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Research Article

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The participating team's technical analysis of women's basketball in the 30th Olympic Games based on neural network

Liang Wu

Institute of Physical Education, Henan Institute of Science and technology, Xinxiang, China

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ABSTRACT

In this paper, it studies the various technical indicator values of 12 women's basketball teams in the 30th Olympic Games, in the research process uses neural network-based fuzzy comprehensive evaluation method. First it expounds the principle and method of the single-level fuzzy comprehensive evaluation model, multi-level fuzzy comprehensive evaluation model and the evaluation results test, and then focuses on the construction method of neural network structure and the determination method of the connection weights in neural network method, and finally on the basis of the theory conducts reasonable comprehensive evaluation on each team's offensive ability, defensive ability and comprehensive offense and defense abilities for the 30th session's technical indicators data. Through the analysis of the results: the comprehensive evaluation results are in consistent with the actual competition rankings, this method has a higher feasibility in the process of applying, and it provides feasible suggestion for the team's future development direction.

Key words: Fuzzy comprehensive evaluation, neural networks, connection weight distribution, comprehensive strength of offense and defense

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INTRODUCTION

Since the 21th Olympic Games, held in Montreal, Canada, 1976, women's basketball program is listed as an official Olympic sport, which marks the women's basketball in one fell swoop on the world athletics stage, so all the previous women's basketball tournament in Olympic Games has become the limelight project. The women's basketball tournament of the 30th Olympic Games was held in London Olympic Park basketball Pavilion from 2012 July 28 to August 12, a total of 12 teams took part in; finally U.S. team wins the title with battles and eight titles; the United States won five Olympic Games champion continuously since the 1996 Atlanta Olympics team. During the race, through video recording and other means, the IOC will collect each participating team's technical indicator data in the race process in order to obtain valuable information, this article studies the offensive and defensive techniques of 12 representative teams.

This paper uses the fuzzy comprehensive evaluation method to study the team's index data during the match, in order to get the team's comprehensive assessment situation through technical indicators; an important step in the fuzzy comprehensive evaluation method is solving the weights of the index system, there are many methods for solving the weights value. For the application of the neural network in fuzzy comprehensive evaluation many people have made efforts, with the efforts of these people the method has obtained more broad application. In this study, based on the previous efforts it proposes a fuzzy neural network-based comprehensive evaluation method, conducts research and analysis on the technical index data of women's basketball program in the 30th Olympic Games, to study the specifications of the data analysis, and then evaluates each team's comprehensive offensive and defensive ability using the established model and calculation method.

2. Results analysis of fuzzy comprehensive evaluation

Fuzzy comprehensive evaluation method is a systemic analysis method based on fuzzy mathematical theory analysis and evaluation, aiming at fuzziness things. The method is a analysis method based on fuzzy reasoning that combines with quantitative analysis and unites the precision with non-precision. The results of fuzzy comprehensive evaluation are each grade fuzzy subset's membership of the evaluated object. This membership is usually a fuzzy vector, not a point value. so the information that the result provides is rich; for the comparison and sort of multi-evaluated-objects, we need to do further processing, calculate the comprehensive score for each evaluation object and sort according to size, and then pick follow the order. There are usually two ways to process the fuzzy comprehensive evaluation vector, one is the principle of maximum membership degree, the other is the weighted average principle.

If the result vector of fuzzy comprehensive evaluation is shown in formula (1), the evaluation object overall belongs the r level, this principle is called the principle of maximum membership.

$$B = (b_1, b_2, \cdots, b_n), b_r = \max_{1 \le j \le n} (b_j) \tag{1}$$

Weighted average principle refers to take the level as a relative position, and make it continuous. For the convenience of quantify handling, use" $1,2,3,\cdots,m$ " to represent each level, and call it the rank of each level; and then use the corresponding component in B to weighted sum the rank of each grade, thereby obtain the relative position of the object being evaluated, and its expression is shown in the formula (2):

$$A = \frac{\sum_{j=1}^{n} b_j^k \cdot j}{\sum_{j=1}^{n} b_j^k} \tag{2}$$

In Formula (2), k means the undetermined coefficient, its purpose is to control the effects caused by the larger b_j; when it tends to infinity, the weighted average principle is the maximum membership principle.

3. Weights determination based on neural network

3.1 Neural network's structure

Neural networks have many different forms, the neural network's input and output of this paper is in formula (3) below, and the structure is shown in Figure 1:

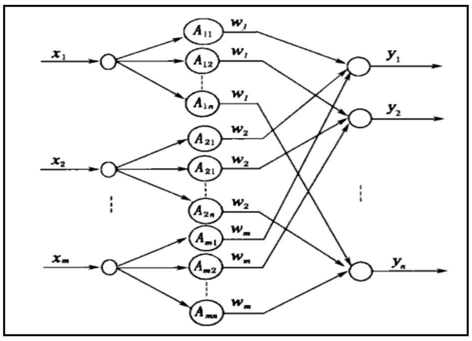

Figure 1: Structure chart of neural network

$$X = (x_1, x_2, \cdots, x_m)$$
$$Y = (y_1, y_2, \cdots, y_m) \tag{3}$$

In Formula (3) it indicates that there are m inputs and n outputs; and the entire network consists of three layers, namely the input layer, hidden layer and output layer; the connection weights w_i between the hidden layer and output layer in the network is the weight value of each indicator in comprehensive evaluation.

Elements in the input layer are performance evaluation index values, but the dimensions of the index value are not the same. So before the comprehensive evaluation each index value is required to transform into dimensionless standardized data, this is the only way to apply the same standards to measure. Usually we adopt linear non-dimension method, use the range transformation formula to standardize various indicators. In Figure 1the input layer has a total of m neurons, the input and output of neurons in the input layer is shown in formula (4):

$$I_i^1 = x_i , O_{ij}^1 = x_i , (i = 1,2,\cdots ,m;\ j = 1,2,\cdots ,n) \tag{4}$$

Hidden layer is to conduct comment level differentiation process to the input, and calculate each input's membership value of each level based on the membership function. In Figure 1 the review level of the network structure is divided into n , so there is a total of $m \times n$ hidden layer neurons; if the domain A exists and it satisfies the formula (5), that is when $n = 4$, then there are 4 fuzzy sets, membership function $\mu_j(x)$ and $j = 1$, the calculation method is shown in formula (6):

$$\{A_{ij}\} = \{NB , NS , N , PS\} \tag{5}$$

$$\mu_1(x) = \begin{cases} 1 & x \le a_1 \\ \dfrac{a_2 - x}{a_2 - a_1} & a_1 < x \le a_2 \\ 0 & x > a_2 \end{cases} \tag{6}$$

In Formula (6) when $j = 1$, the corresponding parameter to A_j is the membership function of parameter a_1 and a_2 ; when $j = n$ and the corresponding parameter to A_j is a_{n-1} and a_n , the corresponding membership function is shown in formula (7):

$$\mu_n(x) = \begin{cases} 0 & x \le a_{n-1} \\ \dfrac{x - a_{n-1}}{a_n - a_{n-1}} & a_{n-1} < x \le a_n \\ 1 & x > a_n \end{cases} \tag{7}$$

When $1 < j < n$, the corresponding parameter to A_i is the membership function of a_{n-1} , a_j and a_{j+1} as shown in the formula (8):

$$\mu_j(x) = \begin{cases} 0 & x \le a_{j-1} \text{or } x \ge a_{j+1} \\ \dfrac{x - a_{j-1}}{a_j - a_{j-1}} & a_{j-1} < x \le a_j \\ \dfrac{a_{j+1} - x}{a_{j+1} - a_j} & a_j \le x \le a_{j+1} \end{cases} \tag{8}$$

The input of the hidden layer is in the formula (9):

$$I_{ij}^2 = O_{ij}^1 , i = 1,2,\cdots ,m;\ j = 1,2,\cdots ,n \tag{9}$$

The outputs of the hidden layer, that is, the membership value of each class for various evaluation indexes under the role of membership function, is shown in the formula (10):

$$O_{ij}^2 = A_{ij}(x_j) \tag{10}$$

In Formula (10) $A_{ij}(x)$ represents the membership function of the j th comment level value, the output O_{ij}^2 means the degree of fuzzy relations between the i th indicator and the j th indicator.

Output layer completes a comprehensive evaluation of the input vector X , the corresponding evaluated vector can be obtained according to evaluation level, the input and output is shown in formula (11):

$$I_{ij}^{3} = O_{ij}^{2}, O_{i}^{3} = \sum_{j=1}^{m} w_{j} I_{ij}^{3}, (i = 1,2,\cdots,m;\ j = 1,2,\cdots,n) \tag{11}$$

3.2 The determination method of the connection weights in the neural network

Learning process is essentially an unconstrained optimization calculation process. Back propagation algorithm has slow convergence, may reach local minimum energy value and other shortcomings, so in practical engineering we use improved back propagation algorithm.

Back propagation algorithm refers to obtain the output value along the direction from the network input to output, and obtain the error of the output values and the sample values, and then along the reverse direction of calculation process, transfer the error message, correct the connection weight values, so as to reduce the output error of the network. Suppose learning sample $(x_{1p}, x_{2p}, \cdots, x_{mp}; t_p)(p = 1,2,\cdots,P)$, for a particular sample $(x_{1p}, x_{2p}, \cdots, x_{mp}; t_p)$, when a random network connection weight $\mathbf{W}$ is given, according to the above calculation process the output value y_p of the network can be drawn; for the sample p , the output error of the network is shown in formula (12):

$$d_p = t_p - y_p \tag{12}$$

The error function e_p is in the formula (13):

$$e_p = \frac{1}{2}(t_p - y_p)^2 \tag{13}$$

The learning process is essentially adjusting the vector $\mathbf{W}$ constantly, so that it will gradually reduce the error d_p and improve the precision of network computing. The learning process used in this paper is the gradient descent method in optimal calculation, in essence, that is to correct $\mathbf{W}$ along the negative gradient direction that the error function e_p changes with the vector $\mathbf{W}$. If $\Delta \mathbf{W}$ is the correction value of $\mathbf{W}$, then it satisfies equation (14):

$$\Delta \mathbf{W} = -\eta \frac{\partial e_p}{\partial \mathbf{W}} \tag{14}$$

In Formula (14) η means learning efficiency and it ranges from 0-1.

If corresponding error surface of the energy function is in long and narrow type, this algorithm is jumping in the valley walls. Then we need to add additional momentum to it, so the iteration formula of correction value $\Delta \mathbf{W}$ is shown in formula (15):

$$\Delta \mathbf{W}^{(n)} = -\eta \frac{\partial e_p}{\partial \mathbf{W}} + \alpha \Delta \mathbf{W}^{(n-1)} \tag{15}$$

In Formula (15) α means momentum factor and the value is generally around 1. According to the continuous iteration in the formula (15), when the output error meets the requirement, the network training can finish.

4. Data analysis and study results

4.1 Standardization of the raw data and establishment of the evaluation system

The final outcome of basketball game is reflected in the score situation during an effective amount of time. During the game what the team needs to do is to make the team score the most and stop the opponent team scoring at the extreme. In this process the variety of techniques that the team uses can be summarized as offensive and defensive techniques. A team with both offensive and defensive techniques will win with a bigger probability. In this paper, it conducts statistical analysis for the participating team’s offensive and defense techniques of Women's Basketball Team in the 30th Olympic Games, and carries through fuzzy comprehensive evaluation. The offensive indicators is shown in Table 1, Table 2 shows the defensive indicators.

Table 1: The data standardization of the participating team's defense indicator for women's basketball in the 30th Olympic Games

Ranking and Team		Score	The hit number	Two-point shot	Three-point shot	The penalty hit number	Assists	Offensive rebound	Turnovers	Being violated
1	United States	2.4563	2.5877	1.9633	0.2434	0.9317	2.0341	1.4089	-1.2246	2.4738
2	France	0.2454	0.148	0.4908	1.4042	0.6545	-0.5888	-0.9047	0.1861	0.2757
3	Australia	0.5855	0.3375	0.9498	-0.5304	1.7171	0.5621	0.1275	0.5976	0.4464
4	Russia	-0.2861	-0.4204	-0.6183	0.669	-0.2695	-0.2676	1.2309	-0.9307	-0.2365
5	Turkey	0.0221	0.148	-0.255	1.0947	-1.1935	0.4015	0.1987	-0.7543	0.2757
6	China	0.0221	0.1954	0.5291	-0.1241	-0.3157	0.5888	-1.3318	-0.1078	-1.3889
7	Czech	0.1603	0.2665	0.4335	0.0306	-1.0087	0.455	-0.3352	-1.0483	0.3824
8	Canada	-0.5093	-0.5862	-0.102	0.4562	-0.2695	0.1338	-1.047	2.0671	-0.3859
9	Brazil	-0.1798	-0.3731	-0.0637	-0.5884	1.1165	-0.2409	-0.3352	0.3625	-0.1938
10	Croatia	-0.2861	-0.1362	-0.2167	0.3789	-1.1935	-0.2944	-1.1182	0.5976	0.0196
11	Britain	-0.2223	-0.3731	-1.2494	-0.5884	0.7469	-0.5621	1.2309	-0.8131	-0.1938
12	Angola	-2.008	-1.7942	-1.8614	-2.4456	-0.9163	-2.2214	0.875	1.0678	-1.4743

Table 2: The data standardization of the participating team's defense indicator for women's basketball in the 30th Olympic Games

Ranking and Team		Lose points	defensive rebound	Steal	Block shot	Foul
1	United States	-2.1756	2.2047	2.0813	1.312	-1.0307
2	France	-0.3786	0.5948	-0.2241	1.2417	-0.0074
3	Australia	-0.2621	0.7771	0.1052	0.5389	0.9268
4	Russia	-0.4118	-0.7113	-0.6084	1.1714	0.5265
5	Turkey	-0.9443	-0.6201	0.9835	-0.8669	-0.0519
6	China	0.6032	-0.1645	-0.9377	-1.2183	-2.3653
7	Czech	-0.3619	0.5037	-0.6633	0.8903	-0.4968
8	Canada	0.1872	-0.772	-0.279	-1.0074	1.1048
9	Brazil	0.2371	-0.1038	0.0503	0.2577	0.6154
10	Croatia	1.0691	0.686	-0.0595	-0.8669	0.3485
11	Britain	0.8361	-1.015	1.1481	-0.4451	-0.5413
12	Angola	1.6016	-1.3795	-1.5964	-1.0074	0.9713

The team's offensive ability is denoted by U_1, the defensive ability is denoted by U_2, U means the team's comprehensive strength, offensive ability and defensive ability is a subset of the team's comprehensive strength.

There are nine elements in the subset $U_1 = \{U_{11}, U_{12}, \cdots, U_{19}\}$, respectively: score, the hit number, two-point shot, three-point shot, the number of free throws, assists, offensive rebounds, turnovers and being violated. There are five elements in the subset $U_2 = \{U_{21}, U_{22}, \cdots, U_{25}\}$, respectively: lose points, defensive rebounds, steals, block shots and fouls.

Use Matlab to solve the offensive ability weights A_1, defensive ability weights A_2 and offensive and defensive ability weights A based on neural network, as shown in the formula (16):

$$
\begin{aligned}
A_1 &= (0.30 \quad 0.25 \quad 0.15 \quad 0.15 \quad 0.05 \quad 0.1 \quad 0.2 \quad -0.25 \quad 0.05) \\
A_2 &= (-0.20 \quad 0.45 \quad 0.55 \quad 0.30 \quad -0.1) \\
A &= (0.55 \quad 0.45)
\end{aligned} \tag{16}
$$

The total evaluation level is divided into four membership degrees, and the four membership degree intervals is shown in formula (17):

$$NB = [0.85, 1), NS = [0.75, 0.85), N = [0.65, 0.75), PS = [0.05, 0.65) \tag{17}$$

4.2 Study results

Table 3 shows the comprehensive evaluation results of the participating team's offensive ability, the defensive ability and the comprehensive offence and defense ability of women's basketball in the 30th Olympic Games.

Table 3: The comprehensive evaluation results of the participating team's comprehensive offensive and defensive ability of women's basketball in the 30th Olympic Games

Ranking and Team		Offensive ability	Defensive ability	Comprehensive ability
1	United States	0.8733 --1	0.9336 --1	0.9004 --1
2	France	0.8174 --4	0.8429 --3	0.8289 --2
3	Australia	0.7854 --6	0.8528 --2	0.8157 --3
4	Russia	0.8221 --2	0.8002 --4	0.8122 --4
5	Turkey	0.8219 --3	0.7917 --5	0.8083 --5
6	China	0.7990 --5	0.7195 --9	0.7632 --6
7	Czech	0.7593 --7	0.7505 --7	0.7553 --7
8	Canada	0.7030 --9	0.7537 --6	0.7258 --8
9	Brazil	0.6759 --10	0.7257 --8	0.6983 --9
10	Croatia	0.7385 --8	0.6324 --10	0.6908 --10
11	Britain	0.6090 --11	0.6152 --11	0.6118 --11
12	Angola	0.4338 --12	0.4202 --12	0.4277 --12
Note: The meaning that the data expresses, evaluation results - ranking				

Table 3 shows that the comprehensive ranking of offensive and defensive abilities is consistent with the result of the game, the 12 teams are divided into four levels of stages, as shown above.

Only U.S. team belongs to the level of NB , the French team, the Australian team, Russia, Turkey, China and Czech team belong to the level of NS , the Canadian team, Brazil, Croatia and Britain team belong to the level of N , only the Angola team belongs to the level of PS .

We can also learn from Table 3 , the U.S. team 's offensive ability and defensive ability are the first in the overall rankings, the defensive ability is better than offensive ability; French team's offensive ability and defensive ability are both not ranked second, but the comprehensive offensive and defensive levels are in second place, indicating that the French team has done better in the balanced development, its defensive ability is slightly higher than its offensive ability; Australian team's offensive ability comes in sixth place, but the defense 's ability gets a second ranking, its defensive ability is the team's strengths, in the future training process they should also focus on improving the offensive ability, which helps the overall strength of the team on the rise to a higher level; Russian team 's offensive ability is very strong, at this time the defensive ability becomes a bottleneck, only breaking the bottleneck of defensive ability can improve its comprehensive strength; Turkish team 's offensive capability is superior to defensive ability, the team's defensive ability is also its bottleneck as the same problem with the Russian team; Chinese team's offensive ability is stronger than defensive ability, to strengthen the defensive skills training while maintaining the offensive ability can make it enter a new level; Czech team's offensive and defensive capabilities are more balanced, on the basis of balancing the two they need to strengthen the training of both at the same time, but they should pay attention to defense, to improve defense ability can effectively suppress opponent's score and get better development; Canadian team 's defensive ability is superior to offensive capabilities, the offensive capabilities needs for enhancement training; Brazil also have issues like the Canadian team, the relative levels are both poor, but effectively improving the offensive abilities can promote the development of the team's level faster; Croatian team's offensive level is better than its defensive abilities, its defense ability becomes a bottleneck, a higher intensity training for the defense ability may have better results; British team and Angolan team's offensive and defensive capabilities are relatively weak, need to improve the training intensity at the same time.

CONCLUSION

In this paper, it explains the comprehensive evaluation method based on neural network fuzzy, and the method is used in the participating team's level analysis of women's basketball in the 30th Olympic Games; derived comprehensive strength evaluation of each team using theoretical methods is in consistent with the competition results, thus it can reflect the scientific of the method; On the basis of the comprehensive evaluation results analysis of the defensive ability and offensive ability, the overall strength of each team are ranked, and propose feasible plan for the future training of the former 12 teams in the research results.

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