An Improved Neural Network Algorithm and Its Application on Agricultural Information Degree Measurement in Hebei Province

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ABSTRACT
The agricultural information level is on the initial stage in Hebei province, so we should pay more attention to its construction. And on this basis we can find out the influencing factors and corresponding countermeasures. To evaluate the agricultural information degree in Hebei province scientifically and accurately, this paper proposes the improved BP neural network model which imports the adjustable activation function and the Levenberg-Marquardt optimization algorithm. The improved model not only can simulate the expert in evaluating the agricultural information degree and avoiding the subjective mistakes in the evaluation process, but also enhance the learning accuracy and the algorithm convergence speed greatly. The evaluation of 11 cities in Hebei province shows that the results are reliable and the method to evaluate the agricultural information degree is feasible.

Keywords
Agricultural information degree; Improved BP neural network; Evaluating model; Indices system

1. INTRODUCTION
In today's world, developing the modern agriculture to use information technology has become an important topic. Agricultural information as the main component of national economy and social information is an important symbol of agricultural modernization, it is the significant way to plan the development of town and country and the important aspect to construct the harmonious society. It is in this understanding, Hebei Agriculture Department took the agricultural information construction as the significant measures of comprehensive building a rural well-off society. According to incomplete statistics, the hit number of Hebei Agricultural Information Network has reached 110 million passengers, and the information published volume has reached 120 million per year.

The investing absolute amount of agricultural information construction in Hebei province is relatively large, but their information degree is still at the preliminary stage. For the construction of agricultural information, there are some problems, such as: insufficient financial and technical input, late start, and poor foundation. So under this circumstance, it is extremely meaningful to construct the indices system about the agricultural information degree evaluation and measure the information construction degree. The agricultural information degree evaluation is a systematic evaluation process, and a scientific and quantitative argumentation. The methods have been widely applied, such as: determinant analysis, variance analysis, etc. However, these methods are subject to stochastic factors in the evaluation, and the evaluation results are influenced by subjective experience and knowledge limitations easily, which often with personal bias and one-sidedness. In recent years, with the rapid development of the neural network that has the unique advantages—self-learning, self-organizing and self-adapting ability, it can overcome the influence of subjective factors and has been applied widely. This paper will use the improved BP neural network algorithm to measure the agricultural information degree synthetically.

2. INDICES SYSTEM CONSTRUCTION OF AGRICULTURAL INFORMATION DEGREE EVALUATION
When evaluating the agricultural information degree, we should keep to the ideas and methods of system engineering, follow the principle of comprehensive, correlation, comparable, independent, construct the multi-objective comprehensive evaluating system. The following factors are taken into account when we evaluate the agricultural information degree:

(1)Agricultural investment/Total investment in Hebei province(U_1); (2)Farmers investment/Rural investment(U_2); (3)Non-farmers investment/Rural investment(U_3); (4)Rural added value/GDP(U_4); (5)Rural practitioners/Social practitioners(U_5); (6)Non-agricultural labors/Social practitioners(U_6); (7) E-mail index per sq.km.(U_7); (8)Calling index per sq.km.(U_8); (9)Letter index per sq.km.(U_9); (10)Newspaper index per sq.km. (U_{10}); (11) Network information index per sq.km.(U_{11}); (12) Internet explorer hitting index(U_{12}); (13)Telephone index per sq.km.(U_{13}); (14)TV set index per sq.km.(U_{14}); (15)Computer index per sq.km.(U_{15});

(16)Tertiary industry population index per sq.km. population (U_{16}); (17)Undergraduate index per sq.km. population(U_{17}); (18)Information practitioner index per sq.km. population (U_{18}); (19)Internet user index per sq.km. population (U_{19}); (20)Information consume proportion in the individuals or groups consume(U_{20}).

3. THE EVALUATING MODEL BASED ON IMPROVED BP NEURAL NETWORK ALGORITHM

3.1 The Parameters Determination of the Improved BP Neural Network

The input vector in the input layer is: $X \in R^n$, $X=(x_0,x_1,x_2\ldots,x_{n-1})^T$; the input vector in the first hidden layer is: $X' \in R^n{}_1$, $X'=(x'_0,x'_1,x'_2\ldots,x'_{n-1})^T$, output vector is: $Y' \in R^m{}_1$, $Y'=(y'_0,y'_1,y'_2\ldots,y'_{m1-1})^T$; the input vector in the second hidden layer is: $X'' \in R^n{}_2$, $X''=(x''_0,x''_1,x''_2\ldots,x''_{n2-1})^T$, output vector is: $Y'' \in R^m{}_2$, $Y''=(y''_0,y''_1,y''_2\ldots,y''_{m2-1})^T$; the input vector in the output layer is: $X''' \in R^n{}_3$, $X'''=(x'''_0,x'''_1,x'''_2\ldots,x'''_{n3-1})^T$, output vector is: $Y \in R^m$, $Y=(y_0,y_1,y_2\ldots,y_{m-1})^T$. The weight value between the input layer and the first hidden layer is denoted with ω_{ij}, the threshold value is θ_j, the weight value between the first hidden layer and the second hidden layer is denoted with ω'_{jk}, the threshold value is θ'_k, the weight value between the second hidden layer and the final output layer is denoted with ω''_{kl}, the threshold value is θ''_l, then the input and output in every layer neurons are met:

$$x'_j = \sum_{i=0}^{n-1} \omega_{ij} x_i - \theta_j$$

$$x''_k = \sum_{j=0}^{m_1-1} \omega'_{jk} y'_j - \theta'_k$$

$$x'''_l = \sum_{k=0}^{m_2-1} \omega''_{kl} y''_k - \theta''_l$$

$$y''_k = f_k(x''_k)$$

$$y_l = f_l(x'''_l)$$

$$y'_j = f_j(x'_j)$$

The activation function f(u) is a nonlinear function. We normally choose sigrnoid function:

$$f(u) = \frac{1}{1+e^{-u}}$$

3.2 The Learning Process of the Improved BP Neural Network

The study process of the BP neural network can be divided into two stages: the first stage is toward pass, namely input sample data from the input layer, transmit signal forward, and calculate the corresponding output neuron of every layer according to the above formula that is not feedback and connected among the layers. The second stage, namely the back pass, If the error between the actual output of the output layer and the goal output doesn't fall into the scheduled precision range, the error signal returns along the original pathway to amend the weight value and threshold value. By the two iterative processes, we make the network to achieve convergence at last. At this time, the error reaches the scheduled range. In the multilayer BP neural network, given a set of sample data (x,t), $X \in R^n$, $t \in R^m$, when input P_ith sample, namely (x^{p1}, t^{p1}), we can calculate the network output $y^{p1} \in R^m$, relative to the x^{p1} using the improved BP algorithm, then the error function is defined as:

$$\varepsilon = \frac{1}{2}\sum_{l=0}^{m-1} (t^{p_l} - y^{p_l})^2$$

To all samples, the total network error:

$$E = \frac{1}{2}\sum_{p_l=1}^{p}\sum_{l=0}^{m-1} (t^{p_l} - y^{p_l})^2$$

We enter into the second stage of the learning process, namely adjustment reversely the weight value and the threshold value, and revise every weight value ω_{nq}:

$$\Delta\omega_{nq} = -\eta(\frac{\partial E}{\partial \omega_{nq}}) = -\sum_{p_l=1}^{p} \eta \frac{\partial \varepsilon}{\partial \omega_{nq}}$$

η is the learning rate.

The learning process of the neural network is the process to seek the smallest of error E, but the traditional BP algorithm to complex networks, it very likely falls into local minimum value. This paper introduces the Levenberg-Marquardt optimization algorithm which can enhance the network convergence speed and reach the error range rapidly.

3.3 The Construction of Improved BP Neural Network Model

We take the 20 indicator of describing the financial risk as the input vector, and take the corresponding comprehensive testing results as the network expectation output. We take enough samples to train the network, make the relative error to meet the scheduled accuracy after ceaseless learning process. At this time the weight value and the threshold value hold by the neural network is the correct internal denotation acquired by the self-adaptive learning. Once the network has been trained, it could serve as an effective tool to evaluate the financial risk.

(1) S.K.Doherty and other scholars' studies have shown that three-layer feedforward neural network, namely the neural network only contains one hidden layer can approximate any nonlinear function relation with any accuracy. So we set up a three-tier feedforward neural network, the input layer neuron number is the above 20 indicators, the determination of the hidden layer neuron number has not to reach a unified theory yet. According to the experience, the node number of the hidden lay should meet 2n>m (m denotes the input layer node number). Therefore, we select 7 network neurons for the hidden layer, and the neuron in the output layer is only one, namely the power enterprise financial risk comprehensive value.

(2) Network parameters initialized: we endow with the link weight value ω_{ij} and the threshold value θ_j between the input layer and the hidden layer, the link weight value ω'_{jk} and the threshold value θ'_k between the hidden layer and the output layer.

(3) Select a tier model randomly as the input signal.

(4) Calculate the input x'_j and the output y'_j of the hidden layer neurons.

(5) Calculate the input x''_k and the output y_k of the output layer neurons.

(6) Calculate the general error u_k of the output layer neurons, judge u_k whether to meet demands, if met to step (9) and not met to step (7).

(7) Calculate the general ion errors of the hidden layer neurons:

$$v_j = [\sum_{k=0}^{m-1}(u_k \omega'_{jk})] f'_j(x'_j)$$

(8) The amending weight value and the threshold value:

$$\omega'_{jk}(N+1) = \omega'_{jk}(N) + \Delta\omega'_{jk}(N)$$

$$\omega_{ij}(N+1) = \omega_{ij}(N) + \Delta\omega_{ij}(N)$$

$$\theta'_k(N+1) = \theta'_k(N) + \Delta\theta'_k(N)$$

$$\theta_j(N+1) = \theta_j(N) + \Delta\theta_j(N)$$

(9) We take the next tier model as the input signal so as to all the training models train a circumference, until the total error reaches the scheduled accuracy. The learning is terminated; otherwise we update the study frequency, and then return to training again.

4. SIMULATION EXPERIMENT

In this paper, we take the agricultural information degree evaluation based on the improved BP neural network of 11 cities in Hebei province as an example, which are shown in table 1.

We use the MatLab to realize the software program, establish the three-layer BP neural network structure, the given study accuracy $\varepsilon = 0.0001$, and we select 7 network neurons for the hidden layer. We take 1-7 group agricultural information degree evaluation data and evaluating results in table 1 as the training set, train the network, and carry through the simulation evaluation using the agricultural information degree evaluation indicators data of the four residual groups and the trained network. In table 2, the network training results and the actual comprehensive evaluation results are shown. The simulation results about the 4 test sets and the actual evaluation results, as shown in table 3. The results in the table 2 and table 3 show that not only all the training samples is very close to the actual evaluation value, but the results of the four simulation test sets is also very close to the actual evaluation. The figure 1 can reflect that the coupling degree between the evaluation results and the simulation results is quite high.

Table 1. Expert evaluating data

No.	U_1	U_2	U_3	U_4	U_5	U_6	U_7
1	0.5	0.5	0.5	0.7	0.7	0.5	1
2	1	0.7	1	1	1	1	1
3	0.7	0.7	0.5	1	0.7	1	1
4	0.7	0.7	1	0.7	0.7	0.5	0.7
5	0.7	0.7	1	0.7	0.7	0.5	1
6	0.7	1	1	0.7	0.7	1	0.7
7	0.5	0.7	0.5	0.7	0.7	0.5	0.5
8	0.5	0.5	0.5	0.5	0.7	0.3	0.3
9	0.7	0.7	1	1	0.7	0.5	1
10	0.7	0.5	0.5	0.7	0.7	0.5	0.7
11	0.7	1	1	1	0.7	1	1

Continued table

No.	U_8	U_9	U_{10}	U_{11}	U_{12}	U_{13}	U_{14}
1	0.7	1	0.7	0.7	1	1	0.7
2	0.7	1	1	0.7	1	1	0.7
3	0.7	1	1	0.7	1	1	0.7
4	0.5	0.7	0.7	0.7	0.5	0.7	0.7
5	0.7	1	0.7	0.7	1	1	0.7
6	0.7	1	1	0.7	1	0.7	0.7
7	0.7	0.5	0.7	0.7	0.5	0.7	0.5
8	0.5	0.5	0.7	0.7	0.5	0.3	0.5
9	0.7	1	1	0.7	1	1	0.7
10	0.7	0.5	0.7	0.7	0.5	0.7	0.7
11	0.7	1	1	0.7	1	0.7	0.7

Continued table

No.	U_{15}	U_{16}	U_{17}	U_{18}	U_{19}	U_{20}	Score
1	0.7	0.7	0.7	0.7	0.7	0.1	0.713
2	1	0.7	1	0.3	0.7	1	0.931

3	0.7	0.7	0.7	0.7	0.7	0.5	0.766
4	0.5	0.7	0.7	0.7	0.7	0.5	0.683
5	0.7	0.7	1	0.7	0.7	0.1	0.727
6	0.7	0.7	1	1	1	1	0.861
7	0.7	0.7	0.7	0.7	0.7	0.5	0.604
8	0.7	0.7	0.7	0.7	0.3	0.5	0.488
9	0.7	0.7	1	0.7	1	0.5	0.827
10	0.7	0.5	0.7	0.7	0.7	1	0.647
11	0.7	0.7	0.7	0.7	1	0.5	0.817

Table 2. The actual evaluating results compared with the network training results and the taxis

No.	1	2	3	4
Evaluating results	0.7130	0.9310	0.7660	0.6830
Training results	0.7185	0.9193	0.7567	0.6890
Actual results taxis	5	1	3	6
Training results taxis	5	1	3	6

Continued table

No.	5	6	7
Evaluating results	0.7270	0.8610	0.6040
Training results	0.7196	0.8612	0.6029
Actual results taxis	4	2	7
Training results taxis	4	2	7

Table 3. The evaluating results compared with the simulating results and the taxis

No.	1	2	3	4
Evaluating results	0.4880	0.8270	0.6470	0.8170
Simulating results	0.4894	0.8289	0.6511	0.8169
Actual results taxis	4	1	3	2
Simulating taxis	4	1	3	2

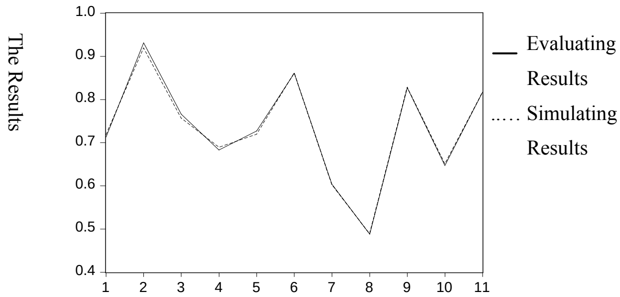

Figure 1. The actual evaluation results compared with the simulation results

5. CONCLUSION

The agricultural information degree evaluation is associated with many factors, it needs large numbers of statistical calculation, and the factitious factors can be mixed into easily. In this paper, we build the indices system and the improved BP neural network model. It can simulate the evaluation made by the experts and avoid the subjective mistakes.

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