Evaluation of Art and Design Talents Based on the Combination of Entropy Method and BP Neural Network

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ABSTRACT: *With the development of the economy and the improvement of people's living standards, the field of art and design has gained widespread application and attention. Evaluating art and design talents is a vital link in art and design. How to objectively and accurately evaluate the comprehensive quality of art and design talents is an urgent problem to be solved. This article proposes a talent evaluation model for art and design, combining the entropy method and BP neural network. This model aims to objectively and accurately evaluate the comprehensive quality of art and design talents and provide a scientific basis for talent selection. This article first introduces the evaluation model's basic principle and construction process and then elaborates on the specific implementation method of combining the entropy method with the BP neural network. Finally, the feasibility and effectiveness of the evaluation model are verified through experiments.*

Keywords: BP Neural Network, Art Design Speciality, Creative Talent

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1. Introduction

The training of creative talents in the art design speciality is the focus of human resource management practice and the place that needs attention in school teaching. The scientific evaluation and selection of talents is an effective way for enterprises to acquire core competence and the prerequisite for enterprises to realize their talents and optimize the allocation of human resources [1]. At present, there is a big subjectivity in the evaluation of creative skills in art design. The main manifestations are as follows: Excessively setting the weight of the evaluation index depends on the experience of the experts and cannot be combined with the reality of the enterprise, making it difficult to promote the application of the evaluation index system. The low participation of talent itself makes the appraisal result less acceptable, and it is easy to crack down on the enthusiasm of

creative talents in the field of art design [2]. With the continuous research and development of talent evaluation, various talent evaluation methods have been applied to the process of comprehensive talent evaluation. However, how the talent evaluation is combined with the actual employment of the enterprise and is consistent with the employment preference of the enterprise is a problem. How to combine talent evaluation with enterprise culture and development strategy and how to develop and build an evaluation system of creative talents for art design is the key issue to be solved by this research [3].

2. State of the Art

Domestic and foreign art and design of professionals are for evaluating innovative talent, first of all from the classification of personnel to proceed. According to the thought of talent classification, starting from the characteristics of creative talents of art design speciality, this paper analyzes the essential qualities of creative talents of art design speciality. This mainly focuses on the definition of management talents of creative talents in art design. This set of evaluation index systems focused on quality management performance, including organizational communication and coordination skills, interpersonal skills, rights orientation, initiative and so on. Management skills include management skills, strategic decision-making ability, team motivation and leadership skills. This all emphasizes the ability of art design professionals to rationally allocate corporate resources and create economic benefits [4]. Domestic evaluation of art design professionals mainly focused on selecting indicators and evaluation methods and other issues, emphasizing multi-dimensional, multi-index comprehensive evaluation. According to different research objects and different characteristics of different types of talents, many scholars put forward their characteristics of the talent evaluation index system. Still, there is less empirical research on applying the index system and its evaluation methods, so there is a lack of better Case analysis and practical tests [5]. For the evaluation of creative talents in corporate art design, qualitative evaluation mainly uses the methods of peer review and expert scoring in the evaluation methods. Most quantitative evaluation emphasizes the use of analytic hierarchy process, fuzzy mathematics, factor analysis and multi-index comprehensive evaluation [6].

3. Methodology

3.1. BP Neural Network Theory and Learning Process

BP neural network is a single-direction and multi-level feed-forward network, including the input layer, the hidden layer (the number of layers is not necessarily 1, it can be multi-layer) and the output layer of three parts. Each layer consists of several neurons; each neuron is called a node, and the upper and lower nodes interact with each other by weights. All the layers and layers are interconnected, but the nodes in the same layer are independent. The figure shows a 3-layer BP neural network structure diagram [7].

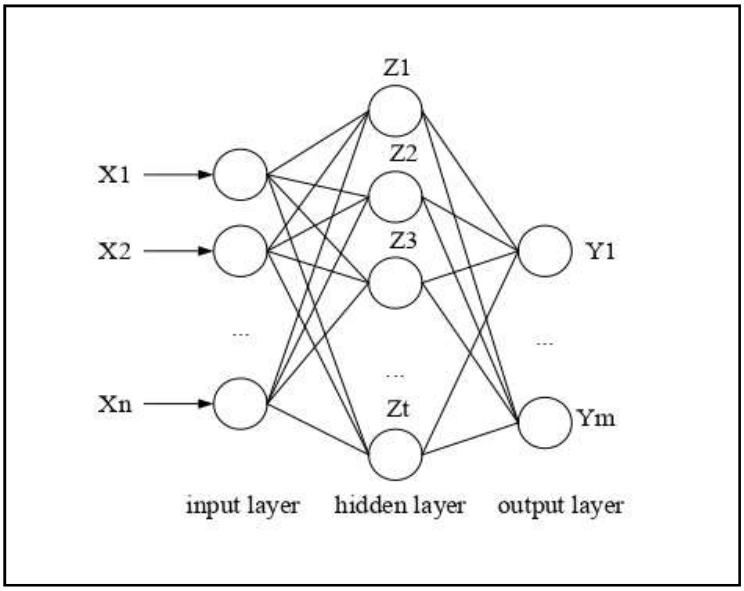

Figure 1. Schematic diagram of BP network structure

The number of neurons (nodes) in the input layer is denoted as n, the input vectors are represented by $X \in R^n$ and $X = (x^1, x^2,..., x^n)^T$, the number of neurons in the hidden layer is t, and the hidden layer vectors are denoted by $Z \in R^t$ and $Z = (z_1, z_2,..., z_n)^T$. The output layer neurons, the number of recorded as m, the output layer vector $Y \in R^m$, $Y = (y_1, y_2,..., y_m)^T$ said. W_{ij} represents the connection weight between input layer neuron i and hidden layer neural network J; $\theta_j (i = 1, 2,...., n; j = 1,2....t)$ is the connection threshold of both; W_{jk} is the connection weight between hidden layer neuron j and output layer neuron k, $\theta_j (k = 1,2,...., m)$ is the connection threshold of both. The relationship between the three is:

$$Z_j = f\left(\sum_{t=1}^{n} W_{ij} . X_i - \theta_j\right) \tag{1}$$

$$Y_k = f\left(\sum_{j=1}^{t} W_{ik} . Z_i - \theta_k\right) \tag{2}$$

Where $f(.)$ corresponds to the activation function of the neuron. In the actual process of neural network construction, the auxiliary modeling software we choose will usually provide a variety of activation functions, which can be achieved by directly calling the activation function. Since the activation function is chosen to be variable, building a BP neural network is a non-linear region of hyperplane relative to a linear region of study, so it is smoother and accommodates more data structures. Therefore, the classification based on the activation function of the neural network has a higher accuracy than the single linearity and has better fault tolerance. In addition, the neural network can be trained and learned by the gradient descent method, eventually making it more accurate.

Then, we explain the learning process of the BP neural network. The BP neural network is a mapping function from the input to the output layer. The learning system can use many integrated and integrated mapping between input and output layers to absorb and learn and apply known learning and training modes to the newly built BP neural network to be trained. At the same time, it does not need to list any recursion formulas or some specific mathematical expressions from input layer to output layer. The trained BP neural network can reflect the mapping from input layer to output layer. The standard learning process of BP neural network can be expressed as a learning flowchart of the figure.

This article does not discuss the BP neural network learning process corresponding to the specific mathematical derivation process, only according to its principle, followed by its learning process and the corresponding input and output layer symbolic representation, to provide a theoretical basis for the subsequent establishment of the BP neural network. For the BP neural network, according to the Kolmogorov theorem, the theorem shows that a BP neural network with a single hidden layer in a closed interval can approximate any continuous function. In other words, only a three-layer structure of the BP network can completely represent any n-dimensional to m-dimensional mapping. Here, we take a three-tier BP network as an example to introduce its learning principles. To make the final expression more concise, we present some mathematical symbols to help explain the principle. Firstly, we describe the mathematical correspondences: input vector is denoted as ; $P_k(a1, a2,..., an)$ target vector is denoted as $T_k(y1, y2,..., yn)$; hidden layer neuron is input vector $S_k(s1, s2,..., sn)$; output Vector $B_k(b1, b2,..., bn)$; output layer neuron is input vector $L_k(l1, l2,..., ln)$; output vector $C_k(c1, c2,..., cn)$; input layer to hidden layer connection weight is W_{ij} , $i = 1, 2, ...,n, j = 1, 2,...., p$; hidden layer to output layer connection weight is V_{jt} , $j = 1,2,...,$n, t=1,2,...., p ; hidden layer input of each unit The threshold is θ_j , $j = 1,2,...., p$; the output threshold of the o utput layer of each unit is γ_j , $j = 1,2,...., q$; parameter $k = 1,2,....,m$. BP neural network learning process can be divided into the following steps: First of all, the data assignment, the connection weights of each neuron, *Wij*, *Vjt* value, θ_j,γ_j must be assigned separately, select the interval (-1,1) Randomly select a set of input vectors and target vectors, denoted as $P_k = (a1^k, a2^k,..., an^k)$ / $T_k = (y1^k, y2^k,..., yn^k)$ for the neural network; Connect the weights W_{ij} through the input vector $P_k = (a1^k, a2^k,..., an^k)$ and the threshold θ_j ; calculate the input vector *Sj* of each unit corresponding to the hidden layer, and then use the input vector *S*; through the transfer function to calculate the hidden layer corresponding to the output of each unit *bj*:

$$\begin{aligned} s_j &= \sum_{i=1}^{n} w_{ij} a_j - \theta_j \\ b_j &= f(s_j) \quad j = 1, 2, ..., p \end{aligned} \tag{3}$$

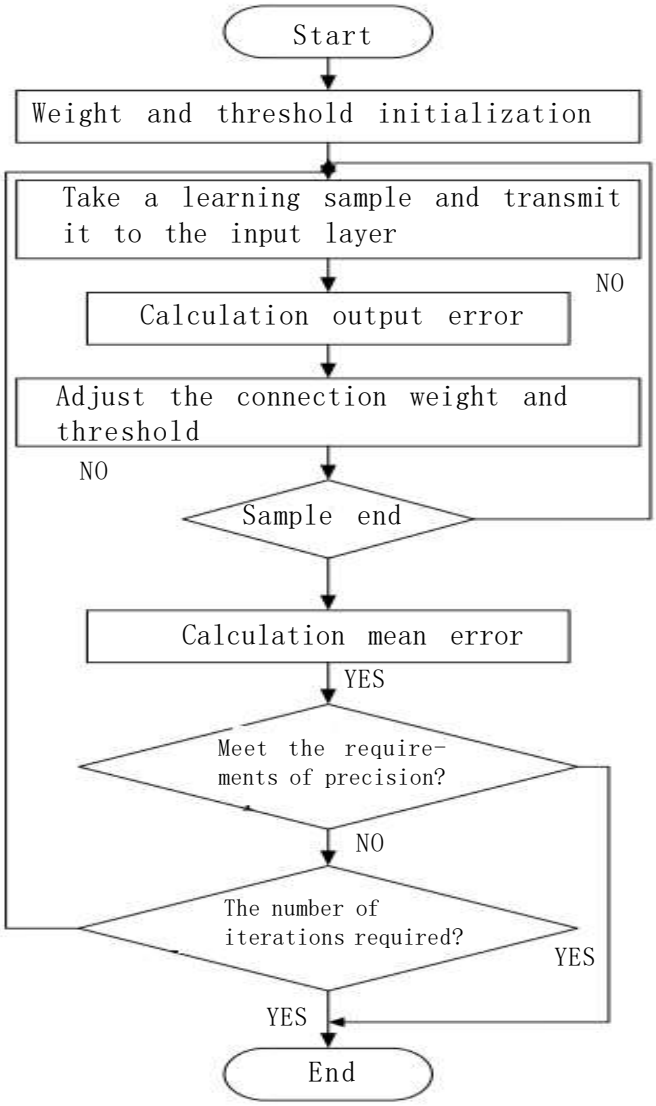

Figure 2. Standard BP neural network learning process flow chart

Calculate the hidden layer output vector *bj*, connection weight V_{jt} and threshold γ_j. This can be used to calculate the output layer corresponding to the output layer of the output vector *Lt*, and then use the transfer function to calculate the output layer corresponding to each cell response *Ct*.

$$L_t = \sum_{j=1}^{p} v_{jt} b_j - \gamma_t \qquad (4)$$

$$c_t = f(L_t) \qquad t = 1, 2, ..., q$$

The generalized calculation error d_t^k of each cell corresponding to the output layer is calculated by using the network target vector $T_k = (y1^k, y2^k, ..., yn^k)$ and the actual output value (response value) C_t of the network.

$$d_t^k = \left(y_t^k - C_t\right) . C_t . \left(1 - C_t\right) \quad t = 1, 2, ..., q \qquad (5)$$

The generalized calculation error e_j^k of each neuron corresponding to the hidden layer is calculated through the connection weight *Vjt*, the output layer generalized error dt, and the hidden layer output vector *bj*.

$$e_j^k = [\sum_{t=1}^{q} d_t . v_{jt}] b_j (1-b_j) \tag{6}$$

3.2. BP Neural Network Talent Training Mode Design

According to the existence theorem of mapping networks, a BP neural network with a single hidden layer can describe the mapping between independent and dependent variables. That is to say, a BP neural network with an S-type implicit layer and a linear output layer can approximate each other with any rational function continuous in the closed interval. Therefore, a three-layer structure of BP neural network can completely represent the space from n-dimensional to m-dimensional mapping relationship. The accuracy of the network is also closely related to the number of hidden layer neurons. We can get the best network accuracy by setting the optimal number of hidden layer neurons in the modeling process. According to the Kolmogorov theorem, this paper uses three layers of BP network structure to construct the evaluation model of art design professionals.

There are no uniform rules for determining the number of neurons in each layer and the number of neurons in each layer. This is related to the problem of the actual research because the research questions and the actual data obtained, as well as the established evaluation index system to determine the number of neurons in the input layer and the output layer. In the actual research process, the structure and quantity of input and output samples are determined according to the previous conclusions. In this paper, the number of neurons in the input layer is the number of indicators in the evaluation index system for art and design professionals established, and the number of neurons in the output layer is the result of a comprehensive evaluation of management personnel, 1. Determining the number of neurons in the hidden layer is complicated, and is usually done through multiple experiments or past experiences of the researcher. There is basically no established formula or theorem to calculate. The number of hidden neurons is not unique. We can choose a different number of hidden layer neurons for the same research question, but we can still solve some rough numerical ranges by some formulas and then get the best number of hidden layer neurons through continuous experiments. The number of hidden layer neurons and neural network modeling requirements, the number of input layer neurons and output layer neurons are directly and closely related. However, the number of hidden neurons is not as good as possible. If the number is too large, the iteration time will be too long, which will not only bring less error but will lead to poor system fault tolerance and cannot thoroughly learn emerging samples. Theoretically, a BP neural network must have an optimal number of hidden layer neurons in its learning iteration process. In practice, we have the following formulas that can be used as references to help researchers screen out the best-hidden layer neurons. $\sum_{i=0}^{n} C_{n1}^{i} > k$, where *k* is the number of learning samples, *n*1 is the number of hidden layer neurons, *n* is the number of input layer neurons, if $i > n1$, then $C_n^i = 0$; $n_1 = \sqrt{n+m+a}$, where m is the number of output layer neurons, and *n* is the number of input layer neurons A, a is a constant between [1, 10]; $\sum_{i=0}^{n} C_n^i > k$, where n is the number of neurons in the input layer. In addition to using formulas to calculate the approximate number of hidden layer neurons, we also have the option of heuristics to determine the optimal number of neurons. First, calculate the approximate number of ranges, then set the number of variable hidden layer units. Or directly select a large number of hidden layer neurons, with continuous network learning will be those who do not contribute to the network learning implicit layer neurons removed until the learning accuracy is no longer shrinking. Correspondingly, it is also possible to put in a small number of hidden layer neurons at the beginning of neural network learning. Wait until the network iteration to a certain number of times; if the network still does not converge, then increase the number of hidden layer neurons until the network convergence. We will get a more reasonable number of hidden layer neurons at this point.

4. Result Analysis and Discussion

In this paper, the survey data is divided into learning sample set and testing sample set according to the BP neural network learning process proposed above, and the learning and testing are conducted separately. We hope that the network model can absorb the expert's evaluation experience, combined with the actual employment of enterprises, in order to test samples with high-precision judgments. There are many software for BP neural network modeling. The most commonly used software is Matlab software. Because of the small training sample size, *NeruoSolutions* is found to be a good software to use at present by referring to the information and continuously learning the new software. It has a visual interface, you can directly create the network and network testing, and you can also directly operate the excel file to complete the learning process.

With NeruoSolutions7.0 software BP neural network modeling, in the actual operation, the software can create a neural network through the visual interface to learn. Not only does the software include *NExpert* modules, which allow for online learning of ACII-type data, simple subsequent modeling operations, and Neur. Solutions for Excel function module, you can directly operate in Excel. As an add-in, it can manipulate data directly. According to the previous research, this paper determines the three-layer network structure. According to the number of evaluation factors, the input layer is 17, and the output layer is 1. The number of hidden layer neurons refers to the previous formula *nl* = Logan. Where n is the number of neurons in the input layer, *ni* is the number of neurons in the hidden layer, logal7 = 4.09, so the number of neurons in the hidden layer is chosen to be four. Therefore, the neural network structure is established as 17-4-1. We use *Tansig* as the activation function of the network. The number of learning samples is 61, and the number of testing sample sets is 36. The learning samples are then input into the neural network system for training. We are learning to get a high-precision learning network. Finally, the network is invoked to simulate the test sample dataset, and the corresponding neural network simulation results of the test sample set are obtained.

After selecting the normalized worksheet interface, click the Train option under Train Network in the menu. The number of iterations is set to 6000, and the network is trained. Then click the Test option in Test Network to test the data. Through network learning and testing, in the main interface *NeruoSolutions*, you can receive the values of Desired and Output of the learning sample data and display the corresponding two groups of importance in the popup box. Learning sample set after the training of the desired output and the actual output of the map, as shown below

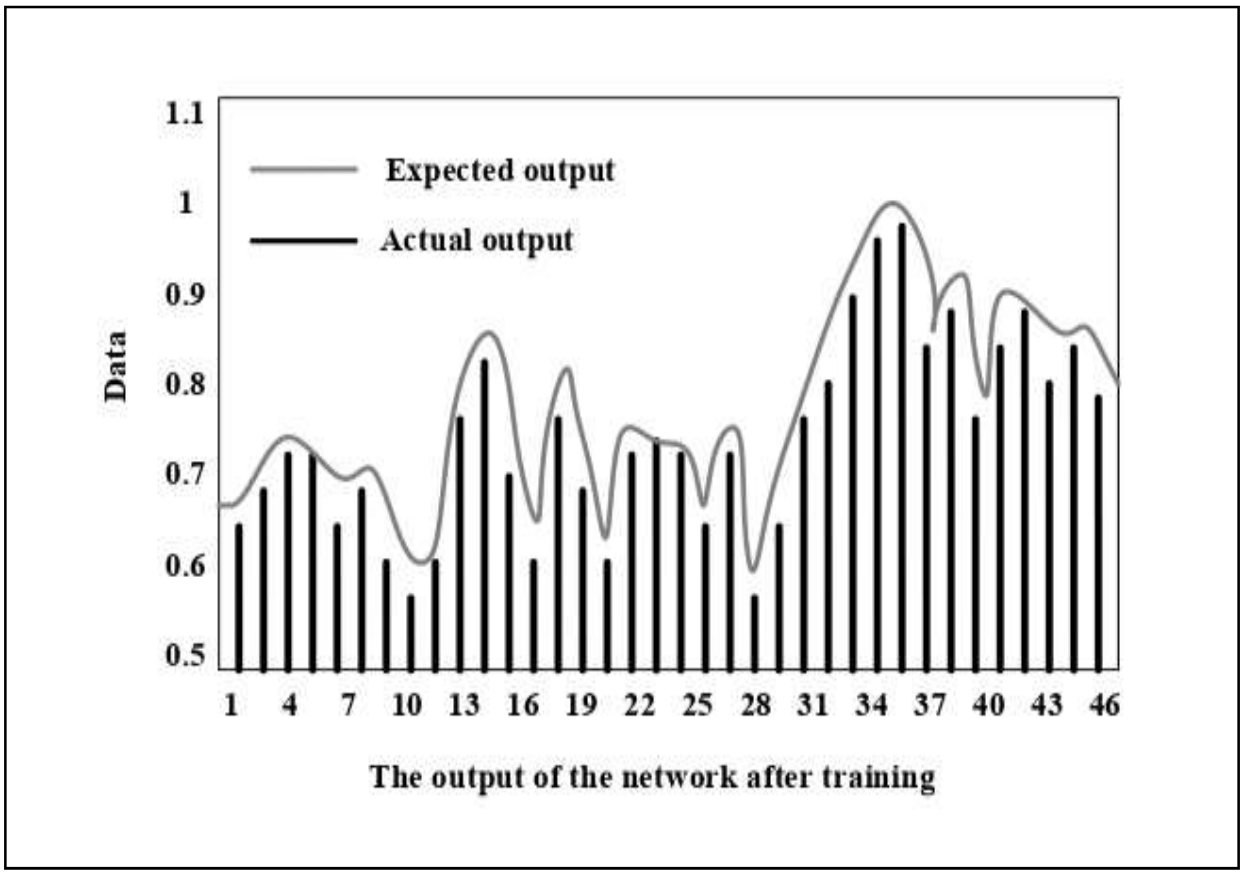

Figure 3. Actual output and expected output of the network after training

It can be seen from the figure that the network input values trained by the network are very close to the expected output. This shows that the trained BP network has achieved a very good learning effect. After the BP neural network training is finished, we test the 36 data of the test sample set by network and obtain the comprehensive evaluation results of 36 art design professionals, and get the test results as shown in the following table. Then we compare the expected output with the actual output, getting the graph of the network output curve.

S.No:	Expected value	Actual value	Error
1	0.824004494	0.809524404	-1.76%
2	0.84938085	0.858146329	1.03%
3	0.930009789	0.952809397	2.45%
4	0.896839246	0.93648148	4.42%
5	0.837487763	0.848175691	1.28%
6	0.824004494	0.859284359	4.28%
7	0.930009789	0.945759544	1.69%
8	0.930009789	0.912809397	-1.85%
9	0.970951438	0.966677652	-0.44%
10	1	1.01	1.00%

Table 1. Test Results 1

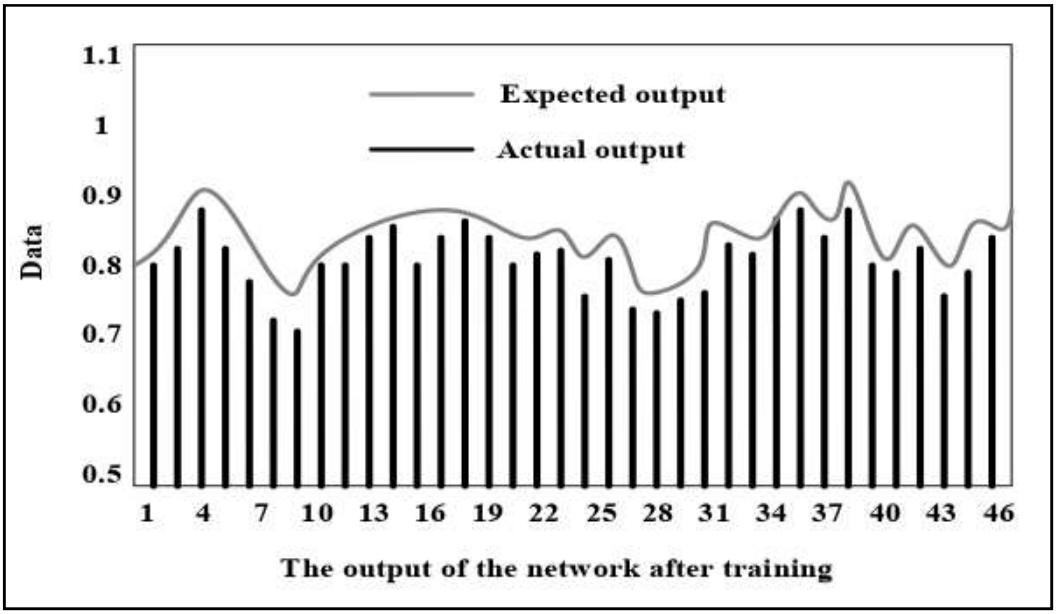

Figure 4. The network output curve of the test set

It can be seen from the network simulation results that the actual output of the network and the expected output error are controlled within 5%, indicating that the established neural network has a good evaluation effect, which can be applied to the subsequent evaluation of art design professionals. This also shows that the BP neural network established can fully absorb the expert judgment experience and the actual employment of enterprises, and make more scientific judgments on the test data. At the same time, it is further confirmed from the empirical evidence that the use of BP neural network for scientific evaluation of personnel and feasibility. The experimental results show that the value of the law and BP neural network applied

to the process of talent evaluation to obtain better evaluation results. This provides a new idea for evaluating art design professionals, and the evaluation process is faster and more accurate. According to the evaluation results obtained from the evaluation network model, it is also instructive for the employer's talent selection and assessment and talent self-evaluation. The above analysis of the basic idea of establishing a neural network, and then from the network layer, the number of neurons in each layer, the neuron's learning rate, the activation function and other aspects of a brief analysis with *NeruoSolutions* software designed 17-4- 1 BP network model for training and testing, and the experimental results were analyzed. Finally, the experimental results show the network model has a good evaluation.

S.No:	Expected value	Actual value	Error
1	0.878429412	0.847684383	-3.50%
2	0.913599517	0.899895524	-1.50%
3	1	1.005	0.50%
4	1	0.99	-1.00%
5	0.878429412	0.88207653	0.42%
6	0.963984915	0.940605594	-2.43%
7	0.948419623	0.943677525	-0.50%
8	1	0.955	-4.50%
9	0.989361271	0.997840014	0.86%
10	0.860019579	0.875618796	1.81%

Table 2. Test Results 2

5. Conclusion

This paper builds the BP neural network through network learning and testing, the establishment of an art design professional evaluation system. BP neural network learning focuses on the selection of learning sample sets and training sample sets. To achieve the purpose of the study, the network learning sample set is divided into two parts: one is the sample data of the comprehensive score calculated by the entropy method obtained in the previous study; this part of the data represents the expert experience; the other part reflects the actual and employing tendencies Sample data, select the salary level of art design professionals as a comprehensive evaluation score (salary level is the experience of enterprises in the process of talent selection and talent evaluation for many years, which is the actual reflection of different employers' different employers, and is the talent ability and position match The practical result). The combination of two parts of the learning sample, through training network will be able to reflect not only the experience of experts, but also reflects the business in the talent selection and appointment process. At the same time, the actual part of employers that learning samples can be used as a test sample set, used to test the accuracy of neural networks. The neural network passed the test has the error within 5%, which shows that the neural network model established has good evaluation ability and can be used for the evaluation of the following art design professionals.

References

[1] Ci Xian Lv., Fei Fan Ye. (2016). Research and Practice of a Talent Cultivation Scheme for Industrial Design. *Applied Mechanics and Materials, 1468* (101), 56-57.

[2] Ming Zhou. (2015). Reflection of the Teaching Reform of Environmental Art Design. *Applied Mechanics and Materials,* 2212 (275), 445-447.

[3] Bao Long Hu., Ji Ren Xu., Huai Hui Gao., Ji Hai Liu., Ke Ren Wang. (2017). Modified BP Neural Network Model is Used for Odd-Even Discrimination of Integer Number. *Applied Mechanics and Materials,* 2746 (423), 516.

[4] Yinzhong HAO. (2017). On the Cultivation of Art Design Values From the Perspective of Cultural Self-Confidence. *Cross-Cultural Communication,* 13(8), 798.

[5] Gaiyun He., Can Huang., Longzhen Guo., Guangming Sun., Dawei Zhang. (2017). Identification and Adjustment of Guide Rail Geometric Errors Based on BP Neural Network. *Measurement Science Review,* 17 (3), 1146.

[6] Zhou Weihong., Xiong Shunqing. (2017). Optimization of BP Neural Network Classifier Using Genetic Algorithm. *Energy Procedia*, 11, 569.

[7] Deqiang Zhou. (2017). A New Hybrid Grey Neural Network Based on Grey Verhulst Model and BP Neural Network for Time Series Forecasting. *International Journal of Information Technology and Computer Science* (IJITCS)*, 5*(10), 4512.