Stock Market Prediction using Backpropagation Algorithm

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***Abstract*—Stock price analysis is a popular and important topic in financial and academic studies. No significant rules are present to estimate or predict the price of share,. Various analysis such as technical analysis, fundamental analysis, time series analysis and statistical analysis, etc. are actively researched in attempt to predict the price of stock but none of the tools implementing these methods prove to be consistent so far. The implementation of Artificial Neural Network approach is done to predict stock market prices for Himalayan bank, Nabil Bank, Everest Bank Limited. The work focuses on implementing Backpropagation algorithm for forecasting stock prices, returns, and stock modeling. The prediction is done on the listed companies of Nepal Stock Exchange Ltd (NEPSE). Opening price, Closing price, High price, Low price are selected as parameters which has relatively significant impact on the share price of a company. The relation between the selected factors and share price is formulated which can help in forecasting results. The main aim of the work is to apply Artificial Neural Network in forecasting the closing price of stock market although share market can never be predicted accurately due to its huge domain.**

Keywords—Backpropagation, Stock Market, Nepal Stock Market and Exchange (NEPSE).

I. INTRODUCTION

Stock market plays an important role in the growth of the industry and commerce of the country which eventually influences economy of the country. The primary source for any company to raise funds for business expansion is stock market. All the concepts for stock market is based on demand and supply. If the demand for any company's stock is high then share price of company increases and if the demand for that company's stock is low then share price of that company decreases.

The only stock exchange where involvement of many number of industries and companies are involved, in the context of Nepal is "Nepal Stock Exchange Limited" (NEPSE), operating under securities act, 1983. Due to large involvement of industries and company it contains very large set of data. That is why it is difficult to extract information. Stock market analysis and prediction will analyze the market patterns and predict the time to purchase stock. The successive prediction of a stock's future price can mean a significant profit.

The main problem in predicting share market is that it is a chaos system. Many variables are present and are unpredictable that could affect the share market directly or indirectly. Drawing any mathematical relation among the variables is pretty difficult. Likewise, no laws are present to predict the share price using these variables.

Backpropagation is an important mathematical tool for improving the accuracy of predictions in machine learning. It is an algorithm used to calculate derivatives quickly. A known, desired output values for each input is required in order to calculate the loss, it is usually classified as a type of supervised machine learning.

II. STOCK MARKET PREDICTIONS

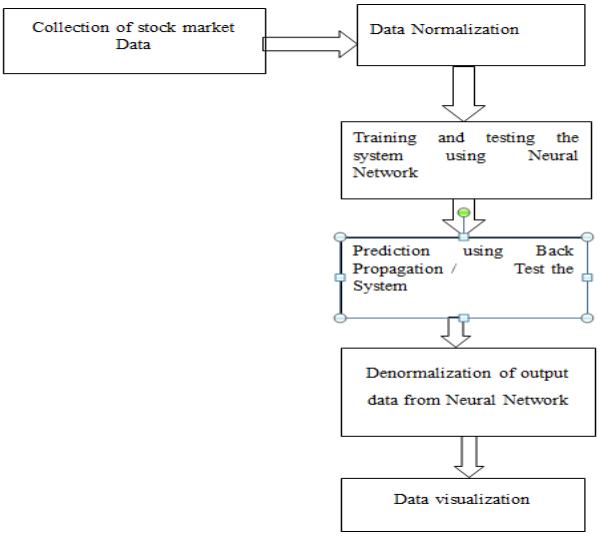

Fig. 1: System block diagram

The data are collected and sorted for relevancy from various sources. Secondly, analysis is carried out on the collected data by examining the current market direction, tracking the industry group and the specific companies.

A) Data Collection

The work aims to predict the stock value with respect to previous stock values and trends. It requires historic data of stock market as it also emphasizes on data mining techniques. The necessary thing is to have a trusted source having relevant and necessary data required for the prediction such that data are real. Nepal Stock Exchange (NEPSE) website (http://www.nepalstock.com.np) is used as the primary source of data. This website contains all the details such as: Opening value, closing value, High value, Low value, number of shares, increase or decrease in stock values for each company. The site keeps on updating on daily basis and also acts as a repository for years of stock market data for Nepal. No API is yet provided by the website for providing data so, the data are collected manually in spreadsheet with reference to the webpage. Other sources for data collection include significant data from Open Data Nepal, sharesansar and relevant online news portals related to finances and share markets.

B) Data Filtering

The data are filtered to create a condition that only certain relevant data are in display making it easier to focus on specific information in a large dataset or table of data.

C) Data Normalization

Before setting input to the ANN, the data is normalized. The input parameters of the training data are normalized in a way that all the features are zero-mean and unit variance. Minmax function is used for normalization such that all the target values lie in the range of 0 to 1. The maximum value is represented by 1 and the minimum value is represented by 0. The equation (1) shows the Minmax function:

$$\boldsymbol{z = \frac{x - min(x)}{max(x) - min(x)}} \quad (1)$$

D) ANN Design and Training

An ANN (Artificial Neural Network) is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. An artificial neuron can process the received signal then signal additional artificial neurons connected to it. In common ANN implementation, the signal at a connection between artificial neurons is a real number, and the output of each artificial neuron is computed by some non-linear function of the sum of its inputs [10]. Edges are the connections between the artificial neurons. Artificial neurons and edges typically have a weight. As learning proceeds, the weight adjusts. The strength of the signal at a connection is signified by increase or decrease in the weight. In Artificial neurons having a threshold, the signal is only sent if the aggregate signal crosses that predefined threshold. Typically, artificial neurons are aggregated into layers. Different layers in ANN may perform different kinds of transformations on their respective inputs. Signals travel from the preceding layer (the input layer), to the last layer (the output layer), possibly after traversing the layers multiple times. Neural network is used for prediction because they can run nonlinear mappings between input and outputs. There is possibility that ANN outperforms traditional analysis like Linear Regression. In our proposed system, during training phase the weights are found from this section and Backpropagation Algorithm is used for this training phase. The weights found here are used in prediction phase using same equations which are used in training phase.

E) Back propagation

The main steps using the backpropagation algorithm is as follows:

Step 1: The normalized input data sample is fed into the system to compute the corresponding output.

Step 2: The error between the output(s) and the actual target(s) is computed.

Step 3: Then, the connection weights and membership functions are adjusted.

Step 4: IF Error > Tolerance then, continues & goes to Step 1

Else the process is terminated.

F) Activation Function

In this work the following activation function has been experimented with:

1) Sigmoid Activation

Sigmoid activation as the activation function at both hidden layer and output layer. A sigmoid function is a mathematical function having a characteristic "S"- shaped curve or sigmoid curve which is given by:

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

2) Soft-plus Activation

Soft plus is an alternative of traditional functions because it is differentiable, and its derivative is easy to demonstrate. Outputs produced by sigmoid and tanh functions have upper

and lower limits whereas soft plus function produces outputs in scale of (0, +∞).

$$f(x) = ln(1+e^x) \quad (3)$$

3) Tanh Activation

The tanh function is also sigmoidal ("s"-shaped), but instead outputs values that range (-1,1). Thus, strongly negative inputs to the tanh will map to negative outputs.

$$f(x)=tan\ h(x) \quad (4)$$

G) Model Design

Feed-forward neural network which has input layer with 3 neurons, a single hidden layer which has 3 hidden neurons and a output layer with single neuron. The backpropagation algorithm has been used for training the network.

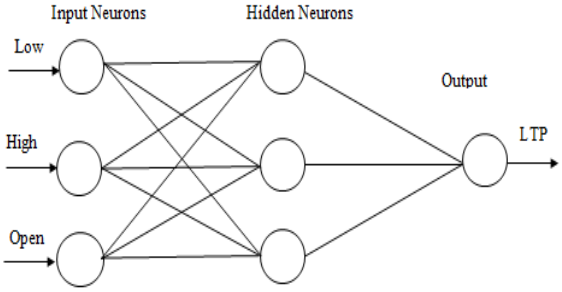

Fig. 2: Feed-forward neural network

In this work, the weight has been randomly initialized between the range of -0.5 to 0.5:

Weight for input to hidden layer:

weight [0][0][0]=0.4;

weight[0][1][0]=-0.3;

weight[0][2][0]=0.2;

weight[1][0][0]=0.1;

weight[1][1][0]=-0.02;

weight[1][2][0]=0.05407000332;

weight[2][0][0]=-0.43000020002384;

weight[2][1][0]=-0.44400005664500013352;

weight[2][2][0]=0.200600179356;

Weight for hidden to output layer:

w[0][0]=-0.03110000030598;

w[1][0]=-0.13330000000034013789;

w[2][0]=0.2344237988;

Also, the learning rate has been set to 0.1 and the momentum is set to 0.9 whereas bias has not been taken into consideration.

H) Data Denormalization

Data denormalization is done after normalized value is determined. For denormalization, minimum and maximum value will be the same as used before during normalization process.

$$X= (z*(max(x)-min(x))+min(x) \quad (5)$$

where,

max(x)= maximum value calculated from dataset

min(x)= Minimum value calculated from dataset

I) Input Data

Here is a brief description about the inputs that are fed to the neural network.

1. Open Value:

It is the opening value of the share price of a company that reaches at the start of the day.

2. Highest Value:

It is the highest value of the share price of a company that has reached in the previous day

3. Lowest Value:

Lowest Value is Similar to highest value, it is the smallest value the share price of a company that has reached in the previous day.

4. Closing Price:

Closing price generally refers to the last price at which a stock trades during a regular trading session. For NEPSE regular trading sessions run from Sunday - Thursday (11:00 AM to 3:00 PM).

III. RESULT

The experiment was carried out with 8-year sample data. The collected data was normalized and then feed into backpropagation for training to achieve adjusted weight then, forward pass was done with the adjusted weights. The output was generated and then de-normalized.

The results obtained are shown in the graph and tables generated by using three different activation functions for the respective analysis of datasets. The datasets under consideration are of Everest Bank Ltd., Himalayan Bank Ltd. and NABIL Bank Ltd.. The result obtained was analyzed by calculating Percentage Error for each dataset using the formula as:

$$Percentage\ error= ((Actual\ LTP- Predicted\ LTP)/ (Actual\ LTP))* 100\% \quad (6)$$

The respective graph for each dataset using sigmoid function, tanh function and soft plus function for all three banks are given below:

A) Everest Bank Ltd.

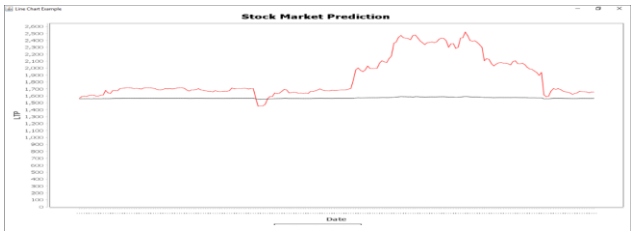

Fig. 3 : Sigmoid output for 1 year

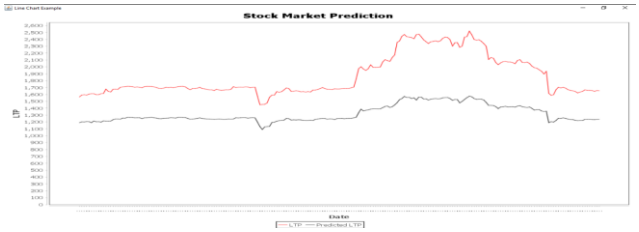

Fig. 4 : Tanh Output for 1 year

Fig. 5: Soft plus Output for 1 year

B) Himalayan Bank Ltd.

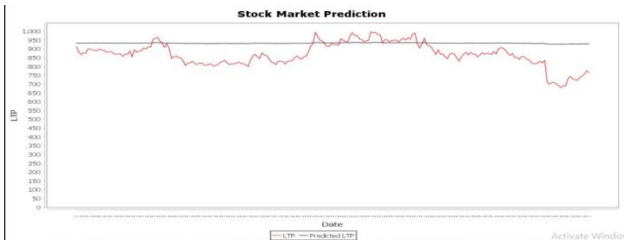

Fig. 6 : Sigmoid output of 1 year

Fig. 7 : Tanh Output of 1 year

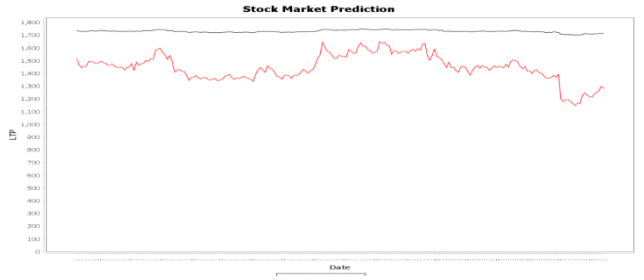

Fig. 8: Softplus Output of 1 year

C) NABIL Bank Ltd.

Fig. 9: Sigmoid Output of 1 year

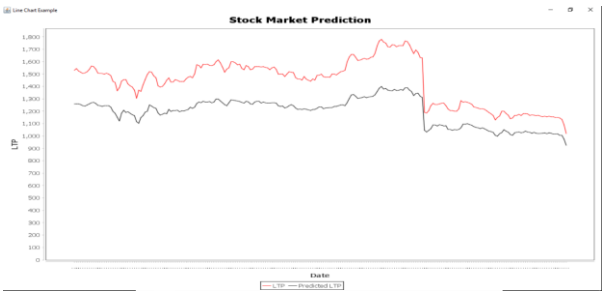

Fig. 10: Tanh Output of 1 year

Fig. 11: Soft plus Output of 1 year

IV. CONCLUSION

The adaption of machine learning system is found to be suitable for the optimization in the work. The experimental dataset applied, is selected from the NEPSE of Everest bank, Himalayan Bank and Nabil Bank. The system is built as web-application using Java Programming that generates values & graph as output. On detailed analysis of graph, LTP output using tanh activation function is found to comply with the variation of actual LTP whereas sigmoid and soft-plus doesn't show significant variation with change in pattern of actual value. For the dataset under consideration, soft-plus is not proved to be efficient as it shows high accuracy for a datasets and very low accuracy for other two. However, the

sigmoid output is found to be focused on accuracy and is suitable for the datasets which are less varying. And the use of tanh activation is found to be suitable for highly varying dataset.

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