

# The Application of SOFM Fuzzy Neural Network in Project Cost Estimate

WenFeng Feng, WenJuan Zhu

<sup>1</sup>School of computer science and technology, Henan Polytechnic University, Jiaozuo, China

Email: [cbfwq3006@163.com](mailto:cbfwq3006@163.com)

**Abstract**—Applications of neural network were widely used in construct project cost estimate. Aim at handling weakness of poor convergence and insufficient forecast, an improved fuzzy neural network method based on SOFM (self-organizing feature map) was proposed to replace the fashionable T-S fuzzy neural network. The method illustrated how to apply SOFM to improve the fault such as poor convergence and insufficient forecast. After optimizing of T-S fuzzy neural network model, construct project cost estimate model had been built up. Finally, the model was set up with the purpose of comparing generalization ability by 18 examples and 2 testing samples. Comparing the simulation, a positive result was found that SOFM fuzzy neural network had a better performance in reducing the forecast error and iterating times than BP, and GA-BP. Therefore, this model is fit for handling construct project cost estimate.

**Index Terms**—fuzzy neural network, self-organizing feature map, cost estimate

## I. INTRODUCTION

With the implement of evaluation of bid method which is proposed in “The construction contract and contract valuation management methods” and “tendering method”, it is necessary to analysis project cost in correctly way during the process of project cost estimate. Construction cost is the essence properties of cost estimate in construct. It is the summation of general expenses. Traditional construct cost estimate method was applying mechanically estimate index and enterprise quota. The method of applying mechanically enterprise quota has great workload, and slow estimated speed. Meanwhile, quota has strong comprehensiveness. So, it can not reflect timeliness of concrete project feature. The method of applying estimate index is calculated according to completed similar project. Due to the uncalculated similarity between project, and the limitation of construct time and market condition, the modified method by price index and regression analysis can not content the requirement of estimate accuracy. How to acclimatize project cost estimate quickly and accurately to reality project cause more and more attention. For the past few years, scholars at home and abroad were proposing numerous methods. BP speediness estimate method is an effective way; however, it has many problems to solve the contradiction between reality scale and network scale

because of the low speed in learning, and the over fitting performance. Reference [1] put forward T-S fuzzy neural network to settle this problem. Whereas owing to random parameter and samples acquired by equal interval, it made an ideal environment for actually samples. The network designed by this way had an inaccuracy output value and poor generalize ability. Some references raised a method that combine BP, K-means, and T-S fuzzy neural network together in order to improve the performance. However k-means need the parameter which has been set by expert. This article presents a T-S fuzzy neural network method based on KOHONEN. In another word, self-organizing feature map confirm the center and width of membership function to avoid the interferences which are made by artificial factors. And then the weight of every rule can be calculated by traditional product operator. At the end of the network, reverse calculation should be chosen to get the output value. Hereinto, the adjusting process can be realized by BP.

For the past few years, artificial neural network provide an efficient way to solve this question. Especially, the application of BP (back propagation) has a popular use. However, BP is easily to sink into birth defects take examples as topo-minimum, slow convergence speed, instability system and so on. This article present a method that combine fuzzy mathematic into neural network. Nevertheless, it is different from the model which proposed by Shi Feng in literature [1]. T-S fuzzy neural network can have a lower error, and faster convergence, merely poor generalization ability. The reason why is that center value and width are randomly set. In order to figure out this problem, this article put forward SOFM clustering method to get the center value and width, and then the center value and width should be put into T-S fuzzy neural network to compute and analysis with the purpose of getting the feasibility of this scheme.

## II. SOFM FUZZY NEURAL NETWORK MODEL PRINCIPLES

### A. SOFM Summary

Self-organizing feature map can be called as KOHONEN model or topology model. At the earliest, it was proposed by Malsburg. The current pattern is developed by Kohonen. The function of SOFM is adjust the weight by a great number of samples through self-organizing method, so as to make the output data can reflect disposition of the samples. The training algorithm has two parts, similarity match and update. The concrete steps can be stated as follows.

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1) Initialization. A random number can be given to weight vector in output layer and then it can get a normalization dispose to acquire  $W_j, j=1, 2, \dots, m$ . An initial winning neighbourhood  $N_j^*(0)$  can be set up, and the learning rate  $\eta$  was given to a initial value.

2) accept input data. Chose an input pattern in a random way from the training data and then normalize it to get  $X_n, n \in c$ .

3) In search of wining node. Compute the dot metrix of  $W_j$  and  $X_n, j=1,2,\dots,m$ . And find the maximum wining node  $j^*$  of the dot metrix. Whereas if the input patterns do not have normalization, the Euclidean distance should be computed according to the following equation.

$$|x - \hat{w}_i^k| = \min_{1 \leq j \leq m} \{|x - \hat{w}_j^k|\}$$

In order to find the wining node which has the nearest distance.

4) Define wining neighbourhood  $N_j^*(t)$ . Initially, neighbourhood  $N_j^*(0)$  is comparatively large. During the training process,  $N_j^*(t)$  gradually shrink in a unit radius.

5) Adjust weight. Node weight in the wining neighbourhood  $N_j^*(t)$  should be adjusted according to the following equation.

$$\hat{w}_i^{k+1} = \hat{w}_i^k + \eta^k(x - \hat{w}_i^k)$$

$\eta(t, N)$  is a function of training time  $t$ , and it is a function of topology distance between wining neuron  $j^*$  and the  $j$ th neuron in the neighbourhood.

After finishing, centers and the distance between centers extracted from SOFM can be considered as center position and width of membership function [2].

### B. Fuzzy System and Neural Network Summary

Fuzzy system is totally different from neural network among their basic feature and application. Both of them have great fault-tolerant capability during information processing. Differently, fuzzy system can simulate people's method of fuzzy logic thinking. Fuzzy mathematics is used for description, research, and handling fuzzy feature which object have. The essential concept of fuzzy mathematics is membership and fuzzy membership function. Among them, membership indicate  $u$  belong to degree of membership of fuzzy subset  $f$ . It can be shown as  $\mu_f(u)$ , and it is the number among 0 to 1. If the  $\mu_f(u)$  close to 0, it indicates that the degree of fuzzy subset  $f$  is small. Otherwise, the degree of fuzzy subset is big. Neural network's fault-tolerant capability which shows up during information processing is from structural features of network. While our brain's fault-tolerant capability is stem from both of them-----fuzziness of thought method and structural features of brain. This feature can give direction to the combination of fuzzy system and neural network.

### C. T-S Model

T-S model designs controller by the method of PDC. Definitely, it means that each topo-subsystem separately design locality controller. Locality controller multiply by various locality weights, and then the value added together is the whole controller output data. Topo-fuzzy controller can be designed in a linear method, and it also can be plan

by other mature theory. A simple linear method is proposed in this article. The feature of T-S model is that it not only can auto update the weight, but also can modify membership function of fuzzy subset. T-S fuzzy system is defined by the rule such as if-then. The rule can be stated as follows.

If variable is congregation Then action.

For instance, a very simple temperature adjuster made use of fan.

If temperature is very cold Then stop the fan.

If temperature is cool Then slow down the fan.

If temperature is normal Then keep the speed.

If temperature is hot Then speed up the fan.[3]

Under the circumstance when the rule is expressed as  $R^i$ , fuzzy reasoning can be shown as follows.

$R^i$ : If  $x_1$  is  $A_1^i, x_2$  is  $A_2^i, \dots, x_k$  is  $A_k^i$  then  $y_i = p_0^i + p_1^i x_1 + \dots + p_k^i x_k$

$A_j^i$  is fuzzy subset of fuzzy system.  $p_j^i$  ( $j=1,2,\dots,k$ ) is parameter of fuzzy system.  $y_i$  is the output data which acquire according to fuzzy rules. The section of if is expressed in fuzzy logic and the section of then is a concrete value. The fuzzy inference process expresses that the output data is a linear combination of input data.

Suppose there is a output vector like  $x = [x_1, x_2, \dots, x_k]$ . Based on T-S model, the membership of input variant  $x_j$  have been computed.

$$\mu A_j^i = \exp\left(-\left(x_j - c_j^i\right)^2 / b_j^i\right) \tag{1}$$

Among the equation,  $j=1,2,\dots,k; i=1,2,\dots,n$   $c_j^i$  is the center of membership and  $b_j^i$  is the width of membership. We should use SOFM to get the parameter of center and width.  $K$  indicates input vector and  $n$  indicates fuzzy subset.

Membership functions are computed by fuzzy, and fuzzy operator are adopted by multiply operator.

$$w^j = uA_j^1(x_1) * uA_j^2(x_2) * \dots * uA_j^k(x_k) \tag{2}$$

Here,  $u$  indicates input data, and  $n$  indicates rule number.

In terms of fuzzy computation, output  $y_i$  can be work out.

$$y_i = \sum_{i=1}^n w^i (p_0^i + p_1^i x_1 + \dots + p_k^i x_k) / \sum_{i=1}^n w^i \tag{3}$$

### D. T-S Fuzzy Neural Network Algorithm

T-S fuzzy neural network can be split into four layers such as input layer, fuzzy layer, rules computation layer and output layer. Input layer connect with input vector  $x_i$ , and node has same dimension with input vector. The fuzzy layer adopts membership function (1) to make the input value into fuzzy membership value  $\mu$ . Fuzzy rules computation layer adopts fuzzy multiply equation (2) to get  $w$ . Output layer adopts equation (3) to compute the output value of fuzzy neural network. The learning algorithm of fuzzy neural network can be stated as follows.

1) Error computation

$$e = \frac{1}{2}(y_d - y_c)^2 \tag{4}$$

In the equation,  $y_d$  is expected output data,  $y_c$  is the real output data, and  $e$  is the error between expected output data and real output data.

2) Factor rectification

$$p_j^i(k) = p_j^i(k-1) - a \frac{\partial e}{\partial p_j^i} \tag{5}$$

$$\frac{\partial e}{\partial p_j^i} = (y_d - y_c) w^i / \sum_{i=1}^m w^i \cdot x_j \tag{6}$$

In the equation,  $p_j^i$  is the factor of neural network,  $a$  is the learning rate of the network,  $x_j$  is multiply product of the membership of input data.

3) Parameter rectification

$$c_j^i(k) = c_j^i(k-1) - \beta \frac{\partial e}{\partial c_j^i} \tag{7}$$

$$b_j^i(k) = b_j^i(k-1) - \beta \frac{\partial e}{\partial b_j^i} \tag{8}$$

In the equation,  $c_j^i(k)$  is the center of membership function, and  $b_j^i(k)$  is the width of membership function. Due to the rectification of parameters, we can get the new center and width, with the purpose of getting a more excellent output data. The parameter rectification process should be excute in the same time as factor rectification.

### III. EXAMPLE APPLICATION AND ANALYSIS

This study investigates the use of SOFM fuzzy neural network in the design and implementation of neural network controller. Features of construction project have been chosen in using matlab to realize cost estimate. According to building operations technology which was written by Xi Zhang in Mach, 2008, 7 features were chosen as classified standards in construction such as base type, architecture form, number of plies, door and window, siding ornamental, wall, and plane assemble. The quantify description can be stated as follows.  $m$  kinds and building project samples have been got. Each sample has 7 features. So a network input model can be fixed as follows.

$$P_k = (P1_k, P2_k, \dots, Pn_k) \quad k=1,2,\dots,m, \quad n=7$$

It can be seen that  $m$  kinds of vectors of building project samples have been built up. There are 7 features in every sample. And then quantify description of any constructional engineering can be given. It can be shown as  $T_i = (t_{i1}, t_{i2}, \dots, t_{ij})$ .  $T_i$  can be stated as the serial-number of the  $i$ th project.  $t_{ij}$  ( $j = 1,2,\dots,7$ ) indicates quantify values of  $j$ th feature in project  $i$ . Taking a project for example, if the project has 7 features such as brick foundation, 5 floors, timber door and aluminum alloy window, siding rock dash, standard brick, three chambers and one hall. So the quantify description can be expressed in  $T_i = (1, 1, 2, 3, 2, 2, 3)$ . We can choose 20 premises from a

constructional operations company in China as these descriptions. 7 features can be considered as samples. On the basis of the above method, training samples can be stated as table 1.

TABLE I. TRAINING SAMPLES

N	input data							output
	x1	x2	x3	x4	x5	x6	x7	y1
1	1	1	2	1	1	2	2	498
2	3	1	2	3	3	2	4	525
3	2	1	1	1	2	2	2	493
4	1	1	1	1	1	1	2	487
5	1	1	1	3	2	2	3	506
6	2	1	2	3	3	2	4	538
7	3	1	1	1	2	2	4	542
8	4	1	2	3	3	2	5	562
9	2	2	4	3	3	3	4	897
10	3	2	5	3	3	3	3	989
11	4	2	6	3	3	3	4	1045
12	5	2	4	2	4	3	4	876
13	5	4	6	3	4	2	4	857
14	5	2	4	3	3	3	4	923
15	6	2	3	3	3	3	4	948
16	6	3	4	3	3	3	3	747
17	6	2	4	3	4	3	4	689
18	6	4	6	3	4	2	3	936

The data of table 1 can be loaded into matlab, and then we can use BP algorithm, GA-BP algorithm and SOFM fuzzy neural network to learn the neural network with the purpose of comparing the ability of predicting test values. There still has other examples of construction cost estimate in [4].

#### A. Matlab realization of BP in Construction Cost Estimate

BP neural network is similar to multilayer perceptron on structure. It is a multilayer feed-forward neural network. Its name derives from adjusting training algorithm which is error counter-propagation algorithm in the training network. [5]The whole name is artificial neural network based on error counter-propagation. It is an excessive mapping function that has counter-propagation and error amendment. Memory connecting in the mind can be expressed after the learning of input and output parameters.

BP network has three layers including input layer, hidden layer, and output layer. The weight from input layer to hidden layer can be set as  $w1$ , and the threshold of the hidden layer can be set as  $v1$ . The weight from hidden layer to output layer can be set as  $w2$ , and the threshold of output layer can be set as  $v2$ . Because of the singularity matrix in the sample, the first step should take the samples normalization.

There have 7 input layer neurons in the code. If we want one output result, the output layer neuron is 1. According to kolmogorov theory, the neuron number in the hidden layer is among 4 to 14.

In our model we set the hidden layer number is 10 with the method proposed by reference [6], deliver neuron function is tansig in the hidden layer, and the output layer's deliver neuron function is purelin. BP network taining function has been set at trainlm. We plan to train 1000 times, and the learning rate is 0.1. The goal value is 0.002. Then we can build up our BP network. The concrete code can be written as the following:

```
net=newff(minmax(input_train),[10,1],{'tansig','purelin'},'trainlm');
```

The input\_test value that we want to predict should be put into the network which has been build up. Input\_test has two vectors, [2 1 1 3 2 2 2.5] and [5 4 7 3 4 3 4.1]. The concrete code can be written as the following:

```
an=sim(net,input_test);The result is shown as figure 1.
```

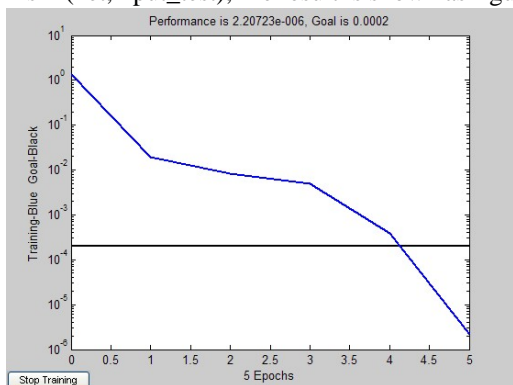


Figure 1. Purelin error alteration

Errors are 0.1075, and 0.1261. If delivering neuron function of output layer is logsig and training function is traingdx, while the other parameters is not changed, then the result can be seen as figure 2.

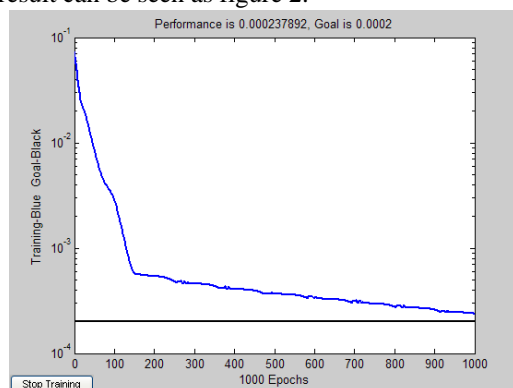


Figure2. Logsig error alteration

From the figure 2, we have seen that BP network has been sank into local minimum. How can we get the goal value in 1000 steps.

● Advantages of BP algorithm

BP algorithm, which has been proposed by Rumelart in 1986, is a supervised learning algorithm. Henceforth, BP neural network has a great application because of the simple structure, multiple adjustable parameters, many

kinds of training algorithm and well manipulation. According to statistics, 80%-90% neural networks adopt BP network or the transformation of BP. BP network is the hard-core of the feed-forward network. It reflects the perfect content of neural network. BP algorithm has been made up of two sections: forward-propagation of information and counter-propagation of error. During the process of forward-propagation, the input information transmits into output layer through input layer and hidden layer. Neural in every layer can affect the neural condition in the next layer. If the expected output result can not get in the output layer, the error alteration should be worked out. Then the process must add counter-propagation. Error signal counter transform into the neural in every layer along the primary connection in order to get the expected goal.

● Drawback of BP algorithm

Due to BP network should be inferred based on gradient method and requires continuous derivative of goal function, the convergence speed is slow during the learning process and the result can easily get locality optimal which can not find global optimum and cause oscillation effect. And as a result of random chooses value of BP network's weight and threshold level, initial value in every time is totally different. This can affect the consequence of prediction after training. Owing to fortissimo macroscopic search ability of genetic algorithm, and because of biggish probability finding global optimum, so the genetic algorithm can accomplish prophase searching by overcoming the defect of BP algorithm. Genetic algorithm is a global search algorithm. BP neural network organic integrate with genetic algorithm in order to give them the ability which can have global search capability of genetic algorithm and local search capability of BP neural network. [7-15]Randomness fault of Weight and threshold value can be made up by genetic algorithm (GA), and a better forecast result can be got by it[16]. With the combination of GA and BP, the result can be seen that it is fit for forecast, and it is better than BP[17-19].

B. Matlab realization of GA-BP model in Construction Cost Estimate

Genetic algorithm applied in neural network on the one hand is used for optimizing the structure of ANN, on the other hand is to lean the weight of ANN[20,21]. i.e., genetic algorithm has taken over traditional algorithms. The concrete steps can be written as the following:

(1) Coding. The first problem we should solve is that decision variables must be changed into string structure data, because actually decision variables can not be handled in genetic algorithm.

```
w1(i,k)=x(inputnum*(i-1)+k);
w2(i,k)=x(hiddennum*(i-1)+k+inputnum*hiddennum);
B1(i,1)=x((inputnum*hiddennum+hiddennum*outputnum)+i);
B2(i,1)=x((inputnum*hiddennum+hiddennum*outputnum+hiddennum)+i);
```

(2) Initialize the population. We set the number of population is 80.

(3) Compute fitness of individual in present population. The goal value can be stated as follows.

$$E = \frac{1}{2} \sum_{k=1}^m (u^k - y^k)^2$$

It can be considered as the count of fitness value.

(4) Selection. In the first step, the selection mechanism computes a selection probability according to which the sampling algorithm generates an intermediate population of parents in order to generate new variants by recombination and mutation. The main method is put the current population onto a roulette wheel, such that the slot size of each chromosome corresponds to its selection probability. The intermediate population is generated from identical copies of chromosomes sampled by spinning the roulette wheel N times. Here we use genetic tool box.

(5) Recombination. Instead of every parent chromosome, only a fraction of parent population selected at random according to the crossover probability  $P_c$  is subjected to recombination. Genetic tool box has the concrete code.

(6) Mutation. In GAs, mutation plays the role of a background operator which arbitrarily inverts one or more bits of a parent chromosome to increase the structural variability of the population. Mutation provides a means to restore lost or unexplored genetic material and prevent the GA from premature convergence to sub-optimal solutions. In this sense, mutation performs an exploration of the search space. The realization process can be seen as follow picture.

Due to the steps that we have stated on the above, we can get the result by the parameters which we have chosen from the above. It is easily to sink into local minimal value while use the BP only, even if the parameters are totally different. However, the combination of GA and BP can handle this problem which can be seen as figure 5.

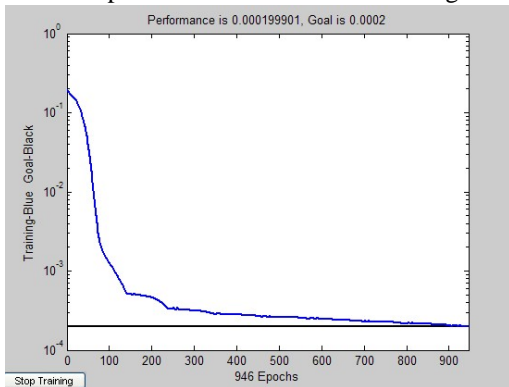


Figure3. Logsig error alteration by GA optimization

It can be seen from figure 3 that genetic algorithm can speed up convergence and handle local minimum problem. The errors are 0.0069, and 0.0263. At this moment, comparing with BP, the error is lower and the generalize ability is better. Therefore, GA-BP model is fit for Construction Cost Estimate. Even though the parameters of figure 1 have been used for comparing, we can see that like figure 4.

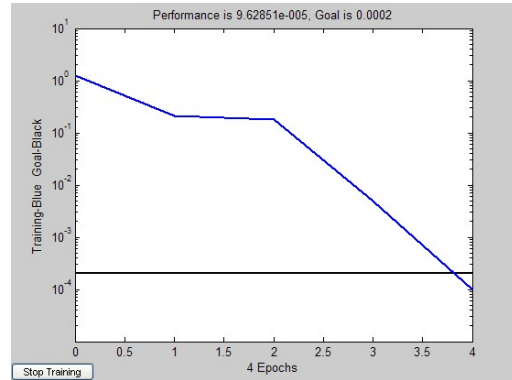


Figure4. Purelin error alteration by GA

Error curve in BP network descends quickly, while error curve in GA-BP network descends gently. But after finding the optimum, the error curve in GA-BP descends rapidly, and the error is lower than BP network. The errors are 0.0492, and 0.1264. Genetic algorithm optimizing figure is as figure 5.

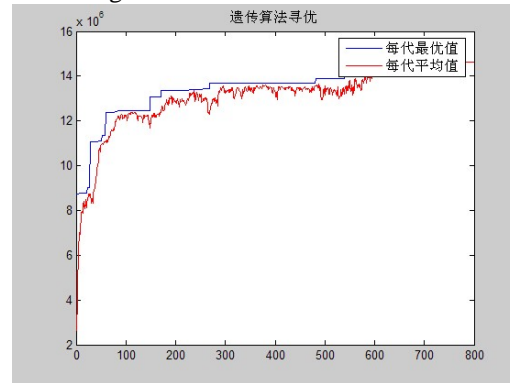


Figure5. Genetic algorithm optimizing

Blue line stands for optimum path, and red line stands for mean value path of each generation. It states that each generation constantly realizes the value that survival of the fittest, consequently the effect of optimal would be obtained.

● Advantages of Genetic algorithm

Genetic algorithms were first proposed by Holland (1975) and are well described in text books (Back, 1996; Goldberg, 1989; Michalewicz, 1996; Mitchell, 1996). Genetic algorithms are theoretically and empirically proven to provide a robust search in complex spaces, thereby offering a valid approach to problems requiring efficient and effective searches. genetic algorithms (GAs) can handle generalize ability problem for improving the accuracy of cost estimation and the performance, and it can have validity of optimizing both the neural network size and its parameters using GAs[22].

An optimization method for construction cost estimate is presented. The method is called GA-BP. GA-BP model adopts the algorithm that chooses the optimized dot from multiply dot in solution space simultaneously. Then a modified BP algorithm is used to search the result. This method not only can avoid local minimum and bad generalize ability problem, but also can overcome the weakness of long training time when GA find the optimum in a random way. It is an effective and efficient

method. The simulate result states that, the modified model has a great improve in generalize ability, and it can give a reasonable response when the new input data is coming. Therefore GA-BP model has got a higher reliability, and it can be used in construction cost estimate.

● Drawback of genetic algorithm

There still has a great many of problems should be researched, and the GAs also have many kinds of shortages. One of the insufficient of the GAs is to drop the convergence speed when the variable quantity is a great many, short-cut process scope is large, or the scope can not be given. Besides, the result can approach the optimum; however, it can not confirm the position of optimum exactly. [23-30]Finally, GAs' parameters can not be chosen in a quantify method. If GAs can be connected with BP in the model, the performance of the model can get lower error and exacter prediction.

So we can see that this method still has shortcoming. It runs a long time, and the error has not attained a satisfied degree. How to realize speediness and efficientness cost estimate is a problem that we need to investigate.

C. Matlab realization of fuzzy neural network model in Construction Cost Estimate

This article presents a T-S fuzzy neural network method based on KOHONEN. In another word, self-organizing feature map confirm the center and width of membership function to avoid the interferences which are made by artificial factors. And then the weight of every rule can be calculated by traditional product operator. At the end of the network, reverse calculation should be chosen to get the output value.

We put the normalized samples into fuzzy neural network and SOFM fuzzy neural network, and set the iterate steps are 100. The performance figure can be stated such as figure 6 and figure 7. After comparing, it can be seen that the error of figure 1 is obviously than figure 2. From this, we can conclude that center and widths of membership function have a great meaning to the result of output data.

Center and widths in a random way may have the error which is rather far from center and widths are set by SOFM.

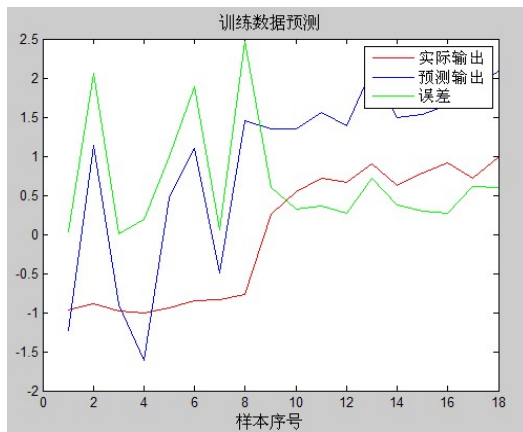


Figure6. General fuzzy neural network error

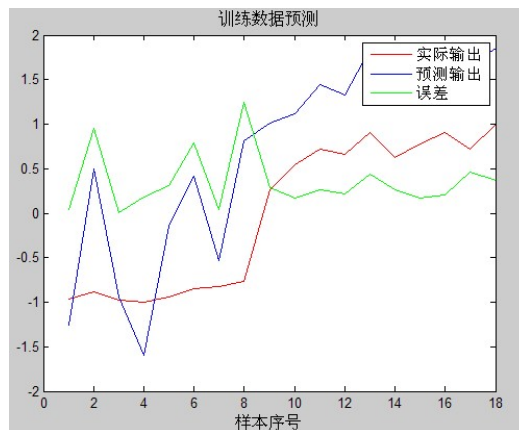


Figure7. SOFM fuzzy neural network error

Put the testing data into these two models to compare the differences. The forecast costs can be described as figure 8 and figure 9. Even though two models both illustrate that three kinds of data costs arrayed from huge to small can be stated as sample sector three, sample sector one, and sample sector two. It is said from accuracy that forecast costs from SOFM fuzzy neural network were more closely to real value 1138.28, 498.76, 1185.84.

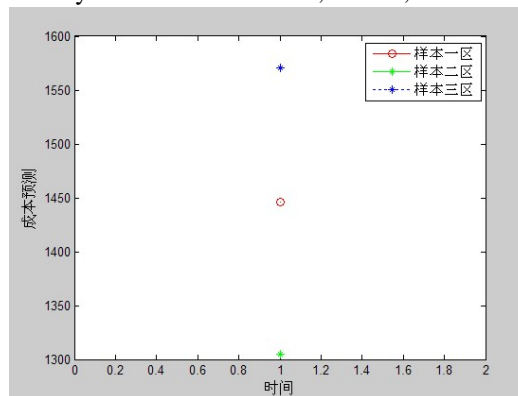


Figure8. General fuzzy neural network error

Figure 3 shows the forecast result of general T-S fuzzy neural network without the process of SOFM system. In another word, the input data without the transformation of fuzzy set can get the similar result as figure 3.

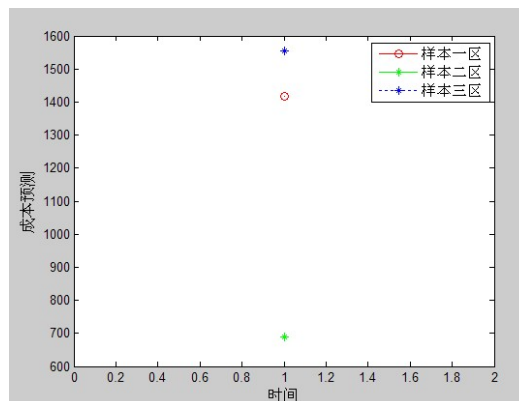


Figure9. SOFM fuzzy neural network error

From figure 8 and figure 9, we can get two conclusions.

(1) SOFM fuzzy neural network forecast costs are more closely to real values. It can be seen that generalization capability of SOFM fuzzy neural network is better than general fuzzy neural network.

(2) Because of the insufficient of sample numbers, input data can not accord with normal distribution. So it leads to the not ideal forecast result.

● Advantages of SOFM fuzzy neural network

T-S fuzzy neural network can have a lower error, and faster convergence, merely poor generalization ability. The reason why is that center value and width are randomly set. In order to figure out this problem, this article put forward SOFM clustering method to get the center value and width, and then the center value and width should be put into T-S fuzzy neural network to compute and analysis with the purpose of getting the feasibility of this scheme.

D. Result analysis

1) the result analysis of BP

After training the error E is 2.9069 and the gradient is small. So we can say that the system has got into local minimum. So we should use algorithm to modify it.

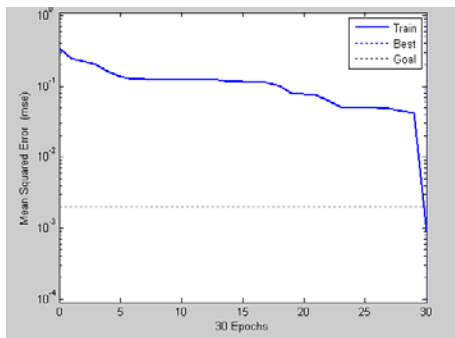


Figure 10. BP running result

2) result analysis of GA-BP

GA-BP is another method which proposed by [31]. The result of GA-BP method can be seen as figure 11.

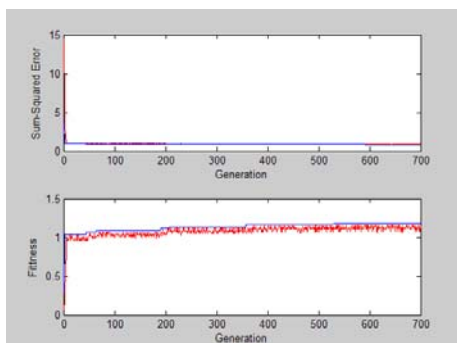


Figure 11. GA-BP result

After running, we can get the error E is 0.0059. After 600 generation, the average fitness of chromosome tends to stable, and the error sum squares curve and fitness curve can be seen as figure 11.

3) result analysis of fuzzy neural network

The result of fuzzy neural network can be seen as follows. The error we can get is 0.0021, and after 90 steps the error tends to stable.

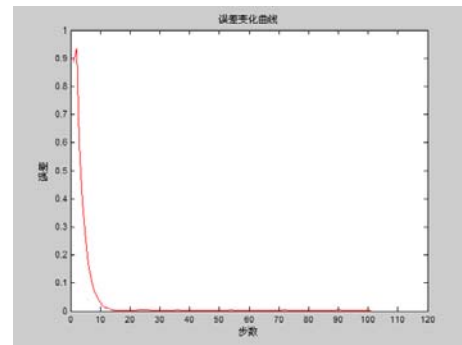


Figure 12. Fuzzy neural network result

In order to understanding the experimental result clearly, we list table 2 to compare the result.

TABLE II. TRAINING RESULT

algorithm	time	error
BP	20.507800	2.9069
GA-BP	7.892145	0.0059
SOFM Fuzzy neural network	197.460613	0.0019

From table 2, we can conclude that the SOFM fuzzy neural network can use shorter time than general network. Comparing with the algorithm which we mentioned above, SOFM fuzzy neural network has the lowest error 0.0019. Therefore, we can say that SOFM fuzzy neural network is the best one among the three models to fit for construct project cost estimate.

IV. CONCLUSION

This article proposes a blended learning algorithm based on SOFM which aims at handling the weakness of general T-S fuzzy neural network. In other words, SOFM can be used in this model to set the parameters of membership function, and the result in the output layer should be back calculated, and then the real output data make a comparison with expected data. Experiments indicate that this method not only improves convergence and efficiency of self-learning in network, but also guarantee conclusion section have higher information collection rate and accuracy rate. Meanwhile, simulation results demonstrate that the algorithm which proposed in this article has a faster speed in best approximation of target function. It is better than the general fuzzy neural network in performance.

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**Wenfeng Feng** is an Associate Professor in the Computer Science and Technology Department at the Henan Polytechnic University, China. He received his M.Sc. in Data Mining from the Beijing Institute of Technology (BIT) in 2003 and Ph.D. in Computer Networking from BIT in 2006. From 2006 to 2008, He worked as a postdoctoral in the Electronic Engineering Department at the Tsinghua University. He has been doing research in the network modeling of complex systems, especially in the complex networks' structure, dynamic, and their application in neural networks.



**WenJuan Zhu** is a post graduate in Henan Polytechnic University. She received her B.Sc. in computer science and technology in Henan Polytechnic University. She has been doing research in neural network and complex network for pattern recognition, and their application to workable network.