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A comprehensive evaluation of athletes' professional skills based on fuzzy theory

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ABSTRACT

The selection and training of excellent athletes is an important task for China. The scientific selection and evaluation of athletes is a key component of the training system of athletes. However, in China, many sports don't have complete standards of selecting athletes. What's more, the different levels of different athletes' comprehensive skills are about the comprehensive fuzzy concept. So it is difficult to work out an appropriate way of evaluating athletes. This paper analyzes the concept of fuzzy theory and the application of fuzzy theory in the comprehensive evaluation of athletes' professional skills, then uses fuzzy quantitative theory to establish an evaluation method and model of athletes' professional skills to quantify athletes' skills, and provide an effective method of training and selecting excellent athletes.

KEYWORDS

Athletes; Fuzzy theory; Professional skills; Comprehensive evaluation.

INTRODUCTION

To promote China's sports undertaking, the priority is to select and train excellent athletes. It is not only related to the achievements of the whole team, but also has can influence China's sports undertaking, thus we must attach great importance to the evaluation and training of athletes' comprehensive skills. The traditional way of selecting athletes depends on some experienced experts' judgments. Some standards of selecting and evaluating athletes are also not complete and reasonable. As a result, the traditional way of evaluating athletes' professional skills are influenced heavily by subjective factors, which bring about great deviations. With the rapid development of computer science and technology, fuzzy theory is employed in the comprehensive evaluation of athletes' professional skills. It uses computer science to do the analysis of large amounts of data and establish a teaching model based on fuzzy comprehensive evaluation The new evaluation system based on fuzzy theory can help experts select athletes in a more scientific way and can reduce the deviations caused by subjective factors. It can also change the qualitative judgment into quantitative analysis, which makes the new evaluation system more scientific, more objective and more accurate.

OVERVIEW OF FUZZY THEORY AND COMPREHENSIVE EVALUATION

In 1965, Lotfi A. Zadeh, an American expert of cybernetics and mathematics, published a paper called "Fuzzy Set", which became the origin of fuzzy mathematics. Fuzzy theory has been a controversial topic since it was formulated, because people have misunderstandings of the word "fuzzy". On the one hand, people misunderstand the connotation of fuzzy theory by simply taking fuzzy theory as a theory that is not clear. On the other hand, people miss the denotation of fuzzy theory by believing that fuzzy theory is equal to fuzzy control theory. In order to correct people's misunderstandings of fuzzy theory, this paper will give an explanation to both the connotation and denotation of fuzzy theory.

The background and basic concepts of fuzzy theory

From the 1940s, people used classical automatic control theory and modern control theory, which contributed much to the development of industrial production and the improvement of people's living standards. However, many traditional control methods employed in the industrial production were not automatic. Instead, they were manually controlled. The modern control theory can slove many problems in industrial production, but its biggest limitation is that people must establish the mathematical model of the controlled object. The industrial control theory is very complicated because the most of the processes are changeable, non-linear and can be easily interfered. Therefore, it is quite difficult to establish the mathematical model. The results of some automatic controls are not as accurate as manual controls; some experienced experts can get satisfactory results through manual control. In the 1960s, Zadeh, as a prestigious scholar of control theory, commented that "the classical control theory put too much emphasis on accuracy, and it cannot deal with complicated system", "a different kind of mathematics is required when people handle the biological system; the mathematics is of fuzzy logic and cannot be described by probability distribution". In 1965, his paper "Fuzzy Set" was published. Fuzzy theory is originated from mathematics. With the development and improvement of the theory, fuzzy theory contains many contents, including fuzzy set theory, fuzzy logic, fuzzy inference, fuzzy control and fuzzy mathematics. The main idea of the fuzzy theory is "based on the existence of fuzzy phenomenon, aiming at handle things with fuzzy concept, changing the compact quantity into the information that can be dealt with by the computer and not using complicated mathematical analysis, such as establishing the mathematical model".

The contents of fuzzy mathematics

Fuzzy mathematics is an important part of fuzzy theory, and it is the mathematics that studies and handles fuzzy phenomenon. Fuzzy mathematics focuses on three aspects:

Studying the relationship between fuzzy mathematics, precise mathematics and random mathematics.

Based on precise mathematical set, Zadeh developed and improved the classical mathematical set. He established and promoted "fuzzy set" mathematical model, forming the theory of operation and conversion. Fuzzy set does not use "yes" or "no" to describe the subordinate relationship between a give element and the given set. Instead, it uses real number between 0 and 1 to describe the subordinate relationship. For instance, an old man is a fuzzy concept. A man aged 90 can be defined as an old man, so its degree of subordination is 1. A man with the age of 40 cannot be regarded as an old man, so its degree of subordination is 0. In other words, fuzzy set is made up of given elements and its degree of subordination is between 0 and 1.

Studying fuzzy language and fuzzy logic

Since human language is fuzzy, people can use fuzzy language and information to make right understanding and judgment. In order to enable human language to communicate with the computer, human language should be set as mathematical model and can carry out the commands given by the computer. Zadeh made mathematical model by formalizing and quantifying human language. For example, the model uses 1 to describe a completely correct human sentence. If the sentence has grammatical or other errors, the model uses a real number between 0 and 1 to describe the sentence and set principles for calculation and judgment.

Applying fuzzy mathematics

The study object of fuzzy mathematics is not precise. Zadeh employed fuzzy set to formalize fuzzy concepts, combined precise and fuzzy study object, and remedied the defect of precise mathematics and random mathematics.

The theory of fuzzy mathematics can be applied to the comprehensive evaluation of athletes professional skills. According to the contents and principles of fuzzy mathematics, experts can use "the degree of subordination" to quantify athletes' performance, make a comprehensive judgment of all the factors influencing athletes' performance and establish a mathematical model, which is objective and precise. In this model, every aspect of athletes' professional skills is described as a real number. By figuring out the aggregate score and using weighted average algorithm, experts can make scientific and objective judgment on athletes and select those outstanding ones. Using fuzzy mathematics to deal with athletes' comprehensive skills and using fuzzy evaluation to carry out the comprehensive evaluation of athletes are the important evaluation criteria in current sports circle.

OBJECT AND METHOD OF THE STUDY

Object of study: tennis athletes

Study method: Delphi method

This paper uses tennis athletes as an example and applies fuzzy theory to make scientific judgment on athletes. The basic skills of tennis include full parts: grip, service, hit and footwork. In order to make a scientific evaluation of the factors' influence on tennis athletes' performance, a survey covering 60 tennis coaches and professional players of Henan universities was conducted. The subjects of the investigation and its proportion are shown in Figure 1.

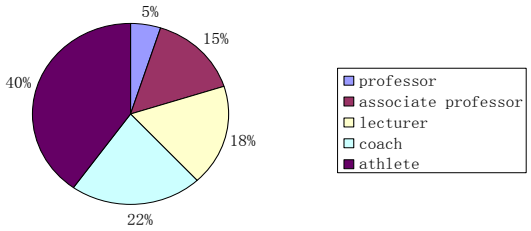

Figure 1 : Subject of the investigation and its proportion

Figure 2 presents tennis athletes' essential skills and its proportion. Each factor is fuzzy when experts evaluate athletes' professional skills.

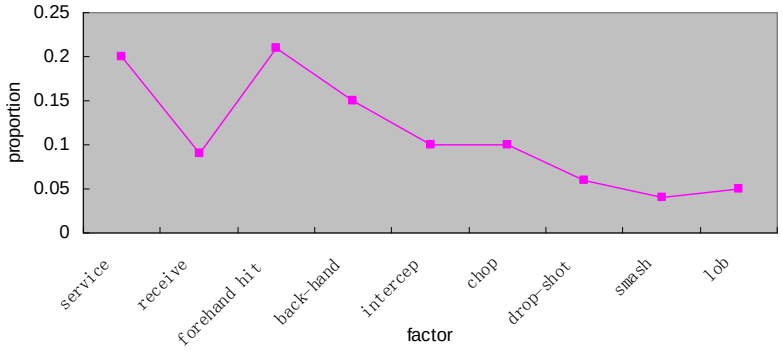

Figure 2 : The nine essential factors and its proportion

On the basis of Figure 2, it can be concluded that nine essential factors take different proportions and the proportions are fuzzy. The best way to carry out fuzzy comprehensive evaluation to analyze the case.

Fuzzy comprehensive evaluation model of tennis athletes' professional skills

After drawing the conclusion of nine essential factors, five steps should be followed to make accurate evaluation of athletes.

Step 1 Determine the factor set. The factor set can be described by a formula: U={U1, U2,U3, U4, U5, U6, U7,U8, U9}. U1, U2..... U9 respectively represent nine essential tennis skills: service receive, forehand hit, back-hand hit, interception, chop, drop-shot, smash and lob.

Step 2 Determine the evaluation set. The evaluation set can be described by a formula: V={V1,V2,V3,V4}. V1, V2, V3 and V4 respectively represent excellent, good, common and weak.

Step 3 Analyze single factors. Firstly, figure out each factor's degree of subordination in the evaluation system. Then, set up a group made up of several experts to make evaluation. The group gives every athlete one degree from V to describe his or her Ui factors. If nij team members use Vi to describe one athlete's Ui, and the evaluation result is Ri=(ni1/n, ni2/n, ni3/n, ni4/n)=(ri1, ri2, ri3, ri4)=(ri1/v1)+ (ri2/v2)+ (ri3/v3)+ (ri4/v4), which is the fuzzy set of V. Fuzzy relationship can be figured out through i=(1, 2, 3… 9):

$$R\begin{bmatrix} R_1 \\ R_2 \\ - \\ R_9 \end{bmatrix} = (rij)_{9*4} = \begin{bmatrix} rr_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ - & - & - & - \\ r_{91} & r_{82} & r_{93} & r_{94} \end{bmatrix}$$

In this relationship, R is a single factor matrix. R is the i factors in line i. This shows the degree of subordination of each level. Line j represents the degree of subordination of the factors of j level. Finally, (U, V, R) makes up a model of fuzzy comprehensive evaluation.

Step 4 Determine each factor's proportion. Nine essential factors play different roles in deciding an athlete's performance, so their proportions are different as well. In order to study each factor's proportion, weight vector A=(n1,n2,n3…n9) is introduced (the meaning and value range of ni is equally to ni in Figure 2, 0≤ni≤1)

Step 5 Carry out comprehensive evaluation. Based on the former mathematical model, the evaluation mathematical model can be worked out as D=(dj)1*m=(d1,d2,d3,dk)=H R=(ni)1*k. [rij]1*k. The calculating method of this mathematical model is matrix operator rule. This model is a weighted average model, which means only weight set H has the meaning of right quantity. Once R and H are settled, the factor fuzzy evaluation is determined. The result can reflect an athlete's professional skills and the degree of subordination of each factor. The result can provide experts with scientific criteria to make evaluation. If experts give "excellent", "good", "common" or "weak" as the judgment of an athlete's performance, after the weight distribution, they will get the final results of the evaluation.

$$W = (c_1,\ c_2,\ c_3,\ c_4)\begin{Bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{Bmatrix} = \sum_{i=1}^{4} b_i * \ c_i$$

EMPIRICAL ANALYSIS

If experts want to make a comprehensive evaluation of a Tennis player M, they should form an evaluation group firstly. Then they ought to study and analyze M's usual training results, competition performance and competition videos. Supposed that 38 percent of experts in the group believe that M's service is "excellent", 28 percent experts think it is "good", 32 percent experts consider it is "common" and 2 percent experts think it is "weak"; the vector of service can be described as (0.38, 0.28, 0.32, 0.02). Then experts give their judgment on each factors and the results are shown in Figure 3.

TABLE 1 : The fuzzy relationship among the nine technical level

	service	receive	Forehand hit	Back hand	Intercept	chop	drop shot	smash	lob
excellent	0.38	0.29	0.54	0.63	0.36	0.11	0.13	0.23	0.31
good	0.29	0.41	0.25	0.23	0.19	0.44	0.27	0.15	0.45
common	0.23	0.19	0.15	0.11	0.22	0.31	0.36	0.42	0.20
weak	0.11	0.11	0.07	0. 03	0.25	0.14	0.24	0.20	0.04

According to the mathematical model and Figure 3, if experts use the largest subordination rule, athlete M will be leveled as "good", and the biggest weight is 0.36. If the corresponding distribution of weight is (1, 0.6, 0.5, 0.1), athlete M's final score will be W=0.73, and he or she will be leveled as "common".

However, it cannot replace experienced experts completely in the process of selecting athletes. Fuzzy evaluation theory is more like the effective supplement in qualitative and quantitative aspects.

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