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Empirical Research of Evaluating Training Base Teaching for Higher Vocation Education

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Abstract: Training base teaching evaluation of higher vocation education is one of the difficult and hot research fields in higher education management. Using BP neural network algorithm, a new clustering segmentation algorithm is presented. Firstly, According to the characteristics of training base teaching evaluation of higher vocation, a new evaluation indicator system is constructed from the perspectives of training preparation, specific training, training administration, training effects; Second, the paper improves the original BP algorithm through adjusting the value of momentum factor, taking dynamic strategy of momentum factor and adaptive change of algorithm step to speed up the calculation; Finally, the empirical results shows that improved model has high evaluation accuracy when used to evaluate training base teaching of higher vocation education and can improve process stability and speed greatly.

Keywords: Higher vocation education; Training base teaching evaluation; BP neural network algorithm; Evaluation indicator system

1. Introduction

Training base teaching in higher vocation education is aimed at training students' technology application ability in producing, building, managing and serving practice. Base training teaching takes up an important position in higher vocation education, which can facilitate the realization of talent training targets and embody the college running direction and characteristics. Same as classroom teaching, base training teaching is to not only establish a set of complete course system but also make a set of evaluation system adapting to self characteristics, thus guaranteeing the further perfection of base training teaching and the further improvement of teaching quality, boosting the deep development of higher vocation education reform. Base training teaching evaluation system, taking professional teaching system as evaluation object, carries out special evaluation on the training base teaching. Therefore, to launch the comprehensive evaluation research on training base teaching including of higher vocation education, the establishment of evaluation indicator system and evaluation method study has significant theoretical and practical value, also one of the research hotspots in the field.

2. Literature Review

As for the study on current literatures of evaluating training base teaching education, this paper mainly summarizes from such three perspectives as evaluation contents, evaluation principles and evaluation methods. ① At present, as for the course evaluation contents, scholars at home and abroad have a variety of views. Huang Puquan and etc. consider that the contents of course evaluation are teachers, teaching conditions, teaching implementation process and teaching effects[1]. And Yang Jing's views are teaching syllabus, teaching materials, teachers, lab construction, teaching process and teaching effect evaluation[2]. Zhao HongGuang thinks that the evaluation contents shall include course planning, teaching reform, imparting knowledge and educating people, teachers, teaching materials construction, teaching status, teaching effects evaluation[3]. Zhang Hongwei and etc. consider that the contents of course evaluation include teachers, teaching conditions, teaching quality and teaching management. ② Currently, as to the course evaluation principles, scholars at home and abroad also hold different views[4]. Professor Yu Jinghuai thinks that the principles to be obeyed for course evaluation of colleges and universities are to meet the education teaching law, combine scientificity with feasibility, combine qualitative indicators with quantitative indicators and combine basic indicators with characteristic indicators[5]. Zheng Xiaomei's view is directionality principle, objectivity principle, typicality principle, comparability principle, quantification principle and feasibility principle[6].③As for evaluation methods, Analytic hierarchy process, Fuzzy comprehensive evaluation, Data Mining evaluation are three mainstream methods and in which BP neural network evaluation, as a typical data mining method, is most welcomed by the most researchers for its high evaluation accuracy and powerful data mining ability. But BP neural network algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization which limited practical uses in engineering evaluation[7-9].

This paper, as for evaluation contents, mainly focuses on training preparation, specific training, training administration, training effects; as for evaluation principles, launching from such four aspects as experts' evaluation, internal evaluation, self-evaluation and social evaluation, obtaining evaluation data by adopting the above principles as for the data selection of specific evaluation indicators; as for evaluation method, BP neural network algorithm of data mining is improved to overcome the question of slow convergence speed of BPNN. In so doing, not only the problem of convergence speed of BPNN has been solved, but also the simplicity of the model structure and the accuracy of the evaluation are ensured.

3. Establishment of Evaluation Indicators System

On the basis of referring to references, experts consultation and practice survey, this paper designs a set of evaluation indicator system of college base training according to base training preparation, specific process, management and effect, which includes 4 first-class indicators, 13 second-class indicators, 30 third-class indicators; see Table 1 for details.

Table 1. Indicator System of Training base Teaching Evaluation

Target Hierarchy	First-class Indicator	Second-class Indicator	Third-class Indicator
university base training teaching evaluation	training preparation	training teachers	teachers' quality
			teachers' structure
		teaching documents	teaching syllabus
			teaching plan
			training instruction
		training facility	training venue
			training equipment
			training safety
			skill test point
		practice discipline	training discipline
	specific training	training guidance	mentoring ability
			instructional method
		training order	training site
			students' feedback
		training supervision	implementation of training contents
			implementation of training progress
	training administration	organizational management	organization in place
			task arrangement
		system management	system soundness
			system implementation
		management effect	faculty responsibility
			diary for instruction
	training effects	skill mastery	comprehensive quality
			operation ability
			analysis ability
			innovation ability
		training achievement	task completion quality
			social evaluation
		training experience	training report
			training summary

4. Derivation of Evaluation Algorithm

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. The paper use basic three-layer BP neural network, its concrete contents see reference 7. But in order to overcome the shortages of original BP neural networks, the paper advances the following improvements.

4.1. Improvement in Adjusting the Value of Momentum Factor α

The introduction of momentum is, in essence, to exert a recursive low pass filter on $\partial E_{all} / \partial(\bullet)$, so as to "attenuate" the error of "high-frequency oscillation" and expand the "direct current" component of error gradient along "the bottom of canyon"; secondly, the investigation of iterative correction formula of network parameter (one of the parameters representing ω, θ, S) can be expressed by formula 1.

$$\begin{aligned}\bar{X}(k) &= \bar{X}(k-1) - \eta(k-1)\frac{\partial E_{all}}{\partial \bar{X}(k-1)} + \alpha\Delta \bar{X}(k-1) \\ &\approx \bar{X}(k-1) + \eta(k-1)\{-\frac{\partial E_{all}}{\partial \bar{X}(k-1)} + \frac{\alpha\eta(k-2)}{\eta(k-1)}(-\frac{\partial E_{all}}{\partial \bar{X}(k-2)})\}\end{aligned} \quad (1)$$

The above parameters are expressed by vectors, which shows that the introduction of momentum makes the approximation similar to the conjugate gradient search process, but $\frac{\partial E_{all}}{\partial \bar{X}(k-1)}$ and $\frac{\partial E_{all}}{\partial \bar{X}(k-2)}$ are not in the form of conjugate gradient; in these circumstances, the value of momentum factor α can be adjusted as follows.

①While the learning errors of recent continuous S' times are increasing, $\alpha = 0$, stop the amplified action on "direct current component";

②Otherwise, the value of α keeps unchanged, maintaining the restrain on "high-frequency oscillation".

Generally, as there are change points of learning speed in "oscillation area" in error curved surface, in order to avoid the over slowness of learning process towards "oscillation area", the value α shall not be too big; [0.1-0.3] will be appropriate.

4.2. Improvement in Dynamic Strategy of Momentum Factor α

Stagnation is the fundamental cause resulting in the inadequacy of BP neural network algorithm. Based on the deterministic and random selections, this paper adjusts the transition probability dynamically to build the selection strategy more conducive to the overall search.

The pheromone in the path occurs continuous change in the evolutionary process. The pheromone of better solution searched is strengthened to increase the selection possibility of next iteration, and some better solutions is forgotten gradually because fewer ants pass in the start-up phase so as to affect the overall search capabilities of the algorithm. If the BP neural network are stimulated properly to try the path occasionally in the selection strategy, it is conducive for the overall search of the solution space. Thus, the inadequacy of basic BP neural network algorithm is overcome effectively. See formula 2 for the improved selection strategy in this paper.

$$P_{ij}^{k}(t) = \begin{cases} \arg\max\{\left|\tau_{ij}(t)\right|^{\alpha} \cdot \left|\eta_{ij}(t)\right|^{\beta}\}, & q \le q_0, j \in allowed_k; \\ \dfrac{\left[\tau_{ij}(t)\right]^{\alpha} \cdot \left[\eta_{ij}\right]^{\beta} \cdot X_{ij}(t)}{\sum_{k \in allowed_k} \left[\tau_{ik}(t)\right]^{\alpha} \cdot \left[\eta_{ik}\right]^{\beta} \cdot X(t)}, & j \in allowed_k, others \end{cases} \quad (2)$$

In formula 2, X_{ij} meets the requirements of formula 3.

$$X_{ij} = \frac{m \cdot N_c}{m \cdot N_c + \delta \cdot Q_c(i, j) \cdot \eta(i, j) / \max \eta} \quad (3)$$

In formula 6, m is the number of ants, N_c is the number of current iterations, $\max \eta$ is the maximum of heuristic function $\eta(i, j)$,and $Q_c(i, j)$ is total number of BP neural network in the current path (i, j) from the first iteration. Q_c and η are considered in X . When previous iteration tends to suboptimal solution, the number $Q_c(i, j)$ of BP neural network increases and its X value decreases constantly in spite of constant increase of the pheromone in the suboptimal solution. Therefore, another selection of the path can restrain the excessive increase of the pheromone to cause premature convergence, and is conducive to global convergence.

4.3. Improvement of Adaptive Change of Algorithm Step

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.

①Under the guiding of non-monotone linear search method, calculate the error change of forward and backward iteration process, see formula 4.

$$E_{all}(k) - \max_{0 \le i \le r_g}\{E_{all}(k-i)\} \qquad \Delta E_{all}(k-1) = E_{all}(k-1) - \max_{0 \le i \le r_g}\{E_{all}(k-i)\} \quad (4)$$

②If the learning errors of recent continuous S times are decreasing, the step change is formula 5, in which $\beta_1 \ge 1$; if the learning errors of recent continuous S times are increasing, the step change is formula 6, in which $\beta_2 \le 1$; otherwise, time varying coefficient L needs to be calculated through formula 7.

$$\eta_k = \beta_1 * \eta_{k-1} \quad (5)$$

$$\eta_k = \beta_2 * \eta_{k-1} \quad (6)$$

$$L(k) = C1 * \frac{-\Delta E_{all}(k)}{E_{all}(k-1)} + C2 * Sgn(-\Delta E_{all}(k)) * \frac{\left|\Delta E_{all}(k) - \Delta E_{all}(k-1)\right|}{\left|\Delta E_{all}(k-1)\right|} \quad (7)$$

If $\Delta E_{all}(k-1) = 0$, then take the first item only; if $L(k) \ge \beta 1\text{-}1$, then $L(k) = \beta 1\text{-}1$, if $L(k) \le \beta 2\text{-}1$, then $L(k) = \beta 2\text{-}1$. Based on this, step change is formula 8.

$$\eta_k = (1 + \mathrm{L(k)}) * \eta_{k-1} \quad (8)$$

In the above formulas, k represents learning times, $E_{all}(k)$ is the error after the kth times of learning (define according to Cauchy error estimation form), $Sgn(\bullet)$ represents sign function, η 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 thesis, the value of β_1 is among [2,4], and the value of β_2 is among [0.1,0.4].

5. Experimental Confirmation

Experimental data come from database of three higher colleges called college A,B,C respectively. Relevant data of 1000 learner of each college are selected as the basis for data training and experimental verification in the paper, totally 3000 learns' data for study data that come from practical investigation and visit of two specific vocation education institutions and students. In order to make the selected learners' data representatives, 600 learners(200 learner from each university) with more than 3 years learning experience, 600 learners with 2 years learning experience, 3000 learners with less than 2 years learning experience.

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. Secondary Evaluation Results of Different Distance Training Schools

	Final Evaluation Results	Evaluation Results of First-class Indicator			
		Training preparation	Specific training	Training administration	Training effects
college A	3.902	3.872	3.891	4.136	3.981
college B	4.336	4.113	4.209	4.561	4.319
college C	4.571	4.241	4.381	4.771	4.608

Table 3. Evaluation Performance Comparison of different Algorithms

Algorithm	Algorithm in This Paper	Ordinary BP Neural Network Algorithm	Comprehensive Fuzzy Algorithm
Accuracy Rate	95.33 %	84.15%	68.92%
Time Consuming(S)	18	451	17

As for the performance of the presented algorithm, this paper also realizes the application of the ordinary BP neural network[9] and comprehensive fuzzy evaluation[6], 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.

6. Conclusion

Evaluating training base teaching of higher vocation education is one of the focuses of important exploration of colleges at home and abroad currently both in theory and practice. All of the current higher vocation education evaluation indicator systems and evaluation methods have some shortages, unable to meet the development demand of higher education. This paper, from the perspectives of training preparation, specific training, training administration, training effects, designs a set of efficient training base teaching evaluation system, and puts forward an evaluation model on the basis of BP neural network algorithm based on analyzing the advantages and disadvantages of all the evaluation methods. Test results show that model in this paper has favorable practicability and evaluation accuracy.

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