KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

Department of Electrical & Electronics Engineering

MINI PROJECT REPORT

Gold Price Prediction Using Backpropagation Algorithm

ETEG 425

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To:

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Abstract

Gold is considered as the emergency asset in world economics. It is used by countries when its economy tries to weaken. Hence, gold prices fluctuate according to the country's economic status. Since, country's economic status is a continuously fluctuating figure, gold price also fluctuates according to it. Gold prices are determined by various aspects of economics like crude oil prices, stock market, dollar to euro conversation prices, inflation rates and other physical factors. Out of these factors crude oil prices and dollar to euro conversation price plays a vital role in determining the prices of gold. Here, in this mini project data of crude oil prices and dollar to euro conversation ratio is taken in order to predict the future price of gold. Supervised backpropagation algorithm is used in order to predict the price.

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Chapter I: Introduction

1.1. Background

Gold is one of the most valuable metal on Earth. Gold is such a significant aspect of our economy that it has been one of the major investment instruments for our economic society for many years. It is perceived as the most reliable means of investment by people during a crisis. It is very important to estimate gold prices not just for the investors who want to earn high profits from their investments but also from a economic aspect of a country as the gold price reveals the true state of the economy of a country.

The interest of investors in gold is shaped by the price of the gold which is a influence of various factors such as international oil prices, foreign exchange prices, interest rates, stocks, commodity prices and so on. Any change in these factors affects the supply and demand of gold and consequently affects the price of gold in the market.

Due to the significance of gold it is very useful for investors to predict the price of gold based on the influencing factors provided. Although gold price is influenced by various factors the most important factors that affect the price is the price of crude oil and the dollar to euro exchange rate price. Hence in this mini project an efficient supervised learning backpropagation algorithm is employed to predict the price of gold.

1.2. Motivation

As stated, earlier gold is the emergency investment that saves finances of an institution during crisis. Hence the prediction of gold price will help various institutions to make the necessary investment at the right time. Gold price may also be the indicator of financial figures like inflation which will help stake holders to make the necessary policy plans to revive the economy of the institution. Hence the prediction of price of gold will make institution predict the future economic plans and formulate reviving plans if the situation gets worsen.

1.3. Problem Definition

Gold price being essential item flatulates according to various economical constrains. To predict the price according to the fluctuating constrains can be very efficient with the help of neural network. Hence, this project aims in predicting the price of gold according to the fluctuating constrains using backpropagation algorithm.

1.4. Objectives.

The objective of this project is:

- To predict the price of gold.
- To display the learning rate while training.

1.5. Methodology

In this project a three-layer neural network is used consisting of a single hidden layer. The structure is shown in the figure below.

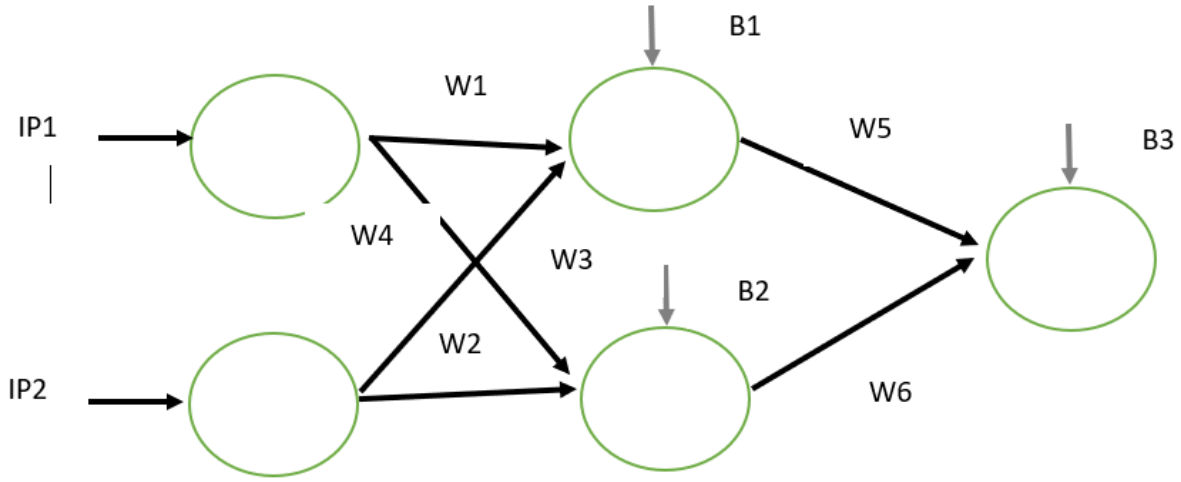

Figure 1 Structure of neural network

The two inputs are transposed and fed to the input layer, the input is multiplied by weight and bias is added to it and is exposed to non-linear transfer function. The output thus obtained are multiplied by weight and bias is added which is again exposed to non linear transfer function and the output is produced. The output is compared with actual output to produce error and necessary backpropagation are performed.

1.6. Limitation

This project has the following limitation.

i. It gives less accurate result for few hundred data.

ii. Cannot predict the exact result if the price fluctuates suddenly.

1.7. Organization of Report.

Chapter II contains the literature review of the project, containing the details of backpropagation learning algorithm. Chapter III contains the methodology used to compute the result. Chapter IV contains the result and outcomes of the project done and chapter V contains the conclusion drawn from the project.

Chapter II: Literature Survey

2.1. Artificial Neural Network

An artificial neural network (ANN) is the piece of a computing system designed to simulate the way the human brain analyzes and processes information. It is the foundation of artificial intelligence (AI) and solves problems that would prove impossible or difficult by human or statistical standards. ANNs have self-learning capabilities that enable them to produce better results as more data becomes available.[1]

Artificial neural networks are built like the human brain, with neuron nodes interconnected like a web. The human brain has hundreds of billions of cells called neurons. Each neuron is made up of a cell body that is responsible for processing information by carrying information towards (inputs) and away (outputs) from the brain.

An ANN has hundreds or thousands of artificial neurons called processing units, which are interconnected by nodes. These processing units are made up of input and output units. The input units receive various forms and structures of information based on an internal weighting system, and the neural network attempts to learn about the information presented to produce one output report. Just like humans need rules and guidelines to come up with a result or output, ANNs also use a set of learning rules called backpropagation, an abbreviation for backward propagation of error, to perfect their output results.

2.2. Supervised learning

As the name suggests, supervised learning takes place under the supervision of a teacher. This learning process is dependent. During the training of ANN under supervised learning, the input vector is presented to the network, which will produce an output vector. This output vector is compared with the desired/target output vector. An error signal is generated if there is a difference between the actual output and the desired/target output vector. On the basis of this error signal, the weights would be adjusted until the actual output is matched with the desired output.[2]

2.3. Backpropagation algorithm

Back propagation is a systematic method for training multi-layer artificial neural networks. It has a mathematical foundation that is strong if not highly practical. It is a multi-layer forward network using extend gradient-descent learning rule, commonly known as back propagation (of errors) rule.

Back propagation provides a computationally efficient method for changing the weights in feed forward network, with differentiable activation function units, to learn a training set of input-output examples. Being a gradient descent method, it minimizes the total squared error of the output computed by the network.

As shown in the figure 2, the architecture of BPN has three interconnected layers having weights on them. The hidden layer as well as the output layer also has bias, whose weight is always 1, on them. As is clear from the diagram, the working of BPN is in two phases. One phase sends the signal from the input layer to the output layer, and the other phase back propagates the error from the output layer to the input layer. [3]

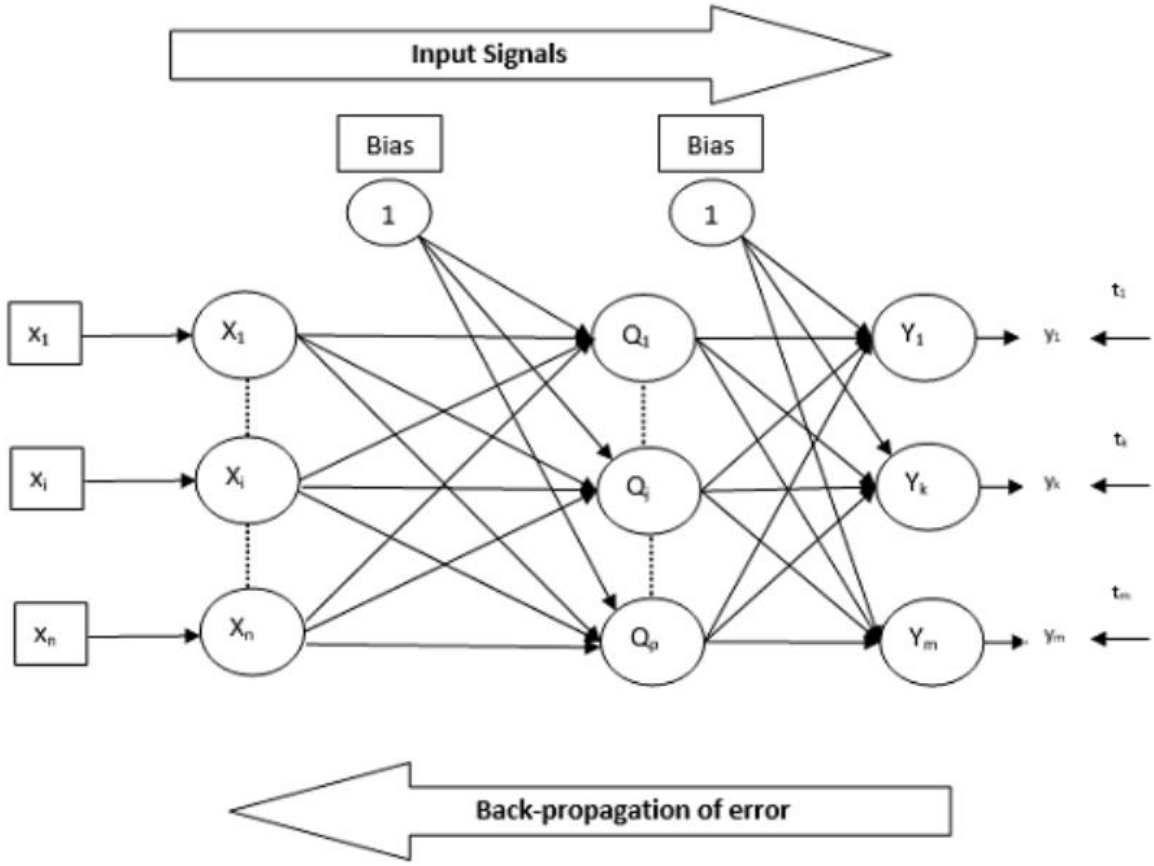

Figure 2 Architecture of Backpropagation

Backpropagation being a gradient descent method, it minimizes the total squared error of the output computed by the network.

The error which has to get minimized is given by:

$$E = \frac{1}{2} \sum_{k} [t_k - y_k]^2$$

By using chain rule, we get, updating formula for output layer as:

$$\Delta w_{jk} = -\alpha \frac{\partial E}{\partial w_{jk}}$$

$$= \alpha \, \delta_k \, z_j$$

Updating formula for hidden layer is given as:

$$\Delta v_{ij} = -\alpha \frac{\partial E}{\partial v_{ij}}$$

$$= \alpha \, \delta_j \, x_i$$

The backpropagation algorithm uses three phases, Feed Foreword phase, Back propagation of error, updating of weight.

In feed foreword phase output is calculated by multiplying weights with inputs and adding bias to it. Then the output is exposed to the non linear activation function to produce the final output, which is shown in expression below.

$$y_{ink} = b_{0k} + \sum_{j=1}^{p} Q_j \, w_{jk} \quad k = 1 \, to \, m$$

$$y_k = f(y_{ink})$$

In phase 2, the error correcting term, in correspondence with the target pattern received at each output unit, as follows –

$$\delta_k = (t_k - y_k) f'(y_{ink})$$

On this basis the weight and bias is obtained as follows

$$\Delta v_{jk} = \alpha \delta_k Q_{ij}$$

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

Then del(k) is sent back to the hidden layer.

Now each hidden unit will be the sum of its delta inputs from the output units.

$$\delta_{inj} = \sum_{k=1}^{m} \delta_k w_{jk}$$

Error term can be calculated as follows

$$\delta_j = \delta_{inj} f'(Q_{inj})$$

On this basis, update the weight and bias as follows-

$$\Delta w_{ij} = \alpha \delta_j x_i$$

$$\Delta b_{0j} = \alpha \delta_j$$

Now each of the output unit updates weight and bias as follows-

$$w_{ij}(new) = w_{ij}(old) + \Delta w_{ij}$$

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

After that a stopping condition is checked which may be either the number of epochs reached or target output matched the actual output.

Chapter III: Methodology

3.1. Block Diagram

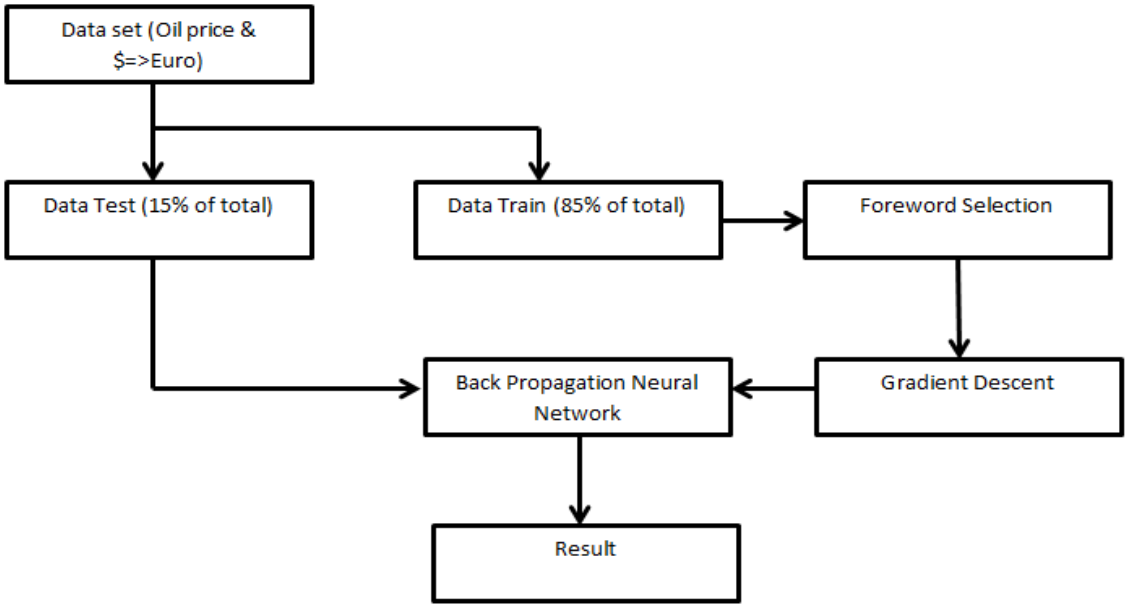

Figure 3 Block Diagram of Back propagation

Two data are taken considered in this neural network, first being the crude oil price and second being the dollar to euro conversation prices. The data is spitted to 85% and 15% for testing and training purpose. For the training data, feedforward method is applied, followed by backpropagation of errors. Then the weight is adjusted accordingly. After following the certain number of epochs, the training is stopped and the data is tested with the final trained weight.

3.2. Flow Chart

The flow chart of the system flow is as shown in the figure 4 below. As shown in the flowchart first the weight and bias initialization is done. After that the output is calculated by feedforward method, then error is calculated. From the errors obtained backpropagation calculating change in weight of output neurons, followed by calculating the change in weight in hidden layer neurons. Then the weight update is performed by adding the weight change. After meeting the certain learning criteria, the iteration is performed after which it is stopped. Then the testing operation is performed based on the final weight updated.

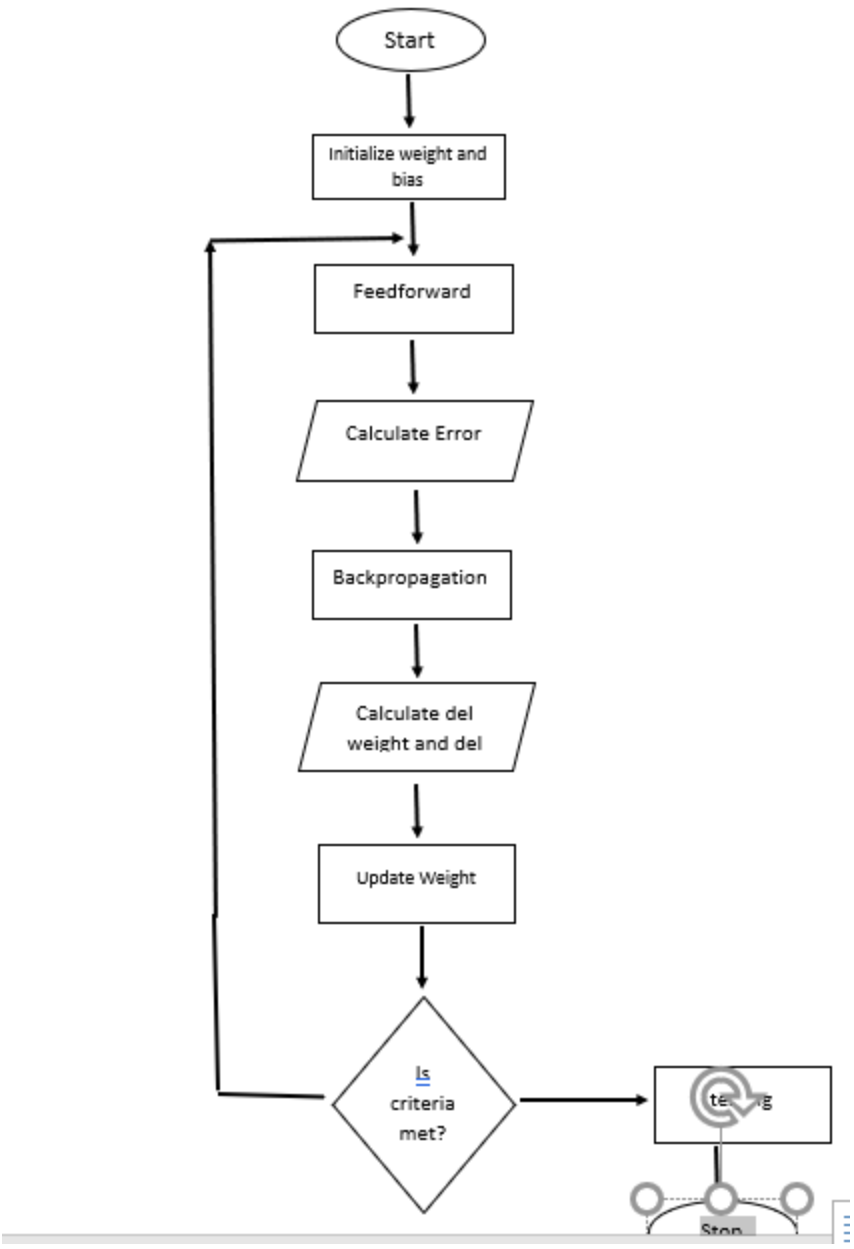

Figure 4 Flow chart

Chapter IV: Result and Analysis.

4.1. Data Format

1	Date	Doller-Euro	Oil Price	GoldPrice
2	2/14/2018	1.1307	60.33	1,192.5
3	2/14/2018	1.1363	59.77	1,204.8
4	2/15/2018	1.1212	61.39	1,208.3
5	2/16/2018	1.1197	61.89	1,214.0
6	2/17/2018	1.1190	60.75	1,212.5
7	2/18/2018	1.1212	61.18	1,212.8
8	2/19/2018	1.1070	59.18	1,199.5
9	2/20/2018	1.1006	60.33	1,202.0
10	2/21/2018	1.0855	59.15	1,175.8
11	2/22/2018	1.0846	58.67	1,168.5
12	2/23/2018	1.0707	55.95	1,162.0
13	2/24/2018	1.0576	56.46	1,150.0
14	2/25/2018	1.0615	56.66	1,152.3
15	2/26/2018	1.0524	54.80	1,152.0
16	2/27/2018	1.0575	52.00	1,150.8
17	2/28/2018	1.0605	52.17	1,150.8
18	3/1/2018	1.0643	52.59	1,147.3
19	3/2/2018	1.0621	52.96	1,166.0
20	3/3/2018	1.0792	53.88	1,183.1
21	3/4/2018	1.0928	53.82	1,186.3
22	3/5/2018	1.0908	53.61	1,191.5
23	3/6/2018	1.0986	54.18	1,195.6
24	3/7/2018	1.0919	57.02	1,203.2
25	3/8/2018	1.0891	56.44	1,195.8
26	3/9/2018	1.0818	53.99	1,185.5

Figure 5 Data Format

Total of 951 data are taken from February 14, 2018 to September 20, 2020. The data is splinted to 85% to 15% ratio for training sets and testing sets respectively. So that 809 data are used for training purpose and 142 data are used for testing purpose. Out of the data, the first column data is dollar to euro exchange price, the second column data is crude oil price in barrel and the third column is gold price per ounce in US dollar. All the data are based on United States and are taken from internet.

4.2. Learning Curve

The learning curve is as shown in figure 6. For each training iteration, the total errors of each training data set were computed and plotted which exhibited the learning process during training. The global minimum is obtained around 700 iterations.

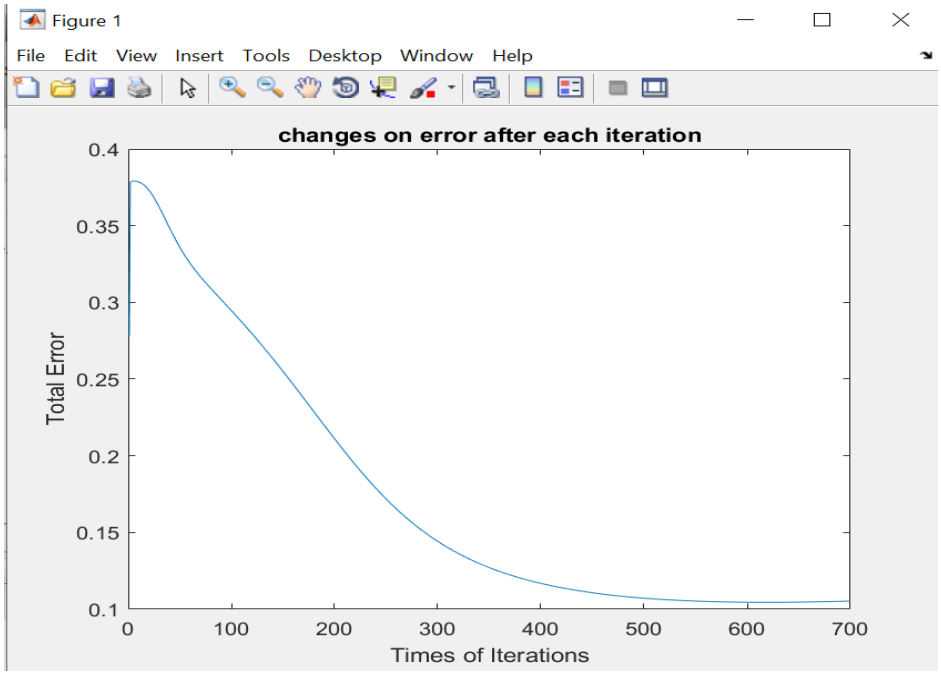

Figure 6 Learning Curve graph

With further increase in number of iterations the error tends to rise which is demonstrated by figure 7.

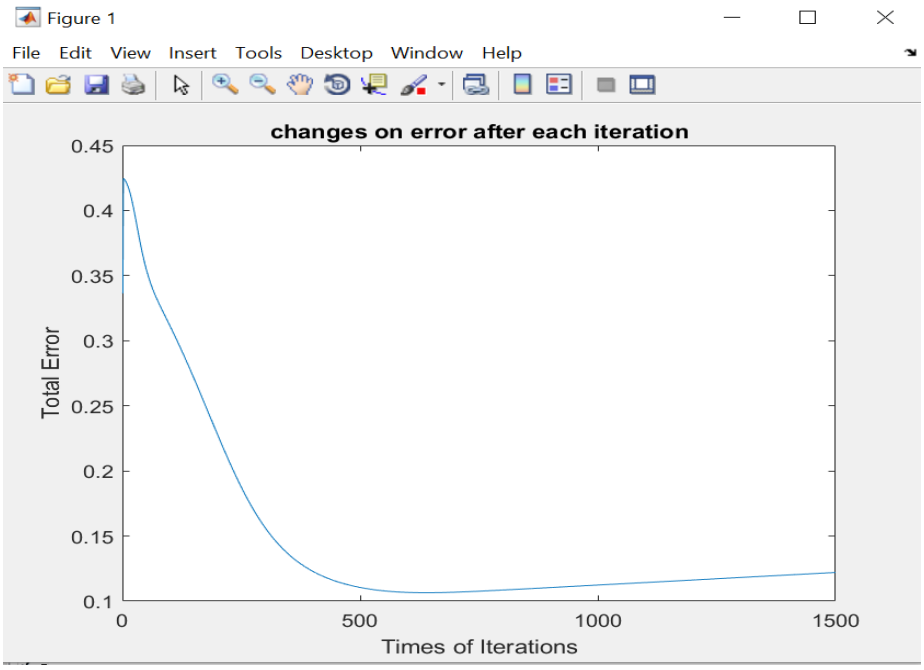

Figure 7 Learning with increase in iterations

Hence, the training process is stopped in 700 iterations to obtain the correct result.

4.3. Testing result

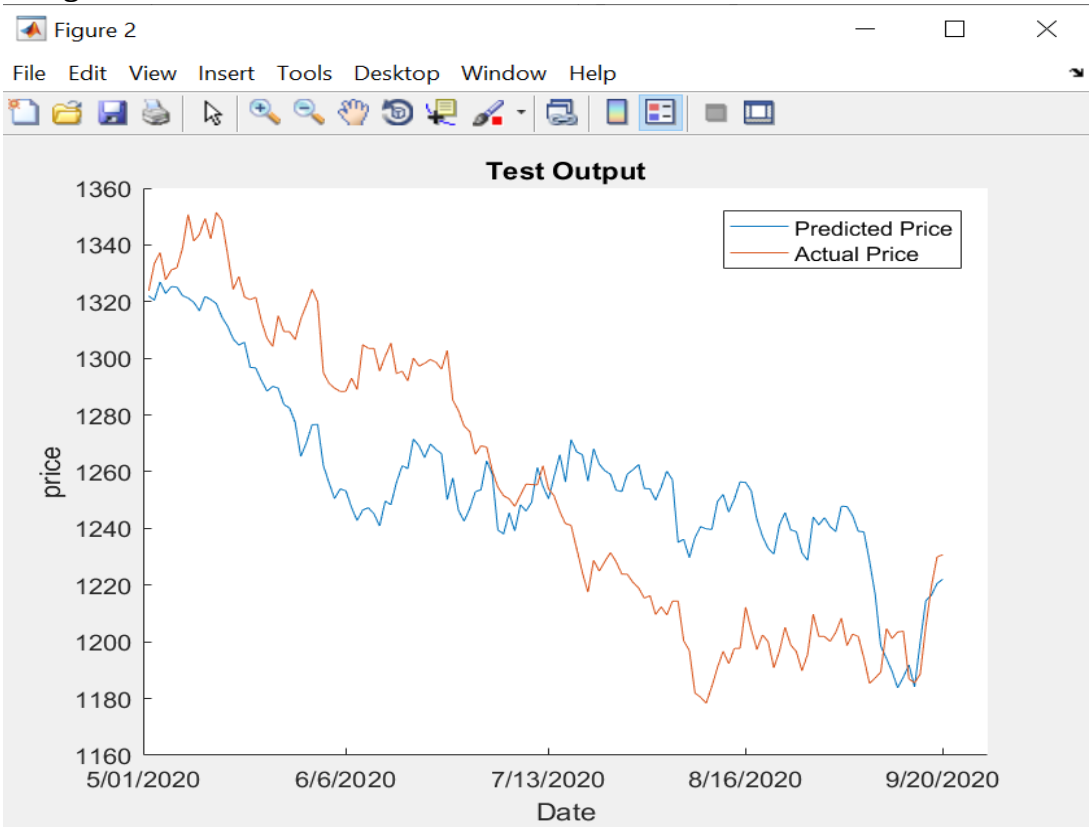

Figure 8 Testing Curve

After performing 700 iterations, testing of neural network was performed, which yielded the result as shown in figure 8. Since the price of gold is sometimes fluctuated rapidly, this neural network cannot predict the actual result, which is a major limitation of this neural network.

Chapter 5: Conclusion

Hence, in this project, the backpropagation algorithm was employed to predict the price of gold. First the data was collected and fed to the neural network of two input, two hidden and one output layer. Data was spitted to training and testing sets and the training was performed to adjust the weight with backpropagation algorithm. Finally, the testing was performed with the adjusted weight and the result of training and testing was plotted. Though a fairly accurate result was obtained as the gold price sometimes flatulates rapidly more accurate result can be obtained if proper data analysis technique is done.

References

[1] SN Sivananndam, S Sumathi, " An introduction of Neural Network Using Matlab", "McGrew Hill", p. 283, April 2006

[2] Charu C. Aggarwal, " Neural Networks and Deep Learning", "Springer", p. 316, 2010

[3] Trivedi, Pankaj, "Backpropagation", Tutorialspoint, "https://www.tutorialspoint.com/artificial_neural_network/artificial_neural_network_supervised_learning.htm", June 2014.