Research on Sports Performance Prediction Based on Genetic Neural Network Algorithm

Songhua li[1], Haibo Jin[2*]
[1]Wuhan College of Arts & Science, Wuhan, 430000, China
**corresponding author*

Abstract

The accurate prediction of Physical Education Achievement provides a reliable analysis basis for the establishment of physical education teaching objectives, and a physical education achievement prediction method based on genetic neural network is proposed. The model is based on neural network. Particle swarm optimization algorithm updates particle position and speed through individual extreme value and global extreme value, and optimizes the variance and weight of neural network to enhance the accuracy of sports performance predicted by neural network. Compared with the traditional methods, the convergence speed of this method is faster, the error is lower, the prediction result of sports performance is more accurate, and has high anti noise performance and practicability.

Keywords*: Genetic algorithm, Neural network, Sports performance prediction*

Ⅰ. Introduction

Human sports ability is a very complex and highly comprehensive multi index control system organically combined with subsystems at all levels such as body shape, physiological function, sports quality, psychological quality, sports intelligence and sports technology. It is evaluated and predicted by using the existing expert scoring method, and the results are often subjective and random, lacking objective basis [1]. Artificial neural network is a nonlinear system simulating human brain information processing algorithm. It has the functions of knowledge distributed storage, parallel processing, memory and association. Theoretical research shows that the three-layer BP network can approach any nonlinear function with arbitrary accuracy. Therefore, neural network has irreplaceable advantages in the modeling of complex nonlinear systems [2]. However, BP algorithm has poor global search ability and slow convergence speed. Although the improved LM algorithm improves the convergence speed, the network generalization ability after learning is very poor. Genetic algorithm is an adaptive heuristic global search algorithm, which uses selection, crossover and mutation to simulate the natural law of "survival of the fittest and elimination of the fittest". It has the characteristics of global convergence, parallelism and robustness, and provides a new idea and way to solve many optimization problems that can not be solved by traditional methods. Combining genetic algorithm with neural network and learning neural network weights with genetic algorithm not only gives play to the extensive mapping ability of neural network, but also makes neural network have global convergence and enhanced learning ability [3].

Because the basic genetic algorithm also has the problem of slow convergence speed in solving complex problems [4], this paper designs an improved hybrid genetic algorithm, which uses real number coding to replace the traditional binary coding, introduces a new genetic operator, and adopts the optimal individual retention strategy when copying individuals. Compared with BP algorithm and LM algorithm, the learning speed and generalization ability of the new hybrid genetic neural network algorithm are improved [5].

Ⅱ. Establishment of Genetic Neural Network Algorithm Model

A. Establishment of Genetic Neural Network Algorithm Model Achievement Prediction Establishment of Genetic Neural Network Model

Neural network identification is not limited by the nonlinear model. It obtains a nonlinear mapping describing the input-output relationship of the system through learning according to the input-output data pair of the identified system. Given an input, you can get an output without knowing the mathematical relationship between input and output [6]. This self-learning feature makes neural network have its unique advantages in solving complex nonlinear problems. For competitive sports, although there are many factors affecting sports performance, it can be regarded as a black box system. Only the observation and prediction results are considered, and the original data required to establish the prediction model is not much, which is easy to collect. Therefore, this paper uses the establishment of neural network model for prediction, and takes the results of the top three men's 100m in previous Olympic Games (x1, X2, x3) as the influencing factors for modeling, as follows:

$$y = f(x_1, x_2, x_3) \qquad (1)$$

Where: Y - predicted first place result

X1, X2, x3) - top three scores

B. Neural Network Structure of Performance Prediction Model Based on Genetic Algorithm

Artificial neural network is an information processing system with distributed storage, parallel processing and adaptive learning. Artificial neural networks have two network topologies - feedforward network and feedback network. Feedforward network is mainly function mapping, which is used for pattern recognition and function approximation [7].

The network structure should be determined before establishing the neural network. When designing the input and output layers, the scale of the system should be reduced as much as possible to reduce the learning time and complexity of the system. According to the above reasons, the input layer of the performance prediction model is determined as three nodes, namely (x1, X2, x3), and the output layer is one node y. In terms of the number of hidden layers, cybenko pointed out in 1988 that when each node adopts S-type function, one hidden layer is enough to realize any decision classification problem, and two hidden layers are enough to represent any output function of the input graph. In 1989, Robert heeht Nielson proved that any continuous function in a closed interval can be approximated by a hidden layer BP network (errorback propagation training) [8]. When the learning steps remain unchanged, through the calculation and comparison of neural networks with different hidden layers, it is found that the neural network with one hidden layer is the most ideal. The selection of the number of hidden layer units is a very complex problem, because there is no good analytical expression, it can be said that the number of hidden units is directly related to the requirements of the problem and the number of input and output units. In 1987, after discussing the function of neural network with single hidden layer, Hecht Nielsen pointed out that it can input any number, and proposed that the number of hidden layer nodes is 2n + 1, where n is the number of input nodes. Accordingly, the network structure is designed as follows: the number of hidden layers is 1, the number of hidden layer neurons is 7, and its network structure (see Figure 1) [8].

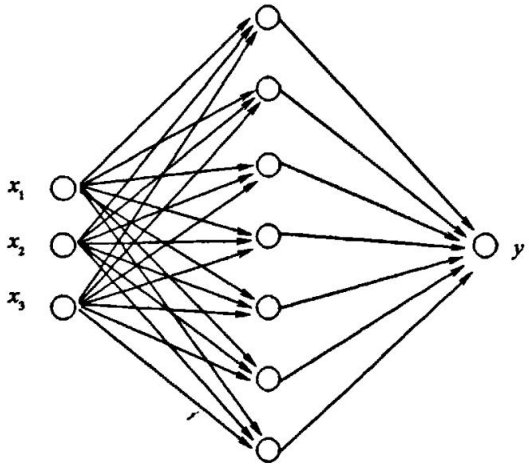

Fig.1 Genetic Neural Network Structure of Prediction Model

Among the artificial neural network calculation models, the back propagation model, namely BP network model, is the most widely used in engineering. BP algorithm is an error back propagation algorithm, which means to calculate from back to front. Therefore, the multi-layer front storage network using this algorithm for error correction is called BP network. BP algorithm is a kind of learning suitable for multilayer neural networks. It is based on gradient descent method. Height, ketolet index,, ankle circumference / Achilles tendon length; Heart function index, vital capacity K, body weight; Acoustic reaction time; 60 meter run, standing triple jump, stride frequency, backward shot put; Athletes' skills, tactics, intelligence, etc. The whole index system includes 14 sub items. The structure of multilayer feedforward network based on BP algorithm is shown in Figure 2.

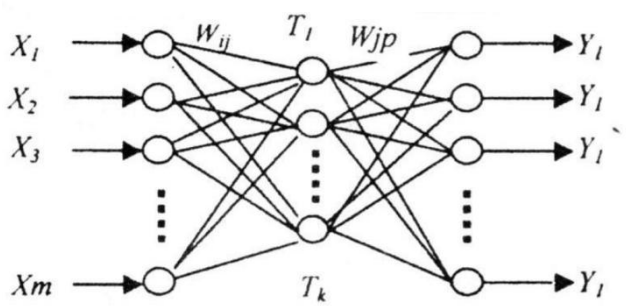

Fig.2 Structure of Neural Network Based on Genetic Algorithm

This network has not only input layer nodes, output layer nodes, but also one or more hidden nodes. For the input information, it is necessary to propagate forward to the nodes of the hidden layer. After the operation of the sigmoid activation function (also known as action function, conversion coefficient or mapping function) with the characteristics of each element, the output information of the hidden node is propagated to the output node, and finally the output result is given. The learning process of network consists of forward and back propagation. In the process of forward propagation, the input signal propagates layer by layer from the input layer to the hidden layer and output layer through the activation function. The state of neurons in each layer only affects the next layer of neural network. If the output layer cannot get the expected output, that is, there is an error between the actual output value and the output value, then turn to the back-propagation process, return the error signal along the original connection path, modify the connection weight of neurons in each layer, propagate to the input layer step by step for calculation, and then through the forward propagation process, the two processes are used repeatedly, Minimize the output error signal [9]. This process is repeated until the output error signal is less than the given value. A set of connection weights mapping the input and output signals are obtained, and the trained neural

network is obtained.

Suppose an arbitrary network with L and N nodes, the activation function of each node is sigmoid type, and the network has only one output y. Given n samples (XK, YK) (k = 1,2,..., n), the output of any node I is oi;, XK for an input., If the output of the network is YK and the output of node I is oik positive, the genetic neural algorithm is as follows:

Forward propagation:

$$net_{jk}^{l} = \sum_{j} \omega_{jk}^{l} o_{jk}^{l-1} \qquad (2)$$

among o_{jk}^{l-1} represents the output of the j-th cell node when the k-th sample is input, $o_{jk}^{l-1} = f(net_{jk}^{l})$

Back propagation:

If node j is an input unit, then $o_{jk}^{l-1} = \overline{y}_{jk}$,among $\overline{y}_{jk}$ Represents the actual output of unit J.

$$\delta_{jk}^{l} = -(y_k - \overline{y}_k) f'(net_{jk}^{l}) \qquad (3)$$

If node j is not an input unit, then:

$$\delta_{jk}^{l} = \sum_{m} \delta_{mk}^{l+1} \omega_{mj}^{l+1} f'(net_{jk}^{l}) \qquad (4)$$

Correction weight:

(5)

among μ Step size

Ⅲ. Prediction of Human Movement Ability Based on Genetic Neural Network

A. Coding Scheme

The weight learning of neural network is a complex continuous parameter optimization problem [10]. The traditional binary coding will cause the coding string to be too long and need to be decoded into real numbers, which will affect the learning accuracy of the network. However, there is no encoding and decoding process in real number coding, which can improve the accuracy and speed of solution. Therefore, real number coding is adopted here, as shown in equation (6).

$$x_i^{(l)} = (v_{i1}^{(l)}, v_{i2}^{(l)}, ..., v_{in}^{(l)}), i = 0, ..., N; l = 0, l_{\max} \qquad (6)$$

Where n represents the population size, Lmax represents the maximum number of iterations, n represents the

number of genes on the chromosome string, and each gene corresponds to a weight or threshold of the network. $x_i^{(l)}$ express,The I chromosome in the L generation and the K Gene in the chromosome are in real numbers $x_{ik}^{(l)}$ express.

B. Design of Genetic Operator

In order to improve the convergence speed and accuracy of traditional genetic algorithm, this paper introduces some improved operators based on the basic genetic operators, such as non-uniform crossover operator, heuristic crossover operator, non-uniform mutation operator and so on. set up $x_i^{(l)}$ and $x_j^{(l)}$ If it is two individuals, the non-uniform hybridization operator is defined as:

$$\begin{cases} x_i^{(l+1)} = a \times x_i^{(l)} + (1-a) \times x_j^{(l)} \\ x_j^{(l+1)} = (1-a) \times x_i^{(l)} + a \times x_j^{(l)} \end{cases} \quad (7)$$

Ⅳ. < A < 1 is a Random Variable

The heuristic crossover operator is defined as(set up $f(x_i^{(l)}) < f(x_j^{(l)})$)

$$\begin{cases} x_i^{(l+1)} = a \times (x_i^{(l)} - x_j^{(l)}) + x_i^{(l)} \\ x_j^{(l+1)} = x_i^{(l)} \end{cases} \quad (8)$$

Ⅴ. < A < 1 is a Random Number

The non-uniform mutation operator is defined as:

$$v'_k = \begin{cases} v_k + \Delta(l, l_{\max}, UB - v_k), \text{If the random number is 0} \\ v_k = v_k \Delta(l, l_{\max}, v_k - LB\ ), \text{If the random number is 1} \end{cases} \quad (9)$$

Where f (x) is the fitness function and VK is the individual $x_i^{(l)}$ As a result of the variation of component VK, LB and UB are the left and right boundaries of the k-th parameter domain respectively. The function Δ returns a value on [0, y], which is close to 0 with the increase of algebra L.

A. Calculate Fitness Function

The greater the nonlinearity of the problem, the greater the n. The initial population is composed of N randomly generated strings, and each string is composed of network weight and threshold. In this paper, real number coding is adopted, and the weight and threshold are random numbers evenly distributed between - 1.0 and 1.0

Assign the weights and thresholds represented on the chromosome to the network structure, take the training samples as the input and output, and calculate the hidden layer output y, output layer output o, sum of squares of error E and individual fitness f according to equation (10).

$$\begin{cases} y_i = f(\sum_j w_{ijPj} - \theta_i) \\ o = f(\sum_i w_{ljyj} - \theta) \\ f = 1/E \end{cases} \quad (10)$$

Among them, $E = \frac{1}{2p}\sum_{j=1}^{p}\sum_{i=1}^{n}(t_i - o_i)^2$

Where Wij is the weight of the first layer after decoding and wlj is the weight of the second layer θ_i Is the hidden layer neuron threshold, θ Is the output neuron threshold, y_i Is the hidden layer neuron output, O is the network prediction output, t is the network expected output, e is the total learning error of the neural network, n is the number of output units, and P is the number of samples.

N individuals are selected according to the fitness (roulette) and the optimal individuals are retained; Then, according to the crossover probability and mutation probability, different individuals are selected for different crossover and mutation operations to produce the next generation of individuals and evaluate the new individuals.

Ⅵ. Experimental Test of Motor Ability Based on Genetic Neural Network

Genetic algorithm optimizes BP neural network. Particle swarm optimization BP neural network has significantly better prediction accuracy of 100m run performance than multiple linear regression model. Because BP neural network is an algorithm with strong nonlinear modeling ability, it can reflect the performance change characteristics of 100m run [11], and obtains better prediction effect, However, the prediction results of individual points are not ideal. The prediction accuracy of 100 m run performance of the multiple linear regression model is the lowest, which shows that the multiple linear regression model can not reflect the performance change characteristics of 100 m run, the prediction error of the established model is large, and the practical application value is relatively low [12].

The first place of men's 100m events in the 20th to 27th Olympic Games is the total sample [13]. The 100m sports performance of the 20th and 27th sessions is determined as the training sample, and the learning algorithm of genetic neural network is used for training and testing. Firstly, the learning samples are normalized to the [- 1,1] interval by formula (11).

$$p'_i = \frac{2*(p_i - p_{\min})}{(p_i - p_{\min})} - 1 \quad (11)$$

Table 1 Shows the Comparison of the Average Values of the Expected Output and the Predicted Output of the Test Samples under the Appeal Algorithm.

Table 1 Comparison of Output Results of Algorithm

Expected output	9.93	9.83	9.92	9.90	9.86	9.85	9.84

Algorithm prediction	9.939	9.841	9.928	9.902	9.865	9.846	9.835

The sum of error squares of test samples are 0.0360 respectively

The prediction accuracy of 100 m run performance of genetic neural network is higher than that of BP neural network optimized by genetic algorithm and BP neural network optimized by particle swarm optimization. This is because genetic algorithm solves the problem that it is difficult for genetic algorithm and particle swarm optimization algorithm to find the connection weight and threshold of global optimal BP neural network, and more accurately reflects the change trend of 100 m run performance, More ideal prediction results of 100 m running results are obtained.

Ⅶ. Conclusions

Neural network is suitable for multivariable and highly nonlinear problems, with self-organization and learnability [14]. It can learn knowledge from samples, and the learned information is distributed in many connection weights. The trained network can quickly reflect new knowledge and information by learning new samples [15]. In particular, the feedforward network has the ability to approach all nonlinear mappings, which makes it a potential and effective modeling tool for nonlinear in competitive sports. The multilayer feedforward network can approach any continuous function. Using the multilayer feedforward network to establish the prediction model of athletes' special performance can also fit any functional relationship between special performance and quality training indicators.

The two characteristics of genetic neural network algorithm can solve the problems and difficulties brought by uncertain factors in sports performance [16]. The first is that genetic network algorithm can learn and store a large number of input / output mode mapping relationships without revealing the mathematical equations describing this mapping relationship in advance; Second, genetic network algorithm has good adaptability and self-organization ability. Therefore, genetic neural network algorithm can become a method of sports performance prediction. At the same time, matlab neural network toolbox brings great convenience to realize the prediction of sports performance, and improves the efficiency of modeling and the accuracy of prediction. Competitive sports is a multi factor, multi-level and multi-objective interrelated and mutually restrictive system. It is very difficult to predict its achievements. The traditional prediction method is to establish a discrete recursive model, which has obvious limitations. Neural network identification is not limited by the nonlinear model. Competitive sports is regarded as a black box system. The artificial neural network model is used to comprehensively observe, analyze and predict the development and changes of the system, which greatly improves the accuracy of prediction.

References

[1] Zhang Chao. Sports performance prediction model based on firefly optimized neural network [J]. Modern electronic technology, vol.000, No.15, PP: 102-104 + 1082017
[2] Zhang Yanrong. Prediction of students' physical performance based on improved grey neural network [J]. Electronic measurement technology, Vol. 42, No. 330 (22), PP: 91-952019
[3] Liu Hao, Liu, Hao, et al. Prediction of College Students' physical performance based on GM (1,1) and reverse transmission neural network [J]. Journal of Nanjing University of technology, Vol.41, no.217, PP: 94-98, 2017
[4] Liu Yu, Yang Liu, Liu Lu. Student achievement prediction based on genetic neural network [J]. Journal of Xi'an University of Posts and telecommunications, Vol.24, No.01, PP: 83-882019
[5] Liu Xiaoju, Zhou Lei, Yan Yina. Student exercise prescription management system based on BP neural network [J]. Vol. 2015, No. 5, PP: 79-842021
[6] Yang Suhan, Yu Lei. Research on Logistics prediction of urban regional circle based on genetic neural network algorithm [J]. Science and technology horizon, vol.000no.300 (06), PP: 224-2262020

[7] Zhang Qi, Wu Yafeng, Li Feng. Research on fault prediction method of rotating machinery based on genetic neural network [J]. Computer measurement and control, Vol.24, No.02, PP: 27-292016
[8] Ke Jifang. Research on prediction model of special performance of long jump based on BP neural network [J]. Vol. 2013, np.22, PP: 148-1482021
[9] Tang Guoxi, Li Wenjun, pan Liangliang, et al. Flatness prediction of hot strip mill based on AGA-RBF neural network [J], vol.000, No.001, PP: 2042019
[10] Guo Hui, Liu Yunting, Kong Zhenxing, Zhang Yimin. Research on maximum prediction method based on BP neural network [J]. Laboratory science, Vol. 23, No. 5, PP: 52020
[11] Zhang Jing, he you, Peng Yingning, et al. Cooperative game path planning based on neural network and artificial potential field [J]. Journal of Aeronautics, Vol.40, No.03, PP: 228-238, 2019
[12] Guo Jianfeng, Li Yu, Anton. Short term prediction based on LM genetic neural network [J]. Computer technology and development, vol.000, No.1, PP: 152-1551592019
[13] Xu Tongyu, Ma Yiming, Cao Yingli, et al. Short term prediction of photovoltaic output power based on principal component analysis and genetic optimization BP neural network [J]. Power system protection and control, vol.000, No.22, pp.262016
[14] Wu minning, Zhang Yongheng, Yang Fei, et al. Prediction model of potato late blight based on GA-BP neural network algorithm [J]. Henan science, Vol.34, no.6, PP: 52016
[15] Wang Fang. Medal performance prediction of 2020 Olympic Games Based on neural network [J]. Vol. 2019, No. 5, PP: 89-912021
[16] Xue Hongqiang, Zhu Meilin. Research on sports performance prediction of MFO optimized extreme learning machine [J]. Modern scientific instruments, vol.000, No.001, PP: 180-1832019