

Forecasting Stock Prices using a Weightless Neural Network

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Abstract

In this research work, we propose forecasting stock prices in the stock market industry in Zimbabwe using a Weightless Neural Network (WNN). We design and implement a neural network application that is used to demonstrate the application of the WNN in the forecasting of stock prices in the market. The proposed network is tested with stock data obtained from the Kingdom Financial Holdings of Zimbabwe. The system prototype is designed using Microsoft Visual Basic version 6.0 and it provides the following features: forecast of stock prices in the market using a WNN that uses a ram node, forecast of stock prices in the market using the single exponential smoothing (SES) forecasting model and a comparison of the two forecasting tools using some quantifiable technique. Basing on the outcome of the comparison, we then conclude that forecasts done employing the WNN are more accurate and closer to the observed real data than those done using the single exponential smoothing model.

Keywords: Weightless Neural Network, Single Exponential Smoothing

Introduction

Traditionally, technical analysis approach that forecast stock prices based on historical prices and volume, basic concepts of trends, price patterns and oscillators is commonly used by stock investors to aid investment decisions. Advanced intelligent techniques ranging from pure mathematical models and expert systems to weighted neural networks have also been used in many financial trading systems for forecasting stock prices. [1] In their book, "Neural Networks in Finance and Investing: Using Artificial Intelligence to Improve Real-World Performance, Revised Second Edition (with software)", Robert R. Trippi and Efraim Turban, have assembled a stellar collection of articles by experts in industry and academia on applications of neural networks in this important arena. This widely acclaimed classic provides portfolio managers, institutional investors, bankers, and analysts with a comprehensive and fascinating introduction to this important technology and numerous insights into its most effective use. Neural network

successes and failures are discussed, as well as the vast unrealized potential of neural networks in numerous specialized areas of financial decision-making. [2]

Ramon Lawrence, from the University of Manitoba, wrote an article on the application of weighted neural networks in forecasting stock market prices. In his research work, he discusses common market analytics techniques and contrasts them with neural networks. He also presents the efficient Market Hypothesis and contrasts it with chaos theory and neural networks.[3] But he does not go on to do some experiments so as to put his theory work in practice. In order to put theory work into practice, there are some researchers that have built systems using the concepts of weighted neural networks that forecasts stock prices in the market. The Tradetrek™ Neuro-Predictor™ is essentially an Artificial Neural Network trained for adaptive prediction of stock prices. During the prediction process, the Tradetrek™ Neuro-Predictor™ determines whether a particular stock is predictable with the accuracy required for a statistically significant prediction. The Tradetrek™ Neuro-Predictor™ has managed to yield prediction refinements well beyond those of other systems by employing a pipelined recurrent ANN architecture (best for time-series prediction) and an adaptive supervised training procedure. [4]

Neuro XL Predictor is a neural network-forecasting tool that quickly and accurately solves forecasting and estimation problems in Microsoft Excel. It is designed from the ground-up to aid experts in solving real-world forecasting problems. The Neuro XL Predictor interface is easy-to-use and intuitive, does not require any prior knowledge of neural networks, and is integrated seamlessly with Microsoft Excel. The software brings increased precision and accuracy to a wide variety of tasks, including stock price prediction, sales forecasting, and sports score prediction. [5] Brain maker v3.7 is another neural network software that allows the user to use their computer for business and marketing forecasting, stock, bond, commodity, and futures prediction, pattern recognition, medical diagnosis, sports handicapping and a lot more. In addition, the user does not require any special programming or computer skills.[6]

There are other researchers as well who have done research work on the forecasting of stock prices in the market combining neural networks with other areas of science like fuzzy logic, while others have done their research extending the concepts of neural networks. Yi-fan Wang, in his paper, “On-Demand Forecasting of Stock Prices Using a Real-Time Predictor”, presents a fuzzy stochastic prediction method for real-time predicting of stock prices. This method is a complete contrast to the crisp stochastic method and it requires a fuzzy linguistic summary approach to computing parameters. This approach, which is found to be better than the gray prediction method, can eliminate outliers and limit the data to a normal condition for prediction, with a comparatively very small deviation of 4.5 percent. [7] Emulative Neural Networks are trainable

analytical tools that attempt to mimic information processing pattern in the brain and because they do not necessarily require assumptions about population distribution, economists, mathematicians and statisticians are increasingly using ENN's for data analysis.[8] In his paper, "Applying Neural Networks to Business, finance and Economics", Dr Yochanan Shachmurove, economics department in the University of Pennsylvania surveys the significance of recent work on emulative neural networks done by researchers across many disciplines in the light of issues of indeterminacy.

Other researchers have conducted experiments on their research work using real stock prices data and have come out with varying results. Yochachnan Shachmurove and Dorota Witkowska examined the dynamic interrelations among major world stock markets through the use of artificial neural networks. The data was derived from daily stock market indices of the major world stock markets. Multilayer Perceptron models with logistic activation functions were better able to foresee the daily stock returns than the traditional forecasting tools in terms of lower mean squared errors. They concluded that neural systems can be used as an alternative method or supplementary method for predicting financial variables and thus justified the potential use of these models by practitioners.[9]

Of all the work done, no one has used weightless neural networks as a tool for forecasting stock prices in the market. Instead all focus has been on the use of the weighted neural networks models. We then propose forecasting stock prices in the market using WNN taking also the following advantages that WNN have over the weighted neural networks. In contrast to the weighted neural models, there are several one-shot learning algorithms for WNN where training takes only one epoch and there exist many iterative learning schemes for WNNs. The possibility of implementing real networks in hardware is often considered to be one of the main features of WNNs. This is mainly the case for neurons such as the RAM node, which can be easily implemented by using commercially available RAM components [10] Instead of adjusting the weights, learning on WNNs generally consists of changing the contents of the look-up table entries, which results in highly flexible and fast learning algorithms. The high speed of learning process in WNNs is due to the existence of mutual independence between nodes when entries are changed, which contrasts with conventional weighted-sum-and- threshold neurons. The flexibility comes from the high degree of functionality of individual weightless neurons. Flexibility, easy parallel implementations, high-speed learning and possibility to implement real networks using commercially available RAMS are considered to be the main advantages of WNNs over their weighted counterparts. [11]

Data and Forecasting Methods Used

Stock data from the Kingdom Financial Holdings of Zimbabwe is used as our data source. The data used contains the daily stock closing prices with the corresponding date and the Company Name.

Forecasting using the WNN

We use a short-term forecast horizon and the WNN we design provides both a one point forecast and an m-point forecast of the stock price in the market (m being a variable ranging from 2 days to 90 days). We focus on the logic required to forecast stock prices in the market using the WNN according to the following constraints: We access the collected raw original closing stock prices data in multiples of x (where x is the forecast length). We have stored the raw closing stock prices data in Ms Access. We then normalize the accessed stock data so that values lie between 0 and 1.

Normalization of the raw stock data is done using the equation 2.1 below

$$\frac{(x - \alpha) \times (\beta - \lambda)}{(y - \alpha) + \lambda} \quad \text{Equation 2.1}$$

where x is the closing stock price

α is the lowest value of the collected list of stock prices

β is the upper limit

λ is the lower limit

y is the highest value of the collected list of stock prices

We then convert decimal fraction numbers to binary fractions and store the converted binary fractions in the network as a series of n patterns (n representing the number of past months). To make a forecast, we input an incomplete pattern into the system the network checks if such a pattern existed in the past. After identifying the pattern, the data lying at position m is then produced as the forecasted stock price.

The WNN is made up of five components. These are: a component for accepting input data, a component for normalizing our data, a component for converting decimal fractions to binary fractions, a component for identifying stored patterns and a forecasting component. We use a sequence diagram to explain how communication takes place inside the WNN we design. This is depicted in the Fig 2.1 below.

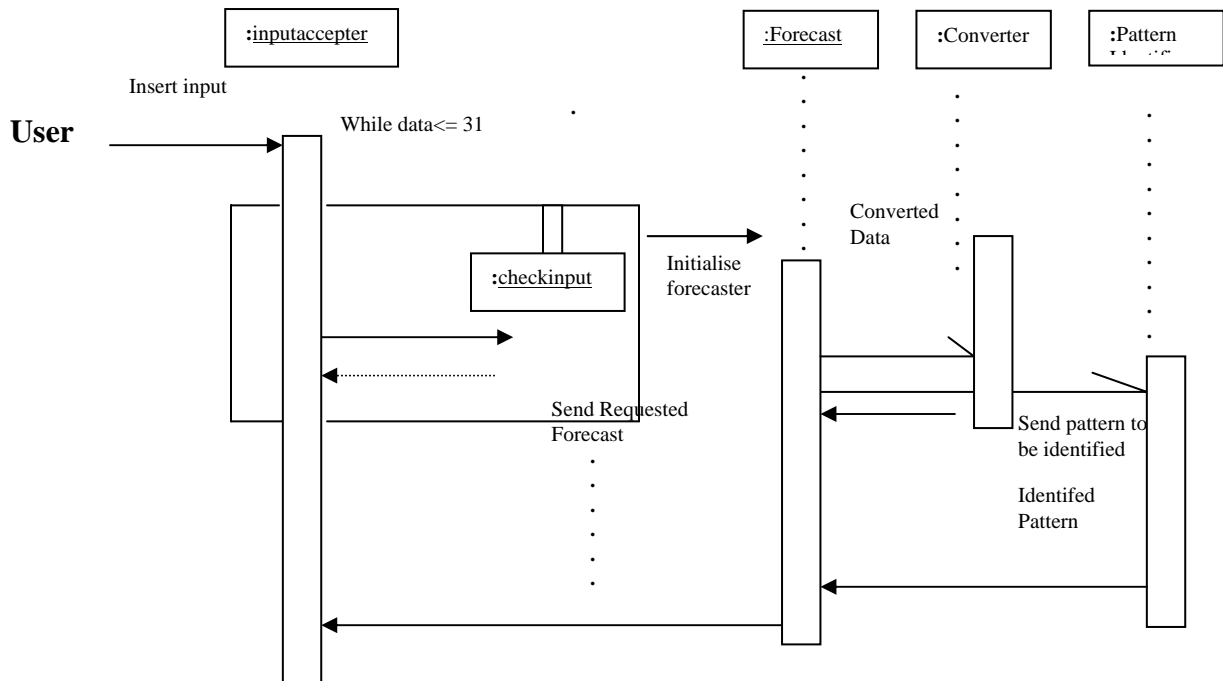


Fig 2.1: The sequence diagram

Forecasting using the Single-Exponential Smoothing Model

In making a forecast using the SES model, raw original closing stock prices data is accessed from Ms Access, in multiples of x where x is the forecast length, and then the collected data is then smoothed. It is then subtracted from the original data to obtain the error. The error of each data is then squared. After that, we find the total of all the errors and then the mean squared error. To make a forecast, we use the value of α that gives us the least mean squared error (α being a decimal number lying between 0 and 1).

Comparing the two forecasting tools

We take past original data of all the data entered, we make our forecasts using each of the forecasting tool. We use real data to find the error of each of the forecasted stock price for each forecasting tool on the forecasted days, we square it up, we sum them up and finally find the mean squared error of each tool. We conclude that the forecasting tool with the least mean squared error is the best tool as it deviates very small from the original data.

Results

In our work, we managed to theoretically justify the appropriateness of the weightless neural network as a tool for forecasting stock prices in the market. When the two forecasting tools were compared, the weightless neural network forecasting tool proved to be better than the single exponential smoothing as it had a smaller mean squared error of 0.7 as compared to the mean squared error of the single exponential smoothing which was 15.4.

Evaluation

The system is a guide to the design of a real software system that can be employed in the stock market industry. There are ideas, which can be put into practical use and it would be worthwhile to consider the use of such a system in industry. The weightless neural network technique is one of the most powerful tools for forecasting stock prices in the market.

Conclusions

We conclude this research work with a few recommendations to make. We recommend that future work be challenged with a more generic approach and that the weightless neural network be implemented using the WISARD. We also recommend that the performance of the forecasting tool be evaluated after every forecast using some statistical approach so as to tell how good the forecast is.

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