Application of Neural Network Model in Marketing Forecast

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Abstract

In this paper, the prediction of the future sales of the product is studied, and the neural network model is established. The neural network model is constructed by using the monthly data as the input of the neural network and the monthly sales data as the output of the neural network. Finally, the Moulded Case Circuit Breaker (MCCB) and Automatic Circuit Breaker (ACB) of the two month sales of 2011-2016 products in a particular area of sales records, is forecasted by using the neural network model, the prediction error is less than 4%. Therefore, the neural network has a good effect in the prediction of product sales.

Keywords: Product sales; Neural network; Forecast; Error

1. INTRODUCTION

With the development of technology forecasting in Mathematics in recent years, enterprises have gradually introduced some mathematical and statistical prediction technology: from past sales data for a product to predict future short-term or long-term product sales (Zhang, 2014). More and more traditional marketing to the relationship marketing, marketing solutions to change the concept of service is more and more important (Zhu, 2014). Master the mature forecasting technology, for the enterprise to solve problems and take the initiative to serve the customer has a huge role in promoting. For a product sales forecast is mainly based on the current business and sale rate, in considering the future of all sorts of factors, using mature prediction method, mathematical statistics, judge (Zhang, 2013) on sales situation of the products in the future. The forecasting methods used in enterprises are mainly qualitative prediction and simple linear regression in traditional statistics. The main weakness of the qualitative prediction is that the subjectivity is too strong, the lack of data support. But in the traditional statistics, the multiple regression method is fixed, the flexibility is poor, and the prediction precision is not very good. There are also carried out some research, such as the Wang Wenhua method of nonstationary random signal processing (Wang, 1997), Liu Changming method using linear prediction and nonlinear Qiu Runzhi model to predict such problems, they are using traditional methods of mathematics, statistics, poor flexibility (Liu, 1994). This paper uses artificial intelligence algorithm - neural network popular methods, artificial neural network (ANN) has been inspired by biology, is a simulation of the biological neural network and its approximation, simulation of biological neural network from the structure, realization mechanism and function. From the system point of view, artificial neural network (ANN) is an adaptive nonlinear dynamic system which is composed of a large number of neurons. Because the biological learning system is a complex network composed of interconnected neurons, each of which has a certain number of real valued inputs and produces a single real valued output (Shu, 2016; Yao, 2012). In 1960, Hof and Luo took the lead in using neural networks for automatic control. Neural network has achieved remarkable results in many practical applications because of its unique structure and information processing methods. In this paper, we make use of the sales data of a product in the past year to forecast the sales situation in the next year. Artificial intelligence is a computer algorithm based on data from previous years their training a set of fixed mode, computer virtual prediction method in statistics and compared with the traditional process, according to the different characteristics of different training data network. The model is more targeted and flexible.
2. BP NEURAL NETWORK COMPONENT OPTIMIZATION ALGORITHM SET FOUNDATION

2.1. Basic theory of BP neural network

BP network is a kind of feed forward network without feedback. The neurons in the network are arranged hierarchically, and the output of neurons in each layer is transmitted to the next layer. The working process is divided into two parts: the learning period and the working period. The key of the calculation is the error back propagation process in the learning period.

2.1.1. Design of BP neural network

Figure 1 is the basic structure of the BP neural network.

![Figure 1. basic structure of BP neural network](image)

The input layer, the hidden layer and the output layer neuron are numbered with $i$, $j$, $k$ respectively.

The specific calculation formula is as follows:

Hidden layer and output layer of each neuron input reference formula 1.

$$\text{net}_j = \sum_i w_{ji} o_i$$

$$\text{net}_k = \sum_j w_{kj} o_j$$

(1)

The output of each neuron in the hidden layer and the output layer are respectively refer to the formula 2.

$$o_j = g(\text{net}_j)$$

$$o_k = g(\text{net}_k)$$

(2)
The activation function \( g(x) \) is a unipolar \( \text{Sigmoid} \) function, with reference to formula 3.

\[
g(x) = \frac{1}{1+e^{-x}}
\]  
(3)

2.1.2. Calculate network error

When the output \( o_k \) of the network is not equal to the actual output \( y_k \) (expected value), there is an error in training, and the average error of the system is shown in figure 4.

\[
e = \frac{1}{2} (o_k - y_k)^2
\]  
(4)

The total error of the network is shown in formula 5.

\[
E = \frac{1}{2} \sum_k (o_k - y_k)^2
\]  
(5)

The formula above is the objective function of the BP neural network. In the learning period, the error back propagation process is to minimize the objective function.

2.1.3. Adjustment of each layer weight

Each layer of the weights of the adjustment is a reverse process, that is, the actual output value of \( y_k \) and the actual error signal \( \delta_k \) compared to the hidden layer and the output layer between the weights of \( w_{kj} \) adjustment, as shown in equation 6.

\[
\delta_k = (y_k - o_k) o_k (1 - o_k)
\]

\[
w_{ji}(n) = w_{ji}(n-1) + \eta \delta_j o_j + \alpha \Delta w_{ji}(n-1)
\]  
(6)

Then the error signal \( \delta_k \) is transmitted back to the input layer, and the input layer error signal \( \delta_j \) is obtained, and the weight adjustment between the input layer and the hidden layer is played as shown in equation 7.

\[
\delta_j = o_j (1 - o_j) \sum_k \delta_k w_{kj}
\]

\[
w_{ji}(n) = w_{ji}(n-1) + \eta \delta_j x_j + \alpha \Delta w_{ji}(n-1)
\]  
(7)

\( \eta \) is the learning rate, \( \alpha \) is the momentum term, so as to improve the training speed of BP neural network, and can maintain a certain stability.

Through the network training, to meet the requirements, the interconnection weights between the nodes of the network is completely determined, it is said that the entire BP network has a good learning.

2.2. Model building

2.2.1. Determining the parameters of BP neural network

The common BP neural network has three layers: input layer, hidden layer and output layer. The input layer, the output layer neuron number is determined based on the actual, and the number of neurons in hidden layer can still determine the principle: the cell number of hidden layer is larger than the half of the input and output.
neurons, and less than the input and output layer neuron number. The learning rate \( \eta \in (0,1) \) and the momentum term affecting the learning efficiency of training \( \alpha \in (0,1) \).

2.2.2. Network training to get the connection weights between each layer

When the parameters of the model are determined, the training samples are trained. When all the training samples are trained, the connection weights between the input layer and the hidden layer, the hidden layer and the output layer are obtained. The training process is shown in figure 2.

![Flow chart of BP algorithm training](image)

**Figure 2.** Flow chart of BP algorithm training

2.2.3. Calculation weight

The correlation coefficient is shown in formula 8.

\[
 r_{ij} = \sum_{k=1}^{p} W_{kj}(1 - e^{-x}) / (1 + e^{-x})
\]

\[ x = W_{jk} \] (8)

The correlation index is shown in formula 9.
\[ R_y = \left(1 - e^{-y}\right)/\left(1 + e^{-y}\right) \]

\[ y = r_{jk} \quad (9) \]

The absolute influence coefficient is shown in formula 10.

\[ S_y = R_y / \sum_{i=1}^{m} R_{ij} \quad (10) \]

The correlation coefficient of each layer is analyzed by using the method of significant correlation coefficient to analyze the influence degree of each index on the global credibility. The normalized relation can be used to obtain the relationship between input and output, that is, the weight vector of the index \( W \). The normalization formula is shown in formula 11.

\[ w = \frac{R_{ik}}{\sum R_{ik}} \quad (11) \]

The \( R_{ik} \) is the absolute influence coefficient in the significant correlation coefficient method.

3. THE APPLICATION OF BP NEURAL NETWORK IN THE PREDICTION OF MARKETING DATA

Source data is Moulded Case Circuit Breaker (MCCB) and Automatic Circuit Breaker (ACB) these two products in a region 2011-2016 sales records. As shown in table 1 and table 2.

**Table 1. Sales volume of ACB**

<table>
<thead>
<tr>
<th>Particular year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
<th>7</th>
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<th>9</th>
<th>10</th>
<th>11</th>
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<td>2011</td>
<td>16</td>
<td>17</td>
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<td>19</td>
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<td>30</td>
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<td>2013</td>
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<td>14</td>
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<td>107</td>
<td>53</td>
<td>58</td>
<td>36</td>
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<td>2014</td>
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<td>16</td>
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<td>162</td>
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<td>2015</td>
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<td>158</td>
<td>75</td>
<td>53</td>
<td>68</td>
<td>51</td>
<td>121</td>
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<td>2016</td>
<td>27</td>
<td>74</td>
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<td>91</td>
<td>208</td>
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<td>84</td>
<td>103</td>
<td>90</td>
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**Table 2. Sales volume of MCCB**

<table>
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<th>Particular year</th>
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As a set of data for every two years to train a neural network, MCCB and ACB can train a total of 6 network structure.

The neural network is used as the input of the neural network, and the real value of the corresponding month is regarded as the output of the neural network. Here is a comparison of the predicted and true values:

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales Volume</th>
<th>Truth Value</th>
<th>Predicted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>35 18 186</td>
<td>44 619 503</td>
<td>409 97 124 155</td>
</tr>
<tr>
<td>2012</td>
<td>134 315 325</td>
<td>613 1636 770</td>
<td>773 740 289 338</td>
</tr>
<tr>
<td>2013</td>
<td>232 710 581</td>
<td>595 1314 3407</td>
<td>1777 3776 1036</td>
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<tr>
<td>2014</td>
<td>1029 648 783</td>
<td>1510 3805 1691</td>
<td>1623 1191 1541</td>
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<tr>
<td>2015</td>
<td>642 689 1118</td>
<td>916 1356 1014</td>
<td>1416 1108 1511</td>
</tr>
<tr>
<td>2016</td>
<td>1394 1244 2474</td>
<td>2748 2300 2066</td>
<td>1989 1832 1659</td>
</tr>
</tbody>
</table>

**Figure 3.** 2011-2012 neural network prediction results

**Figure 4.** 2013-2014 neural network prediction results

**Figure 5.** 2015-2016 neural network prediction results
By the above prediction results can be seen, the prediction results of neural network are in good agreement with the true value can be calculated, the error control in less than 4%, so using neural network algorithm to predict the MCCB and ACB is very suitable.

4. CONCLUSION

The enterprise product sales forecast for the future, the qualitative forecast theory, excessive human intervention, can not reflect the actual situation of all kinds of unexpected objective, so the error is large, there are some wrong information included, so we can use mathematical statistics, the mature prediction method in artificial intelligence, or the neural network method to forecast, this kind of algorithm has theoretical support to mature, reliable predictions of the information. Neural networks can approximate the neuron information of all quantitative or qualitative nonlinear relationship, any complex are stored in the potential distribution in the network, it has strong robustness and fault tolerance, using the parallel distribution processing method, making quick lots of computing is possible, but do not know or learning and adaptive system not sure, can handle both
quantitative and qualitative knowledge of the five major advantages. The results of this paper can be concluded that the neural network algorithm has a high accuracy in predicting the future sales of the product, and the prediction error can be controlled within 4%. Through the establishment of the neural network model of future product sales forecast, we can predict the future product sales, can grasp the market direction, and make the enterprise get the maximum profit.

REFERENCES