Teaching Quality Evaluation Method of Higher Education based on Particle Swarm Optimization Neural Network

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Abstract. In order to address the shortcomings of traditional teaching quality evaluation systems, researchers have implemented PSO neural network technology to develop a teaching quality evaluation system for colleges and universities. This system utilizes PSO neural network technology, with teaching evaluation standards as inputs and teaching evaluation results as outputs. By using Anhui University of Science and Technology as a case study, empirical research demonstrates that this approach not only mitigates the direct impact of human factors on evaluation outcomes, but also provides a basis for establishing a comprehensive and rational evaluation index system.

Keywords: Institutions of higher learning; Teaching quality evaluation; PSO neural network

1   Introduction

In recent years, colleges and universities have made great progress in professional setting, personnel training and social service[1-3]. National education authorities at all levels have always taken improving the teaching quality of higher education as the starting point, with the goal of cultivating high-level specialized talents, and constantly improving the international competitiveness of Chinese colleges and universities[4-6]. At present, countries around the world are generally concerned about the issue of education and teaching quality assurance system and teaching quality evaluation in institutions of higher learning[7-8]. Since the 1980s, the higher education in China has made great progress and made remarkable achievements[9]. It has initially formed a socialist higher education system with multiple levels, various forms and complete categories of disciplines to meet the needs of national economic construction and social development. In the process of the development of higher education, colleges and universities have gradually realized the importance of the construction of teaching quality evaluation system, and a scientific and reasonable teaching quality evaluation

system is of great significance for improving the teaching level of colleges and universities.

Classroom teaching is the main way for schools to achieve educational goals. The evaluation of teachers' classroom teaching quality is helpful for school leaders and administrators to understand the realization of teaching goals, grasp the teaching work comprehensively and accurately, and improve teaching quality. The level of teaching work has a great influence on the level of talent training, so it is of great practical significance to accurately evaluate the quality of teaching.

2   Teaching quality evaluation method based on PSO neural network

2.1   PSO neural network

Particle Swarm Optimization (PSO) algorithm is an evolutionary computing technique based on swarm intelligence methods. It is inspired by the results of group behavior modeling and simulation studies of birds, and attempts to enable particles to fly into the solution space and fall at the optimal solution. PSO is simple in principle, easy to implement, and has better global search ability and faster computing speed for many optimization problems. Therefore, PSO has attracted the attention of scholars in the field of evolutionary computing and has gradually become a research hotspot.

The basic idea of PSO algorithm is as follows: First, PSO is initialized as a group of random particles, the position of the particles represents the potential solution of the optimization problem in the search space, the speed of the particles determines its flight direction and distance, and all particles have an adaptation value determined by the fitness function; Then, the particle follows the current particle to search in the solution space and finds the optimal solution through iteration.

Assuming that the current position and velocity of each particle are x and v respectively, the optimal solution p_i generated by the search from the initial iteration of the particle found so far to the current iteration, and the current optimal solution g for the whole population, the speed and position of the particle are updated according to the following formula.

$$v_{i+1} = w \times v_i + c_1 \times r_1 \times (p_i - x_i) + c_2 \times r_2 \times (g - x_i) \qquad (1)$$

$$x_{i+1} = x_i + v_{i+1} \qquad (2)$$

The PSO neural network algorithm flow is as follows:
Step 1: Initialize the velocities and positions of all particles;
Step 2: Use fitness function to evaluate all particles;
Step 3: Use fitness function to update individual extremum and global extremum;
Step 4: Iterate the speed and position according to Equation (1) and (2);
Step 5: Repeat the Equation (2) to (4) until the iteration stop condition is met.

2.2   Neural Network

Neural networks are abstractions and simulations of natural neural networks and some basic features of the human brain. At present, the most popular neural network is BP neural network. The network is divided into three layers: input layer, hidden layer and output layer. The essence of neural network training is to adjust the link weight of the neural network through the training algorithm to obtain the smallest training error as possible. Assuming that the number of training samples is m and there are n output nodes, the resulting training error is:

$$E = \sum_{i-1}^{m} \sum_{k=1}^{n} (t_i^k - y_i^k)^2 / 2 \tag{3}$$

Where, t_i^k and y_i^k represent the actual output and ideal output of the Kth output node of the training sample i respectively.

2.3   Teaching quality evaluation methods and practices

2.3.1 Evaluation goal.

The goal of teaching quality evaluation is to check whether the teaching content, teaching method and teaching effect can enable students to form a solid professional foundation and a balanced knowledge structure, master the thinking methods and basic skills of the corresponding courses, and form a strong interest in learning.

2.3.2 Evaluation objects

The evaluation objects mainly include teachers and students.

2.3.3 Evaluation content

(1) Teaching attitude
1) Teaching full of enthusiasm, lectures seriously;
2) Teachers' words and deeds are helpful to students' learning;
3) Prepare the teaching content and methods carefully before class.
(2) Teaching methods
1) The course objective is clear and consistent with the actual teaching content;
2) Vivid language, clear explanation, clear thinking;
3) The teaching content is full;
4) Pay attention to the cultivation of students' innovative consciousness;
5) The lectures are participatory and enlightening;
6) The combination of theory and practice;
7) Multi-angle teaching content evaluation;
8) Classroom teaching into the frontier knowledge of the subject;
9) The key and difficult points of the teaching process are prominent;
10) Assignments help students understand the content in class.

(3) Teaching effect

1) Students learn practical knowledge;

2) Students' analytical ability and problem-solving ability have been improved to some extent.

(4) Overall evaluation

Teacher effectiveness rating.

2.3.4 Evaluation methods

(1) Evaluation criteria

X_i (i=1,2,...,15) is used to indicate the evaluation criteria: X_1 indicates that the teaching is full of enthusiasm and the lectures are serious; X_2 indicates that the teacher's teaching by example helps the students to rule the school; X_3 indicates that the teaching contents and methods are well prepared before the class; X_4 indicates that the course objectives are clear and consistent with the actual teaching contents; X_5 indicates that the language is vivid, the explanation is clear and the ideas are clear; X_6 indicates that the teaching content is abundant; X_7 indicates that emphasis is placed on the cultivation of students' innovative consciousness; X_8 indicates that the lectures are participatory and inspiring; X_9 indicates that theory and practice are combined; X_{10} indicates that the evaluation of the teaching content is conducted from multiple perspectives; X_{11} indicates that the classroom teaching is integrated with the cutting-edge knowledge of the discipline; X_{12} indicates that the key points in the teaching process are outstanding; X_{13} indicates that the assignments are set up in a way that helps the students to understand the content of the classroom; X_{14} indicates that students learn practical knowledge; X_{15} indicates that students' analytical and problem-solving abilities are somewhat improved.

(2) PSO neural network training

1) Determine the number of neurons in the input layer: there are 15 teaching quality evaluation criteria, so the number of input layers is 15;

2) Determine the number of neurons in the output layer: the teaching quality evaluation result is taken as the output, so the number of output layers is 1;

3) Determine the number of hidden layers: In view of this, Kosmogorov's theorem shows that the three-layer BP neural network can approximate any continuous function under the condition of reasonable structure and proper weight, so the three-layer BP neural network is selected in this paper[10].

4) Determine the number of hidden layer neurons: According to the convergence performance of the network, the number of hidden layer neurons is 8.

5) Determine the neuron conversion function: $f(x) = 1/(1 + e^{-x})$

(3) PSO neural network evaluation

After the training of PSO neural network, the final teaching quality evaluation result can be obtained by inputting 15 evaluation criteria.

2.3.5 Evaluation practice

(1) Evaluation subjects

The evaluation subjects are students and teachers of Anhui University of Science and Technology.

(2) Processing and feedback of evaluation data

In order to avoid the subjective arbitrariness of the evaluation subject, the evaluation process does not adopt the percentage system, but adopts the evaluation grade, such as A-E grade, and the corresponding score is calculated automatically by the computer. The evaluation results not only reflect the ranking, but also obtain the reasons for the corresponding evaluation results through data analysis technology. In particular, the evaluation indicators should be combined with the evaluation indicators, and the indicators with low scores should be fed back to the teachers, so that they can identify the deficiencies in teaching and constantly improve the teaching quality.

2.3.6 Advantages of evaluation.

Teaching quality evaluation is an effective method to test teaching effectiveness and an important means to measure teachers' teaching and students' learning effect. Students' real feedback to teaching is the objective basis for evaluating teachers' teaching quality. Through teaching evaluation, teachers can understand the classroom teaching situation and the main problems, which is conducive to teachers to further improve their teaching level. Using PSO neural network to evaluate teaching quality, the following conclusions can be drawn from the application effect:

(1) Reliability of evaluation results

PSO neural network overcomes the problems of slow convergence, easy to fall into local optimality, and has better global search ability and faster computing speed. PSO neural network takes the research object as a system and simulates people's comprehensive judgment and reasoning ability to make decisions. By learning statistical data, it provides an effective method for scientific evaluation of teaching quality according to the importance of various factors in the system. Because PSO neural network has good comprehensive judgment ability, the evaluation results are more scientific.

(2) Combination of qualitative analysis and quantitative analysis

Through the analysis of the current mainstream teaching quality evaluation system, the qualitative representation of each evaluation index is obtained, and the PSO neural network is used to conduct quantitative analysis of the evaluation data. This research method, which combines qualitative analysis and quantitative analysis, greatly overcomes the subjective arbitrariness in teaching quality evaluation.

(3) Evaluate the operability of implementation

The whole evaluation step is clear, the evaluation rules are simple, the index quantification and data processing part can be realized by computer programming, and it has good operability.

3   Conclusion

The current mainstream teaching quality evaluation system often contains some non-quantitative factors, and the input and output of the system show a complex nonlinear relationship, so it is difficult to establish a scientific and reasonable mathematical model. In view of the shortcomings of the current teaching quality assessment system, this paper proposes a teaching quality assessment system based on PSO neural network. The system makes full use of the advantages of neural network and PSO algorithm in nonlinear mapping and global search respectively, effectively overcomes the shortcomings of traditional evaluation methods, and lays a solid foundation for establishing a scientific and reasonable teaching quality evaluation system.

4   Acknowledgement

Reference

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