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Research on Independent College Enrollment Expansion and Teaching Quality Assessment Model Based on PSO Algorithm

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Abstract: Teaching evaluation plays an important role in college teaching activity, and how to ensure high teaching quality while the teaching scale is expanding gradually is a core issue in independent colleges. This paper presents an intelligent optimization model based on PSO algorithm for the scale of enrollment expansion and teaching evaluation in independent college, to help conduct teaching quality evaluation in the case of limited resources.

1. Introduction

The teaching scale of China's independent college is expanding year by year, and the growth rate of education investment lags behind the scale expansion, and a large number of independent colleges have been established. However, the Ministry of education proposes to improve the quality of teaching as an important focus of work. Therefore, in order to ensure the quality of teaching in independent colleges with the expansion of teaching scale, teaching evaluation work is of great significance. With the expansion of enrollment scale year by year, the teaching resources is bound to decline, and the teaching resources is an important guarantee to ensure the teaching quality. How to rationally formulate and gradually expand enrollment scale, and meanwhile ensure the steady improvement of teaching quality, involves many aspects of practical problems.

In view of this background, this paper presents an intelligent optimization model for the scale of enrollment expansion and teaching evaluation in independent college, to help conduct teaching quality evaluation in the case of limited resources.

2. Improved PSO Algorithm

PSO algorithm is a new evolutionary computation method proposed by American scholar Kennedy and Eberhart in 1995. The concept of particle swarm comes from a social behavior model imitating birds, fish and other organisms in nature. In terms of operation mechanism, the algorithm simulates the social behavior of biological communities, rather than relying on the laws of individual evolution. Taking use of information sharing mechanism, that is, interactions among biological groups, allows individuals to learn from each other's experiences, and thus promote the development of the entire group.

Conceptually, the PSO algorithm is an evolutionary calculation method between genetic algorithms and evolutionary programming. Similar with other evolutionary algorithm, PSO algorithm is based on group, but it does not involve evolution operators, and just treats each individual as a volumeless particle in the search space, which flies at a certain speed in the search space, and the speed is dynamically adjusted according to its own flight experience and companion's flight experience.

2.1 Basic Principle

The basic idea of PSO algorithm is to build a population model that simulates the behavior of birds.

Through the study of the behavior of similar biological groups, researchers found that there is a social information sharing mechanism in biological communities, which provides an advantage for the evolution of the community. We can imagine such a scene: a flock of birds randomly search for food. However, there is only one piece of food in this area, and all the birds do not know where the food is, but they know how far the current location is from food. Then the best strategy for finding food is to search the area around the bird that is closest to the food. The PSO algorithm can also be seen as a simulation of a simplified social model, and the information sharing among social groups is the main mechanism to promote the algorithm. Each particle in the PSO algorithm is a solution in the solution space, which adjusts its flight based on its own flying experience and fellow flight experience. The best place for each particle to go through the flight, is the optimal solution found by the particle itself. Similarly, the best place for the whole group to experience is the optimal solution that the whole group finds at present. The former is called pBest, while the latter is called gBest. Each particle updates itself constantly through the above two extremes, and produces a new generation of groups. In practical operation, the fitnessvalue determined by the optimization problem is used to evaluate the quality of the particles. Apparently, the behavior of each particle is to follow the current optimal particle search in the solution space.

In PSO algorithm, each particle can be thought of as a point in the solution space. If the particle size of the group is N, then the place of the i-th (i=1,2,…,N) particle can be represented by Xi, and the best place that it goes through is marked as pBest[i], and its velocity is marked as Vi. The index number of the position of the best particle in the population is represented by g. Then, the particle i would update its speed and position according to the following formula:

$$v_i = w * v_i + c_1 * rand() * (pBest[i] - x_i) + c_2 * Rand() * (pBest[g] - x_i) \quad (1)$$

$$x_i = x_i + v_i \quad (2)$$

In the formula, c_1 and c_2 are acceleration constants, related individually to the best position they have experienced and to the best position experienced by the group, called learning factor; rand() and Rand() are random numbers among (0, 1); the inertia weight w is related to the velocity of motion on the particle. The formula consists of three parts: the first part is the particle's previous speed, which shows the current state of the particles; the second part is cognition modal, representing the particle's own thinking; the three part is social modal. Together, the three parts determine the particles' spatial search capabilities. The first part has the ability to balance the global and local search; the second part gives the particles a strong enough global search capability, to avoid local minimum; the third part reflects the information sharing between particles. On the other hand, when the particle is constantly adjusting its position according to the velocity, it also has to be limited by the maximum speed (Vmax), to prevent computational overflow. When vi exceeds Vmax, it will be limited to Vmax.

Tuning parameters of PSO algorithm are respectively: inertia weight w is related to the particle's last movement speed; acceleration constants c1 and c2 are related individually to the best position they have experienced and to the best position experienced by the group; the maximum velocity Vmax is used to prevent calculation overflow.

2.2 Improved Algorithm Process

The Formula (1) is to calculate the new velocity of particles based on Particle's previous velocity, the distance between the particle's present position and its own ever best position, and the distance between the current position and the best position of the group. The particle would move to a new location according to the Formula (2). The goodness of each particle is evaluated according to the defined fitness function, which is related to the problems to be solved.

The improved algorithm process of PSO algorithm is as follow:

a) Initialize the particle swarm, including population size, as well as the position and velocity of each particle;

b) Calculate the fitness value of each particle;

c) For each particle, compare its fitness value with individual extreme value *pBest*, if its fitness value is better than *pBest*, then replace *pBest*;

d) For each particle, compare its fitness value with global extreme velue *gBest*, if its fitness value is better than *gBest*, then replace *gBest*;

e) According to Formula (1) and Formula (2), update the velocity and position of the particle;

f) If the end condition is satisfied (the error is good enough or the maximum number of cycles is reached), then exit, otherwise turn back to the step b).

3. Teaching Quality Evaluation Model

3.1 Index System

In evaluation of teaching quality, the construction of evaluation model is its core content. The construction of evaluation index should not only accord with the actual situation of independent college, but also needs to reflect the teaching quality objectively and truly. Through the analysis of the teaching process of independent college, this paper establish the evaluation model containing 5 first level index (including teaching method, teaching attitude, teaching content, teaching effect and teaching ability) and 16 second level index. These indicators involve all aspects of teaching activities. The weight of each evaluation index set can well reflect the teaching status, and produce relatively true evaluation results. The evaluation model is shown as Table 1.

Table 1. Independent college teaching quality evaluation model

No.	First level index	Second level index	Weight
1	Teaching attitude	Strict requirements and care for students	10
2		Carefully organize teaching activity	10
3		Carefully review the homework	5
4		Treat students fairly	10
5		Seldom absent, late arrival and early leave	5
6	Teaching content	Prominent key and difficult content	10
7		Correctly form the concept, theorem with strong logic	5
8		Rich teaching content, reflect the new development results timely	5
9	Teaching method	Apply modern teaching methods and mobilize the enthusiasm of students	5
10		Improve teaching methods by constantly collecting teaching feedback	5
11		Focus on students’ knowledge, ability and quality	5
12	Teaching effect	Improve students' ability to analyze and solve problems	5
13		Attach importance to the cultivation of students' innovative abilities and improvement of their qualities	5
14		Students can master or understand what they have learned	5
15	Teaching ability	Clear and vivid language expression and	5
16		Neat blackboard writing and clear courseware	5

3.2 Experimental Data

We randomly select 10 teachers and collect the evaluation by students according to the teaching quality evaluation index system above. We take the average score and carry on data normalization, to obtain the correlation coefficient matrix, as well as its eigenvalues and eigenvectors. By this, we obtain the contribution rate and cumulative contribution rate, and then derive the principal component. By principal component analysis, it is concluded that the evaluation index of no. 1, 2, 4, 6, 9, 10, 12 and 15 are major factors affecting the evaluation of teaching quality. The main component is shown as Table 2.

Table 2. Main component

1	2	4	6	9	10	12	15
-4.1	2.2	-2.1	2.0	-0.1	-0.7	-1.0	0.1
-7.2	4.3	1.8	3.3	2.4	-0.3	-0.1	-0.6
-3.4	0.0	2.3	-0.6	0.9	1.2	-0.9	0.3
-3.9	-3.6	2.0	-3.1	1.9	0.0	0.4	-0.0
-3.6	-2.0	-0.6	-3.8	-1.0	-1.4	-1.5	-0.0
-1.5	3.2	-2.1	-1.2	-1.6	-0.2	-0.9	-0.6
1.9	4.2	-0.0	-0.7	-1.8	1.5	-0.2	-0.8
3.5	3.5	2.3	-0.4	-1.3	1.4	0.2	0.7
-1.3	5.9	-1.6	1.6	1.3	-0.8	-1.3	0.2
4.2	-1.9	1.5	1.4	-0.3	-1.1	-0.2	1.5

3.3 Analysis Results

Take the first 8 groups of data as training data, while the last 2 groups of data as forecast data. Apply MATLAB to conduct test, and compare the forecast results with teaching supervision evaluation results and evaluation results with traditional BP neural network, as shown in Table 3.

Table 3. Evaluation results

Improved PSO optimization algorithm	BP neural network	Teaching supervision
94.67	93.34	94.02
92.15	90.56	92.98

We can see from the table above, after we rank teacher's final evaluation results, we compare it with teaching supervision evaluation results and evaluation results with traditional BP neural network, and the results show that the rankings of the three methods did not change much, but the improved PSO optimization algorithm produces results that are closer to teaching supervision. Therefore, the final evaluation results can truly reflect the teaching of teachers.

4. Conclusion

Factors affecting the evaluation of teaching quality vary, course characteristics, student characteristics and teacher characteristics will all affect the quality of teaching evaluation. The evaluation model based on PSO algorithm proposed in this paper is a new program in teaching quality assessment.

Compared with the conventional method, the improved PSO optimization algorithm has quite advantage no matter in terms of prediction accuracy or convene. However, there are still some problems in teaching quality evaluation: The training speed of this algorithm is usually low, so it is not applicable many classification problems with mode components; on the other hand, stability of prediction accuracy of the improved PSO algorithm is not high enough. The experimental result shows that the teaching quality model based on PSO algorithm has higher performance than tradition methods.

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