Intelligent Design Based Neural Network Model for Measuring Analysis of the College Teachers' Teaching Ability

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Abstract—The teaching ability of College Teachers is regarded as one of the core competencies and a critical indicator for measuring comprehensive strength for a college. However, its evaluation process is a highly complex system decision-making, for there are various factors that influence on the assessment of for the College Teachers' the teaching ability. The traditional methods have drawbacks of strong subjectivity, so they are difficult to correctly evaluate the teaching ability of College Teachers, resulting in decrease of measurement accuracy. Based on the analysis of the relevant factors, this paper presents an intelligent design based neural network model of discrete Hopfield for the measurement and analysis of College Teachers' teaching ability. Firstly, a Hopfield neural network model for the measure analysis of the teaching ability is established, and eleven measure analysis indexes are selected as input information of the Hopfield neural network model. Secondly, the College Teachers' teaching ability grades are chosen as the model output, then the input and output model based on the relationship among the self-learning abilities of neural network is established. Finally, the simulation experiment is obtained by using MATLAB. The simulation results show that the model has the characteristics of high efficiency, objectivity and fairness, which can meet the requirements of the measurement and analysis of College Teachers' teaching ability.

Keywords—College Teachers; Teaching Ability; Discrete Hopfield Neural Network Model; Intelligent Design; Evaluation Model.

1 Introduction

College Teachers' teaching ability reflects the comprehensive level of the college, which is the core competitiveness of college teachers [1]. The improvement of teaching ability is the key of college teachers' growth and developed, and can effectively drive the rapid development of the surrounding area and related industries. However, there are many factors that affect the teaching ability of university teachers, and it is difficult to use mathematical methods to express [2-3] these factors, especially when they are intertwined,. Traditional rating methods are based on human subjectivity, i.e. the overall evaluation of teaching ability level is concluded through the subjective evaluation for lots of aspects of teachers in this colleges and the comparison with that of teachers in other colleges. This method needs plenty of preparatory work with poor real-time, and is easily influenced by the personal factors, lack of objectivity. The different teams even have different evaluation results for the same college teachers when they use different scales [4-6].

Therefore, it is needed to establish a general evaluation model to realize the accurate and objective evaluation of teaching and researching ability. Artificial neural network is an intelligent system that is composed of the connection function and the connection weights based on a certain number of artificial neurons, which has the ability to deal with nonlinear and adaptive, and has been widely used in the field of artificial intelligence [7-10]. It can effectively solve the problem of traditional intelligent algorithms in dealing with non-structural information. Now the most widely used neural network model is the BP neural network, but it has defects in the aspects of convergence speed and local extremum, and requires a lot of training sample data [11-39]. In this paper, a new evaluation model based on the discrete Hopfield neural network is designed through analysis the characteristics of the evaluation for the teaching ability, then the model rules is established, verified and analyzed by using the data obtained from the teaching ability investigation in the similar 20 colleges.

2 Evaluation Model of College Teachers' Teaching Ability

The realization process of the neural network evaluation model of College Teachers' teaching ability is shown in Figure 1.

There are many factors that affect College Teachers' teaching ability. In this paper, 11 main factors are selected to constitute the evaluation index system, as is shown in Figure 2.

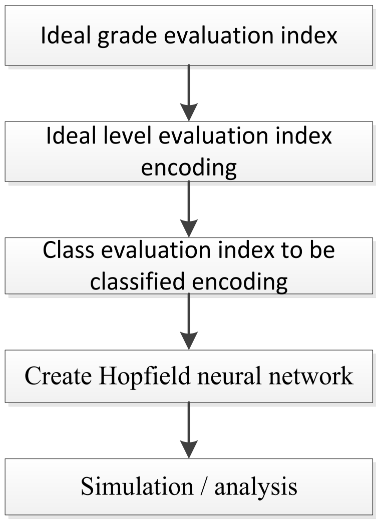

Fig. 1. The realization process of the neural network evaluation model of College Teachers' teaching ability

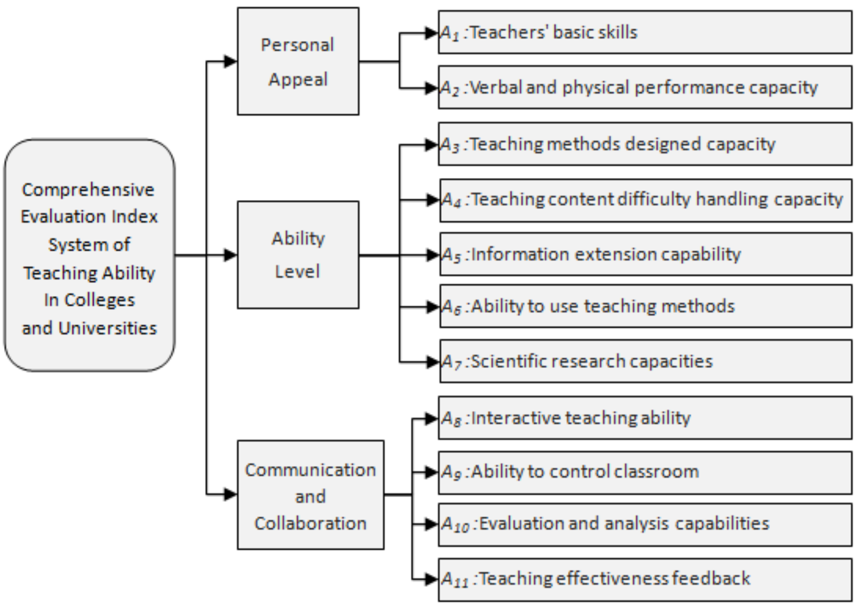

Fig. 2. Evaluation index system of College Teachers' teaching ability

Using percentile system for College Teachers' teaching ability, it can be divided into five levels: EXCELLENT (I), GOOD (II), COMMONLY(III), PASS (IV) and FAIL (V). Each level corresponds to a value range of the percentage, as is shown in table 1.

Table 1. Percentage intervalcorresponding to evaluation level

Scaling	Percentage system	Group median
EXCELLENT	100~90	95
GOOD	80~90	85
COMMONLY	70~80	75
PASS	60~70	65
FAIL	Below 60	30

3 Discrete Hopfield Neural Network

Discrete Hopfield Neural Network is proposed in the 80's of last century, which is a new network model established on the basis of the traditional neural network theory, and can effectively simulate the biological brain's memory capacity. It is a single feedback neural network, using differential or differential equations to describe a dynamic process between the input and output [16-19].

In the first proposed Hopfield network, the output is only 1 and -1, that is a two valued neural network, so it is also known as the discrete Hopfield neural network (Hopfield Neural Network Discrete, DHNN). DHNN is a kind of two valued neuron, which expresses the state of the neuron by the discrete value of the output.

3.1 Network structure

The network structure of DHNN is shown in Figure 3.

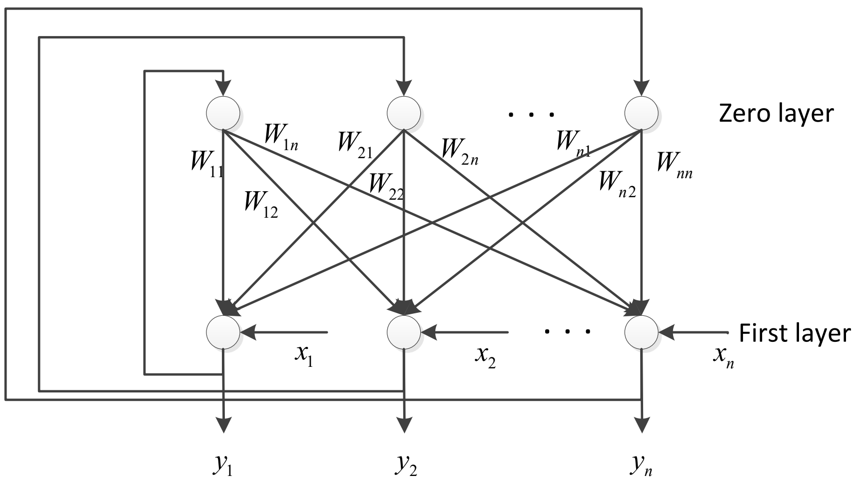

Fig. 3. Network structure of DHNN

In figure 3, the zero layer of the network is the input unit, which does not have the computing power and is not the actual processing neuron; the neurons in first layer are the neurons for information processing, the information is processed by the function f, and then it is outputted. The information processing function is a simple threshold decision function, that is, if the output information is greater than the set value, the output value is 1, else -1 is outputted. By analyzing the structure of DHNN, it is a two-valued nonlinear dynamic system with multiple inputs and a threshold value. In this system, the steady state can be considered that it runs controlled by a certain energy function, the energy value is continuously reduced until meets the minimum.

For the two valued neuron model, the formula (1) is established.

$$u_i = \sum_i w_{ij} y_i + x_j \tag{1}$$

Here, x_j is the external output, and meet the following conditions:

$$y_j = 1, \qquad u_j \geq \theta_j \tag{2}$$

$$y_j = -1, \quad u_j < \theta_j \tag{3}$$

DHNN network status within dimension output information on time t is defined as:

$$y_i(t+1) = f\left[u_i(t)\right] = 1, u_j \geq 0 \tag{4}$$

$$y_i(t+1) = f\left[u_i(t)\right] = -1, u_j < 0 \tag{5}$$

$$u_i(t) = \sum_i w_{ij} y_i(t) + x_j - \theta_j \tag{6}$$

When i equals to j, if w_{ij} is 0, there is no data feedback to the input signal and this type of DHNN is called no-feedback neural network; else if w_{ij} is not 0, this DHNN is called the feedback neural network.

3.2 Working methods of DHNN

The way of DHNN works of s dynamic, which is the neuron changing process from its initial state with the changing direction of the system "energy" reduction. When the network is in a stable state, this state is the output.

In this paper, the DHNN is used in serial operation mode, that is only one neuron is in the working state at any time and its working process follows the formula (4), (5) and (6). The rest of the neurons keep their original state. The working neuron can be specified in advance or randomly determined, and the specific operation steps are as follows:

Step 1: Initialize the network according to the background of the teaching ability evaluation.

Step 2: Randomly select a neuron i.

Step 3: Compute the input $u_i(t)$ of neuron i.

Step 4: Compute the output $v_i(t+1)$ of neuron i, and other neurons continue to keep constant output.

Step 5: Determine whether the network is stable. If the network has reached a stable state or meets the conditions set in advance, the operation is over; otherwise, turn to Step 2 then go on.

The definition of steady state is: from a certain moment, the state of the network no longer changes, that is

$$v(t+\Delta t) = v(t), \Delta t > 0 \tag{7}$$

3.3 Network stability

In the above statement, the DHNN is a nonlinear dynamic system with multiple inputs and thresholds. The system runs in a specific energy function, so the energy value of the system continues to decrease. The system reaches a stable state when the energy value is the lowest. Coben and Gross berg present a sufficient condition for deciding if DHNN achieves steady state: If the weight matrix of the DHNN satisfies the following two formulas (8) & (9), the network reaches stable.

$$w_{ij} = 0, \quad i = j \tag{8}$$

$$w_{ij} = w_{ji}, \quad i \neq j \tag{9}$$

4 MATLAB Simulation and Analysis

4.1 Design Ideal Grade Evaluation Index

In this paper, the corresponding relationship between the evaluation index data and the overall level of the teaching ability of the twenty university teachers is as shown in Table 2.

Table 2. The evaluation index data and the overall level of College Teachers' teaching ability

No	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Level
1	74	86	84	63	87	76	88	78	95	80	83	Ⅱ
2	79	70	78	89	80	91	82	76	64	75	85	Ⅱ
3	99	91	88	93	88	99	95	94	93	94	95	I
4	93	95	96	86	93	93	91	95	94	89	99	I
5	88	95	95	95	90	97	92	86	97	97	95	I
6	34	27	37	18	24	46	40	24	31	43	22	V
7	95	88	98	92	89	98	97	85	94	87	89	I
8	39	42	53	60	46	59	55	44	50	49	55	Ⅳ
9	17	43	34	36	24	37	22	35	35	32	40	V
10	68	64	64	66	61	58	63	67	67	62	66	Ⅲ
11	25	36	47	29	16	31	35	11	23	37	31	V
12	85	79	73	76	71	85	76	65	83	87	76	Ⅱ
13	54	45	49	56	53	38	41	46	53	57	48	Ⅳ
14	94	97	92	94	86	96	99	91	87	92	96	I
15	45	57	57	43	60	56	48	57	56	44	44	Ⅳ
16	36	22	18	25	36	26	31	26	39	20	27	V
17	59	64	64	65	69	71	66	63	71	73	66	Ⅲ
18	74	83	97	76	82	88	78	81	90	74	88	Ⅱ
19	68	72	68	62	63	63	71	69	75	61	69	Ⅲ
20	62	63	64	55	65	70	74	62	64	68	63	Ⅲ

The average value of the evaluation index data at each level is considered as the reference value, which is the equilibrium point of the network, as shown in Table 3.

Table 3. 5 levels of ideal evaluation index

Level	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
I	94	93	94	92	89	97	95	90	93	92	95
Ⅱ	78	77	83	76	80	85	81	75	83	79	83
Ⅲ	64	66	66	61	65	66	68	65	69	66	66
Ⅳ	46	48	53	53	53	51	48	49	53	50	49
V	28	32	34	27	25	35	32	24	32	33	30

4.2 Ideal code of grade evaluation index

In order to realize the mapping of evaluation index to the neuron state, the index coding is needed. When the corresponding data value of the neuron is greater than or equal to the reference value, the state is "1", whereas the opposite is "-1". Under ideal conditions, the coding form of the 5 level evaluation indexes is shown in Figure 4, here, "●"indicates that the neuron state is "1", which is greater than or equal to the corresponding level of the reference value, otherwise,"○" is used.

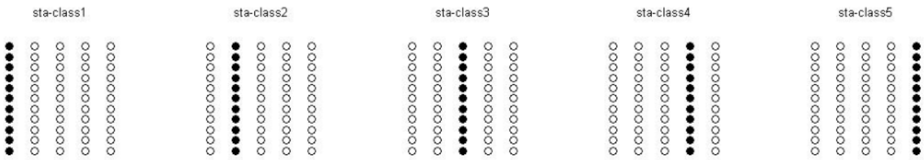

Fig. 4. Ideal 5 level evaluation index code

4.3 Evaluation index code for classification

The related unclassified data of 5 College Teachers is shown in Table 4; the corresponding coding is shown in Figure 5.

Table 4. Evaluation index data of College Teachers' teaching ability to be classified

Sequence	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
1	97	91	87	87	91	89	96	74	99	93	98
2	71	87	77	80	94	81	91	78	85	84	84
3	61	74	70	65	55	76	78	81	70	74	65
4	56	58	43	79	56	75	59	46	57	42	56
5	21	37	44	23	22	39	42	34	22	45	36

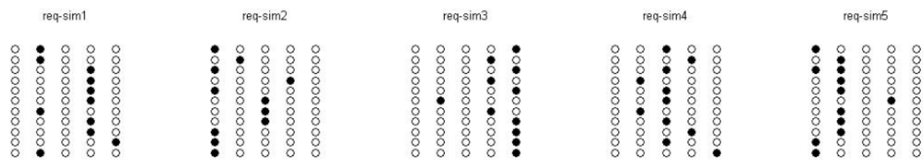

Fig. 5. The source code of College Teachers' grade evaluation index data

4.4 Creating network and simulation

In MATLAB, the neural network toolbox is used to provide the function to create the Hopfield neural network. The encoded data to be classified as the input for the network analysis, after a number of iterations of learning, the network reached a stable state, and the results as is shown in Figure 6.

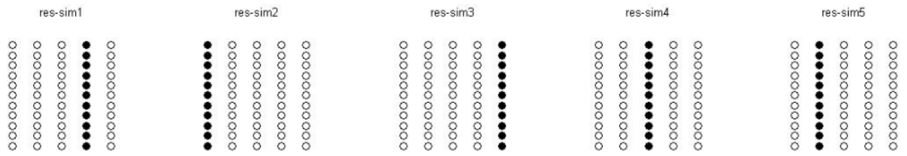

Fig. 6. Experimental simulation results

Comparing the simulation results with the data in Figure 4 and 5, we can draw a conclusion that the evaluation model based on DHNN in this paper is able to objectively, accurately, fairly and effectively evaluate for the College Teachers' teaching ability and to reach pre-goal set.

5 Conclusion

In the view of complexity for the evaluation analysis of the College Teachers' teaching ability, this paper researched and analyzed the evaluation index system, and proposed a new intelligent design based DHNN model for measuring analysis of the College Teachers' teaching ability. Through analysis and simulation, it is indicated that the proposed model not only can be used to properly evaluate the College Teachers' teaching ability by education authorities and enterprises, also can be used for the teachers to give self-appraisal and improve the shortcomings in the comprehensive teaching ability to enhance self-quality. In addition, this model has good applicability, because it can be refined in accordance with the requirements of the evaluation index, in order to achieve the requirements of the measurement analysis.

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