

Retraction

Retracted: Research on Sports Performance Prediction Based on BP Neural Network

Mobile Information Systems

Received 26 September 2023; Accepted 26 September 2023; Published 27 September 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] S. Yang, L. Luo, and B. Tan, "Research on Sports Performance Prediction Based on BP Neural Network," *Mobile Information Systems*, vol. 2021, Article ID 5578871, 8 pages, 2021.

Research Article

Research on Sports Performance Prediction Based on BP Neural Network

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Received 21 January 2021; Revised 16 March 2021; Accepted 23 March 2021; Published 7 April 2021

Academic Editor: Hsu-Yang Kung

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Artificial neural network has the advantages of self-training and fault tolerance, while BP neural network has simple learning algorithms and powerful learning capabilities. The BP neural network algorithm has been widely used in practice. This paper conducts research on sports performance prediction based on 5G and artificial neural network algorithms. This paper uses the BP neural network algorithm as a pretest modelling method to predict the results of the 30th Olympic Men's 100m Track and Field Championships and is supported by the MATLAB neural network toolbox. According to the experimental results, the scheme proposed in this paper has better performance than the other prediction strategies. In order to explore the feasibility and application of the BP neural network in this kind of prediction, there is a lot of work to be done. The model has a high prediction accuracy and provides a new method for the prediction of sports performance. The results show that the BP neural network algorithm can be used to predict sports performance, with high prediction accuracy and strong generalization ability.

1. Introduction

The artificial neural network is a kind of network information processing system inspired by a human brain. It has high nonlinear dynamic processing ability and does not need to know the distribution form and variable relation of data [1, 2]. When the input and output relationships of hybrid systems are too complex to be expressed in general terms, it is easy to realize their highly nonlinear mapping relationships by the God-Jing network [3, 4]. A neural network has achieved good results in pattern recognition, automatic control, and many other fields. In recent years, the neural network model has been successfully applied to economic prediction. For this reason, we use the BP learning algorithm of an artificial neural network to study the prediction of sports achievement [5, 6].

According to the existing sports results, the prediction of the sports results will be used in large-scale games, such as the Olympic Games, the Asian Games, the National Games, and so on. This prediction not only provides clear training and competition goals for athletes and coaches, at the same time, we

can track and judge the development law and characteristics of sports achievement [7]. Therefore, this kind of forecast is always in an important position in the sports achievement forecast research. The more accurate the prediction of this kind of sports achievement is, and the direct influence is on the formulation of training and training objectives. This paper conducts research on sports performance prediction based on 5G and artificial neural network algorithms [8]. This paper uses the BP neural network algorithm as a pretest modelling method to predict the results of the 30th Olympic Men's 100m Track and Field Championships and is supported by the MATLAB neural network toolbox. According to the results of forecasting research, artificial neural networks have advantages. In order to explore the feasibility and application of BP neural networks in this kind of prediction, there is a lot of work to be done [9].

The results show that the BP neural network algorithm can be used to predict sports performance with high prediction accuracy and strong generalization ability. It is also on the discovery of the law of achievement development and the characteristics of sports development [10]. However, due to the small amount of data on which this kind of prediction

is based, the randomness of the data in the process of producing the data is large and there are many hidden influencing factors, which make the data information very uncertain [11]. Therefore, it is difficult to ensure the accuracy of this kind of prediction. Therefore, the selection of a suitable, high-precision prediction method will be the key to prediction.

How to evaluate the performance of sports is an issue worth studying, and many scholars have studied the evaluation method for course performance. The usual method is to make scoring rule, in which the judge marks according to the completion of the rule and adds up the scores. However, this method is greatly affected by the experience and level of the judge. The AHP method is widely used in various types of performance evaluation [12]. In comparison with the traditional direct scoring method, this method achieves significant progress, combining the qualitative evaluation with the quantitative evaluation and improves the accuracy of the evaluation. The BP (back propagation) network was proposed by the scientist team headed by Rumelhart and McClelland in 1986 [13, 14], which is a multilayer feed-forward network trained by using the error back-propagation algorithm. In this paper, we will take advantage of the BP network to establish a prediction model, which can improve the prediction performance.

The BP network is currently one of the most widely applied neural network models. The BP network can learn and store a large number of input-output model mapping without disclosing or describing the mathematical equation of this mapping in advance. This method has wide application prospect in the performance evaluation of sports aerobics. The BP algorithm can better describe the nonlinear relationship between sports performance and various factors [15]. Neural networks prediction, however, is limited in our research due to its large requirement on training samples and weak generalization ability.

Above all, although there are many methods to deal with sports performance prediction, the prediction time and prediction accuracy cannot meet the technical requirements. Therefore, a new prediction algorithm is needed to improve the prediction performance. On this basis, we use the BP neural network algorithm to predict the sport performance.

The contributions of this paper are summarized as follows:

- (1) This paper proposes a new pretest modelling method which combines the BP algorithm and 5G
- (2) This paper uses the combined algorithm as a pretest modelling method to predict the results of the 30th Olympic Men's 100m Track and Field Championships and is supported by the MATLAB neural network toolbox

This paper is organized as follows. Section 2 presents some related work. Section 3 gives the method to establish the prediction network. In Section 4, experiment is

presented and analyzed. Section 5 gives the training result and result analysis. Finally, Section 6 sums up some conclusions and gives some suggestions as the future research topics.

2. Related Work

Based on the existing sports performance, the prediction of sports performance will be used in the Olympic Games, Asian Games, National Games, and other major sports events [16, 17]. This prediction not only provides clear training and competition goals for athletes and coaches, at the same time, we can track and judge the development laws and characteristics of sports achievements. In the 1940s, an artificial neural network was first proposed [18]. It formed a new machine learning method theory by imitating the process of human brain processing problems and the method of solving problems. From the structural point of view, the artificial neural network is composed of some neurons, mainly simulating the interaction between these neurons and embedding the action mode into the network structure [19].

The main feature of artificial neural networks is parallel data processing. Although the structure of a single neuron is relatively simple, the structure formed by combining a large number of neurons is still very complicated. Yan et al. [20] provided a basis for the application of neural network modelling in biomechanics and opened up a broad prospect for research in this area. They took a shot put as an example and used neural network technology to establish a transformation model between feature quantity and original information [21]. In addition, some scholars have explored the generalized inverse transformation of sports biomechanics information [22]. The original data restoration effect is better. Essentially speaking, the neural network eventually acquires knowledge through learning, so it can be used to establish a more complex model of causality in human motion.

3. Methods

The BP neural network is a multilayer pre-error feedback neural network, which belongs to the error back-propagation algorithm [23, 24]. It consists of an input layer, an output layer, and several hidden layers, each of which has several nodes, each node representing a neuron, and the upper and lower nodes are connected by weight. The nodes between the layers are all interconnected, and there is no correlation between the nodes in each layer [25, 26].

3.1. Information Forward Propagation Process. In the BP neural network, the differentiable function of sigmoid strong bending type, that is, strict incrementally, can make the output show a better balance between linearity and non-linearity, so the nonlinear mapping between input and

output can be realized. It is suitable for medium- and long-term forecasts. It has the advantages of a good approximation effect, fast calculation speed, and high precision [27, 28]. At the same time, its theoretical basis is solid, the derivation process is rigorous, the formula is symmetrical and graceful, and it has a strong nonlinear fitting ability. The neural network model of the hidden layer is a linear or nonlinear regression model. It is generally believed that increasing the number of hidden layers can reduce network error. Of course, it also complicates the network and increases the training time and the tendency of “overfitting.” Therefore, a 3-layer BP network (that is, 1 hidden layer) was used in this study [29, 30].

The number of nodes in the hidden layer is not only related to the number of nodes in the input and output layers but also to the complexity of the problem to be solved, the type of transfer function, and the characteristics of the sample data. The condition of determining the number of hidden layer nodes is that the number of nodes in and out layer and hidden layer must be less than $n-1$ (where n is the number of training samples) [31]. The input and output of all kinds of training samples in this study are all 5 and 1, so the number of nodes in the hidden layer is determined to be 3. On the basis of determining various parameters, a neural network was established, and through the training of the neural network, the results of 100,200,400 people in the 30th Olympic Games were predicted, and the results of 7 events were predicted by the following methods: rolling prediction [32, 33]. That is to say, the results of the 23rd and 27th sessions are used to predict the results of the 28th session, the 2400th session to predict the results of the 29th session, and the 25th session of the 29th session to predict the results of the 30th session so as to form the rotation training and repeat it until the full precision requirement of prediction is fulfilled [34, 35]. And the achievement that satisfies the accuracy, namely, the forecast result that wants to obtain for the forecast is shown in Figure 1.

3.2. BP Development Research. The mechanism of artificial neurons and biological neurons is similar. The input accepts the n -dimensional input vector x or receives the output of other neurons. The output can be denoted by the following formula:

$$o = f(wx). \quad (1)$$

The interconnection between two neurons is like the “axon-dendritic” model of information transmission pathway [29, 30], which can be calculated as follows:

$$f_1(x) = \frac{1}{1 + e^{-\lambda x}}, \quad (2)$$

$$f_1'(x) = \lambda f_1(x)[1 - f_1(x)].$$

The weight of the connection indicates the degree of interaction between the two interconnected neurons as follows:

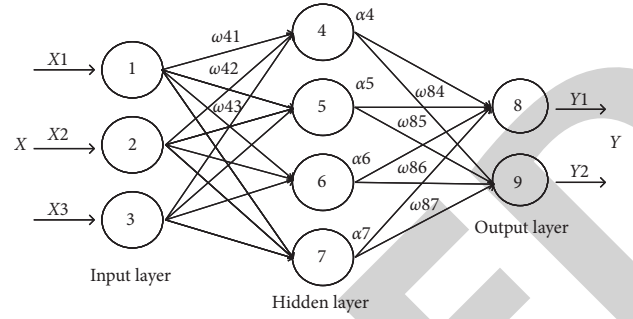


FIGURE 1: A 3-layer fully connected neural network.

$$\Delta w_{ji} = \eta \delta_j x_{ji}, \quad (3)$$

$$w_{ji} = w_{ji} + \Delta w_{ji}.$$

The artificial psychic network is composed of several units like biological neurons and the dense connection between each unit. Each unit can accept numeric input and output [36, 37].

$$E(w) = \frac{1}{2} \sum_{k \in \text{outputs}} (t_k - o_k)^2. \quad (4)$$

One of the motivations of artificial neural network systems is to obtain this highly parallel algorithm based on distributed representation, and it is as follows:

$$\delta_k = o_k'(t_k - o_k) = o_k(1 - o_k)(t_k - o_k). \quad (5)$$

Although artificial neural networks mimic the human brain nervous system as much as possible, in fact, artificial neural networks do not fully exhibit complex features in the biological nervous system.

$$\delta_k = o_k' \sum_{k \in \text{outputs}} w_{kh} \delta_k = o_k(1 - o_k) \sum_{k \in \text{outputs}} w_{kh} \delta_k. \quad (6)$$

In the artificial neural network, we only consider the invariant value of each unit output one but not the real biological nervous system time and impulse information [38]. The neural network model requires a large amount of data for input-output training. The more data, the more accurate the model.

3.3. Error Back-Propagation Process. Morning pulse refers to the number of pulses when you wake up in the morning (per minute); the morning pulse of each person is relatively stable. Therefore, we can determine whether exercise is appropriate by measuring the morning pulse the next day after exercise [39, 40]. Morning pulse testing is an important parameter basis for athletes in match and training, and this kind of measurement is very effective at present, and it also plays an important role in training regulation. Systemic circulation arterial blood pressure is referred to as blood pressure [41]. Parameter test architecture in sports training is shown in Figure 2.

Blood pressure is the pressure on the blood vessel wall when blood flows in the blood vessel; it is also the driving

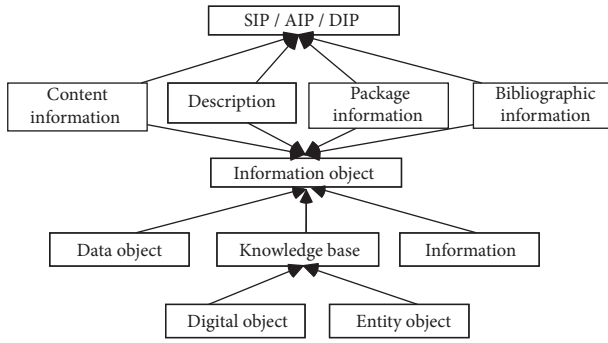


FIGURE 2: Parameter test architecture in sports training.

force of blood flow in the blood vessel. We know that blood vessels can be divided into arteries, veins, and capillaries, so blood pressure should also be divided into arterial blood pressure, venous blood pressure, and capillary pressure [42, 43]. What we usually mean by blood pressure is arterial blood pressure. Oxygen saturation is the percentage of the volume of oxygenated hemoglobin in the blood, that is, the concentration of oxygen in the blood, which is an important physiological parameter of respiratory circulation. It is an important index to maintain the normal physiologic function of the human body. The oxygen saturation of normal arterial blood was 9.8% that of venous blood was 75% [44, 45].

3.4. G Technology and Mobile Information System. The key technologies of 5G include large-scale antenna technology, ultra-dense heterogeneous network deployment, advanced spectrum utilization technology, and flexible physical access technology [46, 47]. Large-scale antenna technology improves the spectrum efficiency of the entire system through multiple antennas with multiple inputs and multiple outputs; ultra-dense networking achieves a substantial increase in capacity through the high-density deployment of base stations; advanced spectrum utilization technologies such as full spectrum access technology can effectively use spectrum resources. Flexible physical access technologies, such as nonorthogonal multiple access technology, simultaneous same-frequency full-duplex technology, and new modulation and coding technology, can bring about a significant improvement in user experience and spectrum efficiency. Among these technologies, ultra-dense heterogeneous networking is the main research technology of this article [48]. On the one hand, all the data used in this prediction model can be obtained from the terminal used to collect the original data by the wireless communication system. On the other hand, we can transmit the predict result to the terminal who is interested to it by this wireless communication system too. The basic model of the data transmission system is shown in Figure 3.

3.5. Numerical Test of Dynamic Performance Prediction. In the process of constructing the neural network model, it is necessary to set the parameters. The appropriate parameter setting can not only guarantee the accuracy of the model

construction but also the best prediction effect and reduce the error. At the same time, the running time can be greatly reduced. The number of neurons in the input layer of the network is the number of characteristic factors of the system, and the number of nodes in the output layer is the number of the target of the system [49, 50]. At present, there is no specific basis for determining the number of hidden layer nodes, which can only be determined by experience and trial and error [51, 52]. The number of hidden layer nodes is usually set to 7.5% of the number of nodes in the input layer. The initial weights are generally determined by experience and cannot be set to a set of values that are completely equal. The training rate is set. In the classical BP algorithm, the training rate is determined by experience. The higher the training rate is, the larger the weight will be and the faster the convergence rate will be. If the training rate is too large, it may cause the system to oscillate. Therefore, the training rate is set on the premise of no oscillation, the larger the better [53].

4. Experiment

The first step of establishing a reliable neural network model is to determine the structure of the neural network [54]. Based on this, the parameters are as follows: the transfer function of the hidden layer is t ensign, the transfer function of the output layer is t ensign, the training function is putt, the display interval is 10, the learning rate of the network is 0.001, the maximum training frequency is 50000, and the target error is 0.65×10^{-11} . In order to prevent overfitting during the antistop experiment, the prediction performance of the network model is low, and the generalization ability is weak.

4.1. Difference Test. In this study, we also analyzed the relationship between the performance of the 3,000-meter dash and oxygen saturation. The results showed that there was a strong correlation between them. In medicine, it is generally believed that the positive oxygen saturation should not be less than 9.4%, but below 94%, we consider this condition to be insufficient oxygen supply. Another group of researchers believed that when oxygen saturation was 90, it could be considered hypoxemia. And they think that when the oxygen saturation is greater than 70, the accuracy can reach ± 2 .

It is also considered that there is a certain error when the oxygen saturation is below 70%. In clinic, oxygen saturation readings can be directly used to reflect the respiratory function of the human body. In actual training, we found that when athletes appear stable and with high oxygen saturation level, they tend to have higher results. When the saturation of blood oxygen decreases obviously, the result of the competition will also decline by a large margin, which is like the degree of decline of saturation of blood oxygen. At the same time, with the gradual improvement of the saturation of blood oxygen, there will be a corresponding improvement in the performance of the athletes. This point has very important reference significance for training, adjustment, and competition.

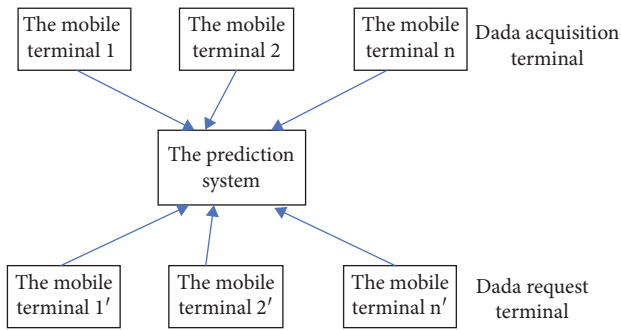


FIGURE 3: Basic model of the data transmission system.

4.2. Correlation Test. As one of the most widely used neural network models, the BP neural network can be used as the research of classification, clustering, pretest, and so on. At present, the BP neural network has been successfully used in the aspects of athlete's competitive state, sports score prediction, the prediction of the special performance of the link and shot, and the comprehensive evaluation of the athlete's sprint ability. Classification of sports performance predictions under different methods is shown in Figure 4.

In Figure 4, sample size is the number of sample, and category classification is the time of classification. Category 1 is the scheme proposed in this paper. Category 2 is the CAO (colony of ant optimization) strategy which is proposed by Shiraishi et al. [55]. Category 3 means the MEPSO (multi-exemplar particle swarm optimization) proposed in [56]. Category 4 means the OSVM (optimized support vector machine) which is proposed by Mahmood and Qasim [57]. Category 5 means the LRFAR (linear regression factor analysis regression) scheme [58].

By Figure 4, it can be seen that the classification of different methods is very different for the analysis of athletes' performance, and classification research must be carried out according to the characteristics of athletes. In order to deal with the instability of the existing performance evaluation method, an artificial neural network-based evaluation model of 3000 m obstacle running performance is proposed, and then the neural network evaluation model is established by the physiological and biochemical indexes and the sports scores of the 3000-meter obstacle running athletes in Ningxia. The results show that the prediction value and the real value obtained by the BP neural network are much better than those of the other four schemes.

4.3. Posterior Error Test. In this paper, a model of the artificial intelligence network is established, in which the physical quality of 3000-meter obstacle runners is related to their special achievements. This method does not need to determine the expression of the mathematical model in advance and can reflect the relationship between the quality and special achievement of 3000-meter obstacle runner intelligently and scientifically. Classification of sports performance predictions under different standards is shown in Figure 5. In this figure, sample size is the number of sample, and category classification is the time of classification. In addition, Category 1, Category 2, Category 3, Category 4,

and Category 5 are with the same mean as they are in Figure 4.

A scientific analysis of the relationship between the performance of the 3000-meter obstacle course and the morning pulsation has been carried out. It is pointed out that when the athlete's morning pulsation is relatively stable, the results tend to perform well. When the athlete's morning pulsation fluctuates, the athlete is prone to unstable and poor performance. From the experimental results, we can conclude that the classification of sports performance predictions of the proposed scheme is much better than those of the other four strategies. With the prediction method proposed in this paper, the coaches and athletes can accurately grasp the development trend and provide a more reasonable mechanism.

5. Training Result and Result Analysis

This paper makes a scientific analysis of the relationship between the results of the 3000-meter obstacle race and systolic and diastolic blood pressure and points out that when the athlete's systolic pressure is lower and the diastolic pressure is higher, it is easier to get better results. When the systolic pressure is high, the athletes' fatigue degree is larger and the body is more uncomfortable. The accuracy of sports performance prediction under different methods is shown in Figure 6.

Figure 6 shows the accuracy of sports performance prediction for different methods. We compare the BP neural network in this paper with the MEPSO algorithm, CAO algorithm, and OSVM algorithm in this figure. It can be seen from the simulation in Figure 6 that the performance of the athletes under different standards is parabolic, which has a great relationship with the physical strength of the athletes. From the simulation in Figure 6, it can be seen that the performance of the athletes under different standards is parabolic. It has a lot to do with the athlete's physical strength. This article scientifically analyses the relationship between the results of the 3000-meter race and the weight and points out that there is no correlation between the 3000-meter race and the weight, as shown in Figure 7. Although the performance of the BP neural network algorithm is worse than that of the other three algorithms at the beginning, the average level of efficiency is almost the same as other three algorithms.

Figure 7 gives the accuracy of sports performance prediction under different standards for the proposed scheme. In this figure, the standard test means that the original test data originate different specified times, and standard test a, standard test b, standard test c, and standard test d mean the sample of the test data, and the specific value varies with each sampling. It can be seen from the simulation in Figure 7 that the performance of athletes under different standards fluctuates, but the overall trend is to moderate. This paper makes a scientific analysis of the relationship between the results of the 3000-meter obstacle race and the saturation of the blood oxygen and points out that the saturation of the blood oxygen has a strong correlation when the athletes appear stable with high saturation of the blood oxygen; it is

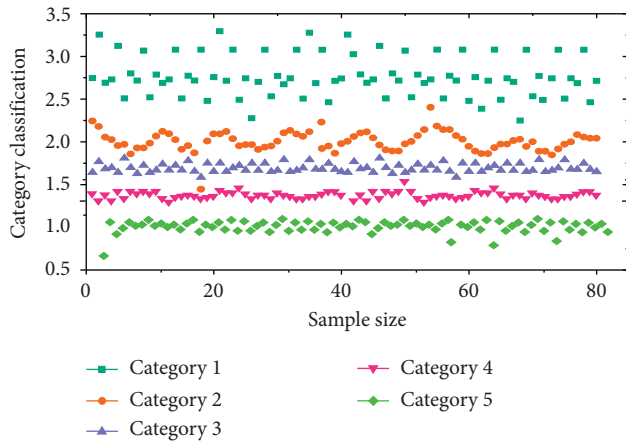


FIGURE 4: Classification of sports performance predictions under different methods.

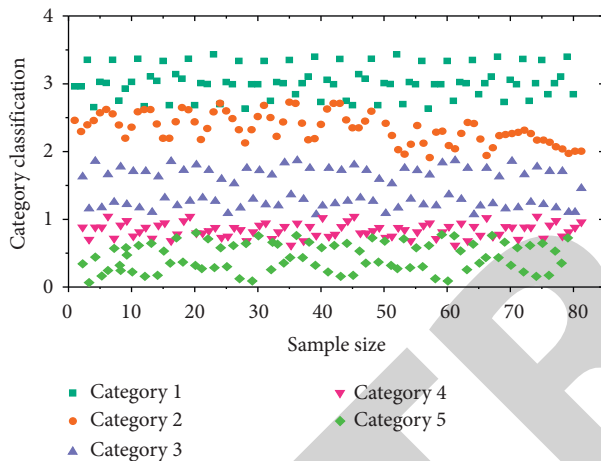


FIGURE 5: Classification of sports performance predictions under different standards.

easy to get high results. At the same time, with the gradual improvement of the athletes' oxygen saturation level, their performance will also be improved.

6. Results and Discussion

Based on the BP neural network model and the scientific analysis of the relationship between the results of the 3000-meter obstacle race and morning, pulse systolic blood pressure is different from diastolic blood pressure weight and oxygen saturation. We have come to the following conclusion: during training and competition, attention should be paid to maintain the morning pulse and systolic blood pressure of the athletes. The diastolic blood pressure is relatively stable. Currently, the athletes have the lowest degree of fatigue, the body is active, and the functional state is the best. In general, in this case, athletes who participate in major competitions can create better results. When athletes have higher pressure and fatigue, unnecessary training should be reduced. Because of the strong correlation between the saturation of blood oxygen, when the athletes

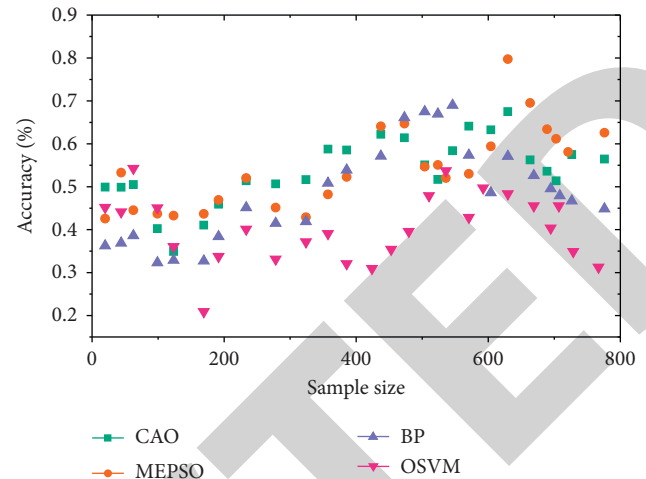


FIGURE 6: The accuracy of sports performance prediction under different methods.

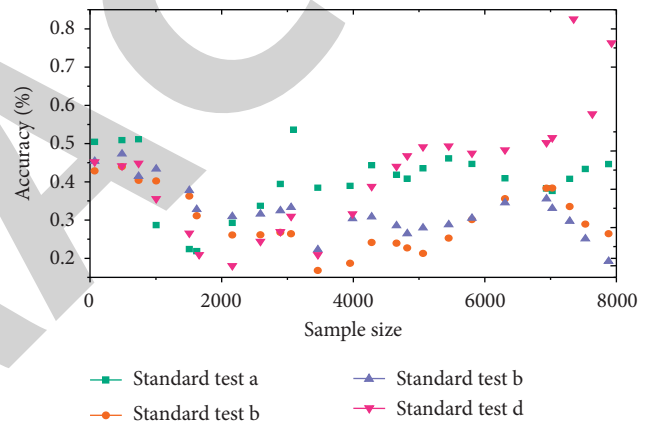


FIGURE 7: The accuracy of sports performance prediction under different standards.

appear stable and with high oxygen saturation level, it is easy to have a higher performance. During actual training and competition, attention should be paid to keep the athlete's high oxygen saturation.

Therefore, the BP neural network algorithm can be used to predict sports performance. At the same time, the MATLAB neural network toolbox brings great convenience to the prediction of sports performance and improves the efficiency of modelling and the accuracy of prediction. The prediction of sports performance is to realize nonlinear mapping, and the BP network can also be regarded as a nonlinear mapping from input to output.

The two characteristics of the BP neural network algorithm can solve the problems and difficulties of predicting the uncertain factors of sports performance. The first is that the BP network algorithm can learn and store many input/output pattern mapping relationships without revealing the mathematical equation describing the mapping relationship in advance. Secondly, the BP network algorithm has good adaptive and self-organizing ability. Therefore, this article establishes an artificial neural network model to predict

sports performance. Numerical experiments show that the prediction accuracy of this method is high, and it has certain practical reference value for studying the development trend of various sports performances in the future and can assist in decision-making and determining the training and development goals of competitive athletes.

Data Availability

Data sharing is not applicable to this article as no datasets are generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Hubei University of Technology (grant nos. 61675164 and 61827827).

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