

ECONOMIC BENEFIT EVALUATION OF INDUSTRIAL ENTERPRISES BASED ON BP NEURAL NETWORK OPTIMIZATION ALGORITHM

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Abstract— The economic evaluation methods of existing industrial enterprises have many limitations. In this paper, an economic benefit evaluation method of industrial enterprises based on BP neural network optimization algorithm is proposed. This method takes the economic indicators of enterprises as input of artificial neural network, and uses the optimized BP neural network model to evaluate and analyze enterprises. The running time is greatly shortened, and the evaluation results are objective and accurate. An example is given to illustrate the implementation of the method. The example shows the feasibility of the method. In the fast-changing market situation, the sustainable development of enterprises has attracted the attention of all sectors of society and has become the focus of research. The sustainable development of the enterprise is the objective requirement of the sustainable development of the economy, the guarantee for the long-term economic benefit of the enterprise, and the fundamental method and way to realize the long-term development of the enterprise. Therefore, for enterprises, sustainable development is the primary task of enterprises. The research on sustainable development of enterprises has become a hot topic in the practice and theory field of enterprise management. However, there has been no effective and systematic theory on the index system, quantification and evaluation methods of the evaluation of the sustainable development of enterprises.

Keywords— BP neural network; optimization algorithm; sustainable development of enterprises.

I. INTRODUCTION

BP neural network is the most beautiful and perfect one in neural network. In essence, it belongs to a class of pattern recognition problems (Kang, 2016). The human brain has great advantages in handling such problems (Wu *et al.*, 2018a). BP neural network has obvious advantages in this field. In the "meteor shower" era of Chinese enterprises, many enterprises almost become famous overnight, and almost disappear at the same speed, which has brought too much confusion and embarrassment to the business and academic circles.

In fact, Scientific Outlook on Development embodies the concept of sustainable development which is unified

by economic interests, social interests and ecological interests (Yang *et al.*, 2016). There is no doubt that sustainable development has become a global problem of mankind and a strategic issue at the macro level (Ke *et al.*, 2018). Sustainable development is the only way for our country to pursue the prosperity of the nation and realize the great rejuvenation of the Chinese one (Rokotyanskaya, 2017).

The economic benefit of enterprise computerization construction project is to produce more social labor results under certain conditions of total social labor volume (Wu *et al.*, 2018b). The evaluation of the sustainable development of enterprises in China is still in the initial stage, and there is not a complete set of theoretical and operational evaluation system and methods suitable for popularization (Markina *et al.*, 2017). From a national perspective, the sustainable development of the economy is not simply equivalent to economic growth. Instead, we should build up economic growth on the basis of structural optimization, coordination of interests and balance and moderation (Šiljić *et al.*, 2015).

II. EVALUATION AND ANALYSIS OF THE ECONOMIC BENEFIT INDEX OF ENTERPRISE COMPUTERIZATION

For a specific enterprise to evaluate, first of all, we need to establish an appropriate evaluation index system before we can adopt appropriate methods for evaluation. The principle of choosing the evaluation index of the enterprise sustainable development ability is to reflect the overall strength of the enterprise scientifically, overcome the one-sided nature of the evaluation of the single index, and emphasize the comprehensiveness of the evaluation (Wu, 2015). Sustainable development involves natural, environmental, social, economic, technological, political and other aspects. Therefore, the definition of sustainable development is different because of different perspectives (Schweickardt *et al.*, 2011). Sustainable development is a development theory and strategy aimed at improving and improving the quality of human life on the basis of protecting the natural resources and environment and encouraging economic development as the condition. It is a new concept of development, morality and civilization.

Table 1. The index input of industrial enterprises in each city.

Index	1	2	3	4	5	6	7	8	9
Index value	0.5	0.6	0.1	0.8	0.5	0.2	0.2	0.9	0.7

Table 2. Model actual output.

Expected output	Actual output	Economic benefit evaluation
1.254	1.594	Poor

The expected output of industrial enterprises in various cities, the actual output of the model and the economic benefits assessed by them are shown in Tables 1 and 2.

Research shows that enterprises implementing sustainable development strategy generally have longer life expectancy than other enterprises. The reason is that the enterprise takes the road of sustainable development. Enterprises have gained vitality and vitality in innovation, thus enabling enterprises to develop for a long time. The life cycle of the enterprise is shown in Fig. 1.

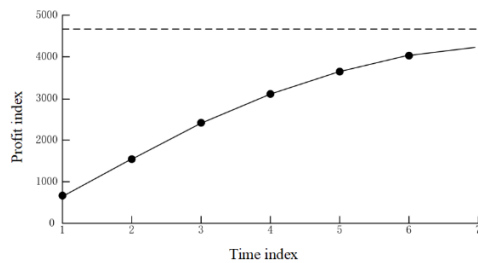


Figure 1. Enterprise life cycle

The sustainable development ability of enterprises is a comprehensive development capability in the process of enterprise development, which penetrates into all fields of enterprises. Therefore, it is necessary to select appropriate evaluation indexes to transform actual values into evaluation values, so as to analyze and evaluate the evaluation objects. From the leadership, strategy, application, efficiency, human resources, information security and other aspects, to guide the healthy development of computerization of Chinese enterprise. The index system consists of basic indicators, efficiency indicators and appraisal indicators. The evaluation indicators affecting the sustainable development of enterprises are shown in Table 3.

Can we scientifically, comprehensively and reasonably conclude various index elements for evaluating the sustainable development of enterprises? It is directly related to the scientificity and rationality of the design of the evaluation system for the sustainable

development of enterprises. To scientifically and reasonably conclude various indicators of sustainable development of enterprises, we must follow some basic principles as follows:

(1) Systematic principle

The index system must comprehensively and systematically reflect the dynamic factors of the sustainable development of enterprises. At the same time, it also reflects the economic, ecological and social benefits of enterprises. It can objectively reflect the state of system development and the coordination among systems, so as to comprehensively and accurately reflect the sustainable development of enterprises.

(2) Scientific principle

When designing the evaluation system of the sustainable development ability of enterprises, the index system can comprehensively and centrally reflect every constituent element of the sustainable development force of enterprises. In the evaluation of the sustainability of the enterprise. This principle is mainly reflected in the correctness of the concept of sustainable development of enterprises, the completeness of evaluation index system and so on.

(3) Hierarchical principle

The subsystem of enterprise sustainable development is composed of various elements at different levels. Therefore, the index system of sustainable development of enterprises is an organic whole. It should be hierarchical, and it can reflect the relationship between ecosystem, economy and society in a vertical way. It is necessary to subdivide the functions according to different indicators to form a complete index system.

It is necessary to evaluate the sustainable development of an enterprise from two aspects, one is the sustainable development of the human society and the two is the development of the enterprise itself. In recent years, there are more and more studies on sustainable development. In order to develop and pursue excellence, enterprises must stick to their bottom line responsibilities.

Table 3. Evaluation index of sustainable development capacity.

Factor	Index	
Social factors	Social contribution	1.564
	Social accumulation	1.297
Industry factors	State support	2.268
	The development stage of the industry	3.264
Enterprise factors	Profitability	4.168
	Growth ability	4.985

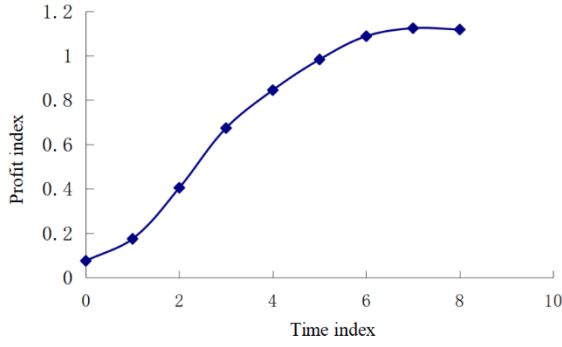


Figure 2. Capital accumulation drives down capital profits.

Enterprises should also pursue a higher level, that is, taking the society as the standard and maximizing social interests as their ultimate goal and promoting the harmony of the whole society. Capital accumulation drives down the profit index of capital as shown in Fig. 2.

III. BP NEURAL NETWORK OPTIMIZATION ALGORITHM

Artificial Neural Network has the characteristics of large-scale parallel processing, fault tolerance, self-organization, self-adaptive ability and strong associative function. It has become a powerful tool to solve many practical problems. It is an empirical model that mimics the function of biological neural network. Artificial neural network has the ability of self-learning and self-adaptation, and can output data through a batch of corresponding inputs. Analyze and grasp the potential rules between them. Finally, according to these rules, we can use the new input data to deduce the output results. A schematic diagram of an artificial neuron is shown in Fig. 3.

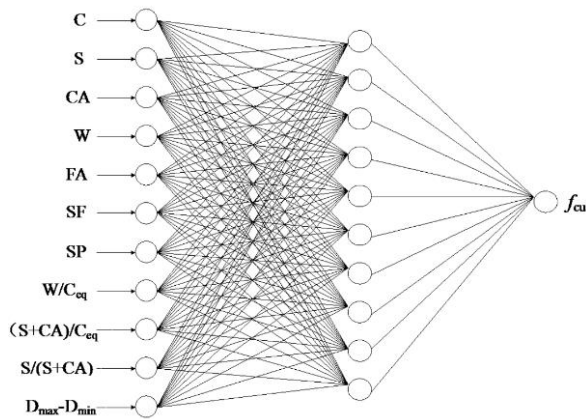


Figure 3. A schematic diagram of artificial neurons.

BP network is a kind of multilayer feedforward neural network. The transfer function of its neuron is S type function, and its output is continuous quantity between 0~1. It can realize arbitrary nonlinear mapping from input to output. Neural network simulates human brain

thinking. Thus, it can be applied to the evaluation of economic benefits of enterprise computerization, which can avoid the interference of human subjective factors and enhance objectivity.

In recent years, the artificial neural network has attracted much attention, especially the BP neural network, because it can approximate any continuous function with arbitrary precision.

It has the following outstanding advantages in evaluating the sustainability of enterprises:

(1) Strong adaptability

Neural network has strong ability to adapt to the change of training samples. When the training sample adds new data, neural network can memorize the original knowledge. According to the appropriate adjustment of new data, the mapping relationship can better depict new samples. This enables the neural network to adapt to the uncertainty of classification objects, while other methods are slightly worse at this point.

(2) Evidence response

In the problem of pattern recognition, artificial neural networks can be designed to provide information not limited to which particular pattern is chosen, but also to provide confidence in the decision.

(3) Nonlinearity

A neuron can be linear or nonlinear. An artificial neural network interconnected by nonlinear neural networks is nonlinear and nonlinear. It is a special property distributed throughout the network. Nonlinearity is a very important nature.

A multilayer artificial neural network model can be described as follows:

The network contains an input layer, P hidden layer and an output layer:

$$P_i = (P_{i1}, P_{i2}, P_{i3}, \dots, P_{id})^T \quad (1)$$

The V layer contains w neurons:

$$V_{id} = wV_{id} + c_1r_1(P_{id} - X_{id}) + c_2r_2(P_{gd} - X_{id}) \quad (2)$$

The weights of the i neurons in layer X to id on layer X are:

$$X_i = (X_{i1}, X_{i2}, X_{i3}, \dots, X_{id})^T \quad (3)$$

$$X_{id} \in (X_{min}, X_{max})$$

The input of the x neuron in layer E is defined as:

$$E(x) = \sum_{j=1}^n E_j \quad (4)$$

HWt is the input vector, D is the output vector, N represents the dimension of the input vector, and x represents the dimension of the output vector.

$$HWt = \frac{\sum_{i=1}^n D_i(x)}{N} \quad (5)$$

The BP learning algorithm requires the transfer function of the neuron model to be a bounded continuous differentiable function, and a network composed of

neurons with such transfer functions. The principle of BP neural network in evaluating the economic benefits of enterprise computerization is that all kinds of indicators that affect the economic effects of enterprises are used as the input amount of neural network. With the continuous development of neural network theory and computer technology, the application of artificial neural network is deeper. At present, there are many factions in the field of neural network research, and a lot of research results have been obtained. For example, multi-layer network BP algorithm, self-organizing feature mapping theory, Hopfield network model, adaptive resonance theory and so on.

For 10 step training, the training error meets the target error requirement, as shown in Fig. 4.

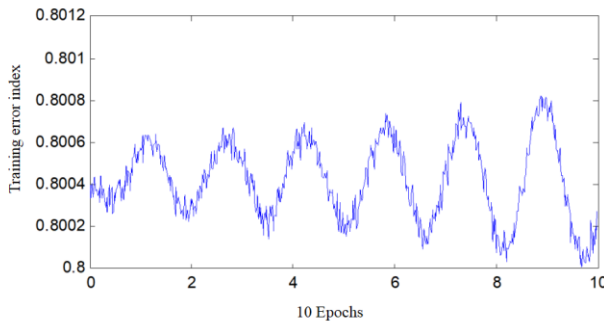


Figure 4. Variation of the sum of squares of errors with training times.

After the network is initialized and trained 300 times by Trainrp, the network error reaches the error target, as shown in Fig. 5.

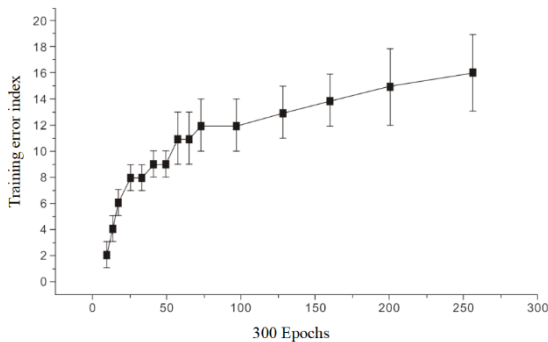


Figure 5. Network training error variation curve.

The BP algorithm is a fast descent method, using the most common gradient descent algorithm in the optimization method. The aim is to minimize the mean square error between the actual output and the expected sample output. It requires transformation functions to have continuous differentiable nonlinear characteristics. The S type logic nonlinear function is generally used.

The function expression is as follows:

$$\begin{cases} \omega^T x_i + b \geq 1, & y_i = +1 \\ \omega^T x_i + b \leq -1, & y_i = -1 \end{cases} \quad (6)$$

The initialization weight f and threshold x are the connection weight sign of the input layer unit to the hidden layer unit. The connection weight of the hidden layer to the output layer is ω . The threshold value of the

hidden layer is T . The output layer unit threshold b randomly assigned a smaller value between $(-1, 1)$.

$$f(x) = \text{sign}[\omega^T x + b] \quad (7)$$

The input vector w and the corresponding expected output vector t are given. The value of w_2 is input to the input layer node, and the output of the neurons in the hidden layer is calculated:

$$w(t) = w_2 + (w_1 - w_2) \frac{T - t}{T} \quad (8)$$

The output p of the output layer neurons is:

$$p = \begin{cases} k & \sigma^2 < \sigma_d^2, f(P_g^t) > f_d \\ 0 & \end{cases} \quad (9)$$

Using the given output data, the general error of output layer neurons is calculated as follows e_j :

$$e_j = -k \sum_{i=1}^n f_{ij} \ln f_{ij} \quad (10)$$

The general error of each neuron in the hidden layer is calculated as follows w_j :

$$W_j = 1 + \frac{k \sum_{i=1}^n f_{ij} \ln f_{ij}}{\sum_{j=1}^m (1 + k \sum_{i=1}^n f_{ij} \ln f_{ij})} \quad (11)$$

Using the generalization error a of the output layer neurons and the output neurons of the hidden layer neurons, the connection weights between hidden layer and output layer and m min value w of x are revised:

$$w_{ij} = w_{ij} + a \left(\frac{X_i}{m} - w_{ij} \right) \quad (12)$$

The BP algorithm has a fast learning speed, and it can achieve good results in application. In the complex structure and learning process and other issues, its computation is very large, usually using the neural network toolbox of MATLAB software to carry out operations. In the MATLAB software neural network toolbox, the training function of integrating BP optimization method is TRAINLM. The training parameters for TRAINLM are shown in Table 4.

Table 4. TRAINLM function training parameters.

Parameter	Meaning
Mu	Initial value of parameter mu
Goal	Precision of training requirements
Mu_inc	Coefficient of increase
Mem_reduc	Parameters of memory / speed

The BP neural algorithm transforms the input and output process of a set of sample indexes into a nonlinear optimization problem. The gradient descent method is used to solve the problem of learning memory. Adding hidden nodes to optimize the problem has adjustable parameters, so it can solve the problem more accurately. In training, by calculating the error between output value and expected value, the general error of output layer unit is solved, and the error is backpropagation.

The general error of the hidden layer element is obtained, and the connection weights between the output layer and the hidden layer and the input layer are adjusted, and the thresholds of the hidden layer and the output layer are adjusted. Until the system error is acceptable, the weights and thresholds will not change at this time. The mean square error of BP neural network is the mean square error between output value and target value. As shown in Fig. 6, the variation process of mean square error in training can eventually be seen to converge.

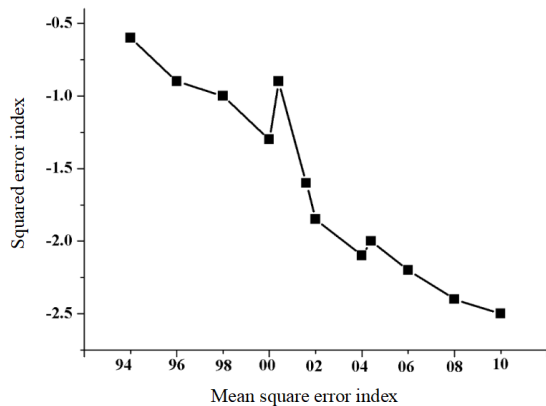


Figure 6. Mean square error curve.

IV. CONCLUSIONS

In this paper, a more objective evaluation method is put forward on the basis of the current industrial enterprise benefit evaluation method. BP neural network is applied to evaluate the economic benefits of industrial enterprises. As the main body of the market, the status of enterprises has been recognized gradually, and the way of management has also undergone a turning change. Using the classification function of the network to classify and evaluate the enterprises, an example is given to show the feasibility of the method. With the maturity of modern company system in China, the form of modern business organization has been developing rapidly. Market competition is becoming increasingly fierce. Owners and managers of enterprises attach more importance to the sustainable development of enterprises. And in the evaluation process of the network system, avoid too many subjective factors interference. It is proved that BP neural network evaluation method is a very effective method for evaluating the sustainable development ability of enterprises. BP based on the data provided, through the study and training, we find out the internal relationship between input and output. So, we can get the solution of similar problems, rather than entirely based on the knowledge and rules of fiber

inspection. Therefore, it has the function of self-adaptive. This is very helpful for weakening the human factors determined by weight.

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