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Adoption of improved neural network blade pattern recognition in prevention and control of corona virus disease-19 pandemic

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ABSTRACT

To explore the adoption effect of improved neural network blade pattern in corona virus disease (COVID)-19, comparative analysis is implemented. First, the following hypotheses are proposed. I: in addition to the confirmed cases and deaths, people suspected of being infected are also involved in the spread of the epidemic. II: patients who have been cured may also develop secondary infections, so it is considered that there is still a link between cured cases and the spread of the epidemic. III: only the relevant data of the previous day is used to predict the epidemic prevention and control of the next day. Then, the epidemic data from February 1st to February 15th in X province were selected as the control. The combined neural network model is used for prevention and control prediction, and the prediction results of the traditional neural network model are compared. The results show that the predictions of the daily new cases by the five neural network models have little difference with the actual value, and the trend is basically consistent. However, there are still differences in some time nodes. The errors of neural network 1 on the 6th and network 3 on the 13th are large. The accuracy of the combined neural network prediction model is high, and there is little difference between the result and the actual value at each time node. The prediction of the cumulative number of diagnoses per day of the five neural network models is also analyzed, and the results are relatively ideal. In addition, the accuracy of the combined neural network prediction model is high, and the difference between the result and the actual value at each time node is relatively small. It is found that the standard deviations of neural networks 2 and 3 are relatively high through the comparison of the deviations. The deviation means of the five models were all relatively low, and the mean deviation and standard deviation of the combined neural network model are the lowest. It is found that the accuracy of prediction on the epidemic spread in this province is good by comparing the performance of each neural network model. Regarding various indicators, the prediction accuracy of the combined neural network model is higher than that of the other four models, and its performance is also the best. Finally, the MSE of the improved neural network model is lower compared with the traditional neural network model. Moreover, with the change of learning times, the change trend of MSE is constant ($P < 0.05$ for all). In short, the improved neural network blade model has better performance compared with that of the traditional neural network blade model. The prediction results of the epidemic situation are accurate, and the application effect is remarkable, so the proposed model is worthy of further promotion and application in the medical field.

1. Introduction

At the end of 2019, there was a serious outbreak in Wuhan, Hubei Province, with the number of infected people rising at a rapid rate. In early 2020, the pathogen was identified as novel coronavirus, and the pneumonia caused by it was named as corona virus disease (COVID-19) [1]. The disease is a respiratory systemic disease with high infectivity and great harmfulness. After being discovered, it quickly spread to all parts of the country, leading to a rapid increase in suspected and confirmed cases [2]. With continuous in-depth research, it was found to be a new acute respiratory infectious disease. Sick bodies often show symptoms of lung infection, which is initially manifested as fever, fatigue, dry cough, and other uncomfortable reactions. Some patients may also be accompanied by nasal congestion, runny nose, sore throat, and diarrhea. In severe cases, dyspnea or hypoxemia may occur one week after onset. When the disease progresses rapidly, it will develop into acute respiratory distress syndrome, shock, metabolic acidosis,

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coagulation dysfunction, and multiple organ failure, which lead to death if not treated in time [3].

Coping with this extremely difficult major public health emergency is an unprecedented test of China's governance system and governance capacity [4]. At the meeting, President Xi stressed the need to improve the emergency response mechanism for major epidemics, who support and encourage the use of digital technologies such as artificial intelligence and big data, which play imperative supporting role in the monitoring and analysis, prevention and treatment, resource allocation, and other aspects of COVID-19 [5]. Domestic and foreign scholars have established the prediction model in the prediction analysis of the spread and development trend of the epidemic, which mainly focuses on the statistical model and dynamic model. Prevention and control strategies for COVID-19 are presented in practical application. In addition, multi-layer perceptron model and social phenomenological model are also applied [6]. Despite the effective transmission path obtained by the above prediction, each model has the limitation that "it can only predict the set parameters". Moreover, the traditional neural network model has a low adaptive ability to new things, is easy to fall into the local extreme point, and has a high blindness in the initial weight. These shortcomings lead to low accuracy, while neural network is a system with learning ability. Generally, its learning and training methods are classified into the following two aspects. There is supervised or tutor learning, in which a given sample standard is used for classification or imitation [7]. The other type is unsupervised learning, where only the learning style or some rules are specified, Specific learning content changes with the environment the system is in. The system can automatically discover environmental characteristics and regularities and has a function more similar to that of human brain [8]. In addition, it also has the characteristics of generalization, nonlinear mapping, and high parallelism. Therefore, an improved neural network blade mode is proposed, that is, the combined neural network mode is adopted for the prevention and control application of COVID-19. The results are reported as follows.

2. Improved neural network prediction model

2.1. Data specification

To make a reasonable prediction, the following hypotheses are proposed. I: in addition to the confirmed cases and deaths, people suspected of being infected are also involved in the spread of the epidemic. II: patients who have been cured may also develop secondary infections, so it is considered that there is still a link between cured cases and the spread of the epidemic. III: only the relevant data of the previous day is used to predict the epidemic prevention and control of the next day.

The epidemic data of X province from February 1st to February 15th are selected as the control, and the combined neural network model is used for prevention and control prediction. t represents time, s represents the number of newly confirmed cases per day, and h represents the cumulative number of confirmed cases per day, o represents the number of cured cases per day, d represents the number of deaths per day, q represents the number of suspected cases per day, and u represents the number of severe cases per day. All data used in the study come from data provided by the National Health Commission.

2.2. Model explanation

The neural network model has the advantages of nonlinear mapping ability, high fault tolerance, self-learning ability, etc. It is automatically adjusted according to the input and output mapping, which also process the difference of different activation functions and the influence of the structure of the neural network on its performance. Therefore, the following four different models are constructed (Fig. 1), and then the predictions of these four neural networks are fitted and predicted. The input of the traditional multi-layer perceptron is used. Giving that the traditional neural network is easy to fall into the local minimum and the convergence is slow in the weight training process, the particle swarm algorithm is used for the weight training of each neural network.

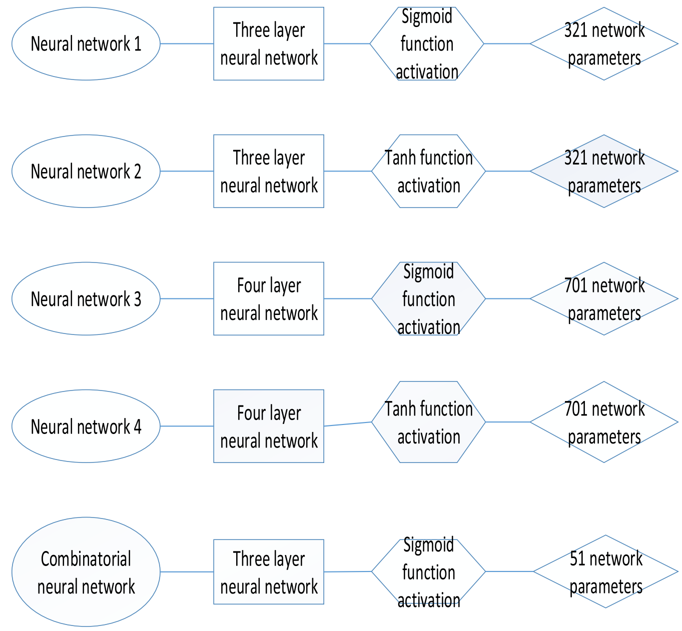

Fig. 1. Neural network model

Sigmoid is expressed as follows.

$$y = \frac{1}{1 + \exp(-x)} \tag{1}$$

Tanh function is expressed as follows.

$$y = \frac{\exp(x) - \exp(-x)}{\exp(x) + \exp(-x)} \tag{2}$$

The architecture of each neural network is obtained from Fig. 1, as shown in Fig. 2.

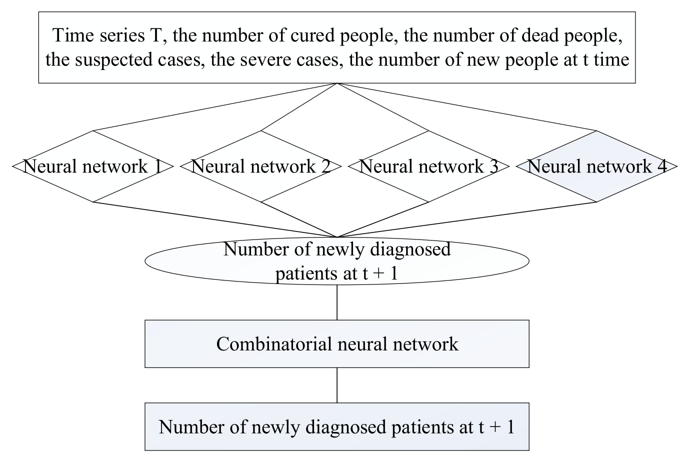

Fig. 2. The architecture of neural networks.

Because of the limitations of traditional network models, the particle swarm algorithm is applied to each weight training. The specific training process is shown in Fig. 3.

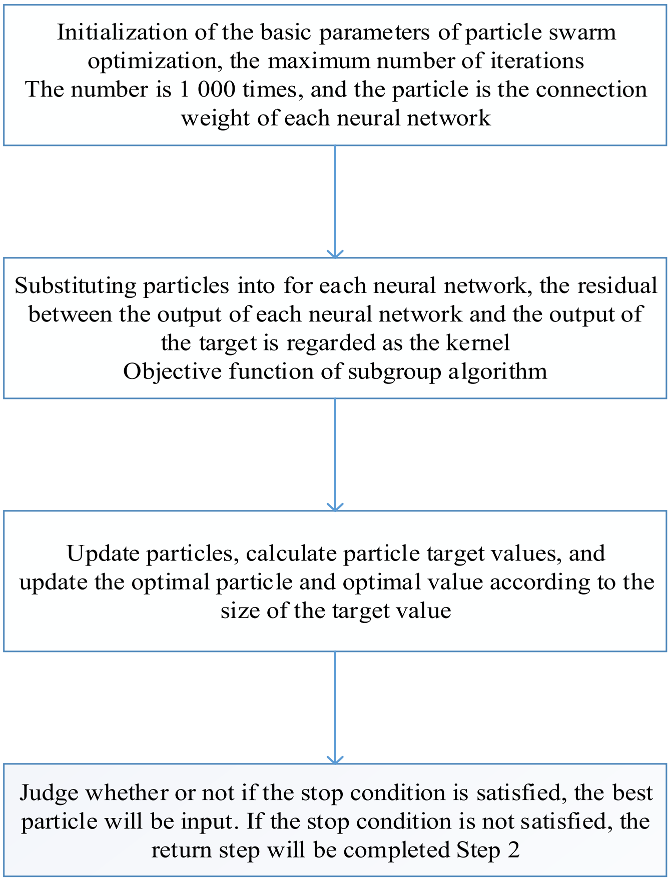

Fig. 3. Neural network weight training process.

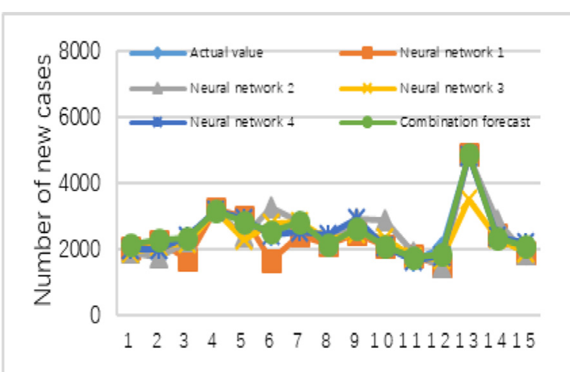

Fig. 4. Forecast of new diagnoses per day.

3. Analysis of epidemic spread prediction results

3.1. Forecast of new diagnoses per day in X province

The epidemic data of the previous day are used as the input of the neural network, and the number of newly confirmed cases of the epidemic on the second day is used as the output value of the network to predict the number of newly confirmed cases of the epidemic on a daily manner. The predicted results are shown in Fig. 4. The prediction of the daily new cases by these five neural network models differs little from the actual value, and the trend is basically consistent, but there are still differences at certain time points. The errors of neural network 1 on the 6th and neural network 3 on the 13th are large. However, the accuracy of the combined neural network prediction model is high, and the results at each node are very little different from the actual value.

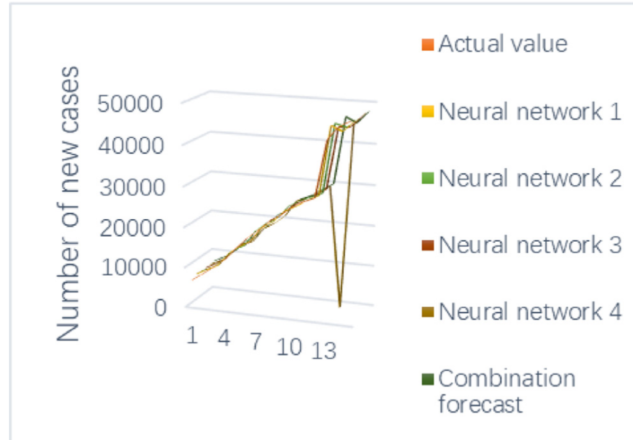

Fig. 5. Prediction of the daily cumulative number of confirmed diagnoses.

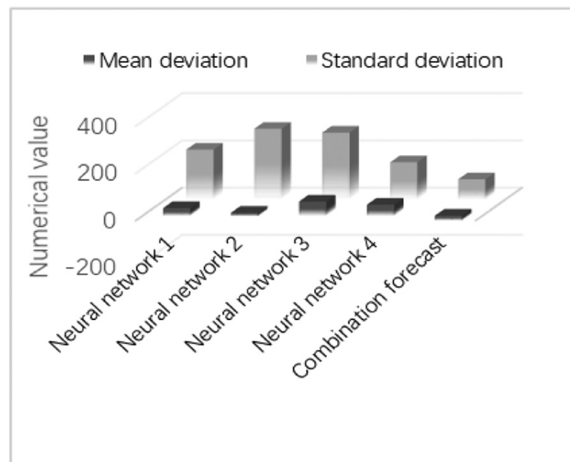

Fig. 6. The deviation of prediction of each neural network.

3.2. Forecast of the daily cumulative number of confirmed cases in X province

Fig. 5 shows that the five neural network models have a relatively ideal prediction of the daily cumulative confirmed number, and the combined neural network prediction model has a high accuracy. The difference between the results at each time node and the actual value is relatively small.

3.3. The deviation of prediction of each neural network

Fig. 6 shows that the standard deviations of neural networks 2 and 3 are relatively high, while the mean deviations of the five models are relatively low, and the mean deviation and standard deviation of the combined neural network model are the lowest. After comparison, the difference is statistically significant ($p < 0.05$).

3.4. Performance analysis of each neural network model

It is found that the accuracy of prediction on the epidemic spread in this province is ideal by comparing the performance of each neural network model. From the perspective of various indicators, the prediction accuracy of the combined neural network

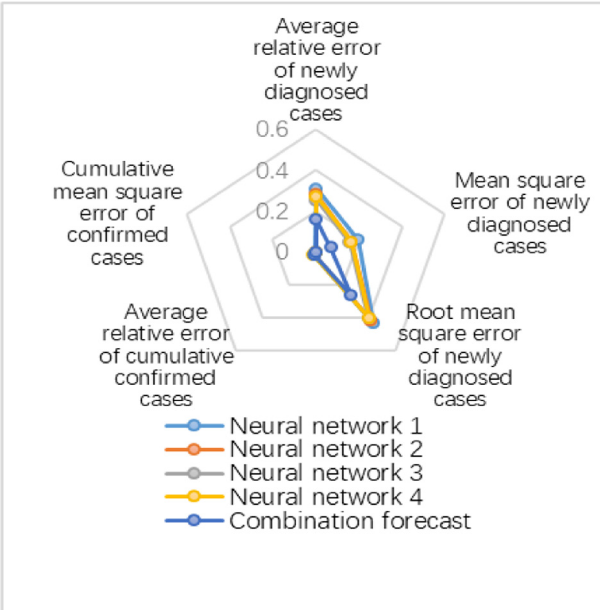

Fig. 7. Performance analysis of each neural network model.

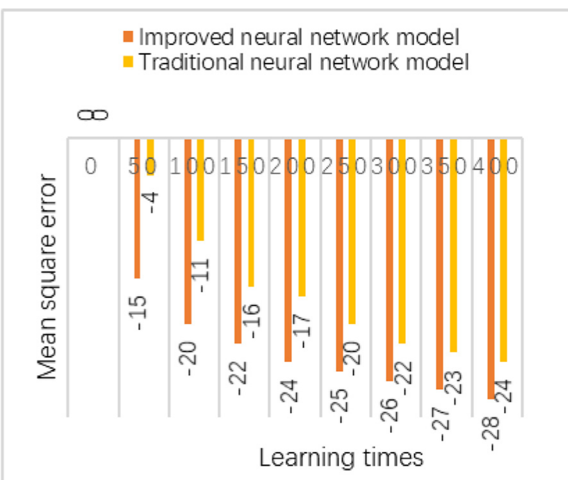

Fig. 8. Changes in mean square error during neural network training.

model is higher than that of the other four models, and the performance is also the best (Fig. 7).

3.5. Changes in mean square error during neural network training

Fig. 8 shows that the improved neural network model has lower mean square error compared with the traditional neural network model. Moreover, the trend of the mean square error is relatively constant with the change of the number of learning. After comparison, the difference is statistically significant ($P < 0.05$).

4. Discussion

Novel coronavirus is a virus that has never been found in humans. The main transmission type of the virus is respiratory tract and contact transmission, that is, infected people's droplets, sneezes, gas, etc., can cause other people to infect. Virus droplets can deposit on surfaces. When people touch objects with deposited viruses and cause hand contamination, touching their own or others' oral cavity, nasal cavity, and eye mucous membranes will also lead to infection [9]. The explosive and unknown nature of novel coronavirus as well as its high infectivity and high susceptibility are the important reasons for this major disaster [10]. The development of science and technology allows researchers to realize zero-contact research. With artificial intelligence technology as the support and mechanical objects as the carrier, it can effectively reduce the risk of infection in the research process. In this outbreak of epidemic prevention and control, the following two measures should be implemented as far as possible [11]. Timely release of real information can help avoid causing social panic, and the masses should be correctly guide through the network [12]. Today's artificial intelligence technology with big data as the link has excellent information collection, processing, monitoring, publication, and other capabilities. The information related to the epidemic should be effectively published, and rumors must be checked in time to avoid the guidance of false information [13].

Neural network refers to the behavior of animals extending into the optical network, which uses the close connection between its internal nodes to realize the information processing in a distributed manner [14]. Artificial neural networks appeared after the 1940s. It is connected by many neurons with adjustable connection weights, and has the characteristics of large-scale parallel processing, distributed information storage, and good self-organization and self-learning capabilities [15]. Its working principle is similar to the theory of brain neurons. If the network makes an incorrect decision, it needs to learn from the network, which should make the network less likely to make similar mistakes next time [16]. First, a random value is assigned in the interval (0, 1) to each connection weight of the network. The image mode corresponding to "A" is input to the network, and the network adds the weight of the input mode, compares it with the threshold, and then performs non-linear operations to obtain the output of the network. In this case, the probability of the network output being "1″ and "0″ each occupies half, which can also be considered random. At that time, if the output is "1″ (the result is correct), the connection weight is increased, so that the network can still make a correct judgment when it encounters the mode "A" input again. If the output is "0″ (that is, the result is wrong), the network connection weight is adjusted accordingly in the direction of reducing the comprehensive input weight, aiming to reduce the possibility of making the same mistake when the network encounters mode "A" input again next time. With this operation and adjustment, if there are repeatedly inputting countless handwritten letters "A" and "B" to the network, the correct rate of network judgment will be significantly improved after the network performs multiple learning according to the above learning method [17]. It shows that the network has succeeded in learning these two modes, and it has memorized these two modes in a distributed manner on each connection weight of the network [18]. The network can make quick and accurate judgments and identifications when it encounters any of these modes again [19]. It is generally believed that the richer the number of neurons in the network, the more patterns it can remember and recognize [20]. The characteristic of neural network is that it has good self-adaptive ability and self-organization ability, which changes the weight value of synapse in the process of learning or training to better adapt to the needs of the surrounding environment [21]. The same network has different functions due to differences in learning methods and content.

In the prevention and control of COVID-19 epidemic, artificial intelligence technology has also played its great advantage. However, using the traditional neural network is easy to enter the local extreme point, and has a high blindness in the initial process of weight. As a result, the accuracy of the final results is low, which is not conducive to a series of operation processing of epidemic information. It is an inevitable trend to improve the neural network blade model. In this study, the combined model of various neural networks, namely the combined neural network model, is applied to the prediction of epidemic situation. The improved neural network model is compared with the traditional network model. The epidemic data of the previous day is used as the input of the neural network, and the number of newly confirmed cases of the epidemic on the second day is used as the output value of the network to predict the number of newly confirmed cases on a daily manner. The prediction results show that there is a small difference between the prediction of the daily new cases by the five neural network models and the actual value, and the trend is basically consistent, but there are still differences in some time nodes. However, the errors of neural network 1 on the 6th and neural network 3 on the 13th are large. The accuracy of the combined neural network prediction model is high, and the results at each time node are very small compared with the actual value. The prediction of the cumulative number of diagnoses per day of the five neural network models is also analyzed, and the results are relatively ideal. The accuracy of the combined neural network prediction model is high, and the difference between the result and the actual value at each time node is relatively small. In the comparison of deviation, it is found that the standard deviation of neural network 2 and 3 is high. The mean deviations of the five models are all relatively low, and the mean deviation and standard deviation of the combined neural network model are the lowest. The performance of each neural network model is compared, and it is found that the accuracy of prediction on the epidemic spread in this province is ideal. Regarding various indicators, the prediction accuracy of the combined neural network model is higher than that of the other four models, and its performance is also the best. Finally, the MSE of the improved neural network model is lower compared with the traditional neural network model. Moreover, with the change of learning times, the change trend of MSE is constant. All the research results indicate that the application effect of the improved neural network blade model is significant, and the prediction results of the epidemic situation are relatively accurate, which is similar to the research results of Lai et al. [22].

The improved neural network blade model based on artificial intelligence can not only predict the epidemic situation, but also trace the source of the disease. In addition, artificial intelligence is adopted to implement the diagnosis and treatment of assistance, which realizes machine replacement. COVID-19 is highly contagious. Minimizing the risk of infection is essential to protect health care workers on the front lines of the pandemic. Based on this, some technology platforms have launched intelligent disinfection robots, intelligent food delivery robots, intelligent throat swab collection robots, etc., which have achieved remarkable results in reducing the risk of infection.

5. Conclusion

In this study, the improved neural network blade model is used to study the prevention and control of COVID-19 epidemic. Then, the improved neural network blade model is compared with the traditional neural network model. It is found that the improved neural network blade model has a high prediction accuracy for COVID-19, and the mean and standard deviation of its deviation are relatively low. Compared with the traditional neural network blade model, the improved neural network blade model has excellent performance and remarkable application effect, so it is worthy of further promotion and application in the field of medicine. The disadvantage of this study is that the sample size of data adopted is relatively small, which makes the research results present less content and may produce large errors. Therefore, it is necessary to expand the sample size for further research and analysis.

Declaration of Competing Interest

The authors declared that they have no conflicts of interest to this work.

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