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About Decision Tree Algorithm in Table Tennis Tournament

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Abstract: Decision tree algorithm has been widely used in the diagnosis, evaluation and classification of table tennis games, and its advantages in the diagnosis of game techniques and tactics have emerged, but there is a lack of systematic scientific research on the model of diagnosis, evaluation and classification. In order to solve the shortcomings of the existing research on diagnosis, evaluation and classification of techniques in table tennis, this paper discusses the steps of ID3 algorithm to build decision tree and discusses the scoring rate and usage rate in table tennis as well as the evaluation of techniques and tactics in table tennis, and then discusses the construction of tactical index system and discretization of winning probability of decision tree algorithm for the application of tactical diagnosis and classification model in table tennis. A brief discussion is given on the construction of a tactical index system and the discretization of the probability of winning by decision tree algorithm. And the design of the decision tree algorithm in the table tennis game tactical classification model is discussed, and the decision tree algorithm is used to classify and diagnose three tactical categories, and the experimental data show that the algorithm has an average correct rate of 97.1% for the tactical classification in the serve, receive and hold sections. Therefore, it is verified that the decision tree algorithm has a high practical value in the technical and tactical classification diagnosis of table tennis matches.

1. Introduction

The continuous summing up of training and practical experience in table tennis tournaments is a very important reference not only for the tournament itself, but also for the development of all ball game events. It has also contributed to the longevity of table tennis in the field of competitive sports.

Nowadays, more and more scholars have conducted a lot of researches through various techniques and systematic tools in the diagnosis, evaluation and classification of techniques in table tennis games, and after practical researches, certain research results have also been achieved. patrick believes that innovative table tennis doubles techniques and tactics analysis methods can provide data support for the technical and tactical diagnosis of Chinese table tennis doubles main players, and prepare Chinese table tennis teams for the Olympic Games, and further enrich the theoretical system of table tennis. METHODS:Using literature method, expert interview method, video annotation method, and comparative analysis method, a new method of eight rounds and three stages was proposed on the basis of the traditional three-stage method and applied to the doubles match between Fan Zhendong and Xu Xin and Morimoto Tomokazu and Kikuyu Fujisato in the 2017 World Cup, and its effect was comprehensively examined [1].Philip S conducted a qualitative study of table tennis technical and tactical research in research and quantitative research were explored. It is shown that quantitative and qualitative research in table tennis mechanics and tactics have their own advantages and disadvantages, and that the combination and application of both research methods will be more effective in practical research. A quantitative research method is used to study the players' tactics and techniques in order to provide objective quantitative statistics. A qualitative research method of table tennis tactical analysis is used to identify the true technical and tactical intentions of the players. The combination and application of quantitative and qualitative research may be the best way to discover the true patterns of table tennis game mechanics and tactics [2].HanChern-Tone explores the effect of 40+ table tennis on the mechanics and tactics of national player Fan Zhendong. Video observation, three-stage statistics, and segmental index evaluation were used to statistically analyze Fan Zhendong's technical tactics of serving before attacking, receiving before attacking, and then opposing. The results showed that:the usage rate of Fan Zhendong's serve-and-aggression increased and the scoring rate decreased; the usage rate of receive-and-aggression changed little and the scoring rate increased; it rarely decreased and the scoring rate was relatively low. Technical and tactical strategies, reduce the proportion of hanging balls, increase the proportion of backhand receiving and side twisting balls, and increase the anti-pull ring of three and four boards. It is recommended to improve the quality of serve, strengthen the awareness of serving first and attacking later, improve passive back-pulling ability, and improve forehand pumping and pivoting ability [3]. Although there is a wealth of existing research on the diagnosis, assessment and classification of techniques in table tennis, there are limitations in its real practice.

In this paper, we study the problem of decision tree algorithm for the classification and diagnosis of techniques and tactics in table tennis tournaments. The classification problem has long been the object of research in mathematical statistics, pattern recognition and other research fields. At present, decision tree classification algorithm is one of the most widely used classification algorithms. This paper firstly introduces the process of constructing a decision tree by ID3 algorithm. Based on the construction of the tactical index system and the discretization of the winning probability of decision tree algorithm, the decision tree algorithm is used to classify the tactics in table tennis matches.

2. Research on the Application Design of Decision Tree Algorithm in Table Tennis Games

2.1. Scoring Rate and Utilization Rate in Table Tennis Game

(1) The role of scoring rate and utilization rate

In the technical and tactical analysis of rivalry, the three most classic and commonly used indicators are score rate, score loss rate and utilization rate. Together, they determine the effectiveness of table tennis tactics [4]. High scoring rate, low score loss, and high usage rate are the

best score models, which correspond to the best technical and tactical performance; while low scoring rate, high score loss, and high usage rate are the worst score models, which indicate that the players are not playing the techniques they are good at on the one hand, and are forced to use a lot of techniques they are not good at on the other hand [5].

(2) Interrelationship between score rate and usage rate

The score rate reflects the quality of a game behavior (including technique or tactics), while the usage rate reflects the quantity of a game behavior. The two interact with each other and are related to each other [6]. When the scoring rate of a game act is greater than 0.5, the greater the usage rate of the game act, the increasing function of the usage rate is the technical efficiency; and the opposite is the decreasing function [7].

2.2. Technical and Tactical Evaluation in Table Tennis Matches

When evaluating the technical and tactical aspects of a table tennis match, one must first choose the appropriate architecture according to the object of analysis and different needs. For example, the technical use system is used to evaluate the opponent's technical use, and the three-stage system is used to analyze offensive players [8].

(1) Three-stage index evaluation method

The three-stage assessment method is a method for assessing the strength and technical diagnosis of table tennis players proposed by Wu Huanqun in 2007. Its basic principle is based on the overall view of the game, and the overall ability of the player is decomposed into three abilities, namely, serving snatch, receiving snatch and holding [9]. He condensed the item technical indicators of table tennis game techniques into three segments of score rate and usage rate, making the method concise and efficient to use. It has been used many times for the national table tennis team's match preparation and opponent analysis [10].

(2) Ten-indicator evaluation method

The ten-indicator assessment method is a method proposed by Jinliang Li in 2007 to specifically assess the technical and tactical strength of offensive players. This method uses continuous statistics for the first four board techniques of athletes [11]. It also combines three aspects of attacking, holding and defending to set up ten evaluation indexes of serve score rate, serve-strike usage rate, serve-strike hit rate, serve-strike score rate, serve-reverse usage rate, receive-strike usage rate, receive-strike hit rate, receive-strike score rate, control-receive usage rate, and holding score rate [12].

(3) Match diagnosis by mathematical model

The development of software acquisition technology and database technology has made it possible to accumulate a large amount of data and has promoted the role of mathematical models in match evaluation [13]. In recent years mathematical methods such as artificial neural networks and association rules have been gradually applied to the technical and tactical evaluation of table tennis matches. The basic idea is to establish an initial model training model a model validation example application. The mathematical model approach proposes the use of competitive efficiency values to describe the role of a particular technique or tactic, and the concept of match winning probability to describe the comparison of strengths between the two sides of a match [14]. The use of the concept of probability to analyze and evaluate matches allows more information to be included in the index system of match evaluation.

2.3. Decision Tree Algorithm

DecisionTree (DT) is an algorithm commonly used in predictive modeling, which classifies a large amount of actual data according to certain rules of classification algorithm according to

predetermined splitting attributes in order to find some valuable and implicit information from it [15]. The core idea of this algorithm is to take a different answer to the question posed by each split node, thus determining the tree construction trend. The decision tree is constructed by searching the training sample set top-down using a greedy algorithm that tests each attribute at each node [16].

The ID3 algorithm uses the information gain degree as the measure of its splitting attributes, and sets node G to represent or store the tuple of division S. For each splitting attribute, the attribute with the highest information gain is chosen to split it. The information entropy required to classify the attributes for the tuples in the training data set S is given by the following equation (1):

$$INFO(S) = -\sum_{x=1}^{n} G_x long_2(g_x) \tag{1}$$

Where g_x is the probability that any attribute tuple in the training data set S belongs to class B_x. Since the primary encoding of information is encoded in binary, a logarithmic function with a base of 2 is used here.

Assuming that attribute C divides tuple S into U equal parts, the information entropy of the subset divided according to attribute C is given by the following equation (2):

$$INFO_C(S) = \sum_{y=1}^{U} \times INFO(S_x) \tag{2}$$

According to the foundation of information theory, the degree of information gain is the difference between the original information demand and the new information demand, which is given by the following equation (3), namely:

$$Gain(C) = INFO(S) - INFO_C(S) \tag{3}$$

According to the foundation of information theory, "The larger the Gain(A), the more information the selection test attribute A provides for the classification. Because the smaller entropy means the purer the node, according to the definition of information gain, the larger the amount of information gain, the larger the amount of entropy reduction, the purer the node.

3. Investigation and Research on the Application of Decision Tree Algorithm in Table Tennis Games

3.1. Tactical Index System Construction

The tactical system is established by the combination of tactical behavior classification and game time sequence, and the table tennis game is divided into serve and grab section, receive and grab section and holding section according to the batting time sequence. The tactical behaviors can be classified into four categories: offense, defense, control and evenness based on human intelligence for the diagnosis and evaluation of table tennis game techniques and tactics. Combining the two, the following tactical system is obtained in Table 1, where serve-steal includes serve and third board, receive-steal includes receive-serve and fourth board, and hold includes after five boards of serve wheel and after six boards of receive-serve wheel [17].

Table 1. Tactical system of table tennis matches

Game time sequence	Indicators
Tee section	Serve stealing, serve control, serve defense
Receiving section	Receive and attack, receive and control, receive and defend, receive and even
Holding section	Holding attack, holding control, machine holding defense, holding even

3.2. Decision Tree Algorithm Winning Probability Discretization

The winning probability is the ratio of the score to the total score, and to discretize it, either by direct expert evaluation or by automatic transformation according to the value domain. Here the interval of Table 2 is partitioned. The winning probability is divided into five segments corresponding to good, better, fair, poor, and poor for qualitative judgments [18].

Table 2. Discretization interval of winning probability

Probability of winning	Discrete values	Qualitative evaluation
[0.5248,1]	5	Good
[0.4752,0.5248]	4	Better
[0.4326,0.4825]	3	General
[0.47,0.4326]	2	Rather poor
(0.048)	1	Poor

4. Research on the Application of Decision Tree Algorithm for Tactical Diagnosis in Table Tennis Tournaments

4.1. About Decision Tree Algorithm in Table Tennis Game Tactics Classification Model

In this paper, 11 tactics types of serve receive and hold tactics in table tennis matches are selected as the basis for establishing a decision tree model for tactics diagnosis, and the results are used as classification attributes to establish a workflow diagram as shown in Figure 1.

The specific implementation process is as follows:

(1) Calculate the information quantity of classification attributes: In the training data set shown in Table 5, there are 350 samples in total, among which 99 data are shown for the result YES and 251 data are shown for the result NO. Firstly, according to the ID3 algorithm and the basic theory of information theory introduced in the previous section, the information entropy required for the classification of a given sample is then calculated using the given formula (1).

(2) The information entropy of each attribute is calculated in turn by combining the ID3 algorithm and the information theory ground theory with the formula (2) given in the previous section.

(3) Combining the ID3 algorithm and the basic theory of information theory, we calculate the information gain of each attribute in turn by using the formula (3) given in the previous section.

(4) By comparing the information gain degree of each test attribute and selecting the attribute with the largest information gain degree as the root node, the information gain rate of the attribute "technology" is the largest according to the previous calculation results, so it can be selected as the root node. A root node "technology" is created, and 11 branches are introduced according to its 11 attributes to divide the sample.

(5) Using the drop point attribute E2 as an example, we continue to build the decision tree and

repeat steps (1) to (5) above.

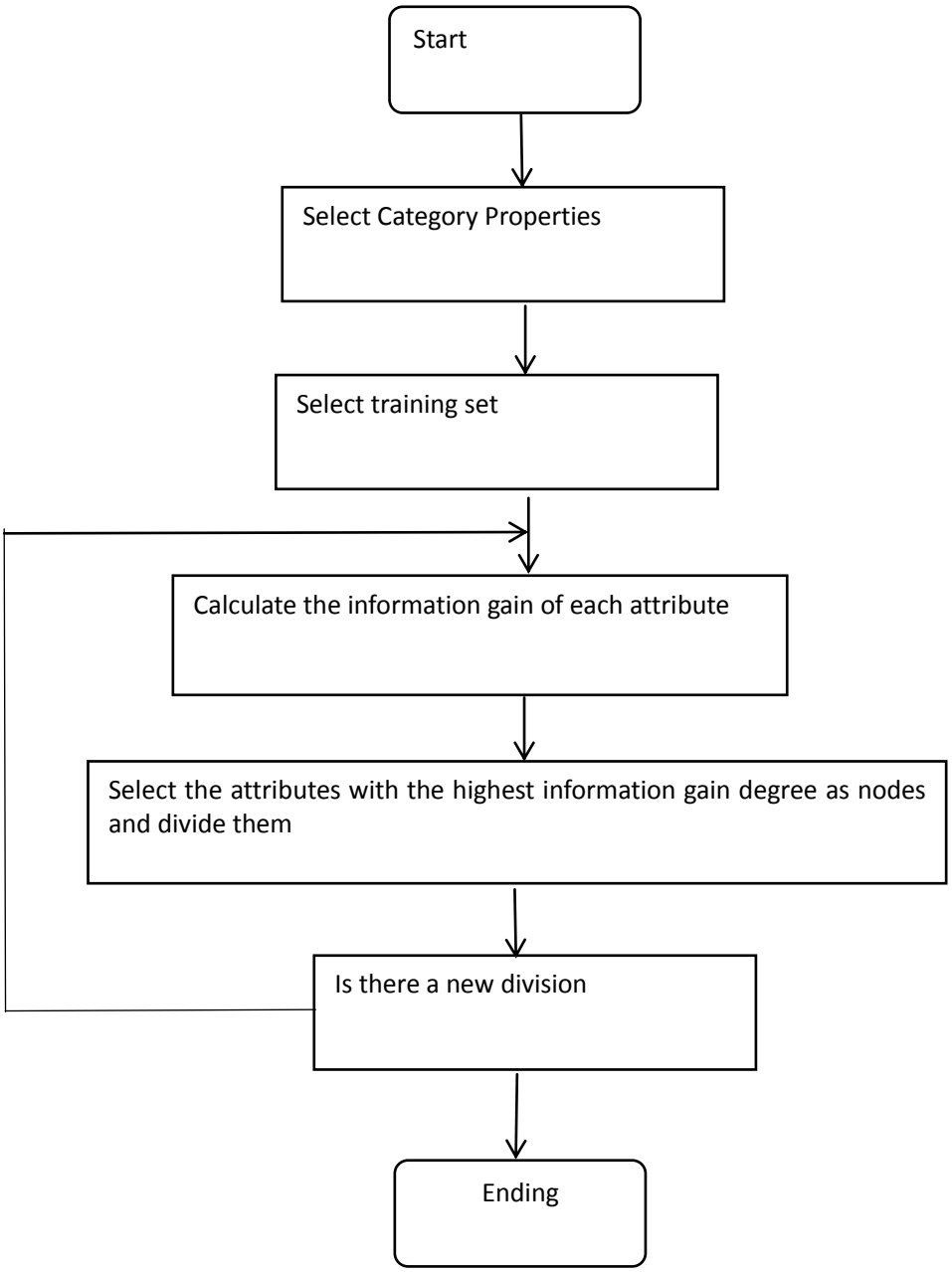

Figure 1. Flow of decision tree algorithm for tactical classification in table tennis matches

4.2. About the Application of Decision Tree Algorithm for Tactical Diagnosis in Table Tennis Games

The classification ability of each attribute in the decision tree building process is mainly reflected by its usage rate in the classification process, and the set of attributes with the strongest classification ability is listed in Table 3. That is, the importance of each tactical attribute is indicated. This is used as a result to diagnose the table tennis game tactics.

Table 3. Classification utilization rate and correctness rate of each indicator

Refined attributes	Classified utilization rate	Rate of classification accuracy
Receiving period	99%	100%
Service period	94%	97%
The American section	93%	100%

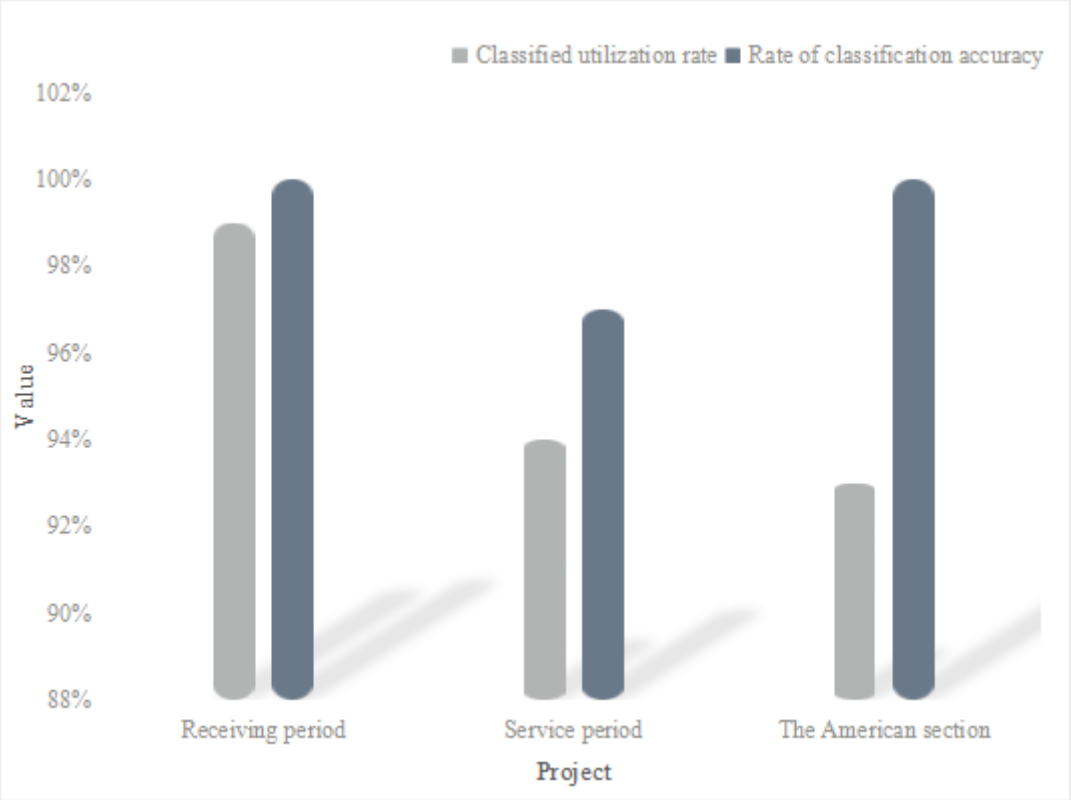

Figure. 2. Comparison of the results of classification usage rate and correct rate of each index of the algorithm

From the data in Figure 2, it can be seen that the decision tree algorithm has achieved 99% and 100% correct rates of usage and classification for the serve-retrieve, control and defense in the serve section, respectively. The usage rate and the classification rate of the receiving serve, control, defense and evenness in the receiving serve segment reached 94% and 97%, respectively. The usage rate and classification rate of holding attack, control, defense and evenness in the holding section reached 93% and 100% respectively.

5. Conclusion

This study conducted a systematic research on decision tree algorithm for diagnosis and classification of table tennis game techniques and tactics. A model based on decision tree algorithm was established to classify tactics in table tennis matches. And the experimental analysis of the effect of the diagnosis and classification of the algorithm was conducted, and it was concluded that the decision tree algorithm has a high usage rate and correct rate in classifying the tactics in the serving section, receiving section and holding section of the tactics in table tennis matches.The technical and tactical diagnosis method of table tennis matches by decision tree algorithm achieves

the technical and tactical diagnosis of excellent table tennis players. It was used for competition preparation and opponent analysis, and the results were recognized by the coaches' players. However, there are still some studies need to be further explored.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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