



An Efficient Model for Stock Price Prediction Using Soft Computing Approach

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Abstract: The analysis and prediction of stock market trends play a pivotal role in financial decision-making and profit generation. In this paper, we explore the efficacy of an Adaptive Neuro-Fuzzy Inference System (ANFIS) model for stock market prediction and compare its results with existing methodologies.

The design of ANFIS can be viewed as an optimization problem aimed at minimizing error functions by identifying optimal parameters. To enhance the performance of ANFIS, we propose a novel approach that combines the Firefly Algorithm with the Adaptive Neuro-Fuzzy Inference System. This integrated scheme involves training the fuzzy neural network model using the Firefly Algorithm and applying it to predict stock prices within the Vietnam Stock Market.

Experimental evaluations entail comparing the performance of our proposed system against ANFIS models trained using alternative optimization algorithms such as the Hybrid Algorithm, Back Propagation, and Particle Swarm Optimization (PSO). Through rigorous experimentation, we demonstrate the efficiency of our proposed system in predicting stock market trends.

Moreover, in this thesis, we conduct an empirical analysis using the Adaptive Neuro-Fuzzy Inference System (ANFIS) model for stock market prediction, followed by a comparative assessment of its performance against other techniques. The evaluation utilizes published stock market data from the National Stock Exchange of India Ltd. for validation purposes.

Keywords: ANFIS, Soft Computing, Prediction, Stock Market.

INTRODUCTION

A stock market is a public market for companies for people to raise money. Stock market helps companies to buy or sell their shares. The price of

shares depends upon the demand and supplies of shares. This process of buying and selling of shares is called trading; only the Listed Companies are allowed to carry out trading. Stock market prediction is the process of trying to determine the future stock value of a company. The successful prediction of a stock's future price could yield significant profit. Stock price movements are governed by the theories random walk hypothesis and efficient-market hypothesis [1] [2].

The Forecasters of stock market focus on developing approaches which successfully forecast/predict stock prices using well defined trading strategies. A successful prediction model is the one which works with best accuracy having minimum input requirements and least complex model. Investors and government organizations rely on forecasting tools to guard against risks and to monitor market situations. For researchers, these serve as a reference for studies of financial issues like pricing of financial derivatives and portfolio selection.

Stock market values are considered to be very dynamic and susceptible to quick changes because of the underlying nature of the financial domain and in part because of the mix of known parameters (Previous Day's Closing Price, P/E Ratio etc.) and some other factors (like Election Results, Rumors, climate etc.) [3]. An intelligent trader would predict the stock price and buy a stock before the price of stock rises, or sell it before its value declines. It is hard to replace the expertise that an experienced trader has gained from his experience but an accurate prediction algorithm can directly result into high profits for investment firms, individual professionals, which indicates a direct relationship

between the accuracy of the prediction algorithm and the profit made from using the algorithm.

RELATED WORK

A lot of research has been done and models based on a range of intelligent soft computing techniques are developed over the last two decades. This section describes briefly some of the work that has already been done in the field of stock price prediction.

In technology major Fujitsu and investment Company, Nikko Securities joined hands to develop a stock market prediction system for TOPIX, Tokyo based stock index, using modular neural network architecture [6]. Various economic and technical parameters were taken as input to the modular neural network consisting of multiple MLP used in parallel.

In 1993 research was done on the effect of change of network parameters of the model using artificial neural network (ANN) with Back propagation on the stock price prediction problem [7]. The paper gives information about the role of the learning rate, momentum, activation function and the number of hidden neurons for prediction of stock market. A hybrid model that integrates GA based fuzzy logic and ANN [10] has been proposed. The model involves quantitative factors (technical parameters) and qualitative factors such as political, environmental and psychological factors. The results shows that the neural network that considers the quantitative and qualitative factors both, excels to the neural network considering only the quantitative factors, both in the clarity of buying-selling points and buying selling performance.

Researchers also used Hidden Markov Models (HMM) approach for forecasting stock price for interrelated markets [11]. HMM, because of its proven suitability for modeling dynamic system was used for pattern recognition and classification problems. It is able to handle new data robustly and also is computationally efficient to develop and evaluate similar patterns. To improve the accuracy and efficiency of forecast the stock market, the author decides to develop hybrid system using AI paradigms with HMM. More efforts has been made towards the development of fuzzy models for stock market prediction made using Takagi-Sugeno (TS) fuzzy models in 2006 [12]. In this paper the models described are used for effort estimation and stock market prediction using TS fuzzy models. The two steps of the process are 1) the determination of the

membership functions in the rule antecedents using the model input data; 2) the estimation of the consequence parameters. Parameters are estimated using least square estimation.

Recently, soft computing techniques are being increasingly employed. Artificial neural networks (ANNs) have been widely used prediction of financial time series. Comparison of the effectiveness of time delay, recurrent and probabilistic neural networks for prediction of stock trends based on historical data of the daily closing price is done in [4]. Combinations of technical indicators and ANNs have been used in [5],[6],[7] and [8] for predicting of stock exchanges, exchange traded funds trading, determining buy/sell points for stocks and currency exchange rates, respectively. In [9], a Takagi-Sugeno-Kang type fuzzy rule based system using technical indexes as inputs, for stock price prediction.

The selected features are then subjected to dimensionality reduction. A total of fifteen dimensionality reduction techniques are considered and the effectiveness of each is evaluated by applying the reduced dataset to an ANFIS based predictor which produces the one-day-ahead forecast. The best dimensionality reduction technique-neuro fuzzy combination is considered for forecasting next day's market. The system is trained at the end of every trading session with the actual market data, to ensure that the system is capable of handling the dynamic nature of the market.

PROPOSED MODEL FOR PREDICTION

A fuzzy model is a knowledge-based system characterized by a set of rules. These rules model the relationship between input and output. They are stored in a fuzzy rule base and defined by their antecedent and consequents. To simplify the explanations, the fuzzy inference system under consideration is assumed to have $n=2$ inputs (x_1 and x_2) and one output (z). M_i denotes the terms number of input linguistic variables. Each input has three linguistic variables, $M_1 = M_2 = 3$. The ANFIS's architecture [9, 10, 17] with two inputs and one output as shown in Fig. 3.1.

For the first order of Sugeno fuzzy model, a typical rule set with base fuzzy if-then rules can be expressed as:

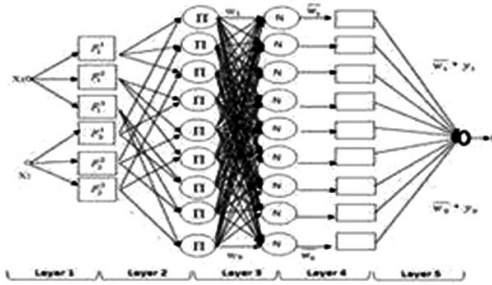


Fig.1: ANFIS architecture of two inputs and nine rules

Data preprocessing, training and testing of the proposed techniques are implemented in Matlab R2013a.

An ANFIS architecture i.e., 06 neurons in input layer, 10 neurons in hidden layer and one neuron in output layer is used to create the required ANFIS model for prediction

[32]. For training Firefly algorithm has been used for time series prediction. The parameters considered for training the ANFIS are:

Performance Goal = 0 Learning Rate = 0.01
 Training ratio = 0.8 Validation ratio = 0.1 Testing ratio = 0.1

After training a trained network is obtained.

The sample data used in these experiments are selected from Stock Exchange based on the comprehensive open price of four companies: Asia Commercial Bank (ACB), Vietcombank (VCB), HDFC and JSPL there were a lot of market mechanisms to support the market development, creating favorable conditions to encourage enterprises to participate in the Vietnam stock market. As a result, together with an increasing number of listed companies, the number of investors was rising as well. VN index reached its peak in March 2007. Stock prices of many companies also jump quickly. In 2008, inflation and market volatility are two main reasons which made Vietnam stock market decline sharply. These reasons explain why most stock prices of many companies have initial fluctuation then quickly drop to lower value and kept fairly stable.

The training data of the system available included 50% samples. Moreover, the efficiency of the system was demonstrated by using 25% validation and 25% for testing data. Each company has specified characteristics, so this study is performed

with four-company’s data to find out the best suitable company for our system. Table 4.1 represents a sample of data from the four companies.

The processing of proposed model as follows:

- Step-1 Collection of data
- Step 2 Determine training, Validation, Testing Data
- Step 3 Encode an ANFIS into a firefly.
- Step 4 Initialize a population of firefly Step 5 Decode each firefly into an ANFIS Step 6 Calculate RMSE
- Step 7 Update light intensity
- Step 8 Compare light intensity of fireflies and move their position Step 9 Update Attractiveness
- Step 10 Rank the fireflies and find the current best Step 11 If Iterative < Max then Goto Step 5
- Step 12 Return the best firefly Step 13 Visualization

RESULT

Table II presents the performance of models with the testing data sets. It is clear that the computed output (using FA) is approaching actual output which is given in the data set with RMSE is smaller than other methods except with SAP company. The SGD Company has smallest RMSE among companies. It can be concluded that training ANFIS by FA performed well with the characteristic of the SGD Company. Moreover, the running time of FA is faster than the others with the same iteration. While Firefly Algorithm and PSO run around 40 minutes, Hybrid Algorithm (mixed least squares and back propagation) and back propagation algorithm took more than 1 hour for 1000 iterations.

Table 4.2 Anfis’s Prediction RMSE

| Name of Company | Training by ANFIS | | | |
|-----------------|-------------------|-------------------|------------------|--------|
| | Firefly | Hybride Algorithm | Back Propagation | PSO |
| ACB | 0.4801 | 0.5644 | 0.5323 | 1.6332 |
| VCB | 0.7403 | 0.9411 | 0.9298 | 0.8514 |
| HDFC | 0.4721 | 0.4687 | 0.4568 | 2.5684 |
| JSPL | 0.3456 | 0.4156 | 0.4321 | 1.9856 |

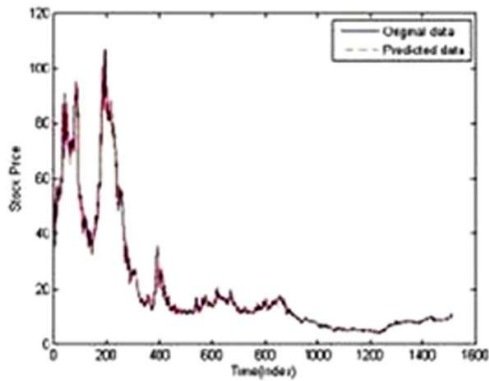


Figure-2: The Original and Predicted Stock Price of ACB

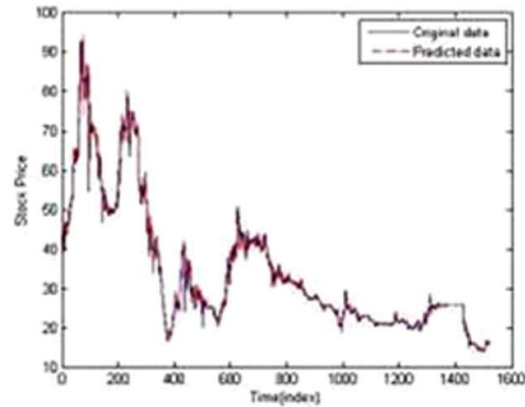


Figure - 5: The Original and Predicted Stock Price of JSPL

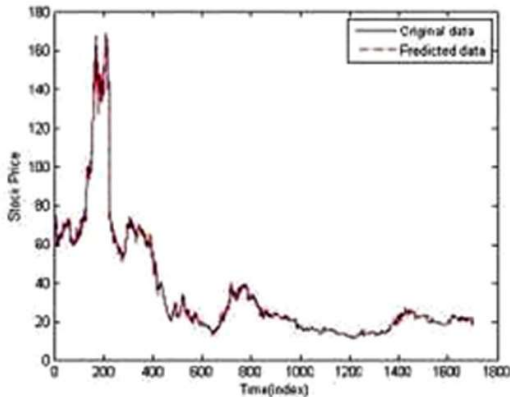


Figure-3: The Original and Predicted Stock Price of VCB

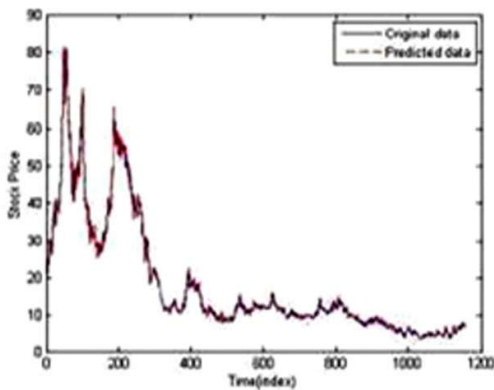


Figure-4: The Original and Predicted Stock Price of HDFC

Performance Criteria

1. Root mean square error (RMSE): RMSE is frequently used performance criteria which measures the difference between values predicted by a model or forecaster and the values actually observed. It is the square root of the mean square error, as shown in equation 14 below:

where,

N : Number of Data points,

i : i th Data point, y_i : Actual value, \hat{y}_i : Predicted value.

2. Mean magnitude relative error (MMRE): MMRE is also used to evaluate the performance of any forecasting technique.

It measures the difference between forecast and actual value relative to the actual value, as shown in equation 15 given below:

3. Accuracy: Accuracy is the degree of matching between the predictions and the actual data. It is calculated as

X : Actual data values, Y : Predicted Data values

CONCLUSION

In this proposed model, an ANFIS system is trained using the Firefly Algorithm (FA) to predict the closing stock price. The design of the ANFIS framework is viewed as an optimization problem aimed at identifying optimal parameters with minimal error function, where FA demonstrates suitability for optimization in this research. The experimental dataset utilized in this study was selected from the Hanoi Stock Exchange.

Stock Exchange and NSE. Experimental results show that, this research could be an efficient system to forecast stock prices.

This research obtained some positive results. However, this research will be widened to consider more factors, which effect the movement of stock price, and the author also desires to improve the performance of the system.

Neural networks are well researched and established method that have been used over decades and are very successful in predicting time series behavior from the past datasets. In this report, different neural network techniques and a fuzzy technique have been compared for predicting the stock market price of four organizations. From the analysis, it has been found that from the three RBFN prediction methods each with different clustering method that are used for training the parameters of RBF, the RBFN model with Subtractive clustering, error was less and accuracy was more. RBFN Model with Subtractive clustering when compared with simple FFNN, TSK fuzzy model, and Elman network model, error in Elman network model was least and maximum accuracy for the data of organizations. Only for the dataset of JSP, gives least error.

In this proposed scheme, only the open price has been considered as the inputs and the target data is also the opening price. In the Future work, different factor indicators would be used as input to these models to further improve the accuracy and efficiency of the system and would be compared with other prediction models.

REFERECES

- [1] S. J. Taylor, Modelling nancial time series. No. 2nd, World Scientific Publishing, 2008.
- [2] E. E. Peters, Chaos and order in the capital markets: a new view of cycles, prices, and market volatility. John Wiley & Sons, 1996.
- [3] Y.-F. Wang, \Predicting stock price using fuzzy grey prediction system," Expert Systems with Applications, vol. 22, no. 1, pp. 33-38, 2002.
- [4] P. Falinouss, \Stock trend prediction using news articles: a text mining approach," 2007.
- [5] C. N. Tan and G. E. Wittig, \A study of the parameters of a backpropagation stock price prediction model," in Artificial Neural Networks and Expert Systems, 1993. Proceedings., First New Zealand International Two-Stream Conference on, pp. 288-291, IEEE, 1993.
- [6] R. J. Kuo, C. Chen, and Y. Hwang, \An intelligent stock trading decision support system through integration of genetic algorithm based fuzzy neural network and artificial neural network," Fuzzy Sets and Systems, vol. 118, no. 1, pp. 21-45, 2001.
- [7] M. R. Hassan and B. Nath, \Stock market forecasting using hidden markov model: a new approach," in Intelligent Systems Design and Applications, 2005. ISDA'05. Proceedings. 5th International Conference on, pp. 192-196, IEEE, 2005.
- [8] Sheta, \Software e ort estimation and stock market prediction using takagisugeno fuzzy models," in Fuzzy Systems, 2006 IEEE International Conference on, pp. 171-178, IEEE, 2006.
- [9] M. R. Hassan, B. Nath, and M. Kirley, \A fusion model of hmm, ann and ga for stock market forecasting," Expert Systems with Applications, vol. 33, no. 1, pp. 171-180, 2007.
- [10] K. Y. Huang and C.-J. Jane, \A hybrid model for stock market forecasting and portfolio selection based on arx, grey system and rs theories," Expert systems with applications, vol. 36, no. 3, pp. 5387-5392, 2009.
- [11] C.-H. Cheng, T.-L. Chen, and L.-Y. Wei, \A hybrid model based on rough sets theory and genetic algorithms for stock price forecasting," Information Sciences, vol. 180, no. 9, pp. 1610-1629, 2010.
- [12] [12]Y.-F. Wang, S. Cheng, and M.-H. Hsu, \Incorporating the markov chain concept into fuzzy stochastic prediction of stock indexes," Applied Soft Computing, vol. 10, no. 2, pp. 613-617, 2010.
- [13] [13]H.-L. Wong, Y.-H. Tu, and C.-C. Wang, \Application of fuzzy time series models for forecasting the amount of taiwan export," Expert Systems with Applications, vol. 37, no. 2, pp. 1465-1470, 2010.
- [14] G. S. Atsalakis and K. P. Valavanis, \Forecasting stock market short-term trends using a neuro-fuzzy based methodology," Expert Systems with Applications, vol. 36, no. 7, pp. 10696-10707, 2009.
- [15] [15]A. Ranganathan, \The levenberg-

- marquardt algorithm," Tutorial on LM Algorithm, 2004.
- [16] O. KISI and E. Uncuoglu, \Comparison of three back-propagation training algorithms for two case studies," Indian journal of engineering & materials sciences, vol. 12, no. 5, pp.
- [17] H. Yu and B. Wilamowski, \Levenberg-marquardt training," The Industrial Electronics Handbook, vol. 5, 2011.
- [18] K. Bataineh, M. Naji, and M. Saqer, \A comparison study between various fuzzy clustering algorithms," EDITORIAL BOARD, vol. 5, no. 4, p. 335, 2011.
- [19] Vahedi, \The predicting stock price using artificial neural network," J. Basic. Appl. Sci. Res, vol. 2, no. 3, pp. 2325-2328, 2012.
- [20] H. Wang and Y. Gao, Elmans recurrent neural network applied to forecasting the quality of water diversion in the water source of lake taihu," in 2010 International Conference on Biology, Environment and Chemistry IPCBEE, vol. 1, 2011.

