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Research on Power Engineering Cost Forecasting Model Based on Artificial Neural Network

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ABSTRACT. *The cost of power engineering is a multi-variable and non-linear complex process. In the past, the cost of power engineering projects often requires analysis and research personnel to estimate the project cost through empirical analysis and subjective estimation. How to use the historical cost data of existing projects to build cost management for new power projects. Providing more reasonable judgments and comparative scientific theoretical analysis requires the use of accurate data mining knowledge. Based on the characteristics of "the interaction of many cost elements in power engineering and ultimately in engineering cost", this paper applies BP neural network to the research of power engineering cost, and builds a rapid analysis model of engineering cost. The simulation study determined the feasibility and effectiveness of the model.*

KEYWORDS: *power engineering; cost management; BP neural network*

1. The investment in construction projects is out of control

1.1 Proposal for investment out of control

The important problem in China's fixed investment field is that the investment in construction projects is out of control. The influencing factors are multi-faceted. The most important thing is that in the process of cost control, the construction phase is mainly controlled, and the project planning and feasibility study phase is not emphasized. design phase. From the stage of project cost control, the possibility of saving investment has dropped rapidly from 100% in the pre-project planning and feasibility study phase to about 10% in the construction phase, and the subsequent changes are quite gradual. The most influential stage of project investment is the work phase before the end of the technical design of about 1/4 of the construction period of the project. Therefore, the investment estimation control in the feasibility study stage has become one of the key points of project investment control.

1.2 Current methods and drawbacks of investment estimation

The current methods of investment estimation mainly include the quota estimation method and the engineering quantity list estimation method. [1-6] There are many factors affecting the cost of construction projects. The composition is complex, the situation is changeable, and there is a large ambiguity. If the quota is simply applied, all the complicated calculations are carried out. Although the results are more accurate, it will waste a lot of manpower, material resources and financial resources. . If you simply rely on the previous experience of cost control and the data of completed projects for rough estimation, such estimates are too rough, and the frequency of investment out of control will increase greatly.

Therefore, today's society needs more simple but more accurate cost estimation methods, which not only saves time, but also allows investment to be controlled within a reasonable range.

2. BP neural network

2.1 Overview of BP Neural Network

BP (Back ProPagation) network is one of the most important networks in artificial neural networks, and it is by far the most widely used network algorithm. The BP network is a multi-layer mapping network with reverse transmission and corrective error in the neural network. The network structure model is shown in Table 1. It usually consists of hidden layer, input layer and output layer. The units are fully interconnected and are interconnected by corresponding network weight coefficients. The neurons in each layer are not connected. When the parameters are appropriate, the network element can converge to a relatively small mean square error, which is one of the most widely used networks.

2.2 BP neural network model principle

The BP network is one of the most commonly used feedforward networks (multilayer perceptron is a back propagation network). It has an input layer, an output layer, and one or more hidden layers. Each layer contains several nodes, each representing a neuron. Information flows unidirectionally between layers from the input layer, passes through the hidden layers in turn, and finally reaches the output layer[7-10].

Table 1 Network model structure

Cost element	unit	Cost element	unit
Sectional area	mm 2	Human transport	m
Voltage level	kV	Car transport	m
full length	m	Number of towers	base
Average range	m	insulator	Sheet/km ^{2}

2.3 BP algorithm two processes

The BP algorithm is a highly nonlinear mapping that completes the input-to-output by minimizing the error function value. In the mapping, it needs to maintain the topological invariant characteristics, which can be divided into two processes: the first step, the input information flow needs to be input from the input. The layer, through the hidden layer to the output layer, processes and calculates the actual output value of each neuron unit node, which is usually called the forward transfer of the information stream. In this process, the sample signal is passed forward layer by layer through the Sigmoid function, and the state of each layer of neurons only affects the state of the next layer of neurons. In the second step, the error between the actual output value of the network and the expected value of the sample is calculated[11-17]. If the error is not within the allowable value range, the weight adjustment needs to be performed according to the error, and the connection weight of each layer of the neuron unit is modified from the back to the front. This process is called the reverse modification process of the error. Although the program of the BP algorithm seems complicated, in the process of applying BP neural network to evaluate the project in work, the following two tasks need to be done: 1 First, select a reasonable input variable, in the power engineering cost control, “ "Selection of input variables" refers to the selection of appropriate "cost elements" according to the specificity of power engineering to facilitate the evaluation of the cost of power engineering; 2 to transfer the transfer function, training function and system parameters of the built model itself Confirmation, that is, the construction of the financial early warning model[18-21].

3. Choice of cost elements

In the process of power engineering construction, many factors affect the cost of power engineering. In the actual project budget process, different staff may have different considerations for the influencing factors. Therefore, in the process of establishing the evaluation model, mainly from the following Three aspects consider how to choose the "cost element":

1) The number of occurrences of this element in similar engineering cost studies; 2) The correlation between this element and power engineering construction; 3) The availability of the indicator data. Taking the cost of transmission and transmission line engineering of power transmission and transformation project as an example, taking into account the basic principles of “cost element” for the sensitivity, comprehensiveness, representativeness, advancement and timeliness of data collection of transmission line engineering cost, The eight cost elements of “section, voltage, total length, average pitch, manpower, car distance, number of towers, and insulators” are used to describe the cost of the transmission line project.

4. BP neural network design and implementation

4.1 Design of hidden layers

Theoretical analysis has proved that a feedforward neural network with a single hidden layer can reflect all continuous functions without restricting the hidden layer nodes. Therefore, when considering a multilayer feedforward network, it is generally necessary to design one first. Implicit layer. Although increasing the number of hidden layers can reduce network errors and improve accuracy, it will complicate the network system, thereby increasing the computation time of the network, and may even appear "over-fitting". In actual operation, it is also possible to obtain higher precision and reduce errors by designing nodes of the hidden layer without setting multiple hidden layers. Therefore, when designing a network, a single implicit layer neural network structure model is adopted, that is, the network structure is: an implicit layer, an input layer, and an output layer.

4.2 Design of the number of input layer and output layer nodes

The 3-layer BP network can map arbitrarily complex nonlinear function relationships and is successfully applied to prediction problems in multiple fields. Therefore, this model selects a 3-layer BP network. The number of input layer nodes is related to the factors affecting the construction cost. Through the analysis of the factors affecting the cost of transmission line engineering, the main factors affecting the construction cost are determined: cross section, voltage level, full length, average range, manpower distance, and car transportation. The distance, the number of towers and the insulator, so the input layer of the selected BP network is not 8 nodes, and its input variables are section product (x1), voltage level (x2), full length (x3), average span (x4).), manpower distance (x5), car distance (x6), number of towers (x7), insulator (x8), the network output layer is 1 node, and the output variable is the cost of the transmission line engineering under the corresponding input conditions (Line discount cost F).

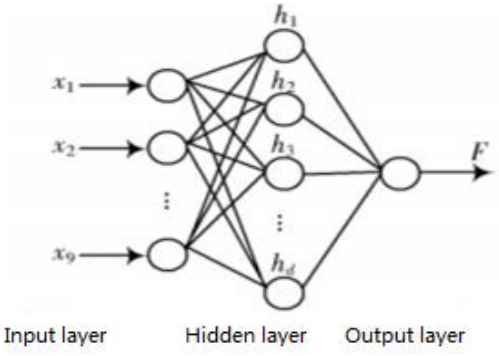

Fig.1 Prediction model of transmission line engineering cost neural network

4.3 Design of hidden layer nodes

The design of the number of hidden nodes is a difficult point in model design. The role of the hidden layer node is to store and extract its intrinsic rules from the selected samples. Each node unit has thousands of weights, each of which is a parameter that enhances the ability of the network image. In general, if the hidden layer of a neural network structure covers a myriad of hidden layer nodes, the neural network structure can implement a non-linear image of any precision from input to output. However, in practice, we cannot implement countless hidden layer nodes for the time being, so we must determine the number of hidden layer nodes as needed. A general method for determining the optimal number of hidden layer nodes is "trial and error method", that is, first set a small number of hidden node training networks, then increase the number of hidden layer nodes in turn, test with the same sample unit set, and select from them. The corresponding number of hidden layer nodes when the network error is minimum. We use the formula $L = (m \times n)\ 3 / 2$ to get an initial value of 4, that is, the training node of the number of nodes in the hidden layer network starts from 4 . According to repeated tests, when the number of hidden layer nodes is 8, the network achieves the best state of speed and stability, and the training and inspection effects are the best. Therefore, the number of hidden layer nodes in this paper is 8.

4.4 Implementation of BP neural network

According to the design of the neural network, the BP neural network to be built is a 3-layer neural network consisting of 8 input nodes, 8 hidden layer nodes and 1 output node. The transfer functions of the 3-layer network are the trainrp, tansig, and purelin functions, and the learning function uses trainlm. The standard BP algorithm will learn the process atmosphere in two phases: the first phase, the forward propagation process, the input variable information is processed through the input layer and the hidden layer and the actual output value of each unit node is calculated; the second phase, through the reverse To the feedback process, if the output layer does not get the expected output value, the difference between the actual output and the expected output is calculated, and the threshold and weight are recursively adjusted according to the difference, and the error value is gradually reduced until the network accuracy requirement is met.

5. BP neural network simulation and conclusion

It can be seen from the experimental results that the BP model has good convergence. By comparing the estimated error of the predicted value with the actual value of the estimate, it can be seen that the BP neural network has achieved a certain accuracy for the estimation of the cost of power engineering. In the total price control of power engineering, the maximum allowable error is 4.46%, and the absolute value of the minimum allowable error is 0.23%. The result is reasonable, indicating that the neural network model has a relatively high pan.

The ability to use this neural network model to estimate the cost of power engineering has significant effects. This paper starts with the cost of the power transmission line project of power transmission and transformation project, simulates the corresponding neural network model, and proves the generalization ability and effectiveness of the model from both experimental results and theoretical analysis. The project-related cost problem of power transmission lines is only one of the problems of power engineering cost. Further analysis of the characteristics of other power engineering cost problems, and the establishment and training of its corresponding network model is the focus of the next analysis. It is believed that after relevant research work, we can use data mining tools such as neural networks to provide scientific and reliable basis for power engineering cost.

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