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Application of Artificial Neural Network to Stock Forecasting- Comparison with SES and ARIMA

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Abstract

Stock market also known as equity market is a public entity which is a loose network of economic transactions, not a physical facility or discrete entity for the trading of company stock or shares and derivatives at an agreed price. Artificial Neural Network (ANN) is a field of Artificial Intelligence (AI), which is a common method to identify unknown and hidden patterns in data which is suitable for stock market prediction. In this study we applied a time-delayed neural network model for forecasting future price of stock by using Artificial Neural Network (ANN) methodology. We compared ANN with Single Exponential Smoothening (SES) and Autoregressive-Integrated-Moving-Average (ARIMA) models, the ANN forecasting tool proved to be more precise than the SES and

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ARIMA as it had a smaller Root Mean Squared Error (RMSE) of 0.686 as compared to the RMSE of the SES which was 2.7400 and ARIMA which was 1.6570.

Mathematics Subject Classification: 68T01
Keywords: Artificial Neural Networks; Forecasting; Stock; Single Exponential Smoothening; Autoregressive-Integrated-Moving-Average

1 Introduction

A neural network in information technology is a system of data structures and programs that approximates the operation of the human brain. A neural network more often than not involves a great number of processors operating in parallel, all with its own small sphere of knowledge and right of entry to data in its local memory. Classically, a neural network is at first "trained" or fed huge amounts of data and rules about data relationships. A program knows how to then inform the network how to behave in reaction to an external stimulus or can start activity on its own. Present applications of neural networks include: oil exploration data analysis, weather prediction, the interpretation of nucleotide sequences in biology labs, and the exploration of models of thinking and consciousness, financial forecasting to mention but a few. However, neural networks are used for quantitative modeling for researchers and practitioners [1], [2]. A stock market also known as equity market is a public entity which is a loose network of economic transactions, not a physical facility or discrete entity for the trading of company stock or shares and derivatives at an agreed price such as securities listed on a stock exchange as well as those only traded privately. The stocks are listed and traded on stock exchanges which are entities of a corporation or mutual organization specialized in the business of bringing buyers and sellers of

the organizations to a listing of stocks and securities together.

The main reason of this paper is to forecast future stock value by using ANN methodology on the basis of available daily data from April 2013 to June, 2013. Also to compare the forecast performance of the ANN model with that of Single Exponential Smoothening (SES) and Autoregressive-Integrated-Moving-Average (ARIMA) based models, as a result of difficulty of data over-fitting with SES and ARIMA. It is experiential that forecasts based on ANN are more accurate than those based upon SES and ARIMA models. This paper is organized as follows: Literature on neural network is the next section, follow by data and methodology section, and then forecasting evaluation section and the last section is on the summary of our findings.

2 Literature Review

ANN is described as [3] the basis lagged six periods, [4] the RSI differential of the futures price and the index, [5] the MACD differential of the futures price and the index, [6] the change of the basis, [7] the RSI of the basis, [8] the MACD of the basis. In their work Zabir et al [9] used Backpropagation algorithm for training session and Multilayer Feedforward network as a network model for predicting stock price. They also introduced a method which can predict share market price using Backpropagation algorithm and Multilayer Feedforward network. Akdemir and Yu [10] proposed method of predicting stock which consist of three stages first, arranging the real time data, second data normalization according to Euclidean distance named Euclidean Based Normalization Method (EBNM) and performing artificial neural network to predict the next swing of the stock or financial marketing. The results compared raw data results and minimum maximum normalization methods to EBNM. Mean squared error and Average Deviation and R2 statistical value were used as performance criteria. The

performance of the proposed method has more accurate than the other two methods. Alexandrov et al.[11] propose a new computational method of input selection for stock market forecasting with neural networks. The method results from synthetically considering the special feature of input variables of neural networks and the special feature of stock market time series. They conducted the experiments to compare the prediction performance of the neural networks based on the different input variables by using the different input selection methods for forecasting S&P 500 and NIKKEI 225. The experiment results show that our method performs best in selecting the appropriate input variables of neural networks.

In their paper, Vaisla et al [12] employed Neural Networks and Statistical techniques to model and forecast the stock market prices and then the results of these two models are compared. The forecasting ability of these two models was accessed using MAPE, MSE and RMSE. The results show that Neural Networks, when trained with sufficient data and proper inputs, can predict the stock market prices very well. Statistical technique though well built but their forecasting ability is reduced as the series become complex. Therefore, Neural Networks can be used as an alternative technique for forecasting the stock market prices. Alhassan and Misra [13] in their work proposes forecasting stock prices in the stock market industry in Nigeria using a Weightless Neural Network (WNN) and a neural network application was used to demonstrate the application of the WNN in the forecasting of stock prices and implemented in Visual Foxpro 6.0. The system is compared with Single Exponential Smoothing (SES) model and WNN is observed to be more accurate and closer to the real data than those using the SES model.

3 Comparing Forecast Performance of ANN and SES and ARIMA Based Models

The performance of the ANN was compared with Single Exponential Smoothening (SES) and Autoregressive-Integrated-Moving-Average (ARIMA) using the same set of data. Results based on ANN methodology as well as both SES and ARIMA methodologies are presented in table 2. The forecasting performance on was evaluated on the basis of RMSE criteria. Therefore, RMSE of ANN based forecasts is less than the RMSE of forecasts based on SES and ARIMA models. At least by this criterion forecast based on ANN are more precise.

3.1 Model Description

Feedforward with backpropagation architecture is used for the neural network for forecasting the next stock value.

$$F_{t+j} = \sum_{k=1}^{n} \phi_k \mathrm{Tanh}(w_k x_{t-1} + b_k) \quad (1)$$

Equation 1 represent the neural network equation for forecasting the next stock. Where: F_{t+j} is the neural network forecast *j* days ahead, x_{t-1} is a vector of lagged inflation variables [F_{t-1}, F_{t-2}] tanh which is the hyperbolic tangent function used as transformation process. ϕ's are layer weights, wi are input weights and b's are biases. The implementation is as follows; A Time-delayed neural network model was used to forecast the next stock value. This model is built to capture the relationship between the historical stock values and next day value. In this model, the normalized stock values of the previous days are fed to a neural network so as to forecast the next value. The formula for normalizing the raw data is given in equation 1. The inputs to the neural network are FX_{i-4}, FX_{i-3}, FX_{i-2}, FX_{i-1}, and FX_i,

while the output of the neural network is FX_{i+1}, the next day's stock value where *FXi* stands for the current day's stock value. The FX_{i-1} means the current day stock value minus the previous day stock value, FX_{i-2} stand for the previous stock value minus the previous two day stock value, as so on.

$$Nm = \frac{2 * Y - (Max + Min)}{Max - Min} \tag{2}$$

Equation 2 is used to achieved the original scaling of data within the range [-1 , +1].

3.2 Forecasting Evaluation

To calculate the root mean of squared errors (RMSE) to evaluate the forecast with the equation 3. The training algorithm is run on the training set until the RMSE starts to increase on the validation set.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (Y_{it} - Y)^2}{n}} \tag{3}$$

4 Data used, figures and tables

The data used in this study are stock data for Zenith Bank collected for the period of three months from April, 2013 to June, 2013. In forecasting the stock we used a time delayed artificial neural network model with 2 hidden layers. On a daily basis on the trading on the floor of Nigeria Stock Exchange Commission, these data were collected within these periods.

Figure 1 represents the stock data collected from Nigeria Stock Exchange Commission for Zenith Bank. The Y-axis represents the stock values while the x-axis represents the date.

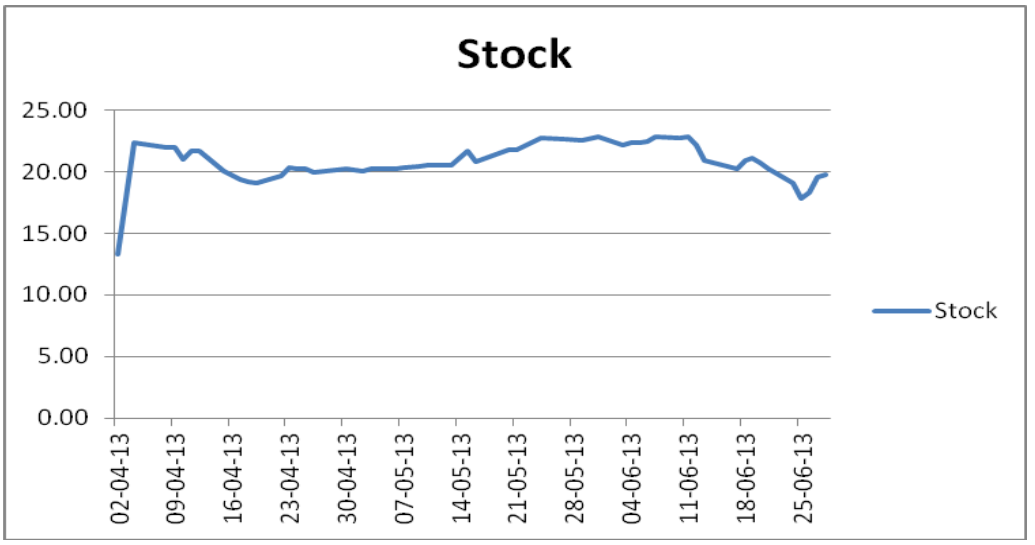

Figure 1: Graphical Representation of the data used

Results of the normalized stock data are shown in Figure 2, the scale is [+1,-1]. The x-axis represents the date of the stock value while the y-axis represents the normalized value of the highest is +1 and the lowest is -1.

The architecture of this neural network is 5-2-1 where 5 represents the number of inputs to the network, 2 represent the number of hidden layers and 1 represent the number of output. We use NMSE to measure the performance of this network.

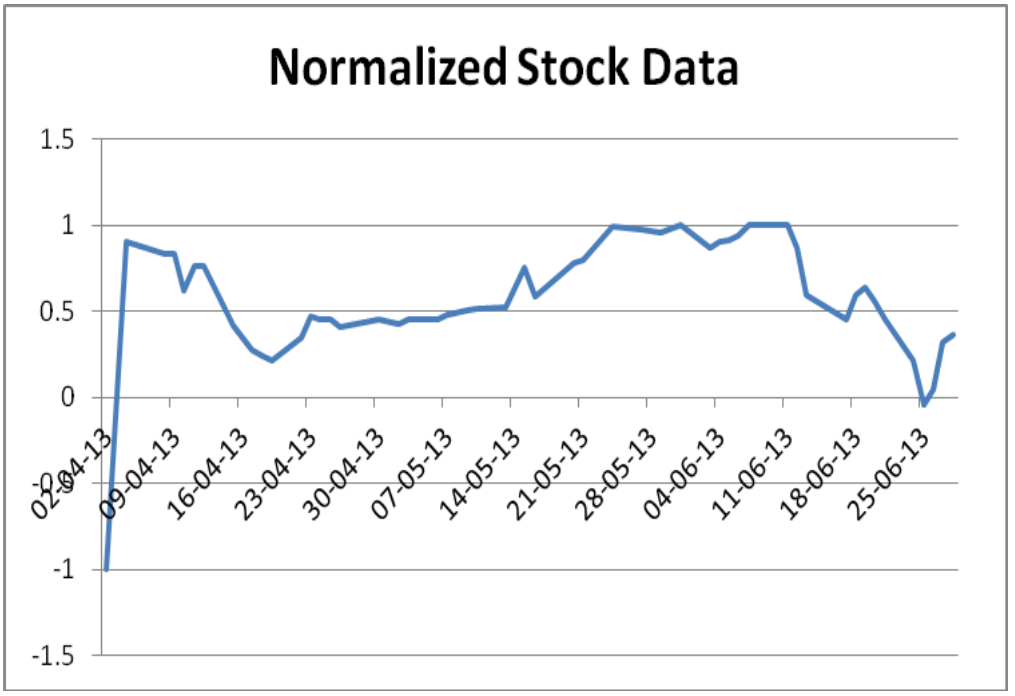

Figure 2: Stock Data in normalized scale [+1, -1]

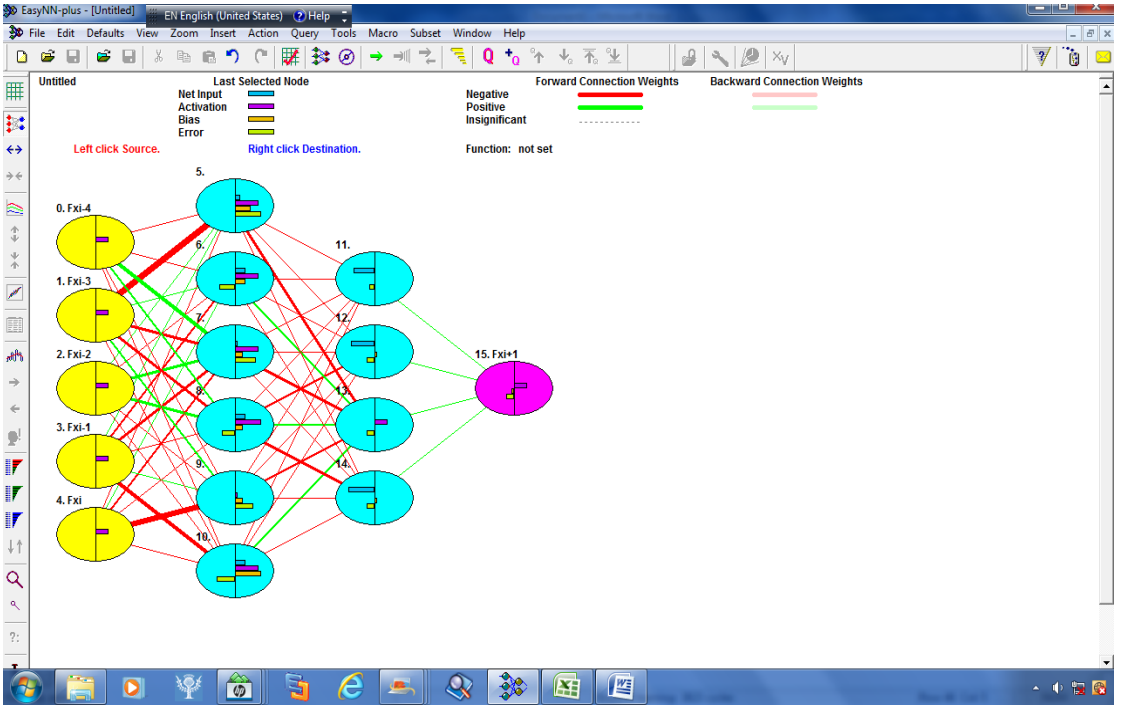

Figure 3: Architecture of the Artificial Neural Networks used

Easy Neural Networks software was used to train the neural network. Before training, this model requires some default values, which are given in Table 1.

Table 1: Neural network parameters used

S/No	Parameter	Value
1	Hidden Layers	2
2	Training rows	101
3	Input Columns	5
4	Input Nodes connected	5
5	Learning Rate	0.6000
6	Learning Cycles	401
7	Target Error	0.0100
8	Momentum	0.8000

Table 2: Comparison of the forecasting tools

TOOL	MIN. ERROR	RMSE
TNN	0.0000	0.0686
ARIMA(0,0,0)	1. 6570	1.6570
SES	0.0100	2.7400

5 Conclusion

In this study, a time-delayed artificial neural network model used to forecast future price of stock by using ANN methodology on the basis of daily data for April 2013 to June 2013. The major aim of this study is to find dependable

out-of-sample forecast based on RMSE minimization criteria, in which error unsteadiness is minimized after training network with 2 hidden layers. The leaning rate of our model is 0.6. Feedforward with backpropagation methodology is used as model simulation; this requires an activation function which used generalized delta rule. From our forecast result, we compared ANN with SES and ARIMA models, the ANN forecasting tool proved to be more exact than the SES and ARIMA as it had a smaller root mean squared error of 0.6860 as compared to the root mean squared error of the SES which was 2.7400 and ARIMA which was 1.6570. Further work can be done by comparing ANN with other available forecasting models.

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