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The Rejection of Particle Group Algorithm based on Nonlinear Strains Fell to Choose in the Application of Artificial Neural Network

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Abstract

Artificial rejection system strains of particle swarm optimization algorithm, introduced selection mechanism and nonlinear optimization, using nonlinear mutation operator, such as copying and improve the algorithm convergence speed and population diversity, so as to put forward a kind of based on nonlinear plant choose the rejection of particle swarm optimization algorithm, has advantages of few parameters to adjust, and easy to implement. Combined with Iris classification problem, a weight optimization is applied to the artificial neural network, and the method based on the standard particle group algorithm and the simple comparison of artificial neural network training, the experimental results show that compared with other two kinds of algorithm performance is better, this algorithm has good convergence and stability.

Keywords: *particle swarm algorithm, the rejection of operator, nonlinear optimization, artificial neural network*

1. Introduction

In economy, management, military, science, and engineering design, and other fields will be a lot of the actual situation involved in the optimization problem, but in reality many of the science, engineering and economic problems are complicated, multi-polarization, the characteristics of nonlinear, strong constraints and difficulty in modeling, which makes people for science and technology put forward new and higher requirements, including the optimization of efficient technology and intelligent computing is particularly urgent.

Particle swarm optimization algorithm is derived from the study of birds feed on behavior and development of an intelligent optimization algorithm, this method is especially suitable for processing of traditional search method cannot solve the complex and nonlinear problem. Similar to genetic algorithm, particle swarm optimization algorithm is an optimization tool based on groups, system is initialized to a group of random solutions, through the iterative search for the optimal value. But there is no genetic algorithm with crossover and mutation operation, but particles (potential) solution in the solution space to follow the search for the optimal particle. Because it USES population organized search, which makes it can multiple areas within the search space at the same time, and this way is especially suitable for large scale parallel computing, from the search space is restricted conditions, such as continuous and differentiable, *etc*.,) of the constraint and does not need other auxiliary information (*e.g.,* derivatives). The characteristics of the new particle swarm algorithm can not only obtain a high efficiency and has the characteristics of simple, easy to operate and general. Therefore, the particle swarm optimization algorithm was proposed, immediately started extensive attention of scholars in the field of evolutionary computation and so on, and in a few years a large number of research results, formed a research hot spot [1-3].

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Although the particle swarm optimization algorithm has been widely applied in the optimization calculation, but after it is used to solve various practical optimization problems, it was found that particle swarm optimization will be due to various reasons, lead to premature convergence, to the local optimal solution of the objective function that is called "premature convergence" problems, and slow convergence in the late evolution, thus affecting algorithm to search the global optimal solution, these deficiencies hindered the popularization and application of particle swarm optimization algorithm. How to improve the searching ability of particle swarm optimization algorithm and improve the convergence speed of the algorithm and make it better used in the actual problem, is a major subject of international scholars have been exploring. In order to further expand the application of particle swarm optimization algorithm in optimization problems. Through in-depth analysis of the characteristics of particle swarm algorithm to find the reasons of premature convergence and improvement, to improve the convergence performance and convergence of the algorithm. Extract the rejection mechanism of the biological rejection system, it is introduced into the particle swarm optimization algorithm, the two together, by maintaining the diversity of individuals, to avoid premature convergence and improve the convergence speed. Due to the introduction of the biological mechanism of rejection greatly improve the performance of particle swarm optimization algorithm, so the particle swarm optimization algorithm can be widely used in the optimization calculation, so as to improve the efficiency and level of optimization calculation.

2. Related Works

2.1. Plant Selection Principle

In biological rejection system are motivated by the foreign antigens, high affinity with the antigen B cells were chosen, replication and super mutations occur in the local scope search higher affinity of B cells. Receptor editing phenomenon makes low affinity of B cells in the shape of space may have mutated from its more distant points, to globally search higher affinity B cells; Other low affinity of B cell death, from the bone marrow produce new B cells to increase the population diversity. After several generations of selection, finally has a high affinity of B cells, further differentiate into plasma cells, it produces a lot and the receptor antibodies to eliminate antigen of the same shape.

Strains fell choice corresponds to a affinity mature process, namely under the choice of antigen, the affinity of antibody and antigen showed a trend of increasing, eventually be able to produce antibodies against antigens of the most effective. From the point of view of problem solving, if the antibody as a problem of the solution, strains fell selection process is a constant process of seeking maximum affinity solution.

Rejection system in the process of affinity maturation, part has four basic characteristics: (1) has a high affinity for individual replication and mutation, promote affinity mature further;(2) the rejection of complementary mechanism to maintain the diversity of antibodies, enables the antibodies to deal with different types of antigens;(3) the replication process is a kind of cell replication process itself, there is no intersection between individual replication and replication.(4) the rejection of the existence of memory makes excellent individuals and their information. These characteristics of mimic rejection system, can design not only has good global search ability, but also has fast optimization algorithm local search ability [4].

2.2. Nonlinear Optimization

Nonlinear state widely exists in natural phenomenon and social phenomenon, is a common phenomenon in many nonlinear system, its behavior is complex and is similar to random, but seemingly chaotic nonlinear change process is not chaos, but there is a subtle inner regularity. Nonlinear motion randomicity, ergodicity and regularity of unique

properties, such as between certainty and randomness, has rich space-time dynamic. Nonlinear optimization algorithm is the use of nonlinear variable characteristics of randomicity, ergodicity and regularity in the solution space optimization search, the nonlinear characteristics of ergodicity can be used as search avoid falling into local minimum in the process of a kind of optimization mechanism, this and other stochastic optimization algorithm to accept make the objective function at a certain probability of point to jump out of local optimal value exists significant difference between the two, nonlinear orbital ergodicity makes nonlinear sequence can be repeated after a certain range of all, this is the fundamental starting point of the nonlinear for function optimization. As a result, nonlinear has become a novel optimization technique, and has been widely attention and extensive research.

Nonlinear optimization is based on the basic idea of nonlinear variable search, its process is divided into the following two phases: first, based on the certainty of iterative nonlinear variable to search the whole solution space, when meet some termination conditions, into the second stage, in the first phase of the results as the center, through additional small disturbance further fine search in local area, until meet the termination criterion. Among them, the additional disturbance can be nonlinear variable, or based on gaussian distribution and uniform distribution of random variables.

2.3. The Rejection of Particle Group Algorithm based on Nonlinear Strains Fell to Choose

The rejection of particle group algorithm based on nonlinear strains fell to choose the basic idea is: antibody after initialization, first, the basic particle swarm algorithm is used in the speed and position of updating formula to guide the direction of the "flying", to accelerate the convergence speed, choose the antibodies with high affinity to copy, make antibodies to more gathered near the position of "good", then to nonlinear mutations, copy after antibodies to make antibodies to the "good" position near to search in all directions, finally abandoned the worst affinity antibodies, to initialize them, to ensure the diversity of population.

Based on replication and mutation nonlinear phenomena design copy operator, is located in the D dimensional search space, there are N particles, speed and position of all particles in the updated new population of $P_k = \{X_1, X_2, ...X_N\}$

According to the antigen of antibody affinity sorting, the highest affinity antibody of elite reproduction population A_k, the rest of the (N, M) of antibody population B_k, population size M is a variable, a antibody affinity function is $f(*)$, the A_k represented as:

$$A_k = \{X_i \,|\, f(X_i) \geq \overline{f}, i = 1, 2, ...N\}, \overline{f} = \frac{1}{N}\sum_{j=1}^{N} f_j \tag{1}$$

In $A_k = \{X_1, X_2, ..., X_M\}$, nonlinear copy operator are defined as follows

a. Copy: population of A_k M antibody affinity of $X_1, X_2, ..., X_M$ values for $f_1, f_2, ..., f_M$, according to the population size N and affinity, X_i copy of the same point $X_{i1}, X_{i2}, ..., X_{iq}$ to q_i . X_i to produce new individual is p_i

$$p_i = f(i) \Big/ \sum_{j=1}^{N} f_j \quad , i = 1, 2, ...M \tag{2}$$

Antibody X_i copy for number q_i

$$q_i = \left\lceil \frac{p_i N}{i} \right\rceil \tag{3}$$

Will duplicate the affinity antibodies in descending order, I is the serial number, the more you copy number, the greater the affinity of antibody. q_i can be adjusted according to p_i and I adaptive, $\lceil * \rceil$ for the integral function.

b. Mutations: nonlinear variable sensitive dependence on initial conditions, ergodicity, randomness and regularity. Compared with the general stochastic search method, nonlinear search in a small space with strong local search ability, careful search effectiveness is stronger. As a result, nonlinear mutation is used to replace the traditional gaussian mutation operator.

The nonlinear mapping technique was used to realize nonlinear mutations:

$$p_{n+1} = 1 - 2p_n^2 \tag{4}$$

Set $x_{ij}(d)$ as the population of antibodies in C_k , in the first d component, of which $i = 1,2,...M$, $j = 1,2,...q_i$, $d = 1,2,...D$, its scope is $[L_d, U_d]$, according to the type (5) the map it to the nonlinear traversal interval [-1, 1], and then according to the type (6) with type (7) to calculate the mutation antibodies after $X_{ij}^{'}$

$$p_{ij}(d) = \frac{2}{U_d - L_d} \cdot x_{ij}(d) - \frac{U_d + L_d}{U_d - L_d} \tag{5}$$

$$p_{ij}'(d) = f_{cm}(p_{ij}(d)) \tag{6}$$

$$x_{ij}'(d) = p_{ij}'(d) \cdot \frac{U_d - L_d}{2} + \frac{U_d + L_d}{2} \tag{7}$$

Type of f_{cm} representative type nonlinear mapping formula of (6).

c. Rejection choice: nonlinear mutation after the population of D_k , for any $i = 1,2,...M$ existing antibodies in

$$d_i = \{X_{ij}' \,|\, \max f(X_{ij}'), j = 1,2,...q_i\} \tag{8}$$

Is composed of d_i species, D_k' from the merger of progeny population D_k' and initial population A_k , size Q choose competition, through the way of league titles, formed a new generation of elite population A_{k+1} .Reproduction of nonlinear operator space extension and compression, effectively improve the ability of local optimization[5-7].

For a population of B_k , 5% of simulated biological strains fell to choose B cell natural death process, choose d a minimum affinity antibodies in B_k using $\Gamma(*)$ die operator shall be abandoned, to initialize, it can maintain the diversity of population:

$$\Gamma(X) = rand() \cdot (up - low) + low \tag{9}$$

3. The Rejection of Particle Group Algorithm based on Nonlinear Strains Fell to Choose in the Application of Artificial Neural Network

3.1. Artificial Neural Network

Artificial neural network model is based on the basic principle of neural network in the biology and set up a way of imitating the human brain work calculation model, can be regarded as a kind of parallel distributed processing system with a large number of connections, it can acquire knowledge and solve the problem, by learning and knowledge stored in the connection weights.

Neurons is a basic processing unit of the neural network, a scalar type p multiplied by a weight w get wp, it into the accumulator and get the value of the combined with offset value b n is often referred to as net input, it is as a parameter to the transfer function f, by operation of f a scalar output. Neural network designers can choose specific transfer function f, and according to the rules of learning and cumulative value w offset value b to meet specific needs. The transfer function mainly includes three types: step transfer function and linear transfer function and logic transfer function. Two layers of f refers to the transfer function of the structure of the neural network. Two or more parallel operation of neurons of the neural network layer, the typical neural network can include a layer or layers. If a layer of output is the output of neural network, the layer to output layer, and other layers of hidden layer.

Neural network from the connection ways mainly divided into two broad categories: feed forward neural network and feedback neural network. Now, the optimization of neural network are mainly concentrated on the feed forward neural network. Information is by input units forward to hidden units, and eventually reached the output unit, without any middle back, this is also the origin of the name of feed forward network. American scholar Dr. Rosenblatt put forward a kind of can be used in the pattern classification of feed-forward neural network model, referred to as the perceptron. It is composed with single neuron threshold value components of the network, can only to solve linear separable problem. In order to increase the classification ability of complex problems, on the single-layer perceptron improvement, increasing the hidden layer between input and output layer, contain hidden layer perceptron network called a multilayer perceptron. Research shows that only contains a hidden layer of multilayer perceptron can not only solve the problem of nonlinear can be divided into, also can approximate any continuous function, as long as there is plenty of hidden layer neurons are available.

Hidden layer increased while improve the classification ability of the network, but increased the difficulty of the training, and the appearance of back propagation network has the problem solved. Back propagation neural network, hereinafter referred to as artificial neural network, is a kind of based on error back propagation algorithm (bp neural algorithm) of multilayer feed forward neural network. Artificial neural network training process consists of two parts, namely the input signals are spread and error back propagation network, according to supervised learning methods for training [8-10].

3.2. Based on the Nonlinear Strains Fell to Choose the Rejection of Particle Group Artificial Neural Network Learning Algorithm

Artificial neural network is a kind of multilayer feed forward neural network structure, its activation function of hidden layer neurons using S function, and the output neuron activation function can be s-shaped function can also be a linear function, proved: the hidden layer neurons using S function, the output neurons using linear function of the artificial neural networks can be arbitrary function fitting. Typical s-shaped function is as follows:

$$f(x) = \frac{1}{1+e^{-x}} \tag{10}$$

Where x is the neuron's weighted input values.

Based on nonlinear strains fell to choose the rejection of particle swarm optimization algorithm as the learning algorithm to optimize neural network weights is the key to the following two points:

(1) Based on nonlinear strains fell choose the rejection of particle swarm optimization algorithm in particle between dimensions and weights of neural network mapping. Each particle dimension of component corresponding to a connection weights of the neural network. That is to say how many neural network connection weights (including offset value), as a learning algorithm based on nonlinear strains fell choose the rejection of each particle in the particle swarm algorithm should be how many dimensions.

(2) Using the mean square error of the neural circuits

$$J = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{C}(y_{j,i}^{d} - y_{j,i})^2 f_j \tag{11}$$

As a rejection of choosing based on nonlinear strains fell the fitness function of the particle swarm algorithm, based on nonlinear strains by dropping it choose the rejection of particle swarm optimization algorithm is a powerful search performance can minimize the mean square error of the network. Type (11) N is in the training set of sample; C is the number of neurons in the output of the network; $y_{j,i}^{d}$ is the first I a sample first j a ideal output value of the output of network; $y_{j,i}$ is the first j a network to the ith a sample output node of the actual output values.

Based on the rejection of particle group algorithm based on nonlinear strains fell to choose artificial neural network learning algorithm can be designed as follows: all the connections between neurons weights (including threshold) encoded into real vector to represent the individual in the population the position vector of the X_i; Randomly generated these vector group, and then based on the nonlinear strains fell in accordance with choice of rejection step iterative particle swarm algorithm; Individual iteration the newly generated vector reduction as the artificial neural network weights, all samples produced by neural network computing variance (this step is equal to the rejection of particle group algorithm based on nonlinear strains fell to choose in calculating the fitness of particle), if the specified error of mean square error is less than the system precision, stop the training process, otherwise iteration continues, until the maximum number of iterations. The algorithm of the specific steps are as follows:

Step1 Determine population size N. Fitness epsilon threshold value ε; The largest number of iterations $G_{\max}$; Learning factor c_1, c_2;

Step2 Random initialization of population, determine the initial position of each particle and speed;

Step3 According to particle X_i and the training sample, according to (11) to calculate the affinity of each particle and updates the P_i, P_g;

Step4 If reach the end condition, the algorithm terminates;

Step5 Speed and position of all particles is updated, and limit its does not exceed boundary;

Step6 For the current population P_k , according to the antigen of antibody affinity sort, select the highest affinity M. A single particle copy of elite population A_k , the rest of the (N, M) particles population B_k ;

Step7 To particles in the population A_k (antibody) to copy, nonlinear mutation and selection operation, get A new generation of elite group A_{k+1}.

Step8 Affinity in the group B_k d a minimum particle using die operator shall be abandoned, to initialize it: $X_i' = \Gamma(X_i)(i = 1,2,...d)$, get new population B_{k+1}

Step9 Populations will be A_{k+1} and B_{k+1} combined to get A new generation of population, $P_{k+1} = A_{k+1} \cup B_{k+1}$

Step10 back to step 3.

Visible, for a given structure of neural network, just to encode the connection weight and map it to code string represented by individuals, will have a mean square error of the training, at the same time as the fitness function of the evaluation of the individual, at this time of the neural network training can be converted to find a set of the minimum mean square error of the best connection weights optimization problem [11-13].

4. The Simulation Experiment and Result Analysis

Iris classification problem is a kind of Iris. Iris is used to test the performance of classifiers, a well-known benchmark functions data set. In data records, each group of data contains four properties of the Iris flower: sepals length, width of sepals, petals length and width of the petals. Three different kinds of flowers have 50 sets of data, each with a total of 150 sets of data. The 150 groups of data were randomly divided into training set and testing set, each set of 75 groups of data.

Experiment with three layer artificial neural network for classification problems of Iris. Network with four input nodes and three output node; Each input node represents an attribute of a flower, and each output nodes represent a class of flowers. The number of hidden layer nodes respectively choose 6, 12, 18, 24 and 30.Hidden layer nodes activation function, as shown in the type (10) output node USES the linear function [14-15].

In the experiments, the standard particle group algorithm of parameter selection for: population size $S = 2$;Accelerated constant $c_1 = c_2 = 2$;Inertial factor along with linear iteration times omega to decrease from 0.9 to 0.4;The maximum number of iterations $G_{\max} = 200$.Rejection based on nonlinear strains fell to choose the parameters of particle swarm optimization algorithm in population size and the maximum number of iterations with the standard particle group, $c_1 = 1.5, c_2 = 2$ the competition scale $Q = 10$.Artificial neural algorithm called is traingdm training function of Matlab, vector $\eta = 0.1$, the momentum coefficient $\alpha = 0.6$, the target error $e = 0.0001$.

Respectively based on the nonlinear strains fell choose the rejection of particle swarm optimization algorithm of artificial neural network learning algorithm, the artificial neural network learning algorithm based on the standard particle group and simple artificial neural algorithm training the neural network on the training set, and then use the test set of sample to the trained neural network for testing. Classification with a test set and will test the sample data is applied to the input nodes of networks, if the output value of the output of network meet the type:

$$\left| y_i^d - y_i \right| \le \theta \qquad i = 1,2,...C \tag{12}$$

Thinks that classification is correct, otherwise, the classification error; Theta is the threshold, the values between the [0,1], this paper experiment, take $\theta = 0.5$.Evaluation index of network classification effect such as (13), including n_{err} said the sample error classification, N said the total number of samples.

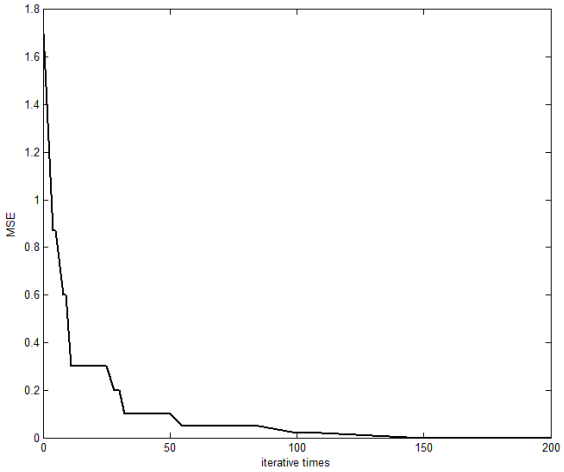
$$E = \frac{n_{err}}{N} \times 100\% \tag{13}$$

Experiments for each algorithm respectively under different network topology computing 50 times, the final results from $\bar{E}$ mean and mean square error, to compare the effectiveness and stability of the algorithm. Table 1 is three algorithms respectively under different network topology the classification results of the test set, including the asterisk line is when $G_{\max} = 400$. Figure 1 is based on nonlinear strains fell chooses the rejection of particle swarm optimization trained artificial neural network mean square error of several kinds of typical cases.

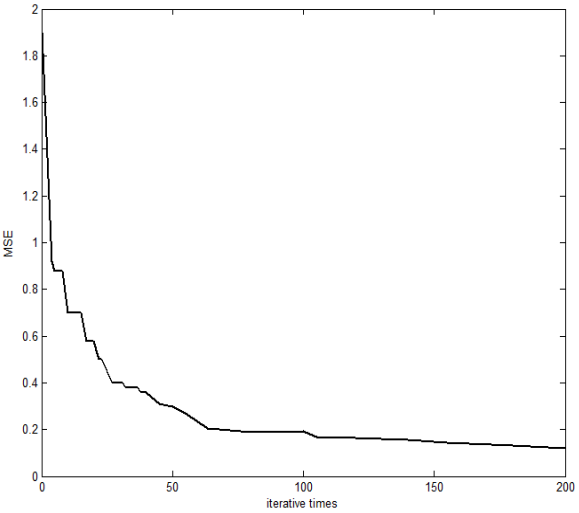
Table 1. Three Kinds of Algorithm Comparing Test Results

Network topology	Algorithm 1		Algorithm 2		Algorithm 3	
	$\bar{E}$(%)	Average variance	$\bar{E}$(%)	Average variance	$\bar{E}$(%)	Average variance
4-6-3	4.9	0.0018	11.3	0.0093	19.5	0.0322
4-12-3	4.1	0.0012	9.4	0.0068	14.9	0.0363
4-18-3	3.8	0.0001	8.6	0.0035	10.2	0.0193
4-24-3	6.1	0.0057	10.5	0.0069	6.4	0.0044
4-30-3	6.7	0.0103	12.6	0.0106	6.1	0.0037
4-30-3	4.5	0.0054	7.3	0.0860	6.6	0.0069

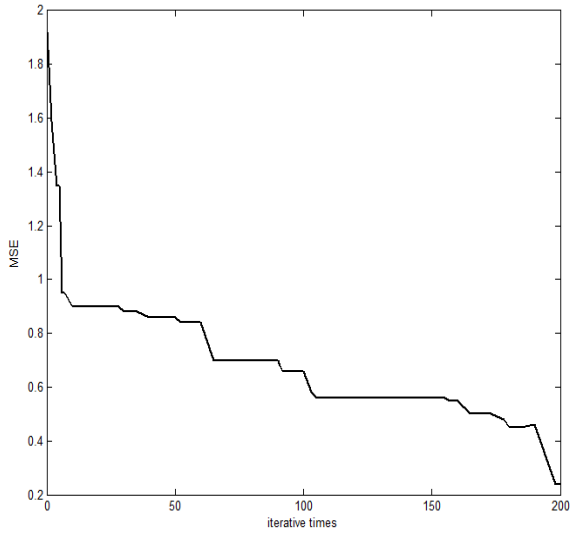
The Table 1 shows that based on the nonlinear strains fell to choose the rejection of particle group algorithm of artificial neural not only in terms of prediction accuracy and stability are better than artificial neural algorithm based on the standard particle group is better, and in the hidden layer node number for 6, 12, 18 is superior to bp neural algorithm. Based on the standard particle group algorithm of artificial neural along with the increase of the number of hidden layer nodes predictor $\bar{E}$ after the first small to big, this is because when the increase in the number of hidden layer nodes on the one hand, sample data is mapped to a high-dimensional space, is advantageous for the sample classification, to predict index $\bar{E}$ gradually decreased;, on the other hand, due to the dimension of increase, increasing the difficulty of optimization, when the dimensionality increases to a certain extent, within a given number, the standard particle group algorithm is difficult to achieve satisfied effect, causing the value of $\bar{E}$ and bigger. Also can be seen from table 1 based on the nonlinear strains fell to select the rejection of particle group algorithm of artificial neural network topology change is not as sensitive to artificial neural network, it brings to the application is convenient, you don't have to in order to find the best topology with a large number of control experiment. Table 1 based on nonlinear plant falls in the rejection of particle group algorithm of artificial neural 50 times the results of the mean square error in the case of a reasonable number of iterations are relatively small, that it is not like artificial neural network is sensitive to initial value selection, which reflect the stability of the algorithm.



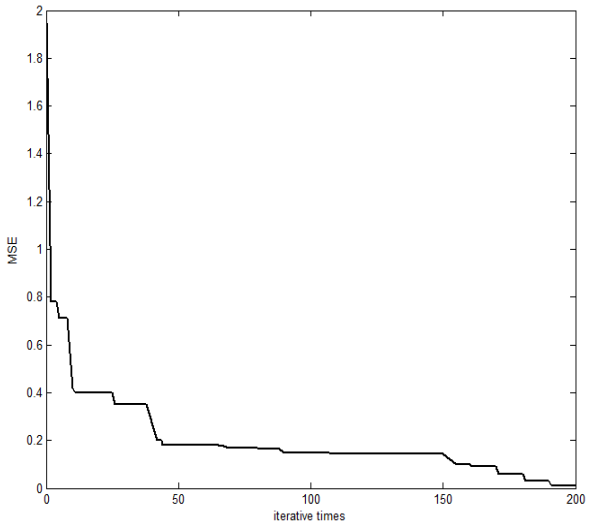
(a) Network Topology 4-6-3, E=4.9%



(b) Network Topology 4-12-3,E=4%



(c) Network Topology 4-18-3, E=3.5%



(d) Network Topology 4-24-3, E=2.7%

Figure 1. The Rejection of Particle Group Algorithm based on Nonlinear Strains Fell to Choose Training Artificial Neural Network Error Curve

Can be seen from the Figure 1 the curve based on the nonlinear strains fell chooses the rejection of particle group algorithm of artificial neural convergence speed is very fast, artificial neural algorithm can overcome the question of "false saturation", in addition, the mean square error network classification effect index $\overline{E}$ is not necessarily good, such as in Figure 1 (a) the mean square error is 0.0018, is smaller than 0.2136 in Figure 6.7 (c), but it's E values higher than the Figure 1 (c) $\overline{E}$ value. So mean square error index can not fully reflect the classification ability of network, it is worth noting.

5. Conclusion

In order to speed up the convergence speed, and at the same time keep the diversity of particle group, the introduction of nonlinear optimization algorithm and artificial rejection system, plant selection mechanism, the objective function and constraint condition as antigen, particle group as antibodies, the high affinity antibodies according to its affinity is proportional to the replication, nonlinear mutation is inversely proportional to the affinity; And low affinity antibodies in a certain proportion to initialize, to ensure the diversity of population. The strains fell selection mechanism and nonlinear optimization algorithm is combined with particle swarm optimization algorithm, is proposed based on a nonlinear strains fell choose the rejection of particle swarm optimization algorithm, the algorithm greatly improves the global convergence ability and convergence precision, and has a simple, easy to implement and few parameters to adjust. The new algorithm and artificial neural network used in the combination of Iris classification problem, and artificial neural network learning algorithm based on the standard particle group algorithm and artificial neural has carried on the contrast experiment. Experimental results show that, based on the nonlinear plant choose the rejection of particle group of artificial neural network learning algorithm has a good stability and convergence, and for other aspects of optimization research provides a new train of thought.

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References

[1] C. Che, J. Su and X. Zheng, "Satellite Module Layout Design based on Adaptive Immune Bee Evolutionary Genetic Algorithm", Journal of Convergence Information Technology, vol. 9, no. 6, **(2014)**.
[2] X. M. Yu, A. L. Qin and J. H. Xue, "Application of Synergistic Optimization Method by Maximin Fitness Function Strategy Based Multi-Objective Particle Swarm Optimization Algorithm in Metal Bellows Structural Design", Advanced Materials Research, vol. 722, **(2013)**, pp. 550-556.
[3] M. H. Moradi and M. Abedini, "A combination of genetic algorithm and particle swarm optimization for optimal DG location and sizing in distribution systems", International Journal of Electrical Power & Energy Systems, vol. 34, no. 1, **(2012)**, pp. 66-74.
[4] Y. Zhang, D. W. Gong and Z. Ding, "A bare-bones multi-objective particle swarm optimization algorithm for environmental/economic dispatch", Information sciences, vol. 192, **(2012)**, pp. 213-227.
[5] A. A. Mousa, M. A. El-Shorbagy and W. F. Abd-El-Wahed, "Local search based hybrid particle swarm optimization algorithm for multiobjective optimization", Swarm and Evolutionary Computation, vol. 3, **(2012)**, pp. 1-14.
[6] J. He and H. Guo, "A modified particle swarm optimization algorithm", TELKOMNIKA Indonesian Journal of Electrical Engineering, vol. 11, no. 10, **(2013)**, pp. 6209-6215.
[7] L. Zhang and J. Yuan, "Artificial immune algorithm based on intelligence complementary strategy", Journal of Computer Applications, vol. 4, **(2013)**, pp. 014.
[8] X. Zhao, Y. Liu and D. Liu, "AITSO: A Tool for Spatial Optimization Based on Artificial Immune Systems", Computational Intelligence and Neuroscience, **(2015)**.
[9] Y. G. Che, C. Y. Xiao and C. H. Kang, "Researches on Function Optimization Problems Based on Chaotic Immune Genetic Algorithms", Advanced Materials Research, vol. 616, **(2013)**, pp. 2064-2067.
[10] Z. Guo, J. Wu and H. Lu, "A case study on a hybrid wind speed forecasting method using BP neural network", Knowledge-based systems, vol. 24, no. 7, **(2011)**, pp. 1048-1056.
[11] D. Y. Han and P. M. Shi, "Identification of Derrick Steel Structures Damage Based on Frequency and BP Neural Network", Zhongguo Anquan Kexue Xuebao, vol. 22, no. 8, **(2012)**, pp. 118-123.
[12] L. Ke, G. Wenyan and S. Xiaoliu, "Research on the forecast model of electricity power industry loan based on GA-BP neural network", Energy Procedia, vol. 14, **(2012)**, pp. 1918-1924.
[13] C. Ren, N. An and J. Wang, "Optimal parameters selection for BP neural network based on particle swarm optimization: A case study of wind speed forecasting", Knowledge-Based Systems, vol. 56, **(2014)**, pp. 226-239.
[14] S. Li, L. J. Liu and Y. L. Xie, "Chaotic prediction for short-term traffic? ow of optimized BP neural network based on genetic algorithm", Control and Decision, vol. 10, **(2011)**, pp. 028.
[15] L. Huang, X. Liang and J. Zha, "Analysis of Factors Influencing Hospitalization Costs for Patients with Lung Cancer Surgery Based on the BP Neural Network", Chinese Medical Record English Edition, vol. 2, no. 6, **(2014)**, pp. 237-241.

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