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Prediction Analysis of Speed Skating Using Genetic Neural Network

Mingyou GAO
Yulin University, Yulin, Shaanxi, CHINA

Abstract: As the scientific research goes deeper, the Genetic Neural Network has been widely used in many fields, and it receives a certain effect. This paper applied Genetic Neural Network to performance prediction analysis of speed skating. It aimed at the movement of speed skating, and use the Genetic Neural Network to construct neural network architecture. And it used the BP neural network as the prediction basic method. Then we build the performance Predictive Analytics model of speed skating based on the Genetic Neural Network. Through the simulation analysis and validation of the model, it shows that the accuracy is very high, the error is small and the maneuverability is strong of the model. So it can provide a reference for performance prediction of China's speed skating athletes.

Keywords: Genetic algorithm; Neural network; Speed skating; Performance prediction

1. Introduction

Speed skating is a kind of ice-sports which competes the sliding speed. The competition event was one of the ten key projects in China, and it also leads in the world in winter sports. Seeing from China's speed skating performance, in recent years China's speed skating performance has a great improvement, especially the Chinese women short track speed skating team. They win honor for our country many times in the international competition[1-2]. But In conclusion, China's long distance speed skating is still in the middle level of the world. And it has a gap with the Netherlands and other European teams. And the present gap is really more of a chasm. To making our country's speed skating project keep upstream level in the world, it remains increase in the speed skating performance[3-4].

The analysis of ice-sports such as the speed skating mainly has video observation method, mathematical statistics and comparative analysis. And the mathematical method has fuzzy evaluation, genetic algorithm and neural network algorithm, etc. In the prediction research, the neural network model has its unique advantage[5].

Neural network model can be used to find the optimal solution. It used the genetic algorithm to construct the neural network architecture and the speed skating performance prediction analysis model, which is based on the genetic neural network, to predict the speed skating performance. So it has a very important significance to improve our country's speed skating project performance[6-7]. Given this, this paper made a prediction and exploration to the speed skating performance based on genetic neural network. And it aim to make innovation so that we can guide the sports training and improve the performance of speed skating, which will give the reference opinions for government and sports administration[8].

2.Genetic algorithm

Genetic algorithm is put forward in the book "Adaptation in Natural and Artificial Systems" which is published in 1975 by John Holland. Its main concept is derived from Darwinian theory. Genetic algorithm has been widely used in engineering or Scientific optimization control, business forecasting, financial applications such as portfolio, trading strategies, option on futures and financial crisis prediction, etc.; Economists mainly employ a genetic algorithm to do the time sequence and foreign exchange market[9-11].

Genetic algorithm is the optimal solution tool, which can be regarded as a kind of efficient search procedure. It includes searching for a group of optimal parameters or a group of optimization models. Comparing with other traditional optimization methods, the process of the genetic algorithm has the following traits:

(1) When we employ the genetic algorithm to solve, the possible solution or parameters can be binary number, integer, real number, symbols; For the non differentiable function, the optimization method based on calculus can't process them, but the genetic algorithm can be used to solve this kind of problems.

(2) When the genetic algorithm is used to search for the best solutions, each time it used a population. Namely at a time it will search a few better solutions from the general solution space. The population size is determined by the problem characteristics or time cost. When the number of population is greater, the longer time it need to make the ethnic convergence[12].

(3)When the genetic algorithm is searching for a solution, it may only find the approximate optimal solution, rather than the real optimal solution. But the approximate optimal solution is the optimal answer which is evolved to conform to a goal conditions from the solution space.
(4) The basic operations of genetic algorithm have selection, crossover and mutation mechanism. These mechanisms are not fixed value, but they random change according to the demand. So even under the exactly same parameter Settings, each answer of the computation may be a little different[13].

2.1. The evolutionary process of genetic algorithm

Genetic Algorithm (GA) imitates the species evolution process by employing three basic operation mechanisms, including selection, crossover, mutation. Through the evolving of the three processes, the parent will produce new offspring. In each generation the better group will have a higher probability, and they will transmit some or all the genes to future generations[14]. Genetic algorithm is an optimization algorithm which is based on the probability criterion. And it developed with the "survival of the fittest" concept between organisms and their environment. It used a special bit string of a group to simulate the chromosome of various organisms. We calculate the environment fitness according to the chromosome. Between each generation we make each chromosome evolve in a random manner. So we can get the progeny with better chromosome fitness. The higher fitness of the chromosome, the higher probability to transmit the genes to progeny. The alternating movements of evolution will continue to a termination conditions.

2.2. The evolution mechanism of genetic algorithm

The basic algorithm of genetic algorithm can be seen as below. The basic operations of the algorithm are selection, crossover and mutation. Before that, we must first decide the coding and adaptive function.

GA ()
{
Setting the initial ethnic populations randomly
Evaluating the group of the ethnic populations
Before getting the termination criteria, repeat the steps
{
Selecting the good group
Taking the crossover and mutation operations
Evaluating the group of the ethnic populations
}
}

(1) Encoding
The common encoding method is Binary, and it also has Integer, Real, Alphabet, etc. In binary coding, the string is a vector (X1, X2... Xn), and the character of the vector is formed by {0, 1}; So the whole possible combinations is 2n.

In the traditional genetic algorithm, we set the chromosome showed by binary as an example. First, we need to code the Phenotype Space of the problems into Genotype Space which is primarily formed by {0, 1}. So that the genetic algorithm can do the operation and the operation results also need to decode for the original Phenotype Space.
(2) Fitness function
The opinion of "natural selection" theory proposed by Darwin is "survival of the fittest". And the fitness function is a objective function that can be used to evaluate the characteristic set which is represented by each chromosome whether it can survive to the next generation. Fitness function is the connecting bridge between the genetic algorithm and solving problem. The searching answer of genetic algorithm is to find out the extreme value (maximum or minimum) of the fitness function. The design of the fitness function depends on the actual problem. For every problem we must set a fitness function that can best measure the performance of the problems, such as in the portfolio problem which we can design the fitness function as return of investment.
If the objective function is the minimum value, the form of the fitness function can be: \

$$fit(f(x)) = \begin{cases} c_{\max} - f(x), f(x) \le c_{\max} \\ 0, others \end{cases} \quad (1)$$

And $c_{\min}$ is the maximum estimate value of $f(x)$;
If the objective function is the maximum, the form of general fitness function form is:

$$fit(f(x)) = \begin{cases} f(x) - c_{\min}, f(x) \ge c_{\min} \\ 0, others \end{cases} \quad (2)$$

And $c_{\min}$ is the minimum estimate value of $f(x)$;
(3) Selection
The selection mechanism must choose the new groups with the same number. According to the fitness function value of each group, we can decide the probability that the group can be selected. The group that has the high fitness function value will be elected with a higher probability to the next generation of new groups, otherwise it will be eliminated. There are many method of the selection mechanism, and the most common method is "roulette wheel". The size of every slot in roulette wheel is set according to the percentage of fitness function value of each chromosome. The higher of the score, the bigger of the area. The percentage of the score can be get by the following:

$$PS_i = \frac{f_i}{\sum_{i=1}^{S} f_i} \quad (3)$$

(4)Crossover
Crossover operation can make different chromosomes of populations gene swaps through the random crossover

process, so that it can produce new progeny. The crossover mechanism fetched out the parent from the crossover pool and the make the exchange of the contents. We hope the offspring can also have the advantages of parents' chromosome through the crossover mechanisms. Randomly selecting two from the crossover slot, known as the parents, then we pick one point from the N gene of the parents' string randomly. We called the point as intersection point. And we will exchange the parents' genes which are located at the right side of the intersection point, so it will produce two new progeny chromosomes. See in Figure 1.

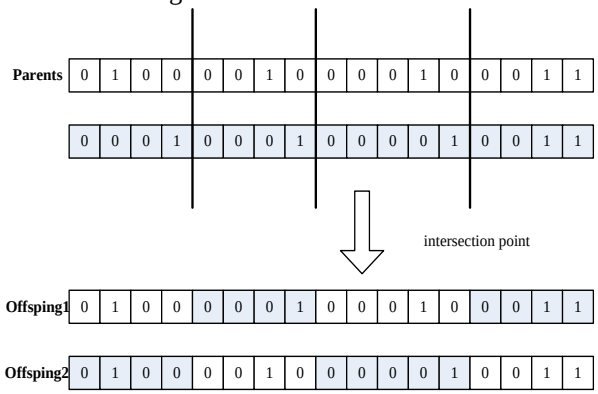

Figure 1. Multipoint crossover

Crossover mechanism cannot assure offspring can inherit the advantages of parents' generation, and it may also inherit the faults of parents' generation chromosome at the same time, which will make the adaptive value become worse than the parental generation. If so, if the adaptive value is too low, the probability that inherit to the next generation will decline or even be eliminated. In the crossover mechanism, the crossover rate is used to control whether the crossover behavior will happen. If the crossover rate is too high, it will cause the change drastically of genetic characteristics. So it can lead to losing the good genes of the above generation, but if it is too low, it will trap in the optimal area.

(5) Mutation

The mutation process is to put the offspring produced after crossing, and the variation is by default probability. The randomly selected reversal is that 0 change into 1 and 1 change into 0. The keeping mutation probability is not high (about 0.001). Although the variation in genetic algorithm is only in secondary status (mainly for the selection and crossover), it can introduce new genetic template (Pattern) and avoid premature convergence. Variation it itself is a random walk process in the parameter space. We can develop new search field and prevent convergence local optimal in the area, and search to the global optimal solution direction. In the code, the variation represents the gene of the change point will carry the inverter operation (i.e. 0 changes into 1, 1 change into 0). The mutation probability values usually are not high, so the genetic algorithm will not in the completely random evolution trend.

3. Neural network

Artificial Neural Networks is made of a number of neurons and the calculation model is based on the parallel distributed processing. The simulation neurons can memory the available experience and knowledge. The basic operation principle is that a large number of processing units are associated with each other, the whole processing units process the input signals of the outside and the learning process dynamically process information. In neural network the feedback network has been widely used. It is a kind of supervised learning neural network. It can feedback back the wrong signals, so that it can correct the weight value. The purpose of the training is to adjust weights. Then after inputting a group of training patterns we can get the target output.

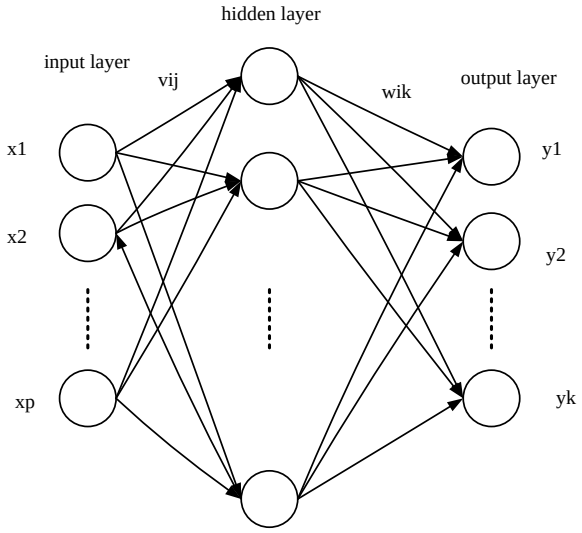

Figure 2. The structure diagram of feedback neural network

We can use the following formula to express the relationships between input and output of the neural network:

$$u_i = \sum_{i=1}^{p} w_{ji} x_i \tag{4}$$

$$y_i = \phi\left(u_j - \theta_j\right) \tag{5}$$

Among them, w_{ji} : the Link Value between the input of ith dimension and the jth neuron

θ_j : the threshold of the neural network

x : the input of pth dimension of the neural network

U_j :the whole input quantity of the jth neural network

$\phi(\bullet)$: activation function

y_j : the output value of the neural network

The activation function employs the sigmoid():

$$\phi(\upsilon)=\tanh(c\upsilon)=\frac{\exp(c\upsilon)-\exp(-c\upsilon)}{\exp(c\upsilon)+\exp(-c\upsilon)} \quad (6)$$
$$=\frac{1-\exp(-c\upsilon)}{1+\exp(-c\upsilon)}$$

The c is the real type constant, this is a monotone increasing and smooth differentiable function. The learning rule the weights is as follows:

$$w_{ji}(n+1)=w_{ji}(n)+\left[\eta y_j(n)x_i(n)-\alpha y_j(n)w_{ji}(n)\right] \quad (7)$$

The α is the real type normal number. The cost function is defined as follows:

$$E=\sum_j e_j^2(n)$$
$$=\frac{1}{2}\sum_j\left[d_j(n)-y_j(n)\right]^2 \quad (8)$$
$$=\frac{1}{2}\sum_j\left[d_j(n)-f\left(v_j(n)\right)\right]^2$$

According to the gradient descent method we can get:

$$\Delta w_j(n)=-\eta\frac{\partial E}{\partial w_j(n)} \quad 9)$$
$$=\eta\left[d_j(n)-y_j(n)\right]f'\left[v_j(n)\right]x(n)$$

4. Genetic neural network construction

Although the traditional neural network model can be used to find the optimal solution, it is often the area optimal solution. In addition, in the practical application, it really can show its superior ability. But for a certain application the neural network cannot determine the optimal topology and control parameters in advance. Therefore, how to design a good neural network paradigm will become a most important issue. This study used the genetic algorithm to construct the neural network architecture construction, and then it putted BP neural network as a learning and prediction methods. So we can construct a prediction model which is different from the traditional technology. So we can avoid the disadvantages of using individual technology and can retain the advantages of individual technology. The operational process of GABPN is shown in the following diagram.

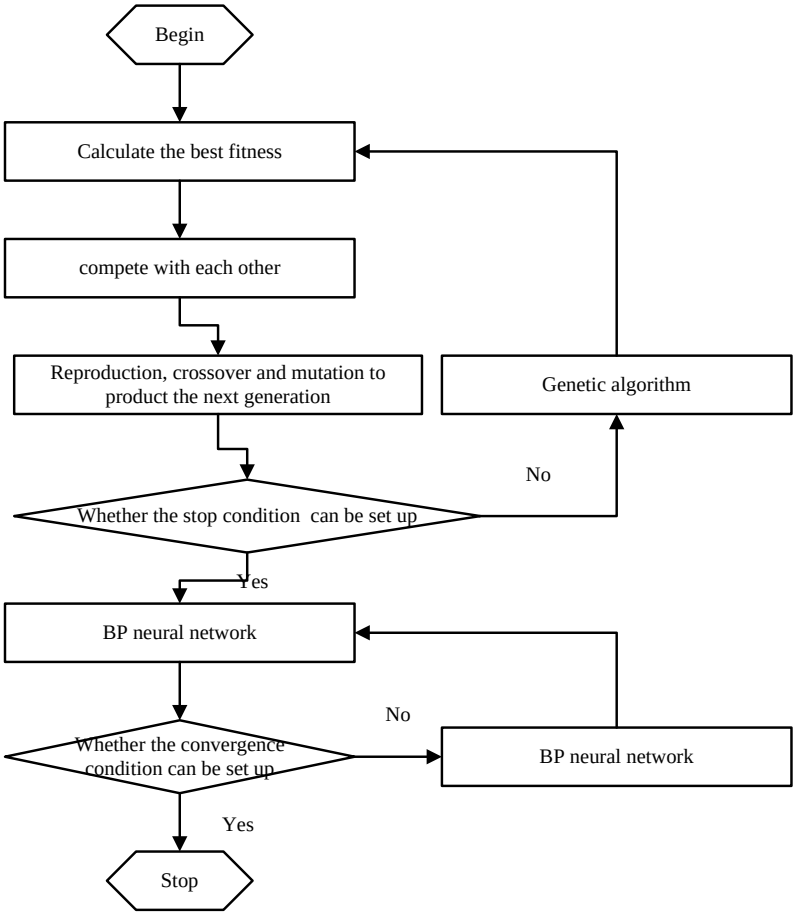

Figure 3. The operational process of GABPN

In the practical application, the method that we employed is network topology optimization model, which automatically search the structure and parameter that can meet the conditions by using genetic neural network. And it searches the median error mean square root and the average fitness of internet architecture complexity. The goal is to get a better evaluation model.

Step one: Determining the solution set (i.e. parent) and randomly generating fifty subsets as the first generation. Each subset represents different network structures and parameters.

Step 2: Determining the evaluation fitness function, and working out the fitness value of first generation subset. The structure and parameter combination of the first generation subsets is randomly chosen. Setting the fifty subsets into the fixed neural network, the error square value gotten from the network is as the fitness value of each subset.

Step 3: According to the fitness value of the first generation, we can use the genetic algorithm to reproduction, crossover and mutation so that we can get the better next generation. Before breeding the new generation, we must evaluate the average fitness of parent whether it gets the ideal reference value.

Step 4: If in the step 3 it has reached the ideal reference value, then it can direct to step 5; Otherwise it will continue to step 3.

Step 5: After achieving the ideal reference value, the screening process is completed. Then we can determine the network architecture of maternal (the number of hidden layers and hidden node), then we can do the further research by reusing the Internet nerve; Then we can hunt out the weights of the mutual connection neurons whose fitness can achieve the convergence standard so that we can improve the predictive power.

5. Simulation analysis

Women's speed skating project has great strengths in our country. This article selects the women's speed skating 1000 m, 1500 m and 3000 m first result in the winter Olympic Games from the first to the 17th as the training samples. We respectively used BP and GABPN which are proposed in this paper to train, and then use the winter Olympic Games women's speed skating first results from the 21st session to eighteen to test. The result unit is s, error unit is % and the results are as follows.

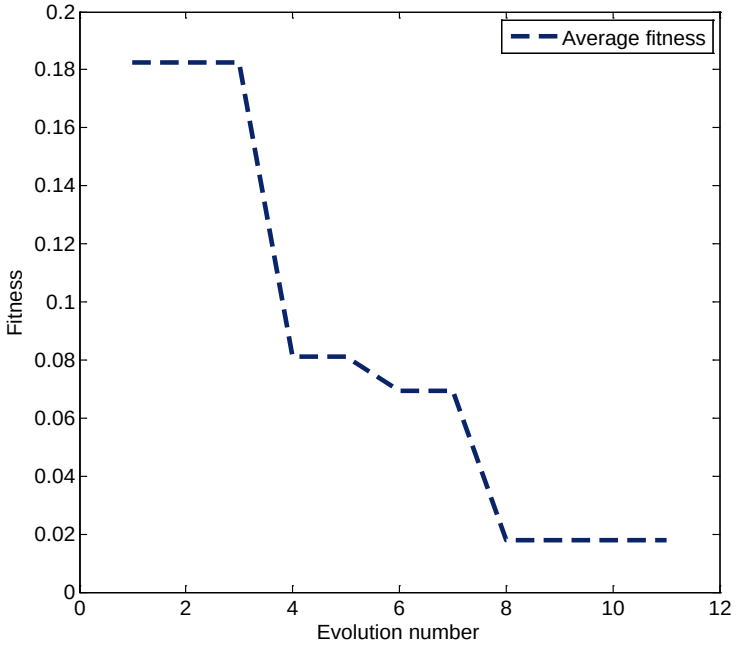

Figure 4. GABPN training evolution algebra

Table 1. Actual achievements and the contrast between BP and GABPN

Project name	18th session				19th session			20th session			21th session	
	actual	BP	GABPN	actual	BP	GABPN	actual	BP	GABPN	actual	BP	GABPN
1000m	76.51	75.26	76.21	73.83	75.52	73.07	76.05	77.89	77.21	76.56	75.12	75.32
1500m	117.58	116.21	116.97	114.02	112.85	113.76	115.27	117.31	116.35	116.89	113.28	115.77

3000m	247.29	241.22	243.53	237.7	242.24	240.15	242.43	244.45	243.7	242.53	240.37	241.03

Table 2. BP, GABPN error contrast

Project name	18th session		19th session		20th session		21th session	
	BP	GABPN	BP	GABPN	BP	GABPN	BP	GABPN
1000m	-1.63	-0.39	2.29	-1.03	2.42	1.53	-1.88	-1.62
1500m	-1.17	-0.52	-1.03	-0.23	1.77	0.94	-3.09	-0.96
3000m	-2.45	-1.52	1.91	1.03	0.83	0.52	-0.89	-0.62

6. Conclusion

The purpose of this essay is to improve the performance of China's speed skating project. It analyzes the speed skating project, and studied the evolution process and evolution mechanism of genetic algorithm. It uses the genetic algorithm to construct the neural network architecture construction. And then it uses BP neural network as the prediction method. Finally it established the predictive and analytics model about the speed skating performance based on the genetic neural network. It selected the training sample to simulate analysis. Then through the actual performance and the contrast between BP and GABPN, it shows that the error of the model is small, the maneuverability is strong, and it can provide training and prediction reference for Chinese speed skating movement.

References

[1] Liyong, Yansheng, "The neural network model of the Speed skating performance prediction", Sports on Ice and Snow, Vol.32,No.3,pp.60-63,2010

[2] Nan xiang-hua,li wei,deng xue-feng,zhang yuan-feng,Gao jun, "Discussion on the Main Attack Direction and Strategic Keystone of China Speed Skating in the 21st Olympic Winter Games", China Winter Sports, Vol.31,No.5,pp.49-53,2009

[3] Linhua Liang, Mengmeng,"Thoughts on the Sustainable Development of Chinese Speed Skating——Comparing the Development of Chinese Speed Skating with the Korean", China Winter Sports, No.2,pp.1-5,2010

[4] YuJing Tao, Zhangqiang, "The race of the 9 ~ 11 session national games speed skating", Journal of Physical Education, Vol.18, No.2,pp.112-116,2011

[5] Yuan Zhang, "Application of Grey System Theory in Data Management of Track-andfield Training System", JDCTA: International Journal of Digital Content Technology and its Applications, Vol. 6, No. 17, pp. 235 ~ 242, 2012

[6] Wei Xiong, "Anomaly-based detection using synergetic neural network", JDCTA: International Journal of Digital Content Technology and its Applications, Vol. 6, No. 4, pp. 188 ~ 196, 2012

[7] Wanghai, FengKai, "Comparison and analysis results of short track between China and south korea in torino olympic winter games",Shandong Sports Science& Technology, Vol.28, No.4, pp.4-6,2006

[8] SunQi, Shuisheng Xu, "The discussion about the short-track speed skating movement social sports system in South Korea", China Winter Sports, Vol.10,No.5,pp.13-14,2005

[9] Gujun Wang, "The investigation and analysis about the present research situation of the short-track speed skating in our country", China Winter Sports,, Vol.4,No.2,pp.15-17,2006

[10] ChengXue Guan, Huiying Ren, "Theoretical Research and Development Trend of Chinese Ice Sports in Recent 10 Years", China Winter Sports,Vol.31,No.1,pp.60-63, 2009

[11] Lixia Xie, Bingzhe Li, "Increasing the Qualification Rate of Chinese Children Short Track Speed Skaters by Starting from the Detail", China Winter Sports, Vol.31,No.3,No.5,pp.17-19,2009

[12] Lijun Song, Ningyu Zhao, "A Study on Performance Evaluation Model of Individual Knowledge-sharing", JCIT: Journal of Convergence Information Technology, Vol. 7, No. 4, pp. 238 ~ 245, 2012

[13] Qingsong Song, Xibin Liu, Xiangmo Zhao, "Adaptive Recursive Least Squares Algorithm based on Echo State Neural Network", IJACT: International Journal of Advancements in Computing Technology, Vol. 4, No. 5, pp. 311 ~ 317, 2012

[14] Liao Hui-fen, "The Research on Network Security Detection Based on Improved Genetic Neural Algorithm", AISS: Advances in Information Sciences and Service Sciences, Vol. 4, No. 13, pp. 69 -75, 2012