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Research Article

Research on Performance Evaluation of Integrates with Agriculture Food Base and Supermarket

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Abstract: Performance evaluation of integrate with agriculture food base and supermarket is a research hotspot and difficulty in the theory and practice research of agriculture super-docking mode. The study presents an evaluation indicator system and a fuzzy neural network evaluation algorithm for evaluating performance of integrates with agriculture food base and supermarket. Firstly, a performance evaluation indicator system is designed through analyzing the similarities of general performance evaluation and the specialties of the evaluation of integrates with agriculture food base and supermarket; Secondly, the study integrates the advantages of fuzzy evaluation methods and BP neural network evaluation methods, designs a new algorithm structure, selects different learning methods and analyzes the algorithm performance, then presents a new fuzzy neural network evaluation algorithm; Finally, three integrates are taken for experimental examples and the results illustrate that the improved algorithm can be used for evaluating the performance of integrates with agriculture food base and supermarket feasibly and effectively and can provide reference for evaluating other complex systems.

Keywords: BP neural network, fuzzy evaluation method, integrate with agriculture food base and supermarket, performance evaluation

INTRODUCTION

In the research of agriculture super-docking mode, the performance evaluation is a very hot and important research area, the use of performance evaluation method to analyze the agriculture super-docking mode, to sort out the various nodes of the farmers, supermarkets, cooperatives and other agricultural super-docking mode their proper locations and each node on the overall operational efficiency and on this basis and constantly adjust the whole industry chain to enhance the performance of the agriculture super-docking operation. Practical performance, can help companies to identify problems as soon as possible, seek solutions and promote the model optimization. Therefore, the effective performance evaluation is the key to promoting the development of agriculture super-docking mode. So the study takes performance evaluation of integrate with agriculture food base and supermarket for example to research on the evaluation indicator system and evaluation algorithm (John *et al*., 2013).

Following methods are wildly used in performance evaluation of integrates with agriculture food base and supermarket:

- Analytic Hierarchy Process (AHP) effectively combines qualitative analysis with quantitative analysis, not only able to guarantee the systematicness and rationality of model, but also able to let decision makers make full use of valuable experience and judgment, so as to provide powerful decision-making support for lots of regulatory decision making problems. The method has such strengths as clear structure and simple computation, but due to its strong subjective judgment, the method also has shortcomings like low evaluation accuracy (Yobin and Hinton, 2012).
- Multi-hierarchy comprehensive evaluation of fuzzy mathematics, its principle of is to firstly evaluate various kinds of factors of the same thing, dividing into several big factors according to certain attribute; Then carry out initial hierarchical comprehensive evaluation on certain big factor and carry out high hierarchical comprehensive evaluation on the result of initial hierarchical comprehensive evaluation based on that. The key of successful application lies in correctly specifying the factor set of fuzzy evaluation and reasonably form fuzzy evaluation matrix, obtaining evaluation result according to matrix calculation result. Make use of fuzzy comprehensive evaluation method can obtain the value grade of evaluated object or mutual precedence relationship; however, the method requires to establish appropriate evaluation matrix of evaluation object,

which will obtain different evaluation matrixes due to the inconformity of different experts, leading to the inconformity of final evaluation results (Smolensky and Hanazawa, 2013).

- **Data Envelopment Analysis (DEA):** Starting from the perspective of relative efficiency, evaluates each decision-making unit and the indicators selected are only relied on input and output. As it doesn't rely on specific production function, it is effective for dealing with the evaluation with various kinds of input and output indicators, suitable for the analysis of benefit, scale economy and industry dynamics. But it is complicated in computational method, subject to certain limitations in application (Fei and Wiesel, 2013).
- **BP neural network method:** BP neural network learning algorithm adopts gradient search technology so as to minimize the error mean square value between actual output value and desired output value; the method is adept in the processing of uncertain information. If the input mode is close to training sample, the evaluation system is able to provide correct reasoning conclusion. The method has such advantages as wide applicability and high evaluation accuracy, but it also has some disadvantages like easy to fall into local minimum in the computation, low rate of convergence and etc (Yohan, 2010).

BP neural network evaluation algorithm are wildly used in performance evaluation of integrates with agriculture food base and supermarket for their own advantages, but they also have their own disadvantages in practice, such as like easy to fall into local minimum in the computation, low rate of convergence. The study redesigns a new fuzzy neural network evaluation algorithm to overcome their own questions and bring their superiorities into full play. In doing so a new algorithm for evaluating complex system is advanced.

MATERIALS AND METHODS

Establishment of evaluation indicator system: As performance evaluation of integrate with agriculture food base and supermarket needs to focus on farmer value which is a special and complicated factors, the similarity of general performance evaluation and the specialty of the topic in this study shall be combined to establish evaluation indicator system of performance. Integrating the general idea of performance evaluation and combining existing research literature (Sarnowski, 2012; Vinton and Janbiner, 2012; Mrel and Sengio, 2012), this study will, from such four aspects as evaluation of internal and external performance, establish the evaluation indicator system of the performance of integrate with agriculture base and supermarket, which includes 3 hierarchies, 4 categories, 15 second-grade indicators (Table 1).

Fuzzy neural network structure design: Obviously complementary are the advantages and disadvantages of fuzzy system and neural network and the common target of them is the imitation of human intelligence, which creates necessity and possibility for their organic combination. Fuzzy neural network is the product with the combination of fuzzy logic and neural network. At present, there are many scholars engaging in different fuzzy neural network models, applied in different fields. This study, on the basis of fuzzy system model and neural network model, designs its own fuzzy neural network model, as shown in Fig. 1 (Yann and Jerouxn, 2012).

The model defines the basic function of a node. A typical network is composed of a group of nodes which are fan-in nodes from other groups adding weighted quantity and fan-out nodes. What's related to a group of fan in is an integration function *f*, for the connection of information or data from other nodes. The function

Table 1: Performance evaluation indicator system

Target hierarchy	First-class indicator	Second -class indicator
Performance of integrates with agriculture food base and supermarket	Consumer value performance	Customer satisfaction
		Repeat purchase rate
		Customer complaint rate
		Handling time of the complaint
	Supermarket value performance	Return rate of investment
		Supply stability
		Rate of quality monitoring coverage
		Market reaction force
	Farmer value performance	Rate of farmer's return
		Improved varieties of agriculture food
		Ability of anti risk ability
		Transportation convenience
	Value performance of professional farmers cooperatives	Coordination degree
		Extension rate of agriculture technology
		Own brand promotion

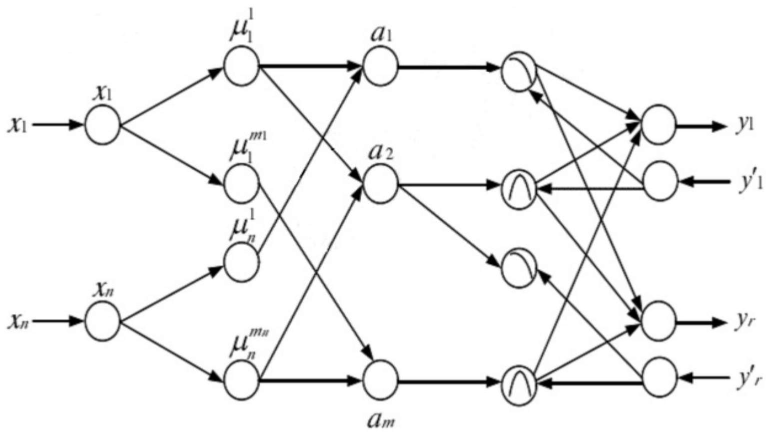

Fig. 1: The structure of the improved fuzzy neural network algorithm

provides network input for the node as shown in Formula 1 (Sarochelle and Laxe, 2012):

$$net - input = f(u_1^k, u_2^k, ...u_p^k; \omega_1^k, \omega_2^k, ...\omega_p^k) \qquad (1)$$

In the formula, the superscript indicates number of layer. The second role of each node is to output activity value as the network output of the node as shown in Formula 2, in which $g(\cdot)$ is activation function. This study adopts activation function with standard form:

$$O_i^k = g(f) \qquad (2)$$

The 1st layer:
Input layer: This layer directly transfers the input value to the next layer; the number of neuron NN_1 is the number of input variable, as shown in Formula 3, in which $u_k^{(1)}$ is the *kth* input variable value. Link weight is $\omega_k^1 = 1$:

$$f_k^{(1)} = u_k^{(1)}, g_k^{(1)} = f_k^{(1)} \qquad (1 \le k \ge NN_1) \qquad (3)$$

The 2nd layer: Input language variable lay, also called fuzzy layer. The function is to calculate the membership function of fuzzy set of each input component belonging to each language variable value. The number of neuron NN_2 is related to that of input variable NN_1 as well as that of fuzzy subset of each input variable. If choosing the same number of fuzzy subset of each input variable ($|T(x_i)| = N_2, i = 1,2,..., NN_1$, $NN_2 = NN_1 \times N_2$. Each neuron indicates one fuzzy subset. If choosing Gaussian function as membership function, Formula 4 is satisfied.

$$f_k^{(2)} = M_{xi}^{\,j}(m_{ij}, \sigma_{ij}) = \frac{(u_i^{(2)} - m_{ij}^{(2)})^2}{\sigma_{ij}^{(2)}},$$
$$g_k^{(2)} = e^{f_k^{(2)}} \qquad (1 \le k \le NN_2) \qquad (4)$$

In which, m_{ij} and σ_{ij} is the center and width of the membership function of the jth fuzzy subset of the ith input variable of X. Link weight $\omega_k^2 = m_{ij}^{(2)}$. At this time, the relationship among *i*, *j* and *k* meets Formula 5.

$$i = (k-1)/N_2 + 1, \qquad j = (k-1)\%N_2 + 1 \qquad (5)$$

The 3rd layer:
Rule layer: The connection of this layer is used for matching the preconditions for fuzzy logic rule; rule nodes have the function of "AND" operation. The number of neuron NN_3 is equal to that of rule and the largest number of rule is $NN_2^{NN_1}$, then Formula 6 is satisfied:

$$f_k^{(3)} = \min_{1 \le j \le NN_1}(u_{kj}^{(3)}),$$
$$g_k^{(3)} = f_k^{(3)} \qquad (1 \le k \le NN_3) \qquad (6)$$

In which $u_{kj}^{(3)}$ indicates the jth input of the kth node; link weight $\omega_k^{(3)} = 1$.

The 4th layer:
Output language variable layer: The nodes of this layer have two working modes, transferring from left to right and from right to left. In the left-to-right mode, "OR" operation is implemented. The number of neuron is equal to the number of all fuzzy subsets of output variable, similar to the 2^{nd} layer, $NN_4 = NN_5 \times N_5$. In which NN_5 is the number of network output variable, N_5 is the number of fuzzy subsets of each output variable ($|T(y_i)| = N_5, i = 1,2,..., NN_5$; Formula 7 is satisfied:

$$f_k^{(4)} = \sum_{j=1}^{N_{4k}} u_{kj}^{(4)}$$
$$g_k^{(4)} = \min(1, f_k^{(4)}) \qquad (1 \le k \le NN_4) \qquad (7)$$

In which N_{4k} is equal to the number of input linked with the kth node of this layer and $u_{kj}^{(4)}$ indicates the jth input of the kth node. Weight value $\omega_k^{(4)} = 1$.

The 5th layer:
Output layer: There are two kinds of nodes in this layer. The first kind of nodes plays a right-to-left transferring role on the training data of feed-in network; the number of neuron of such kind of node is NN_5; Formula 8 and Formula 9 are satisfied:

$$f_k^{(5)} = y_k^{(5)} \qquad g_k^{(5)} = f_k^{(5)}) \qquad (1 \le k \le NN_5) \tag{8}$$

In which, $y_k^{(5)}$ is the kth output variable value; link weight $\omega_k^{(5)} = 1$. The second kind of nodes plays a left-to-right transferring role on decision signal.

Selecting learning algorithms for the improved algorithm: In the actual calculation of fuzzy neural network mode of this study, the following learning algorithms are adopted:

- Back propagation algorithm, rule antecedent and rule consequent parameters are updated via back propagation algorithm.
- Least square method, adopting least square method to update all the rule antecedent and rule consequent parameters.
- Back propagation algorithm and primary least square method, only adopting least square method to update rule consequent parameters in the first iteration and adopting back propagation algorithm to update other parameters.
- Blended learning algorithm is a kind of learning algorithm combining least square method with gradient descent method, able to reduce the dimensionality of search space in the back propagation algorithm and improve the rate of convergence. For each time of sample training, blended learning algorithm has two process of forward and back propagation. In the entire training iteration, adopting least square method to update rule consequent parameters and adopting back propagation algorithm to update rule antecedent parameters. First, fixing antecedent parameters, antecedently transferring the input variable to the 4th layer of model, at this time, total system output can be indicated as linear combination of consequent parameter, i.e., Formula 9:

$$z = (\overline{w_1}x)p_1 + (\overline{w_1}y)q_1 + \overline{w_1}r_1 + (\overline{w_2}x)p_2 + (\overline{w_2}y)q_2 + \overline{w_2}r_2 = A \cdot X \tag{9}$$

- In the formula, $\{p_1,\ q_1, r_1, p_2,\ q_2, r_2\}$ consists of vector *X*; *A*, *X* and z are matrix, dimensionalities are respectively *p*×6, 6×1, *p*×1; *p* is the number of groups of training data. Using back propagation algorithm to update antecedent parameters and changing the shape of membership function, as Formula 10:

$$X^* = \square A^T A)^{-1} A^{-1} z \tag{10}$$

- The selection of the above algorithms mainly takes the complexity of time and space into consideration. In terms of space complexity, back propagation algorithm is the best. From the perspective of time complexity, least square method is the best. In the realization of this study, algorithm 4 is adopted (blended learning algorithm). In the entire learning iteration, back propagation algorithm and least square method are jointly adopted.

Performance analysis of the improved algorithm:

- **Analyzing from model building:** From the fuzzy network model structure of this study, we can see that the model in this study is the optimization of fuzzy system of an established rule, the learning process of which is the process of continuous updating and optimizing of above-mentioned parameters.

The fuzzy rules include input and output variables of system, division of input and output sample space and number of fuzzy rules. These factors determine the specific structure of model. However, in practice, these rules are not an easy thing indeed; global rule (rule enumeration) is generally adopted for determining processing rule base. In establishing actual model, after the sample data are determined, such two major tasks are needed to be finished for establishing models as structure identification, i.e., setting network structure and parameter identification, i.e., model parameter adjustment.

Structure identification is setting network structure, mainly including the following aspects: determining the input and output variables of models, obtaining optimal input and output variable combination; determining input and output space division, the number of if-then rules and the number of membership function, as well as the initial parameters of membership function.

Parameter identification is the identification of a group of parameters under determined structure, adjusting each parameter in the model to obtain the optimal model parameter of the system. Parameter identification in the model mainly includes membership function and rule consequent parameter; in the process of parameter identification, network training is mainly relied on to judge training error. The learning of model is actually a process of parameter identification.

Table 2: Part evaluation results of different integrates

	Consumer value	Supermarket value	Farmer value	Cooperatives value	Final evaluation
A	4.698	4.201	4.702	4.551	4.521
B	4.388	3.908	4.391	4.236	4.231
C	3.903	3.501	4.046	3.653	3.673

Table 3: Evaluation performance comparison of different algorithms

	Algorithm in the paper	Ordinary fuzzy algorithm	Ordinary BP algorithm
Evaluation accuracy	94.01%	74.87%	85.77%
Calculation time (s)	11	10	692

Form the above analysis, we can see that the establishment of the model in the study is a part of the standard fuzzy neural network algorithm (parameter identification); the design of network structure (structure identification) always plays a more important role. Actually, it is difficult to determine first-order fuzzy system of absolute optimal structure, so the model target of the paper is to obtain a fuzzy model structure approximate to the optimal one.

- **Analyzing from the input and output of the improved algorithm:** Input and output are main interface of model application, closely related to specific application. Output variable is determined by model establishment purpose, generally easy. Difficulty generally lies in the selection of input variable.

There are two methods to determine input variable; one is to consult experts' experience, asking experts to offer factors influencing models. The other is to analyze sample data via other statistical method or algorithm to determine the factors closely related to output as the input of model. Besides, the establishment of the model of the paper is based on fuzzy neural network model of T-S model, which is only able to process Multiple Inputs and Single Output (MISO) model, for other Multiple Inputs and Multiple Outputs (MIMO) models, it only needs to transfer them into several multiple inputs and single output models.

- **Analyzing from determining membership function and parameter identification:** After division of input space, the main task is to choose appropriate fuzzy membership functions of proper types for each fuzzy division. Commonly-used membership functions are triangle, trapezoid, Gaussian function and etc. Membership functions adopted by the models of the paper are Gaussian function and bell shaped function.

Through the foregoing steps, model network of the paper has been determined. Structure identification process is also finished. Parameter identification mainly includes setting network initial parameters, setting training parameters, network training and network detection. Network training and detection in parameter identification is a continuously repeated process. Train network with training sample and detect network with detection sample. Stop when the detection accuracy reaching certain requirement. Otherwise, network designing and detection shall be carried out again until reaching detection requirement.

RESULTS AND DISCUSSION

Experimental data come from database of three integrates with agriculture food base and supermarkets, call A, B and C, respectively. For data of customer part, consumers of integrates are selected as the basis for data training and experimental verification in the study, totally 1500 consumers' data for study data that come from practical investigation and visit. In order to make the selected consumers' data representatives, 300 farmers (100 farmers from each supermarket) with more than 2 years, 300 farmers with 1 year integrate experience, 300 farmers with less than 1 year integrate experience.

Limited to paper space, the evaluation of intermediate results is omitted here, only providing secondary evaluation results and final comprehensive evaluation results (Table 2).

As for the performance of the presented algorithm, ordinary BP evaluation algorithm (Yohan, 2010) and ordinary fuzzy evaluation algorithms (Smolensky and Hanazawa, 2013) are also realized in the same calculation environment in the study, evaluation performance of different algorithms can be seen in Table 3. The calculation environment of the calculation platform can be listed as follows: Intel i7 4510U, 4GB (4GB×1) DDR, AMD Radeon R5 M230 and 2 GHz CPU and windows 8.164. The Table 2 shows us clearly that the improved algorithm in the study has greater value than that's of in evaluation accuracy and time consuming.

CONCLUSION

Performance evaluation of integrate with agriculture food base and supermarket plays a key role in agriculture super-docking mode and is hot research spot for the researcher related. In order to evaluate performance of integrates with agriculture food base and supermarket effectively and accurately, the paper presents an evaluation indicator system and a fuzzy neural network evaluation algorithm. Finally the paper carries out case study taking the data of three integrates as an example to illustrate the superiorities of the improved algorithm including simple algorithm process, fast convergence speed, get out local minimum easily, small oscillation and so on. Meanwhile, the improved algorithm built in this study can be reference for the analyzing and evaluating other complex system analysis.

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