Scientific Research

Location of the Refuge Chamber

Tongyong NAN, Lizhong XIANG

Liaoning Technology University Fuxin, Liaoning, China, 123000

Email: *Tongyongnan77@163.com*

Abstract: The location of the refuge chamber is relationship to the life safety of mine workers, policy makers need to Integrat a number of factors for making decision, establishing the refuge chamber in decision-making fuzzy evaluation matrix in this paper, using BP artificial neural network for processing to avoid the fuzzy evaluation matrix inconsistency test problem, an objective decision-making program on the merits of multiple locations to conduct a comprehensive evaluation, a reasonable choice for the location of the refuge chamber to make the right decision.

Keywords: refuge chamber; Location decision; neural networks

1 Introduction

Reasonably layout refuge chamber for the mine workers in the face of crisis situations, to secure valuable time and reduce routine maintenance difficulties. Therefore, the location of refuge chamber for the entire mine safety decision-making system optimization is a very important issue. For such problems, researchers generally establish fuzzy evaluation matrix to solve such problems. However, AHP is often necessary for fuzzy evaluation matrix consistency test, so this method is not practicable. In this article, based on the analytic hierarchy process, BP artificial neural network approach to the location of the refuge chamber can be a good decision-making to solve the above problems, BP artificial neural network can be trained to learn the characteristics of the test to avoid the analytic hierarchy process , better decisions.

2 BP artificial neural network

BP network in 1986 by Rumelhart and McCelland led team of scientists is made an error back propagation algorithm by training the multilayer feedforward network, which is one of the most widely used neural network model . BP neural network can learn and store a lot of input - output model mapping, without having reveal the mathematical of the mapping equations. Its learning rule is the steepest descent method, with back-propagation network to continuously adjust the weights and thresholds, minimum squared error of the network. BP neural network model topology including input layer (input), hidden layer (hide layer) and output layer (output layer). Which is only one layer, hidden layer can have one or more layers. There is no connection between the same layer nodes. Each network node represent a neuron, its transfer function is usually used Sigmoid-type function [9]. BP algorithm from the data stream prior to the calculation (forward propagation) and the error signal of the two processes constitute the back-propagation. Forward propagation, the propagation direction of the input layer → hidden layer → output layer, each neuron's state only under the influence of a layer of neurons. If not desired in the output layer output error signal is turned to the back-propagation process. By alternating these two processes, the implementation of the right vector space gradient descent strategy of error function, the dynamic iterative search for a set of weights vector, the network error function reaches a minimum, thus completing the process of information extraction and memory. BP algorithm is a kind of mentor learning algorithm, a single sample study as follows:

1) pre-

① determine the training sample set xp p = 1,2 ... take one of the sample code;

② give the desired output value (class value).

(2) Initialize the weights Wi i Wj k.

(3) prior to the calculation

① input to the hidden layer $h_j = \sum_i w_{ij} x_i$ and output $y_j = f(h_j)$ Is, $f(x) = \frac{1}{1+e^{-x}}$ which is sigmoid the function.

② the input of the output layer, $h_k = \sum_i w_{jk} y_j$ Output $y_k = f(h_k) = \sum_j w_{jk} f\left(\sum_i w_{ik} x_i\right)$

③ defined error $\varepsilon = \frac{1}{2}\sum_k (t_k - y_k)^2$

(4) error back propagation

① update rule

Use gradient descent method to adjust the weights, learning rate is η.

$$\Delta w_{jk} = -\Delta w_{jk} \frac{\partial \varepsilon}{\partial w_{jk}} = \eta \delta_k v$$

Among $\delta_k = f'(h_k)(t_k - y_k)$

978-1-61896-007-8

$$\Delta w_{ij} = -\eta \frac{\partial \varepsilon}{\partial w_{ij}} = \eta \delta_j x_i$$

Among $\delta_j = f'(h_j) \sum_k \delta_k w_{jk}$,

② update the weights

$$w_{ij}^{new} = w_{ij}^{old} + \Delta w_{ij},$$

$$w_{jk}^{new} = w_{jk}^{old} + \Delta w_{jk}$$

Thus, finish a calculation of sample.
When the number of training samples is P, the update on the following principles:

$$\Delta w_{jk} = \eta \sum_p \delta_{pk} y_{pj},$$

Among $\delta_{pk} = f'(h_{pk})(t_{pk} - y_{pk})$

$$\Delta w_{ij} = \eta \sum_p \delta_{pj} x_{pi},$$

Among $\delta_{pj} = f'(h_{pj}) \sum_k \delta_{pk} w_{jk}$,

3 Use BP artificial neural network location of the refuge chamber with decision analysis

The decision of the location of the refuge chamber is usually under the guidance of certain conditions, such as the ability to maintain refuge chamber, the time of mine works reach refuge chamber under the disaster, the refuge chamber for ease of construction, refuge cave room construction cost of these conditions, pre-select some programs, and then compare these programs with a variety of ways, and ultimately choose the one or few satisfactory programs as the new location of the refuge chamber. The following will be combined with a simplified example to illustrate the use of BP neural network to complete the evaluation steps:

3.1 Determining the location of the refuge chamber indicator system of decision-making

The decision of the location of refuge chamber can be affected by many factors, this paper will combine the situation and characteristics of the refuge chamber to select a number of important factors, as indicators for making decision. These factors include the ability to maintain the refuge chamber, the refuge chamber of anti-disaster capacity, the density of workers, the cost of the refuge chamber, time of reaching the refuge chamber.

3.2 The establishment of fuzzy evaluation matrix

Collecting the historical data of the refuge chamber and four factors of the pre-program, some indicators are the qualitative and some are quantitative, so the different indicators are used different membership function, then determine the degree of membership of each level of the indicator. These data as possible, this will help our future network adequate training.

Previous data identified eight indicators, assuming that the resulting fuzzy evaluation matrix in Table 1.

Top 5 program is based on the use of the refuge chamber of the data, as this training program, after the 10 programs are alternative solutions to be processed.

3.3 Neural network model design

Reasonably determine the network layer, and the number of neurons in the network's successful application of BP neural network model is the key. Connection weights of each layer generally take a random number, usually a layer of hidden layers on it. Choose the number of hidden layer unit is a complex issue and there is no good analytical expression, depending on the requirements of the problem, the input and output layer units to determine how much, not too much, otherwise the network training time increased dramatically, and difficult to distinguish data in real mode, of course, not too little.
As examples of the target system has five indicators, so the number of input layer units can be designed for five. Designed for the middle layer, unit number three, the number of output layer unit designed for one. Model structure is shown in Figure 1.

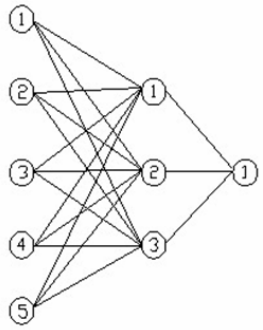

Figure 1. The location of the refuge chamber design of the neural network model instance

3.4 Training neural networks

Fuzzy evaluation matrix in Table 1

Chamber position	population density	the ability to maintain	cost	required time	against disaster
Scenario 1	1.0	1.0	1.0	1.0	1.0
Scenario 2	0.81	0.52	0.72	0.66	1.0
Scenario 3	0.90	0.66	0.32	0.55	0.45
Scenario 4	0.77	0.69	0.88	0.39	0.81
Scenario 5	0.61	0.86	0.91	1.0	0.66
Scenario 6	0.42	0.52	0.60	0.53	0.61

Scenario 7	0.38	0.46	0.62	0.30	0.52
Scenario 8	0.29	0.71	0.55	0.48	0.36
Scenario 9	0.88	0.33	0.44	0.40	0.51
Scenario 10	0.50	0.49	0.61	0.56	0.71

Give the value of teachers to determine the learning factor and the initial value. General learning factor is between 0.1-0.9, the initial value of weights and thresholds, including the initial value, usually a random value between 0 and desirable. The training data input network, to learn, until the train was close to expected results.

Experts to evaluate the first five programs have been used, given the value of evaluation, that teachers value. Take the learning factor of 0.1, the initial value of taking a random number, according to the previously described three-layer BP neural network learning algorithm and neural network model for calculation of the preparation of computer programs, the use of computer training, until the value of basic teacher training results and close. Each training program is trained for 283, that is 283 times the loop executes the above algorithm results in table 2.

Table 2. BP neural network training results

neural network training results					
sequence	Results of evaluation of training	program	sequence	the value of the program ranking	program
1	0.93	1	1	1.0	1
3	0.753	3	3	0.742	3
5	0.58	5	5	0.576	5
4	0.732	4	4	0.708	4
2	0.80	2	2	0.808	2

3.5 With the trained neural network processing of data to enter data into neural network processing, the results obtained in Table 3

According to the results in Table 3

Program	The results	Ranking
6	0.536	2
7	0.456	5
8	0.478	4
9	0.512	3
10	0.574	1

The results can be seen in Table 3, the best program is program 10, and program 7 is the worst. According to this table to determine the location of the program of refuge chamber.

These are simplified examples, in practical applications, because many indicators, the design of neural network input layer unit number will be more and more, the network layer may be greater than three, this time using principal component analysis is generally method to remove some of the indicators related to retain the main index, so you can still use the steps above for processing. Conclusion: From the above analysis shows that use of BP artificial neural network approach downhole refuge chamber of the location decisions relative to other methods the following advantages: First, BP network is based on the data provided, through learning and training, identify the input and output of internal relations, and thus find the solution of the problem, rather than empirical knowledge, which has adaptive capabilities, can weaken the target weight to determine the influence of human factors, it is better than the fuzzy evaluation method. Second, the location of underground refuge chamber program evaluation in practice is very complex interaction between various factors, showing a complex non-linear relationship, BP artificial neural network is a powerful tool for dealing with such problems, and linear programming lacks the ability to handle non-linear, interactions between factors also limit the use of AHP. Therefore, the location of refuge chamber decision-making, if certain historical data are available, use the BP neural network based on a comprehensive evaluation of decision-making compared to other evaluation methods have great advantages.

References

[1] Gong shang-bao, Guo yu-cui, “BP neural network-based community hospital site selection,” China Science and Technology Information.pp. 185–186, November 2009.

[2] Qiu ming-jing, “Logistics center location of the fuzzy comprehensive evaluation,” The higher Vocational Education of weifang.pp69-72, April 2006.

[3] Zhang jing-ru, Yang de-zhi, “Floyd shortest path algorithm in a community hospital located in the application,” Science and Technology Information. pp. 484–486,May 2008.

[4] Wu jian,Shi zhong-ke, “Based on genetic algorithm distribution center location problem,” Journal of south china university of technology pp.71-74,June 2004.

[5] Lu hua,Yang jia-qi, “Fuzzy heuristic ordering and logistics center location in the application,” Journal of Wuhan University of Technology, pp. 389–392, June 1987.

[6] Huang xiao-qing, “Fuzzy comprehensive evaluation method in the application of logistics center location, ” Modern Logistics pp.7-15, March 2002.

[7] Zhao li-an,Wang tie-li, “Chamber underground coal mines abroad, the application of disaster prevention and Enlightenment, Mine Safety 2007.

978-1-61896-007-8 © 2012 SciRes.