Psychological State and Training Method of Athletes before the Game Based on Simulated Annealing Algorithm

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Objectives: The mental state of athletes before the game is the key to determining the performance of the game, and it is also the problem that every coach tries to solve. Methods: Based on this, based on the simulated annealing algorithm, the athletes' psychological state and training methods are studied before the game, and the anxiety diagnosis model and algorithm for over-training are proposed. Then the relevant data is collected, and then the Bayesian method is used to influence the psychological stress of basketball and the anxiety of different situations on the athletes' mind and body. Results: The DH algorithm is proposed, and the DH mental prediction model based on simulated annealing algorithm is constructed. The psychological modeling under the human understanding angle is predicted to try to explain the human causal model. Finally, the built model is tested and it is concluded that: the accuracy of overtraining diagnosis based on the over-trained diagnostic model and training sample data of this application example is 72.7%. When there is emotional stress, "mental exhaustion", "natural adjustment", while without "fatigue", "psychological fatigue", "feel good", "self-efficacy", "physical recovery", there is a 20.24% chance of over-training. Conclusion: Based on the psychological state of the athletes before the game, this study combines the relevant knowledge of psychology to find out the methods that affect the athletes' psychological state before the game, and provides reference for the athletes' psychological state control before the game.

Key words: simulated annealing algorithm; pre-match; mental state; training method
Tob Regul Sci.™ 2021;7(5): 1934-1944
DOI: doi.org/10.18001/TRS.7.5.114

Since the establishment of the Sports Psychology Branch of the Chinese Sports Science Society in 1980, China's sports psychology has experienced 30 years of development. In these 30 years, sports psychology has made outstanding contributions to the sports cause of our country, especially the contribution of sports psychology to competitive sports. At present, sports psychology has become a relatively mature subject, and the application of many psychometric techniques has also promoted the development of sports psychology. In the era of rapid development of competitive sports, it is no secret that athletes are trained and competed in physical, technical and tactical aspects, and the key to winning or losing is often the psychological stability of the game, athletes with good mental qualities will have a greater chance of winning on the court. Studies have shown that targeted pre-match mental training can effectively improve athletes' performance [1]. As an important factor in the psychological quality, the psychological state before the game provides an effective theoretical foundation for training in the psychological training of athletes, and the evaluation of the athlete's pre-match mood can effectively train the athletes and take different special training for different athletes. In previous studies, there is a lot of literature pointing out that psychological function training has a positive effect on the growth of performance, and the results are directly related to psychological factors [2]. The impact of pre-match psychological adjustment on athletes' performance is more important. Therefore, the pre-competition mental state that is usually said is, to a certain extent, an important component of psychological skills. Based on this, the athletes' psychological state

and training methods before the game are studied.

From the perspective of psychological training, the influence of psychological state on the training effect of different trait athletes is studied. An anxiety diagnosis model and algorithm for over-training were proposed. The relevant data were collected and the Bayesian method was used to analyze the psychological stress of basketball and the anxiety of athletes in different situations. The DH algorithm is proposed, and the DH mental prediction model based on simulated annealing algorithm is constructed. The psychological modeling under the human understanding angle is predicted to try to explain the human causal model.

The innovation lies in the reference of the simulated annealing algorithm. The search process of the algorithm introduces a random factor and accepts a solution that is worse than the current solution with a certain probability, so it can jump out of the local optimal solution and reach the global optimal solution. Compared with the previous approximation algorithm, the proposed simulated annealing algorithm has the advantages of simple description, flexible use, wide application, high operational efficiency and less constraint on initial conditions. Applying simulated annealing algorithm to the research of athletes' psychological state before the game can solve the problem of large-scale combinatorial optimization.

Based on simulated annealing algorithm, the research on Athletes' Psychological State and Training Methods before the Match is carried out. Firstly, the status quo of research on the psychological state before the game is elaborated. Furthermore, the anxiety reasoning algorithm, DH algorithm and annealing simulation algorithm in over-training are proposed, and the characteristics, principle and implementation flow of the algorithms are introduced, and an anxiety diagnosis model for over-training is constructed. Finally, the proposed algorithm is verified and the conclusion is drawn.

At present, many countries attach great importance to the study of athletes' psychological state before the game. They believe that the psychological state before the game is a guarantee that the high-level athletes will achieve good results. Regarding the research on the psychological state before the game, there are many related research results at home and abroad. It is generally believed that the psychological state before the game is one of the main factors affecting the normal play. TourmenteM et al. conducted a related study on the pre-competition mental state of elite Chinese Taekwondo women athletes, who used psychological test and on-the-spot observation method to test the psychological state of excellent Taekwondo athletes, and the results showed that athletes of different grades have obvious differences in psychological state before the game [3]. Klein J et al. conducted a related study on the psychological adjustment of gymnasts before the game. He pointed out that the reasonable guidance of athletes before the game, understanding themselves and having a good psychological quality is the key to winning the game [4]. When conducting psychological tests on different levels of Taekwondo athletes, Goudarzi S et al. pointed out that the pre-competition psychological adjustments for different levels of athletes are different, and for different athletes, the psychological adjustment method before the game must be different [5]. Lo J C et al. believes that psychological training before the game can eliminate the nervous state of the athletes before the game, and psychological training before the game can also improve the performance of the game. If the athlete can receive psychological training for a long time, it can improve the athlete's ability to resist the game and have a certain influence on the formation of the athlete's excellent personality [6]. Sun D et al. conducted a survey on the psychological state of Henan college track and field athletes before the game, and found that the psychological state of the athletes before the game is generally divided into the following four types, namely, excessive tension, combat readiness, indifference, and blind confidence, and pointed out the corresponding measures that should be taken to solve these problems [7]. Terhune V et al. proposed the psychological training of track and field athletes before the game, combining physical training, technical and tactical training and psychological training to eliminate the unfavorable factors before the game, reduce the impact of negative factors, and make the athletes' competitive state the best [8]. Sullivan C pointed out the psychological state analysis of the college football team in Guangxi

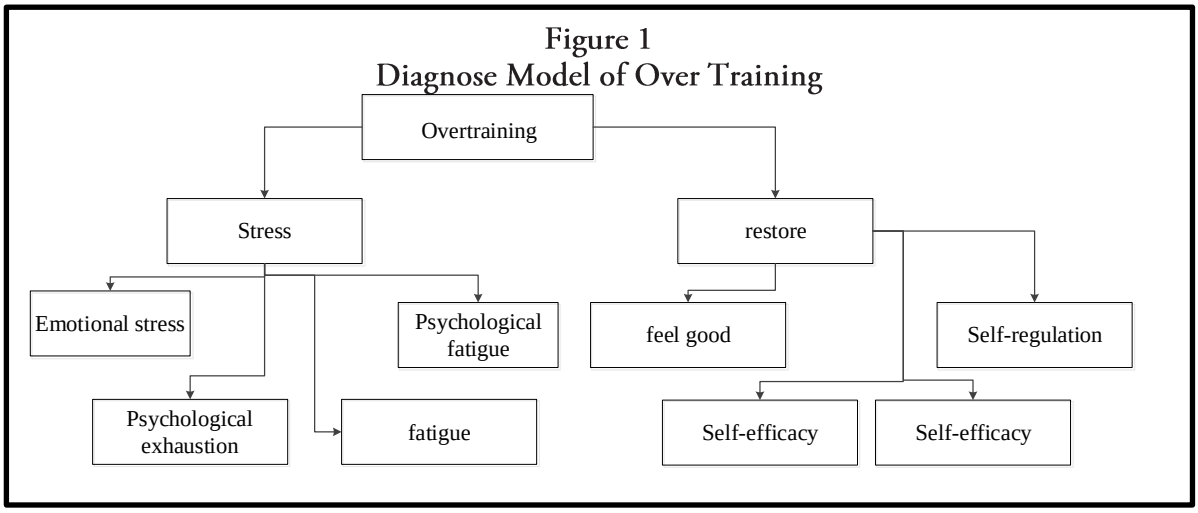
after the game: pre-match mental state instability and other situations exist in a considerable number of football players, which affect the performance of technical and tactical levels. Solving the psychological problems of athletes is a very large project, which requires the joint efforts of athletes, coaches and psychologists to effectively solve related problems [9]. Subramaniam A et al. took 18 male archers in the archery team for an example, and experiments were conducted on the athlete's competition strategy, pre-match mental state and competition performance. It is found that different competition schemes and competition strategies have different effects on reducing the state anxiety of athletes, indicating that certain psychological intervention experiments have certain effects on improving the mental state of archers [10]. In a survey of 30 middle school students' pre-competition anxiety levels, Smith A S J et al. found that middle school basketball players had higher levels of pre-competition anxiety and their anxiety levels affected the actual level of athletes [11]. Zhao R et al. used the bio-energy meter to conduct experimental research on the pre-competition anxiety of shooting athletes, and it was found that the anxiety of the experimental group using this instrument was significantly improved before the game. The function of this bioenergy meter is to control the discharge of adrenaline and dopamine, increase the intake of oxygen, and alleviate the excessive nervousness caused by hypoxia, which indirectly affects the mood [12]. Von R P et al. verified the relationship between the pre-competition anxiety level, gender and sports level of 31 shooting athletes. The results indicated that, the index that distinguishes between elite athletes and general athletes is state self-confidence, and gender indicators only have a certain impact on athletes' physical anxiety, the elder athletes are relatively stable in terms of psychological anxiety before the game than younger athletes [13].

With the rapid development of sports psychology, a large number of research results have appeared in the academic world. The research results of sports psychology have been applied to the competition and have achieved satisfactory results. From the current research status, the research on the psychological state before the game is now close to maturity, but the research on the mental state based on the simulated annealing method is rare. At present, the research on pre-competition anxiety mainly focuses on the status quo and the research methods of related adjustment methods. Many items have the same adjustment methods for pre-match anxiety, but sometimes anxiety may be a way to promote exercise.

METHODS

Anxiety Diagnosis Model During Over-Training

At this stage, the over-training judgment generally relies on two different standards, namely physiological and biochemical indicators and psychological indicators. In terms of physiological indicators, people use excessive weight, heart rate, hormones, ECG changes, white blood cell count, respiratory system, urinary system, digestive system, endocrine system, immune system, etc. as indicators to diagnose over-training. Although there have been a large number of test indicators, such as the relationship between cortisol testosterone, creatine kinase, blood urea, heart rate during sleep, blood lactic acid analysis, etc., have been used in the different stages of basketball player training, but not satisfactory. Relevant research shows that it is necessary to grasp the excessive changes in the UI side, which should be the same as the basketball performance [14]. The best way to avoid over-training is systematic monitoring and effective prevention. However, there is no simple tool for measuring excessive practice in China today. Based on the indicators of over-training research, through over-training experts and guidance from Bayesian network experts, and based on further literature review or in-depth research, based on 11 index factors, an over-trained Bayesian network model is established. The model structure is shown in Figure 1:



In this model, the conditional dependencies and independent relationships between the various network nodes can be clearly seen. By setting the conditional probability distribution of each node of the model and setting the state value of the evidence node, the diagnosis result of each network node except the evidence node is obtained. Among them, the "over-training" node is the most important diagnostic target in this study. By judging and interpreting the value of the node, the result of over-training can be obtained. But be aware that the result is also a possible answer, a speculation or inference, rather than an absolute affirmative or negative answer.

Anxiety Reasoning Algorithm in Over-Training

Over-training diagnosis is performed when the network model is known and the training sample data is known, and the network inference algorithm uses Polytree Propagation, and the main idea of this method is to directly use the graphics structure of the reliability network to assign a processor to each node. Each processor computes the message transmitted by the neighboring node and the conditional probability table stored in the processor to obtain its own reliability, that is, the posterior probability, and propagates the result to the remaining neighboring nodes. In the actual calculation, after the reliability network receives the evidence, the reliability value of the evidence node changes, and the processor of the node propagates the change to its neighbor nodes; after receiving the delivered message, the neighboring processor recalculates its own reliability and then propagates the result to its neighbors, and this continues until the impact of the evidence propagates through all nodes. The model is over-trained based on the propagation of reliability in the network, and reliability is the conditional probability of each node in the belief network for its parent node (if the node has a parent node), if there is no parent node, the reliability is the unconditional probability of the node. If there is a direct influence between the variable M and the variable N, then M is directly connected to N (M->N). For the causal relationship X->Y, where X = (x1, x2, ..., xm), Y = (y1, y2, ..., yn), the conditional probability matrix M is used to determine the causal relationship between X and Y in the reliability network.

$$M_{y|x}P(y|x)=\begin{bmatrix} P(y_1|x_1) & P(y_2|x_1) & \cdots & P(y_n|x_1) \\ P(y_1|x_2) & P(y_2|x_2) & \cdots & P(y_n|x_2) \\ & & \cdots & \\ P(y_1|x_m) & P(y_2|x_m) & \cdots & P(y_n|x_m) \end{bmatrix} \quad (1)$$

Where A represents the probability when X takes the value of x_i and Y takes the value of y_i. To express the impact of new evidence and new facts on the proposition, a confidence distribution BEL(X) is defined for each node variable X:

$$BEL(X)=p(x|e)=p(x_1|e),p(x_2|e),...,p(x_m|e) \quad (2)$$

It means the probability distribution of the value of Proposition X under all the facts and evidence E conditions currently in existence. The probability distribution here is different from the probability distribution, but in general, the probability of low probability is also low, and the probability of obtaining a high probability is also high. The propagation of the reliability distribution is achieved by the propagation of two independent vectors, λ and π, defined as:

$$\lambda(x) = p(e^- \mid x), \pi(x) = p(x \mid e^+) \quad (3)$$

Where: e+, e- are the evidence obtained respectively at the head and tail of the causal chain, namely:

$$e^+ \to U \to X \to Y \to e^- \quad (4)$$

$$BEL(X) = p(x \mid e^+, e^-) = p(x \mid e^-) p(e^+ \mid x, e^-)$$

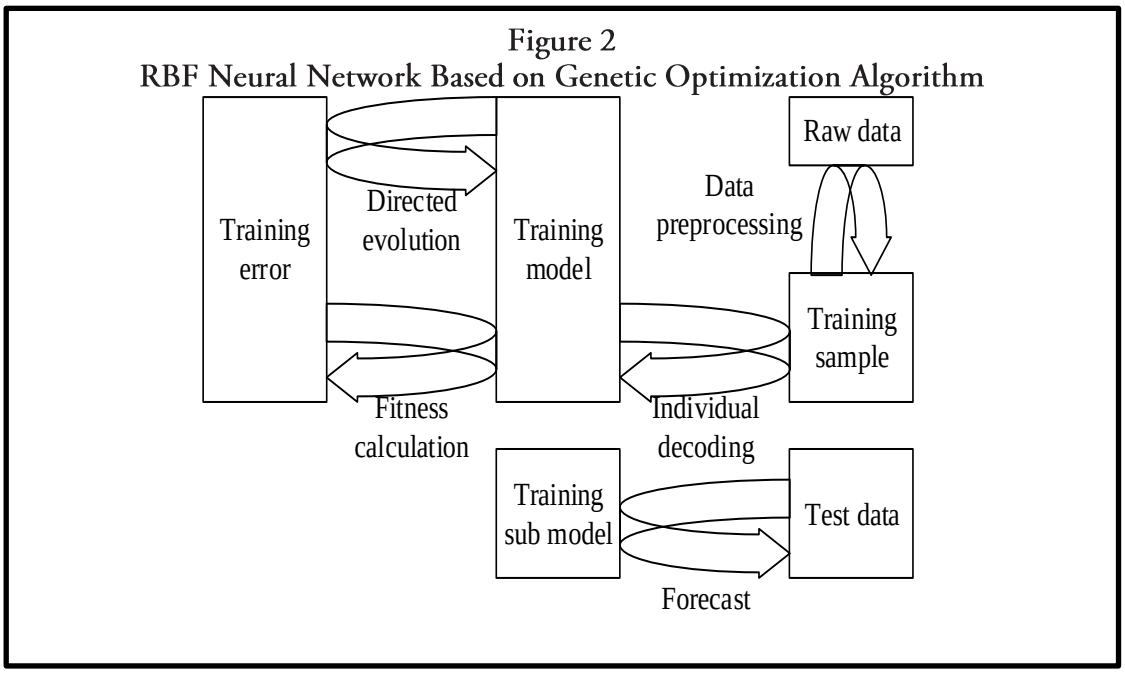
$$= ap(x \mid e^-) p(e^+ \mid x) = a\lambda(x)\pi(x) \quad (5)$$

In the formula, a is the normalization constant. After the reasoning is over, the system will display the corresponding conclusions, and the results are also based on the probability, which is to give the probability of different influence reasons, rather than directly giving a positive judgment conclusion that occurs or does not occur.

DH Algorithm

The proposed algorithm belongs to a genetic algorithm based on special design, the overall design idea is as shown in Figure 2, and the network parameters and network structure are synchronized in the actual training process. For neural networks with structural differences, they are divided into two steps: the first is to expand the small-structure network into a large-scale network without loss, and then develop the traditional poor and mutated; the second is to tailor the weight of the tiny nodes to the new network model and reduce the network complexity.

Figure 2
RBF Neural Network Based on Genetic Optimization Algorithm



According to the DH key exchange method, J Builder is used to develop application software, including server and client programs. The key exchange parties run their own programs, and one party connects to the other party in a client mode, and an arbitrary initial value (operation index) is set, the program calculates and exchanges key seeds, calculates and generates keys. The server and client design schemes are shown in Table 1 and Table 2.

Table 1
Server-Side Processing Flow

N mReady=1 Y	
Sequential execution	Computing Key: k=Nnmodq
	Exit cycle

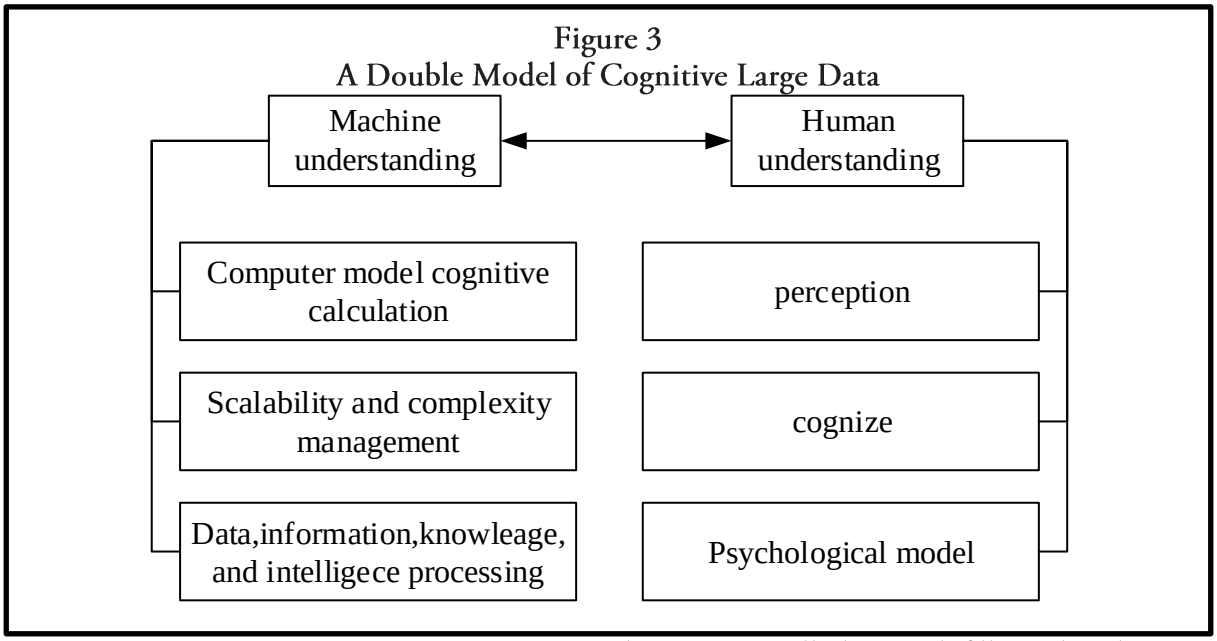
Table 2
Server-Side Processing Flow

N connected=1 Y	
Sequential execution	Receive each other's key seed to N
	Exit cycle
It's always true	
N mReady=1 Y	
Initialization	Computing Key: k=Nnmodq
	Exit cycle

Establishment of DH Mental Prediction Model Based on Simulated Annealing Algorithm

The earliest idea of Simulated Annealing (SA) was proposed by N. Metropolis et al. in 1953. In 1983, S. Kirkpatrick et al. successfully introduced annealing ideas into the field of combinatorial optimization [15]. It is a stochastic optimization algorithm based on the Monte-Carlo iterative solution strategy. The starting point is based on the similarity between the annealing process of solid matter in physical matter and the general combinatorial optimization problem. The simulated annealing algorithm starts from a higher initial temperature, and with the continuous decrease of temperature parameters, combined with the probability jump feature, randomly finds the global optimal solution of the objective function in the solution space, that is, the local optimal solution jumps probabilistically and eventually tends to be globally optimal. The simulated annealing algorithm is a general optimization algorithm, which has the global optimization performance of probability in theory, and has been widely used in engineering, areas such as VLSI, production scheduling, control engineering, machine learning, neural networks, signal processing, etc. The simulated annealing algorithm is an optimization algorithm that can effectively avoid the serial structure that is trapped in the local minimum and eventually tends to be globally optimal by giving the search process a time-varying and eventually zero-probability jump. The application of simulated annealing was categorized as a standard and compared to human cognition, as shown in Figure 3. It can be found that the "machine" understanding based on simulated annealing has a certain internal relationship with human psychological modeling. It is assumed that humans mainly seek to establish causal models, while machines apply computational methods to explain causality.

Figure 3
A Double Model of Cognitive Large Data



RESULTS

Data Source

By analyzing the results of the questionnaire "Basketball Player Training Status Monitoring Scale 32×3", it is possible to easily and effectively understand the mental state, physical health and activity of the tested person in the past 3 days (including day and night). Based on the model of over-training diagnosis, the actual data collected by the "Basketball Player Training Status Monitoring Scale 32×3" is used as a practice sample, and it can be tried to start the diagnosis of over-training with the Bayesian network. A questionnaire of 562 college basketball players and 67 basketball sports school basketball players in the "Basketball Player Training Status Monitoring Scale 32×3" questionnaire was selected, and a total of 629 people were used as training data sources. There are 408 males and 221 females, with an average age of 19.27 years and a standard deviation of 1.52 years; there are 1 international athletes, 3 athletes, 73 at the first level, 534 at the second level, 2 people at the third level, and 16 people without basketball, and the nationality is mainly Han. There are 32 entries in the "Basketball Player Training Status Monitoring Scale 32×3" questionnaire. Each entry has 3 options 0, 1, 2, which represent the frequency of occurrence of each situation. Data cleaning is carried out on incomplete, inconsistent, and noisy data in 629 questionnaire data is mainly performed by eliminating null data and filling the abnormal data with an average value to complete the data preprocessing part, the sample size of the final participating operation is 547. The first 525 pieces of data are selected as the training sample data, and the data in the questionnaire is converted into the data obtained by each component in the over-trained model.

Algorithm Test

Compared with a large number of machine learning methods, classification methods, and uncertain judgment methods, Bayesian network has a high demand for discreteness. To this end, continuous values in the over-trained diagnostic sample data must be discretized between network parameter learning. Numerical discretization algorithms require the ability to automatically determine the correspondence from continuous attributes to discrete attributes. The discretization algorithm can be divided into unsupervised discretization algorithms, such as equal-width interval method and equal-frequency interval method, K-means algorithm, etc. There are supervised discretization algorithms, such as decision tree discretization algorithm, Chi Merge algorithm, D-2 algorithm and so on. Discretization here refers to dividing the value range of a numerical attribute into several subintervals, each interval corresponding to a discrete value, and finally updating the original data to a discrete value. In the discretization process of the continuous value of the selected index variable, the mean value is

used as the cut point of the discretized data to divide the attribute of the node into a binary attribute. This division method may have some errors for the accuracy of over-training diagnosis. In practical applications, it is possible to try to improve the prediction accuracy by appropriately increasing the number of attributes and changing the division method. The discretized data is shown in Table 3:

Table 3
Table of Parameter Discrete

Index	Over-training	Attribute 1 (value 0)	Attribute 2 (value 1)
Data table field	C1	<avg(Q1,Q9,Q17,Q25)	>=avg(Q1,Q9,Q17,Q25)
Psychological exhaustion	C2	<avg(Q7,Q15,Q23,Q31)	>=avg(Q7,Q15,Q23,Q31)
fatigue	C3	<avg(Q3,Q11,Q19,Q27)	>=avg(Q7,Q15,Q23,Q31)
Psychological fatigue	C4	<avg(Q8,Q16,Q24,Q32)	>=avg(Q8,Q16,Q24,Q32)
feel good	C5	<avg(Q2,Q10,Q18,Q26)	>=avg(Q2,Q10,Q18,Q26)
Natural adjustment	C6	<avg(Q5,Q13,Q21,Q29)	>=avg(Q5,Q13,Q21,Q29)
Self-efficacy	C7	<avg(Q4,Q12,Q20,Q28)	>=avg(Q4,Q12,Q20,Q28
Physical recovery	C8	<avg(Q6,Q14,Q22,Q30)	>=avg(Q6,Q14,Q22,Q30)
Stress	B1	<avg(C1,C2,C3,C4)	>=avg(C1,C2,C3,C4)
Recovery	B2	<avg(C5,C6,C7,C8)	>= avg(C5,C6,C7,C8)
Overtraining	A	B1<B2	B1>=B2

After the network model is built and the sample data is processed into discrete data that can be processed by the Bayesian network, the next step of network parameter learning can be performed, and the conditional probability distribution of each node can be obtained by learning from the data. Select the first 525 samples of the sample training data. When the sample data is complete, after connecting to the data source and setting the relationship between nodes and fields through the learning probability module provided in the system. The parameter distribution learning results of Bayesian network over-training model in each node obtained by learning are shown in Table 4, Table 5, Figure 4, and Figure 5:

Table 4
Unconditional Probability of Node A

	P
1	0.08439
0	0.91561

Figure 4
CPT of Node B1 and B2

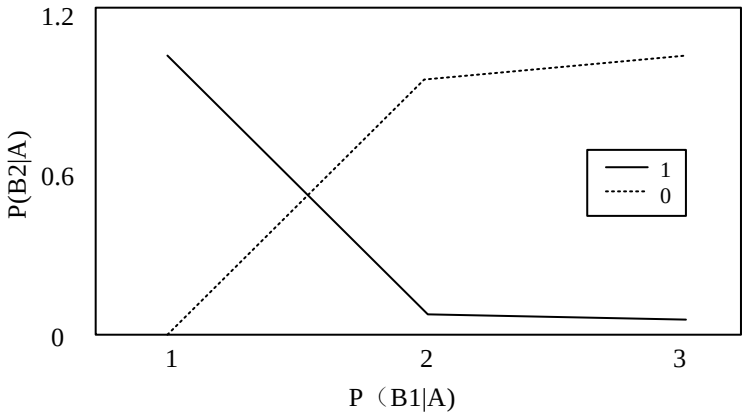


Figure 5
CPT of Node C1、C2、C3 and C4

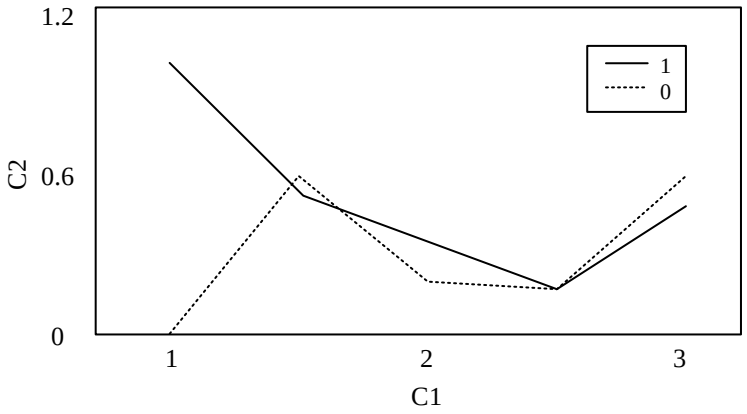


Table 5
Joint Probability Distribution of Node E

B1	P(C5|B2)	P(C6|B2)	P(C7|B2)	P(C8|B2)
1	0.50433	0.377123	0.27383	0.48181
0	0.41177	0.60784	0.47059	0.33333

After calculating the reliability of each node in the Bayesian network over-training model, network reasoning can be performed according to the reliability of each node, and the cause of over-training and the presence of over-training can be diagnosed. Select 22 sample data of the sample that are not used as parameters to learn the training data as the verification data to draw the conclusion of the diagnosis and verify it. Based on the results of these verification data,

the diagnosis results of basketball players' over-training can be obtained. From the above experimental results, it can be seen that in the correct prediction results, the predicted value of the second data is correct and the largest, that is, 0.2024. Find the raw data before the discretization, so it can be concluded that: when emotional stress, "psychological exhaustion", "natural adjustment" occurs without "fatigue", "psychological fatigue", "feeling good", "self-efficacy", "physical recovery", there is a 20.24% chance of over-training. The accuracy of this diagnostic result can be verified using an evaluation algorithm. Based on the results of these verification data, the diagnosis results of basketball players' over-training can be obtained. In the correct prediction results, the predicted value of the second data is correct and the largest, that is, 0.2024. Find the raw data before the discretization, so it can be concluded that: when emotional stress, "psychological exhaustion", "natural adjustment" occurs without "fatigue", "psychological fatigue", "feeling good", "self-efficacy", "physical recovery", there is a 20.24% chance of over-training. The accuracy of this diagnostic result can be verified using an evaluation algorithm. All data has gone through this process. Finally, the ratio of the correct number of tests to the total number of tests is used as the evaluation result of the Bayesian network.

DISCUSSION

With the rapid development of science and technology, the competition in the sports field is very fierce, and scientific training methods have long been the focus of experts, as one of them, psychological training methods are getting more and more attention from the sports world. Research on the mental state and training methods of athletes before the game is carried out through simulated annealing algorithm. An anxiety diagnosis model and algorithm for over-training are proposed. The Bayesian method is used to influence the psychological stress of basketball and the anxiety of different situations on the athletes' mind and body. The DH algorithm is proposed, and the DH mental prediction model based on simulated annealing algorithm is constructed, the model is tested and the conclusion is drawn: the accuracy of over-training diagnosis based on the over-trained diagnostic model and training sample data of this application example is 72.7%. When emotional stress, "psychological exhaustion", "natural adjustment" occurs without "fatigue", "psychological fatigue", "feeling good", "self-efficacy", "physical recovery", there is a 20.24% chance of over-training. Based on the results of these verification data, the diagnosis results of basketball players' over-training can be obtained. It can be seen that the proposed method is feasible. The shortcoming of the research is that the research sample is too small and the test time is short, which may affect the accuracy of the results and needs to be improved in future research.

Human Subjects Approval Statement

This paper did not include human subjects.

Conflict of Interest Disclosure Statement

None declared.

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