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Risk Evaluation of the Wind Power Project Investment Based on BP Neural Networks

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Abstract. With the rapid development of the society, more and more countries have been increasingly optimistic about wind power projects because of its advantages, such as non-polluting, renewable, energy-saving and emission reduction. While facing the temptation of high profit, it is necessary to assess the risks of wind power project investment scientifically. Therefore, this article combines with the risk characteristics of Wind Power Project under the current social environment to build a evaluation index system of wind power project to evaluate the risk of wind power project based on BP neural network.

I. INTRODUCTION

With the rapid development of modern society, industry competition is gradually increasing and many enterprises are facing more and more uncertainty. Coupled with the environment the global financial crisis, the project investment risks are playing an important role in this highly modern society. The proportion of wind power projects investment, which is an emerging industry, is not high in the power structure. However, it's non-polluting, renewable, and have made outstanding contributions to the energy saving and emission reduction. What's more, it has tremendous potential for development and has been adapted to the new concept of modern society, and its innovation and practicality has become increasingly apparent. Therefore, the risk assessment of wind power projects investment is particularly feasible.

The traditional project risk evaluation methods have their own shortcomings, that is, along with the increasing random factors in the evaluation, the evaluation result is susceptible to the subjective personal experiences of the evaluation personnel, and influenced by personal prejudices and subjectivity. In recent years, the neural networks which has been developing rapidly has its unique advantages, such as self-learning, self-organizing, adaptive ability, scientific, easy to operate, and it overcome the influence of subjective factors. It has been widely used in the project investment risk in various areas.[1]

[1] Hebei province science and technology research and development planning Items(09457272D)

II. THE METHOD OF BP NEURAL NETWORK

BP neural network is a multi-layer feed-forward nonlinear mapping network which uses back-propagation algorithm (BP algorithm) to train. In BP neural network, each neuron receives an input from the former one and output to the next level, and the network has not feedback connection. Because the input layer nodes and output layer nodes can be linked with the outside world, and directly influenced by environmental, they are called visible layers, while the other middle layers are called the hidden layers.

The input neuron is h, hidden layer neurons is i,and output neurons is i; n_h, n_i, n_j are the number of nodes, θ_i, θ_j are thresholds of hidden layer nodes i and output layer nodes j; ϖ_{hi}, ϖ_{ij} are weight between input layer nodes h and hidden layer nodes i,and between hidden layer nodes and output layer nodes j.The input of each node is x and the output is y.Steps of BP algorithm are as follows:

Step 1: Input and output sample.

$$\left\{x_{k,h}, d_{k,j} \middle| k = 1,2,..., n_h; j = 1,2,..., n_j\right\}$$

Step 2: $k = 1$,the sample $(x_{k,h}, d_{k,j})$ provided to the network.

Step 3: Calculate input values x_i and output values y_i.

$$x_i = \sum_{h=1}^{n_h} \varpi_{hi} x_{k,h} + \theta_i \qquad y_i = 1 \Big/ (1 + e^{-x_i})$$

Step 4：Calculate input values x_j and output values y_j.

$$x_j = \sum_{i=1}^{n_i} \varpi_{ij} \bullet y_i + \theta_j \qquad y_j = 1 \Big/ (1 + e^{-x_j})$$

Step 5：Calculate the following formula.

$$\frac{\partial E_k}{\partial x_j} = y_i(1 - y_i)(y_i - d_{k,j}) \qquad E_k = 0.5 \sum_{j=1}^{n_j} (y_j - d_{k,j})^2$$

Step 6：Calculate the following formula.

$$\frac{\partial E_k}{\partial x_i} = y_i(1 - y_i) \sum_{j=1}^{n_j} \left(\frac{\partial E_k}{\partial x_j} \bullet \varpi_{ij}\right)$$

Step 7: Modify the connection weights and thresholds.

$$\varpi_{ij}^{t+1} = \varpi_{ij}^{t} - \eta \frac{\partial E_k}{\partial x_j} y_i + \alpha(\varpi_{ij}^{t} - \varpi_{ij}^{t-1}) \qquad \theta_j^{t+1} = \theta_j^{t} - \eta \frac{\partial E_k}{\partial x_j} + \alpha(\theta_j^{t} - \theta_j^{t-1})$$

$$\varpi_{hi}^{t+1} = \varpi_{hi}^{t} - \eta \frac{\partial E_k}{\partial x_i} x_{k,h} + \alpha(\varpi_{hi}^{t} - \varpi_{hi}^{t-1}) \qquad \theta_i^{t+1} = \theta_i^{t} - \eta \frac{\partial E_k}{\partial x_i} + \alpha(\theta_i^{t} - \theta_i^{t-1})$$

Modify the number of is t.Learning rate is $\eta \in (0,1)$ .Momentum factor is $\alpha \in (0,1)$.

Step 8： $k = k+1$ ， Repeat step 2 to step 8. Until the network meet the requirements of the global error function。The global error function is

$$E = 0.5 \sum_{k=1}^{n_k} \sum_{j=1}^{n_j} (y_i - d_{k,j})^2$$

Neural network structure is as follows:

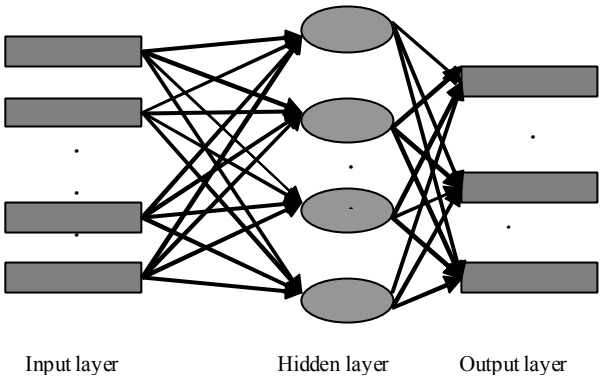

Figure 1 Neural network structure

Process flow chart of BP algorithm, as shown in Figure 2

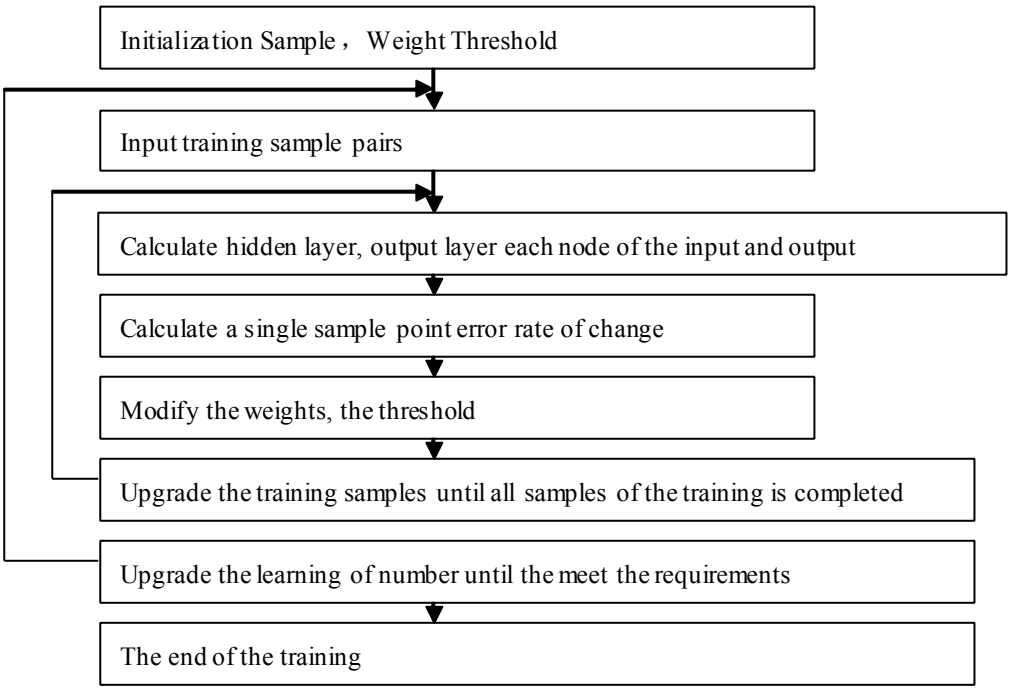

Figure 2 BP algorithm flow chart

So we can see that BP algorithm can sum up the input and output problems of a group of samples in a non-linear optimization problem, which uses negative gradient descent method in optimization methods. It uses iterative method to get the weight and threshold of network

corresponding to the process of learning and memory in the network, and increase the adjustable parameters of optimization problem by adding hidden nodes, to obtain more accurate solution.

III. The Wind Power Project Investment Risk Evaluation Based on BP Neural Networks

A. The index system of wind power projects

The evaluation of project investment should be in line with the ideas and methods of systems engineering, and follow the principles of comprehensive, comparability and economic, social and environmental benefits.So we build a multi-objective index system , according to the characteristics of project investment and the subordinate relationship between the factors.

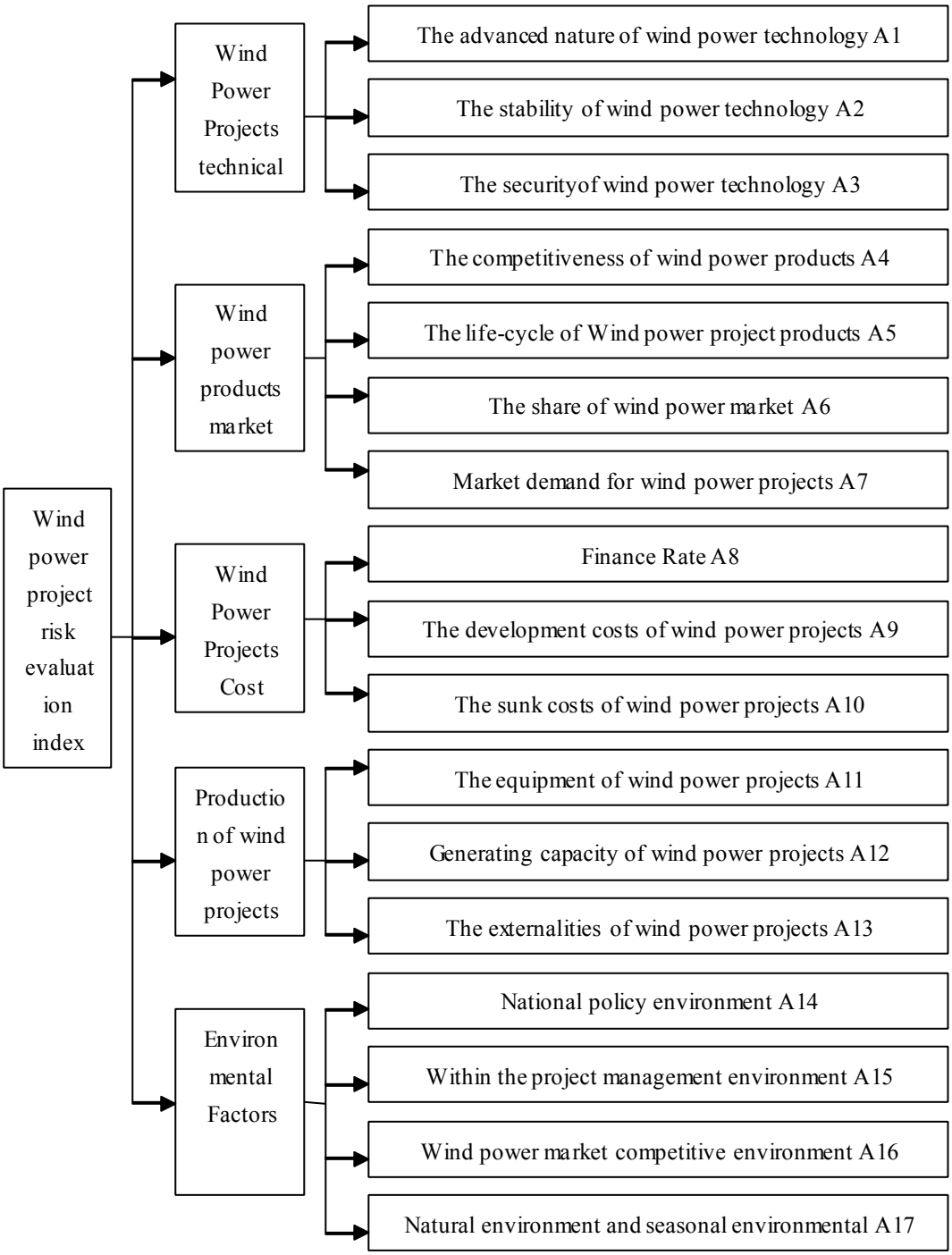

Figure 3 index system of wind power projects

B. Application of BP neural networ

TABLE 1 EXPERT EVALUATION FORM

No.	1	2	3	4	5	6	7	8	9	10	11	12
A1	0.3	0.5	0.5	0.5	0.7	0.3	0.5	0.5	1.0	0.7	0.5	0.5
A2	0.7	0.7	0.5	0.5	0.3	0.7	0.5	1.0	0.7	0.7	0.7	0.5
A3	0.7	1.0	0.7	0.7	0.7	0.7	0.5	0.5	0.7	0.5	1.0	0.5
A4	0.5	0.5	0.7	0.5	0.5	0.7	0.3	0.7	0.5	0.5	0.7	0.7
A5	0.7	1.0	1.0	0.7	0.5	0.5	0.7	0.5	1.0	0.7	0.7	0.5
A6	0.7	0.7	0.7	0.7	1.0	1.0	0.7	0.7	0.5	1.0	0.7	1.0
A7	0.5	0.5	0.7	0.5	0.3	0.7	1.0	0.7	0.3	0.7	0.7	0.3
A8	0.7	1.0	0.5	0.5	0.5	0.7	0.7	0.5	0.7	0.5	0.5	0.7
A9	0.3	0.1	0.5	0.3	0.3	0.3	0.1	0.5	0.5	0.3	0.3	0.3
A10	0.7	0.3	0.7	0.7	1.0	0.5	0.5	0.7	0.5	0.7	0.7	1.0
A11	0.3	0.7	0.3	1.0	0.5	0.7	0.7	0.5	0.7	0.7	1.0	0.5
A12	0.5	0.5	0.3	0.7	0.1	0.3	0.3	0.5	0.5	0.5	0.3	0.5
A13	0.7	0.7	1.0	0.5	0.7	0.7	0.5	1.0	0.7	1.0	0.5	0.5
A14	0.7	1.0	0.7	0.5	0.7	0.7	0.5	0.7	0.7	0.5	1.0	0.5
A15	1.0	0.7	0.7	0.7	0.5	0.7	0.7	0.5	0.5	0.7	1.0	0.7
A16	0.5	0.3	0.3	0.5	0.7	0.5	0.5	0.3	0.7	1.0	0.5	0.5
A17	0.1	0.3	0.1	0.1	0.3	0.3	0.1	0.1	0.5	0.5	0.3	0.1

Take the previous nine wind power plant datas as test data for BP neural network, and the mean value from rating form as the results of expert evaluation, to analyze the data of the three wind farms, and then get a conclusion that error of network analysis agree with the results of expert evaluation, so it meet the requirements. As shown in the Figure 4

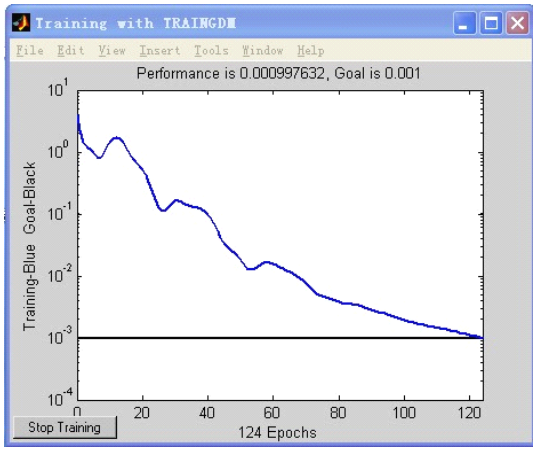

Figure 4 The results of network training

Where learning rate of 0.05, the training frequency of 1000 times, and we also pointed out that indicators of the degree of risk factor assessment form.As shown in Table 2:

TABLE 2 INDICATORS OF IMPORTANCE AND RISK TABLES

Indes	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17
The number of evaluatio-ns	6.5	7.5	8.2	6.8	8.5	9.4	6.9	7.5	3.8	8.0	7.6	5	8.5	8.2	8.4	6.3	2.8
Risk facto-rs	0.054	0.063	0.068	0.057	0.071	0.078	0.058	0.063	0.032	0.067	0.063	0.042	0.071	0.068	0.07	0.053	0.023

In the table above, smaller risk factors mean the higher risk, that is, this indicator is more important. Therefore, it is easy to see that risk factors in the table A9, A12 and A17 are less than 0.05, that is, , these three indicators in the system of risk project should be priority.

IV. CONCLUSION

This paper uses Matlab neural network toolbox which covers neural networks packaging functions, initialization function, training function, and other network properties to establish a neural network object, and then to train and simulate. And the results meet the requirements.

This paper establishes the system of risk evaluation index for wind power project and risk assessment model of BP neural network. According to the study ,we can obtain that have shown that the model can make an accurate assessment of the risk of wind power projects,which have far-reaching practical significance.

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