ISSN : 0974 - 7435 Volume 8 Issue 9

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 8(9), 2013 [1193-1198]

Evaluation model of young basketball players' physical quality and basic technique based on rbf neural network

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ABSTRACT

In order to conduct comprehensive judgment on young basketball players' physical quality and basic technique scientifically and systemically, this study establishes the combination evaluation model of young basketball players' physical quality and basic technique, uses fuzzy analytic hierarchy process to determine the weight of each level indicator and calculate the combination weights of the lowest level indicators, and carries through a comprehensive evaluation of the different young basketball players' physical quality and basic technique using Topsis method. The evaluation results truly reflect the comprehensive situation of every athlete, and the use of the indicators in the evaluation model to establish the RBF neural network model making the evaluation modeled. This model provides a new idea for the comprehensive evaluation of young basketball players' physical quality and basic technique, and is conducive to the timely monitoring and regulation on training for coaches and young basketball players.

KEYWORDS

Fuzzy analytic hierarchy process;
Basketball player;
Physical quality;
Neural network model.

INTRODUCTION

At present, many researches have been carried through on physical quality and basic techniques for young athletes, but the research are mainly about the athlete's body shape, special achievements and game results, and most of them are elaborate macro theory. Comprehensive evaluation model for physical quality and basic technique is much less. Yu Shao-yong conducted research on 12 young basketball players' physical indicators using principal component analysis and cluster analysis, obtained the ranking of the quality indicators; Yang Fei described the selection indicators of teenage basketball players in a macroscopic scale in Sichuan Province; Zhang Bo compared and analyzed the test scores of young basketball players' physical quality and basic technique. In the research of evaluation model of youth basketball players' physical quality and technical indicators, the indicators used by the researchers are not the same, and the weight of each index are mostly determined through experience, which is lack of certain scientific.

This study plans to use fuzzy analytic hierarchy process and TOPSIS integrated evaluation method to establish the combination evaluation model on youth basketball players' physical quality and basic technique, uses fuzzy analytic hierarchy process to determine the weights of indicators at all levels and calculate the combi-

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nation weights of the bottom indicators, and conducts comprehensive evaluation of different youth basketball players' physical quality and basic techniques using Topsis method. This model provides a new way of thinking for the young basketball players' physical quality and basic technique, and is conducive to the timely adjustment of basketball athletes in training.

BRIEF INTRODUCTION OF FUZZY ANALYTIC HIERARCHY PROCESS

The realization of this work supposes the availability of a great number of repetitions of samples responding to the same known theoretical model. In practice, as the theoretical model is unknown, we use the Monte-Carlo method based on the generation of the data by computer according to a fixed theoretical model. Fuzzy analytic hierarchy process is put forward in order to make up for the difficulty and un-scientifically of traditional analytic hierarchy process in testing the consistency of judgment matrix. Fuzzy analytic hierarchy process is a system analysis method of qualitative analysis and quantitative analysis, the principles of which are basically the same with that of AHP.

The basic step of fuzzy analytic hierarchy process is similar to that of traditional analytic hierarchy process, shown as follows: Construct a multilayer hierarchical structure and form a target tree diagram, as shown in Figure 1.

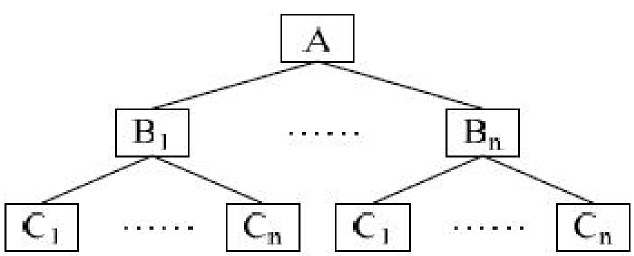

Figure 1 : Model structure of fuzzy analytic hierarchy process

Build a fuzzy consistent matrix: R stands for the fuzzy consistent judgment matrix. Firstly, select certain factor in the upper layer and determine the indexes that are related to the factor, from the lower layer. Then compare the relative importance of indexes in the lower layer. Suppose that a upper layer indexes can be explained by indexes $a_1, a_2, \cdots, a_n$ from the next layer, and then a fuzzy consistent judgment matrix can be built, as shown in TABLE 1.

TABLE 1 : Fuzzy consistent judgment matrix

C	a_1	a_2	…	a_n
a_1	r_{11}	r_{12}	…	r_{1n}
a_2	r_{21}	r_{22}	…	r_{2n}
…	…	…	…	…
a_n	r_{n1}	r_{n2}	…	r_{nn}

In TABLE 1, $r_{ij}(i=1,2,\cdots,n;\ j=1,2,\cdots,n)$ means the relative importance of index a_i, the number i index from upper factor C, and index a_j, the number j index from the same upper factor C. In order to quantify the concept of "importance", the following evaluation standard can be used, shown in TABLE 2.

In accordance with the evaluation method in TABLE 2, after pair wise comparison of the evaluation indexes of factor C,, a fuzzy judgment matrix can be obtained:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix}$$

The matrix has the following three properties:

(1) $r_{ii}=0.5, i=1,2,\cdots,n;$

(2) $r_{ij}=1-r_{ji}, i, j=1,2,\cdots,n;$

(3) $r_{ij}=r_{ik}-r_{jk}, i, j, k=1,2,\cdots,n.$

Calculate the weight of each index:

Suppose the weight set of indexes $a_1, a_2, \cdots, a_n$ is $W=(\omega_1,\omega_2,\cdots,\omega_n)$, then: $r_{ij}=0.5+a(\omega_i-\omega_j),\ i,j=1,2,\cdots,n$

In the above formula $0<a\le 0.5$, a is the evaluator's measure of the degree of difference between the proposed evaluation objects. When R is inconsistent, the above formula is not strictly true. Then weight vector $W=(\omega_1,\omega_2,\cdots,\omega_n)$ can be determined by the least squares principle, shown in formula (1):

$$\begin{cases} \min\ z=\sum_{i=1}^{n}\sum_{j=1}^{n}[0.5+a(\omega_i-\omega_j)-r_{ij}]^2 \\ s.t. \sum_{i=1}^{n}\omega_i=1, \omega_i\ge 0, (1\le i\le n) \end{cases} \quad (1)$$

According to Lagrange's theorem, the above formula and the formula below are equivalent.

$$\min\ L(\omega,\lambda)=\sum_{i=1}^{n}\sum_{j=1}^{n}[0.5+a(\omega_i-\omega_j)-r_{ij}]^2+2\lambda(\sum_{i=1}^{n}\omega_i-1)$$

In the formula λ is the Lagrange multiplier.

TABLE 2 : Evaluation standard for fuzzy analytic hierarchy process

Importance scale r_{ij}	Degree of relative importance	Explanation
0.5	Equally important	The two elements compared are equally important
0.6	Slightly important	Within the two elements compared, the importance of one element is slightly higher than the other
0.7	Absolutely important	Within the two elements compared, the importance of one element is apparently higher than the other
0.8	Really important	Within the two elements compared, the importance of one element is significantly higher than the other
0.9	Absolutely important	Within the two elements compared, the importance of one element is extremely higher than the other
0.1,0.2,0.3,0.4	Converse comparison	If the importance degree ratio of index a_i to index a_j is r_{ij}, then the importance degree ratio of index a_j to index a_i is $r_{ji} = 1 - r_{ij}$

Calculate partial derivatives of $\min L(\omega, \lambda)$ about $\omega_i\ (i = 1,2,\cdots,n)$ and supposing that value of is zero, the following equation set can be obtained:

$$a\sum_{j=1}^{n}[0.5 + a(\omega_i - \omega_j) - r_{ij}] - a\sum_{k=1}^{n}[0.5 + a(\omega_k - \omega_i - r_{ki}] + \lambda = 0$$

$$(i = 1,2,\cdots,n) \qquad \textbf{(2)}$$

The above equation set is equivalent to the following equation set:

$$\sum_{j=1}^{n}[2a^2(\omega_i - \omega_j) + a(r_{ji} - r_{ij}) + \lambda = 0 \quad (i = 1,2,\cdots,n) \qquad \textbf{(3)}$$

The number of unknowns in this equation set is n+1, i.e. $\omega_1, \omega_2, \cdots \omega_n, \lambda$, and the number of equations is n+1,

$$\begin{cases} 2a^2(n-1)\omega_1 - 2a^2\omega_2 - 2a^2\omega_3 - \cdots - 2a^2\omega_n + \lambda = a\sum_{j=1}^{n}(r_{1j} - r_{j1}) \\ -2a^2\omega_1 + 2a^2(n-1)\omega_2 - 2a^2\omega_3 - \cdots - 2a^2\omega_n + \lambda = a\sum_{j=1}^{n}(r_{2j} - r_{j2}) \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ -2a^2\omega_1 - 2a^2\omega_2 - 2a^2\omega_3 - \cdots + 2a^2(n-1)\omega_n + \lambda = a\sum_{j=1}^{n}(r_{nj} - r_{jn}) \\ \omega_1 + \omega_2 + \cdots + \omega_n = 1 \end{cases} \qquad \textbf{(4)}$$

Solve the equation set (4) and weight of each evaluation index can be determined. Calculate the combination weight C_i of the bottom layer indexes in weighting method. C_i =index weight of layer B*index weight of layer C.

INTRODUCTION OF RBF NEURAL NETWORK MODEL

Radial Basis Function neural network (Radial Basis Function, RBF) is a neural network proposed by J. Moody and C. Darken in the late 1980s. It is a kind of function taking the distance to the fixed point as the independent variables. RBF network is a three-layer structure, respectively the input layer, hidden layer and output layer. The typical three-layer structure of RBF network topology is shown in Figure 2:

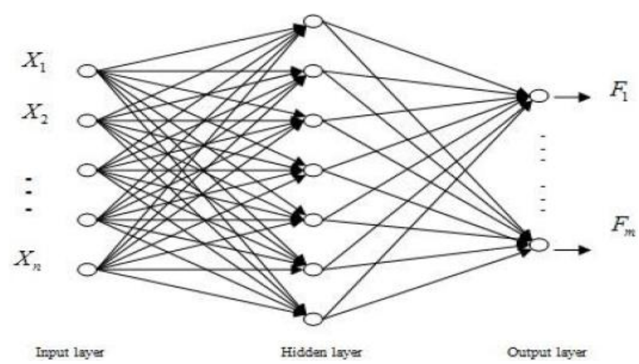

Figure 2 : RBF network structure topological graph

In Spiking neural network, a spike neuron j corresponds to a collection of neurons receiving a plurality of signals from the upper neuron in the moment of t_j, wherein, X is on behalf of the input layer, Q is representative of the hidden layer, and F represents the output layer. Assumes that w_{mj}^k is the connection weights of neuron m 's synapse k with neuron j, d^k is the delay of the synaptic k. The weights calculation method using RBF neural network is shown as follows:

$$w_j(k) = w_j(k-1) + \eta(y(k) - y_m(k))h_j + \alpha(w_j(k-1) - w_j(k-2)) \qquad \textbf{(5)}$$

$$\Delta b_j = (y(k) - y_m(k))w_j h_j \frac{\|X - C_j\|^2}{b_j^3} \qquad \textbf{(6)}$$

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$$b_j(k)=b_j(k-1)+\eta\Delta b_j+\alpha\left(b_j(k-1)-b_j(k-2)\right) \quad (7)$$

$$\Delta c_j=\left(y(k)-y_m(k)\right)w_j\frac{x_j-c_j}{b_j^2} \quad (8)$$

$$c_{ij}(k)=c_{ij}(k-1)+\eta\Delta c_{ij}+\alpha\left(c_{ij}(k-1)-c_{ij}(k-2)\right) \quad (9)$$

Substituted into the Spiking pulse signal to adjust weight, it improves the response speed of the network, the more its regulation ability of the neural network is more stronger, which can be adapted to the situation where initial weights are un-ideal, at the same time learning speed is much faster.

ESTABLISHMENT OF THE YOUTH BASKETBALL PLAYERS' PHYSICAL FITNESS AND BASIC TECHNIQUE'S EVALUATION SYSTEM

Through a large number of document literature and consulting basketball senior experts, this paper finalizes the evaluation indexes of Youth Basketball Players' physical quality and basic technique, ultimately establishes a three-tier hierarchical structure, uses fuzzy evaluation method by constructing judgment matrix of pairwise comparison, and determines the weight of each layer's indicators and the combination weights of the lowest level indicator; the results are shown in TABLE 3-7.

TABLE 3 : Comprehensive evaluation system of young basketball players' physical quality and basic technique

First layer index	Secondary layer	Three-layer index
Comprehensive quality A	Physical quality B1	100m run C1
		5.8m*6 shuttle run C2
		Standing long jump C3
		Run-up hop touch height C4
		multi-group pitch shuttle run C5
		body precursor C6
	Basic technique B2	90s the rebounding ability C7
		Overall pass and lay-up ball C8
		comprehensive dribble C9
		The backsliding defensive C10

The comprehensive level evaluation model of young basketball player is shown in TABLE 7.

Through assessing the 3 Young Basketball Players, the results of each person are shown in TABLE 8.

TABLE 4 : Fuzzy consistent matrix of the first layer indexes

A	B1	B2	weight
B1	0.5	0.6	0.55
B2	0.4	0.5	0.45

TABLE 5 : Fuzzy consistent matrix of the second layer indexes (physical quality)

B1	C1	C2	C3	C4	C5	C6	weight
C1	0.5	0.4	0.7	0.4	0.6	0.8	0.19
C2	0.6	0.5	0.8	0.5	0.7	0.9	0.22
C3	0.3	0.2	0.5	0.2	0.4	0.6	0.12
C4	0.6	0.5	0.8	0.5	0.7	0.9	0.22
C5	0.4	0.3	0.6	0.3	0.5	0.7	0.16
C6	0.2	0.1	0.4	0.1	0.3	0.5	0.09

TABLE 6 : Fuzzy consistent matrix of the second layer indexes (basic technique)

B2	C7	C8	C9	C10	weight
C7	0.5	0.2	0.4	0.6	0.22
C8	0.8	0.5	0.7	0.9	0.36
C9	0.6	0.3	0.5	0.7	0.26
C10	0.4	0.1	0.3	0.5	0.16

TABLE 7 : Comprehensive Evaluation Model of Young Basketball Players' Physical Quality and basic technique

First layer index	Secondary layer	Three-layer index	Combination weight
Comprehensive quality A	Physical quality B1	100m run C1	0.1
		5.8m*6 shuttle run C2	0.12
		Standing long jump C3	0.07
		Run-up hop touch height C4	0.12
		multi-group pitch shuttle run C5	0.09
		body precursor C6	0.05
	Basic technique B2	90s the rebounding ability C7	0.1
		Overall pass and lay-up ball C8	0.16
		comprehensive dribble C9	0.12
		The backsliding defensive C10	0.07

According to the formula, conduct standardized transformation on each index; the results are shown in TABLE 9.

According to the results in TABLE 9, the positive ideal solution and negative ideal solution are:

TABLE 8 : The three Young Basketball Players' various accomplishments

Team member	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	12.35	9.21	2.68	3.15	172.54	26.58	12	43.96	12.20	12.38
2	12.14	8.84	2.89	3.27	168.32	23.77	10	45.14	13.43	13.54
3	12.28	8.53	2.75	3.40	166.15	22.59	8	46.82	14.18	14.31

TABLE 9 : The normalized values of 3 Young Basketball Players' various performances

Team member	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
1	0.58	0.60	0.56	0.56	0.59	0.63	0.68	0.56	0.53	0.53
2	0.57	0.58	0.60	0.58	0.57	0.56	0.57	0.58	0.58	0.58
3	0.58	0.56	0.57	0.60	0.57	0.54	0.46	0.60	0.62	0.62

Z^+ (0.58,0.6,0.6,0.6,0.59,0.63,0.68,0.6,0.62,0.62)

Z^- (0.57,0.56,0.56,0.56,0.57,0.54,0.46,0.56,0.53,0.53)

Seen from TABLE 8, by Fuzzy AHP determine the combination weights set of each evaluation index is W = (0.1, 0.12, 0.07, 0.12, 0.09, 0.05, 0.1, 0.16, 0.12, 0.07). According to Equations 13 and 14, calculate the weighted Euclidean distance C_i of positive ideal solution and negative ideal solution, and use formula 15 to calculate the relative closeness, the results are shown in TABLE 10.

TABLE 10 : The closeness and sort of the athletes and the positive ideal solution

Team member	D_i^+	D_i^-	C_i	Sort
1	0.035	0.007	0.17	3
2	0.024	0.025	0.51	2
3	0.014	0.029	0.67	1

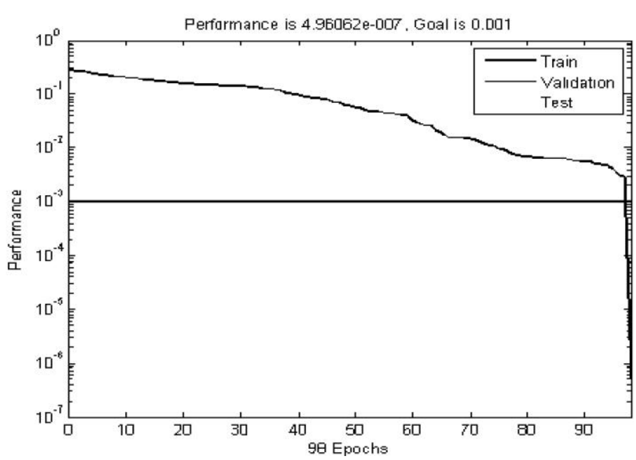

Figure 3 : RBF neural network error condition

The three men's basketball players are sorted according to the relative closeness reflecting the differences in the overall quality of the athletes.

According to the above indicators and their weights, using SPSS17.0 statistical software to build a radial basis function neural network model, the model's error is shown in Figure 3.

Figure 3 shows that the model's error is very small indicating that the evaluation ability of the model is superior.

CONCLUSIONS

This study uses fuzzy analytic hierarchy process and TOPSIS method to establish a comprehensive evaluation model of young basketball players' physical quality and basic technique, substitute the indicators of three teenager men basketball players' physical quality and basic technique into the model, and obtains the comprehensive ranking of each athletes. The fuzzy analytic hierarchy process in the combined model is used to determine the evaluation index weight. On this basis it uses Topsis comprehensive evaluation method to conduct comprehensive evaluation on each object to be evaluated. The judgment result is more objective and reasonable than the traditional method. The RBF neural network model established according to various indicators and their weights, the error is small, and the evaluation performance is superior. The evaluation model can be used for the evaluation of young basketball players' physical quality, can also be extended to the evaluation of other athletes' quality, and has broad application prospects and higher application value.

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