Early Warning Model of Track and Field Sports Injury Based on RBF Neural Network Algorithm

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Abstract. Track and field events are the foundation of sports events. To learn other sports events well, you must also have a certain grasp of track and field events. As the movements of each track and field event become more and more complex, the competition becomes more and more intense, and the technical requirements are getting higher and higher. Therefore, sports injuries are gradually increasing. The prevention of sports injuries is a hot spot in sports medicine. Studies have found that as many as twenty factors can directly or indirectly cause track and field sports injuries. Based on the collected data on the injury-causing factors of elite athletes’ track and field sports, and on the basis of in-depth research on mobile data processing technology and early warning risks, a mobile early warning system and radial system using sports injury risk early warning algorithms, functional design and architecture are proposed. The basis function (RBF) neural network algorithm is released. Research on Early Warning Model of Sports Injury. This article analyzes and evaluates different hazard factors through the method of literature data, expert review and extensive analysis. In the investigation, the various causes of the injury were analyzed in detail, and it was found that most sports injuries were caused by students’ lack of attention, technical errors, insufficient preparation activities, etc., and finally proposed countermeasures to solve the problem, so that the sports injury situation was obtained improve.

Keywords: RBF Neural Network Algorithm, Track And Field Sports Injury, Early Warning Model, Risk Assessment

1. Introduction
Track and field sports require long-term training to achieve excellent results, that is, its training must be systematic. If an athlete or student is injured in a competition or examination, its training or competition has to be interrupted or can no longer be engaged in or Participating in sports, sports injuries directly affect the athletic state and sports performance of track and field athletes [1]. This is why prevention of sports injuries is very necessary for athletes and students. How to prevent sports injuries has become a very worrying issue for coaches and athletes. In the training and competition of track and field sports, it is necessary to enhance the awareness of preventing sports injuries and make
it clear that prevention is more important than treatment [2]. Sports injuries are a common problem in track and field sports. In recent years, athletes have been training for a long time and have heavy body load, which has led to an increase in the incidence of injuries, which has seriously hindered the durability of athletes in the process of sports and the improvement of sports and performance, and even athletes have left the field too early. Therefore, the treatment and prevention of sports injuries has always been the focus of attention [3]. How to make athletes avoid and delay the occurrence of injuries to the greatest extent, and to extend the best competitive state for the longest time is a difficult problem that needs to be solved urgently in the current track and field training and competition [4].

At present, artificial neural network algorithms are widely used in complex systems such as hardware fault detection, medical diagnosis, medical image processing and other complex tasks to classify and predict, and have achieved good results [5]. In terms of sports injury risk prevention, DFMulphy and RBohr, etc., based on the summary of previous studies, the risk factors leading to sports injury are divided into two categories: internal factors and external factors [6]. These factors can be divided into controllable factors and uncontrollable factors. These include internal risk factors, which are usually uncontrollable factors [7]. However, it is far from enough to explain the occurrence of sports injuries from the perspective of internal and external factors. To establish a complete mechanism model of sports injuries, the interaction between various factors and the role of injury-inducing events must be considered [8]. In the field of sports injury risk early warning research, predecessors have done a lot of research on the injury factors of sports injury and established qualitative models, but there is no quantitative evaluation research, and the artificial neural network algorithm has good performance in the classification and prediction of complex systems, so the application of artificial neural network algorithm to the research of sports injury risk early warning is a very meaningful work [9].

Studies at home and abroad have shown that most sports injuries can be prevented, and some occasional acute injuries are difficult to prevent, but the risk of injury can be reduced through corresponding preventive measures [10]. At present, in order to study the incidence of sports injuries in track and field competitions and quantitatively evaluate the risk factors of sports injuries, domestic scholars are using one-sided research and other mechanical investigation methods to study the prevention of sports injuries. The analysis and research of foreign scholars on the prevention of sports injuries have concluded that based on the incidence survey, multiple risk factors of the disease are identified, the size of the impact on the disease is estimated, and possible preventive measures are proposed. Most scholars believe that the main reasons for injuries are insufficient training level, poor competition organization, lectures or education classes, poor physical condition of athletes and bad weather factors. However, most studies have not pointed out the internal relationship between the cause of this injury and the outcome of the injury. However, in actual application, the operability is not good, and the timely warning of the injury risk is insufficient.

2. Algorithm Establishment

2.1. RBF Neural Network Algorithm

RBF neural network is a three-layer forward network with a single hidden layer. The first layer is an input layer composed of signal source neurons connected to the network and the external environment. The number of neurons is determined according to the angle of the input signal; the second layer is the hidden layer, the neurons are the base of radiation, and the number of neurons is determined according to the needs of the system; the third layer is the output layer that responds to input patterns.

The first part is the connection between the input layer and the hidden layer, that is, the nonlinear mapping of \( X \rightarrow h_j \) is realized, and the expression is:

\[
h_j = f(x_1, x_2, ..., x_n)
\]

Where \( j = 1, 2, ..., m \), \( f(x) \) is the radial basis function of the RBF neural network.

The second part is the connection between the hidden layer and the output layer, that is, the
realization of the linear mapping of \( h_j \rightarrow y_m \), and the expression is:

\[
y_m = \sum_{j}^{m} \omega_j h_j
\]  

(2)

In other words, the first part of the RBF neural network is to non-linearly map the input space to the new space. The second part realizes linear combination in this new space. Therefore, the working principle of the RBF neural network can be briefly described as follows: For the seventh data point \([x_1, x_2, \ldots, x_n]\) in the scapular space, each hidden layer neuron will generate a response \( r(d) \), and the output of the network is these responses weighted sum.

Radiation base function of RBF neural network usually has the following functional form:

1. Gaussian Function: \( f(x) = \exp\left(-\frac{\|x-c\|^2}{2b^2}\right), b > 0. \)
2. Cubic Function: \( f(x) = (x - c)^3. \)
3. Multiquadric Function: \( f(x) = \left(\|x-c\|^2 + c^2\right)^{\frac{1}{2}}. \)
4. InVerse Multiquadric Function: \( f(x) = \left(\|x-c\|^2 + c^2\right)^{-\frac{1}{2}}. \)
5. Thin Plate Spine Function: \( f(x) = (x - c)^2 \log_2 (x - c). \)
6. Linear Function: \( f(x) = x - c. \)

The Gaussian function also has the advantages of simple expression and radial symmetry. Therefore, the Gaussian function is used as the radiation basis function of the RBF neural network, that is, the output of the hidden layer neuron at \( k \) is:

\[
h_{j,k} = \exp\left(-\frac{\|x-c\|^2}{2b_j^2}\right)
\]  

(3)

Among them, the center vector of the \( j \)th hidden layer neuron in the network is \( c_j = [c_{j1}, c_{j2}, \ldots, c_{jn}]^T \), \( j = 1, 2, \ldots, m \), \( b_j \) base width parameter, and \( b_j > 0 \). Then the output of the network at time \( k \) can be expressed as:

\[
y_{m,k} = \sum_{j}^{m} \omega_j \exp\left(-\frac{\|x-c_j\|^2}{2b_j^2}\right)
\]  

(4)

When the structure of the RBF neural network is determined, the parameters that need to be learned and adjusted in the network include the hidden layer neuron center, base width parameters and the connection weights from the hidden layer to the output layer.

Assuming that the actual output of the object at time \( k \) is \( y_k \), and the output of the RBF neural network is \( y_{m,k} \), then the performance index function of the network is taken as:

\[
E_k = \frac{1}{2}(y_k - y_{m,k})^2
\]  

(5)

The gradient processing algorithm is used to modify the hidden layer neuron center, baseline parameters and exit weights of the RBF neural network. The specific iterative algorithm is as follows:

\[
\Delta c_{ji} = (y_k - y_{m,k})\omega_j h_j \frac{x_i - c_{ji}}{b_j^2}
\]  

(6)

\[
\Delta b_j = (y_k - y_{m,k})\omega_j h_j \frac{\|x-c_j\|^2}{2b_j^2}
\]  

(7)

\[
c_{ji}(k) = c_{ji}(k-1) + \eta \Delta c_{ji} + \alpha(c_{ji}(k-1) - c_{ji}(k-2))
\]  

(8)

\[
b_j(k) = b_j(k-1) + \eta \Delta b_j + \alpha(b_j(k-1) - b_j(k-2))
\]  

(9)

\[
\omega_j(k) = \omega_j(k-1) + \eta(y_k - y_{m,k})h_j + \alpha(\omega_j(k-1) - \omega_j(k-2))
\]  

(10)
Among them, $\eta$ is the learning rate, $\alpha$ is the momentum factor, $\eta \in [0, 1]$, $\alpha \in [0, 1]$. And the learning rate and momentum factor in the correction formula of the parameters $c, b, \omega$ can be different values respectively.

Through RBF neural network identification, the sensitivity of target input is:

$$
\frac{dy_k}{\partial u_k} \approx \frac{\partial w_{n,k}}{\partial u_k} = \sum \frac{\partial w_{i,j}}{\partial u_k} = \sum \omega_i \frac{c_{ij} - x_i}{b_i}
$$

(11)

Among them, take the first input of the RBF neural network as $u_k$, that is, $x_1 = u_k$.

3. Model Method

3.1. N-Gram Model

The construction technology of data statistical model based on the distribution theory has become a new research hotspot. The model is generally a data false detection rate model. Through the data false detection rate parameter of the statistical data model, the computer does not simply judge whether the data exists, but can calculate the detailed information of each data in the database in detail according to user requirements. This data statistical model uses PHP linguistics, emphasizing that the database is the place for data collection. Through the deep processing, statistics and learning of the database to obtain the set database data, large-scale statistical data can be analyzed objectively. Subtle data information has the function of processing large-scale data.

Assuming a data message $s$ is composed of a data sequence $w_1 w_2 ... w_l$, it means that the data misdetection rate of data $s$ is:

$$
P(s) = p(w_1)p(w_2|w_1)p(w_3|w_1w_2)...p(w_l|w_1w_2...w_{l-1})
$$

$$
= \prod_{i=1}^{l} p(w_i|w_1w_2...w_{l-1})
$$

(12)

But when $l$ is very large, the data false detection rate $p(w_i|w_1w_2...w_{l-1})$ is difficult to calculate because each variable has a large space. Therefore, if it is assumed that the current data depends on all the previous data, and only depends on the previously limited data (such as: $n$-1 data), then the Markov hypothesis will also be introduced. then:

$$
p(s) = p(w_1)p(w_2|w_1)p(w_3|w_1w_2) \times ... \times p(w_n|w_1w_2...w_{n-1})
$$

$$
\times ... \times p(w_l|w_1w_2...w_{l-n+1})
$$

(13)

This can greatly reduce model parameter storage. Specify $n=1, 2, 3$ for Unigram, Bigram and Trigram models respectively. Assuming that the data false detection rate of the current data in the Bigram model is only related to the previous data, the data detection rate can be expressed as follows:

$$
p(s) = \prod_{i=1}^{l} p(w_i|w_1w_2...w_{l-1}) \approx \prod_{i=1}^{l} p(w_i|w_{i-1})
$$

(14)

In order to estimate $p(w_i|w_{i-1})$, maximum likelihood estimation is usually used for estimation:

$$
p(w_i|w_{i-1}) = \frac{p(w_i | w_{i-1} \times w_i)}{p(w_i | w_{i-1} \times w_{i-1} + 1)} = \frac{c(w_{i-1} \times w_i)}{c(w_{i-1} \times w_{i-1} + 1)}
$$

(15)

Among them, $c(\alpha)$-the number of times the data sequence $\alpha$ appears in the training database.

4. Evaluation Results and Research

This experiment uses the expert validity test method to analyze and evaluate the overall, structure and content of the questionnaire (using a five-level evaluation scale that is very complete, relatively complete, basically complete, imperfect, and imperfect). The feasibility and effectiveness of the questionnaire were tested by issuing 15 questionnaires (Annex 3) to 15 experts who are engaged in the coaching work of the track and field professional team. Recovered 14 copies, the recovery rate was
93.33%, the expert situation table is shown in Figure 1, and the expert's evaluation results of the validity of the questionnaire are shown in Figure 2. The results show that in the overall evaluation, structure evaluation, and content evaluation of the questionnaire, no experts think that it is imperfect or imperfect. It can be considered that the validity evaluation of the questionnaire can meet the design requirements of the questionnaire.

![Figure 1. Expert situation diagram](image1)

![Figure 2. Statistical graph of validity evaluation results](image2)

Reliability test: Using the questionnaire reliability test method, the questionnaire survey results are tested for "content continuity coefficient", and the reliability coefficients are calculated as 0.83 and 0.81 according to the Spearm Brown formula. The reliability and recovery rate of the calculated questionnaire meet the data analysis Claim.

**Table 1. Model test results**

| Serial number | Model warning results | Actual results | Risk level     | Serial number | Model warning results | Actual results | Risk level     |
|---------------|----------------------|----------------|----------------|---------------|----------------------|----------------|----------------|
| 1             | 1.0383               | 1              | Low risk level | 6             | 2.0038               | 2              | Low risk level |
| 2             | 2.0249               | 2              | Low risk level | 7             | 0.9532               | 1              | Low risk level |
| 3             | 3.0217               | 3              | Low risk level | 8             | 2.0038               | 2              | Low risk level |
| 4             | 2.9734               | 3              | Low risk level | 9             | 2.0164               | 2              | Low risk level |
| 5             | 2.0199               | 2              | Low risk level | 10            | 1.0166               | 1              | Low risk level |
On the basis of attribute reduction, the existing neural network early warning model is combined with the sports injury information of the track and field athletes in Province A, the value is input into the constructed model, and the obtained early warning results are compared with the actual results.

The test result is to use the successfully trained neural network to test and verify 10 test samples, and get a relatively ideal result. The error value of the prediction result is basically between 0.02 and 0.04. Among the subjects, the risk of athletes being injured during exercise also requires the accuracy of early warning, and the accuracy of the early warning of sports injury risk reaches 100%. Therefore, this algorithm is suitable for the early warning of sports injury risk of athletes.

5. Conclusion

Researches by domestic and foreign scholars have shown that most sports injuries can be prevented. Although it is difficult to prevent occasional acute injuries, the risk of injury can be reduced through corresponding preventive measures. Based on the analysis of injury factors in track and field competitions, this paper establishes an intelligent early warning mode for track and field athletes with RBF neural network as the core algorithm. After the test sample library test, in order to early warn the danger of sports injuries, the use of the RBF neural network algorithm is relatively ideal. After entering many sports injury cases in the second half, the RBF neural network model will further improve the evaluation accuracy of the risk level. This algorithm can fully realize the athlete's sports injury danger warning. The combination of RBF neural network algorithm is suitable for early warning of the risk of sports injuries of track and field athletes. It can not only improve the performance of the neural network, reduce the complexity of the network, and reduce the network training time, but also prevent track and field sports to a certain extent efficiently, conveniently and in real time. When the injury occurs, it has certain practical value in the actual training process. At the same time, the establishment of this model is still a relatively preliminary stage of discussion, and the realization of some algorithms and functions needs to be further improved and perfected to meet the needs of higher conditions.

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