

PRICE FORECASTING MODES USING NEURAL NETWORK AND TIME SERIES METHODS FOR ELECTRONIC BUSINESS

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Abstract: *With the advent of e-commerce, enterprises can no longer rely on static business strategies. They have to be able to cope in dynamic and uncertain electronic environment especially when developing pricing strategies. The ability to predict the price of any product is a difficult task. Many different techniques have been proposed to solve the task of financial prediction. However, not many works have been dedicated to exploring the problem in relation to the electronic environment.*

Keywords: *E-commerce, forecasting, neural network, time series, classification.*

I. INTRODUCTION

A neural network is a machine i.e. designed to model the way in which the brain performs a particular task or functions of interest. The network is usually implemented by using electronic components or is simulated in software on a digital computer. To achieve good performance, neural network employs a massive interconnection of simple computing cells referred to as neurons or processing units. An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well.

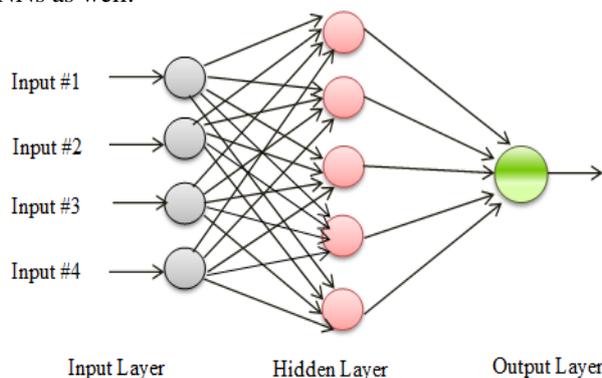


Fig 1.1: Neural network structures.

II. LITERATURE SURVEY

As a part of background work, few application of forecasting price using neural network and time series method are investigated. Each of them is carried out by a detailed study of their research paper. The summary of each of the research paper is given below.

2.1 Forecasting of INR/USD exchange rate using artificial neural network [3].

The objective of this research is to show the effect of number of input nodes and hidden nodes of neural network on forecasting and to show large number of observations reduces forecast errors. The dataset used here is a daily currency exchange rate from beginning of 1989 to end of 2009. They have chosen one layer with ten nodes each for input layer, one layer with five nodes for hidden layer and one layer with one node for output layer. The detailed study of this research leads to the conclusion that number of input nodes has a greater impact on forecasting rather than number of hidden nodes.

2.2 Forecasting sales using neural network [4].

The objective of this research is to show that neural network method of sales forecasting is far better than the traditional way of forecasting. The dataset used here is weekly observation on advertise spending, temporary price reduction, holiday, seasonal, late opening period for one full year. One layer with seven nodes each, one layer with four nodes each and one layer with one node is used for input layer, hidden layer and output layer respectively. Back propagation algorithm is used from hidden, layer to input layer. Detailed study of this research paper leads to the conclusion that neural network approach outperforms the statistical approach.

2.3 Estimation of product final price using Bayesian Analysis and ANN [6].

This research paper introduces a new method of forecasting called Bayesian Analysis. The objective of this paper is predicting future price of a product using Bayesian analysis and neural network methods. Detailed study of this research paper leads to the conclusion that the proposed method is precise, fast and without errors.

III. FORECASTING

Forecasting is a planning tool that helps management in its attempts to cope with the uncertainty of future, relying mainly on data from the past and analysis of trends.

Forecasting starts with certain assumptions based on management’s experience, knowledge and judgment. These estimates are projected into the coming months or years. Price forecasting is defined as the act of predicting business profit or loss of an industry or an organization for a future period of time.

3.1 Categories of forecasting method.

3.1.1 Qualitative and Quantitative method

a) Qualitative method: Qualitative method relies on subjective opinion from one or more experts. Market research, Panel consensus and historic analogy are few of the sub methods in qualitative method of forecasting.

b) Quantitative method: Quantitative method relies on data and analytical techniques. Time series, casual relationship and simulation are few sub methods of quantitative method of forecasting.

3.1.2 Time series method: A time series is a sequence of data points which consists of successive measurements made over a time interval. It uses historical data as the basis of estimating future outcomes.

a) Moving average: The moving average model is used to exclude irregularities in the time series pattern. This strategy calculates the average of the time series values in the historical time horizon. This forecast strategy is only suitable for time series that are constant; that is, for time series with no trend-like or season-like patterns.

b) Autoregressive Integrated Moving Average: A statistical analysis model that uses time series data to predict future trends. It is a form of regression analysis that seeks to predict future movements along the seemingly random walk taken by stocks and the financial market by examining the differences between values in the series instead of using the actual data values.

3.1.3 Artificial intelligence method: Artificial intelligence is an area of computer science that emphasizes the creation of intelligent machine that work and reacts like humans.

a) Artificial neural network: artificial neural networks are a family of models inspired by biological neural networks and are used to estimate or approximate functions that can depend on a large number of inputs and are generally unknown. The unique characteristics of ANN like adaptability, non-linearity and arbitrary function mapping make them quite suitable and useful for forecasting task. ANN’s give satisfactory performance in forecasting.

b) Group method of data handling: GMDH algorithm is characterized by inductive procedure that performs sorting out gradually complicated polynomial model and selecting the best solution by means of so called external criteria. GMDH improves the accuracy of time series forecasting.

3.2 Applications of price forecasting.

3.2.1 Strategic planning: Strategic planning is an organization's process of defining its strategy, or direction, and making decisions on allocating its resources to pursue

this strategy. It may also extend to control mechanisms for guiding the implementation of the strategy.

3.2.2 Financial accounting: Financial accounting is the field of accounting concerned with the summary, analysis and reporting of financial transaction pertaining to the business.

3.2.3 Production and Operation: Production and Operations Management is about the transformation of production and operational inputs into "outputs" that, when distributed, meet the needs of customers.

IV. DATASETS

The datasets used in our project is divided into current dataset and live datasets:

4.1 Current dataset: The current dataset consists of data which is used as input to develop our code. It is given by the management. The parameters in current datasets are advertise spending, promotional expense and quarterly sales. The figure 4.1 shows the current dataset used for developing a code for price forecasting.

Date	advertisin	promotioi	quarterly	predict furure
12-Feb	494	740	4350	1679
12-Mar	536	790	2020	2245
12-Apr	614	928	4764	2590
12-May	665	991	3456	2559
12-Jun	811	819	3658	3439
12-Jul	844	871	5220	3867
12-Aug	1047	945	7678	3460
12-Sep	1050	919	4210	3527
12-Oct	1153	1014	7890	3913
12-Nov	1271	1040	7328	4659
12-Dec	1374	1080	6187	5702
13-Jan	1616	1155	8526	5972
13-Feb	1603	1109	2858	6280

Fig 4.1: Current dataset for price forecasting

4.2 Live dataset: The live dataset consists of data which is used to train our code. Live data is taken from a website <http://www.minkagroup.net/>. Minkagroups are online retailer sellers which sells decorative lightings and fans. The parameters used in live dataset are competitor price, customer rating, minimum delivery time and maximum delivery time and customer ratings. Figure 4.2 shows live dataset used for price forecasting.

No.	Price	Customer rating	Delivery time-min	Delivery time-max	Seller ratings
1	135	0	216	576	99
2	73.9	5	72	120	96
3	119.9	5	72	120	99
4	217.9	5	72	240	0
5	105.9	53	0	12	99
6	185.9	55	0	11	100
7	130.9	895	0	9	100
8	115.9	755	0	8	99
9	95.9	51	0	144	99.6
	339.95	815	24	48	100
11	339.9	725	24	48	93
12	209.95	555	48	96	99
13	209.95	885	336	384	100
14	239.95	25	72	120	99
15	239.95	865	0	11.49	99

Figure 4.2: Live dataset for price forecasting

V. PROPOSED METHODOLOGY

Below Figure 5.1 shows the proposed methodology for this Project.

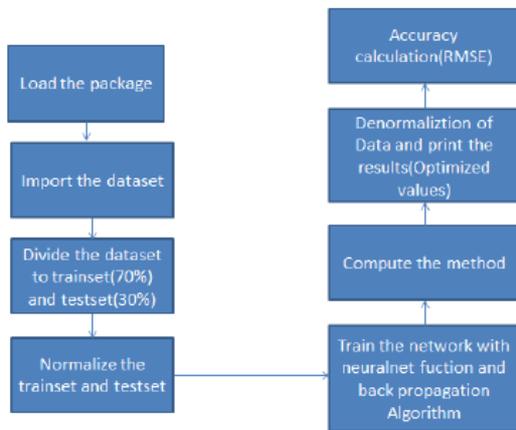


Fig 5.1: Working of proposed method

1. Load the package: load the neuralnet package in the code.
- 2.Import the dataset: we need to import the required dataset.
- 3.Divide the dataset: we need to divide the dataset into trainingset(70%) and testset(30%)
4. Normalize the dataset: getting down to average or within the particular scale.
5. Training a network: Training the network with some parameters using neuralnet function and back propagation algorithm.
6. Compute the method: compute the method with the functions.
7. Denormalization: Again we need to denormalize the data.
8. Accuracy: Accuracy calculated by RMSE.

5.1 Algorithm

5.1.1 Time series forecasting: Time series method is the use of a model to predict future values based on previous observed values. The input for the time series method consists of 48 previous sales observations. It consists of three parameters- promotional expenses, quarterly sales and advertises spending.

The following is the R code for time series method of forecasting.

```

#Step1: Call library function-forecast
#Step2: Import data
#Step3:Fetch the time series data according to the date
# Step4:Perform exponential smoothening
#Step5: Perform forecasting
#Step6:Create an array for the forecast values
#Step7:Perform forecasting based on time series for next values
    
```

5.1.2 Neural network method: This method uses the artificial neural network concept for predicting the future values. The input for the time series method consists of 21 previous sales observations. It consists of three parameters- promotional expenses, quarterly sales and advertise spending.

The following is the R code for neural network method of forecasting.

```

#Step1:Call the library functions
#Step2:Import the data
#Step3:Eliminate the first column
#Step4:Split the data to training and testing set
#Step5:Apply max Function to the columns of data
#Step6:Apply min function to the columns of data
#Step7:Scale is a normalization function
#Step8: Predict the future price using neuralnet function
#Store the output vales in nn variable
#Step9: Create arda file and store the output in rda file
#Step10:Load the library functions
#Step11:Import the input data file
#Step12:scale is a normalization function #scale the center of matrix and store it a data frame
#Step13:Load the rda file. This contains the output of prediction value
#Step14:compute neuralnet function for the scaled matrix and store it in forecast variable
#Step15:calculate forecast result by subtracting the maxima and minima of data matrix
#Step16:create a frame res combining prediction and forecastresult arrays
#Step17:Forecasting values for next few months ahead
    
```

VI. ACCURACY CALCULATIONS, RESULTS

Accuracy is a measurement of closeness between the result and a true value. Root mean square error is the accuracy measurement used in our project. The root mean square error is defined by the following formula,

$$RMSE = \frac{\sqrt{\text{Actual}-\text{Prediction}}}{\text{Total no.of datasets}}$$

Where, n = number of observed values,

yj = input values

yj^ = predicted output values

The following table shows the accuracy values for time series method and neural network method.

Code	Dataset	Accuracy
Time series method	Current dataset	0.19
Neural network method	Current dataset	0.10
Time series method	Live dataset	0.89
Neural network method	Live dataset	0.10

The below figure shows the output of proposed model.

Forecast_Values	
1	1763.7
2	2088.9
3	3589.7
4	4163.4
5	2870.1
6	3362.7
7	4081.4
8	3700
9	4949.1

VII. CONCLUSION AND FUTURE ENHANCEMENT

From the whole project it can be concluded that forecasting can be accurate for a group or family of items and for shorter period of time. Forecasting needs constant observation of historical sales and also every forecast should include error estimate. Finally it can be concluded that forecasting is one of the best application of neural network approach of problem solving. As a part of future enhancement this project can aim to use different neural network architecture, different learning rates and change in number of neurons in the input layer, hidden layer and output layer.

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