Research of Evaluation System of English Autonomous Learning Ability Based on BP Neural Network

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Abstract

This paper focuses on the application of BP neural network, taking an evaluation system of English autonomous learning ability as an example. Based on the full analysis the inscape of the system, the recorded data that is related with Web server log in a process of students' online learning has been collected and analyzed by using data mining technology. With BP neural network pattern, an evaluation model of autonomous learning ability based on BP neural network has been founded on the data collected. The experimental results show that the evaluation results of model are in general accord with those of experts: the highest accuracy was 100%, the lowest is 91.7%, and the average is 94.6%; therefore, it is feasible and effective to apply the BP neural network to the evaluation of autonomous learning ability.

Keywords: BPNN, Data mining, learning ability, Evaluation index

1. Introduction

Modern distance and open education that is developed on the modern education technology and information technology is a new teaching mode based on network environment, which can be used as a special form of teaching, but also can be used as a beneficial supplement for students [1-3]. In the process of network learning, reasonably using teaching evaluation is an effective auxiliary means of English teaching, aiming at testing students' comprehensive language proficiency and cultivating students' ability of autonomous learning, as well as promoting development of teaching and learning. The ultimate aim of English teaching is to strengthen students' awareness of autonomous learning and improve their ability of autonomous learning; therefore, the evaluation system of autonomous learning is an important means to test learning effect and control the learning direction [4-5]. At present, it is one of the basic objectives of English teaching reform to cultivate and develop students' autonomous learning ability.

This paper studied English online teaching assistant system in Agricultural University of Hebei, and interviewed with a number of experts in teaching and teaching management staff to obtain relevant experience information. Based on the existing research on learning ability, and further combined with data recorded in database of network teaching platform, the paper analyzed structure of learning ability and evaluation elements, and used data mining technology to construct learning ability evaluation model suitable for online learning. According to learning performance in the process of online learning, students can receive objective and timely evaluation, so the advantages of individual can

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be encouraged and the disadvantages can be reminded and guided without delay so as to effectively improve the students' learning methods and the quality of network teaching.

2. Evaluation Index

2.1. Data Mining

Data mining generally refers to the process of searching information hidden from large stores of data through algorithms. Data mining, which is often associated with computer science, is completed by using statistics, online analysis processing, information retrieval, machine learning, expert system (on the old rules of thumb) , pattern recognition and so on [4-6].

The data in this paper was mainly from the system of English online assistant teaching in the Agricultural University of Hebei (Figure 1). By applying the Web server log and Web mining technology, information resources that were accumulated when students accessed the network were collected. Based on the mining results, teachers could analyze the online learning status of students by evaluation indexes in the model, make the corresponding evaluation and give timely advice according to students' behavior and performance in order to promote learning ability of students.

Figure 1. The System of English Online Assistant Teaching

2.2. Construction of Evaluation Index System

The paper was based on easy operation, scientific and objective evaluation, combining of integrity and effectiveness, and combining of practical ability and potential ability evaluation for the principle. From the learning process perspective, based on Web log data and the domestic and foreign scholars' view on classification of learning process [7-9], the evaluation index system of students' autonomous learning ability was designed, which was shown in Table 1.

The above learning ability evaluation index system consisted of 3 first-class indexes: ability of knowledge acquisition, ability of knowledge sharing and ability of knowledge absorption. There were total 11 testing items under the first-class indexes.

Knowledge acquisition was the starting point of students' autonomous learning, the basic aim of which was to acquire new knowledge and skills. It should pay attention to effect as well as efficiency from the ability perspective. This paper designed 5 items.

Knowledge sharing referred to the process of sharing knowledge among students, through which, students could produce a new combination of knowledge. This learning

method was exploitive learning. Ability of knowledge sharing depended on students' sharing speed and loss degree in the process of transmission. This paper designed 3 testing items.

Knowledge absorption was direct feedback on students' learning results. Through acquisition and sharing, learning knowledge was translated into their own knowledge. Whether knowledge was understood and used effectively depended on students' ability of knowledge absorptive. To measure it, not only should the efficiency of knowledge absorption be considered, but the consistency of understanding knowledge should be taken into account. There were 3 testing items.

Table 1. The Evaluation Index of Students' Autonomous Learning Ability

	First-class Index	Testing Items
The Evaluation Index of Students' Autonomous Learning Ability	Ability of knowledge acquisition	Total logon time(T1)(h) Actual learning time(T2)(h) Study schedule (T3)(%) Participation time of real-time teaching (T4)(h) Download number of the important resource(T5)
	Ability of knowledge sharing	The number of effective threads in forum(T6) The number of answering threads in forum(T7) Participation time in on-line answering questions room(T8)(h)
	Ability of knowledge absorption	Task completion rate (T9) (%) Task scores (T10)(s) Probabilities of error repeated (T11) (%)

3. Evaluation System of BP Neural Network

3.1. BP Neural Network

BP (Back Propagation) neural network, which was done by a group of scientists headed by Rumelhart and McCelland, is the multilayer feedforward network with error back propagation algorithm training and is one of neural network models applied widely. BP neural network can learn and store a large number of input and output model mapping, without disclosure and description of mathematical equation on the mapping relations beforehand [10-11]. The topology structure of BP neural network model is input layer, hidden layer and output layer, as shown in Figure 2.
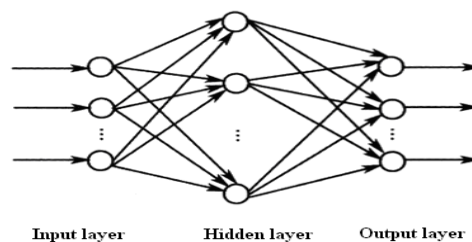

Figure 2. BP Neural Network

3.2. The Design of BP Neural Network

Input layer: According to the evaluation index of students' learning ability, the lowest level index was regarded as input neurons, and 11 testing items were input variables.

Hidden layer: It was generally accepted that network error would be reduced and accuracy was improved when the quantity of neuron in the hidden layer increased, but meanwhile the network became more complex, which would lengthen the network training and over-fitting would appear. Through analyzing and testing again and again, the system selected the hidden layer with 20 neurons.

Output layer: The evaluation of students' learning ability was a process from qualitative analysis to quantitative analysis. In BP network model, qualitative analysis was transformed into quantitative output, which could be regarded as an evaluation index of learning ability. In this paper, there was one node that was the ability of autonomous learning in the output layer. Judging by the final exam score, the autonomous learning ability was divided into six levels of very poor, poor, general, good, better and best, respectively written with [0 0 1], [0 1 0], [0 1 1], [1 0 0], [1 0 1] and [1 1 0].

3.3. Learning Process of BP Neural Network Model

The calculation of BP neural network was basically taking sum of network error square as the objective function and minimizing the objective function according to the gradient method. Its calculation was based on the principle of error correction; using gradient descent method, the output errors of the network were transmitted in the opposite direction and the network connection weights were modified and changed to minimize the error. Learning method of BP neural network was divided into two aspects: error back transfer and forward calculation [12-14]. The whole learning process was shown in Figure 3.

4. The Application of the Evaluation Model for Students' Learning Ability

This paper presented an evaluation model of students' autonomous learning ability based on BP neural network, which was used to evaluate students' learning ability with Matlab2012b software.

4.1. Data Input

With English online assistant teaching system of Agricultural University of Hebei, the system has tested 314 non English major students in 10 classes of grade 2013. By mining Web log data and the experts' comprehensive assessment, learning ability was graded. It was shown in Table 2.
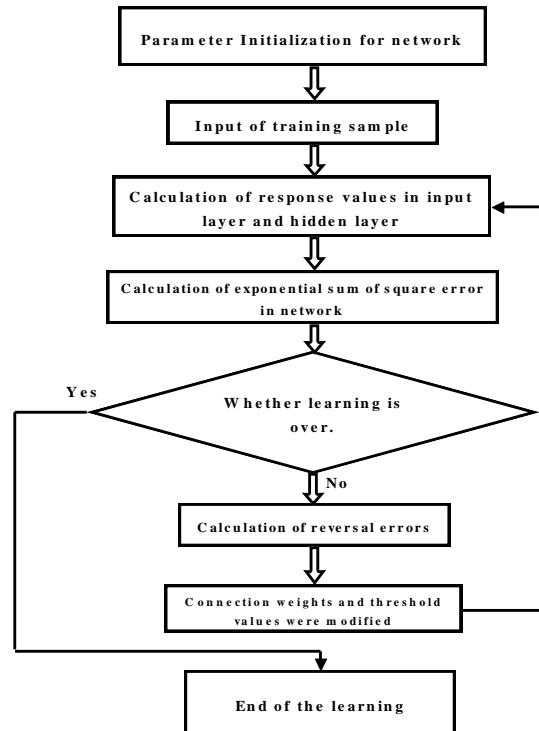
Figure 3. The Flowchart of Neural Network Training

4.2. Network Training

The toolbox was identified with nprtool BP neural network pattern in matlab2012b. The experiment selected 70% at random of 314 groups data as trained network; 15% data was verification network; and 15% data was testbed network. The training was kept until satisfactory results were achieved. The confusion matrix was shown in Figure 4.
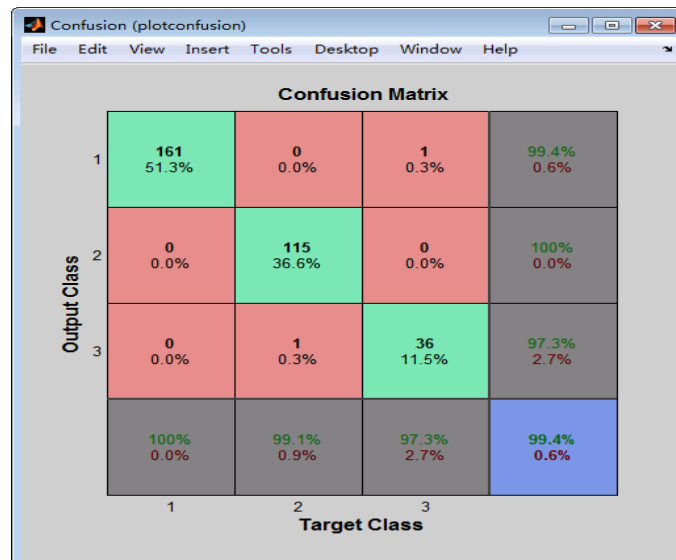

Figure 4. Confusion Matrix

Table 2. Measure Items Web Log Data and Grading

Students' number	Measure items (input)											Grading (output)	Binary output
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11		
1	20.1	3	30	2	0	1	0	0.5	40	60	60	Very poor	0 0 1
2	20.9	3.2	34	2.6	1	2	0	0.7	41	60	58.1	Very poor	0 0 1
3	21.7	3.4	35	2.8	2	3	0	0.8	43	63	57	Very poor	0 0 1
4	25.5	4.5	40	4.2	7	7	2	1.4	47	67	53	Poor	0 1 0
5	27.8	5.9	48	6.4	12	14	5	3.5	58	72	47	Poor	0 1 0
…	…	…	…	…	…	…	…	…	…	…	…	…	…
307	30.3	8	54.5	8.8	17	18	7	4.1	68	73	43	General	0 1 1
308	33.5	8.9	64	11.4	21	22	10	5	73	73	38.4	General	0 1 1
309	36.3	10.6	68	14	23	27	12	5.8	83	80	35.6	Good	1 0 0
310	52	16.8	77	18	30	31	13	8.7	91	78	29.4	Good	1 0 0
311	58.6	21	86	21.5	27	33	17	9.1	92	84	17.4	Better	1 0 1
312	59.7	21.5	88	22.3	27	32	22	9.2	93	88	15.1	Better	1 0 1
313	67.8	24	98	24	25	34	26	10	100	91	8.4	Best	1 1 0
314	72	28	100	24	24	36	25	9.7	100	98	5	Best	1 1 0

Experiencing 92 iterative training, BP neural network gained the best verification performance 1.6646×10^{-4}. As shown in Figure 5.
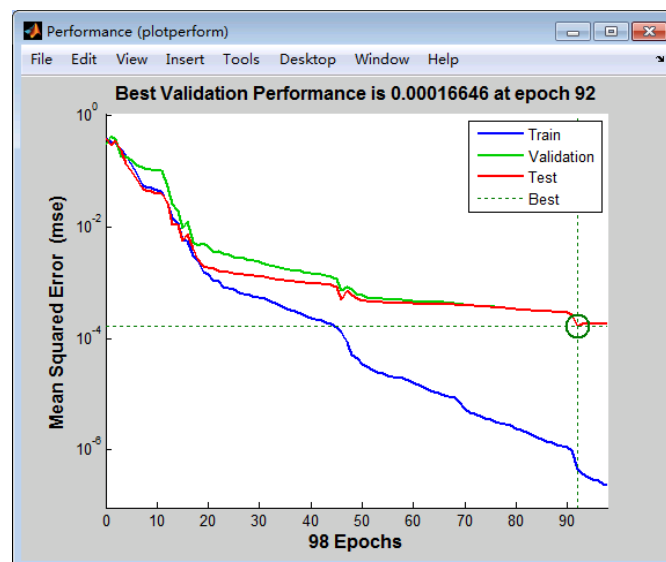

Figure 5. Verification Performance of BP Neural Network
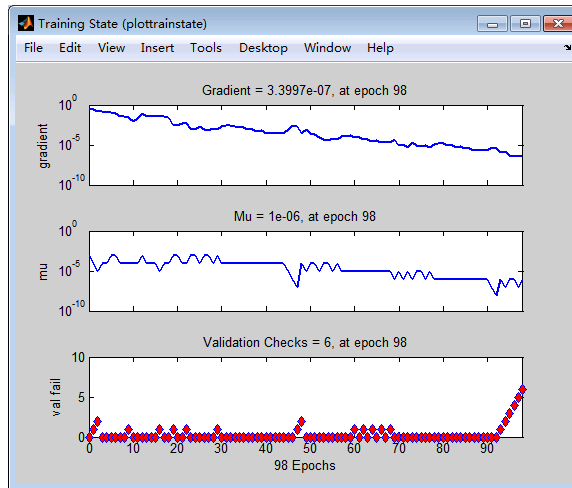
Training Status was shown in Figure 6.

Figure 6. Training Status

After acquiring the satisfactory results, the network was saved.

4.3. Evaluation Testing

The students' autonomous learning ability was evaluated by using the created BP neural network. Experiment objects were 149 students from 5classes. 11 Web log data was input onto the trained network, and finally the output results of the BP neural network evaluation system contrast with experts' evaluation. The results were shown in Table 3.

As shown in Table3, the evaluation results of BP neural network model were in general accord with the experts' evaluation: the highest accuracy was 100%, the lowest is 91.7%, and the average is 94.6%. The results are satisfying, which shows it is feasible and effective to use BP neural network model to evaluate students' autonomous learning ability.

Table 3. Contrast of Evaluation Results

Autonomous learning ability	Experts' evaluation (number)	Correct evaluation of network (number)	False evaluation of network (number)	Correct evaluation rate (%)	False evaluation rate (%)
Very poor	14	13	1	92.9	7.1
Poor	19	18	1	94.7	5.3
General	33	31	2	93.9	6.1
Good	36	33	3	91.7	8.3
Better	28	27	1	96.4	3.6
Best	19	19	0	100	0
Total	149	141	8	94.6	5.4

Based on BP neural network, the evaluation system of students' autonomous learning ability, using self-learning, self-organizing adaptation ability and strong fault tolerance of neural network, could work more accurately following the experts' evaluation method. In the well-trained neural network system, evaluation ideas of experts were assigned to the network in the way of connecting power. The system could not only simulate experts to

evaluate students' learning ability, but also avoid the artificial error in the process of evaluation [15-16].

With the increase of the amount of the online assistant teaching system, the number of samples can be increased, and the evaluation system should be more accurate. Therefore, the BP neural network method is a new way of evaluating the autonomous learning ability, and it is worth implementing.

5. Conclusions

1) Autonomous learning information of students has been gained through the Web data mining.

2) The evaluation indexes of autonomous learning ability have been designed, including 3 first-class indexes: Ability of knowledge acquisition, Ability of knowledge sharing and Ability of knowledge absorption; moreover, there have been 11 testing items under each first-class index.

3) The evaluation system has been created base on BP neural network, and experiments have shown that average accurate rate of evaluation reach 94.6%.

Acknowledgment

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