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Application of computer technology in construction cost management

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ABSTRACT

This research uses Matlab to write neural network programs and processes extraction samples, processing samples and predictive value of output automated and intelligent in construction project cost management. It focuses on the grey RBF neural network applied in estimating construction project cost, and use the actual construction work and civil engineering to validate and evaluate the program. By analyzing error, it is concluded that the estimate should take samples from the amount of cost value approximately equal in construction cost. In other words, the higher value project should take the same number as lower value project. It is good to use computer software for construction cost management, It's easier to extract samples of buildings, extract and eliminate features, normalize and denormalize samples, input sample and output prediction. Then we can get the prediction of construction cost value. This makes building engineering cost management more automated. It makes actual managers can focus on actual projects rather than the specific details of the operation.

KEYWORDS

Computer technology; Construction project cost; Management; Matlab software; Grey RBF neural network.

INTRODUCTION

With the rapid development of China's real economy, the construction industry is booming, it has put forward higher requirements for construction project cost management. Previous management has been unable to meet the needs of rapidly growing industries. The demand for rapid estimation is increasing. The existing methods of estimating is difficult to meet the growing demand for construction industry development.

In construction, engineering cost is the main indicator of construction funds management. It means to complete a project, the construction and installation of engineering price in the land market, labor market, equipment market, contracting procedures and other economic activities. Principles of engineering cost are the decomposition of valuation and combination valuation for the proposed project. It can not be mass producted and be made an uniform price. Construction engineering valuation must decompose the entire project and divided into components, items and other basic building elements to compute separately. In order to calculate the total cost of the project, using certain valuation methods during the calculation process, partial combinations, summary.

Construction work has the characteristic of long-term, single-piece and complexity. So its cost is also necessary to have property of a separate method of valuation, portfolio valuation, multilateral method of valuation, multiple valuation and the complexity of pricing basis. It needs to be priced several times in various stages during the process of implementation. Then step after step to deepen, eventually it forms the actual cost.

In order to meet the needs of rapid development of modern construction projects, people focus on the computer technology. As a tool for advanced management, computer technology is more and more widely used. And it has been functionality replenished and perfected constantly. Throughout Chinese large projects and programs, it all used computer technology. Computer has the characteristics of intelligence, sharing, convenience, speed, fault tolerance. So the computer technology shows great superiority in many projects and programs. It has generally favored especially in computer software.

Construction management is a project. It can make great gains if computer technology has a good application in the project. If it used computer technology at each stage of the project, this project will greatly improve. Management levels will substantially increase. People will be free to engage in more complex tasks. By introducing of computer technology in your projects, you can manage and control project better. It has played a very important role in project budget estimate, risk prediction and risk management. Application of computer technology in construction project management, not only can reduce costs and related expenses, but also some problems can also be found in the project. For example, using the database in your project management can guarantee fast queries, data sharing and reduce the occurrence of mistakes. In addition, Computer-aided design (CAD) is resulting from engineering drawings, Its construction volume is included in the drawings in the corresponding specific computer files. It can't be extracted in the form of required.

In China, architectural engineering estimation research and method of use is still in the exploratory stage. It used very few mathematical models for quantitative estimation in practice. And it didn't build completed information database. Nearly a dozen years, it has set up many associations of engineering cost management in China. But it does not implement a unified model management. There are many differences in each sites without date sharing. In preparation of project investment plan without previous reference data, It's hard to find more information in similar projects and good estimation method. Human factors affecting cost are overrepresented in project estimates. It will influence decisions in the project approval.

INTRODUCTION TO NEURAL NETWORK ALGORITHM

Neurons are the most basic individual units of processing and receiving knowledge in the brain. It includes mainly three parts: dendrites, axons and synapses. Its functions are inputting signal, connecting device and being a bi-directional interface device. We can use computers to simulate function and structure of the human biological neural networks. If we can simplify the neural network properly simplified and abstract a mathematical model concrete, Computer technology can be used in engineering practice.

Characteristics of neural networks

Because of its advantages, neural networks can be abstracted into models and be used in engineering practice with computer technology. Firstly, it has an ability of self-study and summarize. During neural network learning, it can sum up the corresponding input and output in order to predict the next judgment. Therefore you can reasonably expect your construction cost management. Secondly, it has nonlinear characteristics of brain. Because of that, neural network can make it possible to address more complex issues. Thirdly, it has a good parallel processing capability. Neural networks can process multiple items simultaneously and be integrated in parallel without confusion. Fourthly, it has a good adaptability. By adjusting the strength of connections between neurons which means adjusting the size of synaptic weights, neural networks can adapt to changes in the external environment. That means neural networks can adjust the output according to the input. Finally, it has certain fault-tolerant function. To make a small mistake does not to make the whole system a catastrophic destruction.

Grey RBF neural network

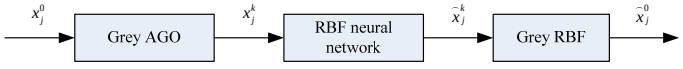

Figure 2 : Schematic diagram of Grey RBF Neural Network

This research will use Grey RBF Neural Network algorithm in computer technology to manage and forecast construction cost in practice. This section focuses on knowledge of grey RBF Neural network. RBF Neural network models have been divided into formalized and generalized. Gray RBF neural network has good characteristics of fast learning. This means that the algorithm is very efficient. The activation function of grey RBF neural network input signals to nodes in the hidden layer implements by using radial basis functions (Gaussian function). Output is a linear combination of each node in the hidden layer. It made up of a simple linear function. So it learns fast. The function of hidden layer nodes can produce local effects on signal in the input layer. When the input signal of n near the central region of the function, the hidden layer node will produce output larger. So the RBF radial basis neural network is also called the local approximation network or local receptive field network. Gauss functions can be the incentive function of grey RBF neural network with radial symmetry, arbitrary order derivative, good continuity and analytical advantages of good. The following are brief descriptions of function-related knowledge.

M-th output function of hidden nodes: $f(p_m - c_i) = \exp\left(-\frac{\|p_m - c_i\|^2}{2\sigma^2}\right)$;

$\| p_m - c_i \|$ is the European norm;

σ is the variance of the Gauss function. The method for determining it is in the following:

$\sigma_1 = \sigma_2 = ... = \sigma_m = \frac{D_{\max}}{\sqrt{2M}}$;

$D_{\max}$ is the maximum distance between centers;

M is the total number of hidden layer nodes;

C_i is the center of Gauss function.

Learning steps of gray RBF neural networks which can be divided into: Identify learning center → Solving the variance (in accordance with the above formula) → Calculation of weight. Which determine the Learning Center can be divided into 5 steps: Initialize the network → Enter the training samples (It's the condition of engineering construction cost in this research) → Focus adjusting in the samples → Re-adjust Center → If the clustering center unchanged (end). It will continue to adjust in the samples if it changes

THE ESTIMATION FRAMEWORK OF CONSTRUCTION PROJECT

This section focuses on building fast estimation frameworks for the construction with the grey RBF neural network. It analyzes the influence factors of the actual construction project cost. Then we can draw the training method for estimation of construction. We can start with establishment of rapid estimation model and use MATLAB to construct. Eventually it also need to validate and assess the program.

Establishment of a rapid estimation model

First of all we should know the sources for sample data if we want to establish a rapid estimation model and predict the cost of construction. In the practical engineering, the sample data is the source of real data which has been completed. It is the actual statistical data. In addition, there are many differences in the buildings, each building is unique with specifications, appearance, address and construction. Every change of characteristics will affect the total cost of construction. So there is a poor comparability of construction. In the actual operation, we need to categorize the characteristic elements of buildings and associate with the actual cost. It is established by using the artificial neural network and formed mapping relationship. Then we can realize the function of prediction.

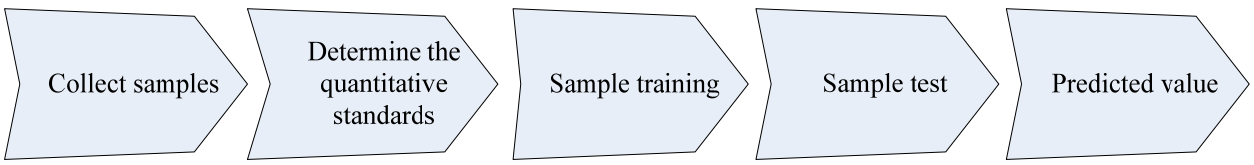

Figure 3 : Schematic diagram of estimating process in construction

Figure 4 shows a structure diagram of computer estimating system. The extraction of data in feature, the training samples, data processing and Simulation of neural network learning are done by computer. Grey RBF neural network is used in neural network on this study.

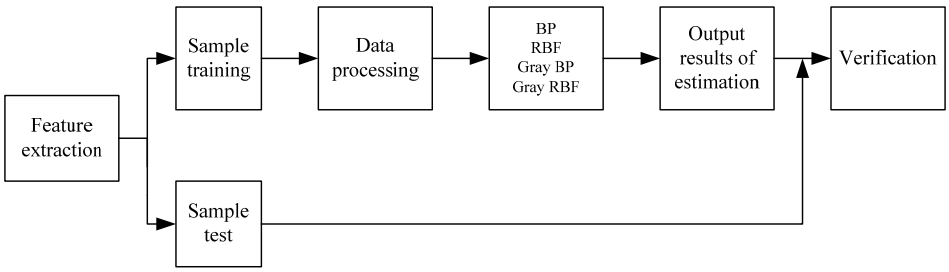

Figure 4 : Schematic diagram of computer estimating

Construction of neural network model with MATLAB

To construct the neural network model in details, this study uses the computer software Matlab. ATLAB is a visualization application for the numerical calculation. Neuralc Network Toolbox in the MATLAB is based on the artificial neural network for the convenience of users to write. It can make the complex calculation into a call to the activation function. MATLAB's toolbox is readable and writable by the source file. And it also can write and revise the source file. The concrete operation process can be divided into several steps.

Sample selection

The research collected more than 80 samples according to the building construction cost and classified them. It put the same properties and uses of the building into a category. In order to improve the precision of estimating and exclude special types of buildings, the analysis of the sample of civil, installation and renovation costs accounted for the proportion of total cost. It is shown as TABLE 1.

TABLE 1 : The proportion of civil, installation and renovation costs

Building category	Criterion	Civil	Installation	Renovation
Residence	Unfurnished	75%-85%	15%-20%	5%-10%
Office building	Mid-range decoration	45%-55%	30%-35%	20%-25%
Two-star hotel	High-grade	35%-40%	30%-35%	25%-30%
Five-star hotel	Luxury	30%-35%	30%-35%	30%-35%

From TABLE 1, with the construction standards to improve, the cost of renovation and the civil cost proportion gradually improved. And the fluctuation of installation cost is small. In order to influence the predictive accuracy of the model as small as possible, we removed the decoration cost with high ratio such as hotel buildings, luxury decoration construction. We chose a total of 54 samples such as office, residence, villa without decoration, school and hospital building to divide into training and test samples.

Feature extraction

Some projects are common in construction cost. They exist in each individual such as drainage engineering, water engineering, installation of cable television network and so on. Some projects are associated with buildings category such as weak current management, broadcasting system, fire-fighting system, teaching system and so on. These are existed and in need of specific buildings such as military construction, fire protection building. These don't belong to the feature project. We should remove them in extraction.

Quantification of construction sample

By extracting feature vectors, the study doesn't explain the specific process of this.

Normalization

It's normalized by using this formula: $x_{ij} = \dfrac{x_{ij} - x_{j\min}}{x_{j\max} - x_{j\min}}$

If you need to use multiple neural networks, you should process the gray BP and grey RBF network accumulatively first. Then you can normalize them.

VERIFICATION OF GRAY RBF NEURAL NETWORK BASED ON THE CONSTRUCTION PROJECT COST

The estimation of construction cost need to estimate the amount of investment in earlier stage of construction. It includes the estimation of construction investment, liquidity and interest during construction. The followings are the program for the civil engineering of construction based on grey RBF neural network.

```
P=xlsread('e:\shujufenxi.xls',jianxun22','A1:AP13')
t=xlsread('e:\shujufenxi.xls',jianxun22','A14:AP14')
Ptest=xlsread('e:\shujufenxi.xls',jiance22','A1:L13')
ttest=xlsread('e:\shujufenxi.xls',jiance22','A14:AP14')
goal=0.001;
spread=15;
MN=42;
DF=5;
Net=newrb;
[net,tr]=newb(p,t,goal,spread,MN,DF);
errl=sum(t-sim(net,p).^2);
y=sim(net,ptest);
err2=sum(ttest-y).^2;
plot(1:12,ttest'r+:',1:12,y,'bO:');
title('+is true value,0 is Forecast Value');
```

Run the program, the results are as follows:

y = *Columns* 1 *through* 11

1.0443 0.5260 0.0125 0.0474 0.0352 0.0014

0.0403 0.0593 0.0675 0.5299 0.1735

TABLE 2 gives results by comparing the gray RBF neural network with other artificial neural network. TABLE 2 lists the training times among BP neural network, grey BP neural network, RBF neural network and grey RBF neural network. The projects of prediction are civil engineering in construction.

TABLE 2 : Comparison of gray RBF neural network and other neural network in learning times

projects of prediction	learning times			
	BP network	Gray BP network	RBF network	Gray RBF network
Civil Engineering	4018	4979	20	10

From TABLE 2 we can see, after 10 times of training and learning, grey RBF neural network will be able to achieve the error requirement. Results show that the prediction value and the real value are very close, and the training effect is more outstanding. TABLE 3 shows the analysis of civil prediction results. The first item in TABLE 3 is sample number. It has 12 samples. The second item is the actual building cost and unit for 10 thousand yuan. The third item is the predictive value of y which compared with the actual output value y. The fourth item is the actual cost and unit for 10 thousand yuan. The fifth item is the different between the actual and predicted cost price. The last item is the percentage error. It reflect the difference of the proportion of price.

TABLE 3 : Predictions of construction based on grey RBF Neural network (ten thousand yuan)

Sample No.	Actual building cost	Predictive value of y	Forecast cost	Difference	Fractional error
1	22946.41	1.0443	23961.11169	1014.7017	4.42%
2	11339.35	0.5260	12089.33098	749.9810	6.61%
3	903.16	0.0125	327.49538	-575.6646	-63.74%
4	2118.80	0.0474	1126.88790	-991.9121	-46.81%
5	1484.50	0.0352	847.44410	-637.0559	-42.91%
6	41.18	0.0014	73.24732	32.0673	77.87%
7	1141.25	0.0403	964.26077	-176.9892	-15.51%
8	2721.90	0.0593	1399.46014	-1322.4399	-48.59%
9	2460.45	0.0675	1587.28303	-1071.3386	-8.09%
10	13250.00	0.5299	12178.66138	-1071.3386	-8.09%
11	5190.00	0.1735	4015.23741	-1174.7626	-22.64%

The output value of Y is based on the civil engineering prediction of gray RBF neural network. We can get the results by reversing the normalization y in TABLE 3. Then we can Figure out the fractional error. There are 5 samples' error within 30% to 11 samples. 4 samples' error close to 30%. The error of No. 3 and No. 6 is bigger. It need further analysis of the reasons and improve models.

TABLE 4 gives the actual cost of sorting TABLE in civil engineering. It can be used for error analysis. The first item in TABLE 4 is sample number. It corresponds with TABLE 3. The second item is building category, including office, information center and so on. The third item is the amount of cost, unit million yuan. The fourth item is fractional error which the researchers paid more attention to.

TABLE 4 : Analysis and sequencing of the actual cost in civil engineering

Order of the actual cost in civil engineering from high to low			
Sample No.	**Building category**	**Cost of building**	**Fractional error**
1	Office	22946	4.42%
10	Information center	13250	-8.09%
2	Office	11339	6.61%
12	Hospital ward	8165	-0.41%
11	Hospital outpatient	5190	-22.64%
8	Teaching building	2722	-48.59%
9	Teaching building	2460	-35.49%
4	Residence	2119	-46.81%
5	Residence	1485	-42.91%
7	Teaching building	1141	-15.51%
3	Residence	903	-63.74%
6	Villa	41	77.87%

From the above TABLE we know that there are 229.05 million yuan between the sample with higher price and the sample with low price. In the list of 12 samples, the majority of them is the sample with high price. The number of low cost is a few. Therefore, the prediction in the same environment, low cost and small amount of sample of 3, 6 are influenced by the most samples. That leads the error bigger. It also revealed the researchers that the estimate should take samples from the amount of cost value approximately equal in construction cost. And the higher value project should take the same number as lower value project. So the problem can be avoid.

CONCLUSION AND ANALYSIS

This research uses Matlab to write artificial neural network programs and analyzes the cost on the construction project. It also verifies and evaluates the cost of civil engineering. Generally speaking, it is good to use computer software for construction cost management, It's easier to extract samples of buildings, extract and eliminate features, normalize and denormalize samples, input sample and output prediction. Then we can get the prediction of construction cost value. This makes building engineering cost management more automated. It makes actual managers can focus on actual projects rather than the specific details of the operation

In addition, using computer technology can analyze the error in prediction of the construction cost and find the reason for the error. A revelation in final is that the estimate should take samples from the amount of cost value approximately equal in construction cost. And the higher value project should take the same number as lower value project.

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