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Health status assessment model of national higher education system based on BP neural network

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Abstract: Higher education is closely related to national development and is the driving force of national technological innovation. By data the United States, Australia, Japan, India and South Africa five countries, the establishment of a health evaluation model for national systems of higher education. PCA is used for dimensionality reduction, then constructing a BP- neural network and introducing a PSO into the BP-neural network model, the optimal population particle decoding is obtained, and a model is established to evaluate the health of the national higher education system, and the health of the United States, Australia, Japan, South Africa and India is obtained the ratings are 7, 7, 6, 3, and 1 respectively.

1. Introduction

Higher education is an important support for national development and the source of power for national development [1]. In the United States, higher education is no longer a luxury, but as a necessary personal economic opportunity and the United States' competitiveness in the global economy [2]. The higher education system is an important factor for a country to provide further education for its citizens, provide better talents for national construction, and attract a large number of international students every year to help economic development. Therefore, the higher education system not only has the value of the industry itself, but also plays a more significant role in supporting and leading economic development. Looking around the world, we see that the methods of higher education in different countries are different, and the higher education system of each country has its own advantages and disadvantages and room for improvement.

2. National Higher Education Health Evaluation Model

At this stage in the discussion, we will be categorized according to results of the previous three established following the BP neural network evaluation model division level indicators. In order to

make the results persuasive, objective and visual, and to make the calculation easier, we will use standardized data for neural network training, and then get the corresponding results to make a grade evaluation of the education system of 5 countries. The grade evaluation is divided into 1 level, the larger the number, the higher the health level of the country's education system. Among them, the United States is at level 7 and India is at level 1.

2.1 Model establishment

The classification algorithm modeling based on BP neural network includes three steps: BP neural network construction, BP neural network training and BP neural network evaluation. The algorithm flow is shown in Figure below.

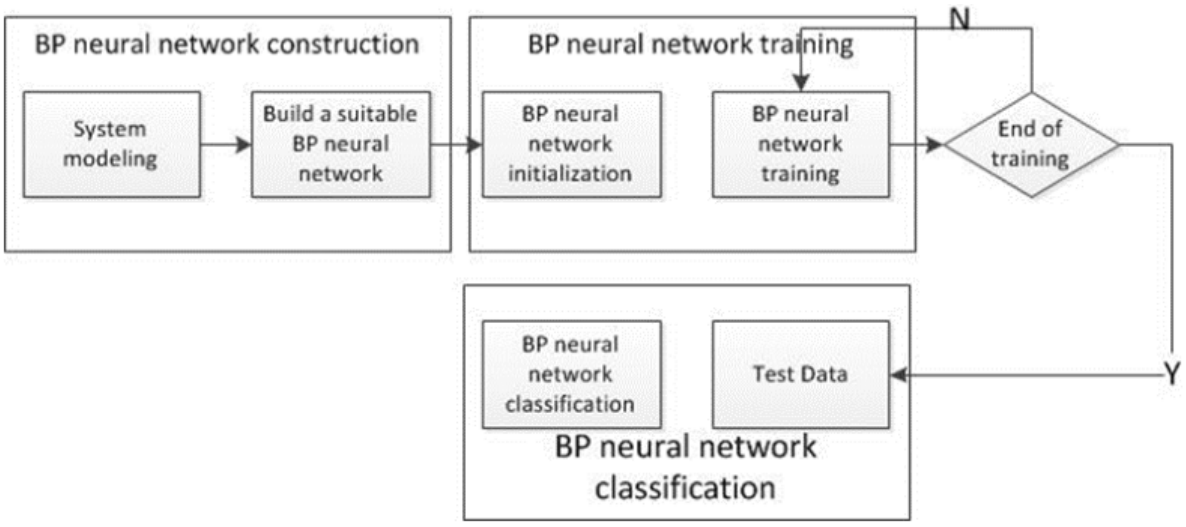


Figure. 1 The algorithm flow

We know that the construction of BP neural network is based on the characteristics of system input and output data to further determine the specific learning training and output structure of BP neural network. Since there are 5 first-level indicators to be input, and the number of national higher education health conditions to be evaluated is 7 in total, the structure of the BP neural network can be described as 5-7-1, which means that the input layer has 5 nodes, the hidden layer has 7 nodes, and the output layer has 1 node.

In constructing evaluation model BP neural network, we need a lot of training data so that neural network learning, output mode, in order to establish from the evaluation system. In order to make the evaluation results more accurate and reduce the impact of various errors on the evaluation, we consider using the behavioral anchor quantification method to define different horizontal scales (the following table), and construct a data set that meets the conditions as training samples.

Table 1 Comprehensive evaluation indicators of the health status of national higher education

Horizontal scale	Scientific research results (a)	Education status 1 (B1)	Education status 2 (B2)	Personal development 1 (C1)	Personal development 2 (C2)
7	a≥0.82	b1≥0.72	b2≥0.72	-1.42≥c1	-1.42≥c2
6	0.82≥a≥0.42	0.72≥b1≥0.02	0.72≥b2≥0.02	-0.92≥c1≥-1.42	-0.92≥c2≥-1.42
5	0.42≥a≥0.02	0.72≥b1≥0.32	0.72≥b≥0.32	-0.52≥c1≥-0.92	-0.52≥c2≥-0.92
4	0.02≥a≥-0.38	0.32≥b1≥-0.08	0.32≥b2≥-0.08	-0.12≥c1≥-0.52	-0.12≥c2≥-0.52
3	-0.38≥a≥-0.78	-0.08≥b1≥-0.48	-0.08≥b2≥-0.48	0.28≥c1≥-0.12	0.28≥c2≥-0.12
2	-0.78≥a≥-1.28	-0.48≥b1≥-1.38	-0.48≥b2≥-1.38	0.68≥c1≥0.28	0.68≥c2≥0.28
1	-1.28≥a	-1.38≥b1	-1.38≥b2	c1≥0.68	C2≥0.68

Subsequently, the data from the United States and India are substituted into the neural network for testing, and the verification results are consistent with the preset, which can be used as an objective evaluation method and system.

2.2 Improvement of Neural Network by Particle Swarm Algorithm

The particle swarm optimization algorithm is introduced into the BP neural network model. The particle swarm optimization algorithm is a swarm intelligence optimization algorithm in the computer field. The algorithm is proposed based on the phenomenon of bird predation. It gradually approaches the optimal solution by searching the surrounding area of the bird closest to the food. In the algorithm, three indicators of fitness value, speed and position are used to represent the movement characteristics of the particle (bird). The particle swarm optimization algorithm has a better global optimization capability. In this study, the connection weights and thresholds of each layer in the BP neural network are modeled as particles for coding, replaced by the particle swarm position vector, and the algorithm is iterated continuously to obtain the optimal population of particles. On this basis, the decoding is transformed into the optimal solution, which is the global optimal connection weight and threshold of the BP neural network, and the particle swarm optimization BP neural network algorithm model is established. The construction process of PSO-BP neural network model is shown in Figure 1. First build a 4-layer BP neural network (including 2 hidden layers). Based on the neural network, initialize the initial position value and velocity value of the particle swarm. Each particle corresponds to a hidden layer node in the BP neural network, and each particle swarm represents a group of connection weights and thresholds in the BP neural network. After decoding, the BP neural network model is obtained.

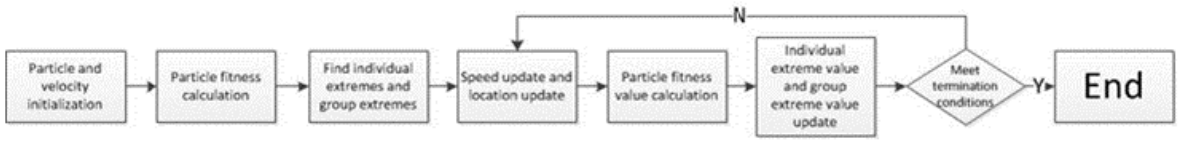


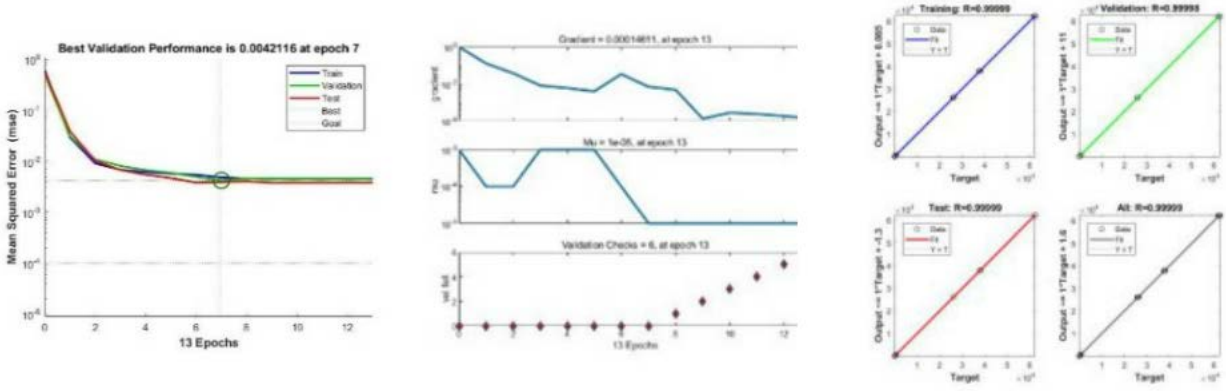
Figure. 2 The construction process of PSO-BP neural network model

In order to construct the neural network model, the optimal solution is approached by updating the velocity and position of the particle swarm. Among them, the calculation formula of particle fitness value F is as follows:

$$F = \sum_{i=1}^{N} \mathrm{abs}(y_i - t_i) \tag{1}$$

Where: y_i represents the observed value of sample i; t_i represents the predicted value of sample i; N represents the number of samples; abs is the absolute value function. On this basis, the speed and position of the particles are continuously updated until the iteration error reaches the set precision e or the number of iterations reaches the preset maximum number of iterations N_{num}. When the iteration stops, the position corresponding to the particle with the smallest fitness value is the optimal solution. Decode the optimal population particles obtained by the particle swarm optimization algorithm to obtain the optimal connection weights and thresholds of the BP neural network, and establish the model.

The training error of PSO-BP neural network is shown in the figure below:



Training Performance Training State Regression

Figure. 3 The training error of PSO-BP neural network

The comparison between the predicted result and the real one is as follows:

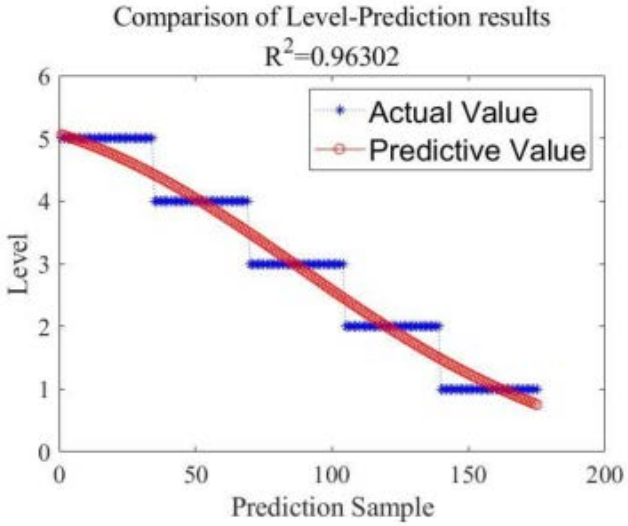


Figure. 4 The comparison between the predicted result and the real one

3. Conclusion

According to our national higher education health evaluation model, we can get the specific ratings of six countries as follows:

The six countries were rated as: United States 7, Australia 7, Japan 6, South Africa 3, India 1

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