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Prediction of Future Stock Close Price using Proposed Hybrid ANN Model of Functional Link Fuzzy Logic Neural Model

Kumaran Kumar. J, Kailas. A
Department of Computer Science and Engineering, Pondicherry Engineering College
Email: kumaran@pec.edu, kailash1989@yahoo.com

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ABSTRACT

In this paper, the prediction of future stock close price of SENSEX & NSE stock exchange is found using the proposed Hybrid ANN model of Functional Link Fuzzy Logic Neural Model. The historic raw data's of SENSEX & NSE stock exchange has been pre-processed to the range of (0 to 1). After pre-processing the inputs and forwarded to functional expansion function to perform neural operation. The activation function of neuron has fuzzy sets in order to show the future close price range of SENSEX & NSE stock exchange. The model is trained with the pre-processed historic data's of stock exchange and the prediction rate (Performance & Error rate) of the Proposed Hybrid ANN model of Functional Link Fuzzy Logic Neural Model is calculated at the testing phase using the performance metrics (MAPE & RMSE).

Corresponding Author:

Kumaran Kumar. J
Department of Computer Science and Engineering,
Pondicherry Engineering College,
Puducherry, India
Email: kumaran@pec.edu

1. INTRODUCTION

A neural network is an interconnected group of nodes, akin to the vast network of neurons in the human brain. An Artificial Neural Network [1] is a mathematical model or computational model based on biological neural networks. Detecting trends and patterns in financial data is of great interest to the business world to support the decision-making process. So far, the primary means of detecting trends and patterns has involved statistical methods such as statistical clustering and regression analysis. The mathematical models associated with these methods for economic forecasting, however, are linear and may fail to forecast the turning points in economic cycles because in many cases the data's are highly nonlinear.

A new generation of methodologies, including neural networks, knowledge-based systems and genetic algorithms, has attracted attention for analysis of trends and patterns. In particular, neural networks are being used extensively for financial forecasting with stock markets, foreign exchange trading, commodity future trading and bond yields. The recent resurgence of interest in the field of NNs has been inspired by new developments in NN learning algorithms, analog VLSI circuits and parallel processing techniques. One main possibility for the use of artificial neural system is to simulate physical systems that are best expressed by massively parallel networks.

The Main objectives of this work is

- To integrate FLANN & Fuzzy Logic model.
- To implement Proposed Hybrid Functional Link Fuzzy Logic neural model on Stock market prediction case study.

2. BASICS OF FINANCIAL FORECASTING AND SUITABILITY OF ANN MODELING

Stock market [3], [4], [7] has long been considered a high return investment field and backbone of Indian economy. Due to the fact that stock markets are affected by many highly interrelated economical, political and even psychological factors that interact with each other in a very complex fashion, it is very difficult to forecast the movement in stock market.

Predicting is telling about the future which will incur certain error. To produce a meaningful prediction, the error incurred must be minimum. There are several ways used by investors to predict stock market returns such a technical analysis, fundamental analysis and mathematical models. However these techniques incapable of determining the exact forecast price. Due to these imperfection factor current studies using soft computing techniques (Soft Computing represents that area of Computing adapted from the physical sciences.) such as Granular Computing, Rough sets, Neural Networks, Fuzzy sets and Genetic Algorithms are highly used to improve the prediction accuracy and computational efficiency compared to earlier techniques. With the advancement being made in computer and telecommunication technologies today, the world's major economies and financial markets are becoming more and more globalize.

As this trend accelerates, financial markets are becoming more and more interrelated and fundamental factors will become increasingly critical to financial market analysis. In the global marketplace, the prevailing methods of technical analysis where a single market is modeled through historical simulation and back testing of its own past price (or volume) behavior is rapidly losing its competitive advantages. Institution and individual traders both are increasingly applying new technologies to financial forecasting. Recent research shows that these nonlinear domains can be modeled more accurately with these technologies (like ANN) than with the linear statistical and single-market methods that have been the mainstay of technical analysis throughout the past decade.

Another advantage of ANN [1], [7] implementation is that the processing is distributed among many nodes. Even if some of the nodes fail to function properly, the effect on the overall performance of the system will not be significant. This assertion can be verified by turning off m randomly selected hidden layer nodes and observing the resulting effect on the system performance. However due to their large number of inputs, network pruning is important to remove redundant input nodes and speed up training and recall. Essential features of a neural network are: The network topology, Computational functions, and Training algorithm [5]. Decisions on the target output with respect to concerned inputs will select these features along with their respective parameters like learning rate, number of hidden layers, and number of nodes in each layer etc. Financial neural network must be trained to learn the data and generalize, while being prevented from overtraining and Memorizing the data. Once trained, the network parameters (weights) will be kept fixed and can be designed to predict the direction, magnitude.

3. SURVEY OF THE RELATED WORK

3.1 Functional Link Artificial Neural Network

FLANN [10], [11] is a single layer, single neuron architecture, which has the exceptional capability to form complex decision regions by creating non-linear decision boundaries. The architecture of the FLANN is different from the linear weighting of the input pattern produced by the linear links of the better known Multi-Layer Perceptron (MLP) [2]. In a FLANN, each input to the network undergoes functional expansion through a set of basis functions. The functional link acts on an element or the entire pattern itself by generating a set of linearly independent functions. The inputs expanded by a set of linearly independent functions in the function expansion block, causes an increase in the input vector dimensionality. This enables FLANN to solve complex classification problems by generating non-linear decision boundaries. In our experiment, the functional expansion block comprises of a set of trigonometric functions.

3.2 Fuzzy Neural Networks

Neural fuzzy networks [6], [8], [9] have an advantage over expert systems because they can extract rules without having them explicitly formalized. In a highly chaotic and only partially understood environment, such as the stock market, this is an important factor. It is hard to extract information from experts and formalize it in a way usable by expert systems. Expert systems are only good within their domain of knowledge and do not work well when there is missing or incomplete information.

According to the mechanism of fuzzy logic control system, the fuzzy neural network [12] usually has 5 functional layers: (1) Layer 1 is the input layer. (2) Layer 2 is the fuzzification layer; (3) Layer 3 is the fuzzy reasoning layer which may consist of AND layer and OR layer; (4) Layer 4 is the defuzzification layer; (5) Layer 5 is the output layer. The architecture of a fuzzy neural network is described in Fig.1. Usually, the fuzzy neural network maps crisp inputs xi (I=1,2,…,n) to crisp output yi (j=1,2,…,m). A fuzzy neural network is constructed layer by layer according to linguistic variables, fuzzy IF-THEN rules, the fuzzy reasoning method and the defuzzification scheme of a fuzzy reasoning method and the defuzzification scheme of a fuzzy logic control system.

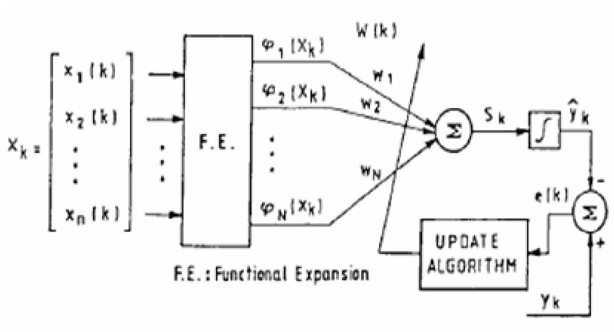

Figure 1. Architecture of FLANN Model

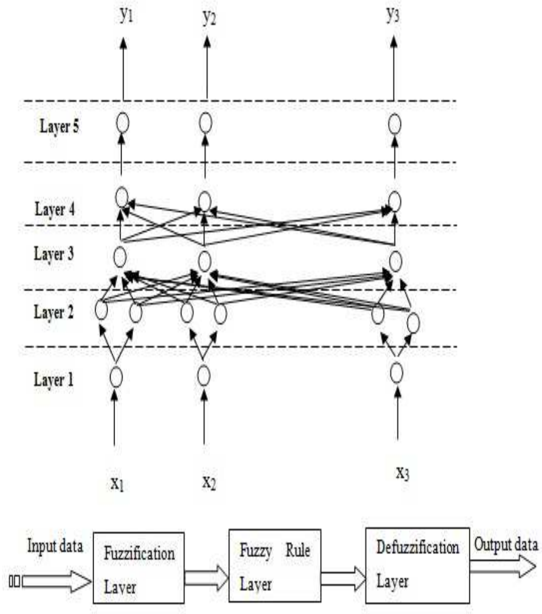

Figure 2. Architecture of the fuzzy neural network

Each neuron in the fuzzification layer represents an input membership function of the antecedent of a fuzzy rule. One common method to implement this layer is to express membership functions as discrete points. Thus for a fuzzy rule "IF X1 is A1 and X2 is A2 THEN Y is B", A's characterize the possibility distribution of the antecedent clause "X is A". Each of the hidden nodes is defined as a fuzzy reference point in the input space. The function of the defuzzification layer is for rule evaluation. Each neuron in this layer represents a consequent proposition "THEN Y is B" and its membership function can be implemented by combining one or two sigmoid functions and linear functions.

4. PROPOSED HYBRID MODEL

4.1. Functional Link Fuzzy Logic Neural Model

The structure of the FLANN is fairly simple. It is a flat net without any need for a hidden layer. Therefore, the computation as well as learning algorithm used in this network is simple. The functional expansion of the input to the network effectively increases the dimensionality of the input vector and hence the hyper-planes generated by the FLANN provide greater discrimination capability in the input pattern space. Various system identifications, control of nonlinear systems, noise cancellation and image classification systems have been reported in recent times. These experiments have proven the ability of FLANN to give out satisfactory results to problems with highly non-linear and dynamic data. Further the ability of the FLANN architecture based model to predict stock index movements, both for short term (next day) and medium term (one month and two months) prediction using statistical parameters consisting of well-known technical indicators based on historical index data is shown and analyzed.

The Proposed Hybrid [4], [14] Functional Link Fuzzy Logic Neural model (FLFNM) uses the nonlinear combination of input variables. The proposed hybrid model architecture is explained below:

1. The raw datasets are stored in database (.mdb); the fuzzification process gets started with the raw datasets.
   This process involves, crisp value conversion that helps to train the neural network with greater accuracy.
2. After the fuzzification process, the converted crisp input values are moved to neural network input layer.
3. The input layer has nodes that collects the inputs from fuzzification block and pass the inputs to neuron.
4. The functional expansion block (neuron- FLANN model) collects the inputs and multiplied with weights assigned between input layer and functional expansion block.

5. The multiplied inputs are summed collectively and forwarded to activation function.
6. The activation function used in this neuron is (tanh function), this function gets the summed inputs and coverts it to 0 to 1 range using tanh mathematical function.
7. After range conversion over, the value is passed to fuzzy sets to check which operation will perform.
8. The fuzzy sets has three relations
   a If (Value<0) then tomorrow close price value < than today's price (loss).
   b If (Value<=0.5 && Value>=0) then tomorrow close price value remains same as today's price (no loss).
   c If (Value>0.5) then then tomorrow close price value > than today's price (profit).
9. Finally the satisfied condition throws the output to the neural network output layer.
10. In training phase, the error will be back propagated using back propagation algorithm [5].

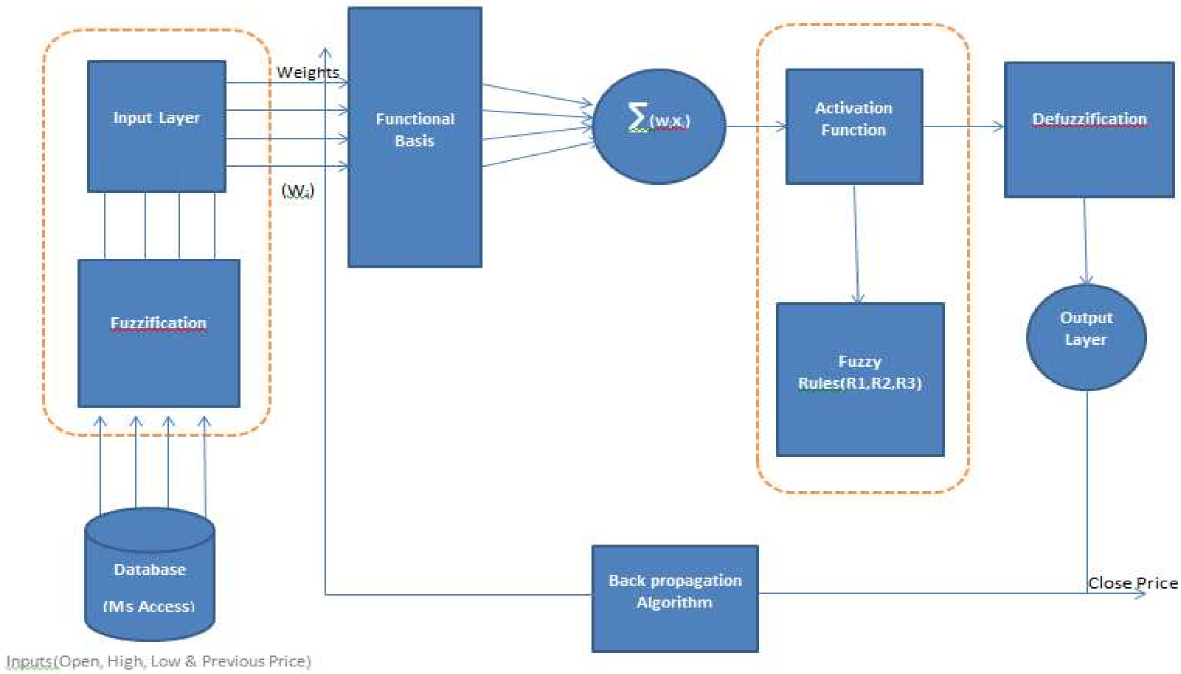

Figure 3. Architecture of Hybrid Functional Link Fuzzy Logic Neural Model

5. PERFORMANCE METRICS

5.1 Performance Metrics

a. Root Mean Square Error

$$RMSE = \sqrt{\frac{1}{N}\sum_{k=1}^{N}(t_k - o_k)^2} \quad (1)$$

Where t_k is predicted value, o_k is desired value and N is total number of test data

b. Mean Absolute Percentage Error

$$M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right| \times 100 \quad (2)$$

Where A_t is predicted value and F_t is desired value

5.2 Implementation Screenshots and Error Rate of Proposed Model on prediction of future stock price of SENSEX & NSE

Table 1. Error Rate Analysis for SENSEX & NSE Stock Exchange

STOCK EXCHANGE	RESULT	FLFNM (proposed)	FLANN (Existing)
	DESIRED	0.1302	0.1102
SENSEX	ACTUAL	0.2333	0.2333
	ERROR %	0.07	0.5
NSE	DESIRED	0.04128	0.02124
	ACTUAL	0.07929	0.07929
	ERROR %	0.08	0.43

5.3 Accuracy & Error Rate Analysis

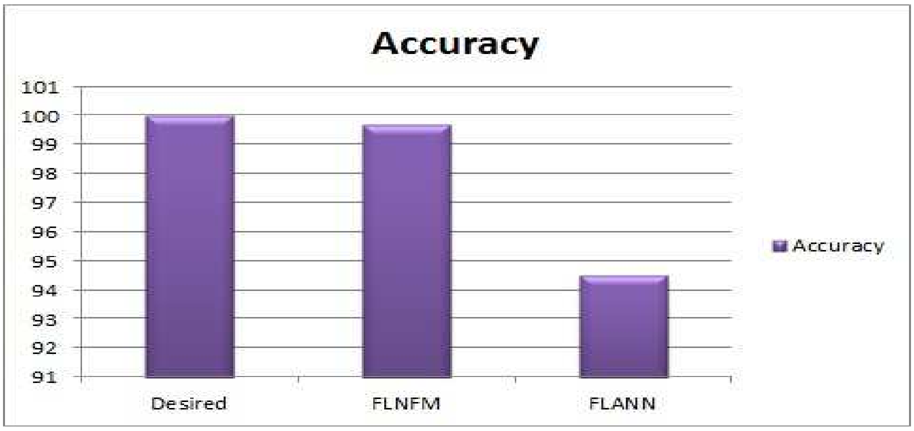

Figure 4. Accuracy of FLFNM and Existing Model (FLANN)

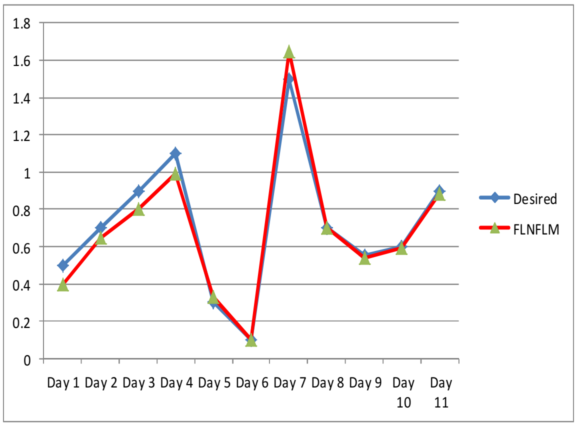

Figure 5. Error Rate of FLFNM for SENSEX Datasets

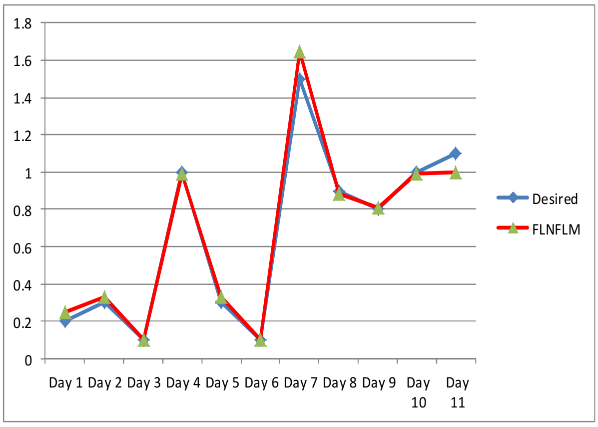

Figure 6. Error Rate of FLFNM for NSE Datasets

6. CONCLUSION

The proposed Hybrid Network model (Functional link Fuzzy Logic Neural Model) predicts the future stock close price of both SENSEX and NSE using past historic datasets. Performance metrics of ANN (RMSE & MAPE) calculates the accuracy and error rate of FLFNM model is more efficient than the existing model (FLANN).

In future, the fuzzy sets can be filled with suitable relations that will be capable of dectecting various attributes of stock market case study.

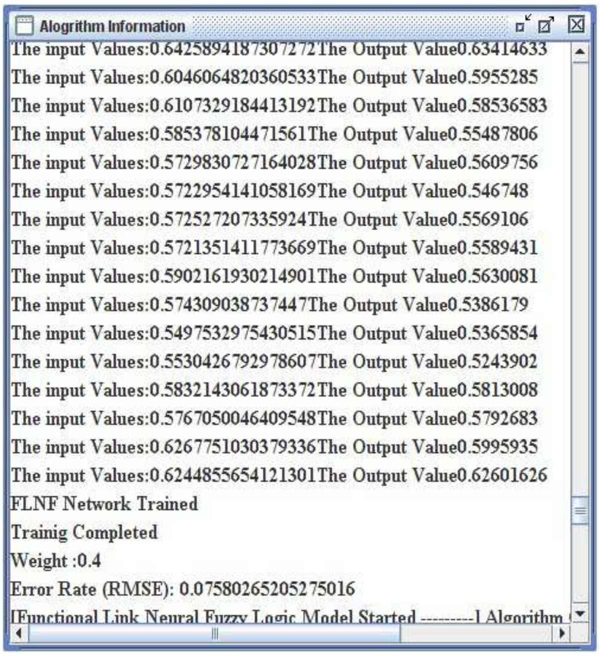

Figure 7. Screenshot of FLFNM Training Phase

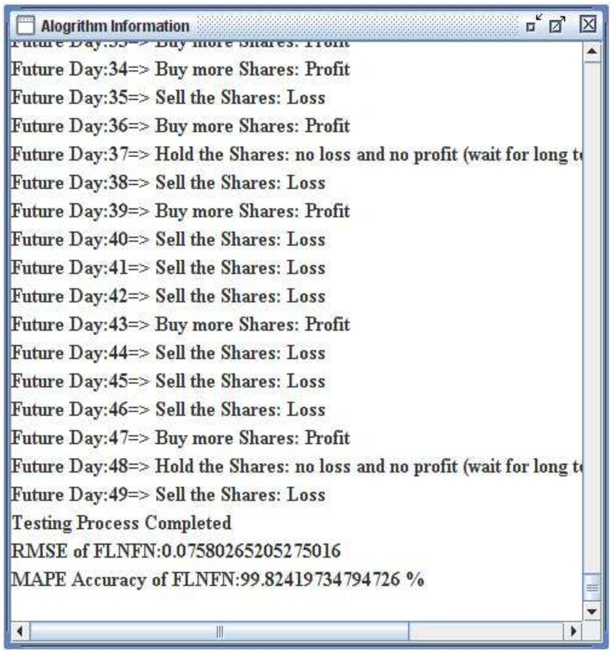

Figure 8. Screenshot of FLFNM Testing Phase

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