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Selection of mathematical modeling team members in summer school

Hongtao Lin [1, a], Yingying Zhang [2, b]

[1]School of Economics, Jinan University, Guangdong, China

[2]School of Mathematics and Statistics, Huizhou University, Guangdong, China

[a]865629968@qq.com, [b]1473848095@qq.com

Abstract

In 2018, Guangdong Summer School of mathematical modeling and statistics was held in Guangdong University of Finance and economics. In view of the frontier understanding of statistics and mathematical modeling of graduate students in this summer school, this paper will simulate the selection process of mathematical modeling team members in graduate research competition. In the process of selecting graduate mathematical modeling team members, we often need to inspect some quality indicators of students to select team members and form teams. Therefore, this paper uses principal component analysis and subjective weight proportion analysis to calculate the weight, and uses fuzzy evaluation analysis and 0-1 integer programming model to select and form team members. To solve problem 1, first of all, we need to investigate and analyze the qualities of 15 graduate students randomly selected, and then establish principal component discrimination and subjective weight proportion analysis to get the weight of each quality index, so as to calculate that the key quality is the major and the grade. Through the weight calculated by the model, we can verify the correctness of the students' qualities in mathematical modeling. In this paper, we will establish fuzzy evaluation analysis, 0-1 integer programming and other subjective and objective models to select and form team members, and test each other between the models to get the accuracy of the best scheme. Among them, through the fuzzy evaluation analysis model, we establish the students' quality grade, and use the membership degree of students' quality, we will select {X2, X3, X7}, {x4, X12, x15}, {X5, X6, x14} the three teams; through the 0-1 integer programming model, we establish the constraint equation, and obtain {X3, X7, X12}, {X2, x4, x15}, {X5, X8}, X9}} the three teams; check each model, found that {X2, X3, X7}, {x4, X5, X12}} the two teams must be selected, the other X6, X8, x9, x13, x14, x15 five players, need to select another team, through the unilateral ability of the prominent degree, and finally select X6, x14, x15 team.

Keywords

Fuzzy evaluation analysis, 0-1 integer programming, Select best.

1. Introduction

1.1. Background knowledge

1.1.1. Team formation in mathematical modeling competitionIn

2018, Guangdong modeling and statistics graduate summer school was held in Guangdong University of Finance and economics! More than 100 master's and doctoral students from different universities all over the country gathered in Guangdong University of Finance and economics. The purpose of this summer class is to strengthen the education of mathematical modeling and statistical frontier theory for postgraduates, improve the training quality of

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relevant postgraduates and their interest in Mathematical Modeling Contest for postgraduates! For this reason, based on the problem of graduate students' digital simulation team participation, we randomly selected 15 students to participate in the summer school according to the different positions of the students' colleges and universities. Therefore, it is necessary to have a good understanding of the establishment of mathematical model from the aspects of mathematical basis, necessary mathematical modeling knowledge, good programming ability, skilled use of mathematical software, strong language expression ability and writing ability, good team spirit and quick thinking, and solve the problem of modeling team from all aspects!

1.1.2. Significance of team formation in mathematical modeling competition

The purpose of graduate mathematical modeling competition is to build an effective platform for the majority of graduate students to explore practical problems, carry out academic exchanges, cultivate team spirit, cultivate graduate students' innovative consciousness, improve graduate students' innovative practice ability, further promote the reform of graduate training mechanism and the implementation of "graduate education innovation plan", and promote the improvement of graduate training quality. And an excellent team can reflect the highest level of the participating group, so as to improve the award rate of the school.

1.2. Part of students' information and digital processing

1.2.1. Partial information of students

Table 1 Student information

student	Students and graduate schools	Major (undergraduate or graduate)	grade	Modeling times	be quick-witted	width of knowledge	Other information
X1	Guangdong University of Finance and Economics	statistics	first year graduated school student	3	C	B	
X2	Central South University	mathematics	first year graduated school student	4	A	A	Good mathematics foundation
X3	Dongbei University of Finance and Economics	Finance	second year graduated school student	3	A	A	
X4	Xi'an University of Electronic Science and technology	Electronic information	first year graduated school student	2	C	B	Good foundation of MATLAB Studied SAS
X5	Shanghai University of Technology	Electronic information	first year graduated school student	1	C	B	Good foundation of MATLAB
X6	Chongqing Business University	management science	second year graduated school student	1	B	D	

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X7	South China University of Technology	computer	first year graduated school student	2	A	B	Pass computer level 3
X8	Jinan University	mathematics	first year graduated school student	2	B	A	
X9	South China Agricultural University	mathematics	first year graduated school student	1	A	D	Tested as a programmer
X10	Guangxi Normal University	statistics	first year graduated school student	1	C	B	
X11	Guangdong University of Finance and Economics	mathematics	Prospective graduate student	2	B	C	
X12	Zhejiang Gongshang University	Quantitative economics	first year graduated school student	2	B	B	
X13	Xi'an University of science and technology	mathematics	first year graduated school student	1	B	A	
X14	Guangdong University of Finance and Economics	Finance	Prospective graduate student	2	C	A	
X15	Jinan University	statistics	Prospective graduate student	6	A	B	He has won the provincial award of digital analog for many times

1.2.2. Digital processing of student information

For the convenience of the research, we will digitize part of the information of 15 students. In terms of colleges and universities, according to the ranking of Alumni Association in 2018 and the popularity of the region where the school is located, the scores are as follows:

85 - Central South University ; 84 - South China University of technology;

83 - Jinan University; 82 - University of Electronic Science and technology;

81 - South China Agricultural University; 80 - Shanghai University of technology; 79 - Northeast University of Finance and economics;

78 Zhejiang Business University; 77 Guangxi Normal University;

76 Xi'an University of science and technology;

75 - Chongqing Business University; 74 - Guangdong University of Finance and economics;

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Education level: 1-associate degree, 2-first degree, 3-second degree;

Major number: 1 - Mathematics, 2 - statistics, 3 - electronic information, 4 - management science, 5 - Finance, 6 - computer;

Other conditions: 0 - did not participate in any relevant training or examination, 1 - has participated in relevant training or examination;

Quick thinking, machine test, knowledge: 1-D, 2-C, 3-B, 4-A;

Table 1-2 is obtained after information digitization

Table 2 Information table after digital processing

student	Graduate School	major	grade	Modeling times	be quick-witted	width of knowledge	Other information
X1	74	2	2	3	2	3	0
X2	85	1	2	4	4	4	1
X3	79	5	3	3	4	4	0
X4	82	3	2	2	2	3	1
X5	80	3	2	1	2	3	1
X6	75	4	3	1	3	1	0
X7	84	6	2	2	4	3	1
X8	83	1	2	2	3	4	0
X9	81	1	2	1	4	1	1
X10	77	2	2	1	2	3	0
X11	74	1	1	2	3	2	0
X12	78	5	2	2	3	3	0
X13	76	1	2	1	3	4	0
X14	74	5	1	2	2	4	0
X15	83	2	1	6	4	3	1

1.3. Problems to be solved

Question 1: many of the students in this summer school are from the major of mathematics and statistics. The focus of this summer school of Guangdong University of Finance and economics is to cultivate students' frontier thinking on statistics and modeling. Therefore, assuming that 15 students are randomly selected from the participating students to form a team, how to investigate which qualities are the key qualities of mathematical modeling.

Question 2: according to the information in Table 1, a mathematical model for selecting modeling team members is established, from which nine students are selected and three teams are formed, so that the graduate students of the three teams have good knowledge institutions and interaction.

2. Problem analysis

2.1. Analysis of problems

This summer school focuses on Cultivating Postgraduates' frontier knowledge of statistics and mathematical modeling competition. Therefore, the influencing factors involved in the modeling process should be analyzed, including the school, major, grade, knowledge, modeling

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times and thinking agility, so as to provide a better personnel selection method and team formation for the selection of mathematical modeling team method. Using the given data reasonably, we can select 9 most suitable students to participate in the competition and form a reasonable team.

2.1.1. Analysis of problem 1

On this issue, we need to investigate which qualities of students will affect the mathematical modeling of graduate students, and obtain the necessary data through the questionnaire survey. Secondly, in order to test the correctness of our analysis, we will use objective analysis (principal component discrimination) and subjective analysis (subjective weight proportion analysis) to scientifically demonstrate that we need to investigate students' certain characteristics through subjective consciousness elaboration from both objective and subjective aspects The correctness of some conditions and factors, and then summarize the analysis.

2.1.2. Analysis of problem 2

Aiming at the problem of students' team formation. It is necessary to establish a mathematical model for the selection of modeling team members, select 9 students from 15 students, and form three teams, so that the three teams have good knowledge institutions. For this problem, the objective analysis model (0-1 integer programming, fuzzy evaluation) will be established to analyze the problem. Finally, the characteristics of each model will be combined to modify each other, and the best scheme will be selected. The team selected by this method can reduce the bias effect caused by objective and subjective factors.

3. Model establishment and solution

Starting from the assumption of the problem to be solved, on the basis of the general analysis of the problem, the first three problems are analyzed and solved in detail, so as to establish model 1 and model 2 for problem 1, and model 3, model 4, model 5 and Model 6 for problem 2.

3.1. Definition and description of model symbols

m_{ij} : indicates the quality of the first student;

$m_{ij}^{''}$: the quality of the first student after standardization;

M : denotes the normalized matrix obtained by;

u_{kj} : refers to the first quality of the ideal excellent students' ability;

U : represents the scoring matrix of ideal excellent students;

X : correlation coefficient matrix;

x_{ij} : refers to the second quality and the related quality of the second quality;

λ_i : represents the second eigenvalue of the correlation coefficient matrix;

a_i Represents the second eigenvector of the correlation coefficient matrix;

n_i : represents the second principal component;

N_i : represents the first principal component of the main principal components;

$w_j^{'}$: the weight (or contribution rate) of the first quality (or principal component);

w_j : the weight of the first quality after normalization;

p_j : the cumulative contribution rate of the third quality (principal component);

f : the function of students' quality evaluation;

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d_{ik} : the distance between the second student and the ideal excellent student;

c_{ij} : represents the element in the row of the paired comparison judgment matrix;

3.2. Model analysis and solution of problem

3.2.1. Problem analysis

According to the specific situation of the National Graduate mathematical modeling competition, the following analysis is made

The learning atmosphere of graduate students in different schools and grades may have a potential impact on all aspects of students' learning ability; 2. The students participating in the mathematical model should have a wide range of knowledge, have a certain understanding of the phenomena and problems in life, understand the actual background of the problems, think quickly, make clear its practical significance, and master various information of the objects; 3 The process of mathematical modeling often needs to solve practical problems by establishing models, programming and using related software such as MATLAB and SAS. However, some software needs to be self-taught and applied to modeling in a short period of time, so students should have good programming ability and self-learning ability; 4. The competition requires that a complete paper be completed and submitted in five days and four nights, and the writing of the paper is bound to require the search and search of relevant information. Therefore, students should have a strong ability to obtain information; 5. Even if the model has been established and passed Through programming, we can solve the problem and obtain the required information, but writing, typesetting and the sublimation and beautification of the paper are inevitable to complete a thesis. Therefore, students' writing ability also has certain requirements. At the same time, students had better be proficient in latex.

3.2.2. Solution of the model

Model one: principal component discriminant model

Step 1: Data Standardization

There are seven qualities involved in this problem, and the quality objects are students 1-15. After data preprocessing, the j-th quality of the i-th student is standardized according to the standardized method

$$m_{ij}^{''} = \frac{m_{ij} - \overline{m}_j}{s_j} \tag{1}$$

Where, $\overline{m}_j = \frac{1}{15}\sum_{i=1}^{15} m_{ij}, s_j = \sqrt{\frac{1}{15}\sum_{i=1}^{15}(m_{ij} - \overline{m}_j)^2}$, the normalized matrix $[m_{ij}^{''}]$ is obtained, denoted as

$$M = \begin{bmatrix} m_{1,1} & \cdots & m_{1,7} \\ \vdots & \ddots & \vdots \\ m_{15,1} & \cdots & m_{15,7} \end{bmatrix} \tag{2}$$

Step 2: calculate the correlation coefficient matrix X

correlation matrix:

$$X = \frac{1}{15\text{-}1} M^T M \tag{3}$$

If the correlation coefficient between the i-th quality and the j-th quality is x_{ij} , then the correlation coefficient matrix is $x_{ii} = 1$, $x_{ij} = x_{ji}$., where a = 1.

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The eigenvalue $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_7 \geq 0$ of correlation coefficient matrix X and its corresponding eigenvector $a_j, j=1,\cdots,7$ are calculated, where $a_j = (a_{1i}, a_{2i}, \cdots, a_{7i})^T$ is composed of seven new quality variables.

$$\begin{cases} n_1 = a_{1,1}m_{ij,1} + a_{2,1}m_{ij,2} + \cdots + a_{7,1}m_{ij,7} \\ n_2 = a_{1,2}m_{ij,1} + a_{2,2}m_{ij,2} + \cdots + a_{7,2}m_{ij,7} \\ \vdots \\ n_7 = a_{1,7}m_{ij,1} + a_7 m_{ij,2} + \cdots + a_{7,7}m_{ij,7} \end{cases} \tag{4}$$

Where n_i is the I-th principal component, $i = 1,2,3\cdots\cdots 7$.

Step 3: calculate contribution rate

The information contribution rate and cumulative contribution rate of eigenvalue $\lambda_j (j = 1,2,3,4,5,6,7)$ are calculated

$$. \omega_j^{'} = \frac{\lambda_j}{\sum_{k=1}^{7} \lambda_k} (j = 1,2,\cdots,7) \tag{5}$$

the information contribution rate of the main component n_j;

$$\rho_j = \sum_{k=1}^{j} \omega_k^{'} (j = 1,2,\cdots,7) \tag{6}$$

is called the cumulative contribution rate of $n_1, n_2, \cdots, n_r$. When $p_r \geq 80.24\%$, the first g quality variables $n_1, n_2, \cdots, n_r$ can be selected as the main component to replace the original 7 qualities for comprehensive analysis.

Step 4: get the main influencing factors

According to the above steps, first of all, the correlation coefficient table of each quality is worked out. From the table, it can be found that some qualities have strong correlation. If these qualities are directly used for comprehensive evaluation of the degree of influence, it will lead to information overlap and affect the objectivity of the evaluation. Principal component analysis can transform multiple qualities into a few unrelated ones. The first several eigenvalues of the correlation coefficient matrix and their cumulative contribution rate are shown in Table 4.

Table 3 Results of principal component analysis

Serial number	characteristic value	Itemized contribution rate	Cumulative contribution rate
1	2.4304	0.3472	0.3472
2	1.4211	0.2030	0.5502
3	1.1955	0.1708	0.7210
4	0.7862	0.1123	0.8333

It can be seen from table 4 that the cumulative contribution rate of the first four eigenvalues reaches 83.33%. Therefore, this paper selects the first four principal components for analysis, and the corresponding eigenvectors are shown in Table 5.

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Table4 Eigenvectors corresponding to the first four eigenvalues

	One	Two	Three	Four
m_1	0.5695	-0.0816	-0.1068	0.4418
m_2	0.1670	0.3444	0.6755	-0.3492
m_3	0.0509	0.5988	0.2494	0.2167
m_4	-0.1845	-0.4587	0.2875	0.2733
m_5	-0.3512	0.5412	-0.3883	0.3672
m_6	-0.1082	-0.0802	0.4654	0.6497
m_7	0.6900	0.0801	-0.1415	0.0658

Therefore, the first, second, third and fourth principal components are as follows:

$$\begin{cases} N_1 = 0.5695\,m_1 + 0.1670\,m_2 + 0.0509\,m_3 + \cdots + 0.6900\,m_7 \\ N_2 = -0.0816\,m_1 + 0.3444\,m_2 + 0.5988\,m_3 + \cdots + 0.0801\,m_7 \\ N_3 = -0.1068\,m_1 + 0.6755\,m_2 + 0.2494\,m_3 + \cdots - 0.1415\,m_7 \\ N_4 = 0.4418\,m_1 - 0.3492\,m_2 + 0.2167\,m_3 + \cdots + 0.0658\,m_7 \end{cases} \tag{7}$$

According to the principal component analysis, in the first principal component, quality 7 accounts for the largest proportion; in the second principal component, quality 3 accounts for the largest proportion; in the third principal component, quality 2 accounts for the largest proportion; in the fourth principal component, quality 6 accounts for the largest proportion. Therefore, it can be concluded that the main factors affecting students' mathematical modeling team formation are quality 2, 3, 6 and 7. The actual quality for professional, grade, whether to participate in the relevant training examination, knowledge. Obviously, these four qualities are extremely important in the highly professional graduate students' mathematical modeling. Therefore, these four aspects are the important qualities of graduate students' team modeling.

Model 2: subjective weight proportion analysis model

Step 1: establish the pairwise comparison judgment optimization matrix of the target

Firstly, the standard of the scoring system is established, and the quality of each student is scored by the scoring system, so as to obtain the pairwise comparison judgment matrix.

(1) Establish the standard of scoring system

Table 5 Scoring system

Relative importance	Equally important	Slightly more important	More important	Absolutely important
Score by comparison	1	2	3	4

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The pairwise comparison judgment optimization matrix is established

Table 6 Paired comparison table

quality	universities and colleges	be quick-witted	Modeling times	Other information	grade	major	width of knowledge
universities and colleges	1.0000	0.5000	0.5000	0.3333	0.2500	0.2500	0.3333
be quick-witted	2.0000	1.0000	2.0000	0.5000	0.3333	0.5000	0.3333
Modeling times	2.0000	0.5000	1.0000	0.3333	0.2500	0.3333	0.5000
Other information	3.0000	2.0000	3.0000	1.0000	0.5000	2.0000	0.5000
grade	4.0000	3.0000	4.0000	2.0000	1.0000	0.5000	0.5000
major	4.0000	2.0000	3.0000	0.5000	2.0000	1.0000	2.0000
width of knowledge	3.0000	3.0000	2.0000	2.0000	2.0000	0.5000	1.0000

Step 2: weight calculation

Use weight calculation formula

$$\omega_i^{'} = \sqrt[7]{c_{i1} \cdot c_{i2} \cdots\cdots c_{i7}} \tag{8}$$

Get the initial weight

Table 7 initial weight table

quality	universities	be quick-witted	Modeling times	Other information	grade	major	width of knowledge
Initial weight	0.4033	0.7306	0.5428	1.3687	1.5746	1.7385	1.6685

Step 3: get the weight proportion of each quality.

According to the formula of calculating normalized weight coefficient.

$$\omega_i = \omega_i^{'} / \sum_{i=1}^{7} \omega_i^{'} \tag{9}$$

The normalized weight coefficient of each quality is calculated

Table 8 Normalized weight table

quality	universities	be quick-witted	Modeling times	Other information	grade	major	width of knowledge
Normalized weight	0.0502	0.0910	0.0676	0.1705	0.1962	0.2166	0.2079

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Step 4: get the main influence quality and analyze

According to the normalized weight table, the main influencing factors were major (weight coefficient 0.2166); knowledge (weight coefficient 0.2079); grade (weight coefficient 0.1962); other conditions (weight coefficient 0.1705). Obviously, these four qualities are the main aspects of graduate students' team building in mathematical modeling.

3.2.3. Summary and analysis

Through the analysis of subjective and objective aspects, we get that the main influencing qualities are major, knowledge, grade, and whether there are other aspects of experience. From the model, we can see that the contribution rate of the principal component of the quality of colleges and universities in model 1 and the weight of model 2 are far less than other qualities. Therefore, the following analysis can ignore the influence of the quality of colleges and universities. The other six factors, including grade, major and knowledge, play an important role in the process of graduate modeling. Therefore, the above analysis method based on the combination of subjective and objective is particularly consistent with the actual situation, which is helpful to pay attention to the important factors in graduate modeling.

3.3. Solution of problem 2

Model 3: fuzzy subjective discriminant analysis model

Step 1: constructing the membership degree of students' quality

In this paper, students' grades are divided into five categories, namely {excellent, good, medium, qualified, unqualified}, and fuzzy set $\in[0,1]$ is established. According to the actual situation, this paper selects the uniform distribution of membership degree, which can be obtained in table 10.

Table 9 Grade division of students' quality

Grade	excellent	good	secondary	qualified	unqualified
Membership degree of students' quality	1	0.8	0.6	0.4	0.2

Step 2: constructing the evaluation function of students' quality

The evaluation function of students' quality is obtained by substituting six quality indexes into the following formula

$$f=\sum_{j=1}^{r}\omega_j m_j^{'} \tag{10}$$

Among them, ω_j is the weight of the j quality, which has been solved in model 2. Student quality evaluation function f is a comprehensive evaluation of students' mathematical modeling ability.

The evaluation function of students' quality is as follows:

$$f=0.2166\,m_1+0.1962\,m_2+0.0676\,m_3+0.0910\,m_4+0.2079\,m_5+0.1705\,m_6 \tag{11}$$

Step 3: get the quality membership of 15 students randomly selected from this summer class

By substituting 6 quality data of 15 students into formula (11), table 11 is obtained.

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Table 10 Student quality evaluation table

student	Quality evaluation value	student	Quality evaluation value	student	Quality evaluation value
X1	-0.2781	X6	-0.1109	X11	-0.8796
X2	0.4090	X7	0.7108	X12	0.1453
X3	0.8406	X8	-0.1333	X13	-0.1826
X4	0.1306	X9	-0.3624	X14	-0.0850
X5	0.0814	X10	-0.3765	X15	0.0907

It can be seen from table 11 that the quality evaluation values of 15 students are obtained in this paper. By normalizing the quality evaluation values, the quality membership degree of each student is obtained, as shown in Table 12.

Table 11 Membership table of students' quality

student	Quality membership	student	Quality membership	student	Quality membership
X1	0.3497	X6	0.4469	X11	0.0000
X2	0.7491	X7	0.9246	X12	0.5958
X3	1.0000	X8	0.4338	X13	0.4052
X4	0.5873	X9	0.3007	X14	0.4619
X5	0.5586	X10	0.2925	X15	0.5641

According to table 6, 15 students in Table 12 are divided into quality grades, and table 13 is obtained.

Table 12 Quality level of students

student	Grade	student	Grade	student	Grade
X1	qualified	X6	secondary	X11	unqualified
X2	good	X7	excellent	X12	good
X3	excellent	X8	secondary	X13	secondary
X4	good	X9	qualified	X14	secondary
X5	secondary	X10	qualified	X15	secondary

From table 12 and table 13, students with similar membership can be matched to form teams. It can be seen that X2, X3 and X7 can be formed into excellent teams, and everyone in the team is excellent; x4, X12 and x15 can form teams, X5, X6 and x14 can be grouped, others can be grouped because of their low membership, so they are not allowed to group them.

Model 4: 0-1 integer programming model

Step 1: establish standardized form

It can be seen from question 1 that the influence of the quality of colleges and universities is the smallest, so the influence of this quality is not considered in this question. Because different variables have different units and varying degrees, the data are optimized and standardized.

According to formula (1) and (2), the data after standardized treatment are calculated as shown in table 14.

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Table 13 Data table of 6 qualities after standardization

student	be quick-witted	Modeling times	Other information	grade	major	width of knowledge
X1	-0.4492	0.1123	0.5826	-1.1832	0.0000	-0.7888
X2	-1.0108	0.1123	1.3108	1.1832	1.0000	1.1832
X3	1.2354	1.7969	0.5826	1.1832	1.0000	-0.7888
X4	0.1123	0.1123	-0.1456	-1.1832	0.0000	1.1832
X5	0.1123	0.1123	-0.8739	-1.1832	0.0000	1.1832
X6	0.6738	1.7969	-0.8739	0.0000	-2.0000	-0.7888
X7	1.7969	0.1123	-0.1456	1.1832	0.0000	1.1832
X8	-1.0108	0.1123	-0.1456	0.0000	1.0000	-0.7888
X9	-1.0108	0.1123	-0.8739	1.1832	-2.0000	1.1832
X10	-0.4492	0.1123	-0.8739	-1.1832	0.0000	-0.7888
X11	-1.0108	-1.5723	-0.1456	0.0000	-1.0000	-0.7888
X12	1.2354	0.1123	-0.1456	0.0000	0.0000	-0.7888
X13	-1.0108	0.1123	-0.8739	0.0000	1.0000	-0.7888
X14	1.2354	-1.5723	-0.1456	-1.1832	1.0000	-0.7888
X15	-0.4492	-1.5723	2.7672	1.1832	0.0000	1.1832

Step 2: establish 0-1 integer programming equation

The 0-1 variable is used to control whether the quality is selected or not. When B, the quality is not selected; when C, the quality is selected. The 0-1 integer programming equation can be listed as follows:

objective function:

$$\max Z = \sum_{i=1}^{15}\sum_{j=1}^{7} X_i m_{ij} \tag{12}$$

$$s.t. \qquad X_1, X_2, \cdots, X_{15} \in \{0,1\} \tag{13}$$

$$X_1 + X_2 + \cdots + X_{15} = 9 \tag{14}$$

The results are as follows:

$$\{X_2, X_3, X_4, X_5, X_7, X_8, X_9, X_{12}, X_{15}\}$$

Lingo code is in the attachment, and the result screenshot is shown in Figure 2

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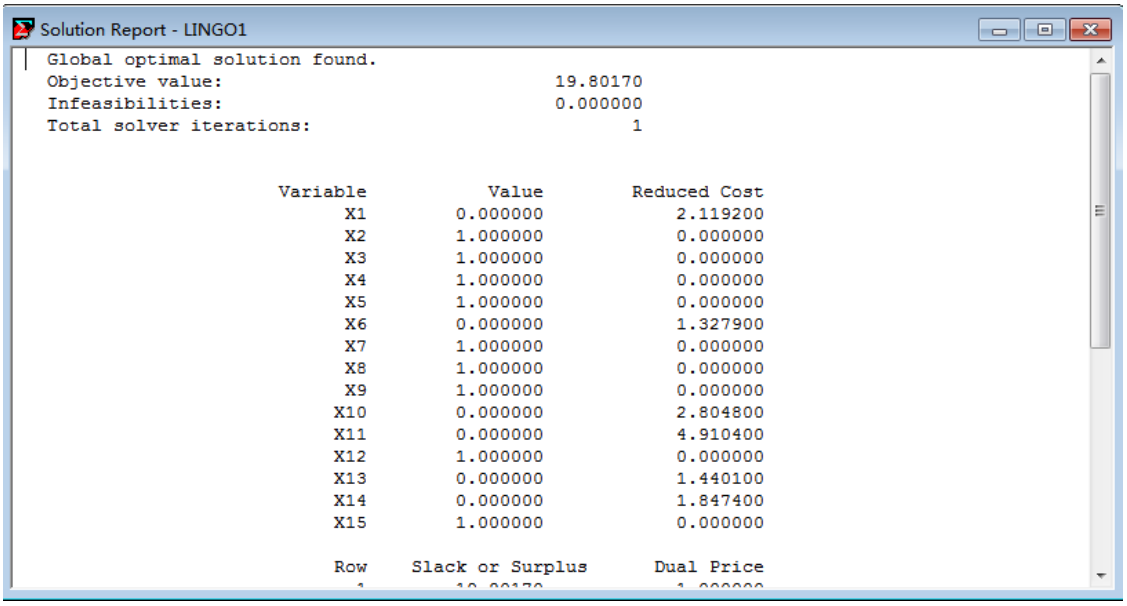

Figure 1 0-1 Integer programming result graph

Step 3: sort 9 students' quality indexes

For the scheduling problem, the cumulative total score is obtained in table 15.

Table 14 Cumulative total score table

student	be quick-witted	Modeling times	Other information	grade	major	width of knowledge	Total score
X2	-1.0108	0.1123	1.3108	1.1832	1.0000	1.1832	3.7787
X3	1.2354	1.7969	0.5826	1.1832	1.0000	-0.7888	5.0093
X4	0.1123	0.1123	-0.1456	-1.1832	0.0000	1.1832	0.079
X5	0.1123	0.1123	-0.8739	-1.1832	0.0000	1.1832	-0.6493
X7	1.7969	0.1123	-0.1456	1.1832	0.0000	1.1832	4.13
X8	-1.0108	0.1123	-0.1456	0.0000	1.0000	-0.7888	-0.8329
X9	-1.0108	0.1123	-0.8739	1.1832	-2.0000	1.1832	-1.406
X12	1.2354	0.1123	-0.1456	0.0000	0.0000	-0.7888	0.4133
X15	-0.4492	-1.5723	2.7672	1.1832	0.0000	1.1832	3.1121

It can be seen from the above table that the selected 9 students form a team, and the students with similar comprehensive ability form a team. The results are as follows: $\{X_3, X_7, X_{12}\}, \{X_2, X_4, X_{15}\}, \{X_5, X_8, X_9\}$.

Acknowledgements

On July 25, 2018, Guangdong mathematical modeling and statistics graduate summer school opened in Guangdong University of Finance and economics! With joy and curiosity, I am also honored to join the summer school training! Today is August 3. It's nearly ten days since the opening of the camp! These ten days are long or short. Here, up to now, I have met students from different schools all over the country and met students from famous schools in legend. I am very

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lucky! Contact with you, but also understand that there is still a big gap between themselves and others, I have a lot to learn! Ten days, perhaps the most contact is the famous professors for all aspects of mathematics and statistics talk! From the first day that Professor Yang Xiaowei of South China University of technology explained the frontier of multivariate statistical analysis to today's Professor Zhao Nan of Beijing Normal University explained the quantitative analysis strategy and economic modeling! From you academic masters, it may be difficult for us to understand the professors' explanations in every lecture, but we can know the frontier knowledge of many disciplines and the general direction of the research field from them! Maybe we will forget the contents of most lectures after a period of time, but there are always a few words, a few reminders, a few skills and a few directions that can benefit us a lot, which is not enough! The significance of the lecture is not to fully understand, but to have a better guiding significance for one's future life planning, which is really the most meaningful and valuable! Here, I would like to thank the Academic Degrees Committee of Guangdong Province once again, and Guangdong University of Finance and economics for providing us with such an opportunity to contact more and learn more! I also hope that in the future, I can apply what I learned in this summer school to practice, and give play to the "big value" in the "small value"!

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