An Empirical Study on the Prediction of E-Commerce Sales by Optimizing Grey Neural Network Model

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Abstract. E-commerce is the main component of the new economy. In recent years, with the rapid development of the Internet, e-commerce shows great vitality. According to the requirements of the 13th five year plan, China's e-commerce needs to be fully integrated into all areas of the national economy, and the e-commerce transaction volume is planned to reach 40 trillion yuan by 2020. However, the transaction volume of e-commerce is an important embodiment of the development level of e-commerce. Therefore, through scientific and reasonable algorithm, we can predict the transaction volume of e-commerce, which will reveal the depth of e-commerce development. Through the prediction of e-commerce transaction volume, enterprises and governments will conduct quantitative supervision on market development, which has become an inevitable requirement of e-commerce development. This paper first analyzes the basic theory of grey neural network. Then, the neural network prediction model is optimized.

Keywords: E-Commerce Sales, Optimizing Grey Neural Network Model, Prediction

1. Introduction
The 21st century is an era of high-speed network development. Internet has become the most potential emerging market industry in the future. Network market is a new business field, which can engage in the business that can not be engaged in in the traditional market, which helps to reduce the cost of enterprises and improve the competitiveness of enterprises. In the e-commerce market, any enterprise can get information from all over the world equally, which provides a basic platform for them to show themselves equally. Through e-commerce, enterprises can set up their own global information network and trade network at a very low cost, which quickly transfer their products to the global market. Finally, e-commerce can fully realize the information exchange of two-way interaction with customers, which provides consumers with greater space for product selection. Customers can meet their shopping needs through lower prices [1-3]. Therefore, e-commerce is favored by many enterprises, and more and more enterprises begin to develop e-commerce. E-commerce is a new industry based on Internet technology. E-commerce has many advantages, such as wide sources of statistical data, accurate statistical results, and clear transaction amount, which greatly guarantees the timeliness of market transactions. Through a variety of traditional statistical indicators, we can establish a model to predict the transaction volume of e-commerce, which will enable enterprises and government
departments to obtain more accurate transaction volume data as soon as possible [4-6]. This paper constructs a prediction model by optimizing the grey neural network and the related index of transaction amount, which can predict the transaction amount of e-commerce in the same period. The model provides timely and powerful support for the strategic decision-making of enterprises and governments.

2. Construction of grey neural network and prediction model

2.1. Grey neural network

Through a small number of sample data, the gray prediction method can be accumulated, which will be able to reduce the impact of random interference. Through the accumulation of the sequence will show a monotonous increase trend, which will be able to better predict the overall trend. Based on the characteristics of grey neural network, this paper combines grey system with neural network, which will form an embedded grey neural network prediction model. Before the BP neural network, we can add a white layer after the BP neural network, which will restore the gray output information of the network. Therefore, we will get a certain output. Grey model refers to the problem of predicting the development and change of the behavior eigenvalue of grey uncertain system. The original data $X_t^{(0)} (t = 0, 1, 2, \ldots, n-1)$ of the uncertain system eigenvalue is the data $X_t^{(1)}$, which is generated by an accumulation. It shows the law of exponential growth. Therefore, we can use a continuous function and differential equation for data fitting and prediction.

Among them, the original sequence $X_t^{(0)}$ is expressed as $X(0)$, the sequence $X_t^{(1)}$ generated by one-time accumulation is expressed as $Y(1)$, and the prediction result $X_t^{(1)*}$ is expressed as $Z(t)$.

When the grey neural network model with n parameters, the differential equation is expressed as Formula 1.

$$\frac{dy_1}{dt} + ay_1 = b_1y_2 + b_2y_3 + \ldots + b_{n-1}yn^n \tag{1}$$

Where $y_2, y_3, \ldots, y(n)$ is the system input parameter, $y(1)$ is the system output parameter, and $a, b_1, b_2, \ldots, b_{n-1}$ is the coefficient of differential equation.

The time reaction formula is formula 2.

$$z(t) = (y_1(0) - \frac{b_1}{a}y_2(t) - \frac{b_2}{a}y_3(t) - \ldots - \frac{b_{n-1}}{a}y_2(t) + \frac{b_n}{a}y_3(t) + \ldots + \frac{b_{n-1}}{a}y_n(t))$$

$$d = \frac{b_1}{a}y_2(t) + \frac{b_2}{a}y_3(t) + \ldots + \frac{b_{n-1}}{a}y_n(t) \tag{2}$$

When

$$z(t) = \left( (y_1(0) - d) \frac{e^{-at}}{1-e^{-at}} + d \frac{1}{1+e^{-at}} \right) (1 + e^{-at})$$

$$= \left( (y_1(0) - d)(1 - \frac{1}{1-e^{-at}}) + d \frac{1}{1+e^{-at}} \right) (1 + e^{-at})$$

$$= \left((y_1(0) - d) - y_1(0) \frac{1}{1+e^{-at}} + 2d \frac{1}{1+e^{-at}} \right) (1 + e^{-at}) \tag{3}$$

After mapping the above formula to an extended BP neural network, we get the grey neural network with n input parameters and 1 output parameter. As shown in Figure 1.
2.2. The prediction model
Through the grey neural network, this paper can predict the volume of e-commerce transactions. The specific process is shown in Figure 2.

3. Optimize the construction of grey neural network prediction model

3.1. Topological structure of grey neural network
The topological structure of genetic optimization grey neural network is shown in Figure 3.
3.2. Grey neural network prediction

According to the above process of genetic algorithm, we assign appropriate operation parameters. After selection, crossover and mutation, we can calculate the fitness value. By judging whether an individual meets the constraints, we can get the optimal weight and threshold. By assigning the individuals to the initial weights and thresholds of the grey neural network, we can train the grey neural network, which can predict the e-commerce transaction volume. Through genetic algorithm, we can optimize the improved grey neural network, which is very helpful to the prediction of e-commerce transaction volume. This is mainly divided into three steps. First, we can determine the grey neural network for the prediction of e-commerce transaction volume. Secondly, we can determine the weight and threshold of the genetic algorithm to optimize the grey neural network. After finding the best individual, we can build the improved grey neural network model of genetic optimization. Third, train the model. Then we can use the trained model to predict the volume of e-commerce transactions. The specific process is shown in Figure 4.

![Grey Neural Network Diagram](image)

**Figure 3.** Topological structure of gray neural network.

**Figure 4.** Grey neural network prediction.

4. Conclusion

With the increasingly fierce competition in today's online trading market, the key to the success of enterprises lies in using existing data resources to understand the actual customer access process and purchase behavior. Through the collected data to predict the future behavior of customers, we can effectively cultivate and manage customer relationships, which will ensure that customers can obtain higher satisfaction from various contacts with the enterprise. By increasing the possibility of customer...
access and purchase, we can improve the efficiency and success opportunities of enterprise marketing activities, which will reduce marketing costs and maximize profits.

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