Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(7):931-936

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

BP neural network-based sports performance prediction model applied research

Jian Wang

Institute of Physical Education, Shihezi University, Shihezi, Xinjiang, China

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ABSTRACT

Take previous Olympic Games athletics performance as reference, use neural network algorithms' relative strong self fault-tolerant ability and self-training learning ability as well as other good advantages to construct BP neural network model, carry out specific application and verification on the model, and research on No. 1 performance by establishing and applying neural network. Research result shows that BP neural network can be used for sports performance predicting, so neural network model provides extremely wide development space for sports performance prediction model researching.

Key words: Neural network, prediction model, BP algorithm, Matlab simulation

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INTRODUCTION

According to previous performance, it makes prediction on performance that to be generated, it is generally used to major sporting events, predict future sports competitive levels is particular more important for athlete, so the sports performance prediction becomes more and more important, but there are many kinds of modern prediction methods, from which neural network is more popular in contemporary prediction and analysis aspect [1-5].

Regarding sports aspect each kind of events prediction research, lots of people have made efforts, and got achievements, which provides beneficial conditions for scholars from all circles of society making research and provides impetus for scientific prediction development [6-9]. Such as: Zhong Wu and others constructed shot special performance prediction in 2004, meanwhile they got that its accuracy is obvious higher than multiple linear regression model [10-12]; Wang Zong-Ping and others made prediction on men swimming by neural network in 2006 and got higher accuracy; There were scholars had ever stated 2N + 1 pieces of hidden layers' model configuration with N as input nodes numbers after ANN function single hidden layer in 1987; Cyrbenko as early as 1988 had ever proposed structural point adopting S type function, he pointed out a hidden layer was used to solve artificial distribution problems, and two hidden layers were using input graphs to output functions. After that, he mentioned any closed intervals one continuous function could use BP neural network model to approach in 1989 [13, 14].

The paper on the basis of previous research achievements, it researches on sports performance influence factors, and uses BP neural network to predict sports performance, and combines with examples to state the method implementation and application, the result shows it will have important effects on establishing neural network prediction model to sports aspect applied researches.

BP NEURAL NETWORK THEORETICAL FORMING

Regarding sports aspect performance, it can be divided into two kinds, in general total performance is a kind of emotional type that focuses on entirety phenotype, and sub performance is rational that focuses on details, but actually total performance and sub performance always appear uneven status, and then it needs BP neural network to

explore their mutual relations, so that it forms neural network model, after relative training, we only input sports performance prediction into the neural network model then it will calculate mass total performance, it improves performance accuracy in this way.

Hierarchical neural network is a feed forward multiple-layer network model and it is one kind of two main connection ways, its minimum unit is using nerve cell to connect and establish output layer, input layer and hidden layer three kinds of modes BP neural network model, its structures is as Figure 1show:

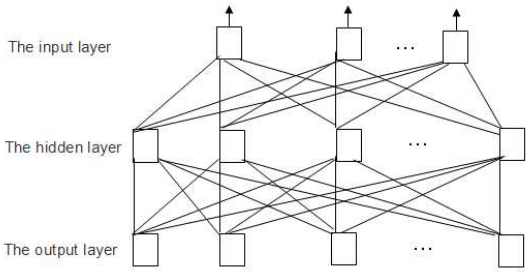

Figure 1: Neural network theory process

Though there are no any connections among them, their nerve cells are mutual correlated. The algorithm learning process is composed of two directions that are respectively forward direction process and reverse two propagation processes, from which, forward propagation is:

$$net_{jk}^{l} = \sum_{j} \omega_{jk}^{l} o_{jk}^{l-1} \tag{1}$$

In above formula, $l-1$ represents number of layers, is expressed by o_{jk}^{l-1}, and when output j pieces of units nodes, the input is the k sample, then:

$$o_{jk}^{l} = f(net_{jk}^{l}) \tag{2}$$

Reverse propagation:

① If input unit node is j, then:

$$o_{jk}^{l} = \overline{y}_{jk} \tag{3}$$

Among them, use j as actual output unit which is expressed by $\overline{y}_{jk}$

$$\delta_{jk}^{t} = -(y_k - \overline{y}_k) f^{/}(net_{jk}^{t}) \tag{4}$$

② If input unit node is not j, then:

$$\delta_{jk}^{t} = \sum_{m} \delta_{mk}^{l+1} \omega_{mj}^{l+1} f^{/}(net_{jk}^{t}) \tag{5}$$

$$\frac{\partial E_k}{\partial \omega_{ij}} = \delta_{jk}^{l} o_{jk}^{l-1} \tag{6}$$

Revise weight:

$$\omega_{ij} = \omega_{IJ} - \mu \frac{\partial E}{\partial \omega_{ij}}, \mu \succ 0$$

Here:

$$\frac{\partial E}{\partial \omega_{ij}} = \sum_{K=1}^{N} \frac{\partial E}{\partial \omega_{ij}} \tag{7}$$

Among them, the process from input layer to hidden layer and then transfer to output layer is information forward direction propagation, but once end cannot get corresponding output result, it will automatically turn to reverse propagation, one nerve cell k is expressed by following formula:

$$u_k = \sum_{t=1}^{m} w_{ik} x_t \tag{8}$$

$$y_k = f(u_k + b_k) \tag{9}$$

In above formula, nerve cell unit threshold value is b_k, in linear combination, input signal output is u_k, output signal is y_k, protruded weight is w_{ik}, input signal is x_k, and meanwhile activated function is $F()$, corresponding function formula is as following:

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

Due to BP neural network nerve cell does not change; corresponding model is as Figure 3.

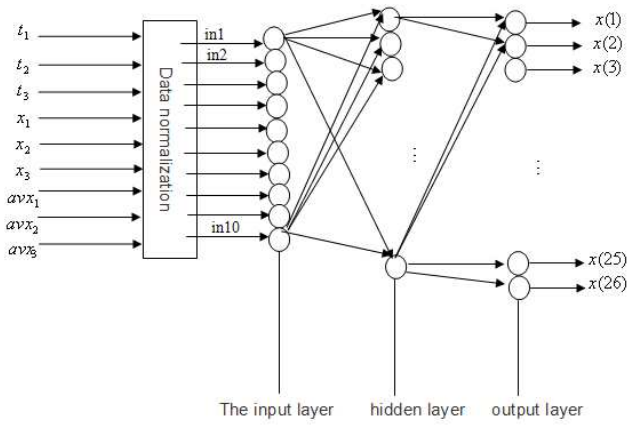

Figure 3:Neural network operation process

For BP nerve cell, its input end is:

$$net = x_1 w_1 + x_2 w_2 + \cdots + x_n w_n \tag{11}$$

In above formula, connection weight value: $w_1, w_2, \cdots, w_n$, input value: $x_1, x_2, \cdots, x_n$, these nerve cells all activated functions use S type function; the function not only is continuous but also can derive.

BP NEURAL NETWORK LEARNING

Neural network is mainly up to two aspects: model parameters, features, from which parameters include stopping, hidden layer, learning rate and other criterions, and the learning process is as Figure 3 show:

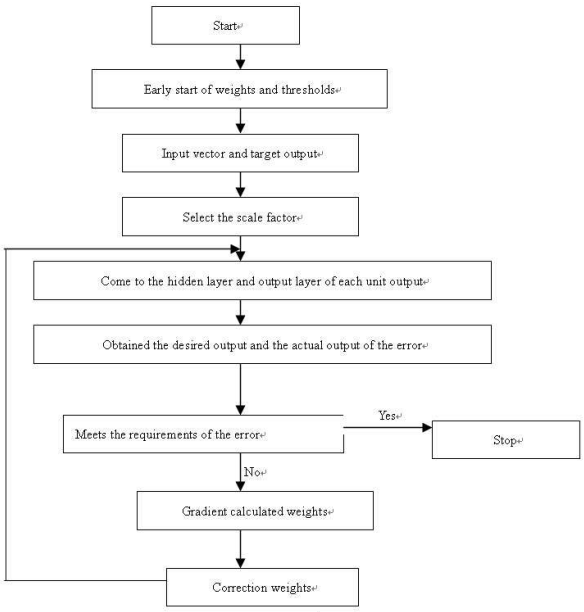

Figure 3: Learning neural network model

Neural network learning process starts implementing form initialized network, and then inputs the input layer into a training corresponding mode, after network transitive signal recognition, it defines output value size and automatically sets a matching minimum value, if error is out of the value, and then system will automatically circulate the function till error reduces to range.

Original data standardization process

Define that between 0 and 1 is BP neural network node value, if input information hasn't arrived at hidden layer, then the node is 0, therefore to avoid the fault status, we adopt standardization handling with these original data, adopt:

$$1 = \sqrt{m = n} + a \tag{12}$$

Hidden point initial number values can be defined by formula (2), that is:

$$1 = \sqrt{0.43nm + 0.12n^2 + 2.54m + 0.77n + 0.35 + 0.51} \tag{13}$$

Among them, in above two formulas, a is a constant, and is a number between 1and 10, n, m are the number of output and input nodes. We work out an initial value by formula (1), and then solve it gradually[7].

Define error

Assume when outputs network, error value is:

$$E_K = \frac{1}{2}\sum_J (y_{jk} - o_{jk})^2 \tag{14}$$

We assume that $E = \sum E_K$ is the sum of the model whole process generated output errors, and in above formula, actual output value is o_{jlk}, ideal output value is y_{jk}.

APPLY NEURAL NETWORK INTO SPORTS PERFORMANCE PREDICTION THEORETICAL RESEARCH MODEL

The paper selects 24th to 30th Olympic Games 1000、50000、1500、800、400、200、$100m$ men's competitions each event champions sports performances as training samples, and testing samples adopt 26th to 30th sports performance, checking samples adopt 25th to 29th sports performance, we let matrix column to be every session different event performance value, and line to be an event different number of sessions, so that fulfill the matrix.

Parameters defining and data handling

The paper defines output layer activated function as $purelin(x) = x$, from which network learning precise is set as 0.00005, iteration times are 10000 times, implicit function corresponding activated function is defined as hyperbolic tangent $(\tan sigx)\ S$ type transmission function:

$$\tan sig(x)\frac{\sigma-\sigma}{\sigma^2+\sigma^{-2}} \tag{17}$$

In addition, it should ensure that input data is between 0-1, by converting p, that:

$$p=\begin{vmatrix} 9.98 & 9.96 & 9.97 & 9.84 & 9.87 & 9.86 & 969 \\ 19.80 & 19.75 & 20.01 & 19.30 & 20.09 & 19.79 & 19.30 \\ 44.27 & 43.87 & 43.50 & 43.49 & 43.84 & 44.00 & 43.75 \\ 103.00 & 103.45 & 403.66 & 102.58 & 105.08 & 104.45 & 104.46 \\ 212.53 & 215.96 & 220.12 & 215.78 & 212.07 & 214.18 & 213.94 \\ 783.59 & 791.70 & 792.52 & 787.96 & 822.49 & 749.39 & 777.82 \\ 1667.57 & 1641.46 & 1647.72 & 1627.34 & 1638.20 & 1625.10 & 1621.17 \end{vmatrix}$$

After that, divide by every column found corresponding maximum value and then get p_1, that:

$$p1=\begin{vmatrix} 1.0000 & 0.9857 & 1.0000 & 0.9803 & 0.9655 & 0.9527 & 1.0000 \\ 0.9801 & 0.9831 & 0.9910 & 0.9845 & 0.9811 & 0.9626 & 0.9844 \\ 0.9970 & 0.9960 & 0.9826 & 0.9865 & 1.0000 & 0.9636 & 0.9881 \\ 0.9850 & 0.9607 & 0.9824 & 0.9762 & 0.9803 & 0.9580 & 0.9759 \\ 0.9880 & 1.0000 & 0.9903 & 1.0000 & 0.9634 & 1.0000 & 0.9824 \\ 0.9860 & 0.9851 & 0.9939 & 0.9940 & 0.9730 & 0.9658 & 0.9745 \\ 0.9701 & 0.9607 & 0.9883 & 0.9719 & 0.9457 & 0.9457 & 0.9721 \end{vmatrix}$$

In the following take p_1 line three to line seven as testing sample $p30$, line two to line six as checking sample $p20$, top five lines as training sample $p10$, on the condition that hidden layer node number meets that hidden layer and input as well as output layer number should be less than $N-1$, samples output is 3 number of nodes is 3, input is 5, from which N is the number of samples.

BP neural network training process

The paper using created BP neural network to predict the 31st Tokyo Olympic Games 1000m 5000m 1500m 800m 400m 200m 100m, prediction way is rolling type alternate training until prediction precise conforms to requirement, the performance is predicted performance.

Neural network about Matlab application program

Input matrix p, and input:

$p = p'; po = \max(p); p00 = ones(7,1) * p0 = p./\ p00; p10 = p1(1:5,:); p11 = p1(6,:);$

$p20 = p1(2:6,:); p21 = p1(7,:); p30 = p1(3:7,:);$

$net = newff\ (\min\max(p10),[31],\{'\tan sig','purelin',\});$

$net.trainParam.epochs = 10000; net.train\ \Pr arm.goal = 0.00005; net.trainParam.show = 500;$

$net = train(net, p10, p11); y1 = sim(net, p10);$

$y10 = y1.* p0;$

Trained the 29th performance $E1 = P11 - y1; MASE1 = mse(E1)$. Training error rate $y2 = sim(net, p20); y20 = y2.* p0;$ trained the 30th performance $E2 = P21 - y2 \quad MASE2 = mse(E2)$; checking samples' error rate $y3 = sim(net, p30);$ $y30 = y3.* p0;$ make prediction on the 31st Olympic Games performance.

Training result analysis

$MSE1 = 4.9198e-5 \quad MSE2 = 1.7114e-4$

$y_1 10 = 1.0e+3*[0.0097 \quad 0.0196 \quad 0.0441 \quad 0.1036 \quad 0.2139 \quad 0.8044 \quad 1.6365]$

$y_1 20 = 1.0e+3*[0.0098 \quad 0.0199 \quad 0.0440 \quad 0.1049 \quad 0.2139 \quad 0.7793 \quad 1.6289]$

$y_1 30 = 1.0e+3*[0.0097 \quad 0.0195 \quad 0.0434 \quad 0.1030 \quad 0.2178 \quad 0.7998 \quad 1.6248]$

CONCLUSION

The paper uses sports competition performance to make BP neural network prediction, it gets the model has feasibilities; it makes indelible contributions to the event future prediction development. Athlete performance prediction is affected by lots of factors, use BP neural network method to evaluate individual prediction that shows it has obvious superiorities. The paper not only introduces performance prediction's BP neural network algorithm, but also applied specific examples to verify, the result shows the model structural rationality. According to sports features, it composes array matrix, so that gets BP neural network algorithms good prediction efficiency. Due to apply previous athletics competitions' performance quantity's limitations, adopt alternate training way, let its result more reliable, correct.

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