Study on Forecasting Model of Enterprise Human Resource Based on Neural Network

Zhu Miaofen, Chen Guojin

Abstract—**The demand forecasting of human resource is a very important work of the enterprise human resource management. Aiming at the complex influence factors, non-linearity, low precision of usual forecasting methods, influence factors of human resource structure forecasting are analyzed, the forecasting method based on the artificial neural network is proposed, and then a 6×18×18×12×3 BP network forecasting model is established. A fastest descent method with an additional momentum item of variable step length is adopted to adjust network weights. The forecasting model is trained by using the enterprise's correlative data as its inputs and outputs, and the parameters are determined finally. The test results indicate that the forecasting error of the forecasting model based on the artificial neural network is less than 5%, it is of high accuracy, wide scope of application, self-learning and adaptive capacity and so on.**

Index Terms—**Forecasting model, Human resource, Neural network, Enterprise**

I. Introduction

THE human resource as the main body of knowledge innovation has already become the most important enterprise strategy resource. The key for business success is how to maximize the staff's enthusiasm and creativity. Modern human resource management has already become a strategic management function, gone far beyond the narrow scope of traditional labor management. It is more strategic, comprehensive. Effective human resource management is essential for achieving the overall strategic goral of enterprises. Human resource demand forecasting is a very important work of enterprise human resource management. It can help enterprises to clear the trend of the future manpower demand, reserve talented manpower. It can also help enterprises to reasonably predict the human demand of each department and position in the future to avoid wasting money and save human resource. Human resource has many forecasting methods. Common methods are experience forecasting, actuality plan, model, and expert discussion. These methods apply to different kinds of human resource forecasting. In recent years, domestic and foreign scholars have been carrying out some researches based on human resource forecasting, by using the dual linear return model, the weighted average forecasting model, the gray forecasting model, time series analysis model and so on. Because real systems are quite complex, it is difficult to choose the correct model. The forecasting method based on neural network has higher forecasting accuracy and stronger applicability comparing with traditional methods.

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II. Neural Network

Now many different kinds of neural networks and algorithms denoting the dynamic process of these models have appeared, such as BP (back propagation) algorithm, Hopfield algorithm and so on and their transformation. The multi-layer perception trained by back propagation is the most common and simplest form in neural network classification.

Multi-layer perception is that one or several hidden layers are added between an input layer and an output layer. First an objective function is chosen as the degree that the network converge to its expected values in BP algorithm, generally, network error is regarded as objective function. Usually the objective function is the network error used in BP algorithm, that is, variance. The advantage of variance is convenient for calculating. Its mathematical expression is as follows.

$$E_p = \frac{1}{2}\sum(t_{pi} - O_{pi})^2 \tag{1}$$

E_p is the error of the pth characteristic vector, t_{pi} is the expectation value of the ith output neural cell, O_{pi} is the real value of the ith output neural cell.

BP is one of very easy algorithms in the training algorithms with falling gradient. Its primary idea is adjusting weights so that the sum of the whole networks is minimum. When the network error adopts a variance function and the output function adopts a sigmoid function, network weights are adjusted as the follow formula.

$$\Delta w_{ji} = \eta \delta_{pj} O_{pi} \tag{2}$$

η is learning speed, δ_{pj} is the error signal of the neural cell j in the L layer, O_{pi} is the output of the neural cells in the L-1 layer. The error signal δ_{pj} is different in different place in the layer where it is. It is as follows.

For the output cells: $\delta_{pi} = (t_{pi} - O_{pi})O_{pi}(1 - O_{pi})$ (3)

For the hidden cells: $\delta_{pj} = O_{pj}(1 - O_{pj})\sum_k \delta_{pk} w_{kj}$ (4)

δ_{pk} represents the error signal of the neural cell k in the $L+1$ layer.

Actually, in Equation 3, a momentum item is often used to enhance the convergence speed in some problems. The effect of historic modification of weight values has been taken into account in this momentum item. The momentum constant α determines the importance of this item. By filtering the high frequency components, the momentum item causes the surface of error curve to be smooth in the weight value space. After adding this momentum factor, the weight values are updated as follows.

$$\Delta w_{ji}(n+1) = \eta \delta_{pj} O_{pi} + \alpha \Delta w_{ji}(n) \quad (5)$$

The work process of BP network can be generalized as follows. Firstly, samples are collected. Secondly, training samples are used to train the network until the network weight values are adjusted to reach the desired goals. Thirdly, testing samples are used to test the network. If the correct rate of testing results is low, the network is trained sequentially. Otherwise it can be used in practical application. The training and testing process of network are shown in Fig.1.

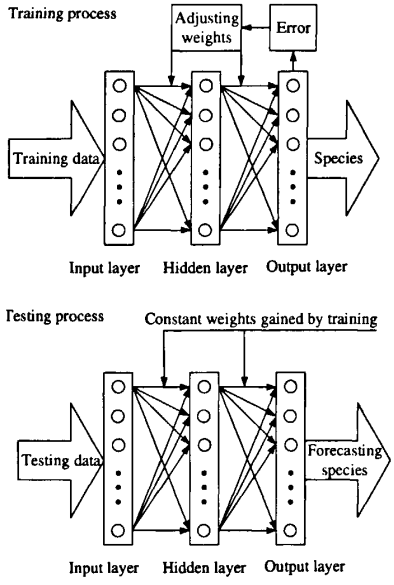

Fig. 1. The training and testing process of network

III. Forecasting Model of Human Resource

The actualization of Neural network model includes the decision of the network type, the topological structure, the number of neuron nodes in the input and output layers, the number of the hidden layers and the number of nodes in each hidden layer, and the choice of the activation functions of neuron nodes, the choice of input data and normalized processing, the determination of the physical meaning of output data, the choice of the adjustment method of weight values, the decision of the network parameters like learning rate, momentum item, learning error, learning degree and so on. The BP neural network already has a determinate network type and topological structure. Its emphasis is the decision of the input, output and hidden layers for the network. The other parameters can be adjusted in the experiment. Generally the degree of complexity is used to determine the number of network layers. The more network layers there are, the better its ability of solving problems is. But the more network layers there are, the longer the time for training and adjusting the connecting weight values will be.

There are no identity rules in designing neural network model. It mainly depends on the application experience in usual. Because it isn't just a simple relationship between the input and the output of network, here takes a 5-layer network with strong function as the human resource-forecasting model. As for the enterprise human resource structure, it is related with many aspects from the interior and exterior of an enterprise. It mainly includes the condition of staff flow in an enterprise and the enterprise's economy condition. When neural network is used to do forecasting, the forecasting model of enterprise human resource structure based on neural network is established by taking the total enterprise's production value, the economy efficiency, the dimission proportion, the structural factors of products, the influence factors of productivity level and the influence factors of management mode as the inputs, taking the total staff quantity of a enterprise, the proportion of managers, technicians as the outputs. According to the general rules, the number of nodes in the hidden layers should be more than that in the input layer, so a 6×18×18×12×3 network structure is adopted, in which the input layer has 6 nodes, the hidden layers have respectively 18, 18, 12 nodes, the output layer has 3 nodes. The hidden layers choose bipolar Sigmoid functions as activation functions, the output layer chooses a unipolar Sigmoid function as an activation function. The whole network structure is shown in Fig.2.

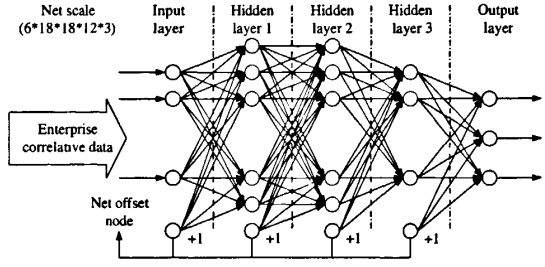

Fig. 2. The whole network structure

IV. Simulation Result Analysis

Using a certain enterprise's correlative data from 1990 to 2006, which are shown in Table I and Table II, the above-established forecasting model based on neural network is trained. Here sets the forecasting error of 0.01. The inputs in training samples are taken inputs of the network, the outputs in training samples are taken as the network's teaching signal. At the beginning, the small stochastic weight values are assigned to the network, then the network begins the forward computation

TABLE I
A CERTAIN ENTERPRISE'S CORRELATIVE DATA (1)

Year	Total production value (million dollar)	Economy efficiency (million dollar)	Dimission proportion (%)	Product factors	Productivity factors	Management factors
1990	12.0	2.1	3.55	1.0	1.0	1.0
1991	18.0	3.1	4.41	1.0	1.0	1.0
1992	26.1	4.5	4.80	1.2	1.1	1.2
1993	36.8	5.9	5.33	1.2	1.1	1.2
1994	50.4	8.6	5.56	1.2	1.1	1.2
1995	68.0	10.2	6.04	1.2	1.4	1.3
1996	90.0	11.0	6.53	1.2	1.4	1.3
1997	117.0	18.5	6.78	1.2	1.5	1.4
1998	138.0	20.7	6.66	1.2	1.5	1.4
1999	164.0	29.5	6.43	1.4	1.7	1.4
2000	200.0	39.0	6.70	1.4	1.7	1.4
2001	240.0	52.0	6.34	1.4	1.7	1.6
2002	295.0	67.8	5.89	1.4	1.7	1.6
2003	362.0	90.5	5.71	1.6	1.8	1.7
2004	445.0	115.7	5.68	1.6	1.8	1.7
2005	556.0	150.0	5.40	1.6	1.8	1.8
2006	771.0	191.0	5.43	1.6	1.8	1.8

TABLE II
A CERTAIN ENTERPRISE'S CORRELATIVE DATA (2)

Year	Total staff quantity	Proportion of managers (%)	Proportion of technicians (%)
1990	56	15.2	30.7
1991	87	12.3	31.5
1992	113	11.5	33.4
1993	160	10.4	40.6
1994	200	10.2	45.2
1995	272	8.9	45.7
1996	345	7.8	48.0
1997	430	7.2	49.6
1998	460	6.6	49.8
1999	525	6.4	53.1
2000	625	6.1	55.2
2001	666	5.7	57.3
2002	756	5.5	58.0
2003	840	5.2	60.2
2004	906	5.1	60.3
2005	1050	4.9	60.5
2006	1120	4.8	60.8

TABLE III
A CERTAIN ENTERPRISE'S CORRELATIVE DATA (3)

	Year	2005	2006
Forecasting values	Total staff quantity	1033	1100
	Proportion of managers (%)	4.8	4.7
	Proportion of technicians (%)	58.8	59.0
Practical values	Total staff quantity	1050	1120
	Proportion of managers (%)	4.9	4.8
	Proportion of technicians (%)	60.5	60.8
Relative errors	Total staff quantity (%)	1.62	1.79
	Proportion of managers (%)	2.81	3.00
	Proportion of technicians (%)	2.31	2.47

process and outputs the stochastic results. Then the network contrasts the stochastic results with teaching signals, and comes into the reverse adjustment process. The adjustment target is to minimum the erroneous energy. The adjustment is the steepest descent method of the added momentum term. The every adjustment result is to reduce the target error. After adjusting the weight values in every layer, the next training vector is gotten to carry on the same training till the error is in an allowable scope, or it reaches the maximum adjustment. The error curve of network training is shown in Fig.3. Then the trained forecasting model is used to forecast the enterprise's human resource structure of 2005 and 2006. Table III shows the comparison between the forecasting values and the practical values. By this comparison between forecasting values and the practical values, we can see that forecasting error of the forecasting model based on neural network is less than 5%, it has reached the desired forecasting precision.

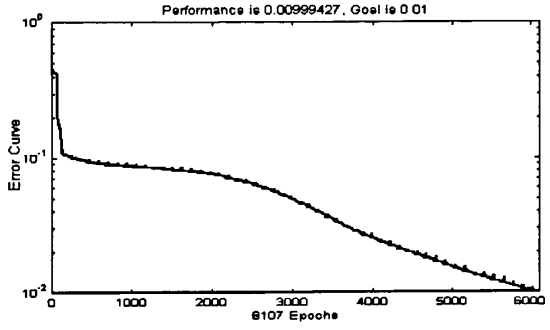

Fig. 3. The error curve of network training

V. CONCLUSION

Human resource layout is an important content in all kinds of economy activities. Among the human resource layout, human resource forecasting occupies an extremely important status. As for the structure of enterprise human resource, there are three kinds of personnel in usual: the managers, the technician, and the ordinary staff. The proportion of these three kinds of personnel may influence the steady development for the entire enterprise. The improper proportion relations of these three will lead to maladjustment of the enterprise human resource structure, thus influence the enterprise's development. It shows that it is a remarkable mission for an enterprise to make well of the structure of human resource, and if an enterprise wants to make well of the structure of human resource, it has to forecast the human resource of the enterprise first. In this way, it can catch the direction of human resource structure, thereby ensure the optimization of human resource structure.

If the enterprise's human resource structure would be forecasted accurately, a quite precise mathematical model should be established. Because the enterprise's human resource structure is a complex system, and is influenced by multitudinous factors like enterprise culture, economy potentiality, as well as external environment, therefore modeling with conventional mathematical methods not only is big in workload, but also is difficult to guarantee the precision. Although the mathematical statistic method may be adopted to

carry the quantification analysis on human resource structure, the method needs massive samples, also requests the good distributed rule between samples. Furthermore, the method induces the historical data of rich connotation, some information may be lost to result in the unconformity of the analysis result with the practical condition. The paper uses the nonlinear and auto-adapted characteristic of neural network, establishes the artificial neural network model, and carries on the forecasting of enterprise's human resource structure. Finally results indicate that the forecasting precision is high, the applicable scope is broad.

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