

Mode Choice of Industrialized Organization Based on the BP Neural Network

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Abstract

This research divides the mode of industrialized organization into the following three modes, that is, the ones driven by large-scale farmers, the ones driven by leading enterprises and the ones driven by professional cooperatives. This paper takes edible fungi industrialized organization as an example and creates 9-12-3 type of BP neural network model to choose the dominant industrialized organization according to the error back propagation multi-layer feed forward method. The experimental results show that the BP network model converts the qualitative output to quantitative output, which is better to simulate the experts' judgment on different modes of industrialized organizations with the system accuracy of 95.0%, and the BP neural network method applied to industrialized leading mode choice is effective.

Key words: INDUSTRIALIZED ORGANIZATION MODE, BP NEURAL NETWORK; INDEX SYSTEM; MODE CHOICE

1. Introduction

Agricultural industrialization is the mechanism innovation of the agricultural management system, which is an effective way to solve the contradiction between small-scale production and big market, and is the important way to improve the competitiveness of the agricultural industry. The mode of industrialized organization is the carrier of agricultural industrialization operation. The scientific and reasonable choice of organization mode is the key to effectively operate agricultural industrialization.

As for the modes of industrialized organization, experts and scholars at home and abroad have carried on them thorough analysis and researches. Agricultural industrialization is generally called the integration of agricultural industrialization in western countries. Gail. Gramer & Clarence. Jensea classified the agricultural integration as the following forms such as vertical integration of agriculture, vertical coordination, farmer cooperatives as well as agribusiness [1]. Gall & Schroder mainly studied the modes of industrialized organization in terms of the traditional and new ones as well as the ones

involving network learning [2]. Terreros & Gorriiz integration model divided the mode of integration into cooperative models and the models of enterprises owned by the investors [3]. The domestic scholars have paid more attention to the issues related to the mode choice of organization led by industrialization. Some scholars believe that leading enterprises are the key to the industrialized operation of agriculture, which is the most effective way to realize the development of agricultural industrialization [4,5]; Other scholars argue that with the rapid development of the cooperatives, it will become the dominant mode for the development of the future agricultural industrialization [6,7]; Besides, some other scholars also argue that the modes of industrialized operation organizations should differ from each other in view of the agricultural development at different levels, the different industrial characteristics, as well as the different transaction efficiency [8,9]. The authors of this essay state that the agricultural industry integration is a dynamic process of development from low level to high level, which results in different industrialized organization modes according to different levels of economic development and different phases of industry development.

In order to summarize a set of feasible solutions and modes provided to people for reference and application, this essay classifies the agricultural industrialized organization as the following modes, that is, the ones driven by large-scale growers, the ones driven by leading enterprises and the ones driven by professional cooperatives on the basis of the different stages of industry life cycle, and finally creates the choice model of industrialized organization in terms of BP neural network on the basis of designing the index system of industrialized organization mode choice, expecting to provide a good theoretical basis for the mode choice of industrialized organization.

2. Research method and Model design

2.1. Research method

BP (Back Propagation) neural network was put forward in 1986 by a group of scientists headed by Rumelhart and McClelland, It is a kind of multi-layer feed-forward network training according to the error Back-Propagation, which is currently one of the most widely used neural network model. BP neural network is a nonlinear dynamic system that is able to learn and store a large quantity of input - output model mapping relation, without revealing and describing the mathematical equations of the mapping relation in advance [10]. The topological structure of BP

neural network model includes input layer, hidden layer, and output layer, shown as in Figure 1.

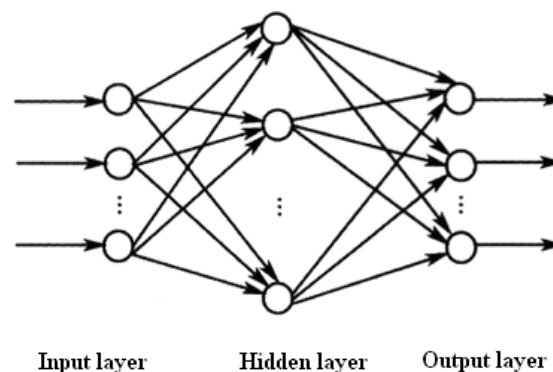


Figure 1. BP neural network

The calculation of BP neural network mainly adopts the network error sum of squares as the objective function. According to the principle of error correction, it utilizes the gradient descent method to reversely transmit the network output error, while amending and changing the connection weights of the network, so as to minimize the error value [11]. The learning method of BP neural network is divided into two aspects that include reverse transmission and forward calculation for errors. The whole learning process is shown as in Figure 2.

BP neural network was used widely in various fields, including economy and management, and evaluation, forecast, distinguishes and choices are the main applications. Rob Law made a reach on improving the accuracy of neural network-based tourism demand forecasting [12]. Tian Yin-hua, Zhou Zhi-qiang made a reach on identifying and selecting the contract governance mode of family enterprises based on BP Neural Network [13]. Daniela Carlucci, Paolo Renna, Giovanni Schiuma evaluated service quality dimensions as antecedents to outpatient satisfaction using back propagation neural network [14]. J.S. Kim, S. Jung analyzed the on-line learning using RBF neural chip with the back-propagation algorithm [15].

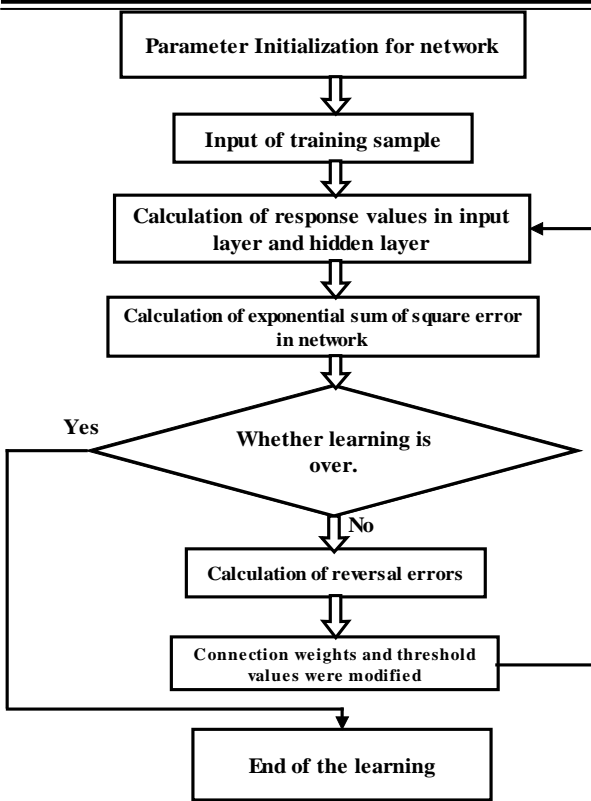


Figure 2. The flow chart of the BP neural network training

According to the basic principle of BP neural network theory, we create the BP neural network model which involves the mode choice of industrialized organization on the edible fungus industry in China. In the BP neural network model, the input layer and output layer, and the determination of the connection weights of each layer neurons is a key to the success of research. Therefore, this paper designs the index system of industrialized organization mode choice which is treated as the input values vector of the input layer (See Figure 1). The county's GDP per capita net income of rural residents herein is to examine the level of development of county economy. The number of industrial enterprises above the designated size and the degree supported by government is to explore the external environment of the industry development. The total scale of planting, average inventory, cropping years, the proportion of large growers as well as the scale differences in size is to examine the characteristics of the development of the industry. According to the usual situation, this research adopts the BP neural network with three layers, that is, one input layer, one hidden layer and one output layer. The determination of concrete structure is as follows:

2.2. Model Design

Table 1. The index system of the mode choice of industrialized organization

The index of mode choice of the industrialized organization	The first class indicators	The second class indicators
	The developmental level of county economy	GDP of county regions (T_1) (Ten thousand CNY)
		Rural per capita net income (T_2) (CNY)
	The external environment for the industry development	The number of industrial enterprises above the designated size (T_3) (Number)
		The degree supported by government (T_4)
	The characteristics of industrial development	The total scale of planting (T_5) (Mu)
		Average inventory (T_6) (Ten thousand tons)
		Cropping years (T_7) (Year)
		The proportion of large growers (T_8) (%)
		The scale differences in size (T_9)

As for the input layer, the index is chosen according to the dominant mode, in which the second class indicators including nine indicators from T1 to T9 are treated as input variables.

Regarding to the hidden layer, it is generally stated that increasing the number of hidden layer neurons is able to reduce network error and to improve accuracy. However, it also

complicates the network, which thereby increases the training time of the network and leads to the tendency of over fitting.

Taking the experience formula in the relevant literature for reference, the number of hidden layer nodes can be determined as follows:

As for the formula $p = \sqrt{n+q} + a$, p refers to the unit number of hidden layer, n stands for the unit number of input layer, q is taken as the unit number of output layer and a is positive integer with the condition of $a \in [1, 10]$. After the preliminary estimation, the number of nodes on the hidden layer should be between 4 and 14. On the basis of repeated testing, the number of the neurons on the hidden layer is 12.

As for the output layer, the number of the node on the output layer is 1 in this paper, that is, the leading mode of organization for each county and city. Discussing with experts again and again and considering the reality of the development of edible fungus industry in China, we divides the industrialized organization into three categories in this paper, which are the ones driven by large-scale farmers, the ones driven by leading enterprises and the ones driven by professional cooperatives.

3. The Mode Choice of Industrialized Organization

3.1. Data Acquisition and processing

The data used in this essay is the data for the basic situation of the edible fungus in the county with

large-scale planting, which was mainly collected by means of questionnaire in terms of on-the-spot investigation and telephone interview. There are fifty-five questionnaires and fifty ones are effective. The rate of efficiency for the questionnaires is 90.9%.

The questionnaires used for this essay, mainly focus on the nine indicators that influence the mode choice. The specific evaluation method of these indicators is that the quantitative indicators are determined according to its actual value. As for the qualitative indicators that are not directly qualitative, could be quantified by means of grade membership method. Expert investigation and the method of set-valued statistics are adopted to define the membership vector, such as the degree of government support. Index evaluation set a standing for the low level of support or no support, general level of support, great support, adopts the evaluation scale which is $B = [1, 2, 3]$.

In the fifty stes of data, the ones from 1 to 16 belong to the modes driven by large-scale farmers labeled 1, the ones from 17 to 32 belong to the modes driven by leading enterprises labeled 2, and the ones from 33 to 50 belong to the modes driven by professional cooperatives labeled 3. The output and input of the BP neural network are shown as Table 2. The visual figure of fractal dimension is shown as in Figure 3.

Table 2. Input and output of mode of industrialized organization

Number	The second class indicators (input)									The mode of organization (output)	Binary output	
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9			
1	445278	4362	22	1	879	5	3	0.015	1	1	0	1
2	798724	6100	50	1	490	5	4	0.018	1	1	0	1
3	840398	5478	48	1	375	5	5	0.010	2	1	0	1
...	...	...	...	...	...	...	...	...	...	...	0	0
26	182567	7945	62	3	2678	13	12	0.020	1	2	0	0
27	139101	11716	15	1	3800	15	4	0.030	2	2	...	...
28	879233	6012	45	3	2020	15	12	0.015	1	2	1	0
...	...	...	...	...	...	...	...	...	...	...	1	1
48	164524	8240	70	3	8900	40	30	0.120	3	3	1	1
49	165710	9294	16	2	12735	40	38	0.100	2	3	1	0
50	139190	7299	72	3	50000	50	25	0.200	2	3	1	0

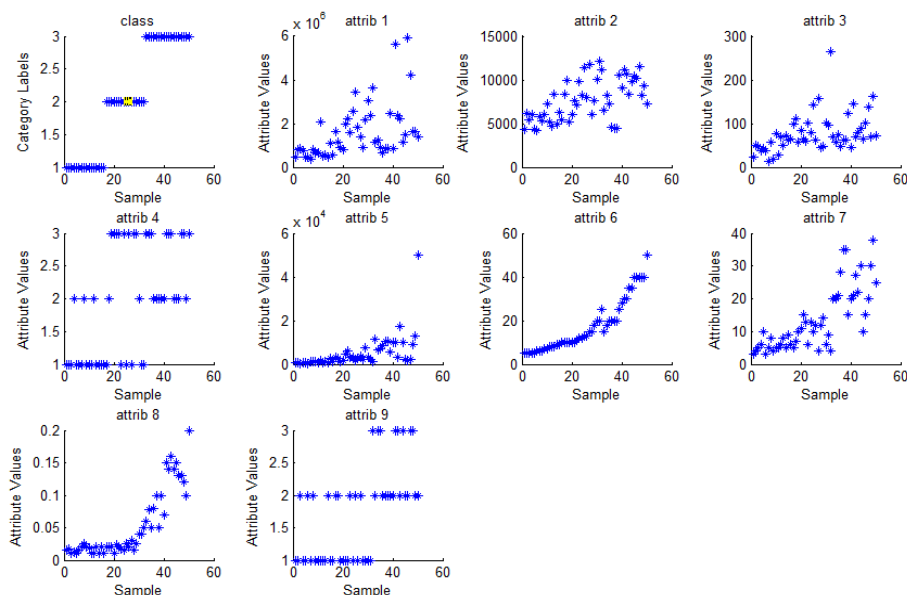


Figure 3. The visual figure of fractal dimension for the data of planting

The data collected by surveys data, exists a certain roughness. Meanwhile, in view of the requirements that the input layer of network input the data, it is necessary to carry on the pretreatment for the target data. For this research, the input data of the target model should be in the range of 0 and 1. As a result, the original data must be carried out the normalization processing. The specific formula is equation (1).

$$V' = \frac{V - V_{\min}}{V_{\max} - V_{\min}} \quad (1)$$

In this formula, V' is the value after the normalization processing. V_{\max} and V_{\min} are the maximum value and the minimum value respectively in the test set.

3.2. Training for Learning the BP Neural Network

Using the identification toolbox of the nprtool BP neural network in matlab2012, the data deriving from the mode driven by large-scale farmers (from Group 1to Group10), the mode driven by the leading enterprises (from Group 17 to Group 26), and the mode driven by professional cooperatives (from Group 33-Group 42), is taken as the sample of network training, which are ten groups of data for each mode, totally thirty groups of data. In the data of thirty groups, 70% data is selected at random used for training network. 15% data is used for data validation and 15% data is used for testing network. After a lot of training, a satisfactory result will be obtained. The confusion matrix is shown as in Figure 4.

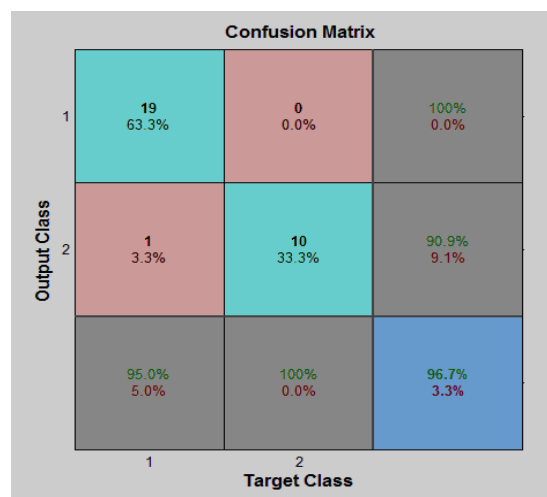


Figure 4. Confusion matrix

After the iteration training of BP neural network for 12 times, the best performance validation acquired, is 2.3451×10^{-9} , shown as in Figure 5.

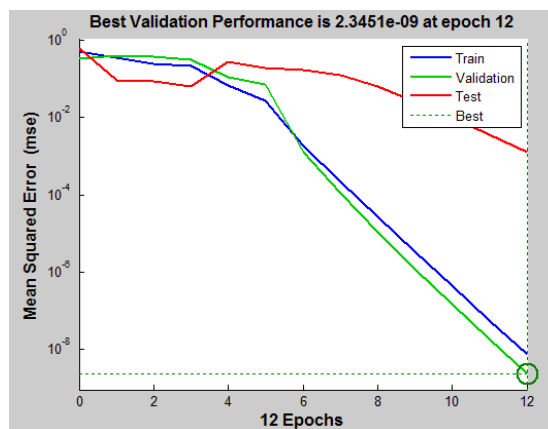


Figure 5. The BP neural network to verify performance

As for the training status shown as in Figure 6, the network will be saved after obtaining the satisfactory training results.

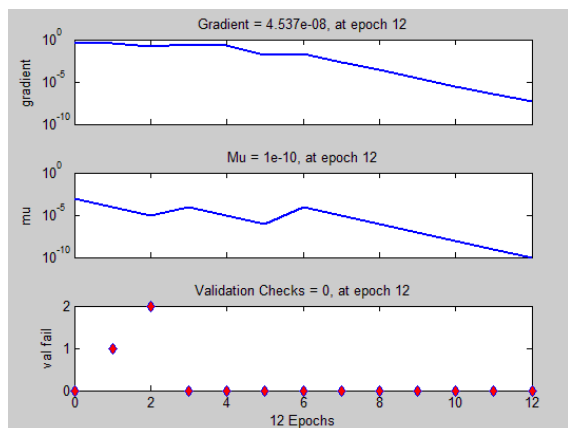


Figure 6. Training status

3.3. The BP Neural Network Test Validation

The created BP neural network is used for testing the mode choice of industrialized organization. The measured object is the other twenty groups of data, that is, the ones from group 11 to group 16, the ones from group 27 to group 32, and the ones from group 43 to group 50 except the training samples. Choosing the network trained before, and inputting the data is to compare the output results of the evaluation system of BP neural network with the actual planting model. The results are shown as in Figure 7.

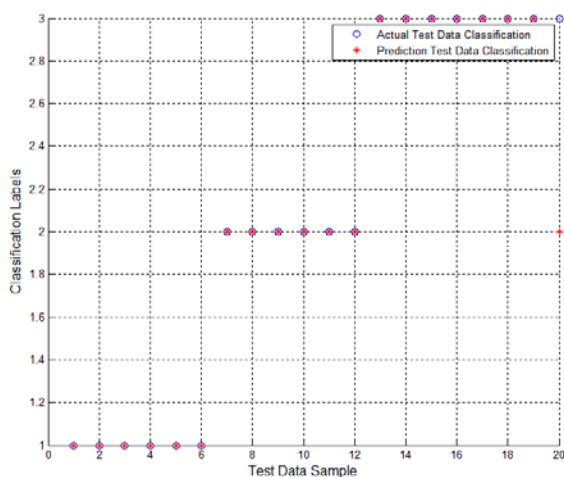


Figure 7. Actual test data classification and prediction test data classification

The testing results show that in the 20 groups of testing data, only the twentieth group is misjudged. The accuracy is 95.0%, which is up to higher accuracy and proves that the established network model is correct and reasonable, and is

able to identify the modes of industrialized leading organization for different counties and cities.

4. Conclusions

According to the actual conditions of industrial development, the index system that influenced the mode of industrialized organization has been designed including the level of economic development, the external environment of industrial development as well as the characteristics of industrial development, which are three first-class indicators. There are nine second-class indicator measurement items for each first-class indicator.

Taking the system of each county and city as input vector and the industrialized leading organization as output vector, the BP neural network model of mode choice of industrialized organization has been created according to the error back propagation multi-layer feedforward method, which can choose the correct leading organization. The method of BP neural network has provided a new thought for the recognition and selection of the mode, which is a kind of evaluation method that is worth promoting.

Limited by data availability, the quantity of the samples for this essay is less. There is certain randomness for the network training. Meanwhile, the times for the training of BP model and the choice for the number of the nodes need to try many times. The training time is much longer.

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