Intelligent Selection Recommendation Algorithm in the "Double" Mechanism

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Abstract. Aiming at the phenomenon of blind selection during the course selection of college students under the credit system, the paper puts forward the most preferred course selection recommendation algorithm and the recommended course selection algorithm based on comprehensive evaluation of curriculum. The most preferred course selection recommendation algorithm uses 0-1 integer programming model to give the minimal courses and the maximum credits; the comprehensive evaluation of curriculum based on considering the students' learning ability and learning interest gives he curriculum evaluation coefficient, students according to the curriculum evaluation coefficient can objectively and accurately select elective courses for their own development ability. These two elective courses conform to the actual situation of students' elective courses, and can effectively guide students to select courses.

Introduction

With the vigorous development of campus informatization and the extensive implementation of credit system education, and the diversification of social demand for talents, these have promoted the reform and optimization of curriculum structure in Colleges and Universities. At present, many colleges and universities have established a "compulsory + elective" double curriculum mechanism in order to cultivate diversified innovative talents, and established elective course selection system, students can independently choose the number and type of elective courses.

The Most Preferred Course Selection Recommendation Algorithm

Students in the learning course often encounter problems of Course selection. Elective courses should not only take into account the interests of their own courses, but also consider the minimum course to achieve the best results, the most important thing is to meet the requirements of the school elective courses, complete graduation.

In the course of course selection, some courses must be chosen under the premise of related subject study. There are always contradictions in the course selection under the influence of these factors. Therefore, only a careful consideration of various factors, can it ultimately get the best course selection results.

Minimum Course Recommendation Algorithm

Problem one description: A university stipulates that students of accounting major want to graduate, requires one math courses, two accounting courses and one computer courses at least. There are nine optional courses in the university, numbered from 1 to 9, and each course has corresponding credits. Elective constraints obtained According to the rules of association: if you want to choose No.3 course, you must have learned No.1 and NO. 2 courses; if you want to choose No.6 course, you must have learned No.5 and No.8 courses.
Table 1. Alternative courses in the university.

<table>
<thead>
<tr>
<th>Course number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course name</td>
<td>Mathmatics</td>
<td>Calculus</td>
<td>Principles of Statistics</td>
<td>Financial Accounting</td>
<td>Basic accounting practice</td>
<td>Accounnting computerisation</td>
<td>Computer programmiing language</td>
<td>Fundamental of computer application</td>
<td>Database management</td>
</tr>
<tr>
<td>Credits</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Suppose that $X_i$ represents the choice of the $i$ course in the course table, $X_i=1$ means elective, and $X_i=0$ means not elective. The range of $i$ is 1 to 9. MinZ means the minimum course in course selection, Max w means the most credits you get in the course selection.

The goal of elective course is the least number of elective course. That is

$$\text{Eq. 1} \quad \text{min}Z = \sum_{j=1}^{9} x(j).$$  \hspace{1cm} (1)

That is

$$\text{Eq. 2} \quad \text{min}Z = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9$$  \hspace{1cm} (2)

Constraint condition: For example, if you want to choose No.4 classes, you must first choose No.5 classes, which means that $x_4=1$ contains $x_5=1$, this condition can be expressed as $X_4 \leq X_5$; If you want to choose No.3 course, you must choose No.1 and No.2 courses, This condition can be expressed as $x_3 \leq x_1$; and $x_3 \leq x_2$. The combination of these two forms is an inequality, $2x_3 \leq x_1 + x_2$. Therefore, the constraints can be expressed as

$$\left\{ \begin{array}{l}
x_1 + x_2 \geq 1 \\
x_3 + x_4 + x_5 + x_6 \geq 2 \\
x_7 + x_8 + x_9 \geq 1 \\
x_1 + x_2 - x_3 \geq 0 \\
x_1 + x_5 - x_4 \geq 0 \\
x_5 + x_8 - x_6 \geq 0 \\
x_i = 0 \text{ (or 1)}
\end{array} \right.$$

The Matlab standard form:

$$\begin{bmatrix}
-1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & -1 & -1 & -1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & -1 & -1 & -1 & -1 \\
-1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 \\
0 & 0 & 0 & 0 & -1 & 1 & 0 & -1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3 \\
x_4 \\
x_5 \\
x_6 \\
x_7 \\
x_8 \\
x_9 \\
\end{bmatrix}
\leq
\begin{bmatrix}
-1 \\
2 \\
1 \\
-1 \\
0 \\
0 \\
0 \\
0 \\
0 \\
0 \\
\end{bmatrix}$$

The Matlab program and results:

```matlab
z=[4,2,2,4,3,2,2,4,3];f=[1;1;1;1;1;1;1;1;1];
a=[1,1,0,0,0,0,0,0,0;0,1,1,1,1,0,0,0,0;0,0,0,0,0,0,1,1,1;1,1,1,0,0,0,0,1,1;0,0,0,0,0,0,1,0,0;0,0,0,0,0,0,1,0,0;0,0,0,0,0,0,1,0,0;0,0,0,0,0,0,0,0,0;0,0,0,0,0,0,0,0,0];
b=[1;2;1;0;0;0;0;0]; aeq=[1,1,1,1,1,1,1,1,1];beq=[4];
[x,y]=bintprog(f,-a,-b, aeq, beq); x,y=-y
Optimization terminated.
That is: x={1, 0, 1, 0, 0, 1, 0, 1, 0}
The optimal solution of the minimum number of courses: $x_1=x_3=x_6=x_8=1$ minZ=4
```

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Get credits: c=4x1+2x3+2x6+4x8=12
That is, when students choose mathematics, statistics, accounting computerization, computer application foundation, the number of elective courses is the least.

**The Recommended Algorithm with the Least Courses and the Most Elective Courses**

On the basis of question one, whether there is a better algorithm in the least elective course, which makes the total credits of elective courses maximized.

Set total credit function:

\[ \text{Eq. 3 max}_w=4x1+2x2+2x3+4x4+3x5+2x6+2x7+4x8+3x9 \]  

The matlab standard model

\[
\begin{bmatrix}
1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & -1 & -1 & -1 & -1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & -1 & -1 & -1 \\
-1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
-1 & 0 & 0 & 1 & -1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & -1 \\
0 & 0 & 0 & 0 & -1 & 1 & 0 & -1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\end{bmatrix}
\begin{bmatrix}
x1 \\
x2 \\
x3 \\
x4 \\
x5 \\
x6 \\
x7 \\
x8 \\
x9 \\
\end{bmatrix}
\leq
\begin{bmatrix}
1 \\
2 \\
1 \\
0 \\
0 \\
0 \\
0 \\
0 \\
0 \\
0 \\
\end{bmatrix}
\]

The Matlab program and results:

\[ z=[4,2,2,4,3,2,2,4,3]; f=[1;1;1;1;1;1;1;1;1]; a=[1,1,0,0,0,0,0,0,0;0,1,1,1,0,0,0,0,0;0,0,0,0,0,0,1,1,1;1,1,-1,0,0,0,0,0,0;1,0,0,-1,1,0,0,0,0;0,0,0,0,0,1,0,1,1;0,0,0,0,0,0,1,1,0;0,0,0,0,0,0,0,0,0;0,0,0,0,0,0,0,0,0]; b=[1;2;1;0;0;0;0;0;0]; aeq=[1,1,1,1,1,1,1,1,1]; beq=[4]; [x,y]=bintprog(f,-a,-b, aeq, beq); x,y=-y\]

Optimization terminated.

\[ x=[1,0,0,1,0,1,0,1,0] \]
That is: x1=x4=x6=x8=1, x2=x3=x5=x7=x9=0

\[ \text{max}_w=4x1+2x2+2x3+4x4+3x5+2x6+2x7+4x8+3x9=14 \]

Similarly, in the choice of 4 elective courses, elective credits can get the maximum credit, which is 14 credits. Therefore, elective courses should be selected according to this algorithm. Comparing the above two algorithms, the 14 credit course selection algorithm is to use elective course for financial accounting instead of statistical principle of 12 credits, these two courses belong to the specialized course elective course, in line with the constraints.

**The Recommended Elective course Algorithm Based on Comprehensive Evaluation**

In the process of the college students’ elective course, the phenomenon that the elective course of passing examination was sold out and some important difficulty electice course have fewer elective students often appears. This phenomenon of course selection is not conducive to the development of
students' individual ability, but also is not conducive to the cultivation of talents. How can college
college students choose their own courses that they like and have ability to learn well according to their
own needs in the course of choosing courses? This paper presents a comprehensive evaluation
recommended course selection algorithm based on the combination of curriculum difficulty
evaluation and individual willingness evaluation.

The Recommended Selection Algorithm Based on the Difficulty of the Course Evaluation

The recommended course selection algorithm based on the evaluation of curriculum difficulty is
calculated according to the curriculum difficulty coefficient and the related curriculum influence
coefficient.

Algorithm of Curriculum Difficulty Coefficient

The coefficient of difficulty of the course is set to $d_i$, Its algorithm is course credits divided by 10. The
Course credit is set to $cc$, thus

$$\text{Eq. 4} \quad d_i = \frac{cc}{10}.$$  

Influence Coefficient of Related Courses

The degree of correlation between the related courses and the academic achievements of the related
courses have great influence on the elective courses. First of all, it is to determine the related course
of elective courses.

- The establishment of the related courses

  The correlation coefficient of an elective course and other courses is $T_i$. The value of $T_i$ is
calculated according to the amount of knowledge used in other courses, which is the proportion of
the knowledge points in the elective course.

  Thus:

  $$\text{Eq. 5} \quad T_i = \frac{Q_i}{Q}$$  

  $Q_i$ represents the number of knowledge points used by other courses in this elective course, and
$Q$ represents the total number of knowledge points in the elective course. When $T_i$ is less than 0.1,
other courses influence is ignored, and we think other courses are irrelevant to this course.

- Relevance of academic achievement of related courses and curriculum

  Because other courses are related to an elective course, the academic achievement of other
courses have an impact on the academic achievement of the elective course. The influence
coefficient of the relevant courses is $C_i$, thus

  $$\text{Eq. 6} \quad C_i = \frac{T_i(100-f_i)}{100}$$  

  ($f_i$ represents the achievements of students in other related courses with 100 points.)

- The determination of influence coefficient of related courses

  Because one elective course may be related to other courses, the academic achievement of other
courses and the degree of association will have some influence on students' learning of this course,
the influence coefficient of other courses on this course is $R$.

  $$\text{Eq. 7} \quad R = \frac{1}{n} \sum_{i=1}^{n} C_i = \frac{1}{n} \sum_{i=1}^{n} \frac{T_i(100-f_i)}{100}$$  

  ($N$ represents the number of courses related)

Calculation of Evaluation Coefficient of Curriculum Difficulty

Curriculum difficulty is influenced not only by the difficulty of the course, but also by the learning
ability of the related courses. The greater the difficulty of the course, the poorer the students' learning ability, the less likely the students will pass the exam. Therefore, the curriculum difficulty evaluation coefficient takes the sum of the curriculum difficulty coefficient and the related curriculum influence coefficient. Thus:
Eq. 8 \[ Cd = \text{dif} + R \] (8)
(The evaluation index of curriculum difficulty is Cd)

**Algorithms for Evaluating Individual Wish**

A student's interest in the course has a crucial impact on students to learn the course well. The more students like a course, the stronger the motivation for students to learn it. Here, the degree of willingness (W) is used to express the students' interest in the course. The range of will degree coefficient is 0～1, w is to take 0 unwillingly, w is to take 1 very willingly, w is to take 0.5 usually willingly. The gradual increase of 0-1 value indicates that the will of elective course is more and more intense.

**An Algorithm for Comprehensive Evaluation of an Elective Course**

Whether a student can learn an elective course well and feel that it is worth learning comes mainly from the individual's prediction of the learning ability of the course and the degree of personal interest. The comprehensive evaluation coefficient of elective courses is CE, The comprehensive evaluation coefficient of elective courses is CE, and the calculation method of CE is the coefficient of individual will minus the evaluation index of curriculum difficulty.

Eq. 9 \[ ce = w - cd = w - \text{dif} - \frac{1}{n} \sum_{i=1}^{n} \frac{T_i (100 - f_i)}{100} \] (9)

When the CE of an elective course is more than 0, it is recommended to choose an elective course; When CE is equal to 0, it is not recommended or objected to choose an elective course; When CE is less than 0, it is against selecting an elective course. According to the value of CE, students can objectively and accurately select suitable courses for their personal ability development. The number of elective courses offered by the university will reach a relative balance, which is conducive to the management of the elective courses. Through the questionnaire survey of 40 students in the last semester of 15 computer applications, we found that students who have a strong desire to take part in an elective course (w>0.5), the calculation value of CE is greater than 0; The calculated values of CE for students who are not willing to take an elective course or do not want to take an elective course (w<0.5), the calculation value of CE is less than or equal to 0. Therefore, the recommended algorithm of the elective course is in line with the actual situation of students.

**Summary**

This paper studies the intelligent recommendation course selection algorithm of College Students' course selection under the credit system. According to the actual situation of students' course selection, the algorithm provides two options for course selection, One is the optimized course selection scheme, and the other is the intelligent course selection scheme. The optimal course selection scheme is based on the 0-1 integer programming model, gives the elective course recommendation algorithm with the least elective courses and the most credits; The intelligent course selection scheme gives the comprehensive evaluation algorithm of elective courses according to the individual situation of students, Students can choose their own elective courses according to the comprehensive evaluation coefficient of curriculum. These two elective courses conform to the actual situation of students' elective courses, and realize the students' own ideal courses according to the school regulations and their actual situation, and can ensure the smooth start of elective courses in schools. These two solutions effectively solve the problem of students' course selection, provide a reference basis for students' successful course selection, and provide data support for the elective courses in the university.
References


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