The Application of GABP Neural Network Algorithm in the Aspect of Security Assessment of Computer Network

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Abstract: With the rapid development and wide application of computer and network technology, there appear increasing number of factors affecting the security of network system. Therefore, it is urgent for network security administrators to adopt efficient network security algorithm to guarantee the network security. On the basis of GABP neural network algorithm, and in combination with different sub-modules and supporting platforms, the small complex network can be evaluated in an all-round way, and the network security can be effectively managed.

1. Introduction

Whether it is concerned with the government, enterprise or other social work, they are all increasingly dependent on the network system. Therefore, the security of computer network system is of particular importance. With the rapid development and wide application of computer and network technology, there are more and more factors that affect the security of network system, and the security of network becomes growingly complex, which requires that the users and administrators of network system must be able to effectively measure the security of network, have a clear understanding of the network integrity, and precisely get hold of the degree of security of the network system and the factors affecting the security, attempting to guarantee the security of the system to the greatest extent, especially the complex structure and large-scale characteristics of computing network, which has demonstrated many security vulnerabilities. Some lawbreakers have taken advantage of vulnerabilities to invade the networks, which has posed a threat to the information security of the entire network system.

The learning process of BP (Back Propagation) neural network consists of two processes: the forward propagation of signals and the reverse propagation of errors. When the forward propagation occurs, the input samples are transferred from the input layer to the output layer after being processed layer by layer through the hidden layer. If the actual output of the output layer does not match the expected output, the back propagation phase of the error will be steered. The back propagation of errors is to transmit output errors in some form from hidden layer to the input layer layer by layer, and distribute the errors to all units in each layer, so as to obtain the error signal of the unit in each layer, which is the basis of correcting the weight of each unit. BP network is composed of of input layer, output layer and hidden layer.
2. The evaluation procedure for complex computer network security

As for the evaluation system of computer network security, it is necessary to make predictions of the evolution law of the network security state when conducting the design. The most basic function is to monitor the security process and identify the acquired results in depth. In the process of safety evaluation, it needs three modules of input, output and operation for the realization.

2.1. The input module

The input module is mainly composed of two sub-modules: data input and processing.

(1) The data input module

The data input module needs to specify the initial indicators and assign them to the selected system. Then the security system is combined to comprehend the actual objectives and the security policy enacted by the nation, so as to define the initial indicator system set in the original state. The corresponding data acquisition system will be constructed in accordance with the formulated indicator system set.

(2) Data processing module

The data processing module is mainly responsible for the data pre-processing before the operation, which contains many operations, and finally analyzing the pre-processed data through the standardized index. The whole operation process is mainly in the form of the mean ratio, constant multiplication or division, etc., which can make the results more accurate.

2.2. The operation module

The operation module is mainly composed of two sub-modules: the index analysis and evaluation model analysis.

(1) The index analysis module

The index analysis module is mainly based on the index data, and can reflect the relationship between the data and the index. Through this relationship, the characteristics of the index data can be analyzed. In the meantime, the combination characteristics of the index group can be analyzed concretely.

(2) The evaluation model analysis module

The evaluation and analysis module mainly describes the security status of the system. Through the description of its overall security status, the system security issues are accurately warned. The whole module of the system needs to determine the security status through the status signal of the security system and index turning point, and use the eigenvalue of the security system behavior to make the prediction.

2.3. The output module

The output module of complex computer network security evaluation is mainly composed of the four target sub-modules as follows:

(1) The safety monitoring module

The security monitoring module is mainly responsible for conducting the evaluation of the current security status.

(2) The security early warning module

The module can make the early warning for the system at any time, and give alarm to the problems that are about to arise.

(3) The security control module

Through the judgment of the early warning information sent by the security early warning module, and then combined with the standardized security index, the reasonable control can be carried out, ultimately ensuring the safe and stable operation of the system.

(4) The visual display module

This module can intuitively show the security problems in the whole system in the form of charts.
2.4. **The resolution of qualitative and quantitative problems**

When inputting relevant data, it is a necessity to analyze the evolution form of the whole security system through the corresponding parameter operation, obtain the parameters of different changing rules by the means of the analytical mode, and then make the classification and evaluation according to the obtained parameters. Due to the influence of different factors, there are many qualitative and quantitative problems in the process of classification and evaluation. For the sake of solving this problem, there is a need to find corresponding solutions according to different types of problems. At present, in the evaluation process of computer network security, the artificial neural network method has become the mainstream method to resolve the problem. The relatively vague black box system can be solved by the Delphi method which centralizes the qualitative evaluation of experts.

3. **The model construction of GABP neural network in computer network security evaluation**

The training results of BP neural network are mainly divided into four matrices. The input node can be set to i, the hidden node to j, and the output node to K in the setting of the matrix.

3.1. **The weight matrix from the input layer to the hidden layer**

The weight matrix from the input layer to the hidden layer is shown in Figure 1.

\[
W = \begin{bmatrix}
W_{11} & W_{12} & \cdots & W_{1j} \\
W_{21} & W_{22} & \cdots & W_{2j} \\
\vdots & \vdots & \ddots & \vdots \\
W_{i1} & W_{i2} & \cdots & W_{ij}
\end{bmatrix}
\]

\[
\gamma = \begin{bmatrix}
\gamma_1 \\
\gamma_2 \\
\vdots \\
\gamma_j
\end{bmatrix}
\]

Figure 1 The weight matrix from the input layer to the hidden layer  
Figure 2 The threshold matrix of the hidden layer

3.2. **The threshold matrix of the hidden layer**

The threshold matrix of the hidden layer is shown in Figure 2.

3.3. **The weight matrix from the hidden layer to the output Layer**

The weight matrix from the hidden layer to the output layer is shown in Figure 3.

\[
V = \begin{bmatrix}
v_{11} & v_{12} & \cdots & v_{1k} \\
v_{21} & v_{22} & \cdots & v_{2k} \\
\vdots & \vdots & \ddots & \vdots \\
v_{j1} & v_{j2} & \cdots & v_{jk}
\end{bmatrix}
\]

\[
\beta = \begin{bmatrix}
\beta_1 \\
\beta_2 \\
\vdots \\
\beta_j
\end{bmatrix}
\]

Figure 3 The weight matrix from the hidden layer to the output Layer  
Figure 4 Output Layer  
Threshold Matrix

3.4. **The threshold matrix of the output layer**

The threshold matrix of the output layer is shown in Figure 4.

In the process of the optimization, GA algorithm can be used to optimize the weights of BP neural network. The whole optimization process is mainly to optimize the matrices 1, 2, 3, 4, so as to form corresponding chromosome strings and then code them.

4. **The implementation of GA algorithm**

4.1. **The weight coefficient coding by using the real number coding**

The weight coefficients of the neural network are combined according to the corresponding combination form by resorting to coding, and the corresponding genetic algorithm dyeing individuals can be obtained by the corresponding combination. When coding, the genetic algorithm can be used to
complete the coding by binary coding and real-number coding. However, if binary coding is used under the requirement of multi-dimensional and high-precision numerical value, the problems are about to arise at a certain level and hinder the whole coding process. In the computer network security evaluation, the whole process will form nearly 100 variables. If binary coding is chosen to complete weight coefficient coding, the optimal execution status cannot be achieved. Therefore, the real number coding can be used to complete weight coefficient coding. The real number coding refers to the signification of different connection weights by real numbers. Through the genetic manipulation, two groups of real numbers can be directly manipulated, and the dyed individuals can be visually signified.

4.2. The initialization and fitness function

In the process of the genetic manipulation, the different individuals can be operated at the same time to achieve the goal of forming different individuals into groups, but the population size needs to be taken into account on the basis of the level of population diversity. In addition, in order to improve the efficiency of GA search, the initial state of the population needs to be uniformly distributed in the whole problem space. Taking many factors into consideration, the population size can be set to 50, and the range of values of different elements can be defined [-1,1]. A value obtained randomly is used as the initial value, which then forms the initial population.

From a certain level, if the number of the hidden layer nodes increases to a certain extent, the error of network training will also decrease slowly. If the number of nodes reaches 5, the training error reduction rate will be basically stable, and so the prediction model error will be smaller. Thus, it can be proved that with the increase of the number of B hidden layer nodes, the network learning ability will be enhanced, and the comprehending ability of its model will be constantly enhanced with the increase of both of them. Moreover, if the number of hidden layer nodes increases to the corresponding quantitative value, although many errors can be reduced to a certain extent, the network prediction ability will be affected. It can be proved that when there are too many hidden nodes and the network is over-saturated, there will appear excessive learning factors, which will produce noise that will affect the network, and the performance of the whole network will be reduced to a certain extent. When the number of the hidden layer nodes reaches 5-8, the combination of network training error and prediction error can reach an optimal state. It is demonstrated that when the number of these three nodes is predicted, the accuracy will reach its optimal status. Therefore, the neural network model with the network structure model of "17-5-1" can be chosen.

5. Conclusion

By choosing GA algorithm, a simulation model on the basis GABP neural network algorithm can be constructed and applied to the evaluation of computer network security. Through the simulation model, and in combination with different sub-modules and supporting platforms, the small-sized complex network can be tested and evaluated in an all-round way, and the trend chart of its system security status can be visually displayed to the users.

Introducing BP neural network model to evaluate the computer network security can conquer the deficiencies of previous evaluation methods, and get rid of the randomness in the evaluation process, the subjective uncertainty of the evaluators and the cognitive fuzziness, and ensure the objective and accurate evaluation results, thus providing an effective evaluation for the computer network security management.

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