening this classroom as a study room to increase the utilization rate effectively.

(4) Compared with the previous model, this model effectively solves the phenomenon of idleness in some classrooms. Our model tries to make the courses as decentralized as possible, and does not concentrate on finishing them together. It is more reasonable to arrange classroom classes and improve the utilization rate.

(5) We think that the same course every day does not meet the actual schedule, so we randomly select the courses in the model to make the schedule more consistent with the actual situation.

7. Task 4: Suggestions and Plans for the Classroom

7.1. Proposal for classroom rewriting of universities

Appropriately reduce the utilization of classroom hours. The classroom hour utilization rate does not need to be too high. The dormitory is a place for students to rest. Therefore, the teaching building assumes the responsibility of the study room. When the school hour utilization rate is too high, the self-study rate is reduced and the students' enthusiasm for learning is reduced. Not conducive to promoting students' autonomous learning. Therefore, it is very important to arrange students' schedules reasonably.

Improve the construction of modern classrooms. According to the above results, the construction of seminar rooms, smart classrooms, drawing rooms, and professional studios is not enough. With the modern teaching equipment and teaching methods becoming more and more abundant, the university's classroom construction of medium-sized classrooms only has multimedia classrooms. There are only small-scale classrooms such as seminar rooms and smart classrooms. For this type, they cannot meet the learning needs of students, the needs of teachers' teaching reform and innovation, and the needs of building first-class universities.

7.2. Classroom Transformation Plan

Strengthen overall layout and planning to integrate classroom resources as much as possible. In order to avoid the planning mode of "building by department" and "small and complete", two or more integrated teaching buildings can be constructed, for example, one is mainly based on multimedia teaching for large-scale and standardized theoretical teaching, and one is based on Seminar-based classrooms and smart classrooms are mainly used for education and teaching reform and innovation, and to improve the level of university education.

Theoretical and practical courses are taught separately. For example, the theory class is in multimedia teaching, and the practice class is more suitable for special classrooms such as laboratories. Practice is to exercise hands-on ability and creative ability. Only in a suitable place can its value be fully exerted, and only by real operation can it experience its laws. The combination of theory and practice can bring out the maximum effect and train more talents for the school.

Set up more small capacity classrooms. According to the needs of the three types of classrooms, the scale of the classrooms is improved according to the needs of the classes. For example, the class hopes to provide more small classes to reduce the burden of teachers calling and correcting homework. It is also for the consideration of students. Management requires students, so more classrooms with a capacity of 40 or 70 are being built. Setting up a small-capacity classroom can also improve the utilization rate of the classroom, make the learning atmosphere more intense, and improve the overall level of the school.

8. Conclusion

8.1. Strengths

(1) Reduce the amount of data redundancy. If there are multiple students in a department or the student has taken more than one course, the department name and the head of the department must be stored multiple times. The student's name, age, and other information must also be stored Secondly, due to the redundancy of the data, we process the data first. The amount of data redundancy becomes smaller; when operating on the data, various exceptions may be caused. The data is filtered, which greatly saves memory space.

(2) Simple to implement, fast to run, and applicable to a wide range of models, that is, classrooms can be automatically assigned by entering course requirements and available classrooms.

(3) The third question is comprehensive. From three perspectives, the allocation schemes are optimized and selected, and the question is to use a random algorithm so that the class schedules are not stiff and different schedules can be generated.

(4) Different schemes can be allocated according to utilization requirements, which solves the problem of class scheduling to a certain extent. Through computer calculation, it reduces labor consumption and improves efficiency and accuracy.

8.2. Weaknesses

The third question is that the number of teachers allocated is not the optimal solution, and the solution is close to the optimal solution.

The question only considers whether the needs of the course are met, and the schedule is a very complicated process. For example, it is necessary to consider the time for students to change classrooms between classes, that is, the shortest distance between classrooms during continuous classes. You can also consider the utilization rate of the number of people, how to arrange the course more comprehensively.

Regarding question one, the regulation on utilization rate is only the utilization rate of school hours, and there are other utilization rates, such as the utilization rate of classrooms, etc. You can consider several aspects for comparative analysis to see which utilization rate is

more in line with reality. As the amount of data increases, the model operation efficiency increases linearly.

8.3. Generalization of the model

By changing the model to lingo solution, the optimal solution of the allocation scheme can be found.And the theoretical lesson and practical lesson of the course can be divided into two courses, which can solve the low utilization rate of some classrooms.

The third question can improve the teacher distribution plan. The problem is more in-depth. Actually, it depends on the problem of class scheduling. It is necessary to meet the free time of the classroom during the course time, and there is no conflict between each class. You can consider using genetic algorithms to solve the problem of class scheduling. The data should be in the best interests of students and teachers.

8.4. Application of models

It can be applied similar to arranging workers on duty in factories, simplifying manual arrangements, saving time and labor. You can also model more detailed problems, such as more specific class requirements, compulsory courses are arranged during the day, and elective courses are arranged at night.

9. References

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10. Appendix

Appendix 1 : Matlab program for problem one

```
%% initialization
clear
clc
% 1,2 is the public teaching; 1 multimedia multimedia classroom; 2 seminar room seminar room; 3 drawing room
% 4 professional drawing room profession; 5 smart classroom smart room; 5 types of classrooms
%% Read classroom data Find out classroom capacity and available class time and classify the classroom
[~, ~, all] = xlsread ('fulu2.xlsx', 'Sheet1');
Class = all (209: end, [3,4,5, end-1]);% is autumn
[n, m] = size (Class);
for i = 1: n
    t1 = cell2mat (Class (i, 1));
    if strcmp (t1 (2), '1')
        Class (i, m + 1) = num2cell (1);
    else
        Class (i, m + 1) = num2cell (2);
    end
end
Class (:, 1) = [];% find out whether it is in 1 or 2 buildings
t1 = 0; Size = [];
for i = 1: n
    j = cell2mat (Class (i, 1));
    t1 = t1 + 1;
    if j <= 49
        Size (t1, :) = 1;
    elseif j <= 79
        Size (t1, :) = 2;
    elseif j <= 120
        Size (t1, :) = 3;
    else
        Size (t1, :) = 4;
    end
end% classifies classrooms with different numbers of people
clear t1 n m i j

%% Read student class data Calculate each class
[~, Data, All] = xlsread ('Changed 1.xlsx');
All = All (1: 1792, :);
Student = All (2: end, [3,4,9,11,12]);% get the lesson and class hour class capacity and class
[n, m] = size (Student);
t5 = 0;
for i = 2: n
    t1 = cell2mat (Student (i, 1));
    t2 = cell2mat (Student (i, 4));
    t3 = cell2mat (Student (i-1,1));
    t4 = cell2mat (Student (i-1,4));
    if (strcmp (t1, t3) && t2 == t4)
        t5 = t5 + 1;
```

```
        tip (t5) = i;
    end
end
Student (tip, :) = [];% delete duplicate data
clear t1 t2 t3 t4 t5 m n i data Data tip all All
%%

% xlswrite ('class.xlsx', Class);
xlswrite ('student.xlsx', Student);
```

Appendix 2 : Compare_deal

```
function [type, flag, class_time] = Compare_deal (Student, Class, Size, rate)
% clc, clear
%% class_time has the same order as CLass
% load student.mat
% load class.mat
% load classroom_type.mat
% rate = 0.4;
flag = 1;
l = size (Class);
type = zeros (1,4);
class_time = ones (1, l (1));
class_time = class_time. * (40 * 19 * rate);
Student = sortrows (Student, 3);
for i = length (Student): -1: 1
    classroom = char (Student (i, 5));
    len = length (classroom) / 4;
    for j = 1: len
        id_b = find (num2str (cell2mat (Class (:, 4))) == classroom (4 * (j-1) +1));
            id_t = find (num2str (cell2mat (Class (id_b, 2))) == classroom (4 * (j-1) +3));% classroom type
        if isempty (id_t)
            continue;
        end
          id_p = find (cell2mat (Class (id_b (id_t), 1))> = cell2mat (Student (i, 3)));% people number bind
        Class_id_copy = sortrows (Class (id_b (id_t (id_p)), :), 1);
        if sum (class_time (id_b (id_t (id_p)))) <cell2mat (Student (i, 2))
            % Available hours are less than the student requested hours
            continue;
        end

        for k = size (Class_id_copy):-1: 1
            % Compare feasible solutions, for loop order from small to large
             if cell2mat (Student (i, 2)) <= class_time (id_b (id_t (id_p (k))))% of hours requested by this student
                    class_time (id_b (id_t (id_p (k)))) = class_time (id_b (id_t (id_p (k))))-cell2mat (Student (i, 2));
                Student (i, 2) = {0};
                break;
            else
                    Student (i, 2) = num2cell (cell2mat (Student (i, 2))-class_time (id_b (id_t (id_p (k)))));% Student Request-Classroom Remaining
                class_time (id_b (id_t (id_p (k)))) = 0;
```

```
        end
      end
      Class (id_b (id_t (id_p)), :) = Class_id_copy;
   end
   if cell2mat (Student (i, 2))> 0
      flag = -1;
      return
   end
end
for i = 1: length (Size)
   if class_time (i) == (40 * 19 * rate)
      continue;
   end
   if class_time (i) <40 * 19 * rate
      type (Size (i)) = type (Size (i)) + 1;
   end
end
for i = 1: 4
   fprintf ('The demand for the% d class classroom is> -------% d room> \ n \ n', i, type (i));
end
% end
```

Appendix 3 : Matlab program for problem one

```
clc, clear
load student.mat
load class.mat
load classroom_type.mat
rate = [0.4 0.5 0.6];
type = zeros (length (rate), 4);
flag = zeros (1, length (rate));
for i = 1: length (rate)
     fprintf ('> When utilization is% d %% ------------------------------------ ------------> \ n ',
rate (i) * 100);
    [type (i, :), flag (i), class_time] = Compare_deal (Student, Class, Size, rate (i));
    zhi (i) = sum (760 * rate (i) * ones (1,217) -class_time);
end
```