DOI:10.13434/j.cnki.1007-4546.2020.0305

Application of Artificial Neural Network in Engineering

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Abstract: This paper mainly studies the dynamic direction of engineering valuation based on the artificial neural network methods, and seeks for a set of rapid, convenient and practical valuation models, for building construction projects.

Keywords: artificial neural network; dynamic engineering valuation; building

1 Introduction

This paper mainly studies the evaluation method of building engineering based on the popular artificial neural network. By demonstrating the advantages of the neural network itself, analyzing the concrete engineering examples, we establish the dynamic evaluation model, and employ the examples to verify the validity of the fitting results, so that the evaluation model based on artificial neural network can be applied to engineering practice.

Determining the project cost is a very important part of the construction work. It has different applications in different design stages: for example, the preliminary design stage compiles the budget estimate, the construction drawing design stage compiles the budget. The most important thing is to estimate the project cost in the early stage of construction. The estimated price of the project is the starting point of the whole cost management process and the basis of cost control. Therefore, in the rapidly changing market economy environment, it is of great significance to explore such a set of rapid, simple and practical engineering valuation model.

Dynamic engineering valuation in China has been based on the static valuation methods used

Received August 03, 2020
This paper was supported by "Challenge Cup" Support Project of Science and Technology Innovation Fund for College Students of Nanjing University of Engineering (No. TZ20200014)

before. Compared with the static valuation, dynamic valuation is no longer just a unified estimate index, estimate quota, unit valuation table and various charging standards, but mainly a regular revised physical consumption quota, long-term accumulation of project cost information and various project cost information. At the same time, the results of dynamic valuation contain more estimation and generalization components. At some stages, the evaluation results can be expressed as a possible range of cost rather than a definite value. And this kind of characteristic exactly accords with the special nature of the project dynamic cost .

In crder to apply the artificial neural network to the field of engineering valuation, the corresponding engineering valuation model is established to provide data analysis guidance and auxiliary decision for dynamic engineering valuation. Based on the historical data of cost control, the neural network model is used to predict the development and change of actual cost. Then through the comparison of cost prediction data and cost plan, the value of construction project plan is defined. Effective improvement measures are taken to ensure the authenticity and reliability of the actual cost prediction results of construction projects to provide economic analysis for the architect responsibility system that the country is vigorously promoting.

2 Experiment part

2.1 Experimental theory

Because there are too many related factors involved in the process of engineering evaluation, and they have the characteristics of concealment, complexity and multilevel, so it is difficult to design an accurate and effective valuation method. Therefore, the popular neural network simulation method is used to demonstrate the principle and effectiveness of data fitting, to extract the main features from the established projects and to study their impacts on the total cost, and then to establish a network for learning and optimization. Finally, a valuation prediction model of engineering project is obtained.

2.2 Experimental methods

Firstly, a simple neural network model is established by MATLAB software to verify the validity of the fitting data. Then the concrete engineering valuation calculation neural network is established, the relevant data is imported, the simulation analysis and learning are carried out, and the final prediction model is obtained.

3 Process and discussion

3.1 Overview of neural networks

3.1.1 Neural Network Principle

Before the subject begins, ask a question, what is neural network? Neural network has three parts: input, output and neuron.

For example, if there are four inputs, then it will output by $y=w_1\times x_1+w_2\times x_2+w_3\times x_3+w_4\times x_4$ and written in a simplified form. We can further convert this into:

$$\boldsymbol{A}=\begin{pmatrix} X_{11} & X_{12} & X_{13} & X_{14} \\ \vdots & \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ X_{n1} & X_{n2} & X_{n3} & X_{n4} \end{pmatrix} \quad \boldsymbol{W}=\begin{pmatrix} W_1 \\ W_2 \\ W_3 \\ W_4 \end{pmatrix} \quad \boldsymbol{Y}=\begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{pmatrix} \tag{1}$$

The resulting $\boldsymbol{A}\times\boldsymbol{W}=\boldsymbol{Y}$, $\boldsymbol{W}=\boldsymbol{A}^{(-1)}\times\boldsymbol{Y}$. When we create any neural network, the most important task is to find out the weight $\boldsymbol{W}$. When the weight is obtained, the predicted value can be obtained by adding new data. And this is the essence of neural network-through some existing data, deduce the characteristics of this network, and then deduce the new data through the network to get its output.

Next is the application of neural network, there are commonly two used stages: classification and regression. For linear data, classification and regression are simple. Assuming that there are some linear data in a coordinate axis, it is only necessary to string them up or separate them with one line. But what if it's nonlinear? Imagine that the data is now mixed in a coordinate axis and can not be separated directly by simple lines. How do you deal with it?

Here we will introduce a branch of neural network-the RBF neural network, which essentially convert the data from one space to another, shown in Figure 1.

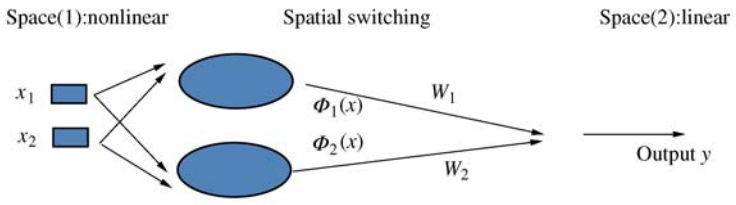

Figure 1 Spatial switching diagram

Supposes we now have two kinds of data, x_1 and x_2, their distribution in space is like

Figure 2a), with circles representing x_1, boxes representing x_2. In this space we find it impossible to separate them in a straight line. So can we think of a way to convert x_1 and x_2 into another space? So let x_1 and x_2 go through two functions before output and convert them to another space. At this point, we find that in the new space, they can be separated by a straight line, shown in Figure 2 and Table 1.

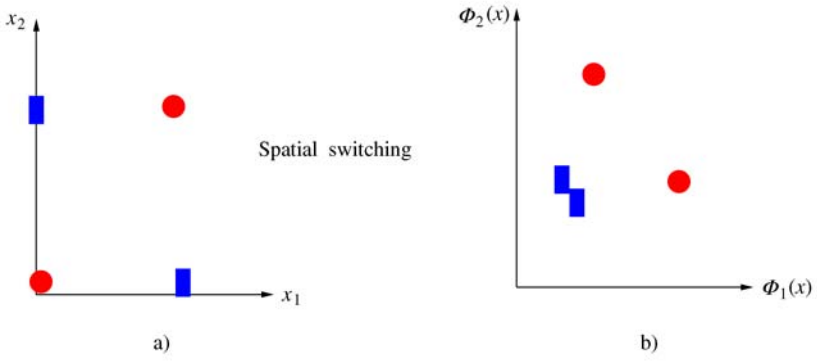

Figure 2 Spatial switching diagram

Table 1 Conversion functions

x_1	x_2	$\Phi_1(x)$	$\Phi_2(x)$
0	1	0.367 8	0.367 8
1	0	0.367 8	0.367 8
0	0	0.135 3	1.000 0
1	1	1.000 0	0.135 3

The commonly used conversion functions for Table 1 are:

$$f(x) = \exp(-x^2/2), \quad f(x) = 2x \tag{2}$$

3.1.2 Establish simple model and analysis

After understanding the basic principles of neural networks, we create a simple network to verify its effectiveness. Select a simple function $F=20+2x_1$. use neural network to simulate its image and compare it with its original image. This process is run in the MATLAB, shown in Figure 3.

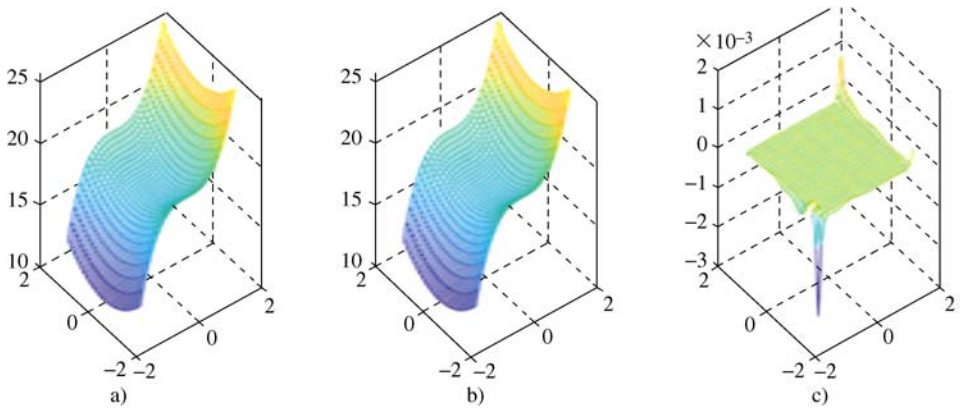

Figure 3 Comparision

The Figure 3a) is the original image, Figure 3b) is the simulated image, and the Figure 3c) is the error between the two images. Therefore, the fitting of neural network has a high degree of similarity. In the course of operation, we find that the original function can be approximated continuously on the premise of increasing the number of samples.

3.2 Case study of engineering valuation based on artificial neural networks

From the list of building construction projects, some engineering characteristics are selected for SPSS correlation matrix analysis, and 8 most important factors affecting the final cost per square meter are obtained: engineering use, engineering structure, basement, ground floor, pile foundation, masonry, waterproof and insulation, decoration and decoration. We use them as the input of the network and build the model, and this process runs in the MATLAB.

```
net=newff (inputData, outputData,3,{'tansig', 'purelin'}, 'trainlm');
net.trainparam.goal=0.000 1;
net.trainparam.show=300;
net.trainparam.epochs=12 000;
[net,tr]=train (net, inputData, outputData);
```

The original date and predicted value is shown in Figure 4.

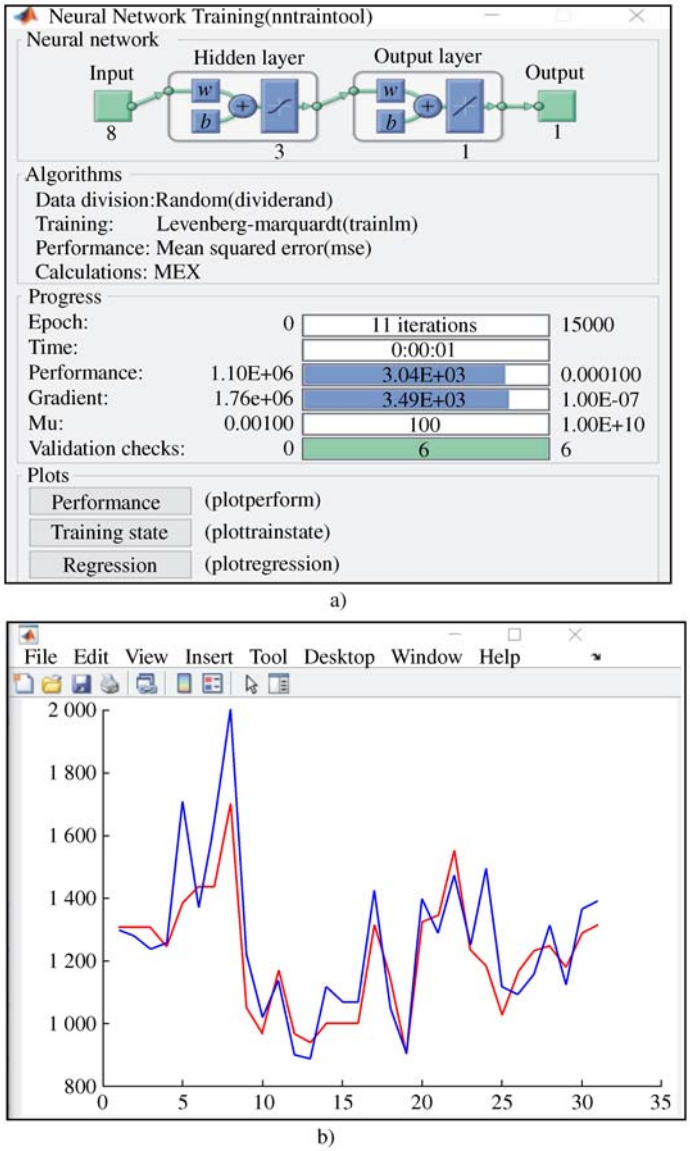

Figure 4 The original data and the predicted value

Figure 4 shows that blue line is the original data and red line is the predicted value. It is proved that the application of neural network in engineering evaluation is feasible and can be applied to engineering practice after further optimization.

4 Conclusions

In this paper, the evaluation model of building engineering is established by neural network method. Firstly, the principle and advantage of neural network are demonstrated, and then the

simple known function model is fitted to prove the feasibility of fitting data, and the conclusion is drawn: by increasing the number of samples learned in neural network, the original function model can be approximated in theory to improve the accuracy. After selecting the main engineering quantity, the neural network model is established and optimized, and then the fitting cost and the original cost are compared. Finally, it is concluded that there is a high similarity between the predicted value and the expected value of the square meter cost established by the neural network. This study provides a strong proof of the feasibility of the application of neural network in the evaluation of building engineering.

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