A New BP Neural Network Algorithm and Its Application in English Education Evaluation

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Abstract

BP neural network algorithm is a non-linear optimal method and is a hot research field for its powerful simulation calculation ability in various disciplines in recent years, but the algorithm has some shortages such as low convergence which limited the application of the algorithm. The paper improves original BP neural network with immune genetic algorithm to speed up its calculation convergence and presents a new BP neural network algorithm for evaluating English education performance. Firstly, an indicator system for evaluating English education performance is constructed through four aspects of university, teacher, student and teaching effect; Secondly, immune genetic algorithm is used to improve standard BP neural network algorithm, in which the specific measures are taken to integrate BP neural network algorithm and immune genetic algorithm, and the calculation procedures of the improved algorithm is redesigned. Finally data from of three universities are taken for examples to verify the validity and feasibility of the improved algorithm and the experimental results indicate that the algorithm has favorable evaluation results in evaluation accuracy and calculation convergence.

Keywords: BP neural network algorithm, immune genetic algorithm, english education evaluation, evaluation indicator system

1. Introduction

Artificial neural network is a nonlinear system which simulates cerebrum information processing algorithm. It has powerful distributed information storage, parallel processing and adaptive learning ability. BP network contains the most essence part of neural network theory. Owing to simple structure and technical mature, it has been widely applied in system evalauation, pattern recognition, intelligent control and other areas. However, BP algorithm uses the steepest descent algorithm, thus there are two main shortcomings of slow convergence rate and easy to fall into local minimum which limites the application of the BP neural network in practice.

And English classroom teaching evaluation takes teaching activity and its effect in the classroom teaching as study object, comprehensively making use of various kinds of methods to collect information, carrying out analysis and processing, so as to obtain objective and true evaluation conclusion reflecting teaching reality. For example, through observing the activities and acts of teachers and students in classroom teaching, in accordance with indicator items as stipulated in evaluation criteria, evaluate grade or mark. The implementation of classroom teaching evaluation can be reference for the evaluated object to design teaching, improve teaching, and be stimulated to carry out creative teaching [1, 2].

In view of the BP algorithm's flaw, this paper makes the improvement with immune genetic algorithm to the standard BP algorithm and tries to apply improved BP neural network algorithm to evaluate the performance of Engilish course.

2. Literature Review

Up to now, mathematical models adopted by evaluation of course education performance mainly include the following categories. (1) Analytic hierarchy process is a good method for quantitative evaluation via quantitative method, having the functions of establishing the ideal weight structure of evaluated object value and analyzing the weight structure of

actually-built value by evaluated object; however, the method has strong limitations and subjectivity, with large personal error, not suitable for complicated system with lots of evaluation indicators [3-5]. (2) BP neural network evaluation method makes use of its strong capability in processing nonlinear problems to carry out evaluation of Music education performance; the method has advantages like self-learning, strong fault tolerance and adaptability; however, the algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization [6, 7]; (3) Fuzzy comprehensive evaluation is a method carrying out comprehensive evaluation and decision on system through fuzzy set theory, the greatest advantage of which is that it works well on system evaluation of multi-factor and multi-level complicated problems. However, the membership of fuzzy evaluation method as well as the definition and calculation of membership function are too absolute, difficult to reflect the dynamics and intermediate transitivity of evaluation indicators of Music education performance [8, 9].

The paper uses immune genetic algorithm to correct and modify standard BP neural network algorithm to overcome the question of slow convergence speed of original algorithm. In so doing, not only the problem of convergence speed of BP neural network algorithm has been solved, but also the simplicity of the model structure and the accuracy of system evaluation are ensured, and then a new BP neural network algorithm is advanced which is used to evaluate English education for different universities.

3. Analysis and Establishment of Evaluation Indicator System

While designing the indicator system of English course education evaluation of universities, this paper first takes the English course education of universities as characteristic. Higher education being a teaching activity transferring advanced knowledge and training senior professional talents, English course education job in universities, besides having the common characteristics of higher education job and common rules to be obeyed, has features different from ordinary education process. Therefore, this paer first refers to literatures related to English course education and experts' opinions, according to relevant principles of education and surveying, deciding the scope of influence of English course education in universities by combining area method with goal method, and designing evaluation indicator system with such four perspectives of English course education job as schools, teachers, students and effects. The system includes 4 first-grade indicators, 12 second-grade indicators, 35 third-grade indicators, see table 1 with more details [2, 4, 6].

4. Research Method
4.1. Simultaneous Analysis and Design

De Castro indicated that there were similarities among the quality of weight value initialization of back-propagation neutral network and the relationship of network output and the quality of antibody instruction system initialization in the immune system and the quality of immune response. A simultaneous analysis and design---SAND algorithm was advanced to solve the problem regarding the weight value initialization in the back-propagation network. In SAND algorithm, each antibody corresponds to a weight value vector of neuron given in one of several layers of neural networks, the length is l, and the affinity $aff(x_i, x_j)$ between antibody x_i and antibody x_j is shown by their derivative of Euclidean distance function $D(x_i, x_j)$ in formula 1. In which, ε is a positive of value adoption 0.001. The definition of Euclidean distance function $D(x_i, x_j)$ is shown in formula 2 [10].

$$aff(x_i, x_j) = \frac{1}{D(x_i, x_j) + \varepsilon} \tag{1}$$

$$D(x_i, x_j) = \sqrt{\sum_{k=1}^{l} (x_{ik} - x_{jk})^2} \tag{2}$$

SAND algorithm aims to reduce the similarities between the antibodies and produce the antibody repertoire to cover the entire form space with the best, so energy function is maximized. The energy function is shown in formula 3 [11].

$$E = \sum_{i=1}^{N} \sum_{j=i+1}^{N} D(x_i, x_j) \tag{3}$$

Table 1. Evaluation Indicator System of English Education Performance

Target Hierarchy	First-grade Indicator	Second-grade Indicator	Third-grade Indicator
Evaluation on English Education performance Universities	Universities	System Construction	Plan Making
			Management System
			Evaluation System
		Implementation Organizing	Plan Implementation
			Management Implementation
			Evaluation Implementation
		Funds and Personnel Input	Management Team
			Construction of Teachers
			Construction of Teaching Materials
		Construction of English Base	Base Construction
			Base Construction Planning
		Education Concept	Emphasis put on English Education
		English Culture Atmosphere	Academic Atmosphere
			English Atmosphere
	Teachers	English Education Ability	Teacher-Student Ratio of English Education
			English Guiding Ability
			Theoretical English Ability
			Practical English Ability
		English Education Concept	English Education Motivation
			Course System of English Education
			Course Contents of English Education
			Off-campus English Education
	Students	Receptivity of English Education	Enrollment Quality of Students
			Self-learning Ability
			Practical Ability
		English Education Learning	Learning Method
			Learning Effect
			Learning Motivation
			Participation Enthusiasm of Off-campus
	Education Effects	Increasing of Students' Innovative Ability	Scientific Activities
			Awards of English Competition
			Professional Skill
			Creative Skill
			Work Motivation
		School English Education Effects	Theoretical Achievement of School English Education
			Practical Achievement of School English Education

In the method of Eculidean form space, the energy function is not percentage. With a view to the diversity of the vector, SAND algorithm has to define the stop condition. Given vector $x_i, i = 1,2,...N$, its standardization is unit vector $I_i, i = 1,2,...N$, $\overline{I}$ shows to calculate the average vector. Therefore, formula 4 shows the diversity of unit vector, in which, $\left\|\overline{I}\right\|$ means the average vector distance from the origin of coordinate. Formula 5 shows the stop condition U of SAND algorithm.

$$\left\|\overline{I}\right\| = (I^T I)^{1/2} \tag{4}$$

$$U = 100 \times (1 - \left\| \bar{I} \right\|) \tag{5}$$

4.2. BP Neural Network Design based on Immune Genetic Algorithm.

According to the actual application, providing that both the input and output number of node and the input and output values in BP neural network algorithm have been confirmed, activation function adopts S type function. The following steps show the specific design of BP neural network algorithm based on immune genetic algorithm.

(1) Every layer of BP neural network algorithm carries on the weight value initialization separately by SAND algorithm.

(2) Antibody code. The initial weight value derived by SAND algorithm constructs the structures of BP neural network algorithm. Each antibody corresponds to a structure of BP neural network algorithm. The number of hidden node and network weight value carry on the mixture of real code. Each antibody serials are shown in Figure 1.

N number of hidden node	Weight value corresponding to the first hidden node	Weight value corresponding to the second hidden node	…	Weight value corresponding to the N hidden node

Figure 1. Antibody Code

(3) Fitness function design. Fitness function $f(x_i)$ is defined as the mean value function of squared error of neural network in formula 6, in which, $E(x_i)$ is shown by formula 7. In formula 7, p is the total training sample, o is the number of node of output layer, T_j^n and Y_j^n are the n training sample's expected output and actual output in the j output node separately, and ξ is the constant larger than zero [12].

$$f(x_i) = \frac{1}{E(x_i) + \xi} \tag{6}$$

$$E(x_i) = \frac{1}{2p} \sum_{N=1}^{p} \sum_{j=1}^{o} (T_j^n - Y_j^n)^2 \tag{7}$$

(4) Genetic operation. The model here adopts the Gaussian compiling method to go on the genetic operation so as that each antibody decoding is the corresponding network structure and change the network weight value as shown in formula 8, in which, x_i and x_i^m are the antibodies before and after the variation, $\mu(0,1)$ shows that the mean value is zero and squared error is normal distribution random variable of l, and $\partial \in (-1,1)$ is the individual variation rate. It is seen in formula 8 that the variation degree varies inversely as the fitness, i.e. the lower the fitness is (the less the fitness value of objective function is), the higher the individual variation rate is, or vice versa. After the variation, all the hidden node and weight value components constitute a new antibody again.

$$x_i^m = x_i + \partial \exp(-f(x_i)) \times \mu(0,1) \tag{8}$$

(5) Group renewal based on density. In order to guarantee the antibody diversity, improve the entire searching ability of the algorithm, the model adopts the Euclidean distance and the fitness based on the antibodies to calculate the similarity and density of the antibody.

Providing that there are x_i and x_j antibodies, and $\eta \succ 0$ and $t \succ 0$, given constants, the fact that formula 9 is satisfied indicates that x_i and x_j antibodies are similar, the number of antibody similar to the antibody x_i is the density of x_i marked by C_i. The probability of selecting antibody x_i is $p(x_i)$ as shown in formula 10, in which, α and β is the adjustable parameters between (0, 1), and $M(x)$ is the maximum fitness value of all the antibodies. It is seen in formula 10 that while the antibody density is high, the probability of selecting the antibody with high fitness is low, and conversely high. Therefore, excellent individual is not only retained, but the selection of similar antibodies is reduced, and the individual diversity is guaranteed.

$$\begin{cases} D(x_i, x_j \leq \eta \\ \left| f(x_i) - f(x_j) \right| \leq t \end{cases} \qquad (9)$$

$$p(x_i) = \alpha C_i [1 - \frac{f(x_i)}{M(x)}] + \beta \frac{f(x_i)}{M(x)} \qquad (10)$$

4.3. Calculation Procedures of Improved Algorithm

The process of the improved algorithm can be listed as follows.

(1) Initial Population, including the population size and the initialization of each weight (generate according to the method for neural network to generate initial weight), and encode it;

(2) Calculate the selection probability of each individual and sort them

(3) Select good individual to enter next generation population according to spinning roulette wheel selection strategy;

(4) In the new generation population, select adaptive individual to carry out crossover and mutation operation according to adaptive crossover probability and mutation probability to generate new individual;

(5) Insert the new individual into the population and calculate the fitness of new individual;

(6) Immigration operator operation. Judge whether there is "prematurity phenomenon", if there is, immigration strategy shall be adopted and turn to step 1;

(7) If the satisfactory individual is found, it shall be ended; otherwise, turn to 2.

5. Results and Analysis
5.1. Sample Data

Experimental data come from database of Peiking University, and Shanghai Jiaotong University and South China University of Technology. Relevant data of 3000 learner of each university who receive the English education of their universities are selected as the basis for data training and experimental verification in the paper, totally 9000 learns' data for study data that come from practical investigation and visit of two specific English education universities and students. In order to make the selected learners' data representatives, 3000 learners (1000 learner from each university) with more than 3 years learning experience, 3000 learners with 2 years learning experience, 3000 learners with less than 2 years learning experience.

5.2. Experimental Results

Limited to paper space, the evaluation of intermediate results is omitted here, only providing secondary evaluation results and final comprehensive evaluation results, see Table 2.

Table 2. Some Evaluation Results of Different Universities

	University	Teacher	Student	Educational Effect	Final evaluation results
Peiking University	4.351	3.873	4.245	4.721	4.442
Shanghai Jiaotong University	3.689	3.545	3.874	4.367	3.992
South China University of Technology	3.578	3.215	3.463	4.221	3.521

As for the performance of the presented algorithm, this paper also realizes the application of the ordinary BP neural network [6], and fuzzy evaluation [9], evaluation performance of different algorithms is shown in Table 3. In Table 3 evaluation results of training effects of different students are selected and compared with artificial evaluation to calculate the evaluation accuracy. And the calculation platform as follows: hardware is Dell Poweredge R710, in which processor is E5506, memory 2G, hard disk 160G; software platform is Windows XP operating system, C programming language environment.

Table 3. Evaluation Performance Comparison of Different Algorithms

	Algorithm in the Paper	Ordinary BP Neural Network	Fuzzy Evaluation
Evaluation Accuracy	95.76%	85.47%	82.17%
Time Consuming (S)	16	893	15

6. Conclusion

English course education is one of the focuses of important exploration of universities at home and abroad currently both in theory and practice. All of the current university education evaluation methods have some shortages, unable to meet the development demand of higher education. So, the study must be launched on the English course education evaluation systems and evaluation methods of higher institutions. This paper puts forward an evaluation model on the basis of BP neural network method based on analyzing the advantages and disadvantages of all the evaluation methods and the standard BP neural network algorithm is improved with immune genetic algorithm to speed up the algorithm calculation and simply the algorithm structure. Test results show that model in this paper has favourable practicability and evaluation accuracy. This paper considers that it is the next research direction to further decrease the interference of artificial evaluation results and guarantee the intelligence of evaluation process.

Acknowledgement

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