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A quantitative analysis model study of research and study trip time path planning and curriculum efficiency improvement

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Abstract As a comprehensive course, the study travel course is well suited to be offered in higher education. In the context of the country's great attention to higher education and study travel, the development of study travel courses in higher education is lagging behind. In this paper, we attribute the study tour path planning objective to the TOTSP problem, define the travel time function of TOP path, and solve the TOTSP problem by mixing particle swarm algorithm and genetic algorithm. Using association rules to set up courses in the process of research and study travel, the efficiency of professional course setting of research and study travel is measured by DEA model. The shortest time using the particle swarm algorithm based on time factor is [3.536,4.154]h, and the maximum time saving degree reaches 25.527%. Among the study population, there are 20 courses such as Principles of Management and Corporate Strategy that have been set up to be purely technically effective, accounting for 71.43% of the courses. The remaining 8 courses had a PTE of less than 1. There is still room for improvement in terms of classroom setting efficiency.

Index Terms TOTSP problem, Hybrid Particle Swarm Algorithm, DEA model, Research and study trip, Classroom setting

I. Introduction

Study travel inherits and develops the ancient Chinese educational concept of “reading thousands of books, traveling thousands of miles”, through collective travel, centralized accommodation, allowing students to go out of the campus, into the nature, into the society, experiential education and research learning [1]. Study tour integrates education, culture, tourism, is an innovative way of education, is the new mode of school education and out-of-school education links [2]. As a new mode of teaching and learning, it can cultivate students' comprehensive qualities such as life skills, collective concepts, practical ability and innovative spirit through practical activities and experiential teaching [3]-[5].

Most of the study activities to have scientific value or tourism value of geological sites and cultural sites left by human activities as the object, teaching in fun, melting learning in the fun, teaching in the heart of the study way by everyone's favorite, has a wide range of participation [6]-[9]. At present, research and study tourism has received the attention and importance of many management departments, while the research and study activities that have been carried out have also achieved certain industry repercussions and economic benefits [10], [11]. However, due to the lack of theoretical guidance on curriculum design, study tours are generally characterized by problems such as the limitation of study objects, shallow curriculum content, insufficient scientific inquiry, and emphasis on touring rather than learning, which hinders the deep promotion of science popularization and the high-quality development of study tours [12]-[15]. Therefore, in order to fully understand and accurately control the new opportunity of study tours, there is an urgent need to study the guiding ideology and methodology of study tour time and route planning and curriculum setting.

In this paper, based on the two problems of shortest path and shortest time, we construct their corresponding mathematical expression models, transform the TOTSP travel time function formula, and design its objective function of shortest travel time. Mix PSO and GA algorithms to solve the TOTSP problem. Using the association rule algorithm, set up relevant specialized courses, and calculate the total efficiency as well as the technical efficiency of each decision-making unit and derive the scale efficiency of the examined decision-making unit through the CCR and BCC models, respectively. With the help of DEA mathematical model, the super-efficiency evaluation model is established to quantitatively analyze and study the efficiency of curriculum setting, and through the redundancy value of inputs and outputs, the effectiveness of the use of curriculum resources of the research object is further examined.

II. Study tour path planning based on time optimization

II. A. Mathematical modeling of the TSP problem

The goal of the TSP problem is to find a closed loop with the shortest distance such that the research trip starts from the origin, traverses all intermediate nodes and returns to the origin [16].

According to graph theory, the whole TSP problem is regarded as a graph and the graph is denoted as $G=(V,E)$, where $V=\{1,2,....,N\}$ is a set of vertices formed by all the cities, N is the number of cities that need to be traversed by the research and study trip, E is the set of edges formed by connecting any two cities, and denote the distance between the domain city i and the city j by d_{ij} with $d_{ij}>0, i, j \in V$, and furthermore, let:

$$o_{ij}=\begin{cases}1 & \text{The line segment formed by } i, j \text{ belongs to the optimal route}\\ 0 & \text{other}\end{cases} \tag{1}$$

Then the mathematical model of the classical TSP problem can be represented by equation (1):

$$MinZ=\sum_{i\neq j} d_{ij}o_{ij} \tag{2}$$

$$s.f.\begin{cases}\sum_{i+j} o_{ij}=1, & i\subset V\\ \sum_{i+j} o_{ij}=1, & j\subset V\\ \sum_{i+j} o_{ij}\leq |K|-1, K\subset V\\ o_{ij}\in\{0,1\}, & i,j\in V\end{cases} \tag{3}$$

In Eq. (3) K denotes a nonempty subset of V and $|K|$ denotes the number of vertices contained in the set, where the first two constraints denote that only one side goes in and one side goes out for any vertex in the graph, and the latter constraints are meant to be solutions that do not generate subloops, and a solution satisfying Eq. (3) forms a Hamiltonian loop [17].

II. B. TOTSP Problem Model

II. B. 1) Concept of the TOTSP problem

The TOTSP problem is to find a closed path for tourists in the scenic area with the shortest time called time-optimized path (TOP), which is the path with the smallest time for research travel. The travel time here consists of three parts: the time required for tourists to walk between attractions, the time tourists wait in line at each attraction and the time tourists need to play at each attraction, Figure 1 shows the formation of routes under the variation of tourist density.

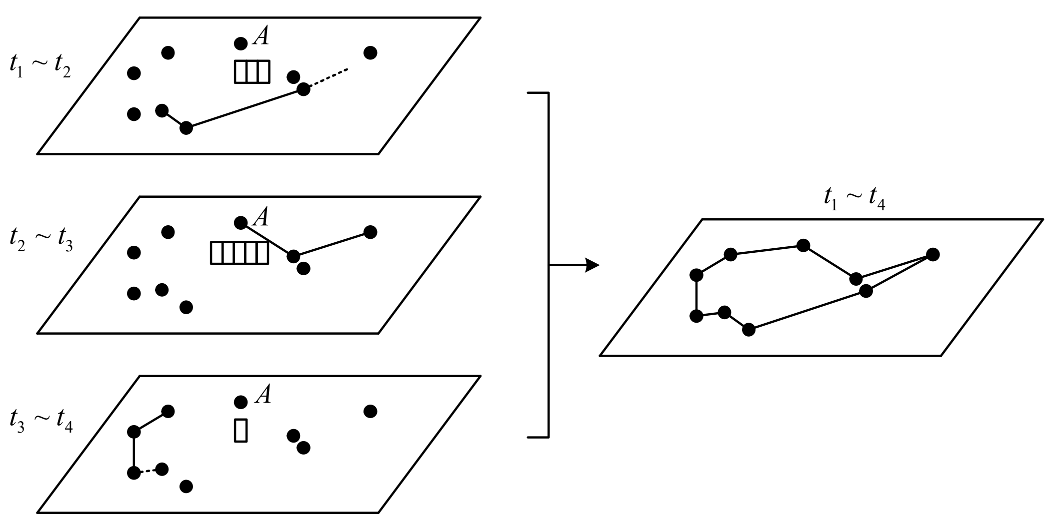


Figure 1: The path formation under changing density of tourist

The TOTSP problem described in this paper will tourists in different time to play the attractions, each attraction at the number of tourists waiting to play is a dynamic change of factors into account, in order to simplify the experimental model and reflect the nature of this change, assuming that the number of tourists waiting to be divided into a number of time segments, the number of tourists waiting for each attraction within each time period is different, under the premise of the completion of tourists to the scenic area of the tour. This solution idea can be represented by Figure 1, in which the parallelogram represents the scenic area, the point represents the location of each attraction, and the entire tour is divided into three time periods $t_1 \sim t_2, t_2 \sim t_3, t_3 \sim t_4$, and each time period Tour a portion of the attractions in the scenic area, thus completing the tour of all the attractions involved in the entire attraction at the end of the process, i.e., the route shown in $t_1 \sim t_4$. The difference in the number of people waiting at each attraction in the three time periods is exemplified by point A in Figure 1, where the rectangles indicate the number of tourists waiting to play at attraction A in different time periods, which is constant in the corresponding time periods and changes at the time nodes t_2, t_3.

II. B. 2) **Research trip time function for the TOTSP problem**

Expression of the fitness function for the TSP problem:

$$f_{TSP} = d_{N,1} + \sum_{j=1}^{N-1} d_{j,j+1} \tag{4}$$

where $d_{j,j+1}$ is the distance between the j th attraction and the $(j+1)$ th attraction, $j \in \{1,2,...,N\}, d_{N,1}$ is the distance between the N th attraction and the first attraction.The solution of the TSP problem is to find the minimum value of equation (4), and the loop corresponding to the minimum value is the length-optimized path, i.e., the LOP path.

For LOP, the expression of the fitness value is based on the TSP problem, to divide the total distance of the shortest path obtained in the TSP problem by the tourists' average walking speed V, to get the tourists' playing time between attractions, i.e., the research travel time, so that the expression of the research travel time function of LOP is defined as:

$$t_{LOP} = (d_{N,j} + \sum_{j=1}^{N-1} d_{j,j+1}) / V \tag{5}$$

The travel time function of the TOP path can be defined as:

$$t = \sum_{j=1}^{N} t_{vj} + \sum_{j=1}^{N} t_{vj} + (d_{N,1} + \sum_{j=1}^{N-1} d_{j,j+1}) / V \tag{6}$$

where $j \in \{1,2,...,N\}$, t_{vj} is the queuing waiting time for tourists at the j th attraction, and t_{wj} is the touring time for tourists at the j th attraction. When the flow of tourists in the scenic area is large, tourists always enter the attractions by batches to play, thus, the number of people waiting for each attraction is converted into batches for calculation. For example, there are 60 people waiting for an attraction, and 20 people enter each time to play, so the number of batches of waiting tourists is 3. According to Fig. 1, the overall tour process of tourists is divided into M stages (i.e., time periods), and the density of tourists within each stage is kept constant, and the density of tourists at the time nodes is changed. In addition, combining the practical significance of the waiting time t_{wl}, it can be seen that t_{wl} is the time that the tourist waits for the tourists in the front of the queue $(g_{mi} - 1)$ batch of tourists to visit the attraction j, and the time for each batch of tourists to visit the attraction t_{vj}, and thus, it is obtained that t_{wj} and t_{vj} between them:

$$t_{vj} = t_{vj} \cdot (g_{mj} - 1) \tag{7}$$

where $m \in \{1,2,3,...,M\}, j \in \{1,2,...,N\}$, and g_{mj} is the number of batches of tourists waiting at the j attraction in the m th stage. Thus, the TOTSP travel time function can be converted into:

$$t_{TOP} = \sum_{j=1}^{N} (t_{ij} \cdot g_{mj}) + (d_{N,1} + \sum_{j=1}^{N-1} d_{j,j+1}) / V \tag{8}$$

where $m \in \{1,2,3,...,M\}, j \in \{1,2,...,N\}$, the objective function of the TOTSP problem is to find the minimum value of the travel time function Eq. (8), i.e., the minimum value of travel time.

II. C.Hybrid PSO-GA algorithm for solving the TOTSP problem

II. C. 1) **Particle Swarm Algorithm**

The particle swarm algorithm, also known as the bird flocking algorithm, is based on the idea that the most efficient way for a single bird (particle) to find food is to search the area near the nearest bird known to be close to the food [18]. The particle swarm algorithm is a population optimization algorithm in which each particle represents a feasible solution, and the particles iteratively update their positions and velocities by comparing the individual optimum, pbest, and the population optimum, gbest, which are the two "extreme values". Let n particles be in a D -dimensional vector space, the position of the i th particle is $X_i = (x_i^1, x_i^2, \dots, x_i^d)^T$, and the velocity is $V_i = (v_i^1, v_i^2, ldots, v_i^d)^T$, then the particle is updated by:

$$v_i^{t+1} = wv_i^t + c_1 rand_1 (pbest_i - x_i^t) + c_2 rand_2 (gbest_i - x_i^t) \tag{9}$$

$$x_i^{t+1} = x_i^t + v_i^{t+1} \tag{10}$$

where $i \in \{1, 2, \cdots, n\}$, t denotes the t th iteration of the algorithm, v_i^t denotes the velocity of the particle i in the t th iteration, x_i^t is its position, w is the inertia weight, c_1, c_2 is the acceleration factor (or learning factor), and $rand_1, rand_2$ are uniformly distributed random numbers between [0, 1]. In order to prevent the particle search from going beyond the space, the particle velocity v_i^t is generally set within the interval $[-v_{\max^d}, v_{\max^d}]$.

II. C. 2) Hybrid PSO-GA Algorithm Implementation

(1) Load data

Load the basic data, including: the distance $d_{i,j}$ between each play item, the play time t_{vj} for each item, the number of visitor batches g_{mj} , the road connectivity o_{ij} , the road congestion y_{ij} , and the average walking speed of visitors V . In addition, the total number of rides n , the number of particles N , and the maximum number of iterations I need to be set.

(2) Initialize the population

Randomly generate n particles and randomly assign values to their position x_i^0 and velocity v_i^0 . For each particle, substitute into the objective function equation of the model to get the individual optimal value pbest, compare all the individual optimal values, and take the one with the smallest value as the initial value of the population optimal value gbest.

(3) Crossover operation

The idea of crossover operation of genetic algorithm is adopted to achieve the purpose of improving the search ability of the algorithm by reorganizing part of the structure of the parent particles by crossover, so as to produce new individuals [19]. In this paper, real-valued encoding is used to realize crossover operation by performing arithmetic crossover of particles, set at t moment there are particles $x_i^t, x_j^t (i \neq j)$, then the two children individuals produced at the $t+1$ moment are:

$$x_i^{t+1} = \alpha x_j^t + (1-\alpha) x_i^t \tag{11}$$

$$x_j^{t+1} = \alpha x_i^t + (1-\alpha) x_j^t \tag{12}$$

where: α is a parameter, $\alpha \in (0,1)$, when α is a constant, it is called a uniform arithmetic crossover, and when α is a variable, it is called a non-uniform arithmetic crossover. A new generation of particles can be generated by the crossover operation, and these new particles continue to be substituted into the objective function equation of the model to get the new $pbest^1$ value, which is compared with the historical pbest value, and the smaller of the values is retained as the pbest of the particle. similarly, the pbest of the new particle is compared with the population optimal value of the gbest, and the value of gbest is updated.

(4) Mutation operation

The mutation operation mimics the genetic mutation in the process of biological evolution. In the algorithm, the mutation operation is realized by mutating one or some genes on the gene sequence into alleles, so as to enhance the algorithm's local stochastic search ability, avoid falling into the local optimal solution that cannot be jumped out, and at the same time, maintain the diversity of the particle population to avoid immature convergence. Replacing the individual optimal solution $pbest_i$ with $x_i^{\max}$, the population optimal solution $gbest_i$ with $x_i^{\max}$, and the cumulative difference of $x_i^{\max}$ with $\Delta x_i^{\max}$ instead of v_i^{t+1}. where $\Delta x_i^{\max}$ is given by Eq:

$$x_i^{\max,t} = x_i^{\max,t-1} + (x_i^{\max,t} - x_i^{\max,t-1}) / n \quad (13)$$

Substituting the above equations into Eqs. (11) and (12), the expression for the variational operator can be obtained as:

$$\Delta x_i^{\max,t} = \Delta x_i^{\max,t} + c_1 rand_1 (x_i^{\max} - x_i^t) + c_2 rand_2 (x_j^{\max} - x_i^t) \quad (14)$$

$$x_i^{t+1} = x_i^t + x_i^{\max,t+1} \quad (15)$$

This completes the mutation operation and updates $pbest_i$ and $gbest_i$.

(5) Updating particle positions and velocities

The substitutions into Eqs. (11) and (12) update the particle positions and velocities.

(6) Termination condition determination

For each iteration, the number of iterations is added to one to determine whether the pre-set maximum number of iterations I has been reached, if not, then jump to step 3 to continue the cycle of iteration cross operation.

(7) Output results

When the number of iterations is equal to the maximum number of iterations I, then the algorithm ends, the final global optimal value $gbest_i$ is the optimal value of the model, and its corresponding particle is the optimal solution, the output of the project play path map, the total time of the study trip.

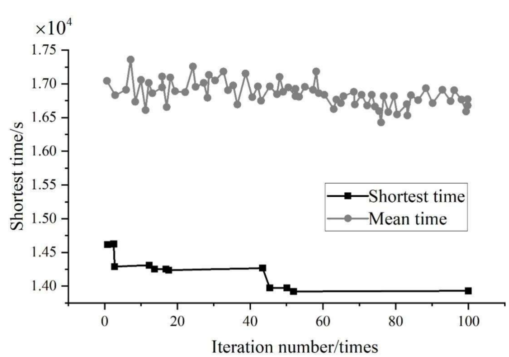
II. D.Case Studies

II. D. 1) Parameterization

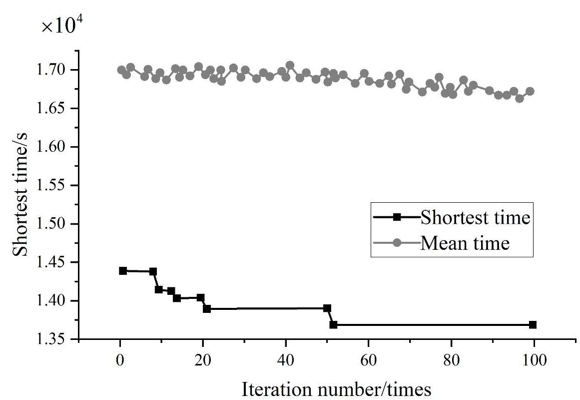
Taking the actual problem of a study travel scenic area as an example, there are 31 stopping points (nodes) in the scenic area. The PSO-GA model is utilized to plan the time path of study travel. When the population is initialized, the number of particle swarms is assigned to 50, 500, 5,000 in turn, and iterated 100 times, respectively, to find the shortest traversal time and path by introducing the time factor to participate in the calculation. When iterating to the shortest path (time), the relationship between the number of iterations and the time (shortest time, average time) is shown in Fig. 2, Fig. (a) is the number of populations 50/iteration 100 times, Fig. (b) is the number of populations 500/iteration 100 times, and Fig. (c) is the number of populations 5000/iteration 100 times. When iterating to the shortest path (time), the path table is shown in Fig. 3, with Figs. (a)-(c) for paths 1-3.

II. D. 2) Analysis of results

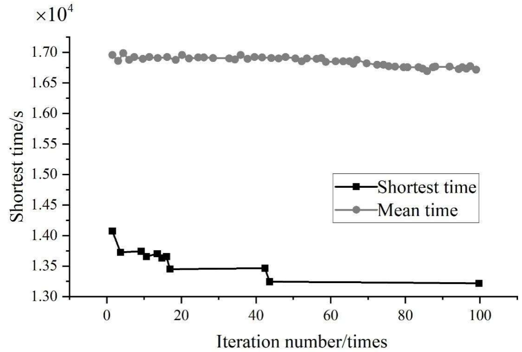
From the above results, it can be seen that the average time taken to pass all the nodes by random traversal is about 4.665-4.748 h. The shortest time taken by the particle swarm algorithm based on the time factor is 3.536-4.154 h, which maximizes the time saving up to 25.527%. At the same time, the total amount of the initial particle swarm has a greater impact on the results, but after the total amount of the initial particle swarm is determined, the convergence can be achieved with fewer iterations, which reflects the superiority of the algorithm.



(a)The population is 50/100 times

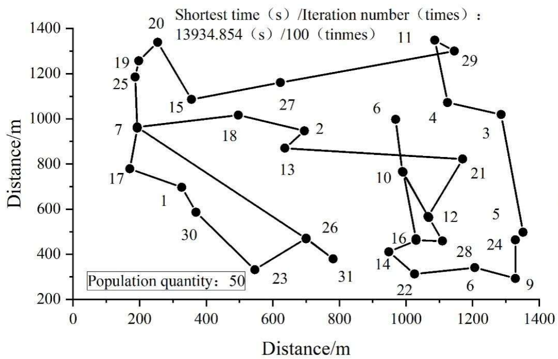


(b)The population is 500/100 times

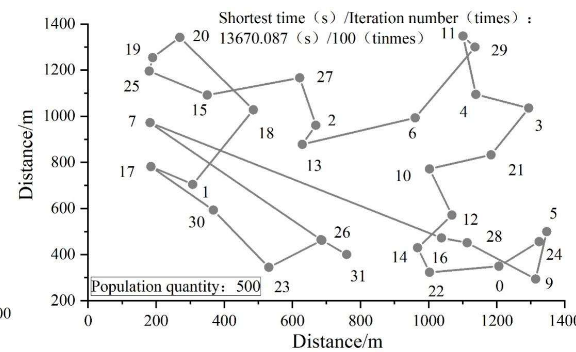


(c)The population is 5000/100 times

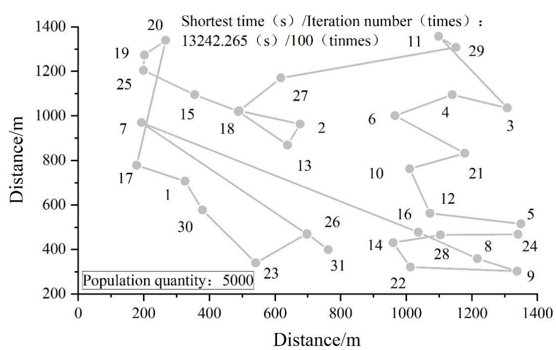
Figure 2: Average time and shortest time



(a)Path 1



(b)Path 2



(c)Path 3

Figure 3: Optimal path

III. Research on curriculum based on association rule algorithm

III. A. ***Association Rule Correlation Algorithm***

III. A. 1) Association rules

(1) Basic concepts and problem description

Let $I=\{i_1,i_2,...,i_m\}$ be a set of items. Let D be the set of transactions and each transaction T be the itemset of $T\in I$. Each transaction has a unique identifier called TID. when $X\subseteq \mathrm{Y}$ the transaction T contains X (X is some itemset in I). An association rule has two important metrics:

Support: the number of transactions in dataset D that contain itemset X is called the support number of itemset X, denoted as σ_X, and the support of itemset X is denoted as Support(X), $Support(X)=\frac{\sigma_x}{|D|}$, where $|D|$ is the number of transactions in dataset D if Support(X) is not less than the user-specified minimum support, then X is said to be a frequent itemset, referred to as frequent (or large itemset), otherwise X is said to be an infrequent itemset, referred to as infrequent (or small itemset).

Confidence: if X, Y are itemsets and XnY=F, the implication $X \Rightarrow Y$ is called an association rule, and X, Y are called the premise and conclusion of the association rule $X \Rightarrow Y$, respectively. The support of the itemset $X \cup Y$ is called the support of the association rule $X \Rightarrow Y$ and is written as $Support(X \Rightarrow Y), Support(X \Rightarrow Y) = Support(X \cup Y)$, and the confidence of the association rule $X \Rightarrow Y$ is written as $Confidence(X \Rightarrow Y)$. confidence is written as $Confidence(X\ Y)$, $Confidence(X\ Y) = \frac{Support(X \cup Y)}{Support(X)}$.

The association rule $X \Rightarrow Y$ is said to be strong if $Support(X \Rightarrow Y) \geq minsupport$ and $Confidence(X \Rightarrow Y) \geq minconfidence)$, otherwise the association rule $X \Rightarrow Y$ as a weak rule.

Support and confidence are two important concepts describing association rules. Generally speaking, only association rules with high support and confidence, i.e., strong rules, may be the association rules that are interesting and useful to the users; too low support indicates that the rules are not general, and too low confidence indicates that the rules are poorly credible.

(2) Interest level of association rules

Some uninteresting association rules are eliminated by evaluating the mined association rules through metrics such as support and confidence. However, in practical applications, there are often many strong rules mined, are all these strong rules of interest to users? Not necessarily so, association rules may contain both causal and stochastic associations, or even negative correlations. Therefore, it is not enough to consider only support and confidence in practical application, and it will also cause misleading.

1) If P(A∪B)=P(A)P(B), then itemset A and itemset B are independent of each other.

2) Correlation between itemset A and A itemset B: $corrn(A,B) = \frac{P}{(A,B)} P(A)P(B)$, if corr(A,B) is equal to I, it means that itemset A and itemset B are independent of each other. If it is greater than 1, it means that itemset A is positively correlated with itemset B. If it is less than 1, it means that itemset A is negatively correlated between itemset B.

3) The interest degree of rule $A \Rightarrow B$: $I(A \Rightarrow B) = \frac{Spport(A,B)}{Support(A)Support(B)}$.

If the value of I is less than 1, the occurrences of A and B are negatively correlated, and if the value of I is equal to 1, A and B are independent and there is no correlation between them. If the value of I is greater than 1, then A and B are positively correlated, meaning that each occurrence implies an occurrence of the other. Thus the larger the I value, the more interesting the rule is.

(3) Association Rule Mining Algorithm Apriori

Apriori algorithm solves this problem by recursive method based on frequent set theory. When all the frequent itemsets are found, the corresponding association rules will be easily generated. In order to generate all frequent sets, the recursive method is used. The basic idea is: first of all, by scanning the data set, generate a large set of candidate data items, and calculate the number of times each candidate data item sweep occurs, and then based on the pre-given minimum support for the generation of a one-dimensional large data item set L1, and then based on the L1 base and the data in the data set, to generate two-dimensional large data item set L2: with the same method until the generation of the N-dimensional large data item set Ln, which is no longer possible to Generate N+1 dimensional big data itemset that satisfies the minimum support.

(4) Algorithm optimization

The specific process of Aprioni algorithm can be described as follows: firstly, find out the frequent 1-item set LI from the candidate 1-item set (C1) containing each item; then use Lk-1 connection to generate the candidate Ck, and according to the nature of Apriori, delete those candidate sets with infrequent subsets. Finally, the database is scanned and the support counts of the candidate sets are counted and compared with the minimum support counts to form the frequent set Lk.

After finding the frequent sets, it is relatively easy to generate association rules, and the generation process is divided into two steps:

1) For each frequent set L, find all its non-empty subsets.

2) For each non-empty subset s of frequent set 1, calculate the confidence level of the rule $s \Rightarrow (I - s)$, ie:

$$confidence = \frac{\text{Support counting for } l}{\text{Support counting for } s} \tag{16}$$

If confidence=minconfidence then association rule $s \Rightarrow (l-s)$ is generated.

III. A. 2) Association Rule Based Curriculum

From the beginning of each professional enrollment, all of its data of the profession will be retained in the Academic Affairs Management System, whether it is the traditional data processing methods or information technology processing methods, so that the amount of data of these data is also inevitable with the professional enrollment of time, in the continuous updating and growth of the content of the update is as follows:

(1) Each new academic year, the number of enrollment, the number of students reported to the statistics of students changing majors.

(2) Statistics on the entry and change of course information for the major in the new academic year.

(3) society is developing, different industries employers on the staff requirements are bound to develop and change, they give the training of professional and technical skills of the school also puts forward new requirements, the school's professional curriculum needs to be set in line with the development of society and the employer's requirements. This requires the academic administration workers to revise and re-enter the course information of the relevant majors and the course contents of the relevant majors that have changed in each new academic year and new semester.

(4) The changes mentioned above are not only for the new students who have just entered the university, but also for the old students who are in the university. According to the requirements of the society and employers, the information that changes at any time conflicts with the data of the previous system and needs to be modified.

(5) Specialized courses other related information. For example, every year, different employers will put forward different requirements, and opinions and suggestions for course improvement, and this information conflicts with the original information of the course, in this way, all the information needs to be updated.

III. A. 3) Data sample collection

This chapter mainly focuses on the curriculum of electromechanical engineering and mechatronics technology majors in a vocational and technical college in Lanzhou as the research object, and the research mainly includes: the situation of curriculum change of mechatronics technology majors, the situation of the requirements of mechatronics technology majors' employers for the professional curriculum, etc., and the data mining of these educational data.

III. A. 4) Data pre-processing

Data cleaning and conversion mainly includes the following parts:

Missing value processing: With the development and requirements of the society and employers, the talent training program changes with it, and the curriculum is adjusted, which is the main reason for the missing data information in the curriculum. For example, different grades should be handled separately, and the data information after the change of the curriculum of the grade should be retained and the data information before its change should be deleted, for example, a course belongs to a different course category. These anomalies are mainly caused by the implementation of the school's teaching reform and the revision of the professional training program. In this case, it is necessary to conduct research based on the category implemented now, for example, the mechanical foundation course of the mechatronics technology major belonged to the category of basic quality competence courses before 2008, but now it is categorized as the core course of the professional direction.

III. B. ***Quantitative evaluation of curriculum efficiency***

(1) CCR model

$$\min \theta$$
$$(CCR)s.t.\begin{cases} \sum_{j=1}^{n} X_j \lambda_j \le \theta X_k \\ \sum_{j=1}^{n} Y_j \lambda_j \ge Y_k \\ \lambda_j \ge 0, j = 1, \cdots, n \end{cases} \tag{17}$$

This model is called the CCR model, which presupposes constant returns to scale. Here θ is the total efficiency value of the k th decision unit under examination ($0 \le \theta \le 1$). The total efficiency value of each examined unit can be obtained by solving the linear programming expressed in equation (17) n times.

(2) BCC model

The assumption of constant returns to scale is stipulated in order to judge the ability of the unit under examination to be able to scale up its output by increasing its inputs in equal proportions, i.e. the size of the scale does not affect the efficiency. However, this assumption is quite strict and in many cases is not satisfied in reality, and in order to address this limitation, a convexity assumption $\sum_{j=1}^{n}\lambda_j = 1$ is added to the CCR model, thus making the CCR model a variable returns to scale (BCC) model, i.e.:

$$\min \theta$$
$$(BCC)s.t.\begin{cases} \sum_{j=1}^{n} X_j\lambda_j \le \theta X_k \\ \sum_{j=1}^{n} Y_j\lambda_j \ge Y_k \\ \sum_{j=1}^{n} \lambda_j = 1 \\ \lambda_j \ge 0, j = 1, \cdots, r \end{cases} \tag{18}$$

The θ value obtained by this model corresponds to the defined technical efficiency.

Using the CCR and BCC models, the total efficiency as well as the technical efficiency of each decision-making unit can be calculated separately, and then the scale efficiency of the decision-making unit under scrutiny can be introduced using the relationship between total efficiency and scale efficiency: total efficiency = technical efficiency × scale efficiency.

(3) Super-efficiency evaluation model

One of the more obvious disadvantages of the original DEA model is that there are more effective units (with an efficiency evaluation value of 1) that may have to be calculated to build the model. For all effective units, the original DEA model can not help to distinguish between their respective efficiencies. On this basis, some scholars have adjusted and proposed an extended DEA model called super-efficiency evaluation, so that it is possible to select the effective units in the DEA model for ranking, the basic form of which is as follows:

$$\min \theta$$
$$(BCC)s.t.\begin{cases} \sum_{\substack{j=1 \\ j\ne k}}^{n} X_j\lambda_j \le \theta X_k \\ \sum_{\substack{j=1 \\ j\ne k}}^{n} Y_j\lambda_j \ge Y_k \\ \lambda_j \ge 0, j = 1, \cdots, r \end{cases} \tag{19}$$

The mathematical form of the super-efficiency evaluation model is very similar to that of the DEA model, and the mathematical notation in the new model has the same meaning as in the previous one. The main difference from the previous model is the basic design idea, which is that this model, when evaluating the efficiency of the k th decision unit, allows the inputs and outputs of the k th decision unit to be replaced by a linear combination of the inputs and outputs of all the other decision units in the model, leaving the k th unit out of the model, whereas the previous original model included this unit. An efficient decision cell can have its inputs increased in the same proportion while its efficiency value remains constant, and the proportionate increase in the inputs of this cell is the super-efficiency evaluation value of the cell. In fact, in this new model, the constraint that the efficiency index is less than or equal to 1 is removed from the calculation of the evaluation of the effective unit k , and then the model will obtain an efficiency greater than or equal to 1 θ , which is called the super-efficiency, and the rate of the super-efficiency will be used to further differentiate between the efficiency of the units that have been treated as being relatively efficient.

III. C. Example Analysis of Static Efficiency Evaluation of Curriculum Efficiency

III. C. 1) **Indicators for evaluating the efficiency of curriculum development**

Table 1 shows the evaluation indexes of curriculum efficiency. In order to more scientifically use the DEA model to measure the curriculum efficiency of accounting courses, this paper divides the evaluation index system into input indexes and output indexes. The input indicators include the number of hours of specialized courses, teachers' academic background, job level, teaching time, teaching methods, teaching and research papers and projects. The output indicators are students' usual grades, students' final grades, and students' evaluation of teaching.

Table 1: Evaluation index of curriculum setting efficiency

Variable type	Variable type
Input index	Specialized class (A1)
	Teacher background (A2)
	Post grade (A3)
	Teaching time (A4)
	Teaching mode (A5)
	Teaching research and project number (A6)
Output indicator	Student performance (B1)
	Final grade (B2)
	Student evaluation (B3)

III. C. 2) Curriculum Efficiency DEA

In this paper, with the help of DEA model, CCR-O and BCC-O models are used for empirical research. The output-oriented CCR and BCC models measure whether the outputs are efficient or not when the current input factors are unchanged, which is consistent with the output orientation of the curriculum. The data were obtained from interviews and the faculty system, and manually organized by the authors.The level of efficiency of the curriculum and the payoffs of scale of the 28 specialized courses for the accounting students in the class of 2023 in College C of AH are shown in Table 2.

(1) Comprehensive efficiency analysis

In the DEA model, when the comprehensive efficiency TE=1, the decision unit is relatively effective, while when TE<1, the decision unit DEA is ineffective. On the whole, most of the curriculums of the accounting program in the class of 2023 in College C achieve DEA efficiency. Among the courses with relatively effective curriculum efficiency are 19 courses, while the rest of the courses have a combined efficiency of less than 1, indicating that the ratio of inputs to outputs in the teaching and learning process has not been maximized. In addition, there are 5 courses whose TE is lower than the average level of 0.987, indicating that the relative efficiency of these course settings is at the lower-middle level, and corresponding measures need to be taken to improve this state.

(2) Analysis of pure technical efficiency

The comprehensive efficiency only reflects the efficiency of each course's setting as a whole, but it does not explain the inefficient decision-making units. Therefore, the BCC model can be used to decompose the comprehensive efficiency value first, and then determine the specific reasons for the ineffective DEA of decision-making units. Where when the pure technical efficiency PTE=1, it indicates that the decision unit is purely technically effective, and PTE<1 is not purely technically effective. The results show that 20 courses, such as Principles of Management, Corporate Strategy, and Principles of Economics, have achieved pure technical efficiency, accounting for 71.43%. However, there are still 8 courses with PTE less than 1, indicating that the structure of inputs and outputs is not reasonable enough to reach the optimal configuration, and there is still room for improvement in the efficiency of classroom settings.

(3) Analysis of scale efficiency

The use of CCR model allows for a more in-depth study of the returns to scale (SE), when SE=1, the decision-making unit is relatively efficient, SE<1, the returns to scale are increasing or decreasing, there is room for scale improvement. Most of the courses are in the stage of constant returns to scale, indicating that the teaching inputs in these courses are moderate, and only 2 courses have returns to scale less than 1. Among them: the course on Cost Accounting (0.998) is in the stage of increasing returns to scale, and an appropriate increase in the teaching inputs may lead to a higher increase in the outputs. The financial management (0.934) course is at the stage of diminishing returns to scale, which indicates that there may be redundancy of inputs in the course, and that a subsequent increase in teaching inputs will not increase outputs, but will only result in a waste of resources.

Table 2: Evaluation results of course setting efficiency

Numbering	Courses	Integrated efficiency	Pure technical efficiency	Scale efficiency	Type of scale
1	Principles of Management	1	1	0.989	-
2	Corporate strategy	1	1	1	-
3	Principle of economics	1	1	1	-
4	Economic law	0.964	0.964	1	-
5	Principles of accounting	1	1	1	-
6	Intermediate financial accounting (upper)	0.945	0.945	1	-
7	Intermediate financial accounting (lower)	0.987	0.987	1	-
8	Integrated accounting	0.996	0.996	1	-
9	Cost accounting	0.998	1	0.998	irs
10	Senior financial accounting	1	1	1	-
11	Financial management	0.908	0.959	0.934	drs
12	Practice of accounting information system	1	1	1	-
13	Securities investment analysis	1	1	1	-
14	Accounting ethics	1	1	1	-
15	Tax law	1	1	1	-
16	Accounting decision training	1	1	1	-
17	Asset assessment	1	1	1	-
18	Tax accounting and tax planning	0.987	0.987	1	-
19	statistics	1	1	1	-
20	Government accounting	1	1	1	-
21	Management accounting	1	1	1	-
22	Audit training	1	1	1	-
23	Financial analysis	0.973	0.973	1	-
24	Practice of tax returns	1	1	1	-
25	Vbse comprehensive training	1	1	1	-
26	auditing	1	1	1	-
27	Internal control	0.935	0.935	1	-
28	Accounting major innovation and entrepreneurship education	1	1	1	-
/	Mean value	0.987	0.989	0.997	-

III. C. 3) Redundancy values of inputs and outputs

The previous analysis of pure technical efficiency and scale efficiency can identify the specific sources of relative inefficiency in the professional curriculum, but it is not possible to make corresponding suggestions for improvement based on the results. Therefore, projection analysis is introduced on this basis to determine the problems involved by analyzing the input and output redundancy of specific indicators of specific courses and to make targeted suggestions. Among them, input redundancy is to indicate that too much input of variables causes waste of resources, and output redundancy is to represent the inefficiency of resource utilization caused by insufficient output of the same situation, and its improvement is conducive to improving the efficiency of teaching and learning.The DEA model is to get the degree of improvement needed by calculating the value of the slack variables of inputs and outputs, i.e., it is possible to calculate the adjustment amplitude of part of the decision-making unit from non-effective to effective. The specific calculation results are shown in Table 3. The 28 specialized courses of the accounting program in College C of AH are divided into two groups: First, the teaching input and output courses have reached the optimal state group. For example, the values of slack variables of inputs and outputs of 19 courses, such as Principles of Management, Principles of Economics, etc., are all 0, indicating that the current teaching inputs and outputs have reached the optimal state of DEA. Second, the structure of teaching inputs and outputs is not reasonable enough. For example, in the 8th course of comprehensive accounting simulation training, from the perspective of input, there is input redundancy in the hours of specialized courses (16.454), teaching time (1) and teaching method (1), which indicates that resources such as the 48 hours of credit hour setting and teachers' on-line classes are not effectively utilized, resulting in a certain amount of waste due to excessive input. From the perspective of output, there is room for improvement in both students' regular grades and assessment of teaching. It shows that under the existing level of faculty, the resources have not been effectively transformed into student-oriented outputs.

Table 3: A list of redundant values for the input and output of professional courses

NO.	Underoutput			Input redundancy					
	B1	B2	B3	A1	A2	A3	A4	A5	A6
1	0	0	0	0	0	0	0	0	0
2	4.789	5.404	0	0	3.021	0	0	0	2.248
3	0	0	0	0	0	0	0	0	0
4	0	5.895	0	0	0	0.055	1.064	0	0.648
5	0	0	0	0	0	0	0	0	0
6	5.468	14.169	0	0	0	0.428	0	0	0
7	0.853	12.169	0	8.048	0	0.815	0	0	1
8	4.266	0	1.798	16.454	0	0	1	1	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	7.798	0	1.489	3.085	0	0	0.648	4.468
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0
18	0	4.598	0.489	0	0	0	0	0.548	2.548
19	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	9.065	0	0	0	0	6.125	0	0.785
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0
27	0	0.098	3.569	9.563	0	0.498	0	0	0
28	0	0	0	0	0	0	0	0	0
Mean	0.549	2.114	0.209	1.27	0.218	0.064	0.292	0.078	0.418

IV. Conclusion

In this paper, the path shortest and the time spent on finding the shortest path are considered comprehensively to establish a conceptual model of the TOTSP problem. On the basis of particle swarm algorithm, genetic algorithm is introduced to improve the algorithm searching ability by cross-reorganizing part of the structure of the parent particles, and the hybrid PSO-GA algorithm is used to solve the TOTSP problem.

The average search time through all nodes using random traversal is 4.665-4.748h, while the shortest time for solving using the hybrid PSO-GA algorithm is 3.536-4.154h, which maximizes the time saving to 25.527%.

The association rule algorithm was used to set up the major courses in five aspects, including the number of students and changes in the entry of major courses. After data sample collection as well as data pre-processing, CCR and BCC models were used for empirical research with reference to the DEA model.

In the DEA model, the decision-making unit is relatively effective when the comprehensive efficiency TE=1. There are 19 courses with relatively effective efficiency of the curriculum, and there are 5 courses with TE below the average level of 0.987, which indicates that the relative efficiency of these curriculums is at the middle to lower level, and it is necessary to take corresponding measures to improve this state.

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