Research on Scientific Management of Living Materials During the Coronavirus Disease 2019 Epidemic

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Abstract: The sudden outbreak of the novel coronavirus disease 2019 (COVID-19) at the end of 2019 has had a significant impact on the lives of Chinese people and social and economic development. During the period of epidemic closure, the scientific management of various groups of people has become very important, and the scientific management of living materials is particularly important. This paper uses the BP neural network model to predict and analyze the development trend of the distribution of vegetable bags and the number of people infected with the new crown and finds that the inflection point of the epidemic after the distribution of vegetable bags appears early and shows a clear downward trend. This paper concludes that the scientific management and distribution of living materials during the epidemic can reduce the intensive contact between people, reduce the risk, and achieve the effect of inhibiting the development of the epidemic. This paper concludes the predictive analysis of the application of technical means, which will provide solutions for the emergency response to major public health events in the future.

Keywords: Novel Coronavirus Pneumonia, BP Neural Network, Living Materials.

1 INTRODUCTION

Since 2022, our country has repeatedly experienced large-scale repeated epidemics. In response to large-scale outbreaks, our country has adopted a closed management method to achieve rapid elimination of the epidemic. The new type of coronavirus pneumonia has the characteristics of rapid onset and strong contagion. To reduce the number of infected cases due to the increase in people gathering, most areas in our country have adopted large-scale closed management to block the spread of the virus [1]. During the lockdown period of the epidemic, the scientific management of living materials has become particularly important. To block the secondary spread of the epidemic, we must propose a scientific and easy-to-implement method for the distribution of living materials.

Since March 2022, the situation of the new crown epidemic in Changchun has become more and more serious and gradually spread to the whole city. To effectively control the spread of the

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epidemic and protect the lives, health, and safety of the people in Changchun City, the Changchun Municipal Government and units at all levels have actively carried out anti-epidemic measures and taken some effective measures to reduce the spread of the epidemic. To ensure the basic living supply of the masses, Changchun City has formulated a series of measures to ensure the reasonable, timely, and effective distribution of materials. The method of material distribution reduces the intensive contact of people to a certain extent, reduces the transmission route of the new crown virus, and inhibits the development of the new crown epidemic to a certain extent. During the period of material supply, the distribution method, time interval, and transportation of vegetable packs are very important [2]. The shelf life of vegetables is short, the demand is large, and storage is difficult. The government and relevant units need to formulate an effective supply process to reduce losses and enable the delivery of materials, maximize utility and overcome the epidemic situation better and faster [3].

2 MODEL ESTABLISHMENT AND SOLUTION

2.1 Person Correlation Analysis

1)Introduction to Person Coefficient

The person correlation coefficient is a statistical method proposed by British statistician Pearson in the 20th century to measure the closeness of the correlation between two variables. It analyzes the correlation by measuring the linear relationship between two variables X and Y The calculation formula is represented by r, and the value range is between -1 and 1. The calculation formula is (1):

$$r = \frac{\sum_{i=0}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=0}^{n}(x_i - \bar{x})^2 (y_i - \bar{y})^2}} \tag{1}$$

where x_i and y_i are the sample means.

The meaning of the formula is: when r>0, the two variables are positively correlated, for example, the greater the value of the x variable, the greater the value of the y variable; when r<0, the two variables are negatively correlated., the larger the value of the x variable, the smaller the value of the y variable will be. That is to say, the larger the absolute value of the correlation coefficient r, the stronger the correlation between the two variables, that is, the closer r is to 1 or -1, the stronger the correlation, and the closer r is to 0, the stronger the correlation is. the weaker. When using person correlation to analyze the relationship between variables, SPSS software is generally used for operation, and the correlation coefficient of r is marked in the obtained result table, and the correlation between variables can be seen; in addition, there is a P value, It is used to indicate the significance level of this analysis. When the p-value is greater than 0.05, there is no need to examine the correlation between variables. When the p-value is less than 0.05, it indicates that there is a correlation between the variables. The r value considers whether the variables are positively or negatively correlated.

2)Analysis of Person correlation results

Using SPSS24 for Person correlation analysis, the variables analyzed in this paper are mainly divided into two categories, one is the number of new coronavirus infections in each district of Changchun City, and the other is the number of vegetable packs distributed in Changchun City. The number of new coronavirus infections in each district was matched with the number of vegetable packs distributed in the district, and 9 correlation analyses were performed. The final results are shown in Table 1.

Table 1 Person correlation analyses

		Number of vegetable packs issued
Changchun New District	Pearson correlation	-.537*
	Significance test (two-tailed)	0.032
	Number of cases	16
Economic Development Zone	Pearson correlation	-0.472*
	Significance test (two-tailed)	0.015
	Number of cases	16
Er dao District	Pearson correlation	-.536*
	Significance test (two-tailed)	0.033
	Number of cases	16
Green District	Pearson correlation	-0.275**
	Significance test (two-tailed)	0.002
	Number of cases	16
Kuan cheng District	Pearson correlation	-0.279*
	Significance test (two-tailed)	0.026
	Number of cases	16
Jing yue District	Pearson correlation	-.582**
	Significance test (two-tailed)	0.008
	Number of cases	16
Chaoyang District	Pearson correlation	-.542**
	Significance test (two-tailed)	0.03
	Number of cases	16
Nan guan District	Pearson correlation	-0.399**
	Significance test (two-tailed)	0.006
	Number of cases	16
Auto open area	Pearson correlation	0.194
	Significance test (two-tailed)	0.472
	Number of cases	16
* At the 0.05 level (two-tailed), the correlation is significant		

2.2 BP Neural Network Model

BP neural network is a multi-layer forward network model that is widely used and effectively based on an error back-propagation algorithm. It was first proposed in 1986 by a team led by Rumelhart and McClelland. BP neural network can simulate the information transmission mode of human brain neurons, perform nonlinear transformation and regression processing on complex information variables, and obtain highly fitting operation results. By simulating the information transmission between neurons in the brain, after inputting the input variables into the input layer, a linear combination of the input variables will be obtained according to the initial set weights [4]. When the weights are continuously modified so that the linear combination value exceeds the threshold, the information is transmitted to the output layer.

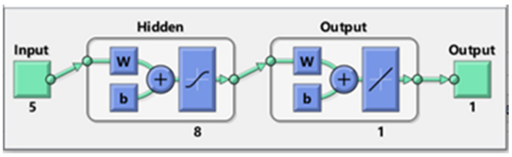

Figure 1 BP neural network structure diagram

The classical structure of a BP neural network usually consists of an input layer, hidden layer, and output layer, each layer consists of multiple neurons, as shown in Figure 1. As the signal propagates forward, the neural network's predictions are output. As the signal propagates backward, the neural network learns by adjusting the weights and biases according to the direction of the fastest descent of the loss function gradient. A large number of experiments show that the three-layer BP neural network is very suitable for the regression analysis of the prediction model [5], so this paper chooses the three-layer BP network for analysis.

The specific steps of the model establishment are as follows: (1) Data set preprocessing: normalize the collected original data set; (2) Construct PB neural network structure: determine the hidden layer of the network, generally, three layers, set the input layer, hidden layer, and output layer are the number of neurons; (3) BP neural network training; (4) BP neural network simulation prediction: test the prediction effect of the model on the training data and data set, and evaluate the effect of the output results, reliability is assessed.

The training set of the BP neural network generally includes forward and backward propagation parts. In the feedforward stage, the input layer neurons transmit the input pattern to the hidden layer. After calculating the weighted sum of each neuron in the output layer, the weighted sum is obtained through its activation function as the output value of the network. The error obtained in the feedforward stage of the neural network is transmitted backward from the output layer to the input layer. To reduce the network error to an acceptable level, the weights are rescaled according to the learning strategy.

1) Data Analysis and Preprocessing

When analyzing problems in real life, the original data we obtained is affected by the external environment, human subjective judgment, and other factors, which makes some data abnormal, missing, and other problems, so it may not be possible to obtain effective results in empirical research. in conclusion. Therefore, after obtaining the original data, the data must first be preprocessed. The data in this paper is mainly aggregated by human calculation, and there may be data anomalies and some data missing, so it is necessary to preprocess the sample data. In this paper, data outlier correction, missing value completion, and data normalization preprocessing are performed on the data.

a) Boxplot method

Before processing the outliers of the original data, we must first judge whether they obey the normal distribution, and then choose the appropriate processing method. The original data was imported into SPSS24 for descriptive statistical analysis, and the results found that it did not obey the normal distribution. Therefore, according to the type of data, this paper selects the boxplot to preprocess the data.

The box plot was proposed by American statistician John Tukey, also known as box plot or box plot, which can be used to observe the distribution and center position of sample data. The boxplot can be very intuitive to distinguish the outliers of the original data, and can also judge the discrete degree of the original data set by the length of the box and the length of the whiskers. The boxplot contains 5 numerical points from top to bottom, namely the upper whisker (Min), lower quartile (Q1), median (Median), upper quartile (Q3), and lower whisker (Max). Among them, the calculation formulas of the upper and lower whiskers are Q3+1.5 (Q3-Q1) and Q1-1.5 (Q3-Q1), the upper and lower quartiles and the median are the values Q1, Q3, and Q2 corresponding to the 25%, 75%, and 50% quartiles, respectively. The definition range of outliers in the original data set can be calculated by [Q1-1.5xIQR, Q3+1.5xIQR]. The 1.5 in the formula is the constant value K assigned in this paper concerning the general practice, and whether each value is this or not is calculated by Python. If it is not within the range, it is an outlier in the test data set. The outliers in the original sample data can be screened out by using the boxplot method for the next step of data correction [6].

b) Data normalization processing

Data normalization refers to the need to normalize the data to make the data have the same measurement standard when the subsets or indicators in the data set have different characteristic value ranges. The data in the normalized dataset has the same limited range, which eliminates the influence of different dimensions between different data and improves the accuracy of the empirical results. According to the requirements of this paper, a neural network prediction model needs to be established, so the general practice is to normalize the data first, and this paper adopts the most valuable normalization method to process the data.

The most value normalization is to map all the data in the data set within the value range of (0,1), the two parallel lines represent the data set before and after mapping, The maximum mapping value is 1, the minimum mapping value is 0, and the calculation formula of the maximum value normalization method is as follows (2):

$$X_{scale} = \frac{X - X_{min}}{X_{max} - X_{min}} \tag{2}$$

where X_{max} and X_{min} refer to the maximum and minimum boundaries of the metadata set data. X refers to the value before normalization, and X_{scale} represents the value after normalization

c) Missing value handling

There are many ways to deal with missing values: mean interpolation, maximum likelihood estimation, multiple imputations, etc. However, for the processing of missing values, it is necessary to identify whether the attribute of the data set is cross-sectional data or time series data, and different data completion methods should be adopted for different types of data. It can be observed that the data obtained in this paper belong to time series data, so the direct deletion of missing data, the nearest supplementary method, the mean interpolation method, or the linear interpolation method can be used. In this paper, the linear interpolation method is used to carry out the missing data. The linear interpolation method assumes in advance that the time series has an obvious trend of change, and fills in the missing values by fitting the changing trend of the data.

2) BP neural network model test

In this paper, mean square errors (MSEs) and coefficient of determination (R2) are used to evaluate the predictive ability of network models. The MSE is calculated to represent the error of the BP neural network during training and testing, and its calculation formula is as follows. MSE represents the degree of deviation between the predicted value and the monitored value. The closer the MSE is to 0, the more accurate the predicted value. R2 was used to evaluate the goodness of fit of the network model to the dataset. The closer R2 is to 1, the higher the degree of explanation of the input variable to the output variable, and the better the prediction effect of the model. The formula for the coefficient of determination is expressed as follows (3) and (4).

$$MSE = \frac{1}{2n}\sum_{i=1}^{n} f^2\left(\sigma_i\right) \tag{3}$$

$$R^2 = \frac{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y}_i)^2} \tag{4}$$

Among them, y_i is the true value; $\hat{y}_i$ is the predicted value; $\bar{y}_i$is the average value of the true value; n is the number of samples in the training set or test set.

a) Mean Squared Error

The mean error refers to the expected value of the difference between the predicted output data of the data set and the target output data. The lower the value of MSE, the better the model effect is. At 0, there is no error. In addition, the x-axis in the figure represents the number of times the BP neural network is trained, and the y-axis represents the mean squared error value. The position of the coordinate point marked by the green circle in the figure represents the number of iterations of the neural network and the size of the value when the validation set is the best mean square error value. It can be seen from Figure 2 that there is an inflection point at (1, 0.02), indicating that the model is reasonable.

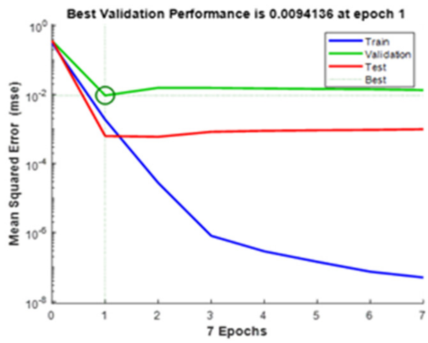

Figure 2 Mean Squared Error Plot

b) R coefficient

The R coefficient refers to the correlation between the predicted output data of the data set and the target output data. The closer the value of R is to 1, the closer the relationship between the prediction and the output data is, and the closer the value of R is to 0, it represents the prediction and the relationship between the output data is more random. The following four graphs represent the data dependencies of the training set, validation set, test set, and overall results after training, respectively. The abscissa represents the target output, and the ordinate represents the fitting function between the predicted output and the target output. It can be seen from Figure 3 that the correlation coefficients are 0.99074, 0.9999, 0.99596, and 0.98225, which are all close to 1, indicating that the fitting effect is good.

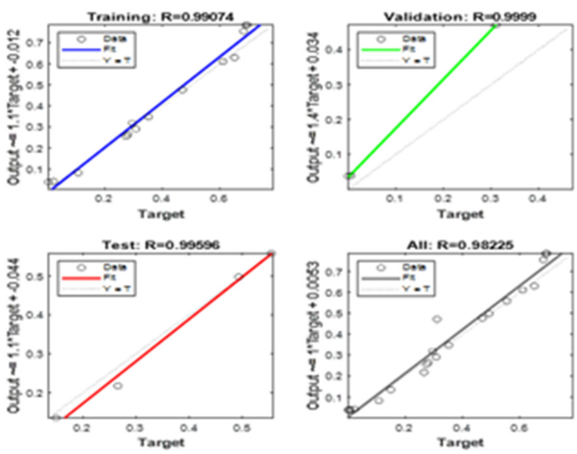

Figure 3 R coefficient diagram

2) Analysis based on BP neural network results

According to the daily changes in the number of new local infections and new asymptomatic infections in the whole city and various districts of the new crown epidemic in Changchun since the outbreak, and after data cleaning, we obtained the data from March 29 to April 12 in

Changchun City. The number of vegetable bags distributed by the district. To know whether the supply of vegetable bags can reduce the contact of people and thus achieve the effect of suppressing the epidemic, this paper adopts the method of BP neural network, assuming that there is no supply of vegetable bags from March 29 to April 12, the number of people infected with the new crown make predictions. Before doing this research, we expected that if the distribution of vegetable packs would have an inhibitory effect on the epidemic, then the daily growth of the number of new crown infections would appear faster than the "V" peak, that is, the occurrence cycle of new crown infections would be shortened. Based on this conjecture, we have obtained the actual and predicted growth trend of the new crown infection as shown in Figure 4. It can be seen from the figure that the development trend of the epidemic reached a small peak on April 7 under the assumption that there is no supply of vegetable packs, and then began to decline. On the premise of the supply of vegetable packs, the growth rate of the number of new crown infections peaked around April 1 and has been on a downward trend since then. Therefore, it can be determined that the distribution of vegetable packs in Changchun City during the epidemic period can play a certain role in the control of the epidemic.

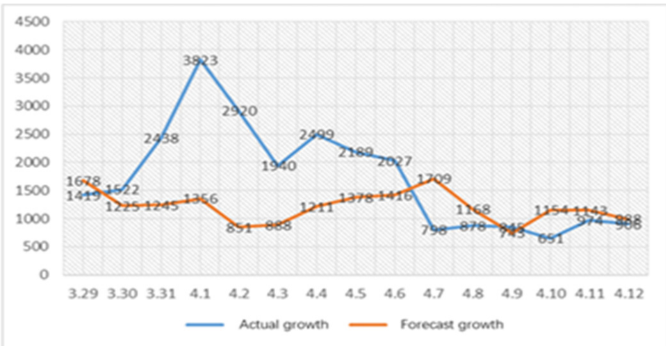

Figure 4 The growth trend of the actual and predicted number of new crown infections

3 CONCLUSION

To explore the relationship between the control of the epidemic and the distribution of living materials, the development of the epidemic was mainly judged by the impact of the epidemic before and after the distribution of vegetable packs. Based on this research purpose, we conducted a PERSON correlation analysis on the number of COVID-19 infections and the number of vegetable bags distributed after vegetable bags were distributed in various districts of Changchun City, and concluded that vegetable bags would have an impact on the control of the epidemic [7]. To further verify, the article uses the BP neural network model to predict the development trend of the number of new crown infections in the future under the premise that there is no distribution of vegetable bags. Therefore, this paper concludes that the scientific management and distribution of living materials during the epidemic can introduce intensive contact between people, reduce risks, and achieve the effect of inhibiting the development of the epidemic.

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