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# Based on the BP neural network algorithm of highway engineering cost data analysis

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**Abstract.** Engineering information is a very precious information resources, and it is of great significance to predict the engineering cost. In this paper, using BP neural network algorithm through to complex, decentralized completed engineering data collecting and analyzing statistics and draw all kinds of traffic engineering of the quantity of consumption, and the market price of the overall trend. This can provide the basis for the investment estimation, calculation of engineering cost, engineering quotation and contract adjustment, and provide the main basis for the new engineering project decision, construction and design.

**Key words.** BP neural network algorithm, highway engineering cost, information system, data analysis

In recent years, with the large-scale construction of provincial transportation infrastructure, traffic engineering cost control, puts forward higher and higher requirements. How to evaluate a project is in line with the principle of economy, how to determine the scale of investment in a project, and how to more effectively control project construction in the process of cost is a problem needs to be solved in the provinces. The rapid development of information industry, also contributed to the provinces to in traffic engineering and cost management as the main line, the establishment of information system including price information, fixed cost, cost analysis, cost review and design changes, and other content, the historical data of these systems become provinces traffic engineering cost analysis, an important basis for the evaluation and management of construction cost, in order to explore the rules of project cost, scientific reasonably determine project cost and improve economic benefits provide support.

In this paper, using BP neural network algorithm through to complex, decentralized completed engineering data collecting and analyzing statistics and draw all kinds of engineering quantity of consumption, economic indicators and indices and the market price of the overall trend. And this can provide the basis for the investment estimation, calculation of engineering cost, engineering quotation and contract adjustment, and provide the main basis for the new engineering project decision-making, construction and design.

## 1. BP neural network model

### 1.1 BP neural network model

BP (propagation back) neural network is a kind of unidirectional transmission of multi-layer forward network, except for input and output nodes, there is a layer or multi-layer hidden layer. The input data from the input node pass through the implicit node in turn, the weighted fitting is transmitted to the output node output, and the nonlinear mapping from the input to the output is realized. The number of input nodes of the network is determined by the dimension of the input data of the actual problem, and the number of output nodes is determined by the number of the expected values of the actual application requirements. The approximation of the network can be realized by any accuracy. The network learning and training is by changing the connection weights between neurons in the network, the network has completed a particular task, change is based on training samples produced by the actual output and the expected output error, and change the value of the error gradient descent technique adjusts the weights of networks.

The BP algorithm is composed of two processes of the forward propagation and error of the information, and is an iterative process. In the forward propagation process, the input information is processed by the hidden nodes and transmitted to the output nodes. If the output node cannot get the desired output, the error between the actual value and the network output is returned along the original link path, that is, the reverse propagation process. By modifying the link weights of each layer, the error can be reduced and then transferred to the forward spreading process repeatedly, until convergence to the accuracy requirements. The model as shown below：

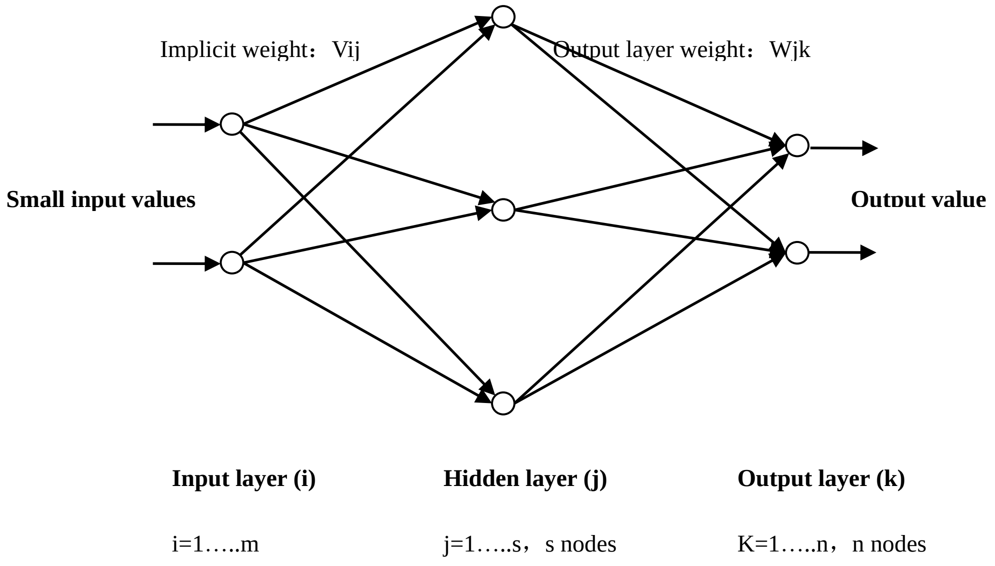


**Figure 1.** BP model

### 1.2 BP neural network algorithm

Under the assumption that the weights of each node are changed under the action of P .Algorithm execution process is as follows:

(1) Calculating the input of the implied element

For the hidden node j, the input information of each node is weighted sum, then the input information of the node is obtained:

$$net_j=W_{1j}x_1+W_{2j}x_2\cdots\cdots+W_{mj}x_m$$

Where $W_{1j}$ is the input node of the first input node to the J implicit node, Xi is the input information for the I input node, and the M is the input node number for all the connected J nodes.

(2) Calculating the implied element output

The output of the node can be obtained after the net signal is transformed by an excitation function. BP algorithm is commonly used Sigmoid function:

$$f(x)=1/(1+exp(-x))$$

That is: $U_j=1/[1+exp(-net_j+\theta_j)]$

Where Uj is the output of the hidden nodes, θj is hidden node threshold.

(3) The input of the output unit

$$net_k=\sum_{j=1}^{s}W_{jk}U_j$$

For the output node, the input information of each node is weighted and the input information of the node is obtained, $W_{jk}$ represents the weight of the J node to the output node of the K node, $U_j$ represents the output information of the J implicit node; s represents the implicit node number for all the K nodes.

(4) The output of the output unit

Output of the output node is $Y_k=1/[l+exp(-netk+\theta k)]$, $Y_k$ is the output information of the output node K; $\theta_k$ represents the output node K threshold.

(5) The training error of each output layer element is calculated by calculating the sample P:

$$\sigma_k^p=(D_k^p-Y_K^p)\times Y_K^p\times(1-Y_K^p)$$

$\sigma_k^p$: *The error of the training procedure of the output unit K of the P sample;*

$D_k^p$: *The expected output value of the k output unit for the P sample;*

$D_k^p$: *The actual output value of the k output unit of the P sample。*

(6)Calculating the training error of each hidden layer element

$$\sigma_j^p = O_j^p \times (1 - O_j^p) \sum_{k=1}^{n} (\sigma_k^p - W_{jk}^p)$$

$\sigma_j^p$: *Training error of implicit element J;*

$\sigma_j^p$: *The actual output value of the j implicit element for the P sample;*

$\sigma_j^p$: *The j p of a sample and the connection weights of the k output units.*

(7) Calculating the output weight adjustment

$$\Delta W_{jk}^p = \eta \sigma_k^p \times Y_k^p$$

$\eta$ ： Learning rate, usually between 0.01~0.8;

(8) Calculating the implied weight adjustment

$$\Delta V_{ij}^p = \eta \sigma_j^p \times O_j^p$$

After the execution of the above process, the node weights of the adjustment layers are needed.

(1) Adjust the output weights

$$W_{jk}^{p+1} = W_{jk}^p + \Delta W_{jk}^p + \mu (W_{jk}^p - W_{jk}^{p-1})$$

$W_{jk}^{p+1}$ ： The initial weight of the sample p+1, that is, the weight of the adjusted P sample；

$W_{jk}^{p}$ ： Weight of P sample before adjustment;

$W_{jk}^{p-1}$ ： Weight of sample P-1；

$\Delta W_{jk}^{p}$ ： Output weight adjustment；

$\mu$ ： Momentum factor， $0 < \mu < 1$。

(2) Adjust the output unit threshold

$$\theta_k^{p+1} = \theta_k^p + \Delta \sigma_k^p + \mu (\theta_k^p - \theta_k^{p-1})$$

$\theta_k^{p+1}$ ： The initial threshold p+1 samples of the K unit, the K unit P sample adjusted threshold；

$\theta_k^{p}$ ： P samples before the adjustment of the K unit threshold；

$\theta_k^{p-1}$ ： The P-1 sample K unit threshold；

$\mu$ ： Momentum factor， $0 < \mu < 1$。

(3) Adjusting the implicit weight

$$V_{ij}^{p+1} = V_{ij}^p + \Delta V_{ij}^p + \mu (V_{ij}^p - V_{ij}^{p-1})$$

(4) The hidden layer unit threshold adjustment

$$\theta_j^{p+1} = \theta_j^p + \Delta \sigma_j^p + \mu (\theta_j^p - \theta_j^{p-1})$$

## 2 Forecast cost target based on BP neural network model

Data preprocessing: the network requires the input and output data, and the data are between 1 and 0. Therefore, the need for the input and output data preprocessing.

For the engineering characteristics can't be expressed with any digital conversion numerical input, such as terrain levels (mountains, plains, hills), we start with the assumption that the an input feature value mountain is 0.5 in the history of engineering cost to determine the ratio of α≈the cost per kilometer (plain) / per kilometre cost (mountain), you can determine the input features of the plain to other analogy 0.5αvalue.

For available numerical expression of characteristic values, such as cross section of subgrade height, using a larger value as the base, the other characteristic value and the base ratio as the input feature values, such as the use of 5m height of cross section of subgrade base, is general engineering subgrade cross section height /5m ratio are between 0 ~ 1, the this ratio as input values.

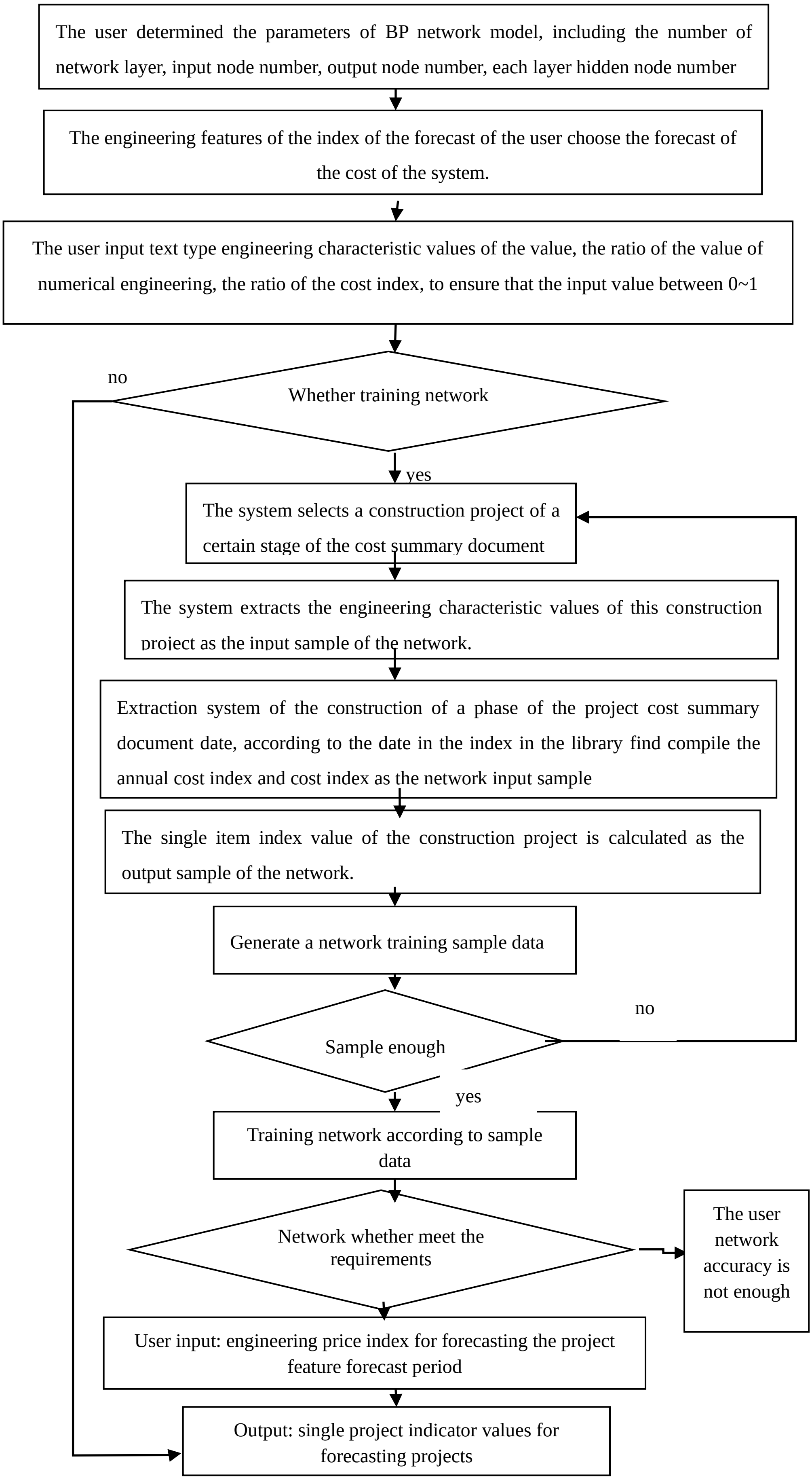

**Figure 2.** Model flow

## 3. Simulation results

Because the BP neural network model needs a lot of sample data training can be more and more accurate, after repeated simulation, the simulation results as shown below：

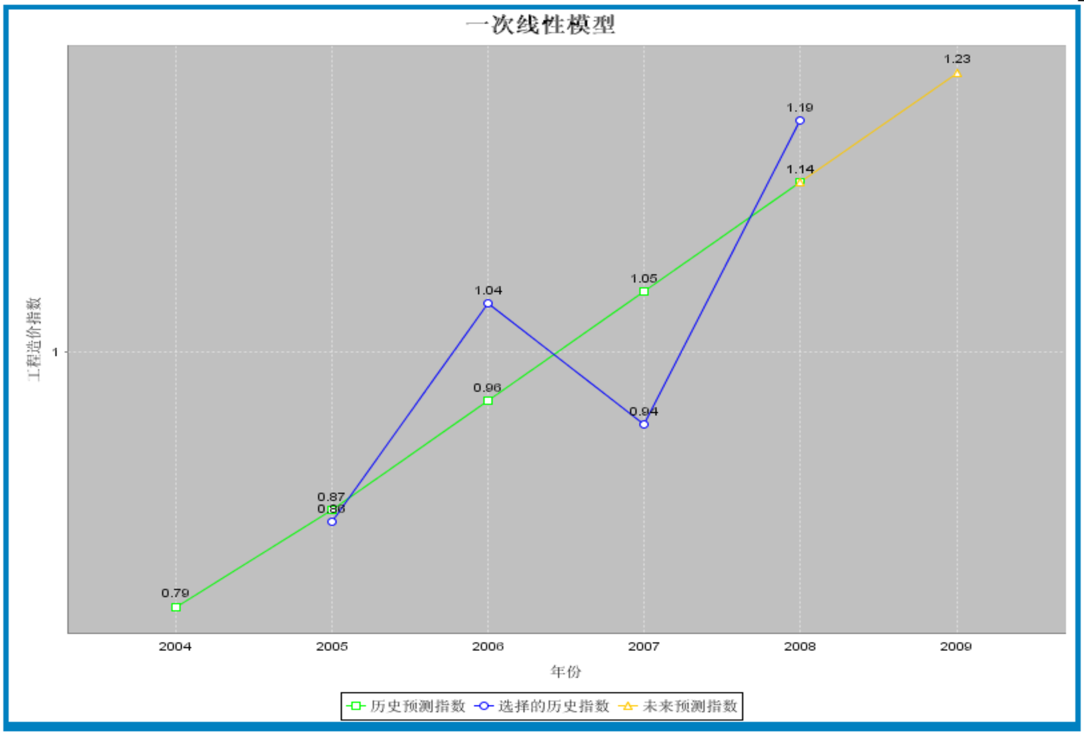


**Figure 3.** Simulation results

The green line said historical prediction index, blue is the choice of history index (actual value), yellow index to predict the future。

## 4. Conclusion

Through the use of BP neural network model, on highway engineering cost data were big data analysis, forecast each cost index, and use this model to predict the results to guide future highway engineering investment estimation, project cost and project quotation, contract adjustment calculation etc. business, by help of information means to guide industry development.

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