ISSN : 0974 - 7435 Volume 8 Issue 5

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 8(5), 2013 [628-633]

Predict the neural network mathematical model of basketball team scores based on improved BP algorithm

Chengliang Li
Sports Training Institute, Shenyang Sport University, Shenyang 110102, Liaoning, (CHINA)
E-mail: 578988075@qq.com

ABSTRACT

Sports performance has increasingly become the measure and the symbol of a country's economic strength, educational level, and comprehensive national strength. As one of the three big ball games, basketball also occupies a pivotal position in the national sport. In order to achieve better play results and provide a good guide for peacetime training and policy development, the study applies the improved BP neural network to establish the mathematical prediction model of the men's basketball performance. Based on MATLAB mathematical software, according to the actual data as shooting rate, three-point shooting, assists statistics, rebounding, obtained from the 2004 Olympic Games, the 14th World Basketball Championships, the 2006 Intercontinental Cup basketball game and the 2004 Athens Olympic Games, the 2012 London Olympic Games sports scores were predicted. The analysis of the predicted results and the actual results showed that the error is small; there is a theoretical feasibility of the algorithm in practical problems. After constantly improving and updating the internal data of the model, the model can provide better service for basketball development and can be applied to other areas.

KEYWORDS

BP neural network;
Basketball game;
Performance prediction;
Mathematical model.

INTRODUCTION

Long before the advent of the computer, humans have already begun to explore the secrets of intelligence, and look forward to be able to reconstruct the human brain and let it complete the corresponding work instead of human. Generally speaking, the study of artificial intelligence can be divided into two ways: the traditional artificial intelligence and artificial neural network-based technology. The development of artificial neural network is divided into five periods: pioneering era of information science in the 1940s is the infancy of the human neural network. In 1949, psychologists put forward the hypothesis that the links between neurons is variable, i.e., the HEBB learning rate, which is the starting point and milestones of artificial neural network training and learning algorithm; from 1950 to 1969, artificial neural network hit the first climax, including that the structure of blow sensor is successfully negated step-by-step; from 1969-1980, is the low period of the artificial neural network. Due to the rapid development of computers and artificial intelligence, neural network suffered

a great impact. But some scholars still sacrificed in the research of neural network, which laid the foundation for the development of neural networks. The late 1980s is the climax of the development of neural network. Due to the rapid development of artificial intelligence theory and parallel distributed processing mode for a dozen years, neural network research ushered a climax. After the 1990s, most scholars focus on research and development of the application of the existing models, transforming of the model algorithm according to the actual operation and improving the training speed and accuracy of the network running. These further researches on the neural network system constantly enrich people's understanding of the human brain.

In this paper, an improved BP neural network, with improved BP algorithm driven by the amount of items adaptive regulation, is adopted. Make full use of linear reinforcement adaptive variable step size BP fast algorithm with momentum items, in the learning process so that the adjustment of the weights is toward the average direction of the bottom and the changes will not have a big swing, playing the role of buffering. If the system reaches to the flat surface area of function curve, the error will become very small. This can effectively solve the problem of low learning efficiency and easily convergence to local minimum value. Verification and optimization of model is conducted by comparing the actual results and the predicted results of the Chinese men's basketball in the 2012 Olympic Games, which lays foundation for other similar applications and researches.

NEURAL NETWORK MODEL

BP neural network, also known as error back-propagation neural network, is a feed-forward network composed by the non-linear transformation units. The information processing function of the neural network is determined by the input and output characteristics (the activated feature) of the network units (neurons), the network topology (neuronal connections), the size of connection weights (synaptic exercise intensity) and neurons threshold (as a special connection weights).

As shown in Figure.1, X_1, X_2, X_3, X_n means the input of the BP neural network, Y_1, Y_2, Y_3, Y_m means the predicted value of the neural network, *Wij* and *Wjk* and are the weights of BP neural network. Judging from Figure 1, BP neural network can be seen as a nonlinear function, and network input and predicted values are respectively the independent variables and the dependent variable of the function. When the number of input nodes is *n* and the number of output nodes is *m*, BP neural network function reflects the mapping relationship from the independent variables to the dependent variables.

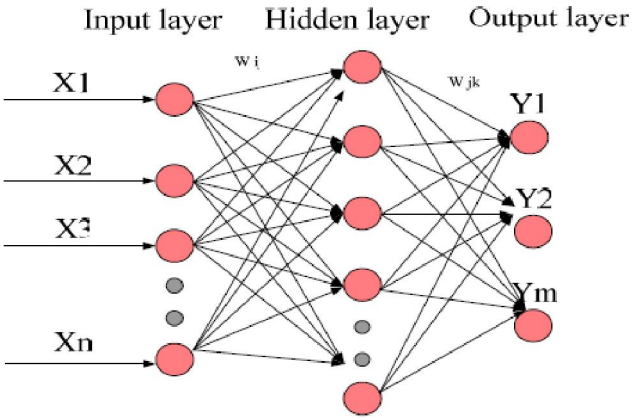

Figure 1 : Neural networks constitute FIG

Wherein: $y = f(\sum_{i=1}^{I} x_i w_i + b)$

Suppose: $X = (x_1\, x_2\, x_3 \cdots\cdots x_n)$, $W = (w_1\, w_2\, w_3 \cdots\cdots w_j)^T$, $XW + b = n$,

Then: $y = f(n)$

The transfer function is a linear function or nonlinear function, commonly used transfer functions contains (hard limit transfer function) *purelin* (linear transfer function) and *logsig* (logarithmic transfer function).

Commonly referred to as BP (back-propagation neural network) model, this is the most widely used neural network model. Structurally, BP network is a hierarchical type of typical multi-layer network with input layer, hidden layer and output layer, between layers are often in a fully connected way. The connection does not exist between each other in the same layer unit. The main difference of BP network from sensor is that the weight of each layer can be adjusted by learning. Since *logsig*, BP neural network adopts *logsig* as a transfer function.

BP neural network can be thought of as a highly non-linear mapping from the input to the output, i.e. $F: R_m \to R_n$, $y = f(x)$ for sample collection of input: input $x_i(R_m)$ and output $y_i(R_m)$, it can be considered that there

FULL PAPER

is a mapping *g* that meets, $g(x_i) = y_i \ i = 1, 2, 3, \cdots p$ and it is now required to have a map *f*, which is the best approximation of *g* in some sense (usually in the least square method sense).

Model building

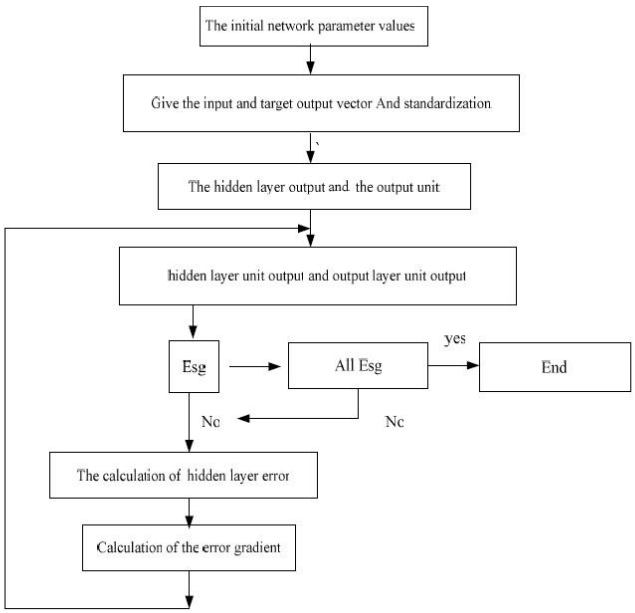

Figure 2 : The flow chart of operation process

Determination of the input layer

Input layer: according to the frequency of use of blast furnace smelting process parameters as well as the silicon content, this study chose the actual data as shooting rate, three-point shooting, assists statistics, rebounding, obtained from the 2004 Olympic Games, the 14th World Basketball Championships, the 2006 Intercontinental Cup basketball game and the 2004 Athens Olympic Games, as input.

The normalized processing of data: BP network hidden layer usually uses the sigmoid transfer function. As dimensional inconsistencies due to a variety of data, it is easy to cause pathological model calculation. As a result, the data must be normalized, so that the input data can maintain in the range of [0,1]. There are mainly two data normalization methods as following:

1) The maximum and minimum method. The functional form is as follows: $x = \frac{X - X_{\min}}{X - X_{\max}}$

Wherein:

x-sample values after the normalized calculation,;

X-original value;

X_{min}, X_{max}- the maximum value and the minimum value of the original data.

2) The average variance method. The functional form is as follows: $x = \frac{X - X_{mean}}{X_{var}}$

Wherein:X_{mean} is the mean value of the data sequence; X_{var} is the variance of the data.

This case adopts the first normalization method. The normalization function often adopts the built-in function *mapminmax* in *MATLAB*, and the function has multiple forms. The commonly used methods are as follows:

$\%input\_train, output\_train$ are respectively the input and output data.

$[inputn, inputps] = map\min\max(input\_train)$; $[outputn, outputps] = map\min\max(output\_train)$; $input\_train$ and $output\_train$ are the original data of training input and output, andare the data after normalization, *inputs* and *outputs* are the structural body after data normalization, which contains the maximum, minimum and average values of the data, which can be used to test data normalization and anti-normalization.

Determination of the hidden layer

The neurons number of the hidden layer represents the degree of nonlinearity between the input and output of the network, and has an important impact on the training speed and forecasting capabilities of the model. If the number of neurons is too small, it will affect the network to extract useful features in the input layer, so the network may not come out or the network is not robust, with bad fault tolerance. But too many neurons means too long learning time is needed and the error is not necessarily the best, as well as the phenomenon of "over-fitting", i.e., training sample shows accurate forecast, but the other samples are with prediction error. There is no theoretical basis to determine the number of neurons in hidden layer, and the formulas generally used are: $l = \sqrt{m+n} + a$

$l = \sqrt{0.43mn + 0.12n^2 + 2.54m + 0.77n + 0.35 + 0.51}$

m: node number of the input layer; n: node number of the output layer; a: often take1-10;

BP neural network prediction errors of different hidden layer nodes are shown in TABLE 1.

Node number of hidden layer	3	4	5	6	7	8	9
Percentage of relative error	5.46%	1.75%	1.64%	0.32%	0.31%	0.29%	0.08%
Mean square error	0.0094	0.0131	0.0076	0.0012	0.0004	0.0002	0.0001

Determination of the output layer

The number of the output layer neurons depends on the requirements of the system for network functions. This model aims to achieve the predicted results, so the output variable is the Chinese men's basketball game results, that is, the output layer neuron number is 1.

THE NEURAL NETWORK MODEL BASED ON THE MEN'S BASKETBALL RESULTS PREDICTION

BP network design

Performance prediction model used the BP network of three layers, i.e. 4 neurons in the input layer, respectively, the shooting average, three-point shooting, assists statistical data and rebounds; 10 neurons in the hidden layer; 1 neuron in the output layer, represents the final ranking. The activation function of hidden layer and output layer respectively adopt the Sigmoid and purelin function.

Network training

Take Chinese men's basketball technical statistics data of the 2004 Olympic Games, the 14th World Basketball Championships, the 2006 Intercontinental Cup basketball game and the 15th World Basketball Championships as the network ideal input, and form the training sample set to train the network until train out a network with better generalization ability.

Input layer are shown in TABLE 2:

TABLE 2 : The original data of the input layer

Year	Year 2004	The 14th session	Year 2006	The 15th session
Shooting average	0.3915	0.4908	0.4459	0.4596
Three-point shooting	0.3145	0.3711	0.3741	0.3906
Assists statistical data	10.14	13.43	13.33	15.33
Rebound	33	30	28	25
Ranking	9	12	5	9

The normalized input layer data are shown in TABLE 3:

TABLE 3 : The input layer data after normalization

0.0024	0	0.3006	1.000
0.0040	0	0.4407	1.000
0.0026	0	0.4690	1.000
0.0028	0	0.6071	1.000

The transcripts are shown in TABLE 4:

TABLE 4 : The transcripts of Chinese men's basketball team participating in the contest

Year 2004	The 14^{th} session	Year 2006	The 15^{th} session
9	12	5	9

Making data of TABLE 2 and TABLE 3, respectively, constitute matrix, and using the function into train the model.

Network prediction

Take the technical statistical data of Chinese men's basketball team in the 2012 Olympic Games as the network input, and forecast the results of year 2012. As shown in TABLE 3, the final results in 2012 are very similar to the actual results of men's basketball.

TABLE 5 : The various technical statistics of men's basketball in 2012

Shooting average	Three-point shooting	Assists statistical data	Rebound
0.398	0.31130	11.25	32

TABLE 6 : The various technical statistics normalized results of men's basketball in 2012

Shooting average	Three-point shooting	Assists statistical data	Rebound
0.0027	0	0.3452	1.0000

FULL PAPER

Analysis results: $\eta = \frac{X - X_{real}}{X_{real}}$

After calculation: $\eta = 0.18$ which is much reasonable. Software runs as Figure 3.

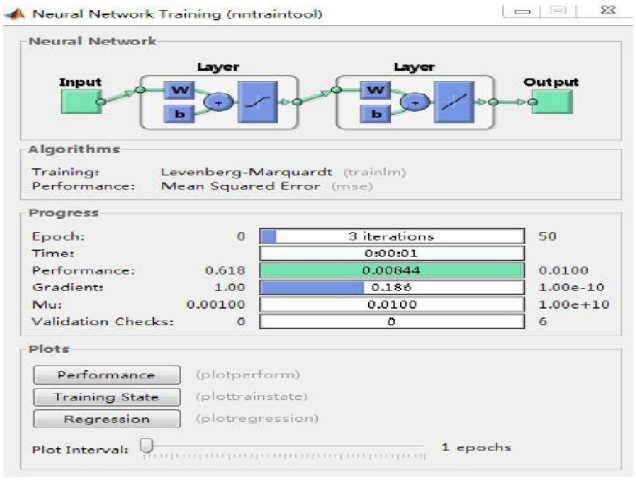

Figure 3 : The running interface of BP neural network

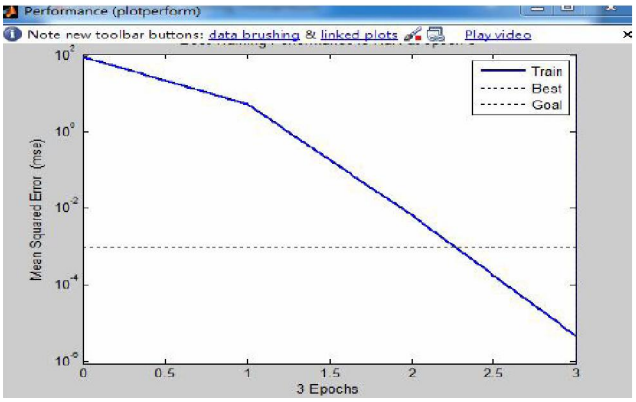

Figure 4 : The running result

As can be seen from Figure 4, when training time reaches 23, the performance of the network meets the requirements. One reason of fast convergence is that the set value of learning rate is relatively large.

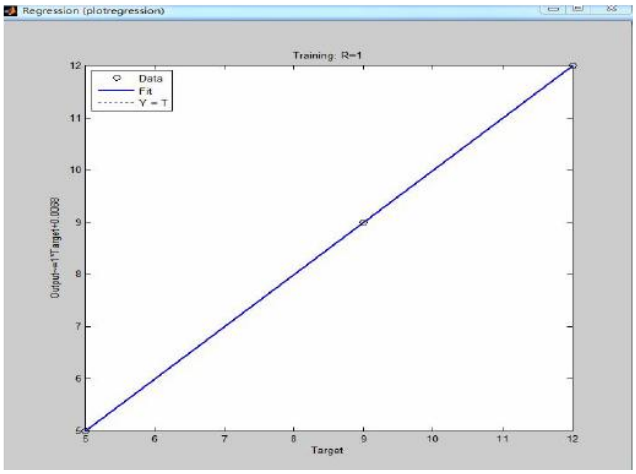

Figure 5 : The linear fitting degree

The correlation coefficient R in Figure 5 presents a measure of the linear association between two variables, r=1 is called perfect positive correlation, r=-1 is known as perfect negative correlation, r=0 referred to as irrelevant. Generally $|r|$ is greater than 0.8, meaning there is a strong linear correlation of two variables. Can be seen from FIGURE 2, the correlation coefficient is R=1, which can be considered as a good degree of correlation.

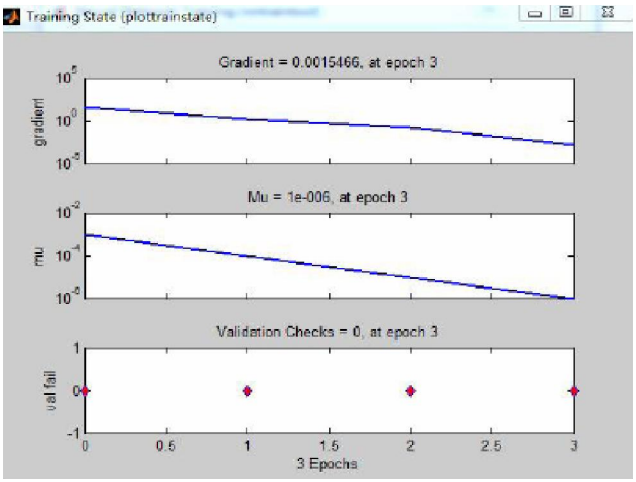

Figure 6 : The mean value and gradient of normal distribution changes over time

We can see from FIGURE 6 that the gradient is equal to 0.001546 when the cycle is equal to 3. The mean value *Mu* of normal distribution is equal to 10^{-6}. It is also obtained when cycle is 3.

CONCLUSIONS

By the improved BP neural network, this paper used the past results of Chinese men's basketball team in the national contest, established a mathematical model which can predict future scores of the men's basketball, and obtained good results after test. Theoretically updating the model data can provide certain guidance for the next game.

However, the model has the space to continue to improve, such as combined with the simulated annealing algorithm. This is also the adjustment direction of the model in the future. If we can further analyze these factors using the prediction model built in this paper, more comprehensive forecast will be obtained. In addition, the Chinese men's basketball competition re-

sults in the World Championships or the Olympic Games, are also related with many factors, such as injuries, adjustment of replacing the old in the national team, as well as some opportunities, luck ball and other factors.

REFERENCES

[1] Bing Zhang,Hui Yue; Bio-mechanical Mathematical Model Analysis for Race Walking Technique. International Journal of Applied Mathematics and Statistics, **40(14)**, 469-476 **(2013)**.

[2] Bing Zhang,Yan Feng; The Special Quality Evaluation of the Triple Jump and the Differential Equation Model of Long Jump Mechanics Based on Gray Correlation Analysis. International Journal of Applied Mathematics and Statistics, **40(10)**, 136-143 **(2013)**.

[3] Bing Zhang; Dynamics Mathematical Model and Prediction of Long Jump Athletes in Olympics. International Journal of Applied Mathematics and Statistics, **44(14)**, 422-430 **(2013)**.

[4] Cai Cui; Application of Mathematical Model for Simulation of 100-Meter Race. International Journal of Applied Mathematics and Statistics, **42(12)**, 309-316 **(2013)**.

[5] Haibin Wang, Shuye Yang; An Analysis of Hurdle Performance Prediction Based On Mechanical Analysis and Gray Prediction Model. International Journal of Applied Mathematics and Statistics, **39(9)**, 243-250 **(2013)**.

[6] Hongwei Yang; Evaluation Model of Physical Fitness of Young Tennis Athletes Based On AHP-TOPSIS Comprehensive Evaluation. Int.J.Appl.Math.Stat., **39(9)**, 188-195 **(2013)**.

[7] Liu Jia-jin; Research on the New Methods of Gray Envelope in Sports Field. Journal of Guangzhou Sport University, **26(2)**, 54-56 **(2006)**.

[8] Nan Kai; Application and Prospect Analysis of Artificial Neural Network in Athletics. Journal of Jilin Institute of Physical Education, **25(3)**, 39-40 **(2009)**.

[9] Sun Yi-liang; From the 14th World Championships to See the Development Tendency of the Men's Basketball in the World and the Weak points of Chinese Men's Basketball Team. Journal of Hubei Sports Science, **22(1)**, 74-75 **(2003)**.

[10] Xiao Yi, Zhang Hui; Research Report on the Preparations of Chinese Table Tennis Team for the Olympics——On the Diagnostic Model of Table Tennis Competition Based on Artificial Neural Network. Sport Science Research, **39(2)**, 1-3 **(2008)**.

[11] Yang Peng-fei, Liu Jian-qing; Analysis of movement laws of factors leading to victory in basketball matches. Journal of Wuhan Institute of Physical Education, **39(10)**, 82-85 **(2005)**.

[12] Yi Liu; The Establishment of Hierarchical Model for Basketball Defensive Quality. International Journal of Applied Mathematics and Statistics, **44(14)**, 245-252 **(2013)**.

[13] Yong Fan; Statistical Analysis Based On Gray System Theory Basketball Team Scores Its Technical Indicators Associated. International Journal of Applied Mathematics and Statistics, **44(14)**, 185-192 **(2013)**.

[14] Zhao Yong-shou; Research on the Specific Performance Forecasting Model for Shot Throwers through Neural Network. Journal of Beijing Sport University, **29(4)**, 486-488 **(2006)**.

[15] Zhong Ping; Research on the Athlete Training Model Based on Artificial Neural Network. China Sport Science, **22(5)**, 58-61 **(2002)**.

[16] Zhong Zhen-xin; Research on the Man's Long Jump Training Model Based on Neural Network. China Sport Science, **22(16)**, 79-81 **(2002)**.

[17] Zuojun Tan; Fuzzy Data Envelopment Analysis and Neural Network Evaluation Mathematical Applications Model Which Based On Martial Arts Competition. International Journal of Applied Mathematics and Statistics, **44(14)**, 37-44 **(2013)**.