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An Efficient Model for Stock Price Prediction using Soft Computing Approach

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Abstract: Analysis and prediction of stock market is very interesting as this helps the financial experts in decision making and in turn profit making. In this paper an Adaptive Neuro-Fuzzy Inference System (ANFIS) model is initially considered for stock market prediction and its result is compared. The substance of the design of Adaptive Neuro-Fuzzy Inference System (ANFIS) can be seen as an optimization problem to find the best parameters with minimal error function. This proposed scheme proposes a combination of the Firefly Algorithm and Adaptive Neuro-Fuzzy Inference System. The fuzzy neural network model will be trained by the Firefly Algorithm, and applied to predict stock prices in the Vietnam Stock Market. The experiments will compare performance between the proposed system and ANFIS trained by the Hybrid Algorithm, Back Propagation and Particle Swarm Optimization (PSO). The experimental results show that the system has reasonable efficient performance. In this thesis Adaptive Neuro-Fuzzy Inference System (ANFIS) model is initially considered for stock market prediction and its result is compared. These techniques were tested with published stock market data of National Stock Exchange of India Ltd. for validation.

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

I. 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.

II. 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 brie y 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 e ort 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.

III. PROPROSED 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 (x1 and x2) and one output (z). Mi denotes the terms number of input linguistic variables. Each input has three linguistic variables, M1 = M2 = 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:

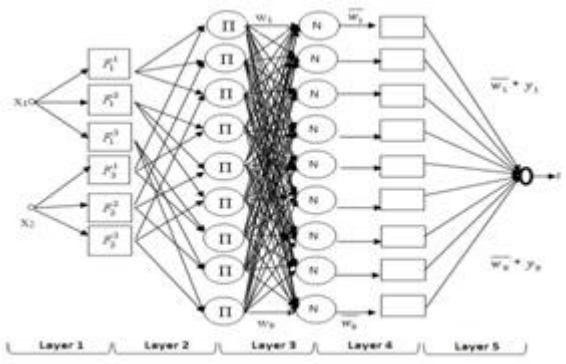

Fig.1: ANFIS architecture of two inputs and nine rules

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

IV. 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

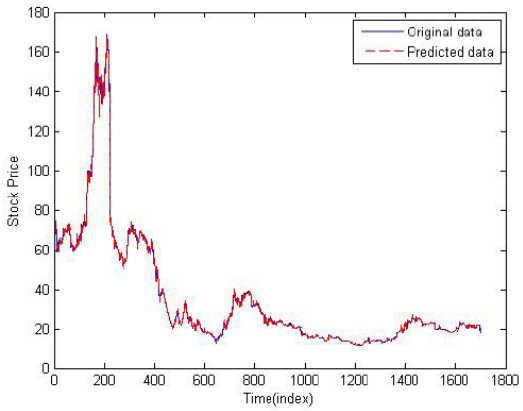

Figure-2: The Original and Predicted Stock Price of ACB

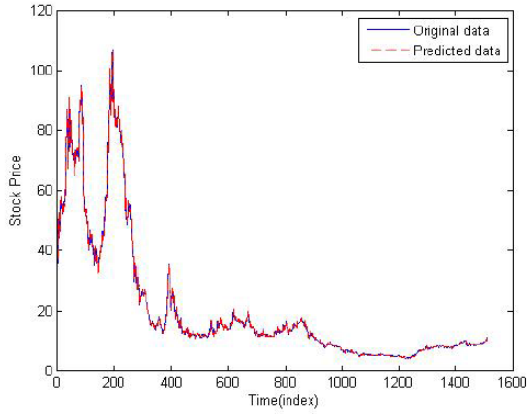

Figure-3: The Original and Predicted Stock Price of VCB

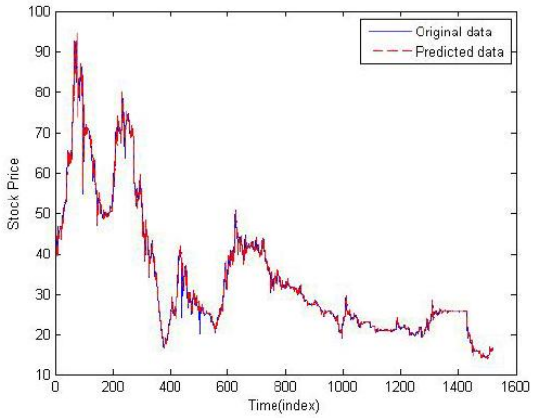

Figure-4: The Original and Predicted Stock Price of HDFC

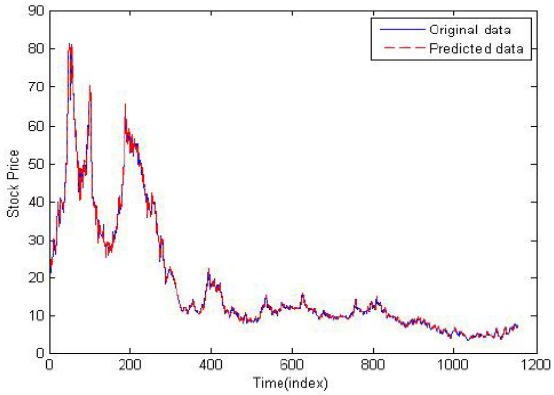

Figure - 5: The Original and Predicted Stock Price of JSPL

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 swan in equation 14 below:

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2} \quad (1)$$

where,
N : Number of Data points,
i: ith Data point,
yi: Actual value,
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:

$$MMRE = \frac{1}{N}\sum_{i=1}^{N}\frac{|y_i - \hat{y}_i|}{y_i} \quad (2)$$

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

$$Accuracy = 100 - 100 * \frac{\Sigma|X - Y|}{N} \quad (3)$$

X: Actual data values,
Y: Predicted Data values

CONCLUSION

In this proposed model an ANFIS system is trained by FA to predict closed stock price. The substance of the design of ANFIS can be seen as an optimization problem to find the best parameters with minimal error function, FA was found to be suitable for optimization in this research. The experimental data set applied in this study was selected from the Hanoi 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.

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