International Journal of Information Technology and Business Management
29th January 2016. Vol.45 No.1

ISSN 2304-0777 www.jitbm.com

TOWARDS ENHANCING STOCK MARKET WATCHING BASED ON NEURAL NETWORK PREDICTIONS

[1]Mohammed Awad, [2]Aseel Kmail
[1]Department of Computer Systems Engineering, Engineering and Information Technology, Arab American University, Palestine
[1]Department of Computer Science, Engineering and Information Technology, Arab American University, Palestine
Email: [1] mohammed.awad@aauj.edu , [2]aseel.kmail@aauj.edu

Abstract

Under the growth of the stock market sector and the widespread of stock market applications, the stock market prediction has become one of the most important and challenging tasks in the stock market. Many data mining techniques are exploited to predict the stock prices in order to help investors in making investing decisions. One of the most common and widely used techniques is Artificial Neural Networks (ANN). In this paper, we aim to present a model for stock market prediction based on artificial neural networks. This model uses the variables of technical analysis of stock market indicators for predicting stock market prices. The proposed model is tested and evaluated using Palestine Exchange Trading (PEX) data, the experimental validations show satisfactory results that help investors and traders to make qualitative decisions. The proposed model employs an adaptive process for optimizing neural network weights based on back-propagation learning strategy. The proposed model improves the effectiveness of forecasting the stock prices of Palestine Exchange Trading (PEX).

Keywords: *Prediction, Stock Market, Neural Networks*

INTRODUCTION

Using forecasting techniques can obtain better results against the need of people to reduce the risk in decision-making and risk aversion as to the choices they have to make. For a long time, people have sought greater access to information, enabling them to make decisions in a correct way, where the possibilities of "mistakes" are the minimum and success in decision-making is as high as possible [1, 2]. Recently, the stock market prediction has become one of the most important issues in the financial market. This is because the stock prices prediction helps investors and traders in making correct qualitative decisions. The stock market can be defined as a public market for trading company's stock at an approved stock price. Palestine Exchange (PEX) is the formal stock market at Palestine, which is one of the most important companies in the economic sector. Investing in PEX is done by either to be a partner in a company posted in PEX or buying bonds and getting a periodical return on investment (ROI). The main motivation of this proposed model is the possibility of making profits by investing in the Palestine stock market without risk too high, using a neural network model. It aims to study the ability of neural networks in predicting stock, and check if benefits are obtained if investment decisions are made based on these. Neural networks have proven effectiveness in other disciplines and there are reasons to think that it can be successfully applied to the prediction of financial series. In general, it intends to make investment decisions based on predictions using neural networks, which influence the profit. Furthermore, predictions of information no longer are useful information that can be used to supplement the insight and market knowledge. Based on discussion with PEX clerks and many investors there is no prediction system for forecasting the stock prices of companies in Palestine. Our goal is to start building a system that provides its users with the ability to predict

International Journal of Information Technology and Business Management
29th January 2016. Vol.45 No.1

ISSN 2304-0777 www.jitbm.com

the stock market prices based on ANN. Though stock market field suffers from unpredictability [3, 4], very high number of research papers have been performed to produce efficient techniques and approaches that enhance the prediction process. These techniques include ANN [5], fuzzy time series predictions [6], data mining [7] and Hidden Markov models [8]. These intelligent systems were not used before in predicting the stock prices in the Palestinian stock market.

As we use a method that depends on neural networks, we present some of the new methods and techniques that used neural networks in stock market prediction; as. In [5] the author present a hybridized method that combines the technical and fundamental analysis variables of the stock market as an indicator for predicting the future price of the stock. The author in [9] presents an approach depending on the basis of filter and function based clustering; the important features in risk and return prediction are selected then risk and return re-predicted. The methodology proposed in [10] use a multilayer perception neural network to derive the relationship between variables use as independent factors and the level of stock price index as a dependent element. A new intelligent model in a multi-agent framework called bat-neural network multi-agent system (BNNMAS) to predict stock price was proposed. The model performs in a four layer multi-agent framework to predict eight years of DAX stock price in quarterly periods [11]. The study in [13] compares four prediction models, Artificial Neural Network (ANN), Support Vector Machine (SVM), random forest and naive-Bayes with two approaches for input to these models applied on Indian stock markets.

In this paper, we used different configurations of multilayer perceptron neural networks. These configurations rely on backpropagation learning method applied on Palestine Exchange Trading. This model start specifying the problem inputs/outputs, and start from simplest structure of neural network, then by tray and error we select the suitable activation function for the hidden layer in the neural network, the weights optimized by using backpropagation learning, the best configuration is selected by test and generalize the network. The organization of the rest of this paper is as follows: Section 2 presents the proposed model. Section 3, shows some results that confirm the performance of the proposed method. Some conclusions will be presented in Section

THE PROPOSED NNs MODEL

The main motivation of the proposed model is the possibility of making profits by investing in the Palestine stock market without a high risk, using artificial neural networks. The proposed model aims to use the ability of neural networks in predicting, and check the benefits obtained if the investment decisions are made based on the suggested model. Neural networks have proven an effective method in many disciplines [9] and there are many reasons to think that it can be successfully applied on the prediction of financial series. It will be used to intend to make investment decisions based on predictions, which influence the profit [14]. Artificial Neural Networks (ANN), which emulate biological neural networks, and They have been used to learn solving strategies based on examples of typical behavior patterns; these systems do not require that the task is scheduled to run, they generalize and learn from experience. The theory of NN has provided an alternative to classical computing systems, for those problems where traditional methods have delivered unconvincing, or inconvenient results especially in nonlinear behavior of real systems [15]. Neuron is a processing unit that maps an input signal to an output, integrated with other neurons on the same layer of the neural network. Multi-layer Feed- forward with backpropagation Neural networks (MFFNNBP), is multi-layer perceptron neural network that passes in inputs and their weights from one layer to the next one through feed forward process, and then it perform the weights update to be back-propagated to the previous layers in order to recalculate and measure the update conditions like (certain error value, or number of iterations [15].

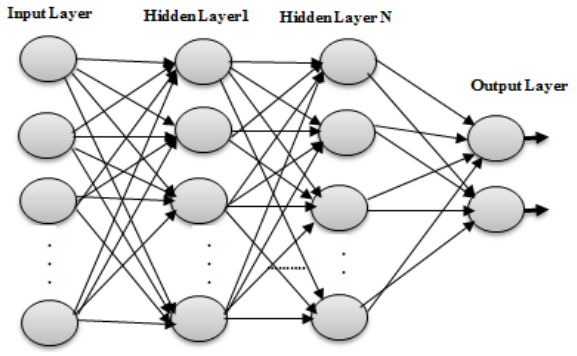

Fig. 1. MLP Neural Network

International Journal of Information Technology and Business Management
29th January 2016. Vol.45 No.1

ISSN 2304-0777 www.jitbm.com

Perform a mapping process between inputs/output data called training of the neural network, the output of the simple neural network is given by the following expression:

$$Y_i = F(\sum_{j=1}^{m} w_{ji} . X_i + bias_i) \quad (1)$$

Where w_{ij} is the weights connection and X_j are the value of the i^{th} inputs for simple form of the NN, $bias_i$ is the NN bias, m is the number of neurons in each hidden layer and F is the activation function. To predict the future output depends on current and previous output the model use the error result, which comparing the actual output of the NN with the desired output in the learning process, this error is calculated using the following expression:

$$Error = Y_{id} - Y_{ia} \quad (2)$$

The training process continues to adjust the weights until the error criteria is satisfied the weight update is performed by the equation 2:

$$\triangle w_{i+1} = \alpha . \ Error . \ x_i \quad (3)$$

Where α is the learning rate. In Multilayer Perceptron Neural Networks (MLPNN), the output of a layer will be an input for the next layer passing from the input layer to the output layer; the equations used for this procedure are illustrated as follows:

$$output = f^2(\sum_{j=1}^{n} out_1 . w_{jk}) \quad (4)$$

Where the output of the first hidden layer out_1, which calculated using the following expression:

$$out_1 = f^1(\sum_{j=1}^{n} x_i . w_{ij}) \quad (5)$$

Where f^1 and f^2 are the activation functions for output layer and hidden layer, which calculated as in the following expressions:

$$f^1 = \frac{1}{1 + e^{-x}} \quad (6)$$

$$f^2 = x \quad (7)$$

Where, x = input vector. Depending on equations above, the weights are updated use as the following expression:

$$\Delta w_{jk}^n = -\mu \frac{dE(w_{jk}^n)}{d\, w_{jk}} \quad (8)$$

Where μ is the learning rate (normally between 0 and 1). The final output depends on all earlier layer's output, weights, and the algorithm of learning used [15]. The backpropagation process calculates the gradient decent error between the desired and the predicted output considering the new weights each time, this gradient is usually use in a simple stochastic gradient descent algorithm to find the weights that minimize the error. The general steps of the neural network training appear in the following pseudocode:

Initialize network weights (often-small random values)
For Each *training example* ***find****:*
Real Output of NN
Error (Real - Target) at the output units
Compute $\triangle w_{i+1}$ *for all weights from hidden layer to output layer*
Compute $\triangle w_{i+1}$ *for all weights from input layer to hidden layer*
Update *network weights depends on the error value.*
Return *the process until the termination condition satisfied.*

From the above algorithm that the backpropagation process calculates the gradient decent error between the desired and the predicted output considering the new weights each time, this gradient is almost always used in a simple stochastic gradient descent algorithm to find weights that minimize the error [15].

The architecture of the proposed model for predicting the prices of the stock market based on exploiting artificial neural networks (ANN). As shown in figure 1, the proposed neural network consists of three main layers [5]:

Input layer: it consists of N units, such that each unit $X_i \in [X_1, X_2,,,,,X_n]$.
Hidden layer: it consists of P processing units, such that each unit $K_m \in [K_1, K_2,,,,, K_m]$.
Output layer: it finds the output Y according to the following equation:

International Journal of Information Technology and Business Management
29th January 2016. Vol.45 No.1

ISSN 2304-0777 www.jitbm.com

$$Y = ActivF(\sum_{m=1}^{P} w_{md} \,.\, ActivF \sum_{i=1}^{N} w_{im} \,.\, x_i)) \qquad (9)$$

Where, w_{im} is the i^{th} connection weights between input units and hidden processing units, w_{md} is the connection weights between hidden processing units and the output unit, *ActivF* is the activation functions for hidden processing elements and output [5].

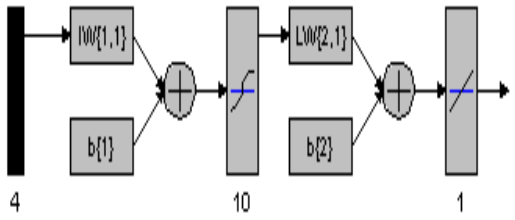

Fig .2 Neural Networks System Architecture

For our model, we defined the following four technical variables as inputs:

- The high price for day_{i-1}
- The low price for day_{i-1}
- The close price for day_{i-1}
- The trading volume for day_{i-1}

The network aims to find the close price for day_i from the data of day_{i-1}.

In general, the algorithm for ANN works as in the following steps:

1. *Understand and specify the problem in terms of inputs and required outputs.*
2. *Choose the simplest form of network to solve the problem.*
3. *Choose appropriate activation function.*
4. *Choose a suitable network structure.*
5. *Find the appropriate connection weights, so that the network produces the correct output for each training data.*
6. *Test the network generalization and evaluate it using new training data.*
7. *If the network doesn't perform well, go back to step 5 and try harder.*
8. *If the network still doesn't perform well, go to step 4 and try harder.*
9. *If the network still doesn't perform well, go to step 3 and try another activation function.*
10. *If the network still doesn't perform well, go to step 2 and try another form of the network.*

EXPERIMENTAL RESULTS AND DISCUSSION

In this section, we detail and discuss experiments that have been instantiated to validate our proposal. The proposed model is tested using Matlab Neural Network Tools Box version 7. 1 on a pc with dual-core CPU (2.4 GHz) and 4 GB RAM. The operating system is Windows 7. In order to carry experiments, we used different neural network configurations such as 4-1-1, 4-3-1, 4-5-1, 4-7-1, and 4-10-1. Our neural network model has the form of feed-forward multi-layer perceptron neural network that is trained with back-propagation algorithm. The training and testing data were selected carefully from Palestine Exchange website. The output of our neural network model was evaluated by comparing the predicted close prices with actual close prices.

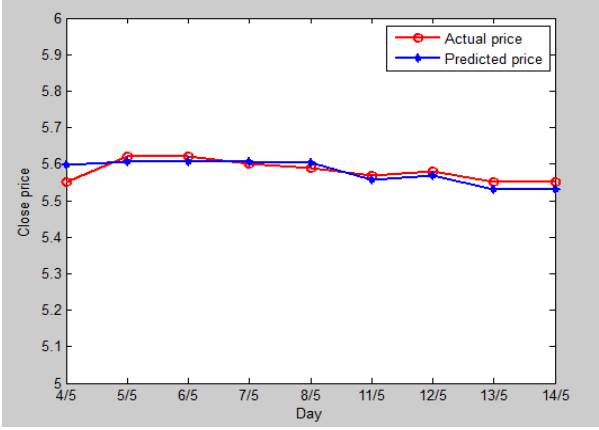

Fig .3. Network prediction for 4-1-1 configuration

After several experiments of different network configurations, we found that the most accurate prediction was produced by 4-1-1 configuration. Table 1 shows a comparison between different network configurations according to their level of accuracy. Figure 3-7 depicts the correlation level of accuracy by comparing the actual stock prices with the predicted values. The neural network structure that gives the best results is 4-1-1.

International Journal of Information Technology and Business Management
29th January 2016. Vol.45 No.1

ISSN 2304-0777 www.jitbm.com

Table 1: Sample of experimental results for different ANN configuration

Sample period	Actual value	Predicted values with different ANN configurations				
		4-1-1	4-3-1	4-5-1	4-7-1	4-10-1
4/5/2014	5.55	5.533	5.530	5.509	5.638	5.487
5/5/2014	5.62	5.606	5.568	5.612	5.327	5.600
6/5/2014	5.26	5.606	5.568	5.619	5.468	5.6
7/5/2014	5.60	5.606	5.559	5.538	5.680	5.581
8/5/2014	5.59	5.604	5.564	5.551	5.671	5.612
11/5/2014	5.57	5.556	5.558	5.533	5.674	5.509
12/5/2014	5.58	5.568	5.562	5.544	5.673	5.565
13/5/2014	5.55	5.531	5.552	5.519	5.649	5.527
14/5/2014	5.55	5.531	5.552	5.519	5.649	5.531

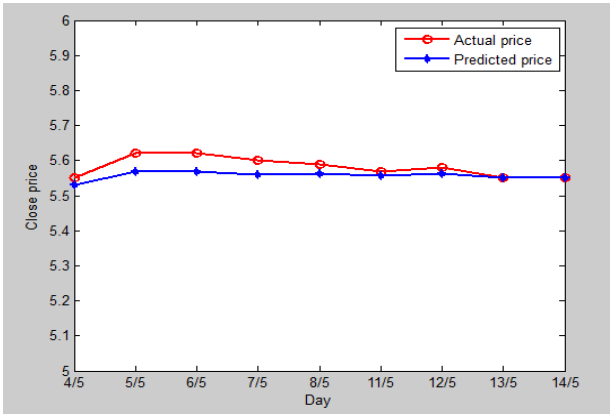

Fig .4. Network prediction for 4-3-1 configuration.

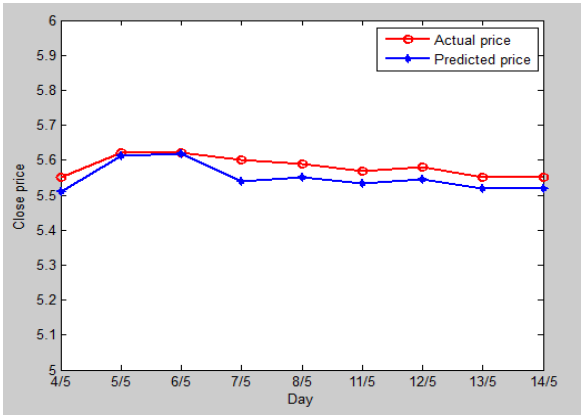

Fig .5. Network prediction for 4-5-1 configuration

From the result in table and the figures, we can show the possessing ability of NN to predict, the best results are obtained with the proposed model configuration 4-1-1 as shown in figure 1. It is clear that the prediction is being made with considerably good accuracy, but the neural network configuration of 4-7-1 produce a higher predicting error than other configurations, these situations can occur when the value of a stock can be influenced by multiple factors that were not taken into account in modeling. In this case, there could have been an **u**nusual behavior.

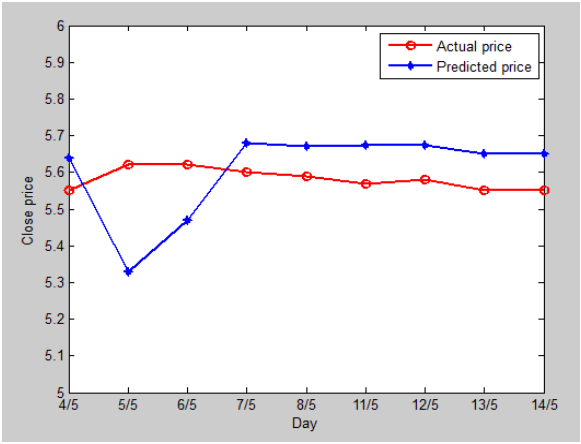

Fig .6. Network prediction for 4-7-1 configuration

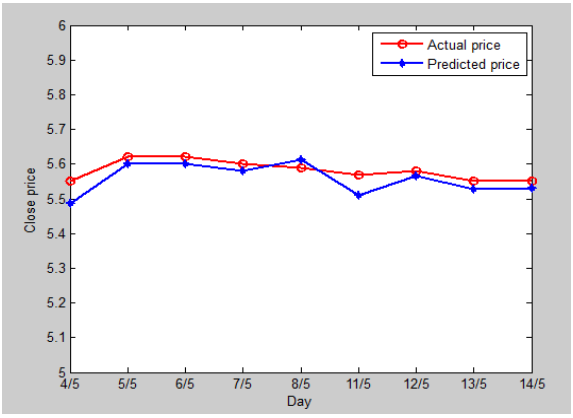

Fig .7. Network prediction for 4-10-1 configuration

The proposed model, for the period and the target market, produce better. Moreover, the model developed optimization protocol allows the user to determine their own level of risk, making this work applicable to a wide range of investors.

ISSN 2304-0777 www.jitbm.com

CONCLUSION

Artificial neural networks have a practice application in the stock market better than traditional statistics models because they depend on theoretical assumptions on which are based on the statistics techniques. We presented in this paper a model for stock market prediction based on artificial neural networks. The proposed model is created to help investors and traders at Palestine exchange to predict the stock prices for specific companies in order to make suitable qualitative investing decisions. The proposed model was tested and evaluated using real-world trading data. The empirical study compared actual data with predicted data, and the produced results showed a high level of accuracy in prediction, which is useful in making decisions. In the future, we aim to increase the number of technical parameters that have been used for prediction and then test the impact of the newly added technical parameters on the accuracy of prediction. The proposed model can be used as an integral part financial operation as it is used ANN tools to predict application in financial decision making in the treasury management and financial risk management in Palestine exchange.

REFERENCES

[1] Araújo, R. d. A., & Ferreira, T. A. "A morphological-rank-linear evolutionary method for stock market prediction". Information Sciences, vol. 237, pp. 3–17. 2013.

[2] W.W.Y. Ng, X-L. Liang, J. Li, D.S. Yeung, P.P.K. Chan, "LG-Trader: Stock Trading Decision Support based on Feature Selection by Weighted Localized Generalization Error Model". Neurocomputing, vol. 146, pp. 104-112. 2014.

[3] M.T. Philip, K. Paul, S.O. Choy, K. Reggie, S.C. Ng, J. Mak, T. Jonathan, K. Kai, and W. Tak-Lam, "Design and Implementation of NN5 for Hong Stock Price Forecasting". Journal of Engineering Applications of Artificial Intelligence, vol. 20, pp. 453-461. 2007.

[4] T. H. Roh, "Forecasting the Volatility of Stock Price Index". Journal of Expert Systems with Applications, vol. 33, pp. 916-922. 2007.

[5] Adebiyi Ayodele A., Ayo Charles K., Adebiyi Marion O., and Otokiti Sunday O, "Stock Price Prediction using Neural Network with Hybridized Market Indicators". Journal of Emerging Trends in Computing and Information Sciences. vol. 3, no. 1 pp. 1-9. 2012.

[6] Tiffany Hui-Kuang yu and Kun-Huang Huarng, "A Neural network-based fuzzy time series model to improve forecasting". Expert Systems with Applications, vol. 37 no. 4, pp: 3366-3372. 2010.

[7] K. Senthamarai Kannan, P. Sailapathi Sekar, M.Mohamed Sathik and P. Arumugam, "Financial stock market forecast using data mining Techniques". Proceedings of the international multiconference of engineers and computer scientist's vol. 1, 2010.

[8] Md. Rafiul Hassan and Baikunth Nath, "Stock Market forecasting using Hidden Markov Model: A New Approach". In Intelligent Systems Design and Applications, 2005. ISDA'05. Proceedings. 5th International Conference, pp. 192-196. IEEE. 2005.

[9] Sasan Barak, Mohammad Modarres,"Developing a approach to evaluate stocks by forecasting effective features with data mining methods". Expert Systems with Applications, vol. 42, no. 3, pp.1325-1339. 2015.

[10] A. Ghezelbash, F. Keynia, "Design and Implementation of Artificial Neural Network System for Stock Exchange Prediction". African Journal of Computing & ICT, vol. 7, no. 1, pp. 153-160. 2014.

[11] R. Hafezi, J. Shahrabi, E.Hadavandi, "A bat-neural network multi-agent system (BNNMAS) for stock price prediction: Case study of DAX stock price", Applied Soft Computing, vol. 29, pp. 196-210, 2015.

[12] J. Patel, S. Shah, P. Thakkar, K. Kotecha, "Predicting stock and stock price index movement using trend deterministic data preparation and machine learning techniques". Expert Systems with Applications, vol. 42 pp. 259-268. 2015.

[13] J.T. Yao, C.L. Tan, and H.L Poh, "Neural networks forTechnical Analysis: A study on KLCI", International Journal of Theoretical and Applied Finance, vol. 2, no. 2 , pp. 221–24. 1999.

[14] Laboissiere, L. A., Fernandes, R. A., & Lage, G. G, "Maximum and minimum stock price forecasting of Brazilian power distribution companies based on artificial neural networks". Applied Soft Computing, vol. 35, pp. 66-74. 2015.

[15] Haykin, S. S. Neural networks and learning machines (Vol. 3). Upper Saddle River: Pearson Education. 2009.