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Sales Forecast Method of Private Enterprises Based on BP Neural Network

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Abstract: The core and purpose of business operation is to make profits. The key to profitability lies in improving the sales revenue of the company, as well as discovering potential users, retaining lost users, and maintaining important users. Therefore, the forecast of sales and the early warning of user loss are very important for enterprise supply chain management and Customer-oriented operations are of great guiding significance. The purpose of this paper is to study the sales forecast method of private enterprises based on BP neural network. This paper summarizes the influencing factors that affect the sales of enterprises, combined with the BP neural network model, analyzes and designs the sales forecast model of private enterprises based on the BP neural network. Using statistical methods and the combination of qualitative and quantitative methods, through targeted analysis, it solves the problem of determining the influencing factors of private enterprise sales and data processing in the process of verifying and applying the private enterprise sales forecasting model based on BP neural network. The experimental results show that the mean MSE of BP neural network is 4.78, and the effect of predicting the sales of private enterprises is good.

1. Introduction

Driven by the digital transformation of enterprises, the business model, work model and process of enterprises have undergone tremendous changes. Data-driven decision-making has become the primary issue for digital business leaders to consider. When analyzing internal data, enterprises must also analyze external data predict what may happen in the future [1-2]. Not only management needs to analyze data and make decisions, but employees also need to analyze data, such as sales staff, buyers and financial staff, so that they can accurately recommend products to customers, provide orders to suppliers and understand financial data , accurately and deeply understand the

operation situation and ensure the efficient completion of the business. Sales forecast will affect the sales plan, inventory stability, etc. of retail enterprises, thus affecting the sales stability [3-4]. The success or failure of an enterprise depends on whether it can predict the future and formulate appropriate sales strategies based on existing data. Only by making accurate sales forecasts can we update marketing decisions in a timely manner, set reasonable goals, improve management efficiency and operating efficiency, and maintain enterprise stability development and obtain greater benefits [5-6].

At present, many scholars at home and abroad have conducted various researches on the methods of sales forecasting, and have formed a relatively rich theoretical system of sales forecasting [7]. Gupta C proposed a new method called DE-ForABSA, which is based on Aspect-Based Sentiment Analysis (ABSA) and a hybrid forecasting model ClusFuDE [8] to predict car sales. In ABSA, the reviews are preprocessed and the ClusFuDE consisting of clustering, fuzzy logic relations and differential evolution (DE) is used to predict car sales [8]. In the distribution industry, the supply chain consists of manufacturers, wholesalers and retailers. Watanabe I uses a model ensemble approach to flexibly handle various product characteristics and reliably perform high-precision predictions. It also reduces the operational burden with automatic adjustment. They also developed an attribute decomposition model for predicting demand for completely new products without data on past results. Dynamic ensemble prediction techniques and attribute decomposition models, solutions based on these techniques and their applications are introduced [9]. Using BP neural network to predict reasonably can provide guidance for real investment and bring considerable benefits to enterprises [10-11].

At present, most of the enterprise sales forecasts studied are only forecasting the sales at the macro level of the enterprise, and have no substantial help for the formulation of enterprise procurement plans, production plans, sales plans, financial plans, etc., and can only stay at the theoretical level. Practically guide the specific operation of the enterprise. Under such a research background, this paper starts from the macro environment and internal factors of enterprises, combines the operating characteristics of private enterprises, establishes a matrix of factors affecting sales forecasting of private enterprises, and uses a large number of sample data to build a sales forecasting model for private enterprises, and obtains a comparative analysis. Good forecasting effect, forecasting enterprise sales from the micro level, is more meaningful and supportive for the decision-making of enterprise management.

2. Research on Sales Forecast Method of Private Enterprises Based on BP Neural Network

2.1. Factors Affecting the Sales Situation of Enterprises

(1) Macro-environmental analysis

The macro factors that affect the sales situation of enterprises are divided into three categories: economic factors, natural condition factors and social factors. Among them, economic factors include regional GDP, consumer price index, and resident consumption level, natural factors include quarterly factors, which are reflected in X years and X months, and social factors include the local resident population in Chongqing. The macro factors that affect the sales status of enterprises include the following factors: GDP, CPI, resident consumption level, year, month and resident population [12-13].

(2) Analysis of internal factors of enterprises

There are many internal factors that affect the sales situation of enterprises, but the most important ones are marketing, management and so on. Marketing includes four factors: product, price, channel, and promotion. Due to the excessive classification of products of data collection companies, when specifying products and prices into variables, the product category and brand are

used as analysis factors; the channel mainly considers the geographical location of chain stores, using department (ie store code), store rent per square meter, The store area reflects factors such as the business district where the store is located, daily traffic [14].

2.2. BP Learning Algorithm

BP network has strong fault tolerance. If some connections are damaged, failed or changed, the overall performance of the network will drop slightly, and it will not necessarily lead to the collapse of the whole system, because the information storage is distributed throughout the system [15-16]. The BP network can match a large amount of input information at a time, and then produce a classification or overall output, which performs well in pattern recognition tasks. As shown in Figure 1, a multilayer feedforward neural network has an input layer, an output layer and at least one hidden layer, each layer has one or more neurons, most of the layers are connected to each other, but the nodes of the same layer are connected to each other , the neurons of two adjacent layers are connected by adjustable parameters.

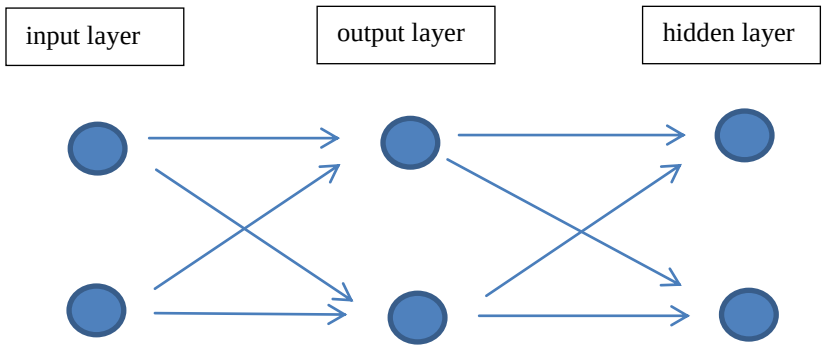

Figure 1. Single hidden layer network structure

2.3. BP Neural Network Prediction Process

The general BP neural network prediction process basically has several modules as shown in Figure 2: First, create a system, create a model and create a suitable BP neural network. After BP neural network training, including BP neural network preparation and BP neural network training, after training the network model, there will be predicted results after inputting new data. The predicted error is then calculated by the predicted result to judge whether the model can meet the requirements of target setting [17-18].

When the input variable is x, the connection weight between the input layer and the hidden layer is w, the threshold of the hidden layer is a, and the output of the hidden layer is set to H, there are:

$$H_j = f(\sum_{i=1}^{n} w_{ij} x_i - a_j) \, j = 1,2,3,...l \tag{1}$$

In Equation 1, is the activation function of the hidden layer, which has many different types of expressions. The activation function selected in this paper is:

$$f(x) = \frac{1}{1+e^{-x}} \tag{2}$$

Calculate the prediction error ek according to the output result O predicted by the network and the output Y expected by the target.

$$e_k = Y_k - O_k k = 1,2,3...,m \tag{3}$$

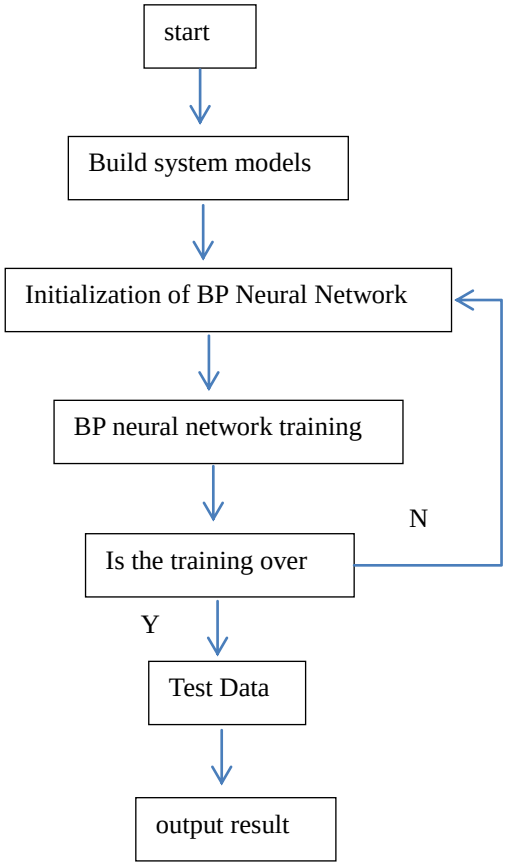

Figure 2. Prediction flow chart of BP neural network

3. Investigation and Research on the Sales Forecast Method of Private Enterprises Based on BP Neural Network

3.1. Data Sources

The output layer variables generally represent the functional goals to be achieved by the system. The purpose of this paper is to predict the store sales of a private enterprise. Therefore, the monthly sales amount of each category and brand of the store is used as the output node, and the sample data comes from XX private enterprises.

In order for the network to be fully trained, the four-year data from 2018 to 2021 are used as training data. The data of macro factors in the influencing factors of sales situation come from the National Bureau of Statistics, and the data of internal factors of enterprises come from XX private enterprises.

The gross regional product collects the 2018-2021 quarterly data of M city's gross regional product, and evenly distributes the quarterly gross regional product of M city to each month of the current quarter to obtain the input layer's gross regional product data.

Consumer Price Index Collect the monthly data of the consumer price index in M city from 2018 to 2021 (the same month of the previous year = 100), convert the data to the consumer price index in January 2018 as the base, and obtain the consumer price index data of the input layer .

Resident consumption level Collect the 2018-2021 annual data on the resident consumption level of M city, and obtain the resident consumption level data of the input layer.

3.2. Model Construction and Related Parameter Selection

This paper chooses to build a BP neural network model with a hidden layer.

According to the empirical formula determined by the hidden layer nodes:

$$M = \sqrt{m+n} + a \tag{4}$$

The number of hidden layer nodes in the sales forecasting BP neural network model is determined between [3, 20].

In the construction of the sales forecast model in this paper, the Tan-Sigmoid function is selected as the transfer function of the input layer; in order not to limit the output value to a small range, the linear function - Pureline is selected as the transfer function.

When training the enterprise sales forecast model, try to train with the improved BP algorithm. According to the characteristics of the sales forecast model, the training method of Trainingdx (the gradient decreasing training function of momentum and adaptive lrBP) was tried.

4. Analysis and Research on Sales Forecast Method of Private Enterprises Based on BP Neural Network

4.1. Conclusion of the Neural Network Model

Table 1 shows the relative error between the predicted value and the actual value generated by the neural network model for part of the test data set. From the prediction results of the neural network test set, that is, the result of the relative error between the actual value of the test data and the predicted value, the maximum relative error of the model is 6.3%, the minimum value is close to 0%, and the relative error of 90% is below 4.5%. It can be seen from Table 1 that the neural network model has a better simulation effect on sales and has a high prediction accuracy.

In the following, the generalized linear model and the BP neural network are used to fit the data, and the effect is reflected in the form of graphics, as shown in Figure 3.

Table 1. The relative error between the actual value and the predicted value of the neural network model data

Test dataset	Relative error (%)
1	6.3
2	2.5
3	3.2
4	3.7
5	4.2
6	4.4
7	1.3
8	1.8
9	0.5
10	3.1

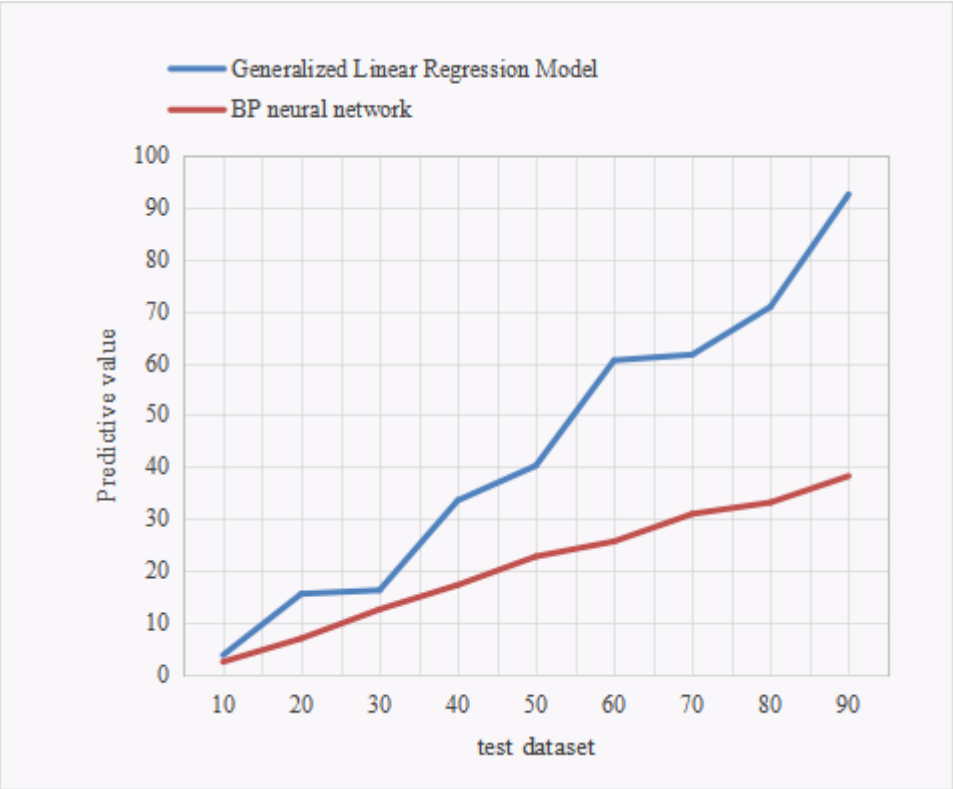

Figure 3. Comparison of fitting effect between generalized linear model and BP neural network

Table 2. Comparison of Fitting Conditions of Two Algorithms

Test dataset	Generalized Linear Regression Model	BP neural network
10	3.7	2.4
20	15.5	6.9
30	16.2	12.5
40	33.5	17.2
50	40.2	22.7
60	60.5	25.6
70	61.6	30.9
80	70.8	33.1
90	92.5	38.2

The vertical axis in Figure 3 represents the fitting effect (predicted value), the red represents the fitting of the neural network, and the blue represents the fitting of the generalized linear model. We can see that the predictions made by the BP neural network bring the scatter points closer to the fitted line than the predictions fitted by the linear model. The mean MSE of our BP neural network is 4.78, while the mean MSE of its generalized linear regression model is 12.29, as shown in Table 2.

5. Conclusion

Although sales forecasting plays a crucial role in future sales decisions, the diversity and complexity of sales forecasting problems make it difficult for decision makers to find a forecasting model suitable for multiple scenarios. Therefore, private enterprises are eager to obtain a

high-precision forecasting model sales forecasting model. Although the work done in this paper has achieved certain results, it plays a certain role in the sales forecast and marketing strategy of e-commerce. However, due to the limitation of data, the research of this paper still has the following shortcomings: (1) Due to the limited time of this paper, the program automation has not been fully realized in the overall analysis process, and many data processing needs to be done manually. , which limits the overall analysis of this paper. (2) Since the data in this article does not give the price of the commodity, it is impossible to analyze each commodity from the perspective of price, the intensity of the impact of price on sales, and what type of products, luxury goods, and daily necessities are sold in the store, household appliances, etc.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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