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Assessment research on E-business website based on RBF algorithm optimization by fruit fly algorithm

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ABSTRACT

The paper comprehensively researched characteristics and various indexes and properties of E-business websites by the expert grading method. A multi-index hierarchical structure was established for assessment of E-business website competitiveness. An assessment index system for E-business website competiveness was set up to quantize competiveness level of websites. Afterwards, the E-business websites were assessed and researched by the RBF neural network algorithm. Aiming at problems in the assessment research, RBF neural network algorithm was improved by Fruit Fly Optimization Algorithm. It was found in empirical simulation comparison that assessment of E-business websites by FOA-RBF algorithm was obviously better than RBF neural network algorithm in accuracy and handling time. In this way, effectiveness and reliability of algorithm in the paper were verified.
Along with rapid development of E-business in recent years, competition has also become increasingly keen. If an E-business website can completely assess and know its competiveness, website construction will be strengthened and the website will be improved. As the premise for an enterprise to strengthen competiveness and obtain competitive advantages, such assessment and acquaintance shall also be realized at present.

RBF NEURAL NETWORK

The bottommost RBF neural network comprises 3 layers including an input layer, a hidden layer (intermediate layer) and an output layer [1]. The input layer is constituted of some source points (sensing units). These points link network with external environment. In this way, only data information transmission is realized. Input information is never changed. The kernel function (or action function) of hidden layer neurons is set to be a radial basis function. In general, such function has relatively high dimensionality for non-linear transformation from input information to the hidden layer space. The linear output layer makes response to the activation model of input layer.

Numbers of neurons on hidden and output layers are respectively set to be M and Q. The input mode is set as X, wherein $X=[x_1,x_2,\cdots,x_R]^T$. The output mode is set as Y, wherein $Y=[y_1,y_2,\cdots,y_Q]^T$. The paper selected a radial basis function as the Gauss function. Hence, the hidden unit output is [2-3]:

$$z_j=\exp\left(-\left\|\frac{X-C_j}{\sigma_j}\right\|^2\right)\qquad j=1,2,\cdots,M \qquad (1)$$

Where: z_j is the output value of the j th neuron on the hidden layer; C_j is the center of the j th neuron on the hidden layer. It is constituted of center components of all the neurons on the input layer, which are corresponding to the j th neuron on the hidden layer, wherein $C_j=\left[c_{j1},c_{j2},\cdots,c_{jR}\right]^T$; σ_j is the width of the j th neuron on the hidden layer. It is corresponding to C_j; $\|\bullet\|$ is the Euclidean norm.

The expression of input-output relations of neurons on the output layer is as follows:

$$y_k=\sum_{j=1}^{M}w_{kj}z_j\qquad k=1,2,\cdots,Q \qquad (2)$$

Where: y_k is the output value of the j th neuron on the output layer; w_{kj} is the weight between the k th neuron on the output layer and the j th neuron on the hidden layer.

Parameters of RBF neural network hereby mainly refer to center, width and adjustment weight of network [4].

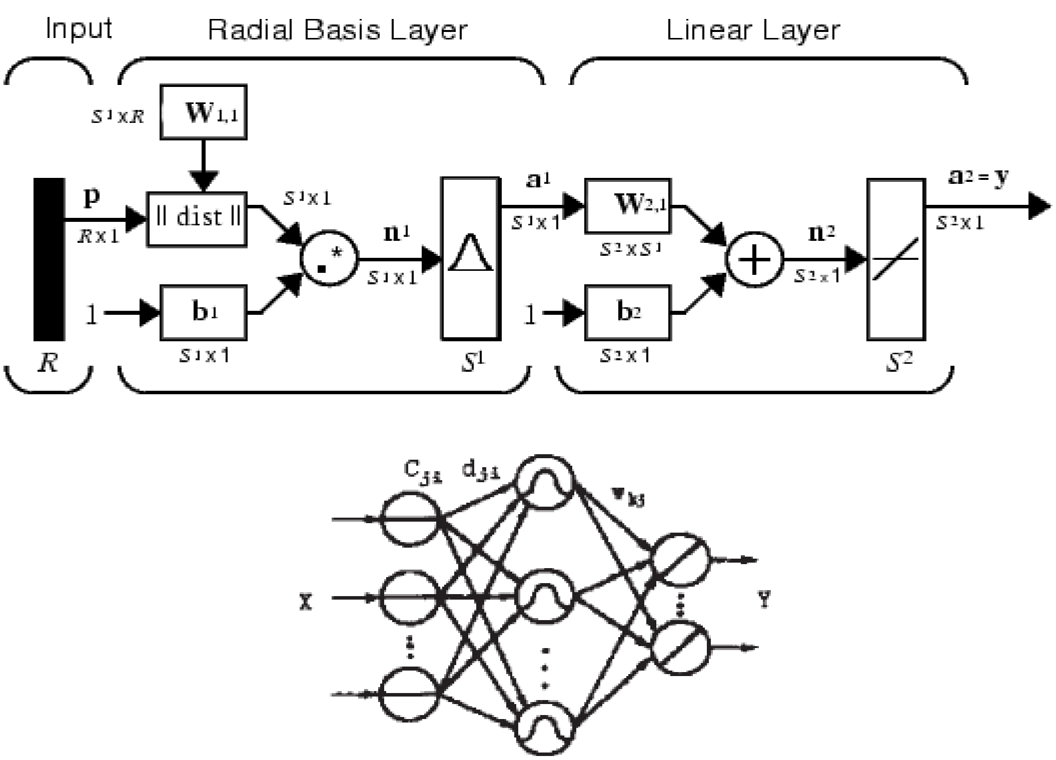

Fig.1 Structural Diagram of RBF Neural Network

FRUIT FLY OPTIMIZATION ALGORITHM

Introduction of fruit fly optimization algorithm

Fruit Fly Optimization Algorithm (FOA) is a new evolution computing method put forward by Pan Wenchao [5-8] – a young teacher in Taiwan during 2011. Fruit flies show superiority in smell and vision, as shown in Fig.1. A fruit fly seeks a food source in the air. After seeking food, it will find positions for food and partners' gathering through its acute vision. In the end, it will fly to the food. Hence, the method believes that a fruit fly finds food by determining the approximate position of food via smell at first; and confirming correct position of food via vision. The new method deduces search of overall optimization based on fruit fly's foraging behavior.

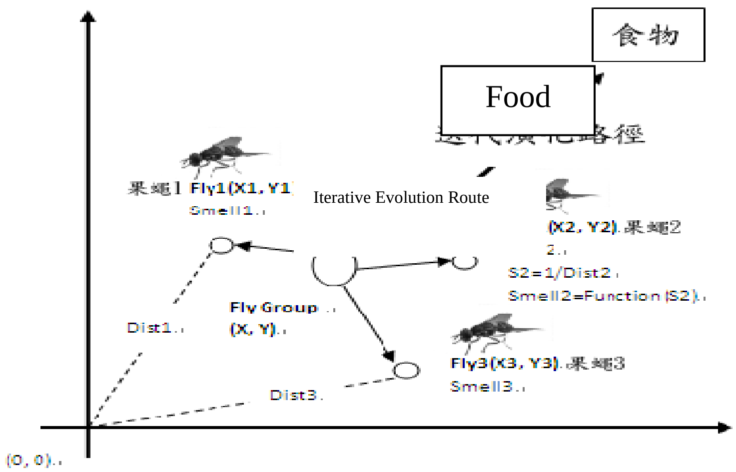

Fig.2 Diagram about Iterative Food Search by Fruit Fly Group

Steps of fruit fly optimization algorithm

Fruit Fly Optimization Algorithm can be divided into 7 steps as follows [9]:

(1) Initialization of position of a fruit fly group is shown in Fig.2. Initialization results are Init X_axis; Init Y_axis;

(2) After setting of search directions **Error! Reference source not found.**and**Error! Reference source not found.**, the random search distance of a fruit fly individual can be obtained by the following formula:

$$Xi = \text{Init X\_axis} + RV_x$$

Error! Reference source not found. (3)

(3) Due to unknown position of food, the distance Disti between current position of a fruit fly individual and the origin point shall be estimated. Afterwards, a decision value Si of smell concentration is worked out. The smell concentration is equal to reciprocal of distance.

$$Disti = \sqrt{Xi\string^2 + Yi\string^2}$$

Error! Reference source not found. (4)

(4) The decision value of smell concentration is substituted into a smell concentration decision function. In this way, the smell concentration of current position of a fruit fly individual is worked out.

Error! Reference source not found. (5)

(5) The optimal smell concentration in a fruit fly group is obtained by the following formula:

$$[bestSmell\ bestIndex] = max(Smelli)$$

(6) The optimal smell concentration value in the fruit fly group as well as its corresponding x coordinate and y coordinate are retained. At this moment, the fruit fly group will orient food source by its own vision. Afterwards, the group will fly to the food source.

$$Smellbest = bestSmell$$

$$X\_axis = X(bestIndex)$$

$$Y\_axis = Y(bestIndex)$$

(7) In iterative optimizing, iterative steps (2) ~ (5) are repeated. In the meantime, whether the smell concentration is better than that in the previous iteration is judged. When such assumption comes into existence, step (6) is carried out.

OPTIMIZATION MODEL OF RBF NEURAL NETWORK WITH FRUIT FLY ALGORITHM

The paper established a neural network assessment model for improvement of RBF by fruit fly optimization algorithm through a RBF neutral network function – matlab neural network toolbox [9]. A spreading parameter Spread of the RBF neural network radial basis function was mainly optimized. The bigger Spread refers to smoother fitting of function. However, too large Spread means that a great many of neurons are needed to suit with rapid changes in the function. In case of too small Spread, more neurons are needed to suit with slow changes in function. As a result, network performances are very poor.

In previous RBF design, different values of Spread were tried to determine an optimal value. In this way, a lot of time was spent, but the optimal value of Spread could not be ensured.

The paper sought the optimal value in the overall scope by FOA algorithm. In this way, the predicted error sum of squares was taken as a smell decision function. The spreading parameter Spread of the optimal radial basis function was then determined. Specific steps of the algorithm are as follows:

1) Determine number of group individuals and maximum number of iterations. Generate the initial position of fruit fly randomly;
2) Grant a random flying direction for food search of a fruit fly individual. Distance interval is [-1 1];
3) Estimate the distance from origin point. Work out decision value of smell concentration, namely the spreading parameter Spread. In case of Spread<0.01, the value Spread is set to be 1;
4) Substitute Spread into RBF for network training and simulation. Afterwards, take the predicted error sum of squares as the smell decision function. Work out smell concentration at the position of this fruit fly, namely error sum of squares;
5) Select the optimal smell concentration in fruit fly group, namely the fruit fly with lowest smell concentration, to obtain the minimum error sum of squares;
6) Retain the optimal spreading parameter Spread and its corresponding x coordinate and y coordinate. In the meantime, the fruit fly group orients a food source by its own vision. Afterwards, it flies to position of food source.
7) Start iterative optimizing. Repeat iterative steps (2) ~ (5). Judge whether the smell concentration is better than that of previous iteration. When such assumption comes into existence, step (6) is carried out.

ESTABLISHMENT OF ASSESSMENT INDEXES OF E-BUSINESS WEBSITE

Establishment of indexes

Based on research of existing E-business website assessment system, the paper took research achievements of other scholars and some organizations for reference. Aiming at situations and characteristics of E-business development, an assessment index system of E-business service website was set up through comprehensive assessment in the principles of comprehensiveness, scientificity, operability, industrial representativeness, and centering on contents. The index system contains first-class indexes and second-class indexes. First-class indexes contain website contents, user services, ease of use, website technologies and website functions. Based on this, 5 first-class indexes were subdivided to constitute second-class assessment indexes [10].

Table 1 Assessment Index System of E-business Website

First-class Index	Second-class Index	Instructions of Index
A1 Website Contents	B1 Timeliness	Update frequency of website information
	B2 Accuracy	Whether website contents are correct or conform to realities; whether there are problems such as grammatical mistakes and improper use of industrial professional nouns
	B3 Specialization	Whether website contents conform to relevant standards; whether provided knowledge about E-business conforms to professional requirements
	B4 Authority	Whether website information sources are reliable and credible; whether information sources are reputable experts or organizations in forestry industry
A2 User Services	B5 Personalized Services	Whether the website can satisfy different demands of customers including customized information and information push according to different requests of them
	B6 Privacy Protection of User	Protection of users' private information and relevant transaction information
	B7 Transaction Specifications and Credit Monitoring	Credit authentication of enterprises; users' grading and assessment of sellers; timely exposure of unreal information, etc.
	B8 Technological Support from Experts	Whether experts in forestry industry can provide on-line answer and guidance
	B9 Website Customer Services	Diversity and usability of consulting manners provided by website to users: online customer service, Email, telephone and message board, etc.

A3 Ease of Use	B10 User Interaction	Whether platforms such as forum, blog and instruction are provided for users' communication
	B11 Website Navigation	Whether website navigation is clear or possesses a website map
	B12 Webpage Design	Whether webpage design is nice and can satisfy industrial characteristics
	B13 Classification of Website Information	Whether forestry information classification of the website is rational or diversified; whether it can satisfy forestry standards and realize convenient use of users
	B14 Search Function	Whether website search function is provided; whether the search manner is diversified
A4 Website Technologies	B15 Link Effectiveness	Whether dead links or wrong links and so forth exist in website links
	B16 Browser Compatibility	Whether the website is displayed correctly and whether functions are usable on different browsers
A5 Website Operation	B17 Website Safety	Virus protection, information safety
	B18 Website Traffic	Subject to Alex flow monitoring results
	B19 Number of Linked Times	Count number of linked times of the website by Google search engine
	B20 Number of Website Users	Number of registered users of the website

Research on assessment index system of e-business website

The research assessed an E-business service website through the method of RBF neural network. Determination of target output is crucial for RBF neural network. RBF neural network belongs to supervised learning. Such manner of learning shall take a set of expected output data as reference for learning. Hence, various indexes of an E-business website shall be graded in order to determine target output.

The expert grading method is commonly used. With such method, an E-business service website is assessed according to the existing assessment index system of E-business service website. Plus, quality of the website is determined through grading. The expert grading method is carried out by combining expert interviews and questionnaire. In this way, objectiveness and effectiveness of the obtained data can be effectively ensured.

Specific rules for grading: 20 second-class indexes in the assessment index system of E-business service website are taken as input of RBF neural network. The website is then assessed. Experts grade each website index and then conduct quantitative analysis of results. In this way, each assessment index is quantized [11].

Table 2 Score Table of Website Assessment Index System

First-class Index	Second-class Index	Good (score)	Medium (score)	Poor (score)	Method for Grading
A1 Website Contents	B1 Timeliness	6	4	2	Method of Monitoring
	B2 Accuracy	6	4	2	Method of Investigation
	B3 Specialization	5	3	1	Method of Investigation
	B4 Authority	5	3	1	Method of Investigation
A2 User Services	B5 Personalized Services	6	4	2	Method of Investigation
	B6 Privacy Protection of User	5	3	1	Method of Investigation
	B7 Transaction Specifications and Credit Monitoring	4	2	0	Method of Investigation
	B8 Technological Support from Experts	4	2	0	Method of Investigation
	B9 Website Customer Services	5	3	1	Method of Investigation
	B10 User Interaction	4	2	0	Method of

	B11 Website Navigation	5	3	1	Investigation Method of Investigation
A3 Ease of Use	B12 Webpage Design	5	3	1	Method of Investigation
	B13 Classification of Website Information	5	3	1	Method of Investigation
	B14 Search Function	5	3	1	Method of Investigation
A4 Website Technologies	B15 Link Effectiveness	5	3	1	Method of Test
	B16 Browser Compatibility	5	3	1	Method of Test
	B17 Website Safety	5	3	1	Method of Test
A5 Operation of Website	B18 Website Traffic	5	3	1	Method of Monitoring
	B19 Number of Linked Times	5	3	1	Method of Monitoring
	B20 Number of Website Users	5	3	1	Method of Monitoring
	Total	100	60	20	

After quantification of each index, grade of each website is determined according to statistic results. The website with higher scores has better comprehensive quality.

Table 3 Instructions of Website Assessment Grade Score

Grade	Score
Excellent	0.9 point and above
Good	0. 75-0. 89 point
Relatively good	0. 65-0. 74 point
Relatively poor	0. 55-0. 64 point
Very poor	0.54 point and below

According to different scores, 5 grades including "excellent", "good", "relatively good", "relatively poor" and "very poor" are divided. Instructions to score of each grade are shown in Table 3.

5. E-business Website Assessment Based on RBF Neural Network Algorithm

With RBF neural network, a website is assessed in the following sequence: data of an established assessment index system of E-business service website is taken as input samples at first. A RBF neural network model was built to train the network [12]; secondly, the established assessment network model is tested according to learning results in training; at last, training results of network learning are summarized and analyzed.

From February, 2012 to March, 2012, 106 collected E-business websites were investigated and analyzed. 20 second-class indexes were finally taken as assessment objects. They were graded through expert grading. The obtained data was processed uniformly. The first 76 sets of data and the last 30 sets of data were tested.

Parameter settings of RBF neural network: error goal: goal=0.0001; spreading constant: spread=1; maximum number of neurons on the hidden layer: mn=20; display frequency in training: df=1. Training results are shown in Fig.3:

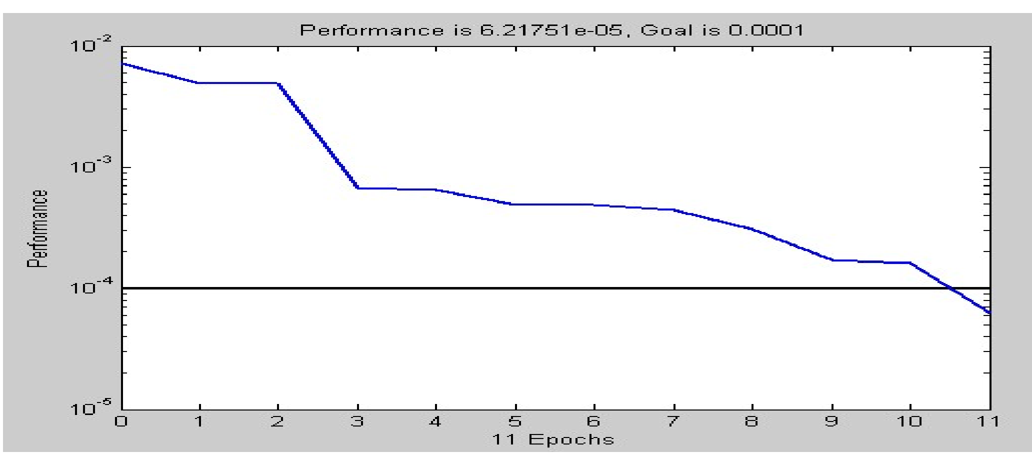

Fig.3 Process Diagram of RBF Neural Network Training

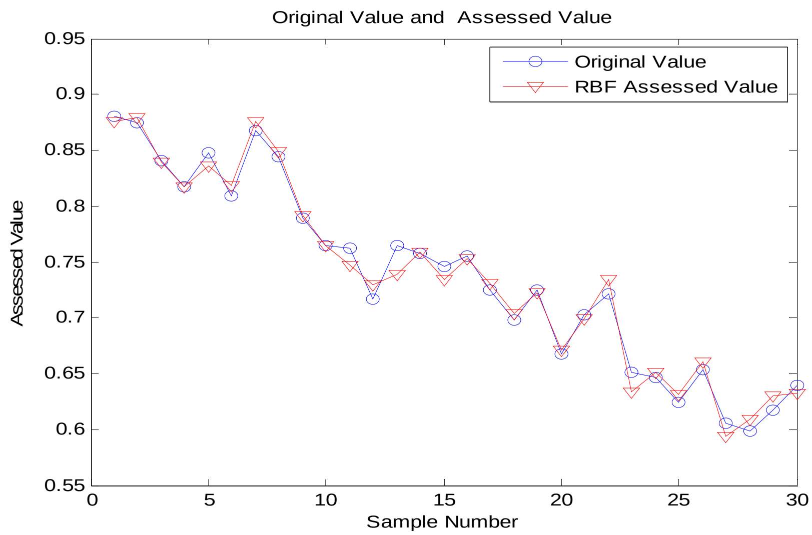

Fig.4 Diagram about Comparison between RBF Prediction Results and Original Values

It is shown in the diagram about comparison between predication results and original data in Fig.4 that, E-business assessment effect was better with use of RBF neural network. Diagram of absolute errors and diagram of relative errors in assessment are respectively shown in Fig.5 and Fig.6.

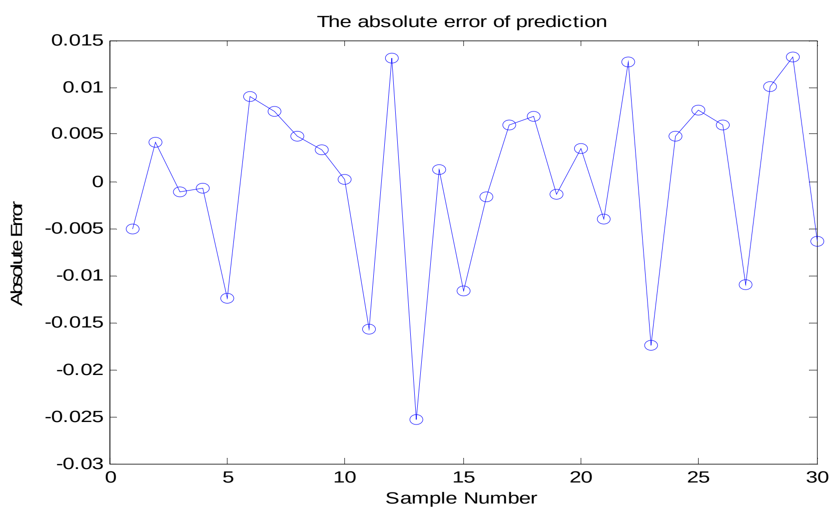

Fig.5 Diagram of Absolute Errors in RBF Prediction

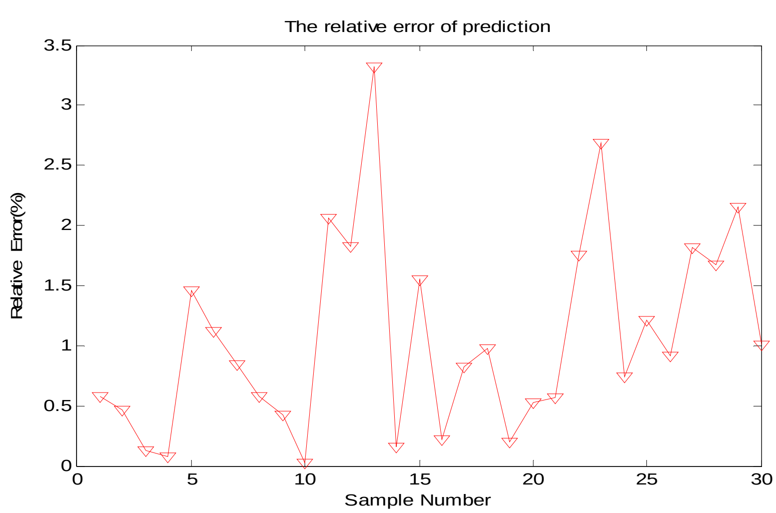

Fig.6 Diagram of Relative Errors in RBF Prediction

It is shown in Fig.6 that the mean value of relative errors in E-business website assessment with application of RBF neural network was 2.5%. Assessment effect was relatively good. However, assessment duration was too long. Errors were too big at some assessment points.

5. E-business Website Assessment Based on RBF Neural Network Optimization by Fruit Fly Optimization Algorithm

Parameters of Fruit Fly Optimization Algorithm were set. Number of iterations was 100. Population size was 30. Programming solving was realized by MATLAB. Solving results are as follows:

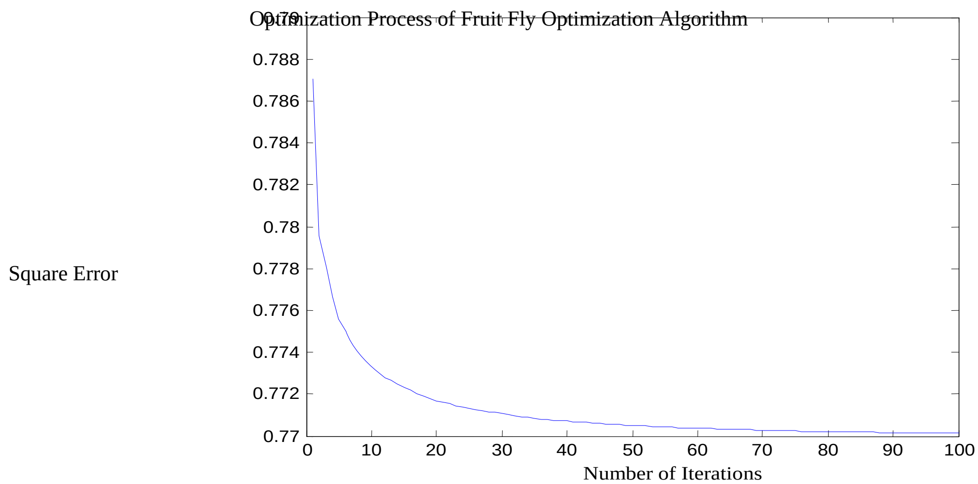

Fig.7 Convergence Map of RBF Square Errors with Fruit Fly Optimization Algorithm

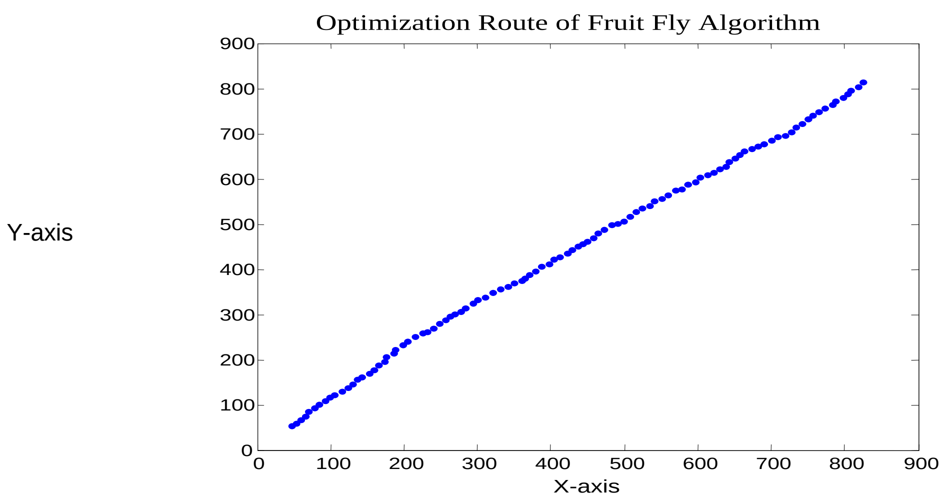

Fig.8 Optimization Route of Fruit Fly Algorithm

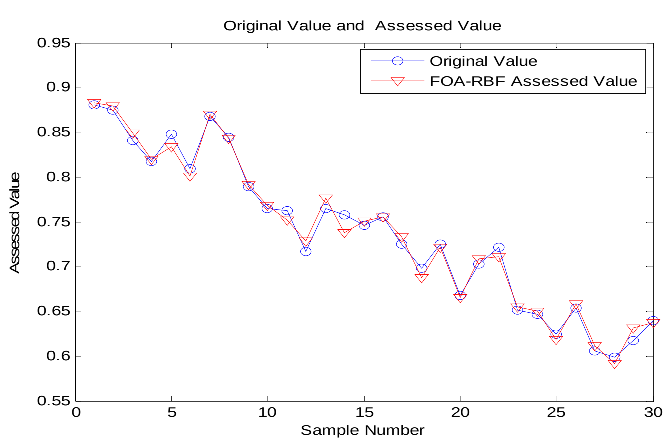

Fig.9 Diagram of Comparison between F0A-RBF Prediction Results and Original Values

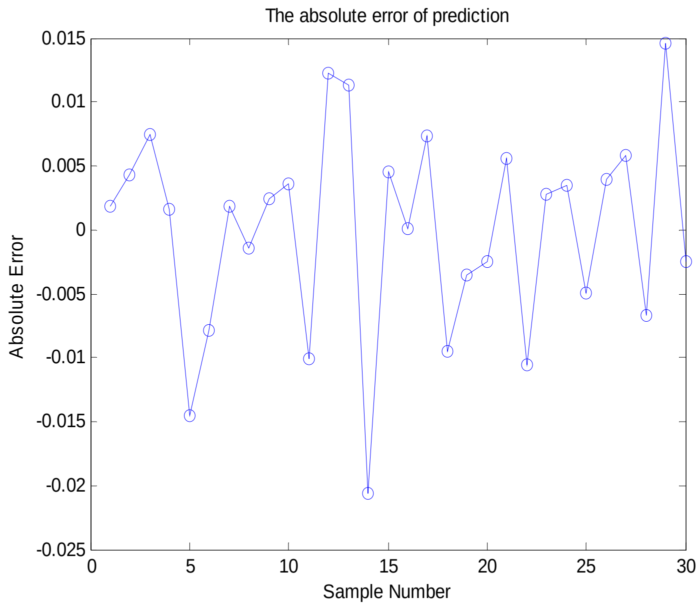

Fig.10 Diagram of Absolute Errors of FOA-RBF Prediction

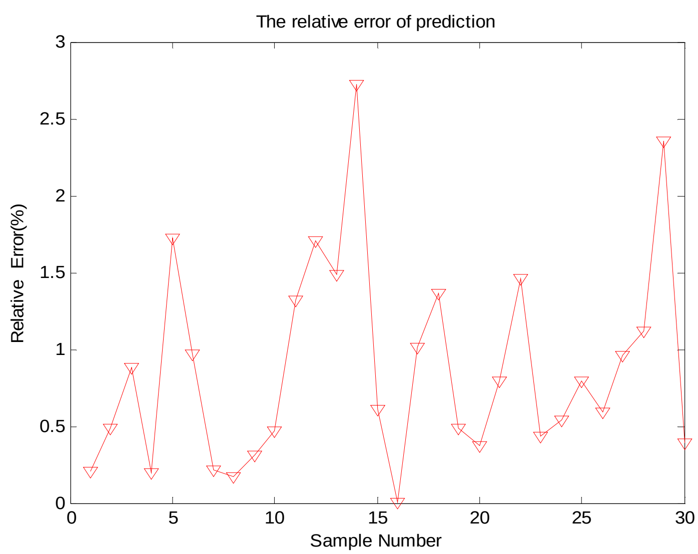

Fig.11 Diagram of Relative Errors of FOA-RBF Prediction

It is shown in simulation results of FOA-RBF algorithm that the prediction accuracy of FOA-RBF algorithm is higher than that of a common RBF neural network algorithm. Absolute and relative errors of its prediction are shown in Fig.10 and Fig.11. During optimizing with FOA-RBF algorithm, the rate of convergence was relatively high while the convergence nature was good. Characteristics of convergence are shown in Fig.7. The optimizing route of fruit flies in two-dimensional space is shown in Fig.8.

CONCLUSION

With the expert grading method, the paper established a multi-index hierarchical structure for assessment of E-business website competiveness. An assessment index system of E-business website competiveness was set up to quantize competiveness level of a website. Afterwards, E-business websites were assessed and researched by RBF neural network algorithm. It is found in instance simulation and comparison that E-business website assessment with the FOA-RBF algorithm was obviously better than that with RBF neural network algorithm in accuracy and handling time. In this way, effectiveness and reliability of the algorithm in the paper were verified. Such method can be popularized to other fields, facilitating solution of other similar problems.

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