

Advanced Deep Learning Framework for Stock Value Prediction



Sumanjit Das, Sarojananda Mishra

Abstract: *The main attractive feature to stock market is speedy growth of stock economic value in short yoke of time. The investor analyses the demonstration, estimated value and growth of organizations before investing money in market. The analysis may not be enough by using conventional process or some available methods suggested by different researches. In present days large number of stocks are available in market it is very difficult to study each stock by help of very few suggested foretelling methods. To know the anticipated stock value we need some advanced prediction technology for stock market. This paper introduce an advanced skillful method to plan and analyze the different organizers stock execution in market and prognosticate best suitable stock by predicting close price of stock. The projected arrangement is based on multilayer deep learning neural Network optimized by Adam optimizer. Recent 6 years (2010-2016) data of different organizations are applied to the model to demonstrate the skillfulness of the projected proficient method. From result it has been ascertained that the projected framework is best suited to all different data set of various sectors. The prediction error is very minimal as visible from outcome graph of framework.*

Keywords: *Stock market, deep learning, multilayer perceptron, ANN, forecasting, soft computing.*

I. INTRODUCTION

In the present economic situation of the world exchange rate of currency and stock market value plays great role. The development of stock value of companies represents growth in terms of doing business and growth of economic status as well as share holders value. In current days people across the globe are more interested to invest money directly or indirectly into share market for quick growth of fund in comparison to other sectors. So before investing into stock market everybody wants to know which one is better in terms of return. The days of technology helps them to find a solution to the problem. The exact prediction of stock price by using chart is now next to impossible. The efficient market assumptions put forward that stock value gives recent data which leads to impulsive. The random walk recommended that stock price cannot be exactly predicted by help of historical values [1]. After all of this uncertainty and risk people are investing in stock market due to high return.

This attraction has been creating a challenge for researcher to develop high efficient models for forecasting. Numerous mathematical models have been developed still the outcomes are not satisfying [2]. People have worked ANN based model for stock price prediction and in some cases hybrid models have been used in relation with stock market forecasting [3]. The stock market index prediction is always toughest task because of its volatile nature, Many researchers have taken this as challenge to develop efficient models which work on real data using fuzzy to predict stock index price [4-9]. Apart from that some models hybrid fuzzy with particle swam optimization [7,10], neural network [11] models are also discovered to develop the accurateness of forecasting in stock market value. To get better result of the financial predictions by help of few extra features in input of supervised models beside among historical data of the intention market. [12-13] used some stock market data in south korean stock and product costs in ANN based semi-supervised model by not paying concentration to the historical data of the time series being expected and accomplished superior outcome contrast to their challenger by using only historical data of the objective. [13-14] suggested a model that supportive in projecting composite associations in between unexpected changes of financial data. An additional dimension of research is time gap of forecasting [15] talk about the significance of data regularity in sampling. noisy character of financial time series formulates it complex to calculate track for short epoch regularities. This paper focused on the approach of deep learning using Multi Layered Perceptron (MLP) to predict close stock price. This model is trained then applied on different stock data and from the result it is observed that simulation performance of the proposed model is best suited to each data set of stock market. The predicted result is measured in terms of Mean Absolute Percentage Error (MAPE) for all data sets. It is observed that the proposed model is prospective enough to predict stock market price with very less prediction error. The origination of paper as like: 'Literature Study' segment illustrates the information of review in interrelated field, 'Materials and Methods' segment consist of data sets, MLP and Optimization technique. The projected foretelling framework, activity flow of framework along with normalized real data used to test the projected framework incontestable in 'Projected Methodology for Prediction' segment. The representation and empirical outcome, provision of input option, statistical and fiscal conditions, MAPE and similitude with different data set results with projected foretelling framework is unregenerate in 'Empirical Result' segment. At last, 'Summery and Emerging Directions' segment concludes the projected framework with its limitation and use.

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II. LITERATURE STUDY

The prospective of fuzziness to improve predicting schemes present in most of the applications because of its compact nature between different data like numerical and qualitative. One liner regression analysis with fuzzy model [16] has been implemented by considering fuzzy data not the statistical. There are also researchers implementing fuzzy concept for prediction using time series data [17]. The authors of [18, 19] focus on randomness associated with random regression model in different situations for estimate of price and implemented the model for oil palm fruit prediction. But in [20, 21] FR-R model and FR-AR Model are used in supervised data set of shanghai composite index to predict weekly. In modern days the working process of random fuzzy variable are also applied to find solution in the field of supply chain master planning and network [22, 23]. In [24] the author's implemented different neural networks like MLP, ANN based DAN2 and hybrid neural network to predict stock value. They have analyzed results and recommended that DAN2 scheme is better than other schemes. To address the constraints of local search in standard model a new hybrid was proposed by [25] based on PSO and GA using congregation biological mechanism. A novel ANN based heuristic optimization hybrid model suggested in [26] to increase the efficiency of stock market growth prediction in language of financial performance. The authors demonstrate that ANN based model has ability to choose and decide inner layer neurons. To choose the appropriate technical pointers, they set prearranged 45 changeable and at last part of synthesis 26 and 23 changeable are particular element not repeated by GA and HS schemes. By following this complex process of changeable choosing is diminished to virtually fifty percent and shaping the best probable number of neurons in inner layer eradicates more or less fitting problems of ANN models. A RCCRO has been proposed in [27] to resolve the improvement difficulty and suggested an accommodate plan of action RCCRO for presentation enhancement. The working efficiency of RCCRO has been evaluated with many different available models on a set of usual uninterrupted standard mathematical relation. An advanced version of PSNN (Pi-Sigma) has been proposed in [28, 29] trained by ACRO known as CRO-PSNN scheme. Result of the implemented model compared with different standard data and it is observed that this composite scheme is finer than PSNN, GAPSNN and PSO-PSNN. The use of GA for selecting the most favorable factor of ANN based representations was suggested in [30]. The scheme engaged composite scheme to discover real data locations in the fiscal supervised data & integrated them to increase the predicting correctness. In [31] a new forecasting scheme based on neural network along with multivariate time series model to predict exchange rate of USA, UK and Japan then GRNN used to find the predictive errors in model. A Bayesian Vector Auto Regression based multivariate time series model designed to predict 33 exchange rates [32] and in [33] prediction of rate for high frequency data set. Another model used Radial basis functions neural network (RBFNN) optimized by particle swam optimization to estimate foreign exchange rates [34]. To examine and prognosis stock market

data in [35] they have used portfolio selection problem. The scheme is implemented and verified for long-standing phase cost. The issue of choosing uncertain parameters in portfolio was address by weighted fuzzy time series (FTS) scheme [36]. In this scheme some modifications has been done to increase the accuracy and the scheme can be used to approximate risks related with trapezoidal fuzzy numbers. This scheme was applied on Spain stock market which shows higher than classic one. Using ANN and PSO a new prediction based mean variance scheme was developed in [37] to choose portfolio assets. The scheme uses Sign and Wilcoxon rank test to measure up to the efficiency with Markowitz model and it shows the new model is better. A PSO based time invariant fuzzy scheme suggested in [38] the scheme uses C-means clustering for fuzzy and it was shown that the suggested methodology is having high accuracy in case forecasting. In [39] the author's projected hybrid model of two stages time series and GRNN. They claim that the forecasting of exchange rate is higher than the single stage models. Another scheme suggested in [40] consisting of chaos and neural network optimized by PSO/DE for forecasting of every day conversation value of JPY, GBP to Dollar this scheme gives good outcome for some PSO and DE than complete NN in provisions of mean correctness. Out of many hybrid model one is [41] uses an reconciling ARMA structure and DE trained for feed-forward and feed-back factors. Improvement is done by DE to get best objects for grooming so that model gives best result with high correctness. People have utilized MRLF framework belong to MRL filtrate join along an adapted MGA that reduces lowest commencement time delay but MGA aggregation is superior using the LMS method [42]. The scheme based on MOPSO and NSGA-II to foretell stock value and it was habituated to an accommodative representation for share industry [43]. A scheme trouble-free IIR filtrate using DNN which was applied on various Indian share information to foretell market worth [44]. Another ANN based prediction model perfected with PSO used to anticipate stock value of different financial share values the authors shown high accuracy result in terms of MAPE [45]. The deep network now days popular in financial time series forecasting due to challenges in field of stock market and large number of features in times series data. Many researches had proposed deep learning network models to predict stock price some of implementations used recurrent NN (RNN) [46], conventional NN (CNN) [47] & long short term memory (LSTM) [48]. In [49] researcher compared the performance of DNN and tree based model in statistical commercialism. They observed that chosen models give better performance on same weights. The deep learning approach is also applied in [50] for stock market forecasting. The authors have focused on feature extraction and analysis of overflowing stock data. This deep learning is employed in unsupervised feature extraction process and classifier to predict stocks which outperform the market performance [51].

III. MATERIALS AND METHODS:

A. Data Description

The data are widely collected from American stock market of different companies from different sector like IT, Energy and Airlines to get high range of share data. In our work we have consider stock shares from January 2010 to December 2016 as shown in table 1 and table 2. There are different features in data set but we have considered attributes like open, close, low and high by selecting them by help of feature extraction process. The data sets are time series numerical data. To maintain the uniformity in data set we have applied Min-Max Scaling method which keeps data in a range of positive value. So that it can be used for prediction model.

B. Cross Validation:

The cross validation is used to split the data set arbitrarily into γ number of folds. The cross validation is represented in eq(1).

$$\text{Cross Validation (CV)} = 1 / \gamma \left(\sum DT_i \right) \quad (1)$$

Where DT_i is fold quality and γ represents regular parameter for number of folds. The information set of stock is split for train and test purpose to get better result.

Table 1: Time series data of different stocks 1/4/2010 to 30/12/2016.

Sl. No	Name of Data Set	No. of Records	Attributes used	Type of Data
1	American Airlines Group Inc	1762	High, Low, Open, Close, Volume	Numerical
2	AbbVie Inc	1762	High, Low, Open, Close, Volume	Numerical
3	Amerisource Bergen Corp	1762	High, Low, Open, Close, Volume	Numerical
4	Alliance Data System Corporation	1762	High, Low, Open, Close, Volume	Numerical
5	Baxter International Inc	1762	High, Low, Open, Close, Volume	Numerical
6	Concho Resources Inc	1762	High, Low, Open, Close, Volume	Numerical
7	Dominion Energy Inc	1762	High, Low, Open, Close, Volume	Numerical
8	Google	1762	High, Low,	Numerical

			Open, Close, Volume	al
9	IBM	1762	High, Low, Open, Close, Volume	Numerical
10	Yahoo	1762	High, Low, Open, Close, Volume	Numerical

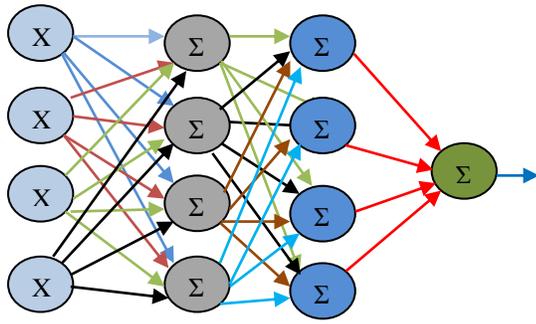
Table 2: Sample of stocks data set chosen from America stock market.

Stock ID	Listed Stock Name	Abbreviation	Sector
1	American Airlines Group Inc	AAL	Airlines
2	AbbVie Inc.	ABBV	Pharmaceutical
3	AmerisourceBergen Corp	ABC	Drug
4	Alliance Data System Corporation	ADS	Marketing and service
5	Baxter International Inc.	BAX	Healthcare
6	Concho Resources Inc.	CXO	Energy
7	Dominion Energy Inc.	D	Power & Energy
8	Google	GOOGL	IT
9	IBM	IBM	IT
10	Yahoo	YHOO	IT

C. Multilayered Perceptron (MLP)

A multilayer perceptron (MLP) is the part of deep learning or deep artificial neural network consisting of more than one perceptron. The MLP is having usual input and output layers as similar to others but having user dependent hidden layers which helps in prediction of input data under certain conditions we call that deep learning. The MLPs are often applied to supervised learning problems here also we have applied to time series data for forecasting stock price. The network is trained by adjusting parameters or weights and biases of model. The MLP is widely used network for stock prediction in this model MLP gives one output for stock close index price by help of hidden layers [52].

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Input Layer Hidden Layer Output Layer

Fig. 1: The regular architecture of MLP.

The hidden layer perceptron and output layer uses activation function as shown in eq (2).

$$Y_{out} = (1 + e^{-\lambda Y_{in}})^{-1} \quad (2)$$

Where Y_{out} represents output of neuron Y_{in} is the input of neuron and λ is the amplification in function. The component is a vector consisting of n variables so the number of input neuron is same n numbers. The first layer is depends on the number of input variable in the problem. The second layer or hidden layer is independent of relationships among variable. For neuron k at hidden layer the weight output O_k is calculated by help of following equation.

$$O_k = S \left(\beta_k + \sum_{i=1}^n W_{ik} \times V_i \right) \quad (3)$$

Where V_i is the input vector for i^{th} , W_{ik} is the weight between input and hidden neuron. The bias factor is β_k and S is the activation function sigmoid. The output \hat{Y} at neuron is computed by following equation.

$$\hat{Y} = S \left(\beta_0 + \sum W_k \times O_k \right) \quad (4)$$

Where W_k is the weight between hidden neuron and output neuron, β_0 is the output bias. The error is computed by comparing expected output with \hat{Y} as shown below.

$$E_i = \sum (Y_i - \hat{Y}_i) \quad (5)$$

Where E_i is the error computed by help of Y_i desired value and \hat{Y}_i observed value for i^{th} training pattern. From this we can find mean square error for all patterns which propagate back to MLP model.

D. ADAM Optimizer

The given name is consequential from adaptive moment estimation. This is a stochastic gradient based optimization algorithm used in various field of science and engineering [53]. The algorithm more focus on scalar parameter objective function requirement. This method needs very less memory to compute respective accommodate acquisition rates for various parametric quantity. It is versatile algorithm can scales high dimensional machine learning problems.

IV. PROJECTED FORECASTING MODEL

A multilayered deep learning forecasting model is proposed to predict stock price. The model uses multilayered structure of artificial neural network to make it more accurate and reduce convergence rate. The hidden layer structure as shown in Fig. 1 makes it random and blind. The parametric quantity of the framework are modified by using Adam's optimizer which gives optimal parameter so that mean square error can be reduced.

The input of the model is financial time series feature vector as represented in equation (6). The output of is also a vector of values shown in equation (7). The bias represented in equation (8).

$$X = (x_1, x_2, \dots, x_n) \quad (6)$$

$$Y = (y_1, y_2, \dots, y_k) \quad (7)$$

$$\beta = (\beta_1, \beta_2, \dots, \beta_n) \quad (8)$$

In the process of computation for hidden layer one a weight matrix W is formed it reflects the non-linear interaction between different persuading factors. The weight matrix W can be represented using equation (9).

$$\text{Weight Matrix (W)} = \begin{bmatrix} W_{11} & W_{12} & \dots & W_{1n} \\ W_{21} & W_{22} & \dots & W_{2n} \\ W_{31} & W_{32} & \dots & W_{3n} \\ \dots & \dots & \dots & \dots \\ W_{k1} & W_{k2} & \dots & W_{kn} \end{bmatrix} \quad (9)$$

Table 3: Description of different Data sets used in proposed model.

Name of Data set	Total Records	No of Records for training	No of Records for Testing
American Airlines Group Inc	1762	1180	582
AbbVie Inc	1762	1180	582
AmerisourceBergen Corp	1762	1180	582
Alliance Data System Corporation	1762	1180	582
Baxter International Inc	1762	1180	582
Concho Resources Inc	1762	1180	582
Dominion Energy Inc	1762	1180	582
Google	1762	1180	582
IBM	1762	1180	582
Yahoo	1762	1180	582

The proposed model takes input of different data set of different ranges so the input vectors need to be normalized using following eq (10).

$$Y = (Y - Y_{\min}) / (Y_{\max} - Y_{\min}) \quad (10)$$

The standardization technique shown in eq (10) is normal process of scaling values in a certain range. This process is utilized to regularize stock data famed as feature scaling technique. The data shown in Table 3 are divided into training and testing data set for all data sets. The activation function used by model is sigmoid function as shown in eq (11).

$$S(x) = \frac{1}{1 + e^{-x}} \quad (11)$$

A. Working Process

- Step 1 Data aggregation from share market then initialization.
- Step 2 Verification and selection of data set extracted from the real data set by help of feature extraction
- Step 3 Normalization of data in certain range using equation(10)
- Step 4 Training of proposed Deep learning neural Network with data set.

- Step 5 Training accuracy can be measured by using equation (13) and (14). Check for optimal parameters If not optimal then goto step 6.
- Step 6 The parameter vector is initialize as input to adam optimizer to find optimum parameter.
- Step 7 Get the gradient and update biased first moment then Update biased second raw moment estimate
- Step 8 Compute bias-Corrected first moment and second raw estimate to update the optimal parameter so that the model can give optimal result. After testing in optimal parameter the model can predict stock close value very efficiently.

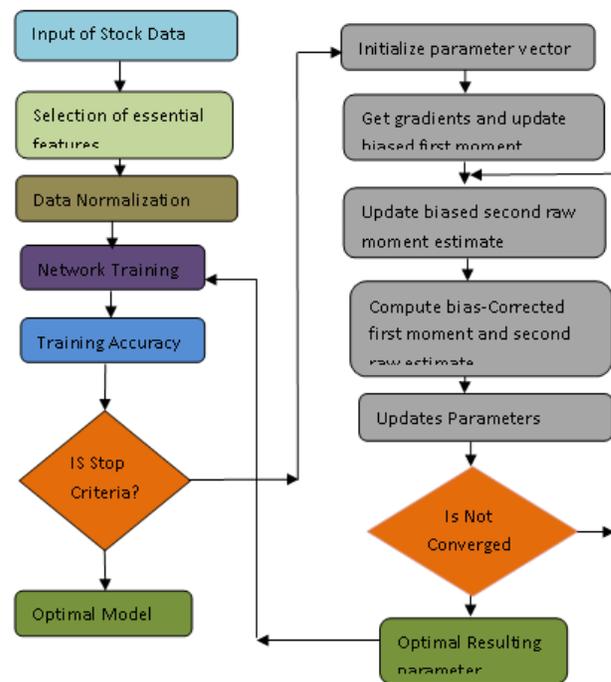


Fig. 2 Represents wok flow of proposed model.

V. RESULT AND DISCUSSION

A. Experimental Result

The projected foretelling framework is skilled healthy to predict stock market price for different data sets as shown in Fig. 3 for stock predicted vs. Actual price American Airlines, Fig. 4 shows predicted vs. Actual stock price of Concho Resources Inc, predicted vs. Actual stock price of AbbVie Inc shown in Fig. 5, similarly the predicted vs. Actual stock price for Dominion Energy Inc in Fig. 6, AmerisourceBergen Corp in Fig. 7, Google in Fig. 8, Alliance Data System Corporation in Fig. 9, IBM stock in Fig. 10, Baxter International Inc in Fig. 11 and Yahoo data in Fig. 12.



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The predicted stock value is shown in red color and actual or ground truth is shown in blue color in result. The experiment is carried out in certain parameter values as shown in Table 4 depending on that value results are drawn.

The American stock data for year 2010 to 2016 of different sectors has been checked by this proposed model and the predicted vs. Actual result is shown in following figures which is very close to each other.

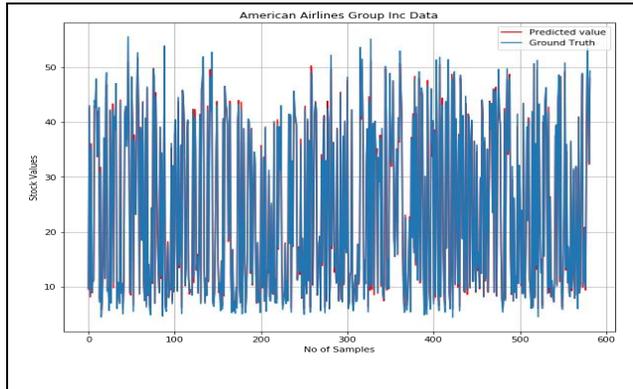


Fig 3: Predicted vs. Actual price American Airlines.

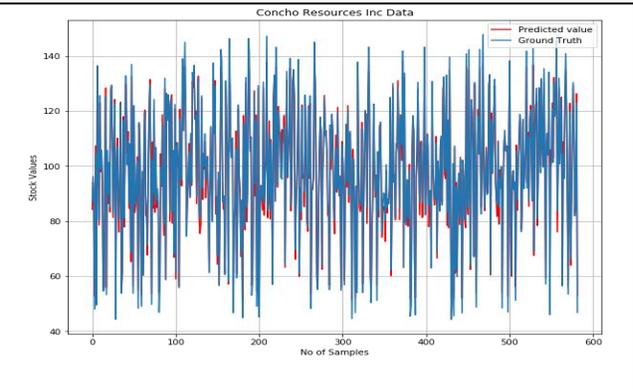


Fig 4: Predicted vs. Actual stock price of Concho Resources Inc.

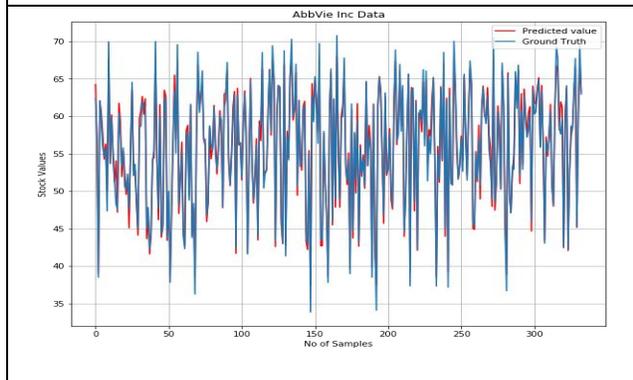


Fig 5: Predicted vs. Actual stock price of AbbVie Inc.

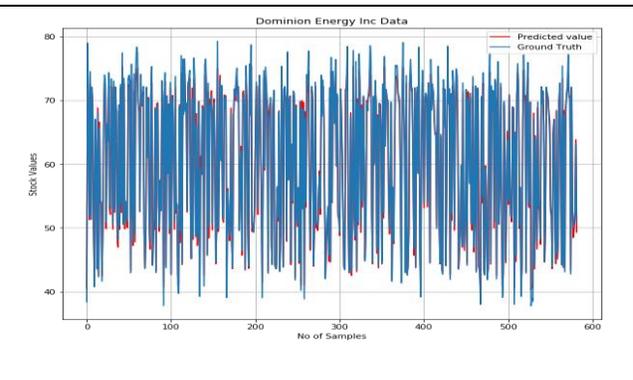


Fig 6: Predicted vs. Actual stock price for Dominion Energy Inc.

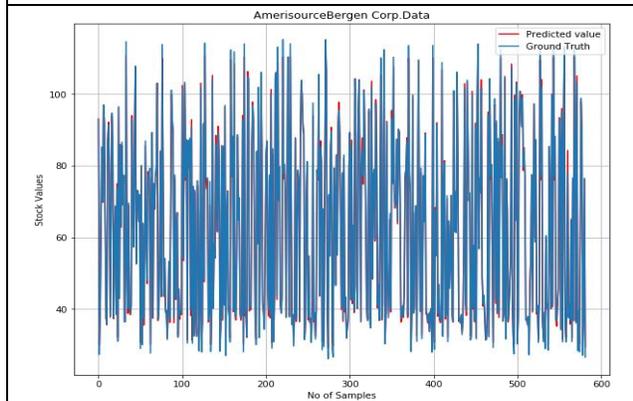


Fig 7: Predicted vs. Actual value of Amerisource Bergen Corp

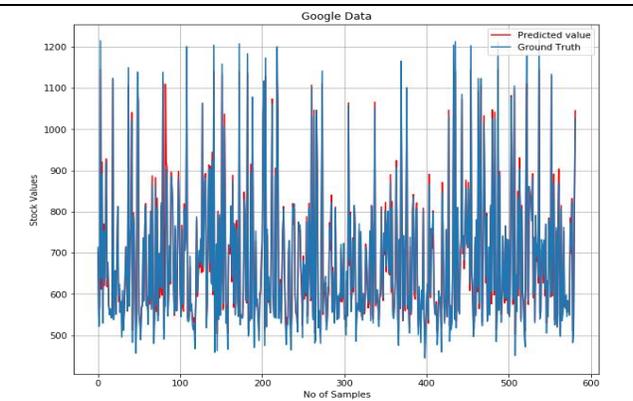


Fig 8: Predicted vs. Actual value of Google data.

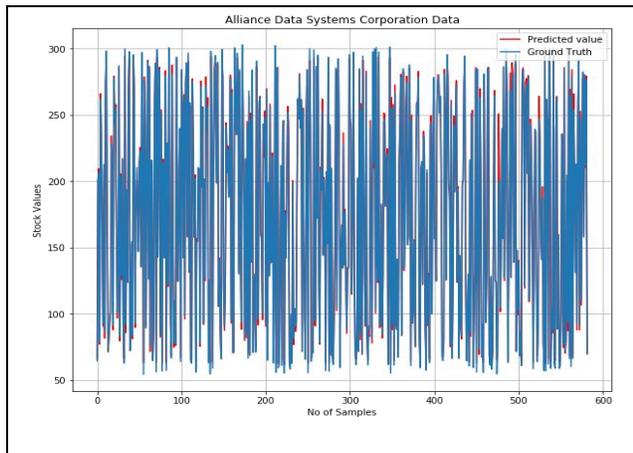


Fig 9: Predicted vs. Actual value of Alliance Data System Corporation.

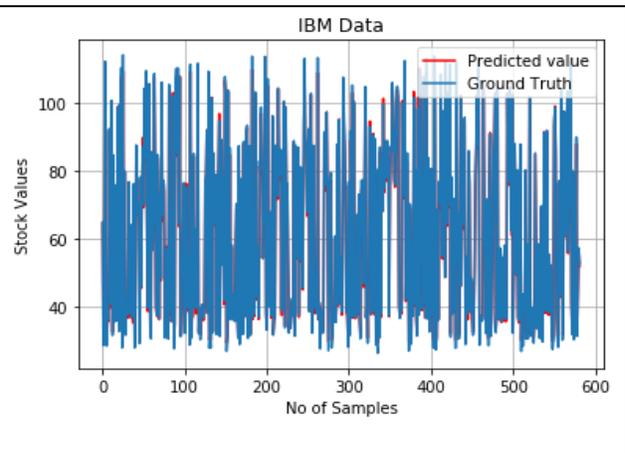


Fig 10: Predicted vs. Actual value of IBM data.

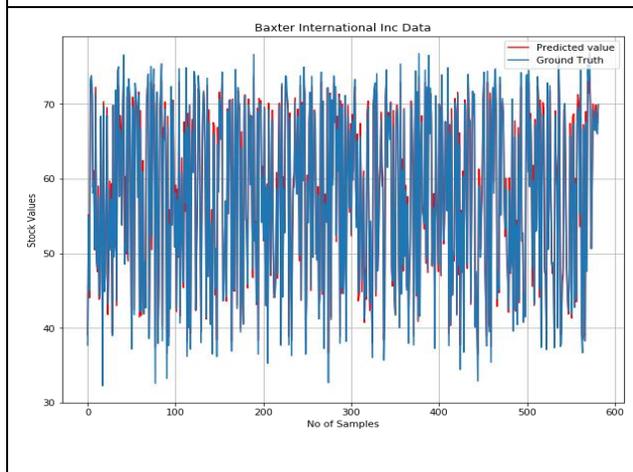


Fig 11: Predicted vs. Actual value of Baxter International Inc.

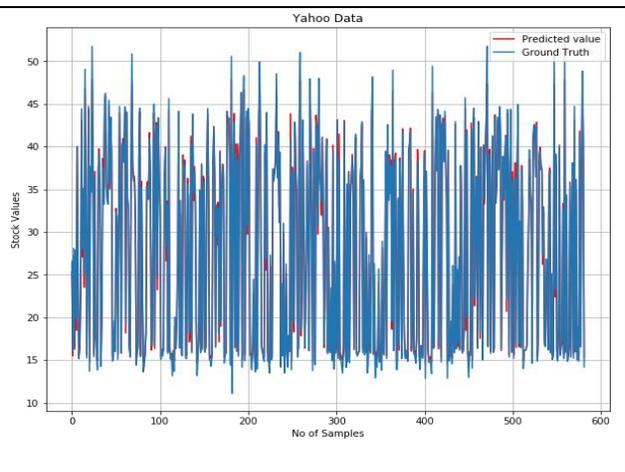


Fig 12: Predicted vs. Actual value of yahoo data.

B. Presentation Assessment

Average of input vector for data sets may be stated as test magnitude of n whose effort quantity for test data as given in equation (12). As per the outcome of the proposed model \hat{Y} is fixed of predicted amounts and Y is a set of actual amounts used for prophecy. So Mean Square error of the forecasting representation can be stated as in equation (13). The feat of projected reproduction can be evaluated by equation (14) and the parameters used are shown in table 4. The proposed illustration is estimated by subsequent equations.

$$Mean = \frac{1}{n} \sum_{i=1}^n X_i \tag{12}$$

$$MSE = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)^2 \tag{13}$$

$$MAPE = \frac{1}{n} \sum_{i=1}^n \left(\frac{Y_i - \hat{Y}_i}{\hat{Y}_i} \right) \tag{14}$$

Table 4: Different parameters used in proposed Model.

Sl. No.	Parameter used Proposed Model	Value used in Model
1	GRU unit Size	512
2	GRU return Sequence	True
3	Model Dropout	0.2
4	Model Dence	2
5	Batch Size	250
6	Epochs	500
7	Validation Split	0.1
8	Index Col	Date

C. Comparison of Experimental Results

The proposed model used to predict stock price of different data sets of different sectors under certain parameter values as shown in table 4 result of model varies slightly in terms of prediction error for different data sets. Each data is tested by the proposed model in an experiment and results are compared with different data as displayed in table 5 and figure 13. the comparison of results with other models is shown in table 6. Quality of the projected framework is much closed to actual values. So the proposed model is a good prediction model for stock price prediction as it suits any sector of stock data.

Table 5: Comparison of observations by proposed model obtained from different data.

Experiments	Name of Data	No of Records	Prediction Error
Experiment-1	American Airlines Group Inc	1762	0.00024238406921356045
Experiment-2	AbbVie Inc	1762	0.0010183275136788998
Experiment-3	AmerisourceBergen Corp	1762	0.00019846774453274855
Experiment-4	Alliance Data System Corporation	1762	0.0003032983833841125
Experiment-5	Baxter International Inc	1762	0.000847515866322014
Experiment-6	Concho Resources Inc	1762	0.0010404603850237282
Experiment-7	Dominion Energy Inc	1762	0.0006493053431430659
Experiment-8	Google	1762	0.001389724447086287
Experiment-9	IBM	1762	0.00018505400100313256
Experiment-10	Yahoo	1762	0.000510688412784922

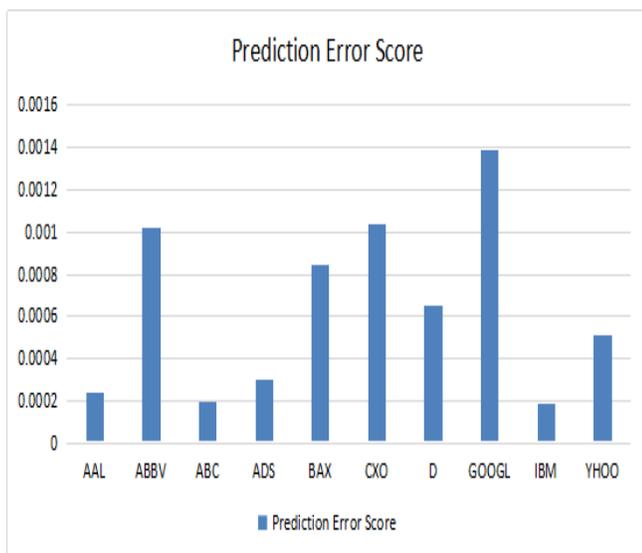


Fig 13: Prediction Error Scores by proposed model obtained from data sets

Table 6 : Result comparison of projected model with existing models

SI No.	Authors Name	Types of Data	Prediction Accuracy
1	H.D Huynh et all [55]	Stock Market Data	65%
2	Q. Mingyue et all [54]	Stock Market Data	86.39%
3	B.Weng et all[56]	Stock Market Data	98.13%
4	Das [Proposed]	Stock Market Data	99.67%

VI. SUMMERY AND EMERGING DIRECTIONS

This new multilayer deep learning approach is optimized by Adam optimizer to foresee close price of current day stock. This reproduction is a competent representation to forecast in time series data of different stock data of different sectors. From the results it is observed that prediction error is very less irrespective of data sets and sectors. The predicted value is very close to authentic value in a time series data. The parameters are best possible parameter for actual existence normalized data sets. The deep learning neural system is skilled, tested & authorized using normalized data sets. But the result is shown in actual range of stock data as listed in stock market. We accept as true that our demonstration is advanced one and ready for stock market prediction in real time. This working model can be suggested for use in any stock value prediction irrespective of sector. This experiment is carried out and tested in online Google Co lab Research lab with support of GPU and in python programming environment. This model can be extended to any field of research with modification of parameters as per requirement of proposed area. This prediction framework can be use as mobile app to predict any kind of price or value in any sector. But the integration may need some change in working model. The limitation of proposed representation is sudden change in stock price due to any economical or political or natural calamities cannot be predicted perfectly.

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