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# Application Research of BP Neural Network in English Teaching Evaluation

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## Abstract

*Teaching evaluation plays a key role for universities to improve its teaching quality and becomes a hotspot research field for related researchers. The paper takes university English teaching for example and presents a new model for evaluating English course teaching based on improved BP neural network. Firstly an evaluation indicator system of university English teaching is designed through analyzing the aspects of teaching effects and teacher factors and student factors. Secondly, BP Neural network is improved by improving its Non-monotone linear search and adaptive step change to overcome its shortages of low convergence in calculation. Thirdly data from of some universities are taken for examples to verify the validity and feasibility of the model and the experimental results show that the model can evaluate university English teaching practically and can help university and English teachers take corresponding concrete measures to enhance its education performance.*

**Keywords:** *English teaching evaluation, BP neural network, non-monotone linear search, adaptive step change*

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## 1. Introduction

Nowadays, the higher teaching quality has attracted more and more attention for it is the lifeline of higher academics' survival and development. Higher teaching evaluation has already developed widely through different forms all over the world to guarantee the teaching quality. Improving teaching quality is the primary job for the development of present higher education. And the teaching quality directly affects the quality of talent training. The high teaching evaluation is the core substance of the whole teaching management in universities because it can improve the teaching quality. Teaching evaluation is playing a more and more important and positive role in the course of teaching. University English teaching curriculum is a basic course on culturing high-quality talents. Nowadays the universities and colleges in our country attach great importance to English teaching and regard it as an important course. In view of the importance of university English teaching, it is necessary to evaluate it [1, 2].

With the coming of digital age, teaching environment has accumulated a good deal of teaching information which can objectively reflect the teaching performance of teachers. However, these data are seldom developed and utilized, simply recorded and inquired; teaching laws, difference of students information ability and correlation rule concealed in these data fail to be mined to effectively provide data basis for the evaluation project teaching. Data mining is a process that explores and analyzes large quantity of data in automatic or semi-automatic form to find meaningful mode and rule therein. Therefore, adopt data mining to carry out study on classroom teaching evaluation hasn't run its full course and is a research hotspot [1, 5].

## 2. Literature Review

This paper here, divide the evaluation methods at home and abroad into such two categories as data mining based and non data mining.

Non data mining teaching evaluation methods mainly include analytic hierarchy process, statistical analysis method and data envelopment analysis. Analytic hierarchy process and statistical analysis method. Analytic hierarchy process, according to multi-targets nature and dynamic nature of course teaching, adopts decomposition hierarchy-by-hierarchy, through quantizing people's subjective judgment on each evaluation indicator, so as to carry out

mathematical analysis and processing. But it is great in limitation, strong in subjectivity and large in personal error, not suitable for evaluating teaching evaluation system with lots of evaluation indicators; Statistical analysis method, through statistics method, makes statistical analysis on each evaluation indicator of classroom teaching, evaluates the scores of each evaluation indicator, so as to obtain the evaluation of teaching effects. The evaluation process of the method is easy to understand, also reflects teachers and students specific evaluation and attitude. But it is cumbersome in evaluation process and low in evaluation precision; Data envelopment analysis is simple in evaluation process calculation and clear in analysis of evaluation indicators; but it is only applicable to evaluate classroom teaching from the perspective of teachers teaching input and students gains [1, 3, 4].

The most important advantage of evaluation method based on data mining is to automatically sort and mine huge quantity of teaching data, analyzing and finding out inherent law. This method has very good generality, which mainly includes neural network method and fuzzy comprehensive evaluation method. BP neural network evaluation method, although BP neural network has such advantages as self-learning, strong fault tolerance and adaptivity, this algorithm is easy to fall into the defects like local minimum, over-learning and strong operation expertise; Fuzzy comprehensive evaluation has the greatest advantage of favorable performance evaluation effects as to multi-factor and multi-hierarchy complicated problems. But the definition and calculation of membership and membership function of fuzzy evaluation method are too absolute, difficult to reflect the dynamic nature and intermediate transitivity of evaluation indicators of internet marketing [2, 5, 6].

The paper modify BPNN model through improving its non-monotone linear search, adaptive step changeto overcome the question of slow convergence speed of BPNN which can solve the problem of convergence speed of BPNN and simplify the model structure and ensure the evaluation accuracy, then a new evaluation model is advanced to evaluate music English teaching for universities.

### 3. Evaluation Indicator System Construction

Table 1. Indicator System of University English Teaching Evaluation

Target Hierarchy	First-class Indicator	Second-class Indicator	Third-class Indicator	
University English Teaching Evaluation	Teaching Effects	Final Exam	Written Exam Result Oral Exam Result Teachers' Evaluation Self-evaluation	
		Process Evaluation	Classmates' Evaluation Self-testing Records Unit Test Interaction of Listening and Speaking Question Answering Records Completion Status of Study Plans	
		Students Factors	Learning Attitude	Participation Status of Teaching Activities Communication with Classmates Completion Status of Difficult Tasks Study Notes and Records Completion Status of Home works Study Status of Instruction
		Teacher Factors	Teaching Objectives	Basic Knowledge Objective Ability Training Objective Teaching Interaction
			Teaching methods	Teaching Atmosphere Design Teaching Guide and Inspiring Teaching Explanation

At present, the establishment of evaluation indicator system of English classroom teaching at home and abroad mainly takes teachers factor, students factor, teaching features into consideration; while insufficient in the attention paid on the evaluation of teaching effect, as

teaching effect is the ultimate aim of classroom teaching. This paper, based on the connotation characteristics of English classroom teaching performance evaluation, especially on the basis of experts consultations, combined with literatures, establishes a wide and scientific evaluation indicator system of English course education performance evaluation [4-9], which includes 4 hierarchies, 4 categories, 5 second-grade indicators, 22 third-grade indicators; see Table 1 for details.

#### 4. Research Method

##### 4.1. Applicability of BP Neural Network to the Teaching Quality Evaluation

Teaching is a dynamic process integrating instructing and learning. There are lots of factors influencing teaching quality, and the influences of these factors are different; therefore, it is difficult to express the evaluation result with a mathematical formula. It is a non-linear classification problem, which brings huge difficulty in comprehensive evaluation. In the previous evaluation systems, the mostly adopted method is to directly establish mathematical model of evaluation system, such as weighted average method, analytic hierarchy process, fuzzy comprehensive evaluation method, all of which are hard to get rid of various randomness and subjectivity in the evaluation process, easy to cause the distortion and deviation of evaluation results.

Neural network technology, in the aspects of pattern recognition and classification, recognition filtering, automatic control and forecast, has shown its extraordinary superiority. The occurrence of artificial neural network provides a new way for the teaching quality evaluation of higher institutions. Through continuous learning and training, artificial neural network is able to find its regularity among huge quantities of complicated data of unknown mode, especially able to process data of any type, which is unparalleled compared with many traditional methods. Hence, to apply the theory of artificial neural network to the classroom teaching quality evaluation system of higher institutions not only solves the problems of qualitative indicators and quantitative indicators in comprehensive evaluation indicator system, conquers the problems of establishing complicated mathematical model and mathematical formula in traditional evaluation process, but also avoids the subjectivity of humans, making the evaluation more accurate and effective; to make use of the mathematical model of classroom teaching quality evaluation system established by neural network theory is an effective way to evaluate teaching quality.

##### 4.2. Working Principle of BP Neural Network

Up till now, hundreds of artificial neural network models are put forward from different views of research, among which multi-hierarchy feed forward error back propagation BP neural network is the most-widely used network model in actual research. Basic three-layer BP neural network structure is shown as Figure 1.

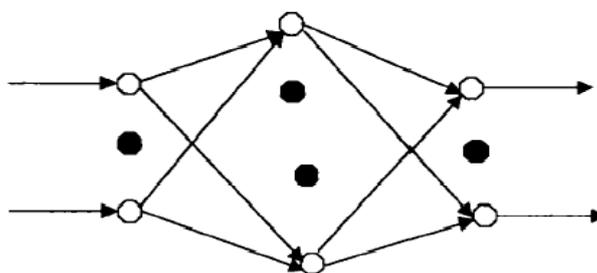


Figure 1. Basic Structure of BP Neural Network

From the picture we can see that three-layer BP neural network is mainly comprised of input layer, hidden layer and output layer. Adjustable weight  $w$  connects the layers. There can be several hidden layers, forming multi-layer BP neural network. The input of BP neural network is recorded as  $x_i(k)$ , the actual output of network is recorded as  $y_j(k)$ , the ideal output of

network is recorded as  $Y_i(k)$ , the subscripts  $i, j$  indicate the nodes of input layer of network respectively, and  $k$  is the running iterations of BP neural network. Its approximation error is defined as Formula 1 in which  $L$  is the quantity of output layer nodes; in this way, the function characteristic of BP neural network can be described as Formula 2.

$$E = \frac{1}{2} \sum_{j=1}^L (Y_j(k) - \gamma_j(k))^2 \quad (1)$$

$$\gamma_j(k) = f(x_i(k), \omega) \quad (2)$$

In Formula 2, function  $f$  is obtained through the composition of weights of each network layer and node function, generally being very complicated non-linear function BP neural network training is to dynamically adjust the connecting weight  $\omega$  to make Formula 3 workable. The learning of weight  $\omega$  adopts the fastest grads descent principle, i.e. the variable quantity of weights is in proportion to the negative gradient direction of approximation error  $E$ . See reference 2 for specific calculation.

$$\lim_{k \rightarrow \infty} E = \lim_{k \rightarrow \infty} \frac{1}{2} \sum_{j=1}^L (Y_j(k) - \gamma_j(k))^2 = 0 \quad (3)$$

### 4.3. Shortage of BP Algorithm

There are some shortages of BP neural network. It is small in the calculation of change of error gradient. Though the weight is large in adjustment amount, the error is descending slowly. So only with correct adjustment direction and long adjustment time can quit the flat site and enter some valley point, which causes a big increase in calculation training times, thus influencing rate of convergence. There are many minimum points. BP algorithm is a non-linear optimal method based on gradient descending method, inevitably having the problem of local minimum. And the solution space of actual problems is often extremely complicated multidimensional curved surface, having lots of local minimum points, leading to an increasing possibility of falling into local minimum point. Generally, while randomly set initial weight in BP algorithm, training of network is generally difficult to reach global optimum, which will make the algorithm training fall into local minimum, thus causing the training fail to converge to assigned error.

### 4.4. Improvement of BP Algorithm

As for BP learning process itself, the delaying of learning speed generally occurs around the local minimum points of error curved surface; so the time taken to passing through these minimum points decides the speed of convergence to a large extent. It is obviously that traditional fixed step method is unable to solve this problem, and the simple multiplying strategy of step (i.e. with the increase of current learning error, the step shall make constant demultiplication; otherwise, the step shall make constant multiplying) can hardly be improved largely. The reason is that the increase and decrease of step are generally aimed at adjacent local area, and the increase and decrease changes are difficult to truly adapt to the comprehensive features of error curved surface. Based on this, this paper makes use of non-monotone linear search method to expand judgment area; as for "oscillation area", learning step is adjusted under the guiding of percentage of error change, thus improving the adaptivity of step change.

#### 4.4.1. Improvement of Non-monotone Linear Search

Non-monotone linear search method is an effective single-dimensional search method to solve unconstrained optimization problem, the essence of which is to, based on keeping the descending overall trend of objective function, permit the local ascending of objective function in the iterative process. It is able to effectively conquer the shortage of traditional single-dimensional search method that the progress is slow upon dramatic change of objective function, thus making BP learning process able to rapidly passing through the "winding and

complicated canyon" on error curved surface and reduce the iterations caused, which is irreplaceable for the introduction of conventional momentum factors. Specifically, the principle of non-monotone linear search is as follows.

Suppose  $f(x)$  is the objective function to be minimized,  $x_k$  is current iteration point,  $d_k$  is search direction, then the next iteration point  $x_{k+1}$  can be obtained through Formula 4.

$$x_{k+1} = x_k + \eta_k d_k \quad (4)$$

In Formula 4,  $\eta_k$  is current step that meets the condition of Formula 5. In Formula 5,  $r_g$  is intended search scope, and  $u$  is adjustment coefficient of constant.

$$f(x_k + \eta_k d_k) \leq \max_{0 \leq i \leq r_g} \{f(x_{k-1})\} + u t_k \nabla f(x_k)^T d_k \quad (0 \leq u \leq 1) \quad (5)$$

#### 4.4.2. Improvement of Adaptive Step Change

In order to make the learning step better carry out adaptive change, adjustment shall be carried out according to different conditions. Specific change steps are as shown below.

Under the guiding of non-monotone linear search method, calculate the error change of forward and backward iteration process, see formula 6:

$$\Delta E_{all}(k) = E_{all}(k) - \max_{0 \leq i \leq r_g} \{E_{all}(k-i)\} \quad \Delta E_{all}(k-1) = E_{all}(k-1) - \max_{0 \leq i \leq r_g} \{E_{all}(k-i)\} \quad (6)$$

If the learning errors of recent continuous  $S$  times are decreasing, the step change is Formula 7 in which  $\beta_1 \geq 1$ ; if the learning errors of recent continuous  $S$  times are increasing, the step change is Formula 8 in which  $\beta_2 \leq 1$ ; otherwise, time varying coefficient  $L$  needs to be calculated through Formula 9.

$$\eta_k = \beta_1 * \eta_{k-1} \quad (7)$$

$$\eta_k = \beta_2 * \eta_{k-1} \quad (8)$$

$$L(k) = C1 * \frac{-\Delta E_{all}(k)}{E_{all}(k-1)} + C2 * Sgn(-\Delta E_{all}(k)) * \frac{|\Delta E_{all}(k) - \Delta E_{all}(k-1)|}{|\Delta E_{all}(k-1)|} \quad (9)$$

If  $\Delta E_{all}(k-1) = 0$ , then take the first item only; if  $L(k) \geq \beta_1 - 1$ , then  $L(k) = \beta_1 - 1$ , if  $L(k) \leq \beta_2 - 1$ , then  $L(k) = \beta_2 - 1$ . Based on this, step change is Formula 10.

$$\eta_k = (1 + L(k)) * \eta_{k-1} \quad (10)$$

In the above formulas,  $k$  represents learning times,  $E_{all}(k)$  is the error after the  $k$ th times of learning (define according to Cauchy error estimation form),  $Sgn(\bullet)$  represents sign function,  $\eta$  is learning step,  $s$ ,  $S$ ,  $C1$ ,  $C2$  are predetermined constants.

The essence of the above step change strategy is to change the step according to the features of "flat area" and "oscillation area" of error curved surface: the increase and decrease of step in "oscillation area" are adjusted with the percentage of forward and backward error change, so the learning process can be better closed to "optimal route"; while in the "flat area", rapid increase and decrease shall be implemented on step to accelerate the convergence of

learning process. Therefore, in the actual calculation of this paper, the value of  $\beta_1$  is among [2, 4], and the value of  $\beta_2$  is among [0.1, 0.4].

## 5. Results and Analysis

Experimental data come from database of Peiking Normal University (Referred to as PKNU), and Shangxi Normal University (Referred to as SXNU) and North West University (Referred to as NWU). Relevant data of 1000 learner of each university who had received university English education for two years.

The middle evaluation results is omitted here in order to make the paper concise and clear and only the second grade indicators and final comprehensive evaluation results of the total evaluation are given in Table 2.

Table 2. Evaluation Results of Secondary Grade Indicators

	Final Exam	Process Evaluation	Learning Attitude	Teaching Objectives	Teaching methods	Final evaluation
PKNU	4.621	4.419	3.892	4.771	4.234	4.459
SXNU	4.229	4.216	4.271	4.701	4.103	4.262
NWU	4.212	3.891	4.135	4.651	3.761	4.112

As for the algorithm efficiency and evaluation accuracy of the algorithm presented in the paper, the realization results of the algorithm and ordinary BP neural network algorithm are given in the Table 3. Matlab programming language, windows XP, CM6731-C21C, i3 2120 and 3.3GHz CPU, 2GB DDR3, 500GB SATA. From Table 3 we can see clearly that the evaluation accuracy and algorithm efficiency are much more better than BP neural network before improvement so the algorithm presented in the paper can be used for universities to evaluate it English teaching and other course teaching evaluation practically.

Table 3. Realization Results of Different Algorithms

	Algorithm in the paper	Ordinary BP Neural Network
Evaluation Accuracy	94%	89%
Time Consuming (S)	12	781

## 6. Conclusion

As an important stage of college English teaching, classroom teaching evaluation plays a significant function evaluation and guiding value role in English teaching. On the basis of focusing on teaching effect, combined with the features of English teaching, this paper builds English teaching evaluation indicator system and puts forward new evaluation method, which is the research features and innovation of this paper; test results also show the applicability and operability of the evaluation method in this paper. It is the major orientation of future study to pay attention to the innovation of teaching means and teaching methods while designing evaluation indicator system as well as the effect evaluation of innovation teaching.

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