Solid State Technology
Volume: 63 Issue: 2s
Publication Year: 2020

Prediction of Portuguese Performance Based on Particle Swarm Neural Network Algorithm

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Abstract- Aiming at the shortcomings of current prediction model of Portuguese performance, such as low accuracy and slow speed, a performance prediction model of Portuguese on the basis of the particle swarm optimization neural network is proposed. First of all, a large number of Portuguese performance data are collected and preprocessed, then the neural network is used to study the teaching samples of Portuguese performance, and particle swarm optimization algorithm is used to select the threshold value, weight value and other parameters of the neural network, so as to establish the optimal prediction model of Portuguese performance, in the end, the effectiveness and superiority of the model are compared and tested with the performance data of Portuguese. The results show that this model can improve the accuracy and reliability of the prediction results, and provide valuable information for Portuguese teaching.

Keywords: *Particle swarm,Neural network, Portuguese, Performance prediction*

1 Introduction

With the constant improvement in levels of people, an increasing number of sub-quality phenomena appear, in especial, the comprehensive quality of college students is far lower than that before, and how to improve the comprehensive quality of college students has aroused a broad concern all over the country. Prediction of Portuguese performance can describe the comprehensive quality status of college students and competitiveness of trainees, so the modeling and prediction of Portuguese performance can formulate relatively reasonable teaching programs for the trainees and college students to improve their sport performance. Take the Portuguese performance as a group of data set, conduct modeling on it through multiple linear regression (MLR) and make estimation on the performance of a certain trainee based on the parameters, while as a balanced distribution is required by the MLR and it shows a nonlinear growth trend, which does not conform to the practical status of data on Portuguese performance, thus the prediction result is not reliable, and the practical application value is low.

In recent years, with the constant development of fuzzy theory and grey theory, a number of nonlinear Portuguese performance predictive models appeared, and the reliability of Portuguese performance prediction is then much superior to the multiple linear regression model. In practical applications, there are also obvious limitations in such models, e.g. the fuzzy theory is difficult to grasp and

certain theoretical foundations are required, while the grey theory regards the predictive process of Portuguese performance as a black box, whose prediction result is of poor interpretability. Scholars nowadays have put forward a Portuguese performance prediction model based on the neural network, which is of self-organizing and nonlinear mapping capacity that can better describe the changing characteristics of Portuguese performance and establish a Portuguese performance prediction model much superior to other models, while the relative parameters of neural network, e.g. the threshold value and weight, have a large influence on the performances of neural network, and if those parameters are not reasonably confirmed, the result of Portuguese performance prediction will be low. To solve the problems on confirmation of neural network parameters, some scholars suggested that genetic algorithm and particle swarm optimization, etc. be adopted to confirm the threshold value and weight of neural network, which effectively improves the prediction accuracy of Portuguese performance. Genetic algorithm and particle swarm optimization belong to stochastic optimization algorithms, which can simply find out the second-best solutions generally and cannot find out the globally optimal solution, and the local optimal threshold value and weight are easy to be found, which brings a long learning time for neural network and a complex network structure, thus affecting the modeling effect of Portuguese performance.

To improve the prediction accuracy of Portuguese performance, a Portuguese performance prediction model was put forward based on the particle swarm neural network. The result showed that this model could improve the prediction accuracy of Portuguese performance, and the prediction result would be more reliable.

2 Chaotic analysis and treatment on performances of trainees

The performance of trainees has a certain relationship with all the following factors, namely the quality of trainees, teaching level of instructors, teaching techniques, teaching equipment, government policies and economic level of the country, which bring complex variations to the performances of trainees, while there is a certain relationship between the performances of trainees and data points at present or others, thus the changing relationship of data points of trainee performances can be excavated through introduction of chaos theory, and then the hidden changing characteristics can be found. Assume that the performance of a trainee collected within a period of time is $\{x(t_j), j=1,2,\cdots,n\}$, of which n presents the number of collected data points, the data can be processed through the chaos theory, and the following data version can be acquired:

$$X(t)=[x(t),x(t+\tau),\cdots,x(t+(m-1)\tau)] \quad (1)$$

In the formula, $t=1,2,\cdots,M$. τ and m represent the delay time and embedded dimension among different data of the trainee, of which embedded dimension is used to describe the relationship among the present data of multiple data points. The C-C and CAO algorithm are adopted to confirm the values of τ and m of the trainees respectively and to describe the hidden changing characteristics of trainee performance data.

Work steps of C-C algorithm:

(1) Assume that the sample points of 2 data items of a trainee are: $X(i)=[x(i),x(i+\tau),\cdots,x(i+(m-1)\tau)]$ and $X(j)=[x(j),x(j+\tau),\cdots,x(j+(m-1)\tau)]$, and calculate the distance between the 2 data points through

Formula (2):

$$r_{ij} = \left\| X(i) - X(j) \right\| \tag{2}$$

(2) Introduce a critical radius r, describe the proportions of all data point logarithms through correlation integral, and the detail is:

$$C(m, N, r, \tau) = \frac{2}{M(M-1)} \sum_{1 \le i \le j \le M} H\left(r - \left\| X(i) - X(j) \right\|\right) \tag{3}$$

In the formula: N represents the scale of data; $H(\cdot)$ represents the Heaviside function, and the computational formula is:

$$H(x) = \begin{cases} 0, x \le 0 \\ 1, x > 0 \end{cases} \tag{4}$$

(3) The performance of a trainee is divided into t subsequences through the above method, and it can be acquired that:

$$S(m, r, \tau) = \frac{1}{t} \sum_{l=1}^{L} \left\{ C_l(m, r, \tau) - [C_l(m, r, \tau)]^m \right\} \tag{5}$$

Assume that the difference computational formula between the maximum and minimum subsequence is:

$$\Delta S(m, t) = \max[S(m, r_j, \tau)] - \min[S(m, r_j, \tau)] \tag{6}$$

Assume that the m of performance of the trainee is $1 \sim k$, then it can be acquired that:

$$\Delta \bar{S}(t) = \frac{1}{4} \sum_{m=1}^{k} \Delta S(m, t) \tag{7}$$

When $\Delta \bar{S}(t)$ is at its minimum value, the value of τ at this moment can be seen as the τ value of the most reasonable trainee performance.

3 BP neural network structure of particle swarm

3.1 BP neural network

It is pointed out by Kolmogorov theory that any continuous function or mapping can be accurately realized through a three-layer artificial neural network, and Hecht-Nielsen also pointed out that a three-layer BP network could meet the fitting and approach problems of general functions[10]. At present, among various kinds of neural network models, the multilayer perceptron model (BP neural network) adopting the counterpropagation algorithm has a broad application in the power system load prediction. BP network is a typical feedback-free forward network which contains nodes in input layer output layer and hidden layer, one or multiple layers can be taken by the hidden layer in theory, while for most of the BP networks applied in the power load prediction field, only one hidden

layer is taken. The BP neural network model is shown as Figure 1.

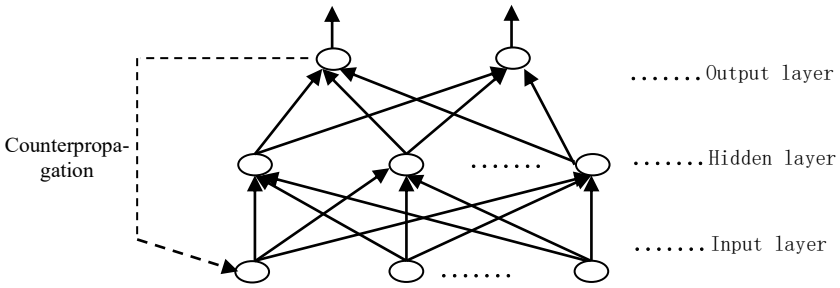

Figure. 1. BP network model

3.2 Particle swarm optimization

Particle swarm optimization is put forward through imitation of behaviors of particle swarms in the real world. Real particles can find the shortest path from the food sources to the ant nest without vision; meanwhile, they can also adapt to the changes of environment, and when there is obstacle in the original shortest path, they can find a new shortest path. This is because information transferring among particles is done through a substance called as pheromone. During the motor processes, particles can not only leave such substance on the paths they have done through but also perceive the existence and strength of it, and then they will shift towards the direction with higher strength of such substance and guide the direction of their motions. Therefore, a kind of information positive feedback phenomenon is presented in the collective behaviors of particle swarms consisting of large sums of particles. The larger the number of particles gone through a certain path is, the higher the probability for the subsequent particles to choose this path will be. Individual particles make their optimal choices on paths through such kind of informative communications to achieve their goal of food searching. The searching mechanism of particles is illustrated here with examples. As shown in Figure 2:

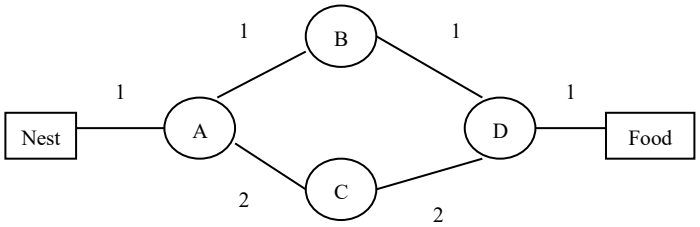

Fig.2. Searching mechanism of ants

As is shown in the figure, assume that 16 particles set off from the nest to seek for food at the moment of t (assume that the particles pass by unit length within unit time). They arrive at Point A at the moment when t=1, as there is no pheromone in AB and AC at this moment, the particles are selected with equal probabilities, 8 select AB and 8 select AC. When t=4, the 8 particles passing through AB arrive at the food source and start to return. At the moment t, the returning particles arrive at D, then the pheromone concentrations on BD and CD are equal, which is 8, so the particles are also selected with equal probabilities, 4 pass through BD and 4 pass through CD. When t=8, the 4

particles returning from BD come back to the nest and come out once again. At the moment of t, they arrive at A once again, when the concentration of pheromone of AB is 16 while that of AC is 12, so more particles will choose to pass through AB. Afterwards, with such a circulation, all particles will choose Path A finally. It can be seen that the information interchange among particles is a process of positive feedback.

3.3 Standard particle swarm optimization

In the standard PSO algorithm, groups consisting of *m* particles fly in the *n*-dimension searching space at a certain speed, each particle considers the historical best point found by itself and the historical lowest point of other particles of the group while searching, based on which variations on position are conducted until it stops and gives out the optimal solution when conditions are satisfied:

$$\underbrace{p_j^i(t+1)}_{\text{Next Location}} = \underbrace{p_j^i(t)}_{\text{Local}} + \underbrace{\omega \cdot v_j^i(t)}_{\text{Speed}} + c_1 \cdot r_1 \cdot \underbrace{\left(pb_j^i(t) - p_j^i(t)\right)}_{\text{individual } Gb_j^i} + c_2 \cdot r_2 \cdot \underbrace{\left(pg_j^i(t) - p_j^i(t)\right)}_{\text{group } Gg_j^i} \tag{8}$$

In the formula, superscript i is corresponding to the i^{th} individual ($i = 1, \ldots, N$, N is the size of the group), subscript j is corresponding to the j^{th} dimension of the particles, and t represents the present iterative algebra; $P^i = \left[p_1^i \ldots p_n^i\right]^{\mathrm{T}}$ and $v^i = \left[v_1^i \ldots v_n^i\right]^{\mathrm{T}}$ respectively represent the position ad speed of the i^{th} particle, of which $\left|v_j^i\right| \le v_{\max}$; ω is the inertia factor; c_1 and c_2 are respectively the historical optimal accelerated factors of individuals and the entirety; r_1 and r_2 are random numbers within [0,1]. **Steps of the algorithm are as follows:**

Step 1: Set parameters including N_p, D, F, CR, $x\min$, $x\max$, c_1 and c_2, etc.; set the counter of evolutionary algebra $t = 0$; set the maximum value of times of space variations as T.

Step 2: Initialize. Generate N_p individuals at random within the searching space $\left[x\min, x\max\right]$ as the initial population $P(0)$.

Step 3: Individual evaluation. Calculate the evaluation functional value $f(i)$ of each individual in the group $P(t)$, then conduct assignment for $pb_j^i(t)$ and $pg_j^i(t)$ based on the evaluation values.

Step 4: Conduct mutation operation according to Formula (7) and generate group $P_1(t)$; and conduct mutation operation according to Formula (8) and generate group $P_2(t)$.

Step 5: Conduct interlace operation on $P_1(t)$ and $P_2(t)$ according to Formula (5) and generate the next generation of group $P'(t)$.

Step 6: Conduct selecting operation on groups of $P_1(t)$ and $P'(t)$ according to Formula (6) and gen-

erate the offspring group $P(t+1)$, and the conduct evaluation for the individuals of group $P(t+1)$.

Step 7: Stop the evolution and output optimal individuals if the precision is satisfied; or should turn to Step 3.

4 Experimental analysis

4.1 Experimental environment

To test the effectiveness of Portuguese performance prediction model of particle swarm optimization (PSO) neural network, 500 performances of 100m running (unit: s) from Wuchang Institute of Technology were selected as the experimental subjects, the VC++6.0 programming realization model was adopted, and the detailed performances of 100m running were as shown in Figure 3.

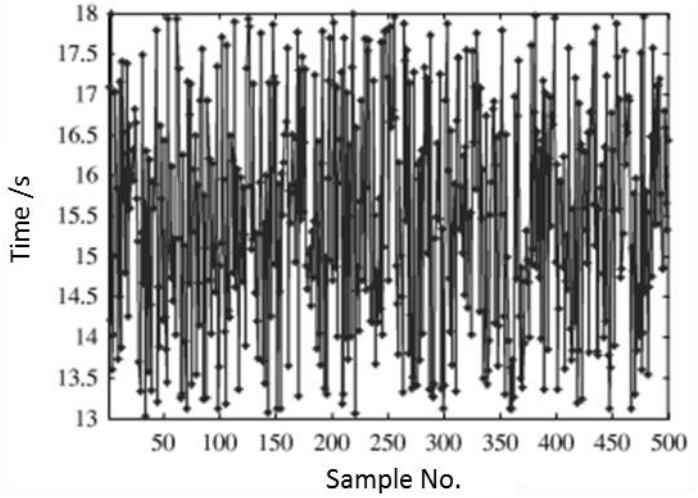

Fig. 3.Performance of 100m running

300 performances of 100m running were adopted to form a teaching sample set, and BP neural network was adopted to conduct teaching for them. First of all, the optimal connection weight and threshold value of BP neural network were found through PSO algorithm, then the structure of BP neural network was confirmed based on the optimal connection weight and threshold value, a performance prediction model for the 100m running was established and finally prediction on the rest 200 performances of 100m running was done, the predicted value and actual value of 100m running performances and the deviation between them were shown in Figure 4, and it could be found through analysis on the result of 100m running performance prediction in Figure 3 that, the predicted value and measured value of 100m running performance were very close, the coincidence accuracy between them was very high, which indicated that a better 100m running performance prediction model could be established through selection on connection weight and threshold value of BP neural network done by PSO algorithm, and there was a small derivation between the predicted and measured values of 100m running performance, which could be ignored completely, and the variation interval of derivations was narrow, the result verified the effectiveness of the Portuguese performance prediction model of the optimal neural network by PSO algorithm, which was of reliable prediction results and small prediction errors.

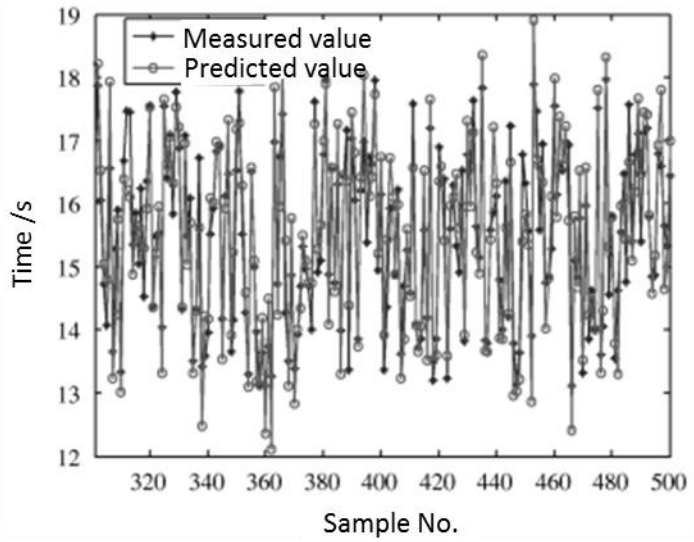

Fig. 4. 100m running prediction effect of PSO neural network

To analyze the superiority of Portuguese performance prediction result of PSO neural network, a contrast experiment was made through the MLR, genetic algorithm (GA) optimal BP neural network and PSO BP neural network, prediction accuracy was selected to evaluate the prediction result of 100m running performances, whose result was shown in Table 1. The following conclusions could be acquired through analysis on the prediction accuracy in Table 1:

(1) The 100m running performance predicted through MLR model was of the lowest accuracy, which indicated that the MLR model could not reflect the changing characteristics of 100m running performances, the established model was of large prediction errors and low practical application value.

(2) The accuracy of 100m running performance predicted by GA optimal BP neural network and PSO BP neural network was obviously superior to that of MLR model, which was because BP neural network was a kind of nonlinear algorithm with strong modeling capacity and could reflect the changing characteristics of 100m running performances, it obtained a better prediction effect but the prediction results of a few points were not ideal.

(3) Accuracy of 100m running performance predicted through PSO neural network was higher than that through GA optimal BP neural network and PSO BP neural network, which was because PSO algorithm better solved the difficulty of GA algorithm and particle swam optimization in finding the connection weight and threshold value of globally optimal BP neural network, and it could reflect the changing trend of 100m running performances more accurately, which acquired a more ideal prediction result of 100m running performance.

5 Conclusion

To improve the prediction accuracy of Portuguese performance, a prediction model on Portuguese performance based on PS neural network was put forward aimed at the difficulty in confirmation of connection weight and threshold value of BP neural network. First of all, a pretreatment was done on the Portuguese performance, to generate a teaching and testing sample for the neural network; then

PSO algorithm was adopted to confirm the connection weight and threshold value of BP neural network, and a prediction model of Portuguese performance was established through study on the teaching sample; finally the prediction effect of it was tested through a detailed simulation experiment. The result showed that, PSO neural network improved the prediction accuracy of Portuguese performance, solved the limitations of other Portuguese performance prediction models, and the prediction result would be more reliable, which could provide foundations for scientific decision-making of Portuguese teaching.

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