ANALYSIS AND FORECASTING OF EXCHANGE RATE USING ARTIFICIAL NEURAL NETWORK

A Dissertation Report

Submitted

By

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Under the guidance of
Pency Juneja (16381)

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ABSTRACT

Exchange rate is the backbone of the internal as well as external sector of the economy. To understand the concept of exchange rate there should be known about the factor whose movements directly or indirectly influence the exchange rate. Exchange rate behavior is volatile, nonlinear and complex make it hard to predict but with the help of movements of forex exchange rate market forecasting is possible which make it an asset for some firms and investors. Prediction of exchange rate with large amount data set of attributes values using artificial neural network is more preferable than other techniques. Artificial neural network have the capability of abstract major useful from huge set of data attributes. This research brings some type of traditional methods ANFIS and Back-propagation for prediction of currency exchange rate. A methodology is used for forecasting US dollar/ Indian rupee exchange rate. In this research currency exchange rate is predict by choosing data of longer period of some parameters whose change in values highly impact the exchange rate and also compare the RMSE, MAPE and MAE values.

CERTIFICATE

This is to certify that **Sanjeev Kumar** has completed M.Tech (Computer Science and Engineering) Dissertation titled **"Analysis and Forecasting of Exchange Rate using Artificial Neural Network"** under my guidance and supervision. To the best of my knowledge the present work is the result of his original investigation and study. No part of the dissertation has ever been submitted for any other degree or diploma.

The dissertation is fit for the submission and the partial fulfillment of the conditions award of M.Tech (Computer Science and Engineering) degree.

Date: _____

Name **Pency Juneja**

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DECLARATION

I hereby declare that the dissertation entitled, **"Analysis and Forecasting of Exchange Rate using Artificial Neural Network"** submitted for the M. Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

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CHAPTER 1

INTRODUCTION

Introduction

1.1 Artificial Neural Network (ANN)

The neural network emerges from the biologically neuron connection of human brain. Neural network inspired by brain as it is act like nonlinear, highly complex and parallel computer. The main element of the artificial neural network paradigm is processing of information and it comprises of huge number of interconnected processing elements, which called as neurons. Neurons work to solve particular problems. Neural network is parallel distributed processor created for the processing of the elements that has capability of storing some important knowledge by creating it and making available for use and it acts like brain as knowledge obtained by the network from environment through the learning process and there are many connections between the neurons, which called as synaptic weights which are used to store the acquired information. Neural network acts like a machine that is designed to do a specific task, several electronic components are used to implement network and that can be simulated in software on the digital machine. The technique which is used to conduct learning process is known as learning algorithm that is used for modifying the weights of network to obtain the desire output. Learning by the means of biological processes involves adjustment of the synaptic connection that exists between the neurons. Neural network is categorized of nonlinear model, the mainly used neural networks architecture is multilayer feed forward network. Several Training algorithms are being designed and used to set the weights that reduces the difference between target and observed value in the network. The advantages of the artificial neural networks models from the classes of nonlinear models is that ANNs are universal approximations which can approximate a high degree of accuracy with large class of functions. Through parallel processing of data their power comes from of the information. In the process of model building no prior assumption of the model is required. The network model is mostly determined by the data characteristics. The most widely used model is single hidden layer feed forward network for time series modelling and forecasting. The model is characterized in the form of three layers of simple processing units connected through acyclic links.

1.2 Benefits of Neural Network

Neural network extracts its computing power through its learning capability and gigantic parallel distributed structure. These properties make neural network possible to find approximate solution to complex type problems. In practical neural networks does not provide the appropriate solution by working independently, it need to be combined with a steady process. Neural network have some of useful benefits and properties.

a. **Input-output Mapping**: a paradigm in which every network comprises of input signal and a desired target response, synaptic weights are used to adjust to reduce the difference between the desired and actual response of the network. Earlier applied training examples may be repeated during the training session in different sequence of order.
b. **Nonlinearity**: Neural network consists of strong interconnection of nonlinear neurons. Nonlinearity is a kind sense divided throughout the network. Nonlinearity is one of the important properties, especially if the physical mechanism which is responsible for the generation of input-output signals is inherently nonlinear.
c. **Adaptivity**: Neural network have the mechanism potential to adapt their free parameters to change in the specific environment. The adaptation power of neural network is important property in pattern classification, control application and signal processing. Adaptivity is measure by learning rate parameter.
d. **Evidence Response**: Neural network can be generated to provide information for the selection of particular pattern and confidence to the decision to be made. That information used in reject the ambiguous pattern.
e. **Fault Tolerance**: A neural network has the potential to be fault tolerance, if neurons and its connecting links are damage then it can recall the store pattern impaired in quality. For fault tolerance it is necessary to take corrective design algorithm which is worked to train the neural network.
f. **VLSI Implementation**: The neural networks have gigantic parallel nature that leads to implementation of Very Large Scale Integrated (VLSI) technology. Computations of complex tasks are made faster by this nature of neural networks.
g. **Analysis and Design Uniformity**: Neural networks have information processes as their universality. Neurons represent common ingredient in one or another form for all

neurons and this commonality feature make it easy to convey their theories and their learning algorithm for the applications of neural network.

h. **Neurobiology Analogy:** Neural network is inspired and design by similarity of brain, which have the consistent proof that fault tolerant processing is physically possible ,fast and also muscular. Neurobiological phenomena uses neural network to behave as a good research tool for solving problems.

1.3 Artificial Neuron

The development of artificial neuron was an effort to the model of human brain. The inputs given to the neurons are multiplied to their respected weight. Neuron can be broken into three parts which are input connections, activation function and output connections.

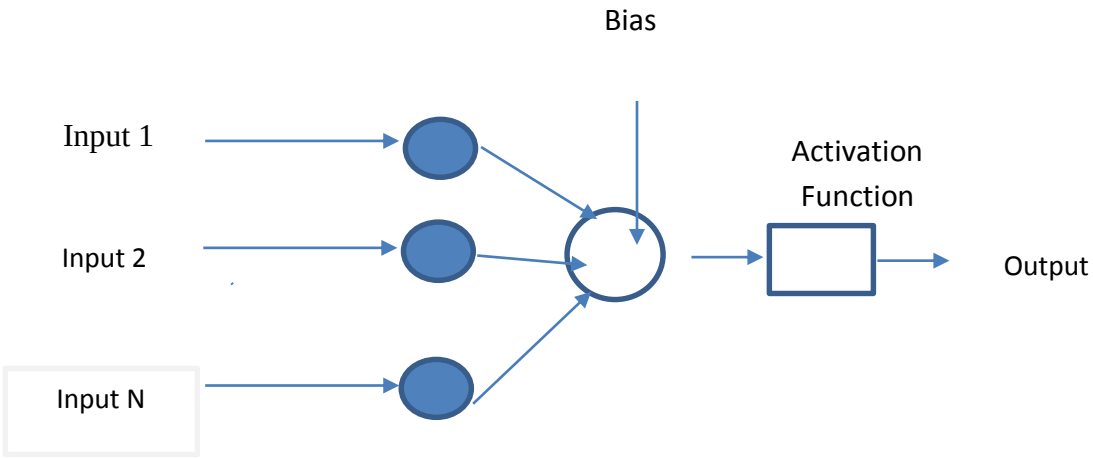

Figure 1: A Simple Neuron Model

1.3.1 Input connection: A neuron connected to other neurons by some connections that called the input connection. There is no any type of limit to the amount of connection with other neurons. The information of neuron that is combination of weight is in between of -1 to +1.

1.3.2 Activation function: In the second portion of neuron there is activation function which is equal to the input information multiplied by corresponding weights is added to it. Many activation functions exist in artificial neural network.

1.3.3 Output Connections: In output connection activation function it returns respective value for the inputs and these values are input to the next neuron that acts as input

for present neuron. The process iterates again and again with current neuron output and output added to others.

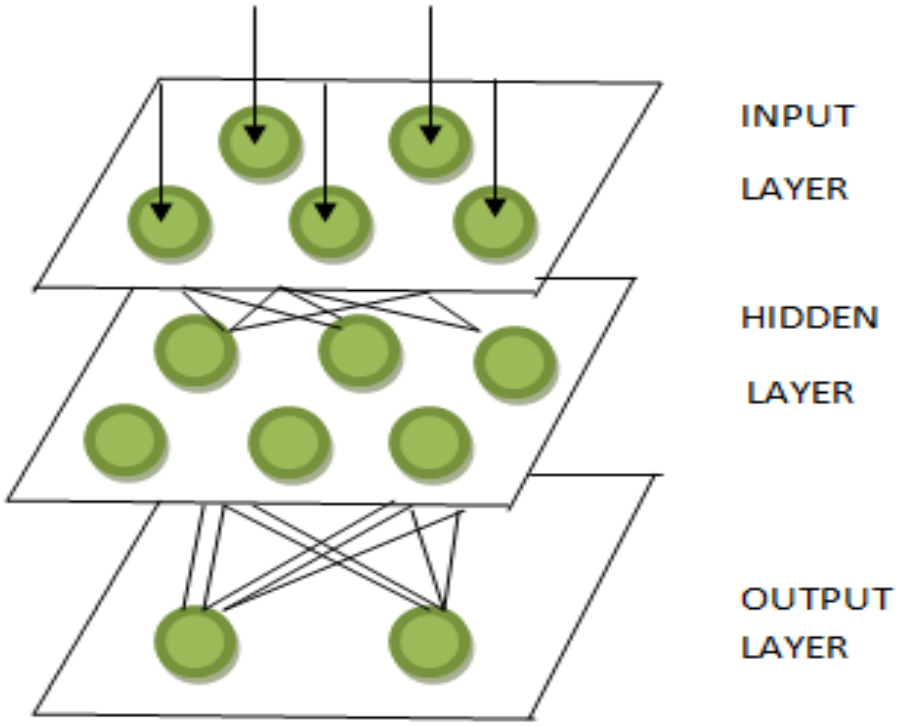

Figure 2: Neural Network Architecture

1.4 Learning

In artificial neural networks learning achieved by changing the weight connections recursively so that network trained to operate some task. Supervised learning strategy is used to minimise the error function between observed output and expected output. Supervised learning also called as learning under some teacher. Reinforcement learning is used when the desired output is unknown to the user. Unsupervised learning is used when no output is available on the correctness of output. This learning is attained without any supervision. There are many ways of the learning in the environment. Neural Networks can be used any of the learning method for learning in which some kind of learning process involves with a teacher and some of learning process without any involvement of teacher. Learning process categories into three types Supervised, Unsupervised and Reinforcement learning these learning described below.

[1] **Supervised Learning:** Supervised Learning is that in which System learns by the help of one or more teachers. Teacher has the particular knowledge of about the field of the environment and that knowledge may be represented by the few of examples of input-output training. A teacher is able to give the built in knowledge to neural network through a desire response for the training vector error signal is calculated by the actual response to the desire response. Learning process is fast as teacher is present in environment.

[2] Unsupervised Learning: unsupervised learning is learning without any teacher or with any help of teacher. Unsupervised learning also called as self-leaning. The learner learns by experience or without any help of external agency.

[3] Reinforcement Learning:. Reinforcement learning system developed by critic instead of a Teacher. Critic takes some primary reinforcement signal after received it converts these signals into Heuristic Reinforcement Signal. The aim of reinforcement learning is use to underestimate cost to go to function which is defined by cumulative belief cost of actions hold over a series of steps besides of immediate of cost. Reinforcement learning also called the motivational learning.

1.5 MLP

A multilayer perceptron (MLP) comprises of a network of neurons known as perceptron. Multilayer perceptron is able to access a single output from multiple input values thereby creating a combination of some weight values and placing the corresponding output value in any nonlinear activation function. Activation function can be used of any type as single perceptron have less mapping ability. Multilayer perceptron uses have input layer, hidden layers and output layer. Input is propagates from one layer to other layer.

1.6 Back propagation

Back propagation algorithm used to obtain the desired result in which weights are propagate back from the last layer which is output layer to the hidden layer to adjust the weights according to the desirable result. Back propagation applies a supervised learning of training algorithms. Back propagation is an abbreviation of backward propagation of errors, it is a common method of training artificial neural networks

Which is used in conjunction with an optimization method such as gradient descent. The method used for calculate the gradient of loss function with respects to all the weights in the network. The gradient is fed to the optimization method which is uses it to update the weights of network, for minimize the loss function of network.

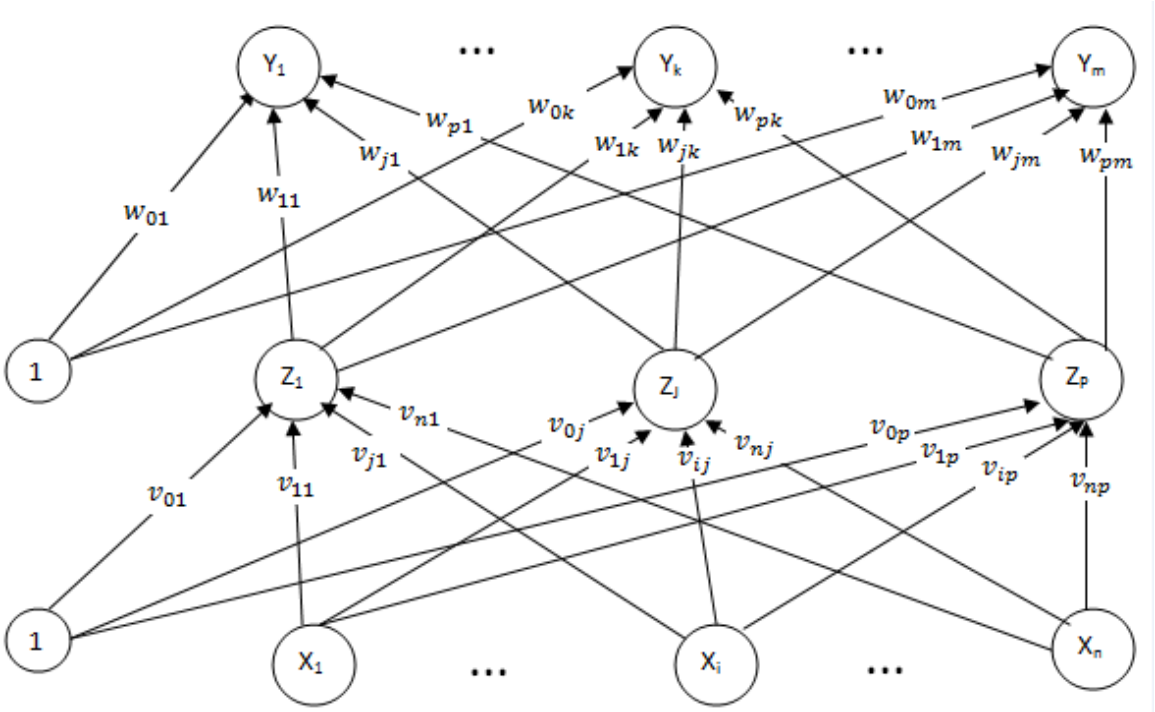

Figure 3: Back Propagation Network Architecture

The figure shows the architecture of back propagation networks which shows how weights are propagates first forward then propagate backward from output layer to hidden layer for adjust the weights where bias value also included and network net out can be in bipolar which uses -1 and +1 or in the binary form which uses the 0 and 1. Back propagation uses the stochastic nature which is based on the gradient descent method. In the above diagram X is input layer, Z is hidden and Y is output layer. For Back propagation requires a known, desired output for every input value for the order to calculate the gradient loss function. Therefore usually supervised learning phenomena is used, although sometimes it is also some unsupervised learning networks like auto encoders. Chain rule is used to compute gradient of every layer, for multilayer feed forward network delta rule is used. In back propagation some activation function

is used and some learning rate parameter is present for learn the network or to train the weights. From the other networks back propagation algorithm works different in the weights are gains in learning duration of the network. Networks which are used in the back propagation are known as back propagation networks. For updating the weights simply gradient descent method is used except from perceptron which uses differentiable units. Back propagation training is done in three parts, first input training pattern of feed-forward, second back propagation and calculation of error and third update of weights. Back propagation networks testing involve in phase of feed forward only. There may be large number of hidden layers but at least on one hidden layer is compulsory. Training of network is very slow but it is capable of producing a rapid outputs. The error is measured at the output layer which is difference of calculated to the target output. At the hidden layers are not any direct intimation of error. Back propagation is a feed-forward multilayer neural network with the three layers of input layer, hidden layer and output layer. There can be any type of activation function used in the algorithm which is differentiable and increases monotonically. For the learning the factors involved in back-propagation algorithm are size and nature of rule, learning rate, initial weights, momentum factor and the number of hidden layer nodes. For the network which have more than one hidden layer all calculations which performed at single layer is summed up at end repeated for all layers.

1.7 ANFIS

The ANFIS which is adaptive network based fuzzy inference systems used for solving problem which is related to parameter identification and this parameter identification done through a hybrid learning rule combination of a least-squares method and back-propagation gradient descent method.

ANFIS is capable of construct a network using of IF - THEN rules. ANFIS structure is simply a graphical network which basically representation of Sugeno-type fuzzy systems with some neural learning capabilities. The network is comprised of large number of layers with some nodes. Layered architecture of ANFIS system supposed to be like showing in figure below. Adaptive neuro fuzzy inference system is a learning information technique which compute a parameter of membership function for track the best allow the data set of input and output data set.

There is a toolbox in matlab for ANFIS which is display using write the anfisedit command. ANFIS uses the Sugeno method which is works well with optimization, computationally effective and adaptive techniques which makes it attractive in dynamic nonlinear systems and particularly for control problems. The acronym ANFIS derives from name adaptive neuro-fuzzy inference system using a given input or output data set it constructs a fuzzy inference system whose membership function parameters are tuned adjusted using either a alone with back propagation algorithm or type of method in combination of a least squares which adjustment provide the fuzzy systems to learn from the data which they are dealing.

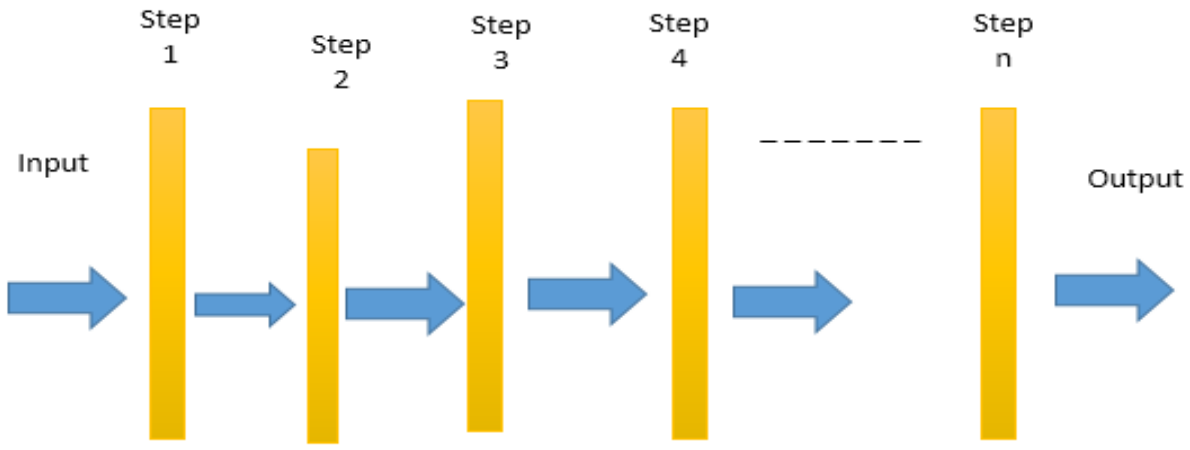

Figure 4: STEPS OF ANFIS

Adaptive neuro fuzzy inference system built inside an adaptive fuzzy neural network which is simply a Fuzzy Inference System which means it have the capability to optimise the parameters of the FIS through applying a learning algorithm. In words of adaptive systems, adaptive fuzzy neural network can be given a set of data with a learn set of fuzzy rules that fit to that data.The adaptive network based fuzzy inference system is a representing a neural network approach and data driven procedure for solution to the function approximation problems. For the synthesis of ANFIS networks data driven procedures are typically based on clustering a training set of unknown function of numerical samples to be approximated. ANFIS networks have been applied to rule-based process control, classification tasks, pattern recognition and other similar problems. The fuzzy model is a fuzzy inference system comprises of the Sugeno , Kang Takagiand to create a systematic approach for the generation of fuzzy if then rules from an input data

set to the output data set. The process of anfis goes through the number of layers of its processing after completing one layer next layer comes for processing output of previous layer act as the input to the second layer.

1.8 Exchange Rate

A currency exchange rate is determined by the proportion of a unit of currency of any country to a unit of the currency of other country at the time of the buy or sells transaction. Exchange rate forecasting is a challenging and important task in terms of business purpose and academic researchers. For each currency, there is a supply and demand. This comes from the trade flows of each country. The higher the exchange rate for one euro in terms of rupee, the lower the value of the rupee. A good economy attracts investors who demands for a currency of any country positively while a bad economy detract investors. Other economic indicators that affect exchange rate are employment situation, non-farm payroll, GDP, interest rate, consumer index, inflation and non-manufacturing index, national economy polities etc. An exchange rate has a counter and base legal tender. In the direct way, the foreign currency is considered as the base currency and the domestic currency is considered as the counter currency whereas in an indirect way, the domestic currency is known as the base currency and the foreign currency is known as the counter currency. The use of US dollar as the base currency and other currencies as the counter currency is done by most of the countries. Exchange rates are generally intimated to four places after decimal value whereas for currency of yen they are measure to two places after the decimal. Exchange rates can be categorised as a fix rates or floated exchange rates. The floating exchange currency rates are defined in terms of market forces which are the norms for most of the major nations while some of the nation’s favour to make their domestic currencies to a widely accepted currency like the US dollar currency.

Exchange rates can also be defined in terms of spot rate which the current rate and forward rate uses to adjust the ups and downs in interest rate. It has been admit that if countries import more than they export and so have a loss on the present account of the balance of payments then their currencies will bear to fall in value. Exchange Rate with relation to forex exchange of money is the price of a country currency show in details of one currency in unit of another country's currency. The Foreign Exchange rate defines the value of any given currency in respect to other.

To determination of exchange rate there are sellers and buyers where currency trading is continuous and determine in the foreign exchange market. Market convention is decide which variable currency is and which is fixed currency. The financial condition have the main role through which foreign exchange market works, and it operates on different levels. Behind the concept banks move to a smaller number of financial firms of dealers, who are actively participate in large quantities of foreign exchange trading.

CHAPTER 2

LITERATURE SURVEY

Adnan Haider and Muhammad Nadeem Hanif (2009) describe the artificial neural network (ANN) is persuaded by biological nervous system like process information and brain. The Researcher attempted to forecast the monthly year-on-year inflation for Pakistan by using artificial neural network on duration July 1993 to June 2007. The Researcher compares the model with conventional univariate time series forecasting models and ARIMA model and determines that root mean square error (RMSE) of ANN is very less than RMSE of ARIMA models. In research feed-forward artificial neural network model used twelve hidden layers and feed forward with back propagation concept with steps of input variable selection, input data processing, network training and forecast accuracy is used. The researcher used learning rate value 0.25 and an activation function is used which have the delta rule. The researcher compare RMSE based on actual inflation, forecast by artificial neural network and forecast by ARIMA modal in monthly wise and calculate the average of that RMSE value. The research defined the error minimization in the out-of-sample forecast based on root mean square value.

Chakradhara Panda and V.Narasimhan (2007) describes the prognosis of weekly Indian rupee with US dollar exchange rate one step ahead with neural network also compare the accuracy of forecasting with random walk model and linear autoregressive model. With the help of some forecasting evaluation techniques the researcher finds that neural network gives the efficient results in both in-sample forecast and out-of-sample forecast rather than in random walk models and linear autoregressive model. Researcher also defines the neural network provides confirmation to the appropriate market hypothesis and defines there is always possibility to extract hidden data and predicting the future exchange rate. The researcher took observations of 350 for in-sample data and 146 observations for out-of-sample data. Researcher defines the value of data in range of 0 to 1. A single hidden layer feed forward network for the purpose of training is designed in which sigmoidal function is used for hidden layer and linear transfer function is used for output layer. Technique of Nguyen and Widrow used for

initialized the small values of weights and for the cost function mean square error is used in the network by using back propagation algorithm. According to author, In-sample forecasting has the RMS value 0.2048 which is lower in comparison of linear auto regressive model and random walk model whose value is 0.2581 and 0.3325 respectively and in out-sample forecasting ,the correlation coefficient of ANN is 0.1851 while Linear auto regressive model is 0.2201 and random walk model whose value is 0.2535.

S.S.Gill, Amanjot Kaur Gill and Naveen Goel (2010) uses artificial neural network as traditional time series analysis for handling enormous data and predicting currency exchange rate proven to be difficult. Author defines that neural network technique is for complex data which may be time consuming and difficult using deterministic techniques. Due to some features like learning ability, inherent parallelism, inherent contextual information and fault tolerance processing make neural network suitable for many complex applications. The researcher collect the weekly sample data from date March 31st, 1995 to December 31st 2003 for training purpose and sample from January 1st 2004 to March 2005 for the testing purpose. Three factors used as input which are rate of USD, gold and crude oil. These factors used for prediction of ten weeks ahead price of USD with neural network modal. Author chooses the scaling or normalization value of input data range from -1 to +1 in middle layer choose the sigmoidal function. As no of inputs may be nearby zero and weight change law directly proportional to input value which realize that weights are not participating in learning. To control this problem a constant is added in input data set so that values approaches to 0.5 and neuron works well. Author took three training sets of different period and find very encouraging and factors choose for analysis the have proved suitable for exchange rate prediction.

Vincenzo Pacelli, Vitoantonio Bevilacqua and Michele Azzollini (2011)" in this paper the main motive of researcher is to predict exchange rate Euro/USD for three days ahead from the previous data available with you. Purpose of this research is to design optimal multilayer perceptron neural network topology and that has been tested using some specific genetic algorithm named multi-objective Pareto-Based. Research aim is to analyze the mathematical models of non-linear type to limelight non-random predictable behavior in a mainly liquid market and identified by a high efficiency of

exchange rate Euro/US dollar. In construction of database which is used for the training of artificial neural network divided into three components in which first is collection of data, second analysis of data and third variable selection in which data collection were from January 1999 to December 31st,2009. Once data is collected author switches to level of analysis data, learning capability of ANN based on the quality of data provided to the network. Next level was evaluating the relation between input variables which is considered and elimination the variable mostly correlated with each other. The researcher use the historical values of seven input variables in which historical data was calculated by a polynomial interpolation of coefficient $R^2 = 0.98$ for 90% cases. For the prediction of previous historical memories of the every variable by finding the angular coefficients used in the Mat-lab software function Polyfit. The author concluded the research by specifying that the first two ANN's are designed with the construction of trial and error technique with the performance of 70% and 60% respectively while the third network is designed with optimized construction techniques with the performance of 80%.

Minakhi Rout, Usha Manasi Mohapatra and Babita Majhi (2012) reviewed the long range exchange rate prediction using Radial Basis Function Neural Network (RBFNN) which is designed to predict currency rate between 1 US dollar to Japanese Yen and Indian Rupees. The Radial Basis Function (RBF) has been compared with Function Link Artificial Neural Network (FLANN) and Multilayer Layer Neutral Network (MLANN) on basis of forecasting and RBFNN have better results. Author describes that there are lot of nonlinear models have been designed for the prediction purpose in which cascaded function link artificial neural network (CFLANN) which is best by Function Link Artificial Neural Network and Least Mean Square models. In Radial Basis Functional neural network a multistage nonlinear network reported for prediction of foreign exchange rates. In process ensemble modeling first stage contain only particular RBF neural network model, second step conditional generalized variance method is used and in last step another RBF network ensemble for the prediction. RBFN groups the homogeneous firms in hidden layer network which performs a logic analysis on groups rather than directly on firms. In simulation study results obtained from MLANN model and FLANN model are compared with the proposed model. Simulation is used for prediction of Japanese Yen and Indian Rupees with respect to the US dollar.

Yusaf Perwej and Asif Perwej (2012) uses neural network for the forecasting of exchange rate Indian Rupee (INR) in comparison of US Dollar (USD) with the effects of input nodes and changes in hidden nodes and takes the size of training sample on the both out-of-sample and in-sample performance. The Researcher took the large data set from 1989 to 2009 which consist of 1043 observations and small ones includes 365 data points from duration of 2003 to 2009 and test sample for all of the cases having 52 observations. The forecasting model consists of three metrics MAE, RMSE and MAPE, in in-sample results with the increment in the value of hidden nodes, RMSE gets decreases but MAE and MAPE do not decrease. Author measure three time horizons for one-month, six-month and 12 month horizons. This paper determines the effect of some useful neural network factors in the model fitting and forecast the behavior. The experimental factors are number of input value and hidden nodes and effects of in-sample fitting and out-of-sample fitting are examined with forecast horizons. By the results author clears that neural network give better outcomes than random walk models for all the three measures across the three time horizons.

D.Ashok Kumar and S. Murugan (2013) The Researcher uses some hybrid model with statistical model integrated with artificial neural network model which used as single model. In this paper research work discuss some idea about need of ANN, importance of stock indices, time series data and survey of previous of previous work. The forecasting is measured with indian stock index which are Bombay Stock Exchange (BSE) and NIFTY MIDCAP50. Researcher uses two types of indices SENSEX and NIFTY. NIFTY consists group of 50 shares while SENSEX consist of 30 shares. Data sets are collected for BSE100 is duration of 2007 to 2011 and for NIFTY MIDCAP50 is also from 2007 to 2011.The mat lab tool is used to graph representation and performance analysis which work on the phenomena of back propagation neural network architecture. The network have one input layer, hidden layer and output layer. Sigmoidal function works as activation function for the hidden layer and output layer. In the experimental process the researcher used some data for training purpose and some for testing purpose in which 70% is used as training and rest 30% is used as testing, learning rate ,momentum and number of epochs can be adjusted if expected output not received according to need. When output which is required is achieved then stop the training process. The Researcher got the effective results for the both BSE100 and NIFTY MIDCAP50 by evaluating Mean Absolute Error, Mean

Absolute Percentage Error, Percent Mean Absolute Deviation, Mean Square Error and Root Mean Square Error.

Kangarani Farahani, Mahsa, and Soheil Mehralian (2013) Researcher compare the artificial neural network with the for the prediction of gold price to the some hybrid model of neuro fuzzy it compare the model for different scenarios and calculate the different error which shoes the result that the researchers hybrid mode have the very less error in root mean square value. The researchers objective was to predict the price of gold by artificial model and adaptive neuro fuzzy model and then with its hybrid model. First researcher compare with the artificial neural network structure in which used the multilayer back propagation algorithm then second it compare with the neural fuzzy structure in which some if then rules are used and adaptive neuro fuzzy inference system is used. Twenty entries of gold data is used as test data and compare with the artificial neural network and adaptive neuro fuzzy system and compared with hybrid model which gives less error then compare of these models. The root mean square value of ANN is 2.62 and ANFIS is 2.52 while hybrid gives the error value of 2.54.

Mehreen Rehman, Sahibzada Ali Mahmud,Gul Muhammad Khan (2014) describes the algorithm of Cartesian Genetic Programming (CGP) for the model of forecasting. The Author defines accurate and efficient model for forecasting using Recurrent Neural Network and Cartesian Genetic Programming which is evaluated using the statistical metric and compared. Recurrent Cartesian Genetic Programming Artificial Neural Network (RCGPANN) is different from CGPANN as the existence of feedback mechanism which uses partially linked neurons in place of fully linked neurons. RCGPANN have hidden states in which output dependent on a number which is randomly generated from previous inputs. A recurrent CGPANN consists of weights, input connections, weights and some node function. New input neurons enter from outer environment is considered as input node and node which receives input from preceding node called as intermediate node. The output weighted patterns are supplied to sigmoidal function and return back to the input layer to perform new patterns of output. The Researcher monitors the network for single, five and ten number feedback paths. In experimental set-up Researcher five hundred days of US data used for train ten different recurrent networks of neural where five seeds are used and sigmoidal used for activation function. The performance of the network has been calculated on five

different currencies on the data sets of 1000 days from 1st February, 2003. Author includes currencies of New Zealand Dollars, Japanese Yen, Korean Won, Canadian Dollars and Indonesian Rupiah. The Author conclude that the network accuracy increase as the number of feedback paths which increases the prediction capability of future data.

Steven Gonzalez (2000): Researcher conducted a research which was related to the forecasting of macroeconomic of Canada by using artificial neural network and results are compared with the model of prediction of linear regression. Steven used artificial neural network model for trained of neurons back propagation algorithm is used in the research the final results shows that the artificial neural network has the less error rate with compared to another linear regression model. From the research researcher concluded that the artificial neural network give better performance than linear regression model and the predicted result of output good as compare to linear model of regression. Researcher calculate the mean absolute errors of both of the cases and results are shown in the form of graphs and charts.

Dr.C.Loganathan and K.V.Girija (2013): From the conducted Survey the author described a research with is comparisons of the result obtains from the back propagation algorithm, gradient descent learning algorithm and third Runge Kutta Learning Algorithm and these training algorithms are applied to the adaptive neuro fuzzy inference system are results of these training algorithms are obtained with the ANFIS. In the result the values error of training data in back propagation is 0.24432 and for the similar data set the gradient descent learning algorithm error is 0.21837 and for the runge kutta learning algorithm it shows the error value of 0.091077. Thus with comparison of these training algorithms with learning mechanism of adaptive neuro fuzzy inference system better results are produced. The error value is reduce with the increment of epochs and results shown in the form of graphs.

CHAPTER 3

PRESENT WORK

Present work

i. The research work have completed with comparison of ANFIS system and Back propagation algorithm.

ii. In the ANFIS technique research work evaluating using two scenarios, in which first scenario the whole data set is taken in which at target end exchange rate and other data attributes in which gold price, crude oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) are taken as input to network and results are evaluated.

iii. In the second scenario of ANFIS rather than whole data set some attribute are not taken and again for prediction at target end exchange rate and other data attributes in which apart from gold price, crude oil price the other remaining domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) are taken as input to network and results are evaluated and find out the error difference of actual and predicted data value

iv. Similar data set is applied to the back propagation networks and compares the results for error measurements of RMSE, MAE and MAPE.

3.1 Scope of the Study

The research study which is implemented is useful in many sense like if we know the future of the currency rates that is whether it is going to increment or it is going to decrement in the nearby future, then it will be every useful for the general people and the investors in stock market because they will get to know how much money they have to spent, what is rate of the currency the next day. Moreover, GDP growth, interest rate, inflation, gold rate, crude oil rate and many other factors depend on the exchange rate only. There are some of other factors that influence the exchange rate which are like political scenarios and socioeconomic policies, but they are not in scope of mathematical correlations as they are not measurable. The advantage of forecasting exchange rate is help to predict future production of services demand and goods so that enough production can be available to

fulfill customer demands according to need by the idea of currency exchange rate profit of the business can be estimated easily. Forecasting of exchange rate helpful to the companies in sense of what will happen in the future will the stock price and nifty thus it can helps to the industries to make them more profitable and stronger. Forecasting exchange rate helps to the researchers and economist for solving the problems of investment, profits, inflation, consumption, and growth domestic products of the nations.

3.2 Problem Formulation

Currency exchange rate of the country defines the internal structure of that country. Exchange rate is the backbone of every nation. Many other parameters are depends upon the value of nations currency exchange rate. In every field modelling of new systems are coming for the accuracy and preciseness of the values for consideration of previous system and compare the result with new system. For prediction of exchange rate back propagation is used in many models but for the more accuracy and reduce the error value, anfis technique there are the chances of more accuracy as there is use of membership function are there and work is done according to some if then rules. The value of exchange rate is affect by many of the parameters these most of the parameter are taken as attribute and for the prediction. The problem with the back propagation algorithm is that it gives the result nearby but not up to that extent for more accuracy some new system is used anfis which use the neural network concept with some fuzzy inference system uses the membership function and values to membership are define using of adaline network algorithm and back propagation with least mean square rule. Learning mechanism of adaptive neuro fuzzy inference system can be applied to different training algorithms for improvement of the efficiency of that training algorithm.

3.3 Objective of the Study

i. To get one step ahead prediction of exchange rate based upon previous data values of longer time.

ii. The depreciation in currency value can be determine by the prediction of exchange rate which will be helpful for investors.

iii. To find out the balance of trade this is mainly import and export of goods and only determined by the prediction of exchange rate.

iv. This research tries reduce the error and more precise result for the future value of exchange rate figure.

v. Other objective is to find out a model for forecasting which will produce a optimal solutions in terms of time, complexity, accuracy of prediction and try for the precise value.

vi. Objective of research is to optimize the efficiency of training algorithm by using some learning paradigm. In this work adaptive neuro fuzzy inference system mechanism is used with the learning back propagation network algorithm.

vii. Other objective is to compare the result of simple training algorithm and with some learning paradigm of same training algorithm.

3.4 Research Methodology

In research methodology there are several steps through which every research have gone, these steps are very much essential for every research. In figure below we have defined those basic steps. Every step has its own importance from researcher point of view. Basic idea about the broader area is needed then narrow down to some topic through which our problem will be configured is needed.

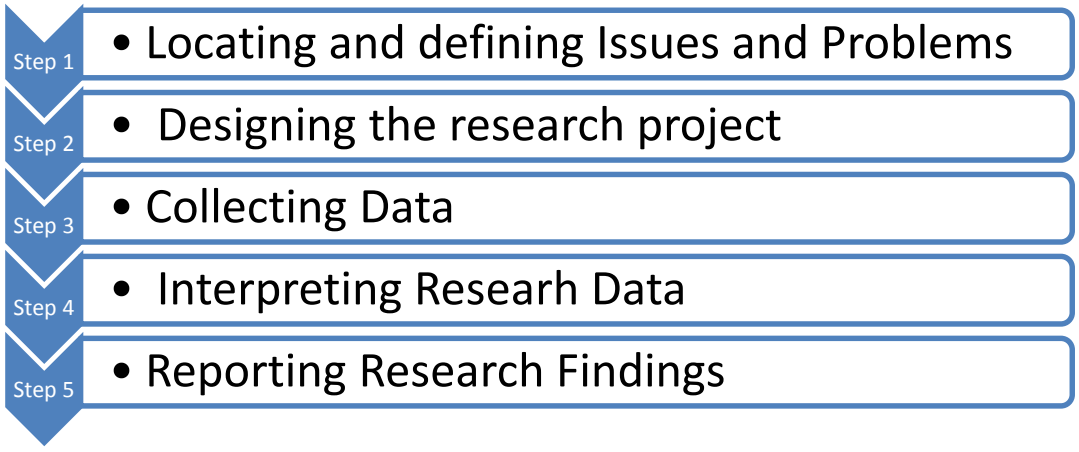

Figure 5: Steps of Research Methodology

In data collection data from a specific duration to longer time period market data is collected from the change the behavior of exchange rate is affected. After analysis that database some variables are selected which act as attribute value of input to the artificial

neural network architecture. By choosing previous monthly wise data of longer period of that attributes in which include forex exchange rate, gold price, crude oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity and mutual fund trading activity data from a period of January 2000 to July 2014 and put that data into some artificial neural network architecture, data of these attribute act as input to the network. In which total entries of all the attributes are used in system, large set of data used for training purpose to train the network then remaining rest of data portion used for testing and validation purpose. In training data respective output to the attributes are provided to the system which used for trained the system to acquire the desired result while on other hand for testing data no respected label output to attribute are provided. Main performance of system is measured by the testing output and validation data defines whether the system gives the accurate results and working of network is up to the mark or not. Some learning rate parameter is use whose value is between of 0 to 1. Membership function defines the impact value of attributes which acts as inputs to network to obtain the desire label. We are going choose some factors that are highly influence the exchange rate. Exchange rate is highly dependent on these factors, some of factors are directly proportional to exchange rate and some of them are inversely proportional to exchange rate. Data is taken monthly wise of every attribute and with respectful to input parameters the data of output label of same period is taken and by putting it in some network calculate the predicted value of label and compare that value with the original label value. The difference between the original data value and predicted data value called the error of respective data value, for calculating the whole data value summation of all errors are taken and which is called the network error of system. For an optimize network the error value must be minimize and there must be very less difference on compare the predicted value with the actual value. For evaluating the results the observed results can be compare with the any model with the same data eateries and find out the performance of each model on different data attribute sets which describes dependency of each attribute on network.

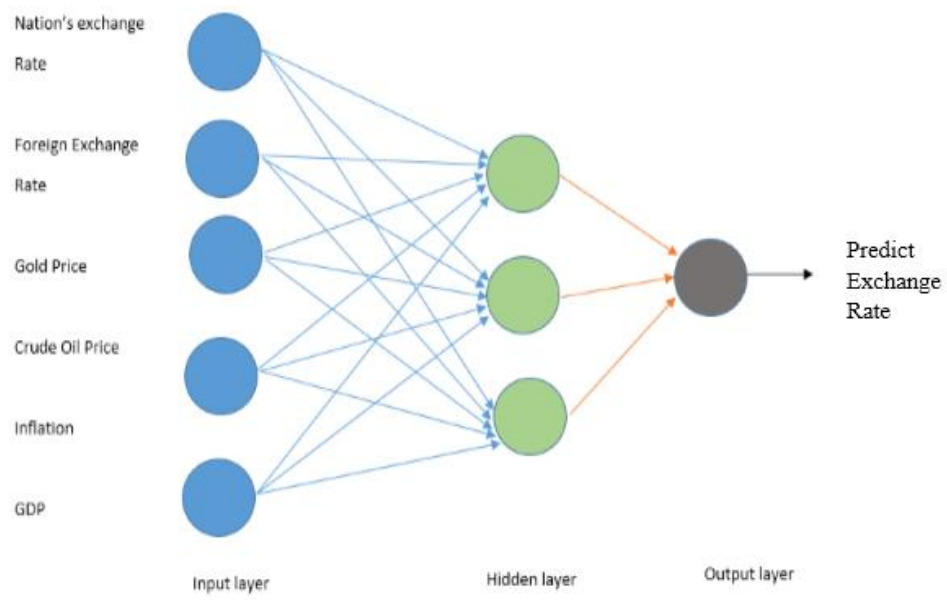

Figure 6: Architecture of System

The research methodology which is used for obtaining the objectives of this study is:

a. **Qualitative Approach:** In the qualitative approach we use to study various previous papers related to forecasting in which different strategies are followed by different authors for the forecast any parameter. There are lot forecasting research papers on inflation and growth domestic products are there. Artificial neural network is a great field for the forecast system there large number of algorithms are proposed.

b. **Quantitative Approach:** In this approach we are going to define the technique used for the forecast and algorithm which is going to be used for the prediction of exchange rate. The technique which is going to use artificial neural network architecture which mainly have three layers as input layer, hidden layer and output layer and proposed algorithm which is going to use in this research is back propagation algorithm (BPA). The purpose behind using the back propagation is used to trained the neurons and change the weight values for obtaining the target value. Some learning parameter is used for learn the neurons and mat-lab tool use for implement the research.

c. **Mixed Approach:** The approach that we are going to use includes both the qualitative approach and quantitative approach. The main terminology that we are going to use in this research study is by combining both the approach is to analyze the Exchange rate forecasting through neural network. Input neurons are trained through back propagation

algorithm will be used for the effective result. Some highly influence parameters previous data used as input to the neurons. Major parameters data used as input to input layer that goes to the main hidden layer in which all mathematical functions work and this goes to provide a the connection to the output layer that gives a single result for that inputs.

3.4.1 The learning algorithm concept of ANFIS

Consider a fuzzy of Sugeno type system Having the following rule base

If x is $X1$ and y is $Y1$, then $func_1 = c_{11}x+c_{12}y+c_{10}$ and

If x is $X2$ and y is $Y2$, then $func_2 = c_{21}x+c_{22}y+c_{20}$

Suppose membership functions of fuzzy sets are Xi, Yi, i=1, 2, be, μ_{Xi} μ_{Yi}.

For evaluating the rules, choose the product for T-norms

1. Calculate the rule premises results in

$$w_i = \mu_{A_i}(x)\mu_{B_i}(y),\ i = 1,2.$$

2. Calculate the implication and rule consequences gives

$$f(x,y) = \frac{w_1(x,y)f_1(x,y) + w_2(x,y)f_2(x,y)}{w_1(x,y) + w_2(x,y)}.$$

On leaving the arguments x, y

$$f = \frac{w_1 f_1 + w_2 f_2}{w_1 + w_2}$$

it can be separated for phases by defining

$$\overline{w}_i = \frac{w_i}{w_1 + w_2}$$

Then function f can be written in form of

$$f = \overline{w}_1 f_1 + \overline{w}_2 f_2$$

Computations can be presented in the form of diagram. Generally ANFIS has five neuron layers of which particular layer neurons are in the same particular function family.

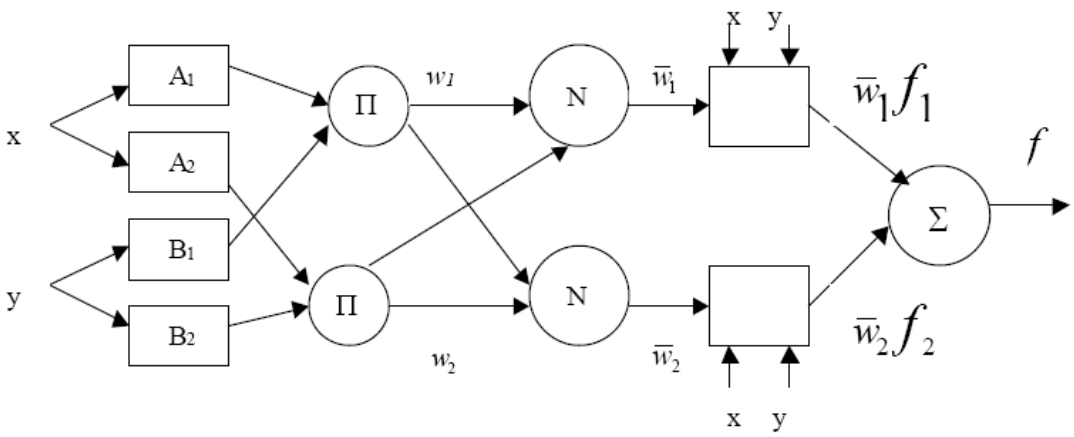

Figure 7: ANFIS Structure network.

The algorithm for the research work is:

Step 1: Initialize parameters.

Step 2: Select attributes which is longer period data of gold price, crude oil price, domestic growth product (GDP), consumer price index (CPI), foreign institutional investors (FIIs) as input attributes.

Step 3: Provide Target label which is longer period data of foreign exchange rate with respect to attributes used for training and testing our results.

Step 4: Start adaptive network based fuzzy inference system training using initial inferences.

Step 5: Every node generates the membership function of linguistic label.

For example of a membership function of a generalised bell function is

$$\mu(x)=\frac{1}{1+\left|\frac{x-l}{i}\right|^{2k}}$$

Where {*j*, *k*, *l*} is the attribute set Bell-shaped function varies shape with change in values of attribute.

Step 6: The firing strength of each node is calculated using the min or prod operator. Normally any of fuzzy operation like AND can be used.

Step 7: The ratios of the rule's firing strength calculated by nodes to the summation of all the rules firing strength. The result is in form of a normalized firing strength.

Step 8: The nodes computes the parameter function on the layer output. Parameters on output layer called the consequent parameters.

Step 9: Normally the summation of all In-coming signals are calculated in a single node.

Step 10: Calculate the root mean square error (RMSE), mean absolute error (MAE), Mean Absolute Percent Error (MAPE) using the given label in testing dataset.

Step 11: If the error is within acceptable limit go to step 12 or else go to step 4.

Step 12: Test the results.

After fixed the premise parameters, the whole output is in a linear combination of the consequent parameters. In mathematic form, the output *f* can be written as:

$$f = (\bar{w}_1 x)c_{11} + (\bar{w}_1 y)c_{12} + \bar{w}_1 c_{10} + (\bar{w}_2 x)c_{21} + (\bar{w}_2 y)c_{22} + \bar{w}_2 c_{20}$$

It gives a linear in the consequent parameters c_{ij} (i = 1,2,3, j = 0,1,2,3). A hybrid algorithm used to adjust the consequent parameters c_{ij} in a forward pass and to adjust in a backward pass the premise parameters $\{a_i, b_i, c_i\}$ used. Inputs propagate forward in the forward pass the network to 4th layer, while for identifying the consequent parameters the least-squares method works. Error signals propagate backwards for the backward pass, and gradient descent updates the premise parameters.

Because the consequent parameters are decoupled and update rules for the premise are used the hybrid learning rule, by using variants of the gradient method or other optimisation techniques on premise parameters a speedup computational is possible.

3.4.2 The learning algorithm concept for back-propagation

Let hidden neuron is denoted by X and output neuron is denoted by Y and have weight W_{XY} .

1. After apply input to the Network and calculate output, the initial output of network may be anything because initial weights are randomly chosen for network.
2. Calculate error of neuron Y.

   $Error_Y = Calculated_Y\ (1\text{-}Calculated_Y)\ (Desired_Y - Calculated_Y)$

   Factor Output (1-Calculated) used due to sigmoidal function as using only threshold value.
3. Let W_{newXY} be the trained weight can be describe as

   $W_{newXY} = W_{XY} + (Error_Y * Calculated_X)$

   Same way update whole weights in output layer.
4. As absent of target value the values of output layer error cannot be calculated directly, So reverse them from the output layer. From the output neuron by taking errors running

them back to errors of hidden layer. Assume if neuron X is connected to neuron Y and Z then errors from neurons Y and Z used to calculate the error of neuron X.

$$Error_X = Calculated_X (1-Calculated_X) (Error_Y W_{XY} + Error_Z W_{XZ})$$

5. Find errors for hidden layer neurons and for changing the weights of hidden layer follow step 3. Repeat the all steps to train any number of layers.

CHAPTER 4

RESULT AND DISCUSSION

Result and Discussion

The algorithm has implemented in the Matlab 2013b version. The proposed method used two techniques first ANFIS technique and second Back propagation network technique. The ANFIS technique is applied for two conditions in which only difference in conditions are values of their data sets. In first condition whole data set is taken and calculate the results with different error values and for second condition first two attribute are not taken of data set and calculate the results with different error values which shows that how exchange rate is affected by different attributes which are gold price, crude oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity. Similarly same data set is applied for the back propagational network algorithm and compare the results and different error values.

4.1 Result Analysis for ANFIS

This is the case when use the data of attributes of gold price, oil price, domestic growth product (GDP), consumer price index (CPI), foreign institutional investors (FIIs) as input attributes. Results have calculated for different attributes which shows great deflection in results outcomes in form of graph and bars. The more data is used for training purpose and remaining data is used for training and validation. Data set of these attributes are taken form the period of January 2000 to July 2014, in which approximate seventy percent of data took for the training purpose and fifteen took for the testing and remaining is used for the validation of network. For the first case data of gold price, crude oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity took as input to the network and respective to these attribute value exchange rate date took as target values.

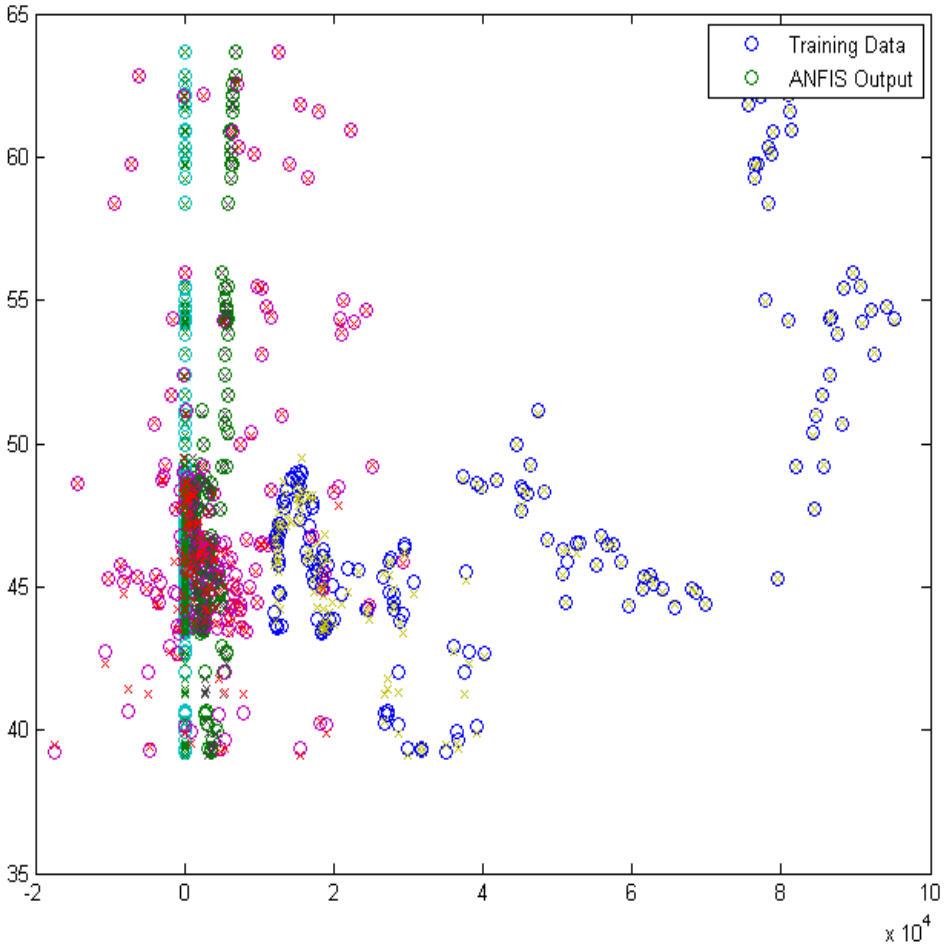

Figure 8: ANFIS leaning Structure network for Case 1

Training for the data can be showed graphically. In which firstly the training data are randomly scattered but after some time it tried follow some pattern.

The table shows network performance the actual data value of exchange rate and predicted data value exchange rate and their respected error value which is difference of actual data and predicted data.

Actual	Predicted	Error
46.4983	46.4771	0.0212
46.7617	46.7358	0.0259
46.4605	46.4124	0.0481
45.8729	45.7941	0.0788
44.3540	44.3713	-0.0173

44.9315	44.9013	0.0302
45.1000	45.1104	-0.0104
45.3750	45.3683	0.0067
45.3795	45.3713	0.0082
44.9143	44.8082	0.1061
44.3010	44.4104	-0.1094
44.9024	44.9123	-0.0099
44.8109	44.7839	0.0270
44.3960	44.3882	0.0078
45.3135	45.2967	0.0168
47.6905	47.6893	0.0012
49.2020	49.2101	-0.0081
50.6785	50.7546	-0.0761
52.3824	52.3476	0.0348
51.0015	51.0438	-0.0423
49.1812	49.2657	-0.0845
50.3635	50.2822	0.0813
51.6900	51.6935	-0.0035
54.3314	54.2940	0.0374

For optimize result the error values are tries to calculate root mean square error (RMSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) and compare with the actual result.

$$RMSE = \sqrt{\frac{\sum (y_t - \hat{y}_t)^2}{T}}$$

$$MAE = \frac{\sum |y_t - \hat{y}_t|}{T}$$

$$MAPE = \frac{1}{T} \sum \left| \frac{y_t - \hat{y}_t}{y_t} \right| \times 100$$

Where symbol $y_{t.}$ is the actual observed value, $\hat{y}_{t.}$is predicted value, and T is the number of predictions. The mat lab tool will be used for whole mathematical calculation. The result will be showing using bar charts or any other interface like graphs. The conclusion of all

the above work is that a new proposed artificial neural network system will be will produce the more effectively and accurately result then other systems. This proposed methodology wills very much effective as very less computations needed and large dataset can be easily processed. In network performance time the value of root mean square error (RMSE) is calculated which 0.0498 and value is of mean absolute error (MAE) is calculated are 0.0372 and mean absolute percentage error(MAPE) is 0.0786. These error are very less as compare to back propagation algorithm.

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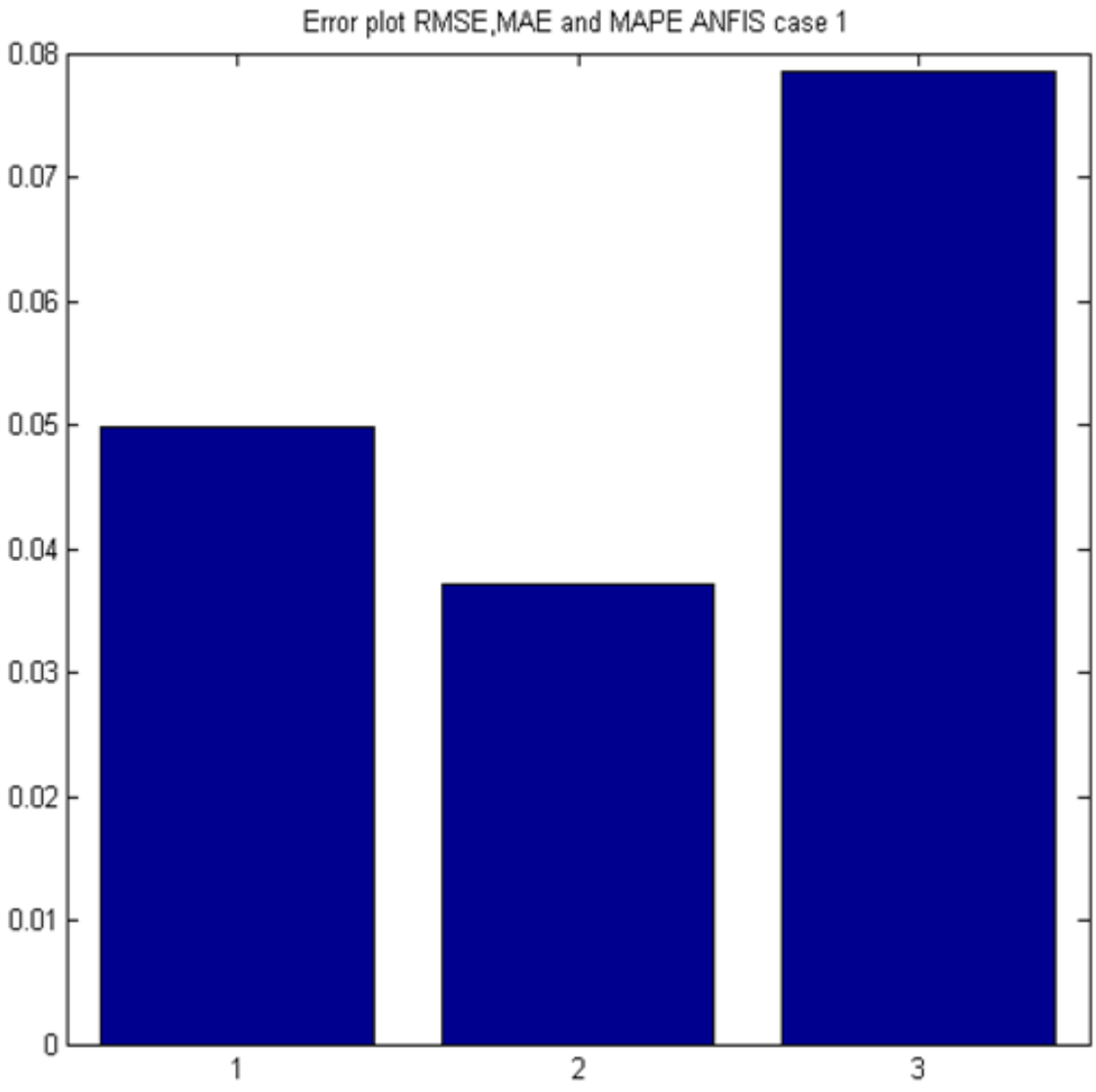

Figure 9: Bar-Chart of RMSE, MAE and MAPE for ANFIS Case 1

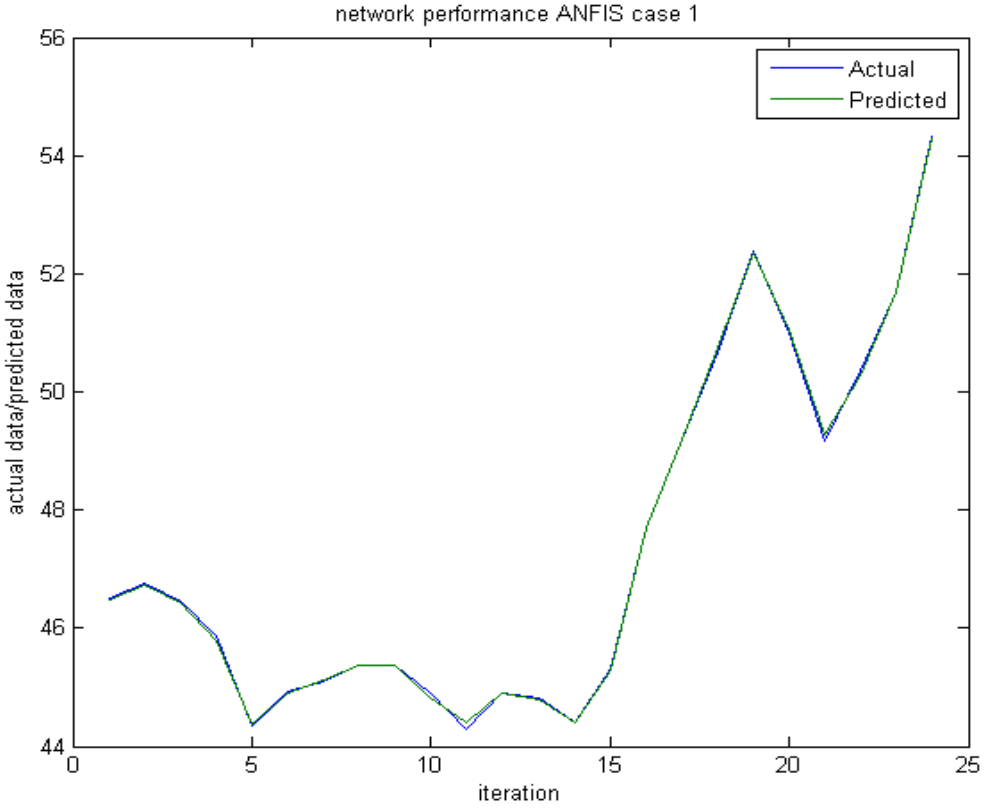

Figure 10: Plot of Actual Data and Predicted Data with iterations for Case 1

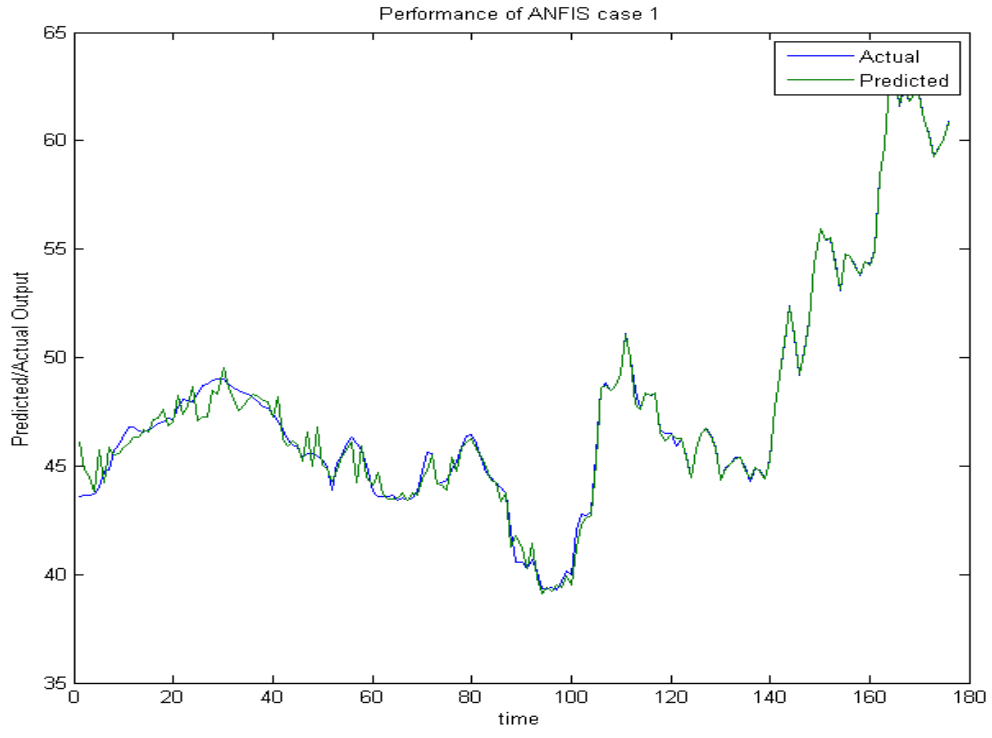

Figure 11: Plot of Actual Data and Predicted Data with time for Case 1

The above diagram show the relation to actual test data to predicted test data with number of iterations and have strong training as predicted green data line is mostly overlap the actual blue data line and next figure shows total actual

The table shows output for second scenario when data gold price and oil price attribute are not included the network performance actual data value of exchange rate and predicted data value exchange rate and their respected error value which is difference of actual test data and predicted data.

Actual	**Predicted**	**Error value**
46.4983	41.5267	4.9716
46.7617	46.4517	0.3100
46.4605	43.6243	2.8362
45.8729	46.7637	-0.8908
44.3540	44.4089	-0.0549
44.9315	47.7846	-2.8531
45.1000	46.0522	-0.9522
45.3750	45.4430	-0.0680
45.3795	47.7522	-2.3727
44.9143	45.1760	-0.2617
44.3010	46.2215	-1.9205
44.9024	44.7902	0.1122
44.8109	47.8546	-3.0437
44.3960	46.2702	-1.8742
45.3135	49.3924	-4.0789
47.6905	48.7483	-1.0578
49.2020	49.4175	-0.2155
50.6785	48.4487	2.2298
52.3824	49.0836	3.2988
51.0015	57.2090	-6.2075

49.1812	52.2212	-3.0400
50.3635	54.0014	-3.6379
51.6900	52.4218	-0.7318
54.3314	48.3827	5.9487

In testing time when data of gold price and crude oil price are not include the value of root mean square error (RMSE) is calculated which 2.8539 and value is of mean absolute error (MAE) is calculated are 2.2070 and mean absolute percentage error(MAPE) is 4.5767. Theses error values are shown through the bar graphical form which shows that there is very huge difference in the error value in both of the conditions. With the absence of two attributes the error values for all three condition are going to large which defines that that parameter have very less impact on the label.

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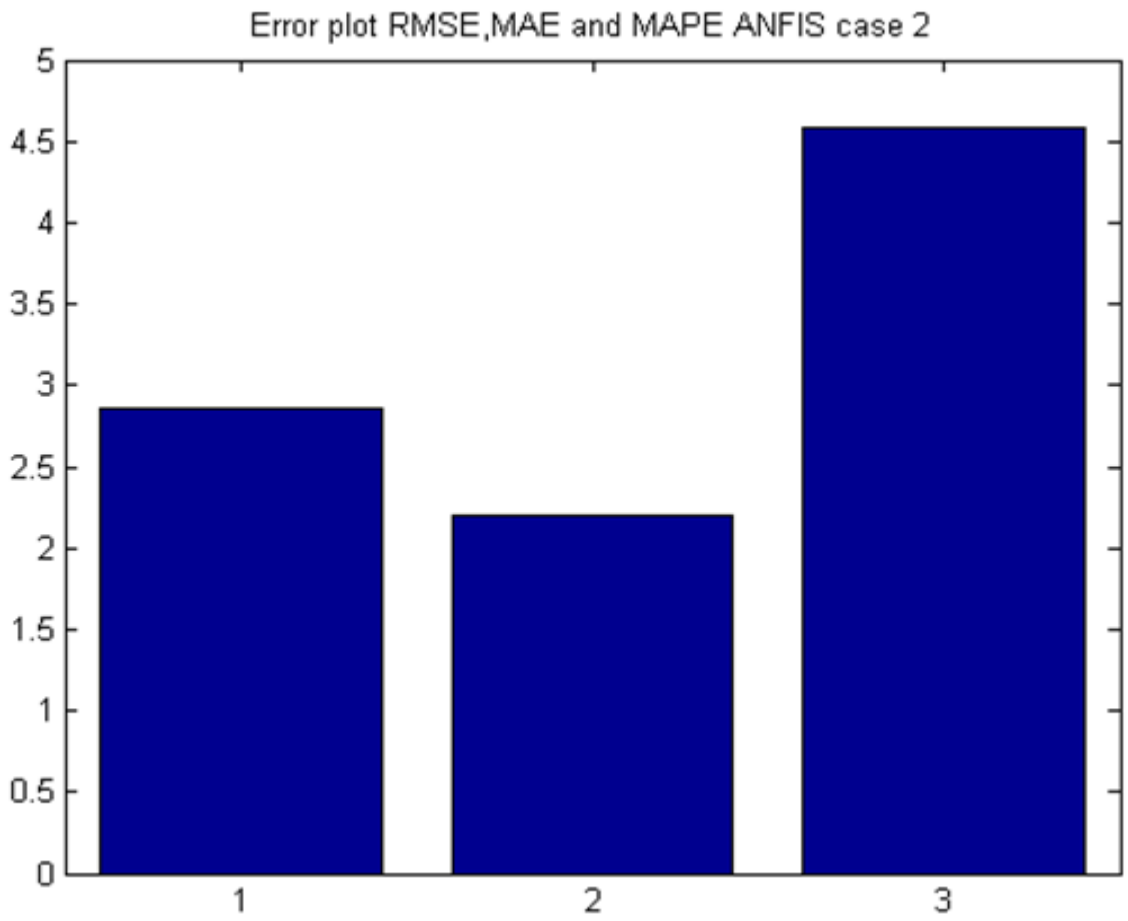

Figure 12: Bar-Chart of RMSE, MAE and MAPE for ANFIS Case 2

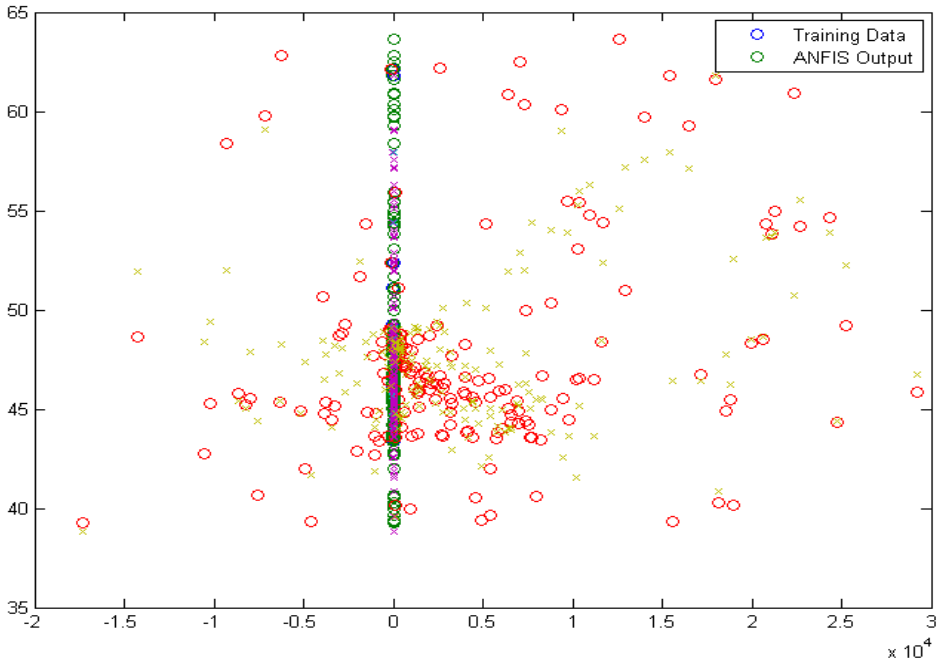

Figure 13: ANFIS leaning Structure network for Case 2

The above figure for the second condition when data of two attributes are not included in the system then ANFIS structure which visible during the training of network given in diagram.

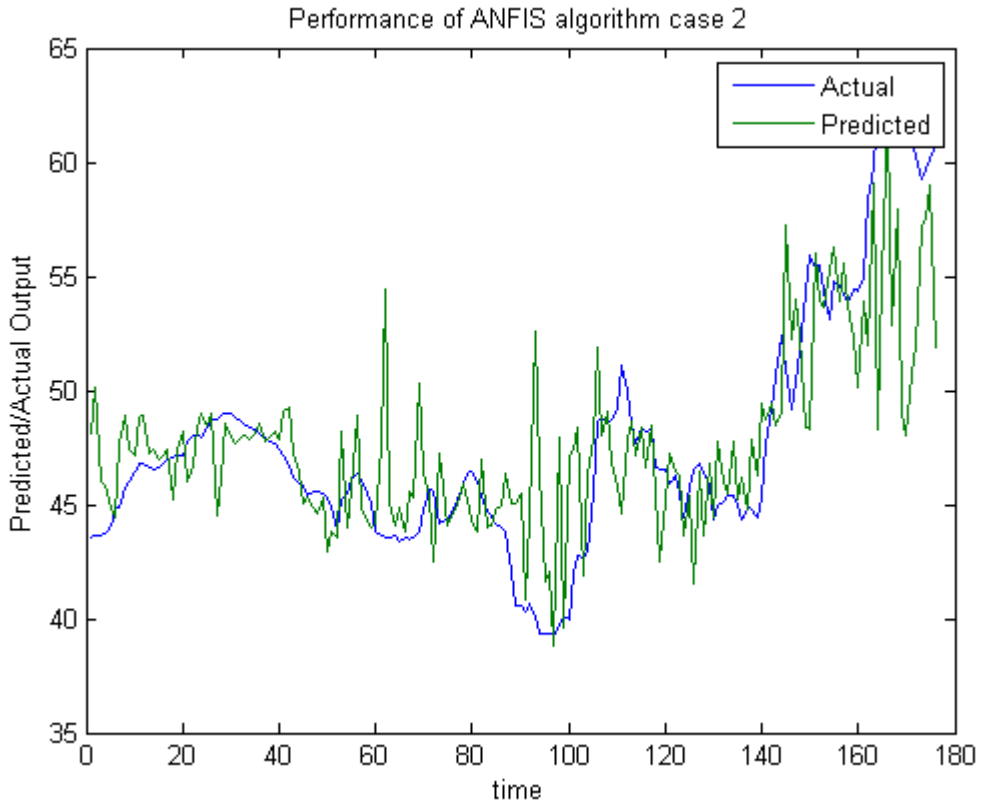

Figure 14: Plot of Actual Data and Predicted Data with time for Case 2

Similarly the above figure for the second condition when data of two attributes are not included in the system the graph of actual data to the predicted data makes a lot difference which defines that with the absence of some affected attribute of exchange rate it varies to large extent difference is visible in given above diagram. Training of network is also influence with is attributes that have highly dependent on the label and there label is exchange rate. Graph show that with increment of time vale the difference is fluctuates more where green line show the predicted value and blue line of graph is actual value.

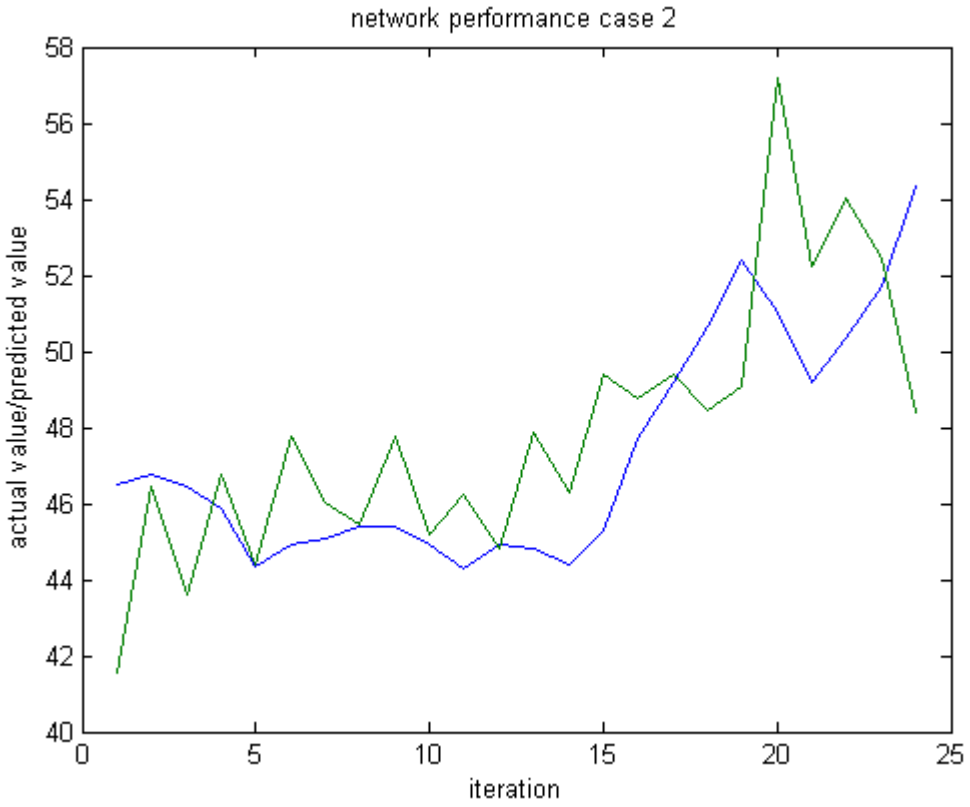

Figure 15: Plot of Actual Data and Predicted Data with iterations for Case 2

Same case for the network performance with number of iterations are calculated for the second scenario when data of two attributes are not included in the system the graph of actual data to the predicted data makes a lot difference which defines that with the absence of some affected attribute of exchange rate it varies to large extent difference is visible in given above diagram where green line show the predicted value and blue line of graph is actual value.

4.2 Results analysis for Back-Propagation Algorithm

Similarly when applying the same data set for the back propagation algorithm the results are varying from the ANFIS. These back propagation algorithm results are not much effective as

of error value is some larger then adaptive neuro fuzzy inference system. From the data set the seventy percent data used as for training purpose then fifteen used for network performance purpose remaining fifteen percent act for the validation purpose. These error value are evaluated as when same data set is used as of used in the first scenario of ANFIS the error value for back propagation is RMSE is 0.1895, MAE is 0.1623 and MAPE is 0.0839 which higher than ANFIS.

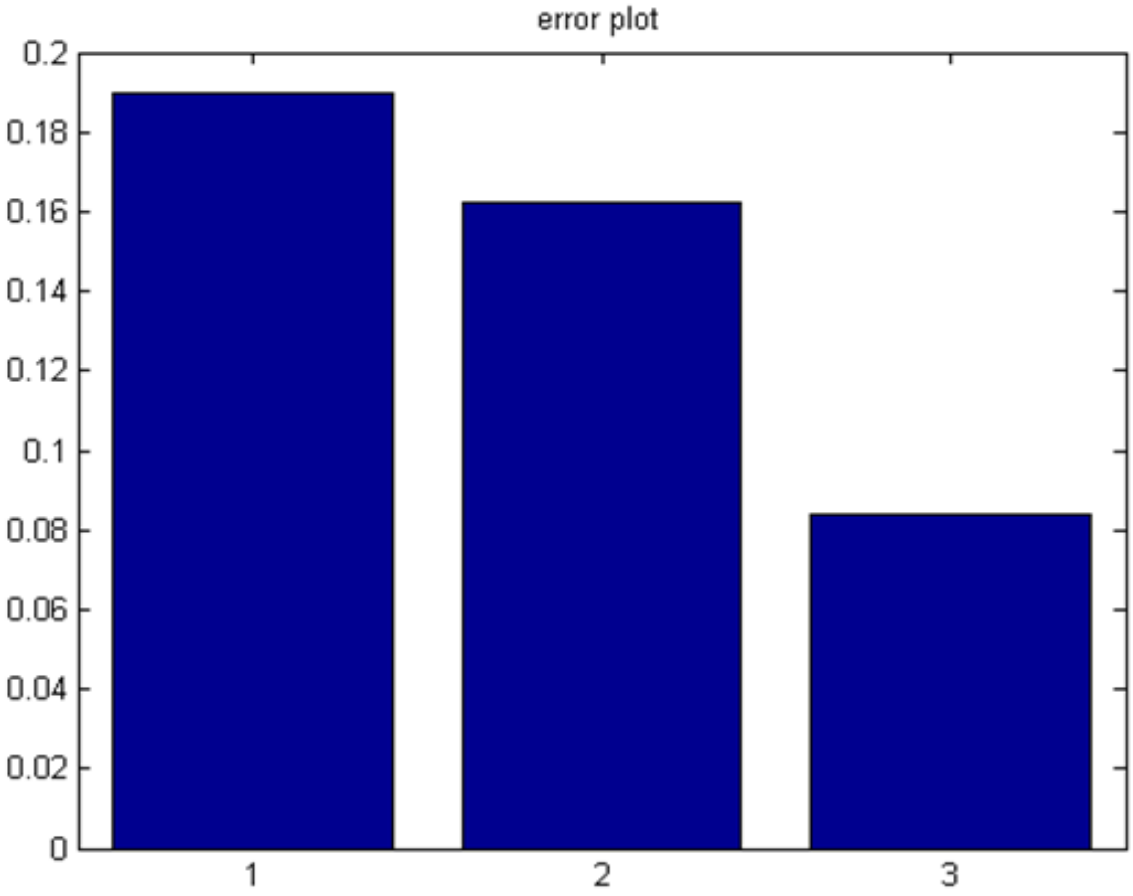

Figure 16: Bar-Chart of RMSE, MAE and MAPE for Back-Propagation

Error value are shown above in figure through the bar graphs. The actual data set and predicted data set and there difference in actual test data and predicted test data is more which is given below in the form of list.

Actual	**Predicted**	**Error**
48.6155	48.3463	0.2692
48.8517	48.7082	0.1435
48.5132	48.6044	-0.0912

48.6995	48.9076	-0.2081
49.2484	49.5360	-0.2876
51.1291	51.1844	-0.0553
49.9655	49.9808	-0.0153
48.5100	48.4140	0.0960
47.6736	47.4106	0.2630
48.3624	48.3163	0.0461
48.2426	47.9920	0.2506
48.2924	48.1534	0.1390
46.6524	46.6904	-0.0380
46.5305	46.6537	-0.1232
46.5273	46.6380	-0.1107
45.8944	46.0798	-0.1854
46.2732	46.2613	0.0119
45.4509	45.5335	-0.0826
44.4440	44.5954	-0.1514
45.7690	46.0162	-0.2472

Where error checks the network performance of difference of actual data to the predicted data. The graph below show the relationship between actual data and predicted data for the back propagation algorithm which shows large variation in the between the actual data line and predicted data line. For a better network error should be minimize and free parameter of weights and bias plays a great role for minimization of error and back-propagational network weights are propagates backward to the network from the output layer to the hidden layer to give the optimize results. Back-propagation gives some large value of error form the same data set which is used in the scenario of first case of the ANFIS network. Thus performance of back-propagation is little bit less than ANFIS and these performances of the back-propagation is shown using graphs and bars with comparison of actual data and predicted data with the time and titrations. The main motive is tries to check the error value and network performance for both of the networks for the same data set and same data attributes in which exchange rate is at result end and others are at the input side.

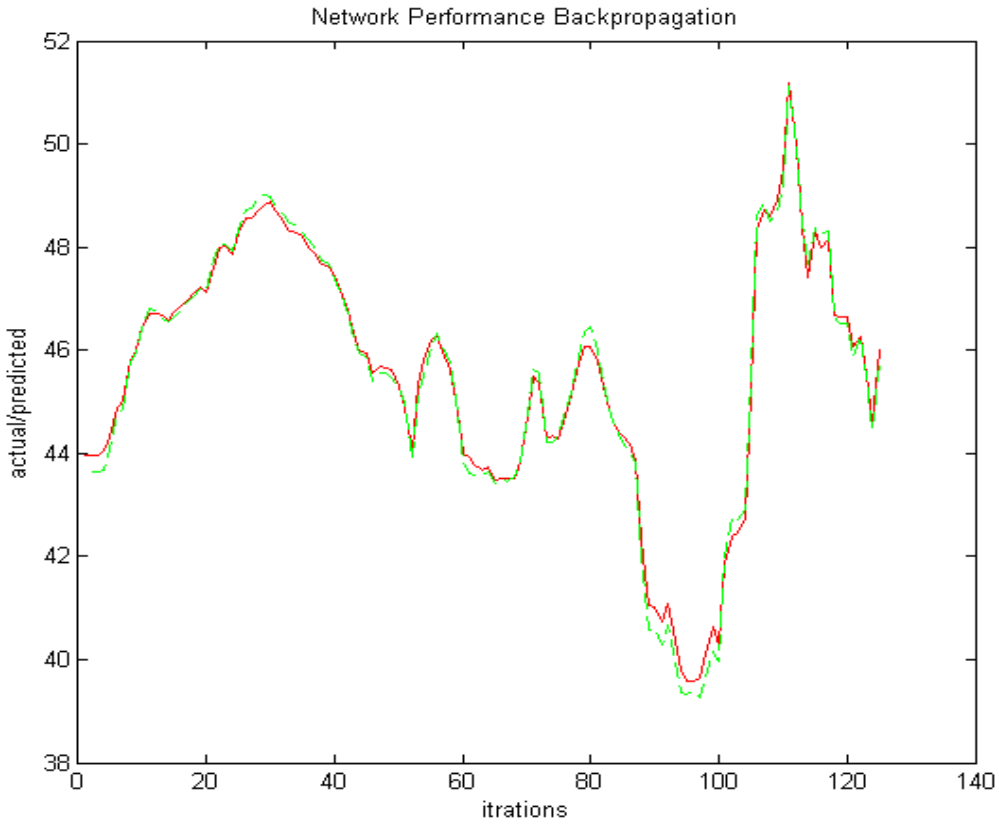

Figure 17: Plot of Actual /Predicted Data with iteration for Back-Propagation

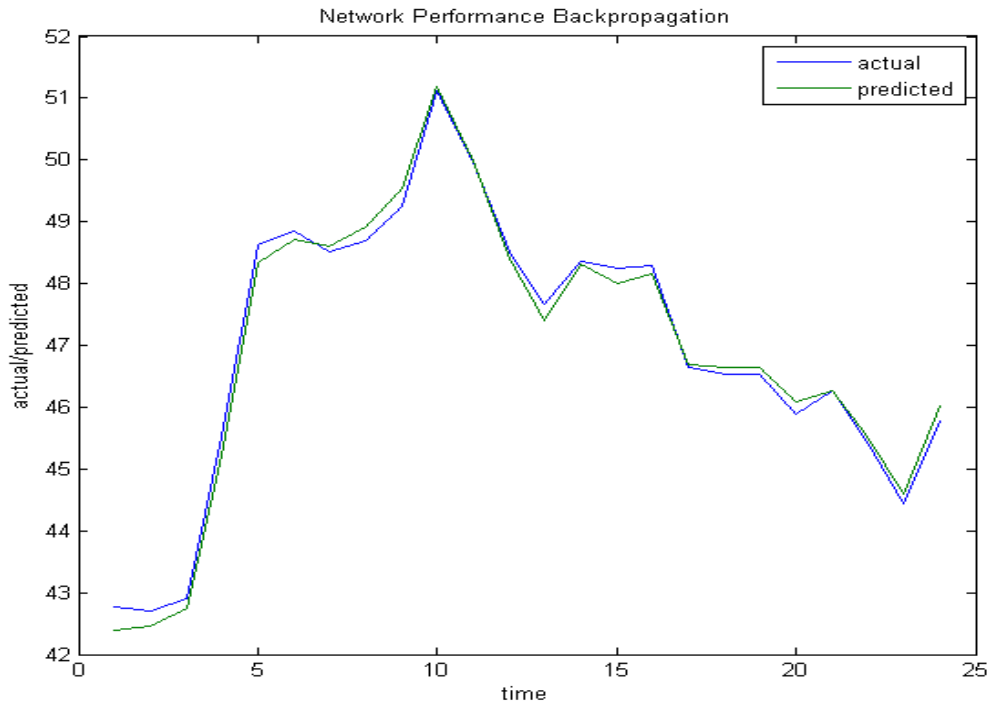

Figure 18: Plot of actual/predicted data with time for Back-Propagation

The above diagram show the error graph for the test data, error is goes on decreasing with time unit and epochs of network.

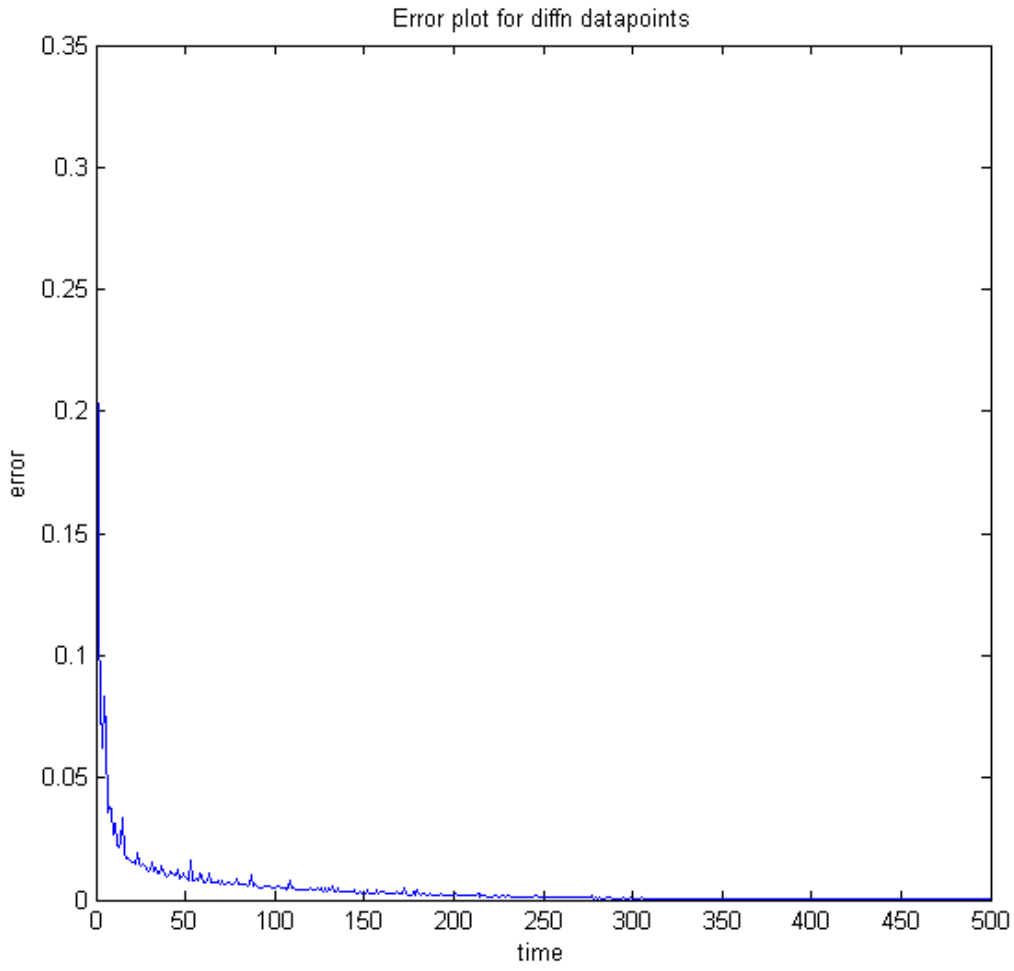

Figure 19: Plot of Error with time for Back-Propagation

The graph show the relationship between network error and time for the back propagation algorithm which shows large variation in the with time, with the passes of time the error value goes to decrease which shoes the difference between actual data and predicted data goes to reduce with time.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

Conclusion and future scope

The conclusion of all the above work is that a new artificial neural network system which produce the more effectively and accurately result then previous system. This methodology is very much effective as very less computations needed and large dataset can be easily processed. The proposed method advantage is that it produces less error than of back propagational network.it gives effective and optimal results. Back propagational network uses only weight updation method while Anfis defines some membership function and works according some if then rules which are defines in the structure of system. By Applying ANFIS Technique for full data set of attributes gold price, crude oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity dataset of exchange rate is taken as target output then on testing data the three error measurements are for case1 is RMSE is 0.0498, MAE is 0.0372 and MAPE is 0.0786. For second case when data of only attributes domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity is taken as input data attribute and dataset of exchange rate is taken as target output then on testing data the three error measurements are for case1 is RMSE is 2.8539, MAE is 2.2070 and MAPE is 4.5767 which reflects a huge difference in the error value from the first case of ANFIS technique, thus the results shows that these different data attributes have a great individually effect on exchange rate these values of error shown in table below.

	ANFIS (Case 1)	ANFIS (Case 2)	BPN
RMSE	0.0498	2.8539	0.1895
MAE	0.0372	2.2070	0.1623
MAPE	0.0786	4.5767	0.0839

Table 1: Results of Comparative Algorithms

For the case of back propagation the whole data set off all attributes that uses in the case 1 of the Anfis technique taken as input to the network in which attributes gold price, crude

oil price, domestic growth price (GDP), consumer price index (CPI), Foreign Institutional Investor (FII) activity dataset of exchange rate is taken as target output then on testing data the three measurements of error are for back propagational network RMSE, MAE and MAPE is calculated. Some learning Rate is used whose value is in-between 0 to 1, some error threshold is used value of 0.1 and activation function of Sigmoid is used in the process.

Future scope

Exchange rate is in research and there are large number of algorithms work to train the network but it is very difficult easy to know that which will give the less error, best performance and better results. Researcher are working on the different algorithms and giving the best conclusion about the used model and the algorithm. Adaptive neuro fuzzy inference system uses the concept of membership functions which describes the participation value of every attribute in the input data set and capable of produce the better results for the same data set that is applied to the back propagational network. The favorable aspect of exchange rate forecasting that it can allows investors to give an idea how much investment will need to be invest to get a beneficial profit and to meet customer demand and satisfaction.

CHAPTER 6

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CHAPTER 7

APPENDIX

Questionnaire

1. Why do we need Exchange rate forecasting?

As the investors came to know from the prediction of exchange rate the dollar price going to increase or decrease, they can be secure their investments and balance of trade also came to know by knowing the future value of currency exchange rate.

2. How proposed method works?

The proposed method work with the comparison of two systems with the same data set of input and output and drives the results for that systems and defines the performance of everyone in the form of prediction value and error value. In anfis learning is depends upon the membership function and rule of the network. In back propagation network learning rate depends on neurons in hidden layer of artificial neural network architecture. In hidden layer they may be one or more than one layers in the hidden layers are their large number of interconnection of one neuron to other neurons are there that goes to output layer to produce output. A back propagation mechanism used to adjust the weights of connections. Output of one neuron act as input to the second neuron and so on which form a network connection.

List of abbreviations

ANFIS-“Adaptive Neuro-fuzzy Inference System”

ANN- “Artificial Neural Network”

BPA-“Back Propagation Algorithm”

BSE-“Bombay Stock Exchange”

CGP-“Cartesian Genetic Programming”

GDP-“Growth Domestic Product”

MAE-“Mean Absolute Error”

MAPE-“Mean Absolute error percentage”

MLP-“Multi-Layer Perceptron”

MSE-“Mean Square Error”

PMAD-“Percent Mean Absolute Deviation”

RCGPANN-“Recurrent Cartesian Genetic Programming Artificial Neural Network”

RMS-“Root Mean Square”

RMSE-“Root Mean Square Error”

VLSI-“Very Large Scale Integrated”

Publications

A Review Paper accepted

Sanjeev Kumar and Pency Juneja (2015)" Analysis and Forecasting of Exchange rate using Artificial Neural Network", International Journal of Applied Engineering and Research (IJAER).