Research on the Teaching Evaluation Model Based on BP Neural Network

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Abstract. Education evaluation has become increasingly important along with the deepening educational reform. Only through evaluation will the teachers further enhance their teaching methods and teaching level. Considering the many factors influencing the teachers, it is difficult to simply adopt one model to evaluation. Therefore, this paper offers an establishment of the teaching evaluation model based on neural network to resolve the nonlinear mapping relationship between evaluation indexes and objectives. The living examples show that the neural network model could better wrestle with the issues unsolved by the traditional evaluation model, thus outshining the subjective resolution of evaluation index weight. 8 evaluation indexes without weight are adopted for the training and text of network. The results show that the 8-5-1 model could properly handle the teaching evaluation.

Introduction

Quality is the lifeline of school and teaching quality has been made the core element of the quality project of the school. Evaluation stems from the pursuit of quality; through which, the teachers will be able to improve their teaching methods and constantly enhance the teaching quality according to the evaluation information. Among the diverse teaching evaluation models, the traditional evaluation model calculates by specifying the weight of each index and capitalizing on the linear model, thus testifying to its strong subjectivity and lack of scientificity and rationality. As the result of many factors influencing the teaching effect and due to their different incidence, it is difficult to use simply one linear model to express their functional relationship. To resolve the deficiency of the traditional evaluation model, the non-linear teaching evaluation model based on BP neural network is introduced for the objective and intelligent teaching evaluation with the reliable information provided in the teaching process and for the optimization of teaching model with the feedback information.

Establishment of Teaching Evaluation Index System

Teaching ability, as the potential quality of the teachers, could only be demonstrated in the teaching process. The level of their teaching level is a manifestation of their teaching ability. Therefore, the measurement of their teaching ability must be carried out through the evaluation of their teaching level in class.

There are many factors influencing the teachers' teaching level; it is worth-noticing that each factor has different contribution degree to the teaching level. So far, there is no universally recognized optimal evaluation index system. From the relevant materials, it is possible to find out the various versions of evaluation index system. On the basis of drawing upon the existing versions, the following evaluation indexes are enumerated according to the author's experience.

(1) High Professional Ethics X_1; (2) Strong Professional Dedication X_2; (3) Solid Basic Knowledge X_3; (4) Excellent Operational Skills X_4; (5) The Level of Oral Language Application

X_5; (6) The Level of Body Language Application X_6; (7) Ability of Blackboard Writing Design X_7; (8) Ability of Controlling the Teaching Order X_8.

At the meantime, the performance of teachers are divided into 7 grades in the teaching process.

BP Neural Network Evaluation Model

BP Neural Network Structure

BP neural network is a multi-layered feed-forward network; the establishment of a 3-layer BP network could realize the continuous function approximation within any square error precision[1]. With logsig excitation function applied to the output layer and purelin function to the hidden layer, the teaching evaluation indexes are set as the input vector and expressed as X=（X_1，X_2，X_3，X_4，X_5，X_6，X_7，X_8）^{T} while the teaching effect set as the target vector and expressed as Z. Both the input vector and target vector are divided into 7 grades, namely, best, better, good, average, poor, poorer and poorest and assigned values, including 1, 0.75, 0.5, 0, -0.5, -0.75 and -1 respectively. Following the network hierarchy, the hidden layer and node number must also be determined. As the continuous function of learning is applied to this model, the relevant problems could be resolved by setting a hidden layer. The determination of hidden nodes number is a complicated issue because the excessive number gives rise to the poor fault tolerance but less number results in the poor generalization capacity. Therefore, the appropriate number should be determined according to the experience and constant network training. In the general empirical formula $l=\sqrt{n+m}+\alpha$, l refers to the number of hidden nodes, n the number of input nodes, m the number of output nodes, α the conditional constant with the number from 1- 10 chosen[3,4]; after training, the network structure with 8-5-1 type has the better effect, as shown in Figure 1.

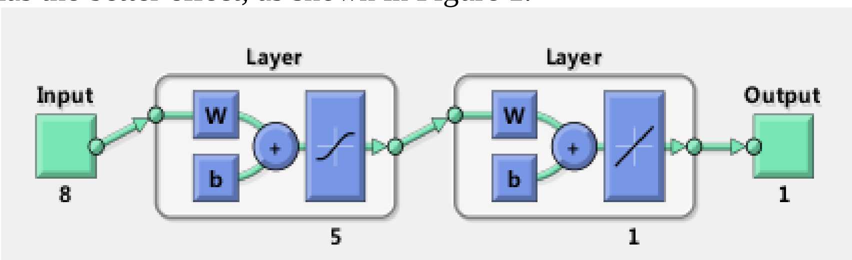


Fig.1. BP Structure of Teaching Evaluation

Learning Algorithm

The Levenberg-Marquardt algorithm is applied to this model for the training with the input vector set as X, the output vector in the hidden layer as Y, output vector as O, expected output vector as d, the weight matrix between the input layer to the weight matrix in the hidden layer as V and the weight from the hidden layer to output layer as W. f(x) is the unipolarity transfer function, and defined

$$E=\frac{1}{2}\sum_{k=1}^{l}(d_k-o_k)^2,\ net_k=\sum_{j=0}^{m}w_{jk}y_j$$, the formula for weights adjustment is:

$$\Delta w_{jk}=\eta(d_k-o_k)o_k(1-o_k) \qquad (1)$$

$$\Delta v_{ij}=-\eta\left(\sum_{k=1}^{l}\frac{\partial E}{\partial net_k}w_{jk}\right)y_j(1-y_j)x_i \qquad (2)$$

The η in (1) and (2) refer to networking learning rate[1].

The examples of teaching evaluation based on BP network

Data Processing Teaching Effect (Simulation Value)

After the end of classroom teaching, the teaching evaluation scales are issued to 2 supervisors, 4 teachers and 14 students for the evaluation of the teachers according to their own experience and convert it to [-1,1] as shown in the following table[2,5,6].

Table Evaluation of Sample Set and Simulation Effect

NO.	Evaluation Index								Evaluation Objective(True Value)
	X1	X2	X3	X4	X5	X6	X7	X8	
1	0.25	0	0.25	0.5	0	0.25	0	-0.25	0.25
2	-0.5	-0.75	-0.5	0	-0.25	-0.75	-0.75	-1	-0.75
3	-1	-1	-0.5	-0.5	-0.75	-1	-1	-1	-1
4	1	1	1	0.75	0.5	0.25	1	1	1
5	0.5	0.5	0.75	0.25	0	0.75	0.5	0.5	0.5
6	-0.75	-0.75	-0.5	-1	-0.5	-0.5	-0.75	-0.75	-0.75
7	1	1	1	0.75	1	0.75	0.75	1	1
8	0.25	0.25	0.5	0	0.5	0.25	0.25	0.25	0.25
9	-0.5	-0.5	-0.5	-1	-0.5	-0.5	-0.5	-0.75	-0.5
10	-0.5	-0.5	-0.5	0	-0.5	-0.5	-0.5	-0.75	-0.5
11	0	0.25	0.25	0	-0.25	0	0	0.25	0
12	0	-0.25	-0.25	-0.5	-0.25	-0.25	-0.25	0	-0.25
13	-0.25	-0.25	-0.5	0	0.25	-1	0.5	-0.25	-0.25
14	-1	-1	-0.75	-1	-1	-1	-0.5	-1	-1
15	1	0.75	0.75	1	0.75	0.75	0.5	0.75	0.75
16	0	-0.5	0.5	-0.25	-0.5	-0.25	-1	-0.5	-0.25
17	0.5	0.25	0	0.25	1	0.25	-0.5	0.25	0.25
18	0.25	0.75	0.75	0.75	1	0.75	0.5	0.75	0.75
19	1	0.5	0.5	0.5	0.5	0.25	0.5	0.75	0.5
20	0	-0.75	-0.5	-0.75	-0.75	-0.75	0.5	-0.75	-0.75

Networking Training and Test

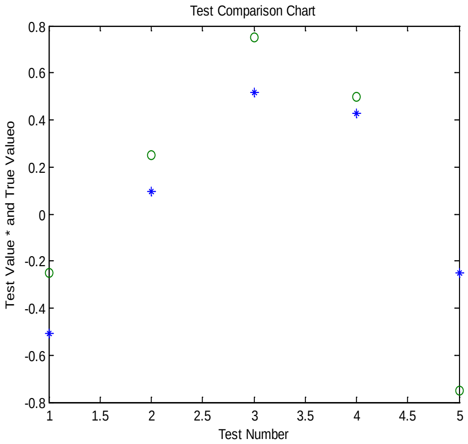
The Setting of Network Training Parameters

According to the training demands, the transfer functions are made as logsig and puelin with 1000 times of network training, minimum mean square error of 0.1, minimum gradient of 0.001, learning rate of amending weight of η=0.01 and other parameters set as the default.

Network Training and Test

The data in the first 15 groups are adopted for the network training and the data in the later 5 groups for network test so as to detect the application effect of network model. During training and test, the hidden node number is set as n=2, 3, 4, 5 and 6, as shown in Figure 2, 3, 4, 5 and 6; in which, “*” and “o” represent the test and expected value.

(1) When n=2, the test value is -0.9179, 0.5234, 0.6313, 0.5574 and -0.5444. The difference value crosses over 2 levels only once, with the test difference shown in Figure 2.



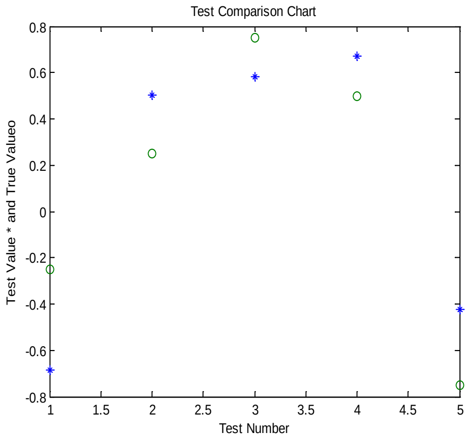
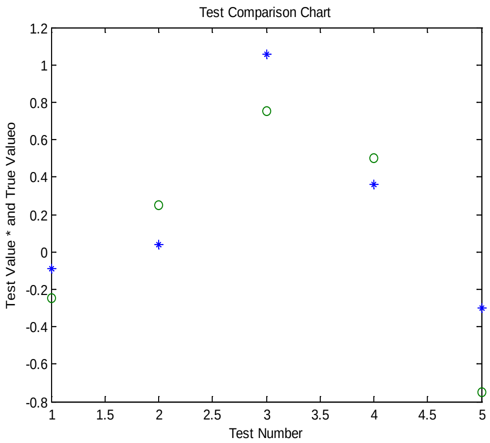


Fig.2. n=2 Test Chart

Fig.3. n=3 Test Chart

(2)When n=3, the test value is -0.6836, 0.5034, 0.5817, 0.6686 and -0.4226. The difference value crosses over 2 levels only twice, with the test difference shown in Figure 3.

(3) When n=4, the test value is -0.0924, 0.0388, 1.0559, 0.3590 and -0.2986. The difference value crosses over 2 levels only once, with the test difference shown in Figure 4.



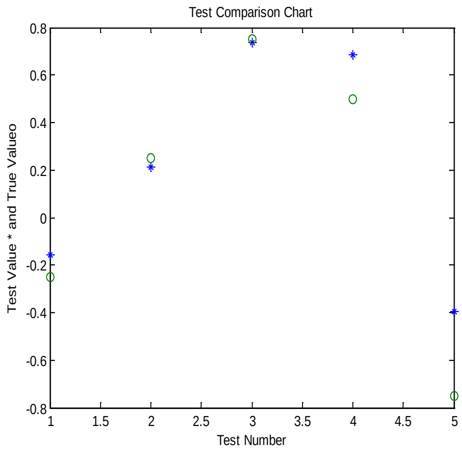


Fig.4. n=4 Test Chart

Fig.5. n=5 Test Chart

(4) When n=5, the test value is -0.1552, 0.2130, 0.7383, 0.6876 and -0.3976. The difference value crosses over 2 levels only once, with the minor test difference shown in Figure 5.

(5) When n=6, the test value is -0.7456, 0.1258, 0.6333, 0.6265 and -0.0389. The difference value crosses over 2 levels twice, with the minor test difference shown in Figure 6.

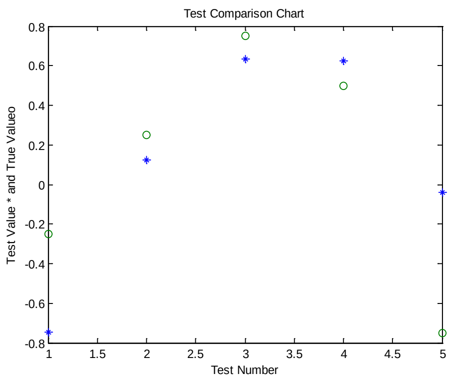


Fig.6.n=6 Test Chart

Conclusions

The test of teaching evaluation programming shows that the network evaluation index is highly relevant to the teaching effect of teachers. Therefore, it is reliable and precise to adopt the neural network evaluation model to assess the classroom teaching behaviors of teachers. The conclusions are shown as below:

(1) As other network parameters have been set, the hidden network neuronal number will exert substantial bearings on the test results. The training and test results of hidden node number n=2, 3, 4, 5, 6 are: when n=4, 5, the test is accompanied by a correct result; when n＞5 or ＜4, the degree of accuracy decreases; however, when n=5, there is a minor difference between the test value and target value. For this reason, the 8-5-1 network model is chosen.

(2) Many factors should be taken into account for the setting of network parameters. Therefore, in the process of network training and test, the selection of hidden node number and network parameter should be coordinated due to the empirical importance.

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