



**ANALYSIS AND FORECASTING OF GROSS DOMESTIC
PRODUCT USING
ARTIFICIAL NEURAL NETWORK**

A Dissertation Report

Submitted

By

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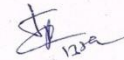
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ABSTRACT

Gross Domestic Product is one of the most economic factors. Importance of GDP forecasting needed Because during the period of 2007 to 2009 Indian Economy was Suffering from Recession and GDP growth rate also affected by Recession .By Observing Past Experiences it have seen that the variances in the GDP economy got up and down. Simulated annealing is one of the crucial algorithms which can be used to optimize the weight value of the Artificial Neural Network. Back Propagation algorithm process the weight values from back to forth. but here simulated annealing algorithm consider all the weight values together and process to all these weights to find optimal weights.SA algorithm here improves the performance over the BPN.A Comparative Analysis between Simulated Annealing and Back Propagation Algorithm has been done in this Research. SA technique can be apply on a specific application algorithm by knowing the input and output parameter. Forecasting is helpful to decrease the uncertainty in the economy.

CERTIFICATE

This is to certify that **Nikit Kumar** has completed M.Tech (Computer Science and Engineering) Dissertation titled “**Analysis and Forecasting of Gross Domestic Product 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.

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DECLARATION

I hereby declare that the dissertation entitled, “**Analysis and Forecasting of Gross Domestic Product 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.

Date: _____

Investigator

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TABLE OF CONTENTS

Sr. No	TOPIC	PAGE
1.	INTRODUCTION	1
	1. Introduction.....	1
	1.1 Nervous System	1
	1.2 Forecasting Techniques	2
	1.3 Models of a Neuron	2
	1.4 Free Parameters.....	4
	1.5 ANN Layers	4
	1.6 Benefits of the Neural Network.....	5
	1.7 Learning Process.....	7
	1.8 Description of the Gross Domestic Product.....	9
2.	LITERATURE SURVEY	11
3.	PRESENT WORK	19
	3. Present work.....	19
	3.1 Scope of the study	19
	3.2 Problem formulation	21
	3.3 Objectives of the study	21
	3.4 Research Methodology.....	22
4.	RESULT AND DISCUSSION	29
	4. Result and discussion.....	29
	4.1 Simulated Annealing Results.....	29
	4.2 Back Propagation Algorithm Results.....	35
5.	CONCLUSION AND FUTURE SCOPE	39
6.	REFERENCES	41
7.	APPENDIX	43

LIST OF FIGURES

FIGURE.NO	TOPIC	PAGE
1.	Human Nervous System.....	2
2.	Model of a Neuron.....	3
3.	Model of a Neuron by adding new Synapse.....	3
4.	ANN Layers.....	5
5.	GDP with additional units.....	10
6.	Multi Layer Feed Forward Artificial Neural Network.....	23
7.	Covered Steps of the Research.....	28
8.	Error on different data points with respect to time for Case1.....	30
9.	Predicted Output corresponding Actual for case 1.....	31
10.	Bar Chart for RMSE, MAE and MAPE respectively for case1....	32
11.	Error on different data point with respect to time for case2.....	33
12.	Predicted Output corresponding Actual for case 2.....	34
13.	Bar Chart for RMSE, MAE and MAPE for case 2.....	35
14.	Error on different data points with respect to time for BPN.....	36
15.	Predicted GDP Corresponding Actual for BPN.....	37
16.	Bar Chart for RMSE, MAE and MAPE for BPN.....	38

LIST OF TABLES

TABLE NO	TOPIC	PAGE
1.	Comparative Results of the Algorithms.....	40

CHAPTER 1

INTRODUCTION

Introduction

Neural Network is the network which made up by parallel, distributed, non linear and interconnected neurons (these neurons are artificial) which process the information.

Artificial Neural Network has proved as a crucial research work tool in many domain of engineering and economic aspects also. ANN is the better choice as compare to the traditional time series forecasting models which have used for prediction [1]. ANN uses in many economic and business applications. Superior performance of the forecast and simulation of the network can be get by regulate the ANN [2].

Neural Networks uses for Non Linear data while Statistical methods compromises with linear data.

1.1 Nervous System

As like human brain there occurs processing of the information by artificial neurons. These Neurons have learning capability. To well know about the artificial neural network it is essential to do study of human nervous system. Human brain uses large no of neurons which interconnected with each other to process the information. Electrical inputs passes through this network of neurons. A neuron takes inputs from dendrites by doing sum of all these inputs from the dendrites and if the value of its result is more than its firing threshold, the neuron fires. When any neuron gets fire it sends an electrical impulse signals by the axon to its synaptic terminals. Synaptic terminals have thousands of neurons these connect by connections. Basically these connections are called synapses.

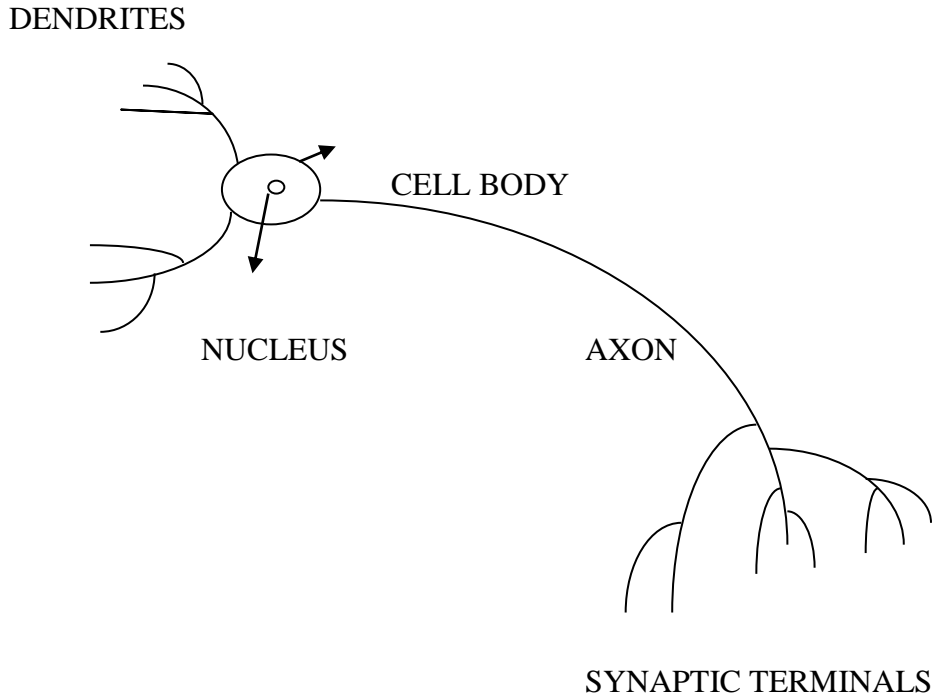


Figure 1: Human Nervous System

A human brain has about to one hundred billion neurons and about to one thousand synaptic connections or synapses.

1.2 Forecasting Techniques

There are two types of forecasting techniques namely artificial Intelligence and Statistical Techniques. Genetic algorithm, Artificial Neural Network and Fuzzy Logic are Artificial Intelligence based techniques. And Multiple Regression and ARIMA fall in the Statistical techniques. Neural Networks uses for Non Linear data while Statistical methods compromises with linear data.

1.3 Models of a Neuron

There are three basic elements of a neural model are given below:

- a. Set of connections:** Each connection is characterized by a synaptic weight value and contains the value of the input multiplied by the synaptic weight value.

b. Adder or Summing Junction: it adds to the all input signal.

c. Activation Function: it is used to make in limit or within range to the output by doing amplitude of the output.

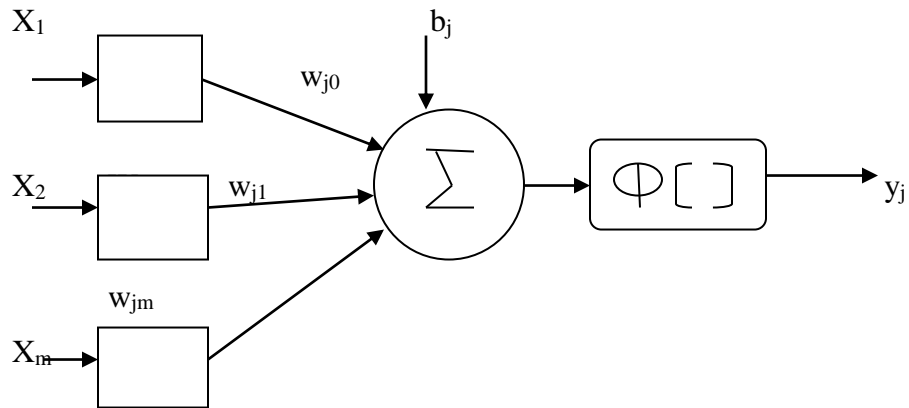


Figure 2 Model of a Neuron

$$u_j = \sum_{i=1}^m w_{ji} * x_i$$

$$y_j = \phi (u_j + b_j)$$

By adding new synapse:

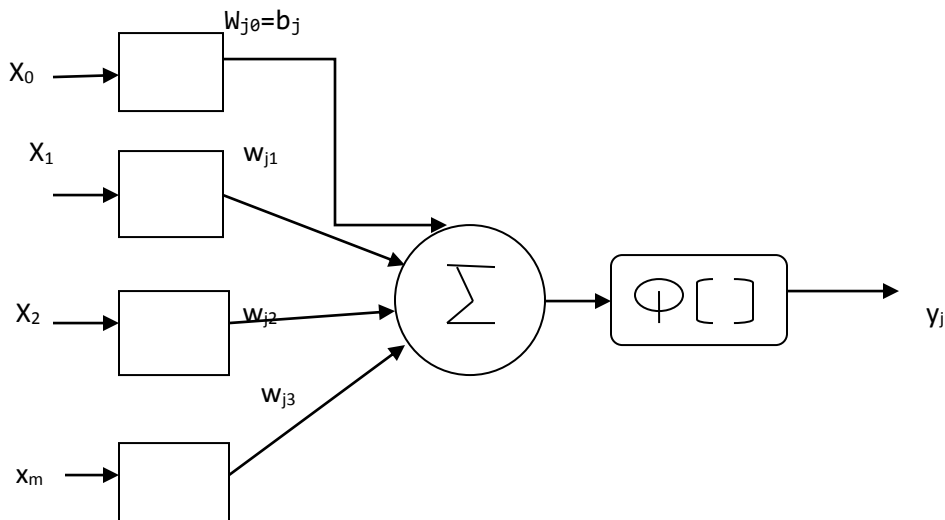


Figure 3 Model of a Neuron by adding New Synapse

$$x_0 = +1$$

$$w_{j0} = b_k$$

m

$$v_j = \sum_{i=0}^m (w_{ji} * x_i)$$

i=0

$$y_j = \varphi(v_j)$$

1.4 Free Parameters

There are given below free parameters that are used in Artificial Neural Network:

- a. **Synaptic Weight:** synaptic weights are used for learning to the neurons by doing change in weight.
- b. **Bias:** any external factor which affects the output of a neural network that is bias.

1.5 ANN Layers

Layers of Artificial Neural Network are defined below:

- a. **Input Layer:** Input Layer is responsible for providing the inputs to the neural network.
- b. **Hidden Layer:** Hidden Layer is the intermediate layer between input layer and output layer. Whole working of the processing of the Neural Network depends upon the Hidden Layer. A Neural Network may contain multiple hidden layers.
- c. **Output Layer:** Output Layer gathers input from the hidden layer if it is single hidden layer otherwise takes input from last Hidden Layer if Network has multiple hidden layers and it provides expected output.

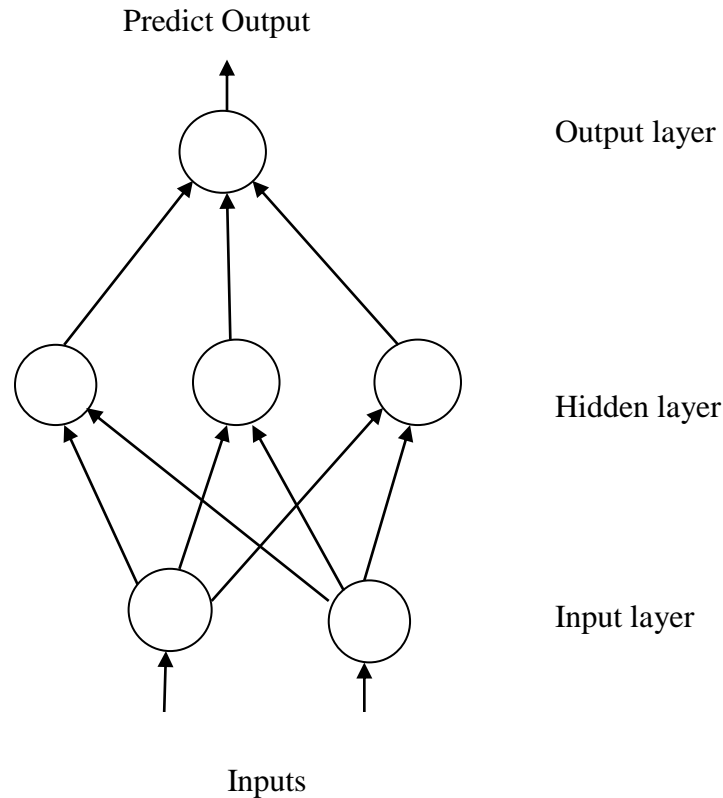


Figure 4 ANN Layers

1.6 Benefits of the Neural Network:

Basically Neural Networks has best computing power by first massively parallel structure and another one is capability of learning.

Neural Networks have some useful Properties and capabilities:

Nonlinearity: Nonlinearity by means of An Artificial Neuron may be Nonlinear and linear. A Neural Network consists of a set of interconnection nonlinear neurons. Nonlinearity is a kind in term sense that is of distributed throughout Network. Nonlinearity is a crucial property if underlying a mechanism responsible for generating of the signal (input signal).

Input-Output Mapping: learning with a teacher or supervised learning is a popular kind of learning which involves changing of the synaptic weights of the Network by applying the set of training examples or can say task examples .Neural Network works with picked the random example from the dataset and free parameters changes their values to get the minimize difference between actual and desired output(response).Network is to be trained

many number of epochs until it gets its steady state where Network does not get further changes in weight values of the Network. Training examples can be repeated during the training time of the Network. Basically there are many of the algorithms and techniques by which Neural Network can be trained. Basically Network learns by examples that provided by training to the Network on the basis of input and output. Therefore input-output mapping is constructed. Nonparametric signifies that no prior assumptions are developed on statistical process for input data set.

Adaptivity: Neural network have special kind of capability that is built in capability to adapt the synaptic weight values to modify in the surrounding environment. Basically Neural Network trained to operate in a special environment for dealing in the minor modification in the environment conditions. When it is operated in non stationary environment, a Neural Network can be design to modify its synaptic weight values. The architecture of neural network for control applications, pattern classification, signal processing, coupled with the adaptive properties of the neural network. This property of the network makes it a crucial tool for the adaptive pattern classification, adaptive control and adaptive signal processing. by making general rule it can be say that make a more adaptive system this system will remain stable and perform with more robust when ever system is required in a condition to operate a no stationary environment. it must be emphasized that adaptively does not ever lead to robustness but it can do the very opposite.

Evidential Response: Neural Network may be design for pattern classification to give information not only just about pattern to select but also the also give information about confidence in decision making. This crucial information can be used later to reject the pattern. Here evidential response improvement in classification performance of the neural network.

Fault Tolerance: Neural Network can be implemented in a hardware form and it has the capability of the robust computation. Like an example, if any neuron and its synaptic links get damaged then its recall to stored pattern is impaired in quality. on the basis of distributed nature of the essential information that is stored in the neural network, damage should be extensive just before all responses of the neural network get degraded in seriously. Thus neural network exist a better degradation in the performance as compare to catastrophic

failure. There is given some empirical evidence just for robust computation but normally it is out of control. So it can be necessary to make corrective measures when designing the algorithm that will be used to train a neural network.

VLSI Implement ability: Neural Network has massively parallel nature and this quality of the neural network makes it very fast for computing the crucial tasks. This similar feature prepares the neural network good for implementation through VLSI technology. VLSI has one of the best beneficial virtues that are to capture truly complex behavior will be in hierarchical fashion.

Neurobiological Analogy: The Artificial Neural Network designed by analogy with human brain which gives proof that fault tolerant distributive processing are not just only physical possible but these are powerful and fast. Neuron biologists search for the Artificial Neural Network that is a scientific tool for neuron biological phenomena. On the other side engineer uses the neuron biology for getting new ideas that can be useful to solve the more complex problems rather than the problems that are based upon the conventional hardwired design algorithm and technique.

1.7 Learning Process:

There are different ways in the environment of the learning. Neural Networks can be made learn by many of these learning processes. There are some kind of learning process by which a system gets learn like learning with a teacher and learning without a teacher. Learning process can be easily sub categories into Supervised Learning, Unsupervised Learning and Reinforcement learning. So there can be performed different form of the learning process on the Artificial Neural Network parallel of human learning.

Supervised Learning: Supervised Learning is that in which any System or Learner learns by the help of the teacher or can say it is learning with a teacher. In Supervised learning A Teacher has the particular knowledge about the field of the environment and that knowledge may be represented by the input-output training examples. But here environment is unknown for the Neural Network. Neural Network and the Teacher are exposed by the training vector fetch from similar environment. By the help of built in knowledge a teacher is able to give the neural network a desired response for the training vector. Optimal actions that are

performed by using Neural Network represent through the desired response. Network Parameter adjusted by the combination of error signal and training vector. Here error signal is the difference between the actual response and desire response. Through training, knowledge of the field of the environment transfers from teacher to the Neural Network. the performance of the network has to be measure in term of the mean square error, mean absolute error and mean absolute percentile error. So In supervised learning learner needs of the supervisor and this supervisor may be a teacher.

Unsupervised Learning: Unsupervised Learning also called the self organized learning, In this learning there is no need of any external teacher or any critic for learning any system or learner. In this learning process Network required to learn and by the free parameter of the neural network optimized in respect to the measure .For a special task independent evaluate Network should be ready for the statistical regularities for input data, Network has ability of the encoding features of these inputs and create a new class by self. Competitive learning rules are uses to perform unsupervised learning. Like an example, Neural Network contains two layers input layer and competitive layer. Input layer is for receiving the input data. Competitive layer have many neurons which compete with each other and winner give the respond to the input data. Here consider "winner takes all" strategy in which neuron with the maximum total inputs win the competition. Winner neuron gets on and other all switches off. In unsupervised learning system learns directly from the environment.

Reinforcement Learning: In reinforcement learning Input-Output mapping performed by continued interaction in order to underestimate scalar index of performance. In reinforcement learning system built by Critic instead of Teacher. Critic takes primary reinforcement signal and converts these signals into Heuristic Reinforcement Signal. The System is developed to learn under delayed reinforcement means that a system works by observing temporal sequence of stimuli that received from environment indicator. Aim of reinforcement learning is that it is use to underestimate a cost to go function that is defined by the belief of cumulative cost of actions hold of over a series of steps besides of immediate cost. Delayed reinforcement learning is hard to perform for two causes: In reinforcement learning there is no any teacher for the learning process. Delay in making of the primary reinforcement signal means machine will resolve a materialistic credit assignment problem.

1.8 Description of the Gross Domestic Product

GDP has three separate words G stands for Gross; D stands for Domestic and P stands for Product which refers to the production of all goods and their services of a country or nation within a period of time. Basically, GDP is to be measured annually. GDP improves the economic health and condition of the country. It is one of the crucial factors of the economy. GDP impacts on the growth of the Economy. GDP can be calculated by using the following formula:

$$\text{GDP} = \text{Con} + \text{Inv} + \text{GE} + \text{BT}$$

Where

Con=consumption

Inv=Investment

GE=Government Expenditure

BT=Export-Import

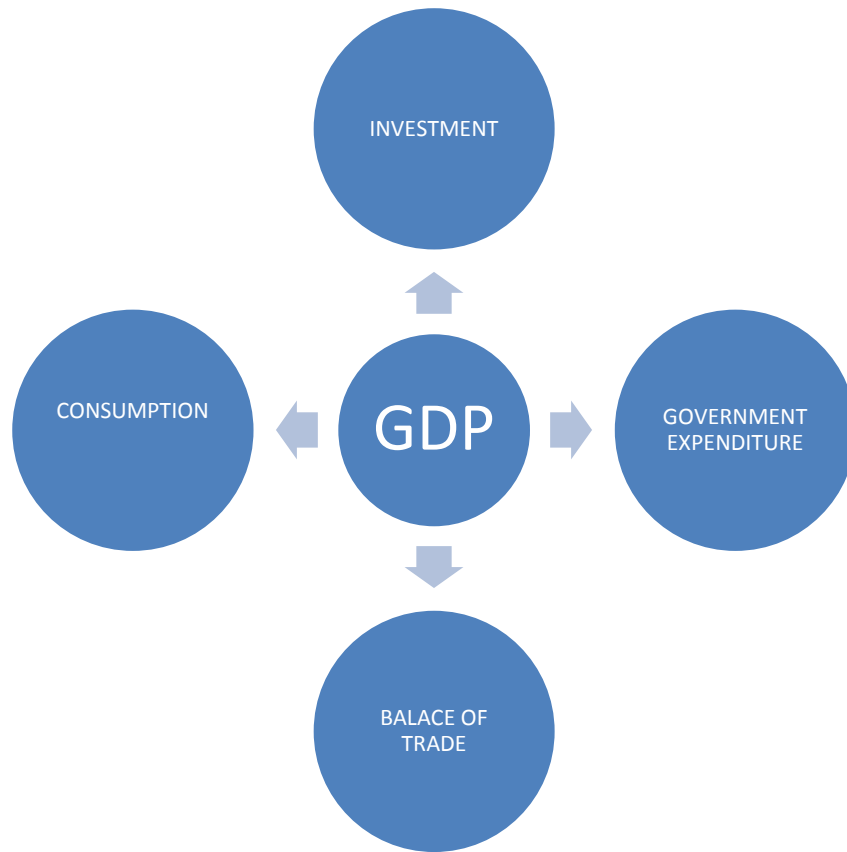


Figure 5 GDP with additional units

CHAPTER 2

LITERATURE SURVEY

Literature survey

Literature Review is crucial part of any research. Basic idea of the research has been taken from the forecasting research papers which have published in various journals and IEEE standard. Artificial Neural Network and Economic Knowledge make interest in this research.

Greg Tkacz, Sarah Hu(1999) : conducted a research and In this Research paper Authors have investigate that better accuracy indicator techniques of output growth by using financial and monetarism factors, this is made using neural networks .In this paper authors have used ANN model to forecast GDP growth for Canada. The main results of this research are that, in 1-quarter forecasting, neural networks does not give better improvements in forecast. On calculating in the 4-quarter, there gets improved forecast accuracy is much better as compared to 1-quarter. In this research this is also found that the RMSE of the final results by the neural network techniques are about 15 to 19 per cent few as compare to the linear model.

Steven Gonzalez (2000): Author conducted a research which was related to macro economic forecasting of Canada by using ANN and compared the result of prediction by the linear regression model. In this Research Steven used ANN model which is learned through back propagation algorithm. And by the Final Results of the evaluation Author got that the neural network gives less error rate as compare to the linear regression technique. Author concluded that the performance of the ANN according to the error of the predicted Output is better as compare to the linear regression model.

Greg Tkacz(2000):Author conducted a survey and found that there is no any indicator model which performs best exceptionally for one quarter forecast. At four quarter horizon it is found that financial and monetary variables are better enough in prediction of output growth. it is also observed that best Neural Network techniques produces an average error in

range 0.25 percentage points few as compare to forecasting error picking from the linear model. And concluded that if Neural Networks used for macroeconomic variable these will have achieved maximum success if they pay attention on longer-run forecast in case when economic theory support to the non linear supposition.

Pengyi Shi, Zhuo Chen, Guangming Xie (2006): Authors conducted a survey and found that traditional econometrical model does not give the accurate results in forecasting by having its linear property. In this paper analysis is to be done of the performance of ANN trained by Genetic Algorithm and Standard ANN model. conclusion of this research paper is that the Artificial Neural Networks which are trained by Genetic algorithms these performs better and more effectively as compare to the Artificial Neural Networks trained by back propagation algorithm. In this paper Author developed a new Hybrid Model by the combination of ANN and GA based on Overlapping Generations model. This model performs better than Standard ANN and Error ANN when predicted the GDP of China.

Adnan haider , Muhammad Nadeem Hanif (2007) : Authors conducted a survey and In this Research Paper Authors found that RMSE of the forecasting by using ANN has very few than the RMSE of forecasting by using AR(1) and ARIMA techniques. So here results of forecasting by ANN is better than AR (1) And ARIMA models.

Massimiliano Marcellino (2007): Author conducted a survey and in this paper there evaluated many models for the Forecasting and compared these Models with their performance and features. There discussed Forecasting Methods these are linear models, time variances models and not linear techniques. For US GDP rate there also presented linear models, Time changing and not linear techniques. For US Inflation also described some models like linear models, time varying and non linear models, additional robustness analysis and a Quarterly Model for Inflation. And after that Author evaluated the Forecasting information. The Final Conclusion is that the linear time series model are much wearied if these are specified in well way and these proved too good in theoretical models.

Christian Schumacher, Jörg Breitung (2008): Authors conducted a survey and in this paper factor model discussed that is used for evaluate the monthly GDP by employing mixed frequency data .EM algorithm is applied here in factor evaluation with the unbalance real time data. EM algorithm supply monthly components for evaluating the monthly observations for the time series data of the GDP in this paper. In this Paper factual forecasting finds out the results that data alteration have just a collier crash on the predict result. if monthly data is present in advance then there will be powerful reaction. It is found that there gets High impact on the forecasting accuracy of the monthly survey data .In this paper this is compared with the simple benchmark models that real time Factors forecasting prompt less Mean Square Errors. These estimation methods uses EM factor works with the monthly data indicators and have good performance.GDP forecasting models can be fair by cause of high degree of the robustness against outliers.

Meijuan Gao, Jingwen Tian (2009): In this Paper Authors conducted a survey on Forecasting of the city like logistics requirement based that was based on SA Neural Network. In this Article Author applied first SA with best approach and then mixed with the Powell algorithm to make a better simulated annealing. It is a mix optimize algorithm rather than Back Propagation trained Network. It has faster convergence speed and greater accuracy. The forecasting results show that this mix approach Improved Simulated Annealing Neural Network is effective and feasible. By this technique ISANN fast convergence and global approximation can be get. And Final results of the urban logistics demand based on ISANN show that improved performance and reliable accuracy.

Dominique Guegan, Patrick Rakotomarahy (2010): Authors conducted a survey and in this paper forecasting of the GDP has been done by using k-nearest neighbor methods. And Researcher found after implemented that the k-NN method give more accuracy in multivariate condition (k-NN, $d > 1$).Author found less error in this paper by worked with Multivariate k-NN method. And when author worked with single variant k-NN method he got more error rate as compare to multivariate K-NN method (k-NN, $d = 1$).In this paper comparison between both of k-NN method is done. And multivariate proved better than single variant k-NN method.

Mirnaser Mirbagheri (2010): Author conducted a survey and in this paper Fuzzy Logic and Fuzzy Neural Networks are applied for GDP forecasting. Fuzzy Neural Network has developed by using Fuzzy logic and Artificial Neural Networks. In this research, performance evaluated of the real GDP forecasting by fuzzy logic and fuzzy neural networks. And performance of the both method compared with respect to error of the predict output. Final Results show that the error rate of the GDP Forecasting by FNN is less than Fuzzy logic. At the End Author concluded that Fuzzy Neural Network is better in the prediction as compare to the Fuzzy Logic.

Li Chungui, Xu Shu'an, Wen Xin(2010):In this paper Authors conducted a survey on traffic flow Forecasting and for this crucial forecasting author choose a Genetic Back Propagation Neural Network approach which is fast ,steady and quick in traffic flow forecasting. But here it is found that Genetic Back Propagation Neural Network has premature convergence and local optimal solution. So To overcome this problem Author applied Simulated Annealing Technique on the processing of the Genetic Algorithm by reducing the chosen pressure. After analyzed the final results of the traffic flow forecasting Author found that Simulated Annealing just not overcome with premature that was in Genetic Algorithm but SA improves the robustness and gives the better performance of the traffic flow forecasting. In this paper Author used a mix model of the Simulated Annealing and Genetic Algorithms. Author used SA for cross and mutate process of the Genetic Algorithm and used a new algorithm to optimize threshold and weights of Back Propagation Network. The Final Results of the traffic flow forecasting shows that new Genetic Algorithm Back Propagation Network which works with Simulated Annealing has less error rate than the Traditional Genetic Back Propagation Network.

Liliana, Togar Alam Napitupulu (2010): Authors conducted a survey and in this Research Paper, ANN tool was used to forecast GDP growth of the Indonesia. In this research paper, authors have done forecasting of GDP for Indonesia and they have given many advantages and disadvantages of the ANN method. According to the final output results, the authors have concluded that the ANN model is the better model in the forecasting for the macroeconomic indicators. In Indonesia GDP Forecast Research work had done by

Government Institutions namely National Planning Board by using macroeconomic model .So in this Research Paper GDP forecasting has been done by the Researchers by taking some variables by ANN model. And Results of this Research of GDP Forecasting were better than the forecast by government. ANN model has proved a good tool to forecast other economic indicators. The Advantages of ANN is that it deals with the non linear data and pattern recognition of the data. Neural Networks deals with the non linear data because these have ability to adjust the available data, careless of the data like distribution of data.ANN has been proved it is very flexible model, where researchers can work by this model with the same application for many cases at once, by changing the value of free parameters, hidden layer structure, the value of learning rate parameter. In the ANN model, the data whatever we are uses that is relatively free, because the ANN does not play role in relationships among data and even not in statistical calculation.

Tang Hui,Niu Dongxiao(2010):In this Research Authors conducted a survey on forecast wind by combining Simulated Annealing with the support vector regression. Wind speed prediction is must for forecasting the wind capacity at final. To Forecast Wind, there is difficulty with distributive in wind speed. In this Research with the forecasting wind a comparative analysis also has been done between the proposed model and default parameters of LSSVM method. In this paper proposed Model is made by the adding of adaptive particle swarm technique of the optimization on relative parameters of the worst square SVM for predicting the wind speed. the proposed model evaluates more accurate results as compare to the default parameters LSSVM method.SVM combined Simulated Annealing technique may excuse the less coming of investigating parameter by human past experience , which is also easy job to apply in actual situation and condition. From the final research comparison, the proposed method has proved good to give better performance rather than the SVM with picking random parameters. It can be relay in wind prediction effectively and efficiently.

Kunwar Singh Vaisla,Dr. Ashutosh Kumar Bhatt (2010):Authors conducted a survey and in this research paper, Authors analyzed the performance of the artificial neural network by doing the prediction of the stock market. In this paper Authors used two important techniques of the prediction namely Neural Network and Regression. Final Result of this research shows

that error of the forecasting by NN is less than Regression. Error rate has been calculated by using MSE,MAE and RMSE. Here Result by proved that performance of the forecasting of stock market by NN is better than the Regression.

Li Ge, Bo Cui (2011): Authors conducted a survey and in this research, forecasting of the GDP is done by two different models. Error rate evaluated of the predict output by using PNN model and Traditional Neural Network. By compared and analyzed the result of both models in forecasting. Authors concluded Results that PNN Model is better enough as compare to Traditional Neural Network due to less error rate. And Performance of the PNN model is best as compare to Traditional Neural Network.

Badri, Z. Ameli and A.Motie Birjandi (2011):In this paper Author Applied two modern methods Fuzzy Logic and Artificial Neural Network for short term load forecasting. After analyzing the final result it is concluded that ANN model gives better result than Fuzzy Logic. And other study on this Research was Application of ANN in prediction medium term load forecasting. On the basis of accuracy of short term load data and its load occurrence time, the short term load forecasting provides better results as compare to medium term load forecasting.

Karaatli Meltem, Göçmen Yağcılar Gamze, Karacadal Hüseyin, Sezer Fırat Suleyman (2012): Authors conducted a survey and In this research ANN tool is used for predicting the GDP of the Turkey. Prediction of the GDP depends upon the investment, employment rate, wages, profits and stock market activities. So the Aim of this research paper was to forecast the GDP of the Turkey and test to the ANN model in this GDP forecasting. In this research we found the final conclusion that was ANN is an efficient tool of the prediction of Neural Network Models which improves the performance of the GDP. Neural Network Models are useful in improve the performance of the prediction.

George Atsalakis,Katerina Tsakalaki(2012):In this research Author conducted a survey on chaotic time series forecasting by applying simulated Annealing and Artificial Neural Network. In this paper Author told that how Simulated Annealing trained Neural Network

works with linear and approximations in prediction time series which is generated through chaotic Mackey-Glass heterogeneous delay equation. Sequences of regressions that work with polynomial approximates and with neural networks which uses simulating annealing and genetic algorithms to train the network are takes a part and compare the analysis with the multiple correlation coefficients. The final results of the experiment show that neural networks which use simulating annealing algorithm for training perform better than the global search algorithm. it is find out that the genetic algorithms are use to find their values which can increase the forecasting effectiveness of the final resulting model when applied on chaotic time series problem. In this paper Network work with one layer any two neurons with simulated Annealing Algorithm to predict chaotic Mackey-Glass time series. this functioning has been on the MATLAB and compared analysis between genetically evolved neural network and polynomial expansions with one layer and two neurons .The results of the forecasting are found very satisfactory, which indicating that this model can forecast good as far as when chaotic time series modeling concerned. By this Research Author states that Neural Network are very effective to solve the such kind of time series prediction which works on the basis of human brain neurons these have the ability of process the information and the data. These also have the ability of solving the business problem.

Yanling Liu, Minbo Li, Zhu Zhu(2013):In this Research Authors conducted a survey on Sales Combining Forecast in FMCC by Simulated Annealing. Fast Moving Consumer Goods Plants and Industries have wide range of the consumer and their demand. So on the basis of these Authors decided to forecast Sales by which un-certainty in sales can be reduce. Many Techniques can be applied to do this crucial job but here Author worked on Simulated Annealing Algorithm to train the Network. Simulated Annealing works with two crucial factors temperature and energy. Simulated Annealing combining Forecast Model proved a optimal to reduce the MAPE error rate up to 16.9% of the Actual and Predict output.

Randall S. Sexton, Robert E. Dorsey, and John D. Johnson: In this paper Author conducted a Survey on Back Propagation and Simulated Annealing. Most frequently using algorithm is back propagation for train the network but this is gradient search technique to obtain local solution .Author found that Back Propagation performs poorly for simple

problem of the forecasting out of sample. Simulated Annealing is one of the global search algorithms which perform better than Back Propagation but it uses point to point search. Back Propagation and Simulated Annealing both contain multiple user determined parameter which can be affects the solution. so there is not such established rules for selecting the parameters, the solution outcome depends upon the chance. Genetic algorithm proved to be able to obtain systematically superior results to simulated annealing for optimize neural networks. This solution gives the researcher the superior estimates of the interpolation data.

Randall S. Sexton, Robert E. Dorsey and John D. Johnson: In this paper Author conducted a Survey and found Simulated Annealing trained Artificial Neural Network is much better to find true functional form. In this research Simulated Annealing and Back propagation got results for seven problems that contain In Sample, Interpolation and Extrapolation. Simulated Annealing was proved better at 0.01 levels for 19 out of 20 comparisons. So here Simulated Annealing worked superior for both interpolation and extrapolation test sets. By taking out of the 2400 estimates, Simulated Annealing found 2281 solution that were very close to the actual output results than estimated by the Back propagation Networks. Since Simulated Annealing and Back propagation implemented on two different platforms and time comparison of both algorithm evaluated for PC based SA Algorithm. The Same SA code recompiled and executed on a 83-MHz PC by using the Windows 95 operating system which system also used for PC based BP algorithm. It was found that SA took longer time in 4 out of 7 of test problems. By taking the performance on time SA is finding far to the superior solution.

CHAPTER 3

PRESENT WORK

Present Work

- i. The work has completed till the comparative analysis between Simulated Annealing Algorithm and Back Propagation Algorithm. Gross Domestic Forecasting is to be done by using both algorithms on the same dataset and same number of epochs, Learning Rate and Error Threshold. This process has implemented in the Mat lab 2013 Plate form.
- ii. Forecasting Results calculated corresponding Actual GDP data and error evaluated on the basis of Root Mean Square Error, Mean Absolute Error and Mean Absolute Percentile Error by the trained to the Network with both Algorithms namely Simulated Annealing and Back Propagation Algorithm.
- iii. There is calculated Predicted Output Values of the Gross Domestic Product by trained to the neural network by two of the crucial algorithms SA and BPA.
- iv. There has to be done analysis between both algorithm by applying on the same application, same dataset, same number of epochs and with same learning threshold.
- v. Final Analysis of the Results shows that Simulated Annealing Algorithm gives more optimal results rather than Back Propagation Algorithm.

3.1 Scope of the Study

- i. Algorithmic Analysis provides a better way to the Researcher to choose best technique to solve the research problem and merit or demerit of the algorithms.
- ii. Forecasting of the GDP does not provide the exact output it helps only predict the nearby output to the actual output but what will happen in the GDP and Economic market and the industries in the upcoming years, but it will help to give us a general

idea of the production of the goods and services. This provides a good way to the industries to grow up in the Market.

- iii. To make timely decision about the future Business Plan of the production of the goods and services like that how much Investment will be able to get big benefit, it can be estimate that what will be the net import and export, how much consumption will be and how much demand of the production and services will be of the customer.
- iv. Prediction of GDP will help to the companies in the sense what will happen in the future on the bases on observing and finding that what has happened in the past. Thus this prediction helps to the industries to make stronger and more profitable.
- v. One of the advantages of forecasting of GDP is that it allows investors to predict how much investment will need to get profit and to meet customer demand and satisfaction.
- vi. Researcher and economist can get crucial information by studying of the GDP forecasting for future related research work and Economy checking qualities.
- vii. Forecasting of GDP helps in set up a good business plan and helps in improve the business quality and efficiency.
- viii. GDP forecasting statistics helps to the economist and researchers for solving the problems of inflation, consumption, investment, profits and national income of the country. By doing so Investors can make a good plan of investment of the money, labor, time and resources. GDP can be useful in finding Consumption, Import, Export, investment and government expenditure because GDP affect to these indicators.

3.2 Problem Formulation

Gross Domestic Product is essential for reducing the un-certainty in economy. Gross Domestic Product is a crucial factor of the economy. Now a day's it very important to be rise up with the grooming market and economy. There are many definite factors which affects to the GDP and help to predict the GDP. GDP can be formulating by adding the Government Expenditure, Balance of trade, Consumption and Investment. There were many techniques and algorithms to predict GDP but Simulated Annealing is one of the best optimal Algorithms to find best results on the dataset. Here comparative analysis between both Algorithms namely Simulated Annealing and Back Propagation .Here Simulated Annealing proved better than Back Propagation by analyzing the final results. RMSE, MAE and MAPE are used to find out the error of the predicting output.

3.3 Objective of the Study

Objective of the research must be very fair, compact and informative description. Research Objective focuses on the measuring the variables like as identify or describe them. To get a good solution of a research problem it is necessary to define the objective. Objective of a research should be related to the statement of the problem. Objective is an Aim that should be achieved within the expected time period with the available resources and parameters. Generally objective of any research has one important point namely what. What stands for what is the target of to do research? GDP forecasting is a crucial thought of the researchers in the favour of economy, production business plan and useful to reduces the un-certainty. Focus of this research is in the prediction of the GDP growth of the Indian economy and is to set up a business plan of the production and the services of the nation. In this research error rate of the predict output tried to reduce and trying to get more accuracy of the predict output result over the dataset by using Simulated Annealing and Back Propagation Algorithms. Error between Actual and Predicted output is evaluated on the basis of the Root Mean Square Error, Mean Absolute Error and Mean Absolute Percentile Error. Comparative Analysis of the both crucial algorithm has been done on the same dataset, same number of epochs and same number of Error Threshold.

3.4 Research Methodology

The artificial neural network, fuzzy logic, neuron fuzzy network, support vector machine and evolutionary optimization algorithms are the developed models and ANN deals for non linear complex problems of the forecasting in a better way by providing training to the neural network. Artificial neural network based models contains back propagation neural networks, recurrent neural networks, adaptive linear element neural network, radial basis function (RBF) neural networks. ANN based model is an appropriate model to apply such kind of problem of forecasting. Supervised learning is used to train the neural network. Basically pattern recognition (is a part of classification) and regression (is a part of function approximation) are the tasks which falls in the supervised learning. Artificial Neural Network is an efficient Model to do such kind of forecasting which works with the neurons. These Neurons have the learning capability .In multilayer Neural Network there can be multiple layers like input, hidden (middle) and output layers. But in Single layer Neural Network only input layer and output layer can be included. In this Research there is used Simulated Annealing Algorithm on the dataset and implemented on the Mat lab. And Error is evaluated the between the target output values and Predicted output values by error calculating formulas. The Learning of the Network can be done using supervised learning techniques.

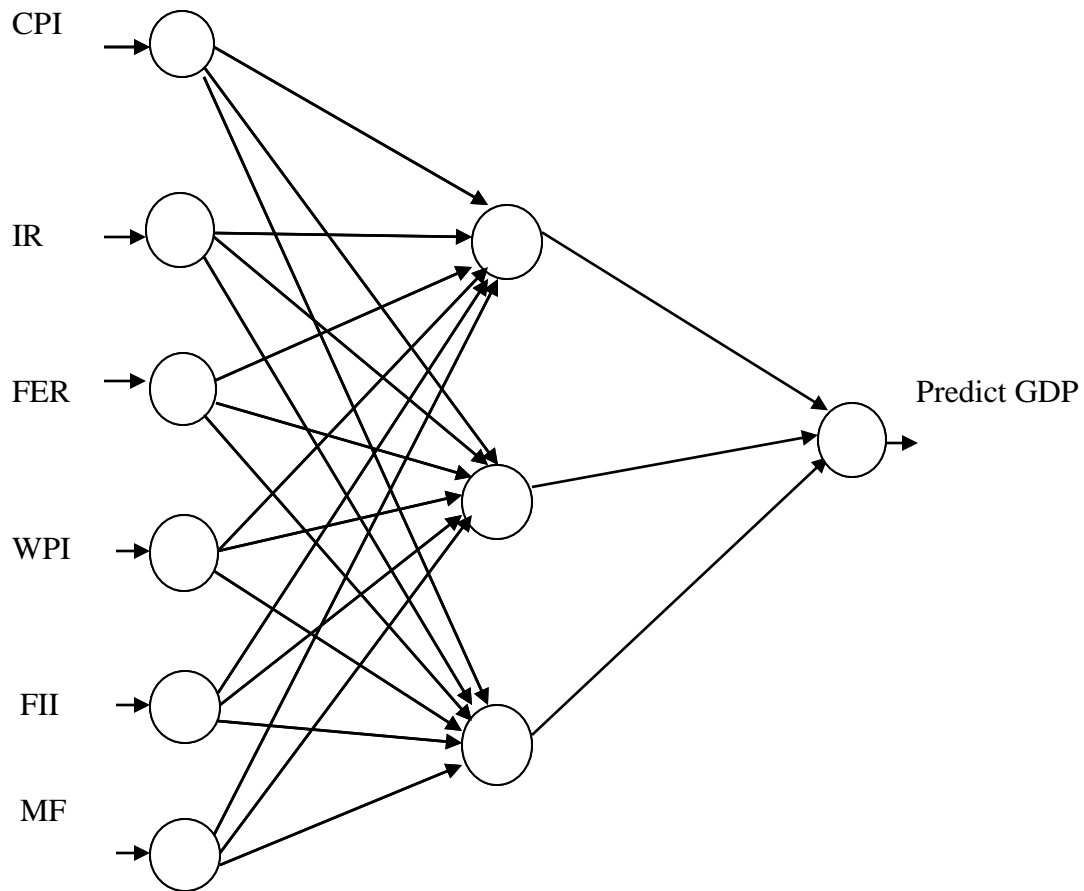


Figure 6 Multi Layer Feed Forward Artificial Neural Network

Factors which affects to the GDP:

There are given below the factors which affect to the GDP Growth:

- a. **CPI (+):** When CPI (consumer price Index) increases GDP also increases. This is because if Consumer Price Index decreases. That means wages and the price value of goods is going to fall which means that the economy is in poor condition. GDP of the country goes fall.
- b. **Interest Rate (+):** If Interest rate goes high that means the cost of having money increases which means savings. More saving help in more investment and GDP goes up.

- c. **Foreign Exchange Rate (-):** Foreign Exchange rate refers to the impact on one national currency with respect to another national currency. If the value of U.S dollar is increasing then the value of Indian rupees goes down by which Indian economy goes fall and GDP of the Nation goes down.
- d. **FII Activities (Foreign Institutional Investors Activities)(+):**In this buyers and sellers deposits money in investment of country then more investment indicates to the more gross domestic product growth.FII Activity indicates to the net buyers and sellers. Investor invests money in purchase and sale to the goods and wages by do so economic conditions goes up and GDP also goes up.
- e. **Mutual Fund Activities (+):** In Mutual Fund investors invest their money by collecting money together. There may be risk of loss in investment for a short period of time but for a long period of time investment is secure and investors can get good return back. Here more investment gives good economy and GDP of the country move up.
- f. **Wholesale Price Index (WPI) (+):** If the wholesale price of the goods increase then demand of the goods will get high. So By this reason production of the goods also increases. GDP will get up.

Data Collection:

Data collection is important part of any research. Data has been taken of last ten years on monthly basis in research. Data of the CPI (consumer price index) inflation has picked from www.inflation.eu .data of Interest Rate and Foreign Exchange Rate picked from research.stlouisfed.org .data of FII (Foreign Institutional Investors) Activity and Mutual Fund Activity has taken from www.moneycontrol.com websites. Data of the GDP found on quarterly basis on the rbi.org.in and it has to be converted on monthly basis. Data of WPI has taken from rbi.org.in in this site.

Back Propagation Algorithm Description:

Stages of the Back Propagation in the training algorithm:

1. First of all initialize the weight values from input to hidden layer and hidden to output layer.
2. Feed Forward Network containing input, hidden and output layers.
3. In the third step calculates the errors and Back Propagation errors of the Network.
4. In the fourth step update weights and bias values.

Update weights and bias of BPN:

1. For each output unit ($y_k, k=1, \dots, m$) have to update its bias and weights ($j=0, \dots, p$). The weight correction term is given by

$$\Delta W_{jk} = \alpha \delta_k Z_j$$

Bias Correction term is showing by

$$\Delta b_{0k} = \alpha \delta_k$$

Therefore

$$W_{jk}(\text{new}) = W_{jk}(\text{old}) + \Delta W_{jk}$$

$$b_{0k}(\text{new}) = b_{0k}(\text{old}) + \Delta b_{0k}$$

2. For each hidden unit ($Z_i, i=1, \dots, p$) updates its bias and weights ($j=0, \dots, n$) weight correction term

$$\Delta W'_{ij} = \alpha \delta_j X_i$$

And bias correction term

$$\Delta b'_{0j} = \alpha \delta_j$$

So

$$W'_{ij}(\text{new}) = W'_{ij}(\text{old}) + \Delta W'_{ij}$$

$$b'_{0j} = b'_{0j}(\text{old}) + \Delta b'_{0j}$$

Description of the Simulated Annealing Algorithm:

Simulated annealing is a technique in which heating of the material and sudden cooling provides a way to increase its crystals size and decrease the defects of the material. Simulated annealing is one of the crucial algorithm which can be use to optimize the weight values of

the ANN. SA algorithm here improves the performance of the BPN.SA technique can be apply on a specific application by knowing the input and output parameters.

Value of the Function $f(X)$ is to be minimize. T_0 is the initial Temperature and X_i is the set of weights. V is taking for step length of values X_i . X and V are of length n . v and x are elements of the vectors V and X . $f(X)$ is sum of squared errors which produced by X . Candidate X' is chosen by varying each x_i and r is random number fetch from the uniform distribution between $[-1,1]$.

$$X_i' = x_i + v_i * r \quad (1)$$

From the new X_i' function value f' is then computes.

If $f' < f$, X' is accepted as the new X .

If this new f is the smallest then solution is so far.

And if $f' \geq f$ then test for acceptance.

From (2) the value of p is computed and compared with p' . If $p > p'$ then new point is accepted and X is updated with the value X' else X' is rejected.

$$P = e^{-(f-f')/T} \quad (2)$$

This Process repeats for a specified number of steps.

Reduction in T is calculated by the formula

$$T_1 = T_0 * r_T \quad (3)$$

Here r_T is also user defined value between $[0, 1]$. Reduction of the Temperature (T) gives current optimal results. By the decreasing of the temperature number of rejections will increase .and step length will get decline.

Step1: Assume Initial Temperature is T and Initial Solution State is S' , for every T performs iterations up to n .

Step2: In step 2, $i=1, \dots, n$ perform step 3 to step number 6

Step3: evaluate S'' for data processing.

Step4: Now find out the Incremental Calculation $\Delta t' = C(S'') - C(S')$

Here $C(S')$ is evaluating function.

Step5: Now check the condition

If $\Delta t' < 0$ then S'' is current solution

Step6: Now check if there is termination condition, the output will be current solution and will be optimal then stop the process.

Step7: T decreases gradually and $T \rightarrow 0$ then move to step no 2.

Evaluate the error rate of the Network by using RMSE (Root Mean Square Error).algorithms

Continue runs on the training set until RMSE tends to increase the validation set.

Functioning of Simulated Annealing in the Coding:

```
if(AF=='p')
```

```
    SAinit=[Iweights.input Iweights.bias];
```

```
    [Iweights,~,~,output] = simulannealbnd(ObjectiveFunction,SAinit);
```

```
    IWeights.bias(j)=IWeights.bias(j)+LR*(db-output(j));
```

```
else
```

```
    IWeights.bias(j)=IWeights.bias(j)+LR*output(j)*(1-output(j))*(db-output(j));
```

Here

db is for Predicted output and output is for Actual Output.

LR is for Learning Rate.

AF is for Activation Function

Covered Steps of the Research:

Here are describing the completed work of the research. The very first step of the Research is to identify the problem according to the interest. After this, the part of the literature review or literature survey covered by studying previous related research papers. And then Purpose or Aim of the Research founded. Next step is defined to the population means define the factors which affect to the Research. And then Collection of the past year data is completed successfully.

There is given a diagram of the completed work which has been done successfully:

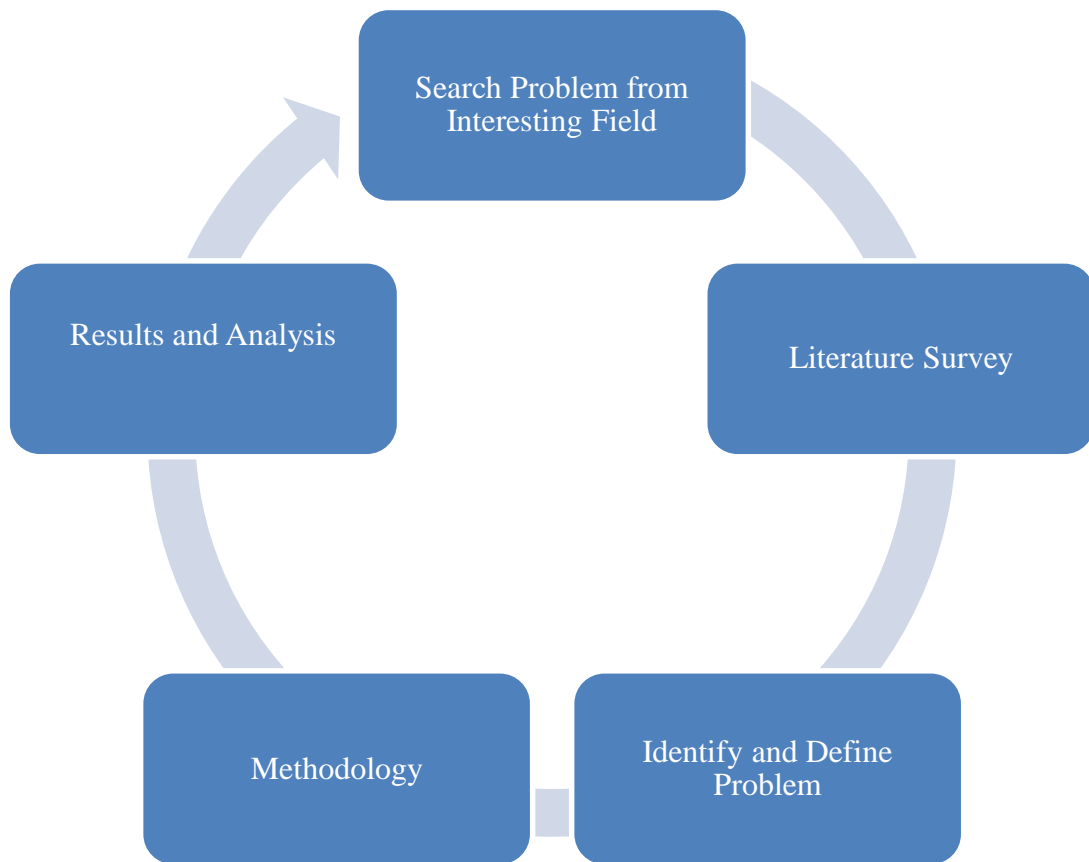


Figure 7 Covered Steps of the Research

CHAPTER 4

RESULT AND DISCUSSION

Result and Discussion

The Proposed Algorithms implemented on the MATLAB 2013a version. The Neural Network has learning ability so here the network is to be trained by using Simulated Annealing and Back Propagation Algorithm up to 500 epochs to fetch out the best results. Here comparative analysis of the performance of the both algorithm is analyzed and trying to get more accuracy of the Gross Domestic Product Prediction. Error evaluated by using RMSE, MAE and MAPE.

4.1 Simulated Annealing Results:

Simulated Annealing Algorithm used here to train the Network up to 500 epochs. After Analyzing the Final Results of the GDP Forecasting Basically two cases are made here:-

Case 1:

When considering all the parameter of the dataset namely Consumer Price Index (CPI), Whole sale Price Index (WPI), Interest Rate (IR), Foreign Institutional Investors (FII), Mutual Fund (MF) and Foreign Exchange Rate (FER) the results are showing below:

RMSE=0.0816

MAE = 0.0676

MAPE =0.0955

Learning Rate=1

Error Threshold=0.1

Epochs=500

Activation Function=Sigmoid

A set of Actual and Predicted Values is showing below:

List=1.0e+04 *

Actual GDP	Predict GDP	Error
1.2430	1.0512	0.1917

1.2421	1.2013	0.0408
1.2413	1.2019	0.0394
1.2404	1.1846	0.0558
1.3526	1.3091	0.0434
1.3711	1.1927	0.1784
1.3896	1.2498	0.1398
1.4081	1.4989	-0.0907
1.3722	1.2949	0.0773
1.3362	1.2775	0.0587
1.3002	1.4866	-0.1864
1.3000	1.2550	0.0449
1.2997	1.3440	-0.0443
1.2995	1.4242	-0.1247

There is showing below the Error Plot for the Different Data Points:

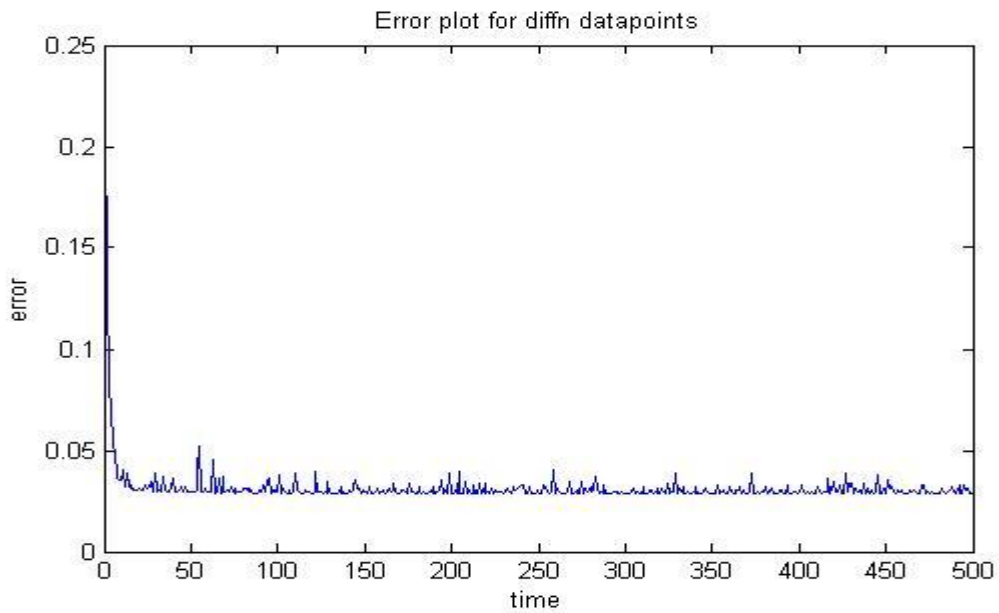


Figure 8: Error on different data points with respect to time for case 1

There is showing a plot of the Actual and Predicted GDP. Here Green points of the Curve are for Actual Data and Red points of the Curve are for Predict Data:

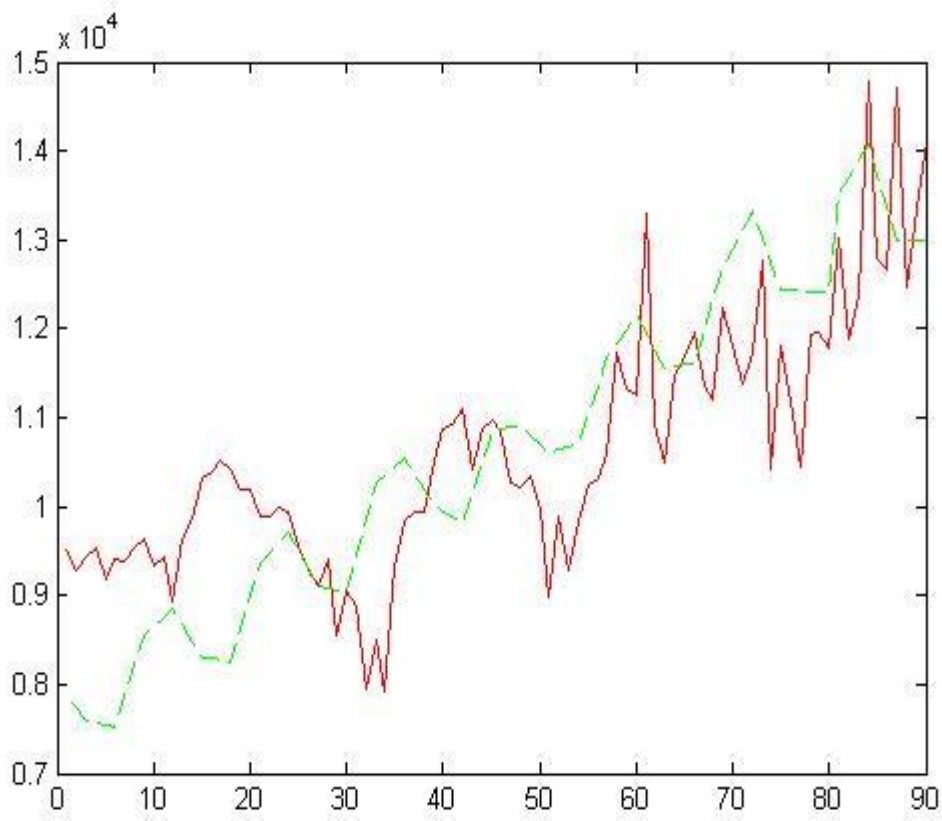


Figure 9: Predicted Output corresponding Actual for case 1

A Plot for the RMSE, MAE and MAPE is showing below and value of the Root Mean Square Error is 0.08, value of the Mean Absolute Error is 0.07 and value of Mean Absolute Percentile Error is 0.09:

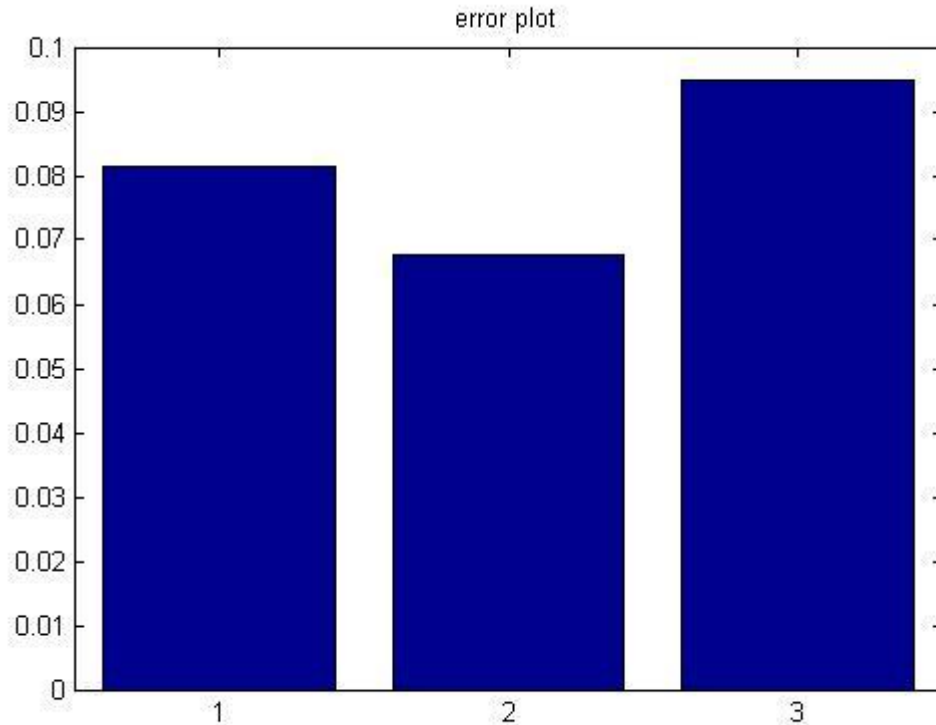


Figure 10: Bar Chart for RMSE, MAE and MAPE respectively for case 1

Case 2:

In Case 2, Only 4 Attribute of the Dataset has been taken CPI, IR, FER, FII Activity and it is seeing that Error Rate of the RMSE, MAE and MAPE is less than the Error Rate in Case 1. So it can be says that these Four Factors are highly dependent out of these six Factors. Case 2 shows better Results of the Forecasting and less error rate as compare to the Case 1. Two attribute of the dataset Mutual Fund and Whole Sale Price Index are not included in case 2.

RMSE =0.0755

MAE =0.0599

MAPE =0.0904

Learning Rate=1

Error Threshold=0.1

Epochs=500

Activation Function=Sigmoid

List =1.0e+04 *

Actual GDP	Predict GDP	Error
1.1376	0.9897	0.1479
1.1368	1.1127	0.0242
1.1360	1.1198	0.0162
1.1353	1.1064	0.0288
1.2379	1.1959	0.0420
1.2548	1.1164	0.1384
1.2718	1.2264	0.0454
1.2888	1.3967	-0.1079
1.2558	1.2389	0.0169
1.2229	1.2354	-0.0124
1.1900	1.3913	-0.2013
1.1898	1.2324	-0.0426
1.1895	1.2969	-0.1074
1.1893	1.3578	-0.1685

Error Plot for the different data points is showing below with respect to time and error:

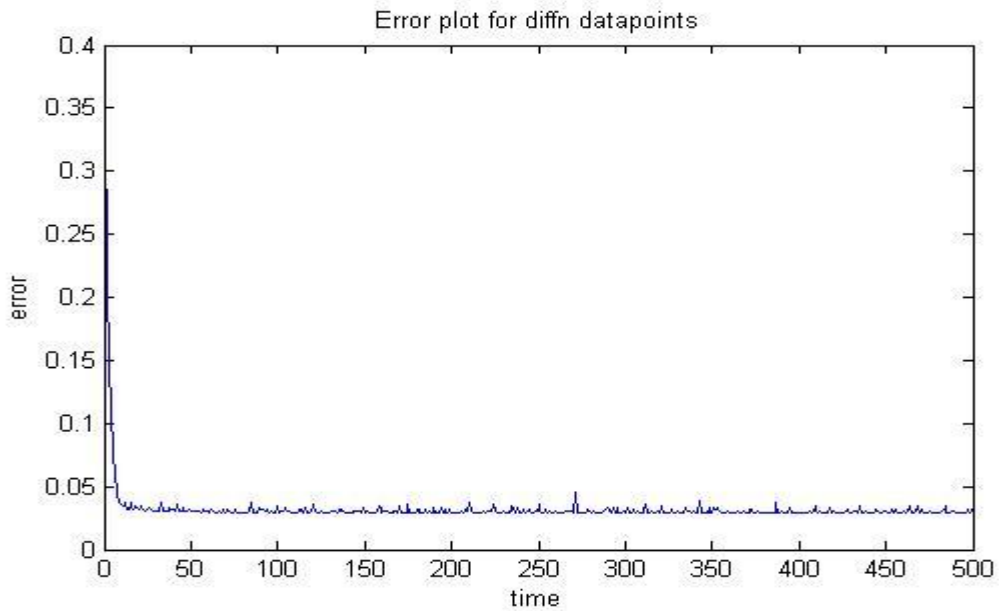


Figure: 11 Error on different data point with respect to time for case 2

There is showing a plot the Actual and Predicted GDP. Here Green points of the Curve are for Actual Data and Red points of the Curve are for Predict Data:

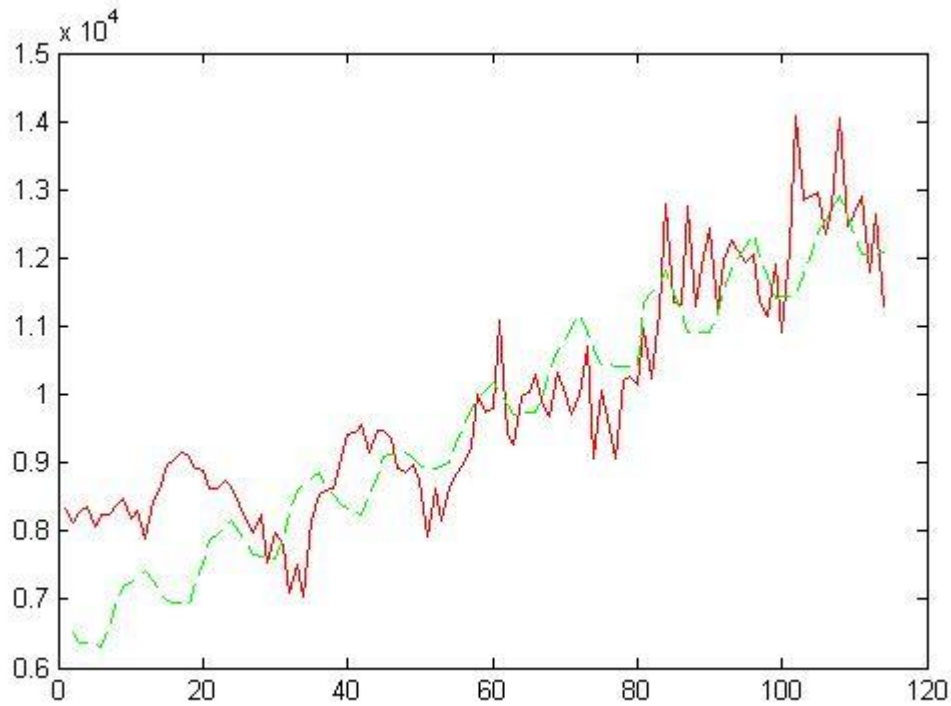


Figure 12: Predicted Output corresponding Actual for case 2

A Bar Chart for the RMSE, MAE and MAPE is showing below. In which Value of the Root Mean Square is 0.0755, Value of Mean Absolute Error is 0.0599 and Mean Absolute Percentile Error is 0.0904:

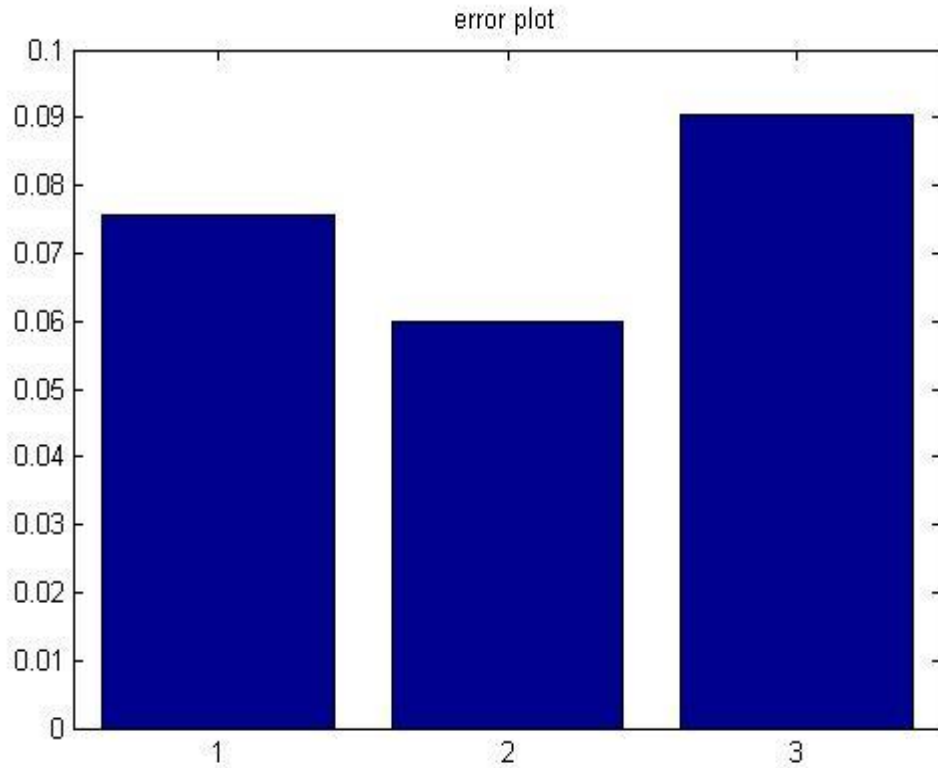


Figure 13: Bar Chart for RMSE, MAE and MAPE for case 2

4.2 Back Propagation Algorithm Results:

Back Propagation Algorithm used here to train the Network up to 500 epochs. Analyzing the Final Results of the GDP Forecasting error evaluated on the basis of the Root Mean Square Error, Mean Absolute Error and Mean Absolute Percentile Error.

RMSE =0.0849

MAE =0.0718

MAPE =0.0972

List =1.0e+04 *

Actual GDP	Predict GDP	Error
1.2430	1.0009	0.2421
1.2421	1.1562	0.0859

1.2413	1.1592	0.0821
1.2404	1.1384	0.1021
1.3526	1.2728	0.0797
1.3711	1.1572	0.2139
1.3896	1.2226	0.1670
1.4081	1.4714	-0.0633
1.3722	1.2537	0.1184
1.3362	1.2365	0.0997
1.3002	1.4515	-0.1513
1.3000	1.2153	0.0847
1.2997	1.3078	-0.0081
1.2995	1.3967	-0.0973

Error Plot is showing below for the Different Data Points:

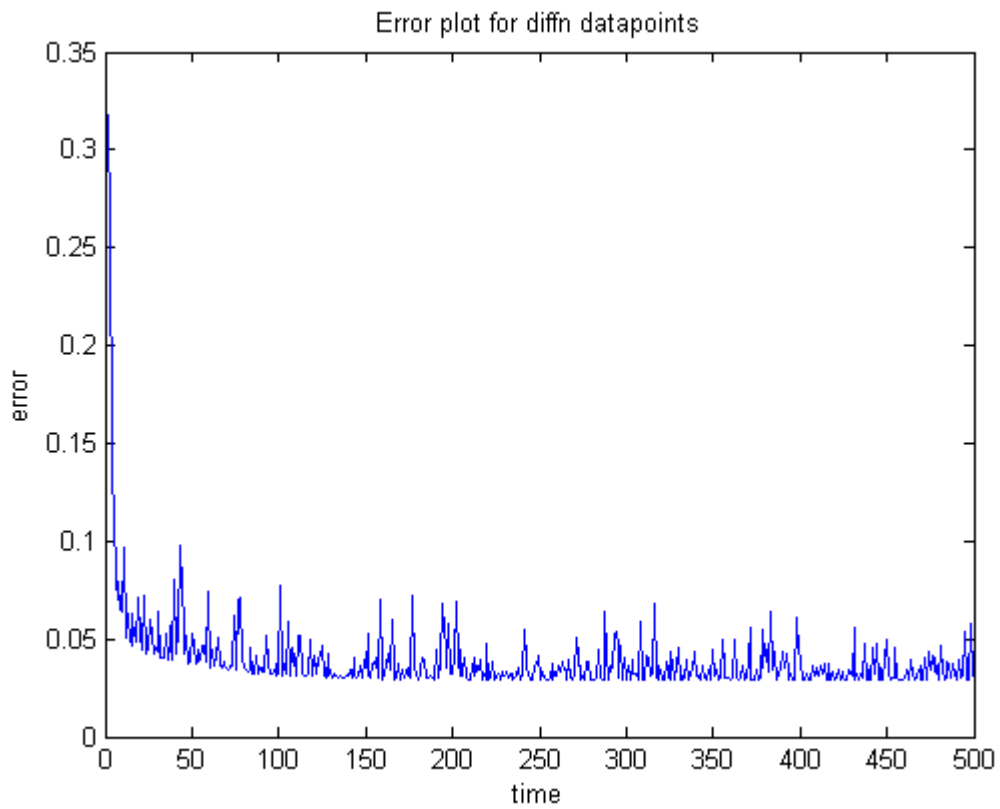


Figure 14: Error on different data points with respect to time for BPN

There is showing a plot of Actual and Predicted GDP. Here Green points of the Curve are for Actual Data and Red points of the Curve are for Predict Data:

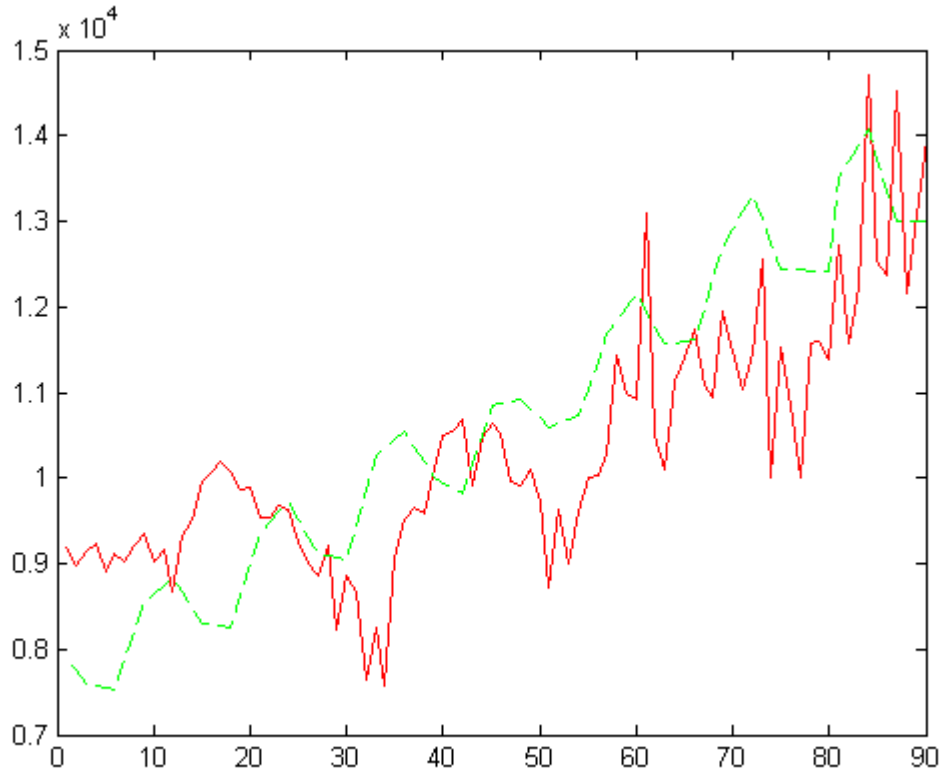


Figure 15: Predicted GDP Corresponding Actual for BPN

A Bar Chart for the RMSE, MAE and MAPE is showing below:

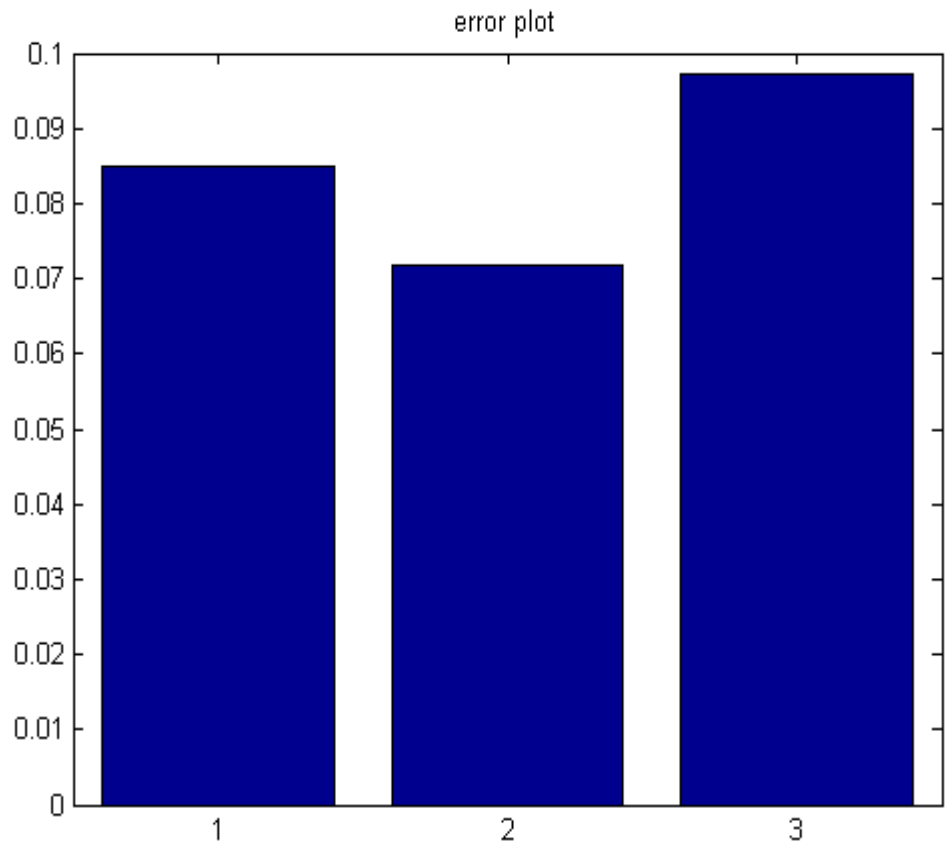


Figure 16: Bar Chart for RMSE, MAE and MAPE for BPN

Conclusion and Future scope

The Advantages of proposed method that is Simulated Annealing provided the optimal results over that Back Propagation Algorithm. Simulated annealing is a technique in which heating of the material and sudden cooling provides a way to increase its crystals size and decrease the defects of the material. Simulated annealing is one of the crucial algorithm which can be use to optimize the weight values of the ANN. SA algorithm here improves the performance of the BPN.SA technique can be apply on a specific application by knowing the input and output parameters. Basically Simulated Annealing works globally while Back Propagation works locally. Simulated Annealing process all the weight values together to find the optimal results of the prediction and Back Propagation process the weight values from back to forth. Here Forecasting of the Gross Domestic Product has been done by both the technique. Comparative Analysis between both the crucial algorithms evaluated on the basis of RMSE, MAE and MAPE. By Applying Simulated Annealing Technique over the whole dataset RMSE is 0.0816, MAE is 0.0676 and MAPE is 0.0955 in case 1. Here total number of epochs is 500, Learning Rate is 1, Error Threshold is 0.1 and Activation Function is taking Sigmoid in this process. Now In Second Case of Simulated Annealing only four attributes has been taken for evaluating the results namely Consumer Price Index, Foreign Exchange Rate, Foreign Institutional Investors and Interest Rate and Whole Sale Price Index, Mutual Fund are not included to find out predict results. In Case 2, RMSE is 0.0755, MAE is 0.0599 and MAPE is 0.0904 which are less than the errors of the Case 1. It is found that case 2 has better results as compare to case 1 so it is concluded that these four factors are highly dependent on the Gross Domestic Product. And the Other Technique that is Back propagation Algorithm applied to train the network and concluded the predicted results of the Gross Domestic Product. It has seen that Back Propagation has poor final results as compare to the Simulated Annealing Algorithm. Back Propagation process all the weight from back and Simulated Annealing is a optimize technique to produce the best results. So here

Comparative Analysis between both algorithm has been evaluated are simulated Annealing proved better in GDP Prediction. The Final Results of the BPN contains RMSE is 0.0849, MAE is 0.0718 and MAPE is 0.0972.

Table is showing the final analysis and results of the GDP Prediction:

	SA (Case 1)	SA (Case 2)	BPN
RMSE	0.0816	0.0755	0.0849
MAE	0.0676	0.0599	0.0718
MAPE	0.0955	0.0904	0.0972

Table 1: Comparative Results of the Algorithms

Future scope

Gross Domestic Product prediction is a crucial job in research and there are many algorithms which can be used to train the network but it is not easy to know that which one will give the best result and performance. Researcher are working on the different algorithms and giving the best conclusion about the used model and the algorithm. So here GDP Forecasting has been done by two crucial algorithms and it is concluded the SA gives the better results as compare to the BPN on the same dataset, same number of epochs, same learning rate and same error threshold. In future, in such kind of application SA can be used instead of using BPN because of having better performance .GDP Forecasting reduces the un-certainty and can be helpful for the set up the future business plan. GDP can be helpful to evaluate Government Expenditure, Investment, Export-Import and Consumption. In future analysis can be done between the Simulated Annealing and any other optimal algorithm by applying these on the same application.

CHAPTER 6

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CHAPTER 7

APPENDIX

List of abbreviations

ANN- “Artificial Neural Network”

AR (1)-“Auto Regressive (1)”

ARIMA-“Autoregressive Integrated Moving Average”

BT-“Balance of Trade”

CPI- “Consumer Price Index”

FER- “Foreign Exchange Rate”

FII-“Foreign Institutional Investors”

GA-“Genetic Algorithm”

GDP-“Gross Domestic Product”

IR- “Interest Rate”

WPI-“Wholesale Price Index”

SVM-“Support Vector Machine”

SA-“Simulated Annealing”

BPN-“Back Propagation Network”

GA-“Genetic Algorithm”

FNT-“Flexible Neuron Tree”

Publications

Paper accepted

- I. Nikit Kumar and Pency Juneja (2015) "A Review: Analysis and Forecasting of GDP using ANN", International Journal of Advances in Engineering and Research (IJAER).