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Artificial intelligence Application to EURO-USD Forex Value prediction using LSTM Tensor flow

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Abstract

The prediction of financial instruments in exchange markets are timesensitive. The application of AI algorithm and the use of big data of past exchange rate are applied to determine the future value of stock. Artificial intelligence as a disruptive technology has impacted various sectors and industries in the world. The impact on the financial sector is evident in the use for data analysis, investment and portfolio management, trading and forex. In view of these developments, several at-tempts and schemes have been developed in recent time to optimize and ensure accurate forecasting of forex. However, existing solutions comes with computation complexity arising from the use of combined or ensemble artificial models. In this work, a proposed LSTM is used without combing to another model to reduce the computational complexity as well as use of nonlinear model to forecast forex with minimalerror and high accuracy. By varying their learning rate, number of hid-den layers, and optimizer. To verify the proposed scheme, we have developed two structures of LSTM. First structure comprised two hidden layers while the second comprised three hidden layers. Data set used is the EURO-USD historical data from investment.com. The incorporated optimizer are "Adam" and gradient decent respectively. With 2 hidden layers, the gradient decent optimizer outperformed the Adam optimizer. However, increasing the number of hidden layers, Adam optimizer achieved less error. Despite this, the best performance with final error rate of 0.0005 (MSE) is with 2 hidden layers and gradient descent optimizer. Thus, the proposed scheme was able to achieve predicted results close to the actual values. This breakthrough opens opportunity for high accuracy software in forex trading.

Keywords: Forex, LSTM, machine learning, prediction, tensor flow.

I. Introduction

Forex or Forex exchange (or) FX trading is the buying and selling between two currencies. Since its inception it has grown significantly and has spread wider than the normal market this has also contributed to its wide capital base which has grown over 5 trillion dollars. [1, 3, 5]. There are also different types of Forex markets according to IG Personal a world-leading online trading provider, they include first the "SPOT FOREX MARKET" just as the name implies it's an on the spot market which involves the physical presence and exchange of the two currencies. Secondly, the "FORWARD FOREXMARKET" this is a contrast to spot forex market where the agreement to exchange currencies at a fixed amount and rate that would be decided in the future. The third category which is FUTURE FOREX MARKET, is to exchange currencies at a set out date and time and a specific currency. Unlikeforwarding, an official contract is legally binding. in the world today the mostused currencies pairs in forex trading's as reported by IG Personal that makesup at about 80percent of the currency pair been used in the market includes EURO/USD, USD/JPY, GBP/USD, USD/CHF, USD/CAD and AUD/USD[1,2, 5].

Figure 1: FOREX TRADING IMAGE.

I.I Forex market

The name forex market has become a household name that is constantly beenused in on social media, business and our ever day life. It would be apparent to know the characteristics of this Market that is so unique. Forex Market as we know has a huge growth and crowd to itself as it is worth an average trade-in value of 5 trillion dollar [1, 5] even dealing with his huge fund it can-not be attributed or traced to any specific structure this characteristics and its ability to be available everywhere at any time has brought peace of mind to investors those who are skeptical of an individual be in custody of their funds instead, the Market is made up of like minds all over the world that sawa need for a change in pace in how transactions should be done, the market is intertwined by means of information and datas.in the past these information are distributed manually but in this modern time it's being done electronically, therefore these is a market which constitute of buyers and sellers inter- connected by networks [1, 2, 3, 5].

According to Prashi juneja review on forex market characteristics, forex market constitutes the highest number of transactions in world volume. The market is valued over four trillion dollars, operating all year round with no limitation of time out. This is unlike the stock and bond markets respectively wheretransactions are limited by days and hours of operation with no flexibility as gained from the forex market. Besides, forex market is considered the most liquid financial markets due to the all year round and high trading volume in the world. Another gain in forex market is the opportunity to trade globally in real time and with anyone irrespective of location of organizations and/or individuals involved in the trading [4, 5] . Moreover, the market provides an opportunity for transparency not found in any other financial markets. This isdue to the availability and open data policy whereby all information regarding trading in the forex market are available to all traders at all times no matter their location. Traders are also availed the option of deciding how and when totrade either on a long or short side of any contracts. These provide investors with Choice regarding various degree of Leverage, various currency and various sizes however is on the risk of the investor.

Currency Pair	Countries	FX Geek Speak
EUR/USD	Euro zone / United States	"euro dollar"
USD/JPY	United States / Japan	"dollar yen"
GBP/USD	United Kingdom / United States	"pound dollar"
USD/CHF	United States/ Switzerland	"dollar swissy"
USD/CAD	United States / Canada	"dollar loonie"
AUD/USD	Australia / United States	"aussie dollar"
NZD/USD	New Zealand / United States	"kiwi dollar"

Figure 2: FOREX IMAGE.

1.2 Factors to consider when determining exchange rates

Today when we mention money we mean currency before the monetary sys- tem of today the world uses the Gold Standard to measure its currency, in the old times people choose gold and silver to be the means of Exchange gold served these purpose for some time for both individuals and government whereeach currency is measured against its weight in gold these was prevalent in
the world up till the 1970s it was replaced and renewed many times[3, 5] .forexmarket therefore came into place in the world when The gold standard was scraped off because at these point the common denominator between currencies which was gold wasn't existing and there was a need for a value to mea- sure currencies against another.

Foreign exchange markets is very complicated compared to stock and bondmarkets, predicting an exchange rates is like predicting the performance of the entire economy of a country the price reflected in the financial markets to-day reflects the expectation of expectation based on the information that theyhave at hand today there are so many factors that influences the rate of ex- change in the market[2, 4] this factors include but not limited to the monetary policy of a country this is based on the exchange rate between the agreement of two countries who has agreed to change money based on a given agreement, so to say the factors that affects the monetary policy of two countries include inflation rate which is based on the ratio between the expected number of units of one currency and the expected number of the units of another country in the market, also the interest rates of a particular currency if an investor has a certain currency he gets an interest applicable on that particular currency this is where the central bank come into be able to monitor this factors. Another means to determine the exchange rate[4, 5] is to know if the rate is a floating rate or a fixed exchange rates floating rate is determined by the open market through supply and demand on the Global Currency Marketwhile the fixed market rates is rates the government sets and maintain as the official exchange rates.

1.3 The use of machine learning for prediction

Machine Learning (ML) has enabled growth in various areas of modern day business research. The capability of computer applications are enhanced with recent and efficient algorithms made possible by the advancements in ML. This is possible, since ML algorithms can be used to develop mathematical models from available data some of which are known as "training data" and "testing data" respectively. The result of the training and testing process is used for decision making with minimal programming on the part of the business decision makers. Therefore, ML in a layman understanding is a way of understanding trends and patterns in a collected data and try to tell from thisgiven data what might be the outcome in the nearest future. Nowadays, ML as an offshoot of artificial intelligence (AI) has found dominant application in various fields, industries and endeavors.

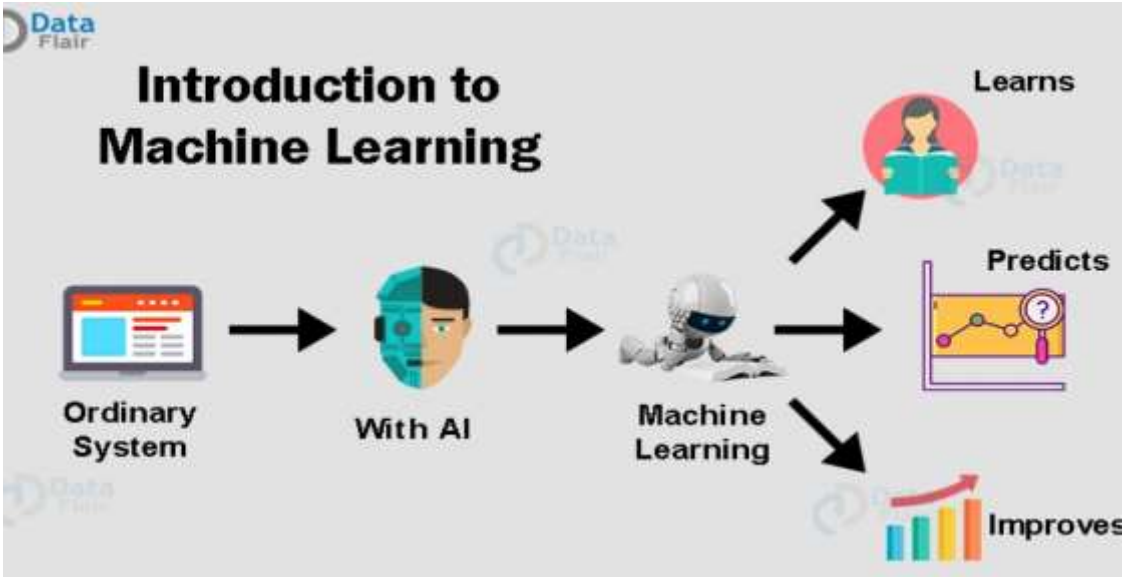


Figure 3: UNDERSTANDING MACHINE LEARNING.

Some of the sectors where ML is readily employed include but not limited to health informatics, computer vision, trends and forecasting, anomalous and human activity classification, regression etc. The learning algorithms have the capability to learning from past experience or historical data.

The use of machine learning (ML) for stock market prediction have been doneby researchers [1, 2, 3], and has also been applied in tax income prediction [6] . This shows that the need to offload the mathematically demanding and highly dynamic forex behavior to the computer using data of past forex records.Since these records are time dependent, the new long short-term memory (LSTM) prediction method is adopted. Among the DRNN architectures, LSTMis employed as an AI tool for a variety of time series forecasting [4]. Unlike other standard feed forward neural networks, LSTM employees' feedback connections to enhance its prediction capability with better computational complexity due to the presence of the gate mechanisms. It has the ability

to train and make predictions from not just single data points, but can handle an entire sequences of data. Typically, basic LSTM architecture comprises of a cell, an input gate, an output gate and a forget gate. While the cell is responsible for remembering data (values) in a trend of time, the rest of the cell unitsmade of gates are responsible for controlling data or information flow in and out of the LSTM architecture [39, 40]. LSTM networks are used mostly in classifying, processing and making predictions based on time series data, sincethere can be lags of unknown duration between important information in a time series.

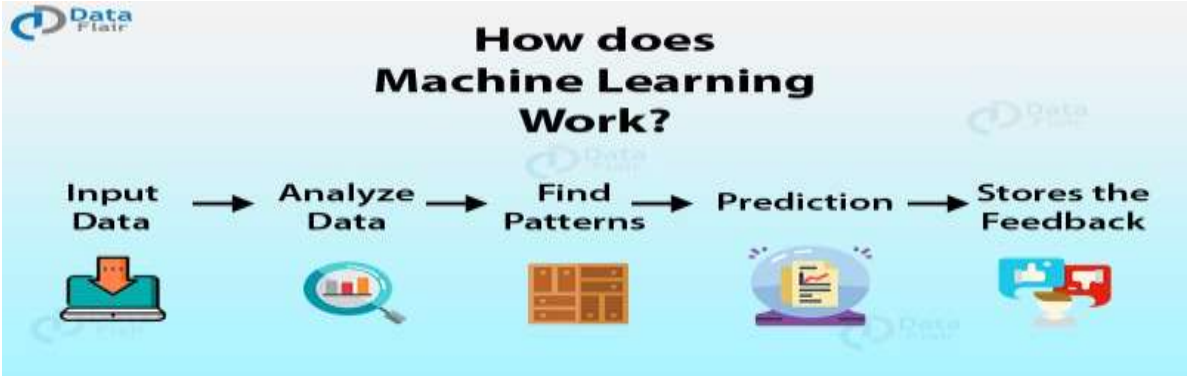
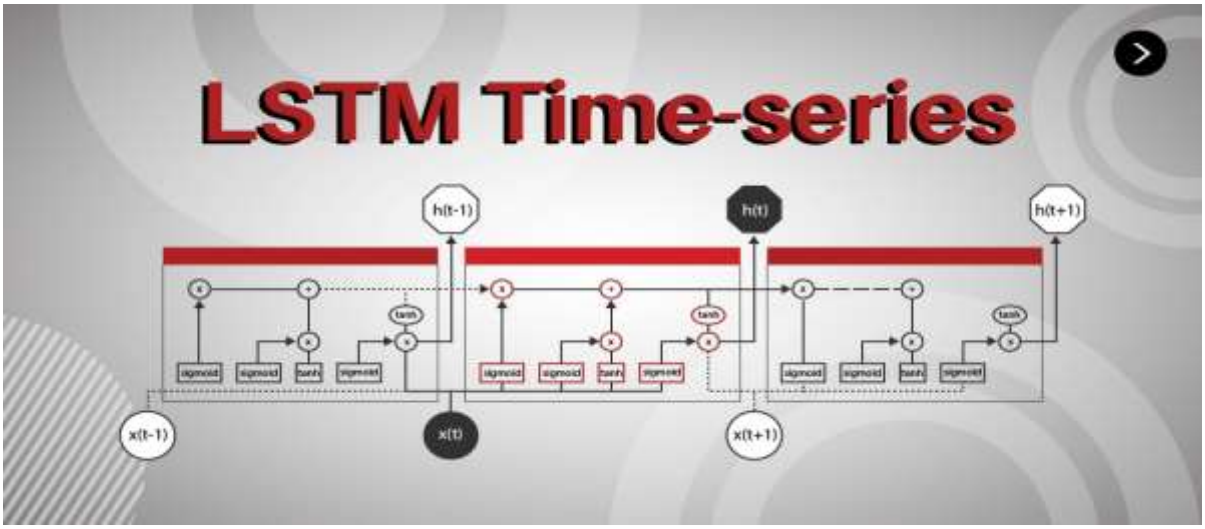


Figure 4: PREDICTING WITH MACHINE LEARNING.

1.4 Purpose of study

Exchange rate are being decided over by the countries government and little has been said in regard to how it's flat mates over the years.so many models have being implored over the years to enable brokers and FX traders trade wisely and get value for their money's worth. AI has also being used in many fields of learning of late to make predictions in time sensitive situations. LSTMwhich has been praised in recent times for its efficiency in making good pre- dictions for time series and sensitive predictions has been used in this work for its predictions.

In previous work authors in [7] proposed the use of Hidden Markov Models (HMM) for Forex Trends Prediction for the next day. They divided theirmodel into three stages: Data analysis where they applied linear regression line to segment the downtrend and uptrend. In the second stage, HMM was trained using Baum Welch algorithm and finally HMM forecasting using for- ward algorithm. The limitation of this work is that it can only predict a short term future. The author used Combined deep recurrent neural network (DRNN)and Autoregressive Integrated Moving Average (ARIMA)[36].ANN was used to forecast the next closing prices and, an ARIMA to predict the deviation. They assumed that the following price will depend largely on a range of hid-den features, financial indicator values, and historical events. Their method indicated there is need to use a nonlinear model to forecast the future price value. The method of combining different techniques increased the computational complexity of their approach [5].



. Figure 5: LSTM ALGORITHM.

II. Literature review

Machine learning has become an essential tool for research both in business and research and it has come to stay.so many networks has been used to makepredictions on different aspects of life and so many result has been gotten to be able to make prediction using time series Patterns a machine learning model which recognizes this pattern has to be used.[5] In recent times simple neural network data are single data vectors that does not provide means for storage of memory. RNN was later used it provided a solution to the storage of memory for data's but was limited to some pitfalls which are very hugeand can't be avoided. These problem are called vanishing gradient problem is caused when parameters and hyper-parameters of a system network is not fixed or arranged properly. The usage of LSTM algorithm has not only solvedthe issue of storage of memory but also that of the vanishing gradient issue.[5] in previous works authors proposed difference method in predicting forex trend, this author[5, 34]compared method previously used in predicting Forex he compared statistical method against machine learning method the statistical method used was adaptive spline threshold Auto regression (ASTAR) he also used super Vector machine (SVM) and a hybrid form of genetic algorithmneural network (GANN)the comparison was measured in root mean square error(MSE) and it was observed that the ASTAR and GANN has advantage over SVM depending on the period of interval. Also another type of net- work by name ARIMA model was used to forecast a gold bullion coin selling price under close examination suggests that the coin selling price are in up-ward Trend and could be considered as a good investment because the mean absolute percentage error was above 10percent after prediction.[8]Technical data analysis has also be employed in prediction of movement of currency trade using genetic algorithm to know how to make a decision on when to buy or sell or predict trades he used a GANN to generate a Prided value. The GANN search for the best value of Feed forward neural network which was trained with neural network method from the validation the prediction was as follows MSE value of 0.0043 for open 0.006 for high 0.0005 for Low and 0.0070 for Close. Another work which combined neural networks for better result is [12]here the author used a linear regression equation to analyse historical data and discovered trends and patterns in forex then he modelled and learned the data using a ANN algorithm as classifier to learn and train the upward and downtrend ,he also studied the value of a the resultant trend with a DTW algorithm to predict the future exchange rate trend.[5]USED svm with radial basis function kernel and k means clustering algorithm to analyse trading using AUD trading data it was observed that EURO/USD and USD/JPY has genitive movement with trading time and that the highestprofit was observed 5 to 15 minutes after start of trade.[12]Also proposed the analyzing of auto correlation and assessment of possible forecast error using neural networks to predict changes in exchange rate especially between currency pairs the method was consistent with the hypothesis of average form of market efficiency.[12]made a prediction on forex rate using euro/usd data withsimple moving average technique and financial factors the financial factors he considered included dollar index ,interest rate ,inflation rate and real gross domestic product. He used multi- layer perception and linear regression for fore-casting and got a significantly good result. All these been said it can be seen that so many works has been done using both single networks and combining then for better result. but combining them comes with more complexity that's why in our work LSTM which has proved to be a good option for time seriesprediction and has been favored by more authors in their research.[12].

2.1 Computational complexity of combining neural net-works

Neural networks are computationally hard to train varying different computational power, size and Algorithm different shape of graphs and figures has been obtained [12]. Leveraging on statistical learning Theory, the makeup of every neural network architecture is influenced by the type of graph as well as Nature and type of the activation function employed. This involves changing the weights of The network, understanding the class involved, computing the required weights, from the training Samples. The whole process results ina prediction that has good performance on future examples. When creating a model or choose a network these three questions has to be answered [12]:

2.1.1 What amount of data samples are needed to train a neural network perclass? This is known as data sample complexity requirement.

2.1.2 How best in terms of mathematical functions can the data be predicted?This is often known as expressiveness requirement.

2.1.3 What is the time required to carry out the learning and training of data?This is referred to as time complexity of neural network computation.

Also to achieve a successful training of a network, these factors are put inplace:

1. Changing the activation function: The threshold activation function, haszero derivative almost everywhere. Therefore, applying gradient-based methods with the activation function.
2. Over-specification: It has been proven empirically that it is easier totrain networks which are larger than needed.

3. Regularization: It was also observed that regularizing the weights of the network speeds up the convergence according to [20] this being saidthere is need to be able to use the best combination of networks effectively so as to get good result and predictions.

2.2 Optimizer choice

Optimizers as the name implies helps the model to increase its accuracy its role in a machine learning model is paramount and can't be waved out. Different typesof optimizers exist but it's good to not that they serve or give accuracy on different levels so it's go to use which is best at each point in time.in these paper we opted for Gradient descent optimizers and Adam optimizer. Gradient decent aim is to find the highest or lowest trials and errors from the different cycles of trials in a model. While Adam optimizer tries to determine the rate at which each variable from the data used for the analysis works at against the desired result and tries to determine or obtain a favorable result at the end of each cycle and also against other learning algorithms. Adam has provento outperform other type of optimizer and has been chosen to be best.[21, 38].

III. System Model

3.1 LSTM relation

In an LSTM model three gates are significant: the keep gate, the write gate and output gate or forget gates [7, 35, 37]. The keep gate is built up by a sigmoid gate which predict the data that will be kept or moved out of the system.

$$f_t = \sigma\left(W_f\left(h_{t-1,}x_t\right) + b_f\right), \quad (1)$$

Where,

f_t = output of forget gate.
σ = sigmond function.
W_f = Weight function.
h_{t-1} = input of the previous cell.
X_t =input to the cell.
b_f = bias
Also the write gate which is used to store information is written as

$$i_t = \sigma\left(W_f\left(h_{t-1,}x_t\right) + b_f\right), \quad (2)$$

$$c_t = tanh\left(W_c\left(h_{t-1,}x_t\right) + b_c\right), \quad (3)$$

$$c_t = f_t * c_{t-1} + i_t * c_t, \quad (4)$$

where, i_t = new cell state.
c_{t-1} =old cell state.
t 1 = subscript t is time step
b = bias
Also the output gate is used to predict what the final result would be.

$$o_t = \sigma\left(W_o\left(h_{t-1,}x_t\right) + b_o\right), \quad (5)$$

$$h_t = o_t * tanh\left(C_t\right). \quad (6)$$

o_t =outputs of sigmond layer in the output gate.
h_t = output of the LSTM cell.
b = bias

3.2 MSE relation

In measuring the accuracy of the prediction we used MSE which is represented as thus

$$MSE = \frac{1}{n}\sum_{i-1}^{n}(Y_I - \hat{Y}_I)^2 \quad (7)$$

Where, n = vectors
y = vector of observed rate
$\hat{Y}_I$ = predicted values

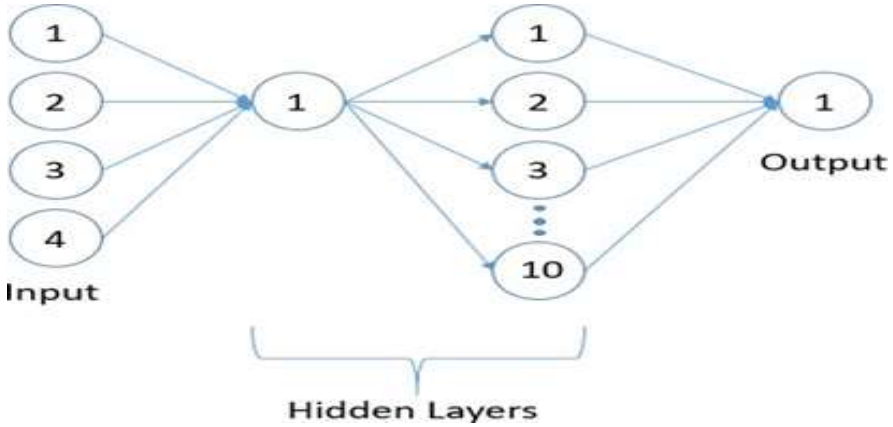


Figure 6: Test loss (MSE) : 0.0015136527 with Layers 1,5,30

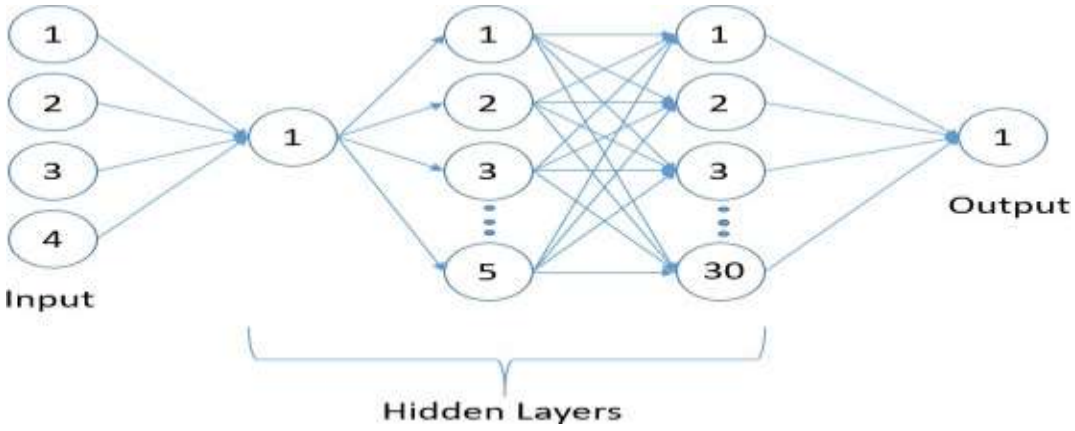


Figure 7: Test loss(MSE) : 0.0015136527 with Layers 1,5,30

3.3 Structure

In this work we adopted two structures, structure first with 2 hidden layers as represented in Fig.6 and structure second as represented in Fig. 7 respectively.

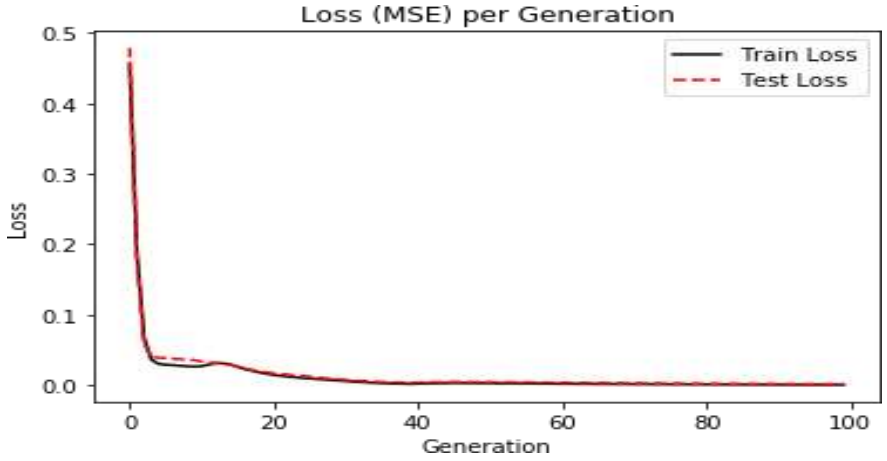
IV. Result

Our historical data set of EURO-USD was downloaded from investing.com [9] The record was from 1st January 2016 to 29th November 2019. Within the setting of our parameters as indicated in table 2, we obtained 8, 9,10,11,12,13,14,15as shown below. For Graph 1-4 3 layers was used 1,5,30 respectively using both Adam optimizer and gradient decent optimizer. Same was done for the 2 layers (1,10) where graph 5-8 represents both the Adam optimizer and gradient decent optimizer as well. Five inputs features namely the price of EURO- USD,the opening price, the percentage change between the highest price and lowest price for each day.

Table 1: Machine learning parameters

Parameters	**2 Layers**	**3 Layers**
Epoch	500	100
Number of neurons	1, 10	1, 5 30
Adams optimizer	0.0005	0.001
Gradient decent Optimizer	0.0005	0.001
Train/test ratio	300/721	700/321

Figure 8: loss function using gradient decent optimizer with 3 hidden layers. Test loss(MSE) : 0.0015136527.



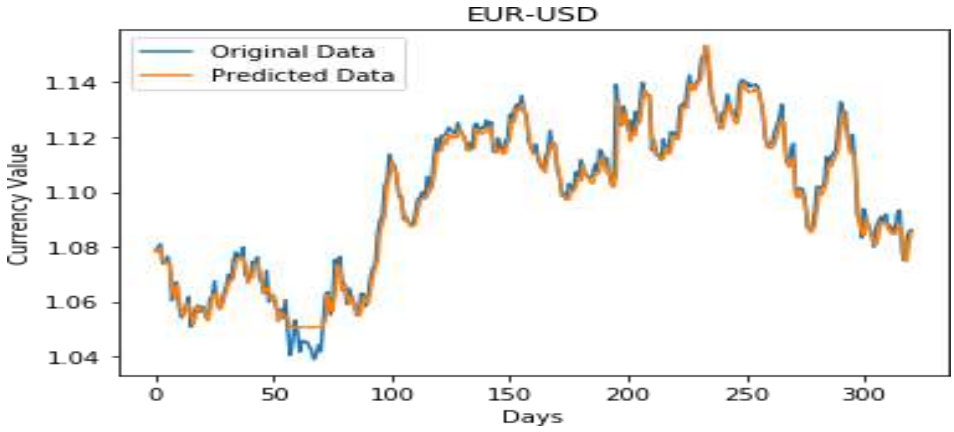


Figure 9: prediction using gradient decent optimizer with 3 hidden layers.

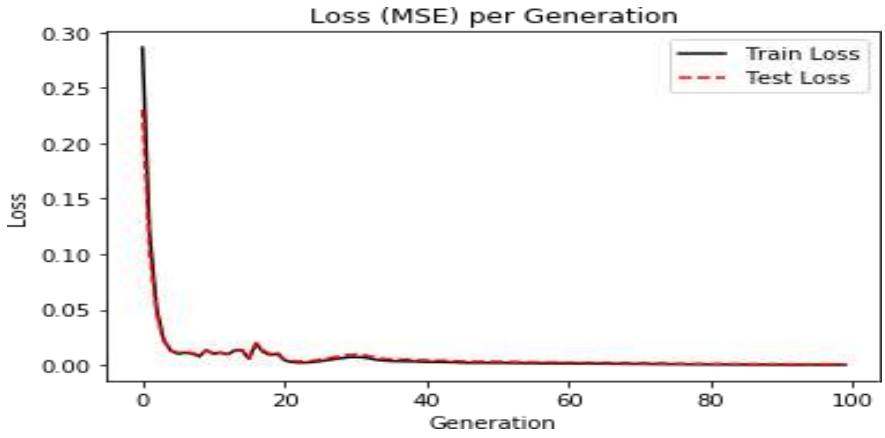


Figure 10: loss function using Adam optimizer with 3 hidden layer Testloss(MSE) : 0.0007462618.

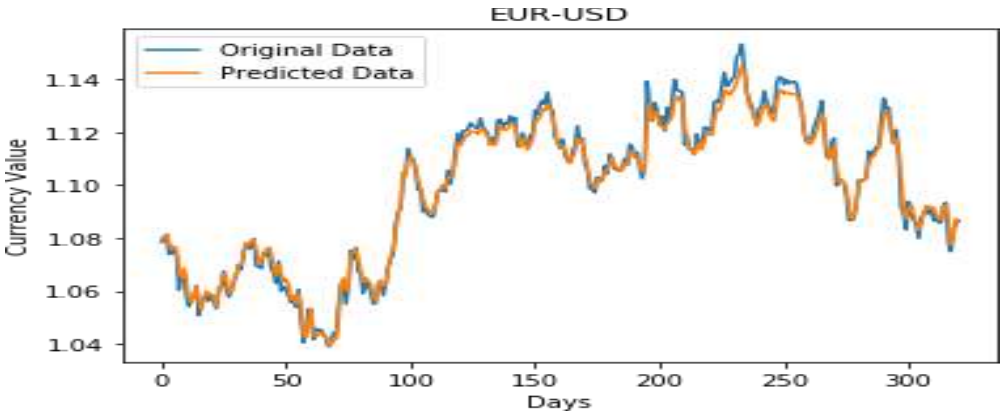


Figure 11: prediction using Adam optimizer with 3 hidden layers.

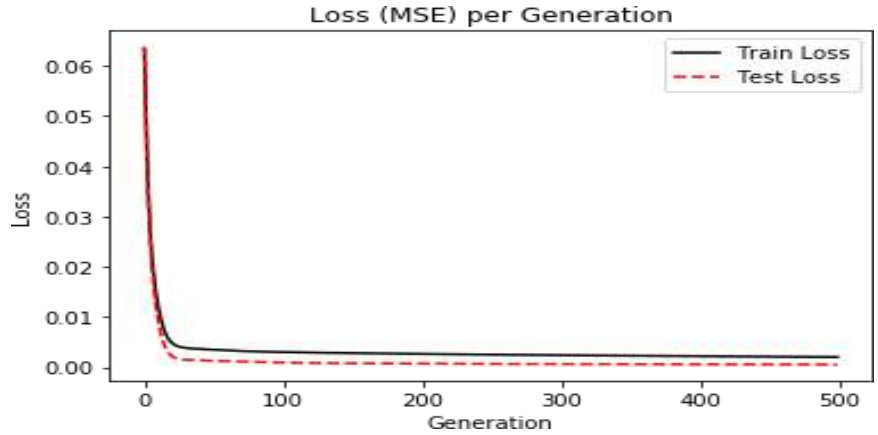


Figure 12: loss function using gradient decent optimizer using 2 hidden layers,test loss(MSE) 0.0005464345.

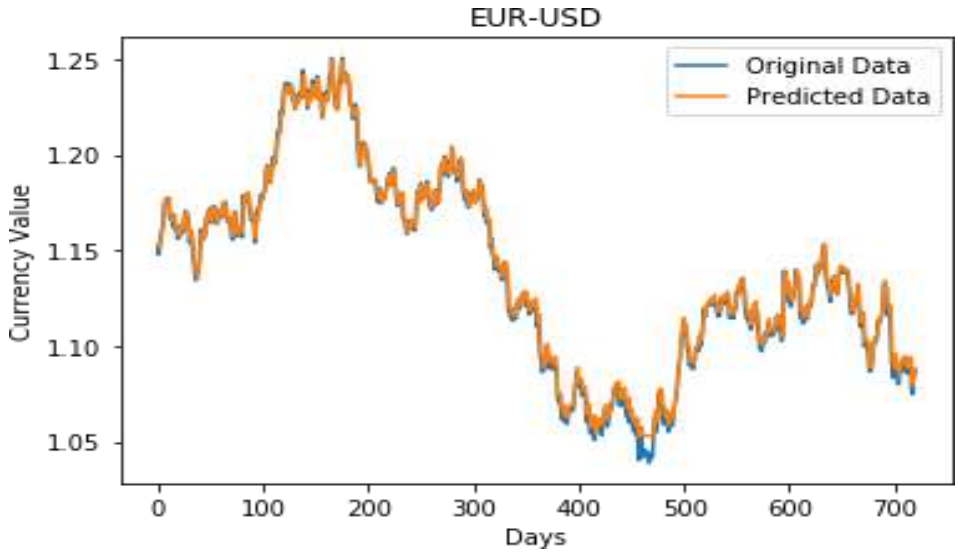


Figure 13: prediction using gradient decent optimizer with 2 hidden layers,Test loss(MSE) 0.000546434

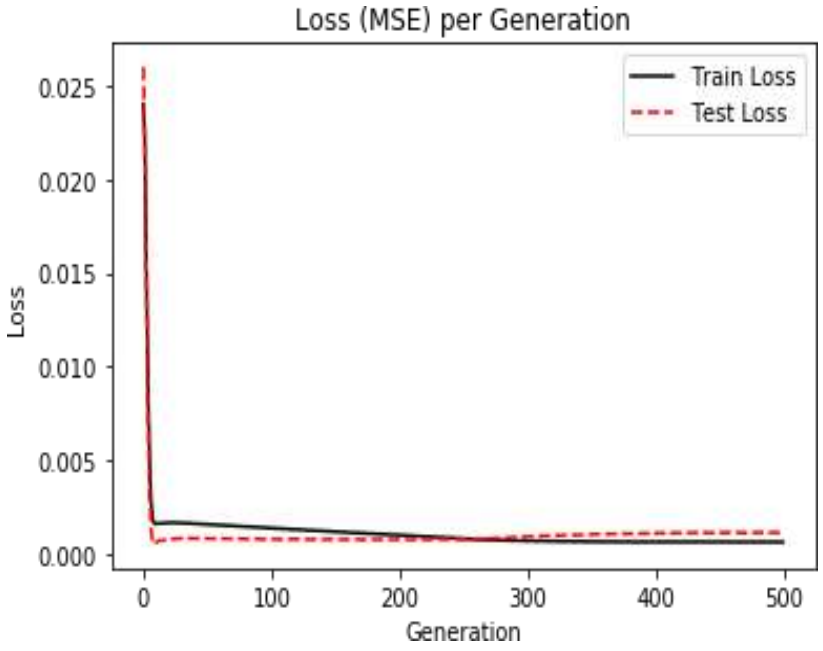


Figure 14: loss function using Adam optimizer with 2 hidden layers, Testloss(MSE) : 0.001155359.

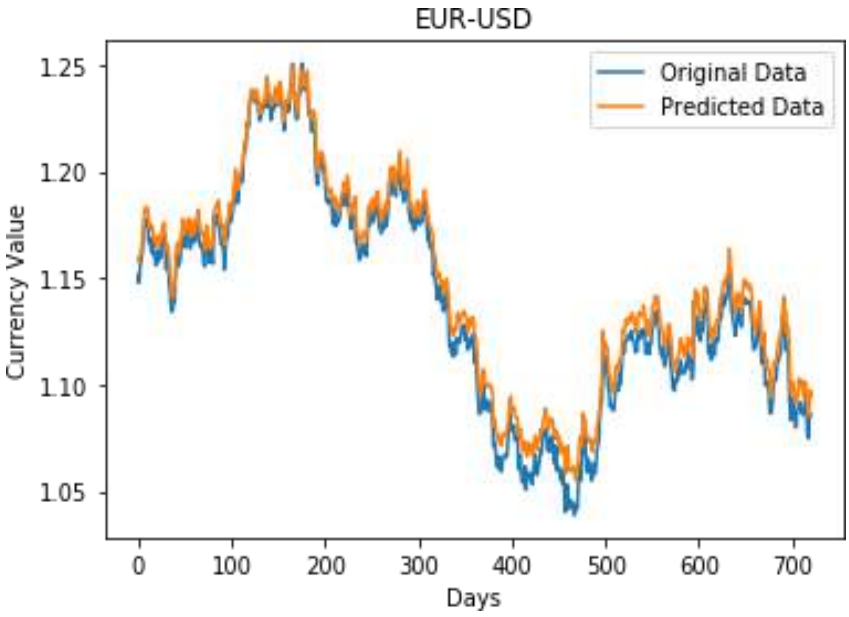


Figure 15: prediction using Adam optimizer with 2 hidden layers, Testloss(MSE) : 0.001155359.

Model scenarios	Hidden layers	Optimizers	RME
1	2	Gradient descent	0.005464
1	2	Adam optimizer	0.001155
2	3	Gradient descent	0.001514
2	3	Adam optimizer	0.000746

Table 2: overall comparison table

IV. Conclusion

In our paper we were able to use two LSTM neural network structure with 2 and 3 hidden layers to predict stock market changes. The results are satisfactory and gives hope for the possible implementation of the use of machine learning in stock market prediction and possible application of efficient AI application to machine stock market forecasting.

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