ISSN: 2581-3404 (Online) IF: 5.68 (SJIF)
IJIRTM, Volume-8, Issue-4, July-2024.

Prediction of Stock Market using Artificial Neural Network to Forecast Closing Prices

Sanjay Kumar Sahu[1], Chandan Kumar[2], Nitin Choudhary[3]
[1]Research Scholar, Sanjeev Agrawal Global Educational (SAGE) University, Bhopal
[2]Assistant Professor, Sanjeev Agrawal Global Educational (SAGE) University, Bhopal
[3]Assistant Professor, Sanjeev Agrawal Global Educational (SAGE) University, Bhopal
sksahu0945@gmail.com[1], Chandan.k@sageuniversity.edu.in[2], choudhary.nitin27@gmail.com[3]

Abstract. *In recent times, stock prices have exhibited considerable random fluctuations on a daily basis. These unpredictable variations have posed significant challenges for investors, making the task of predicting stock market trends increasingly complex. This unpredictability has, in turn, rendered stock market prediction a fertile and dynamic area of ongoing research. As part of this endeavor, this paper aims to explore the prediction of stock market closing prices by leveraging a neural network (NN)-based approach. The proposed methodology begins by validating the fundamental principles of a neural network-based stock market prediction (SMP) model. It establishes the effectiveness of using neural networks for such predictive tasks, given their ability to model complex, non-linear relationships present in financial data. A crucial part of this methodology involves experimenting with varying ranges of moving average features. These features are key indicators that can help smooth out price fluctuations over time, and their variability provides an insightful evaluation of the prediction performance. To assess the effectiveness of the predictions, this study employs two key performance metrics: the Mean Absolute Error (MAE) and error histograms. The MAE provides a straightforward measurement of the average magnitude of errors in the predictions, without considering their direction. Error histograms, on the other hand, offer a graphical representation of the distribution of errors, enabling a deeper analysis of the model's prediction accuracy and its deviations. The results of the proposed approach demonstrate a high degree of accuracy in predicting stock market closing prices. Specifically, the methodology achieves an impressive accuracy rate of 99.987% when tested using Microsoft stock price data. This remarkable result underscores the potential of neural networks in providing highly reliable stock price forecasts.*

Keywords: **-** Stock Market Prediction, ANN, Prediction, Deep learning, closing price, moving average features.

I. Introduction

Stock market price prediction is a crucial task for investors, as precise predictions help guide investment strategies. While numerous learning-based techniques exist for predicting prices, creating a simple yet accurate computational framework is essential due to the complexity of existing methods and the lack of technical expertise among many investors. Regression-based stock market prediction (SMP) models are highly dependent on factors such as model complexity, training duration, and data quality. Although more

advanced models like artificial neural networks (ANNs) demand more data and training time, they tend to offer greater accuracy. This paper explores state-of-the-art stock prediction techniques, particularly those relying on neural networks. ANNs, inspired by the human brain, predict data patterns and generalize insights to recognize new patterns. The study validates machine learning (ML)-based stock market forecasts using data from the Microsoft Yahoo database, showing how these models enhance stock market values and support investment planning.

The architecture of the proposed ANN model is a feed-forward (FF) multilayer neural network as shown in figure 1. It consists of multiple neuronal layers, with an input layer receiving the data, one or more hidden layers for processing, and an output layer presenting the final prediction. This research highlights how feature selection significantly impacts the performance of ANN models, and it addresses both short-term and long-term investment strategies. ANNs have become increasingly popular for stock market prediction, demonstrating their ability to effectively predict stock prices and support better financial decision-making.

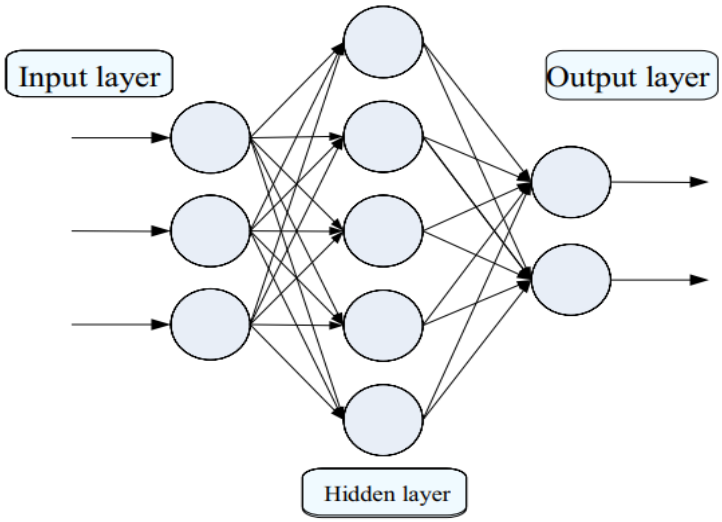


Figure 1: Architecture of FF-ANN for SMP prediction.

II. Literature Review

This review summarizes key methods for stock market prediction (SMP) using neural networks and machine learning (ML) models. Mahdi Pakdaman Naeini et al. [1] found that the MLP neural network outperforms Elman recurrent networks for predicting stock value changes. Shen et al. [2] utilized regression models for short-term prediction, while Birgul Egeli et al. [3] highlighted challenges in predicting stock trends with complex data in Turkey. Xiongwen Pang et al. [4] developed a novel neural network using multi-stock historical data for improved accuracy. Erkam Guresen et al. [5] compared various neural network models, finding MLP and hybrid approaches effective for market forecasting.

Other studies explored ANN applications across different stock exchanges, such as the Bombay Stock Exchange [7], Nigerian Stock Exchange [8], and Bangladesh Stock Exchange [11]. Improved training

algorithms, such as the enhanced Levenberg Marquardt [11], were found to reduce error and computation time. Ensemble models [12] and feature extraction techniques [16] further improved prediction accuracy, demonstrating the adaptability of ANN models for diverse financial markets.

Table 1: Key Findings of Recent Works on Stock Market Prediction Using Neural Network.

Authors	Methodology	Key Findings
Mahdi Pakdaman Naeini et al. [1]	Neural networks: Elman recurrent network and feed-forward multi-layer perceptron system (MLP)	MLP model shows greater promise for share value prediction compared to Elman recurrent networks and regression-based methods
Shen, J., et al. [2]	Regression	Regression approach used for short-term data prediction
Birgul Egeli et al. [3]	Artificial Neural Networks (ANNs)	ANNs used for stock market trend prediction, challenges noted in using complex financial data
Xiongwen Pang et al. [4]	Novel neural network approach utilizing live market data for stock analysis	Illustrates "stock vector" concept, multi-stock historical data used for analysis
Erkam Guresen et al. [5]	Evaluation of various NN-based models including hybrid NNs, MLP, DAN2, and GARCH	Performance evaluation based on Mean Absolute Deviation (MAD) and Mean Square Error (MSE)
Chang Sim Vui et al. [6]	Investigation of ANN techniques for stock market prediction	Explores future directions and applications of ANN in stock market prediction
A. Victor Devadoss et al. [7]	ANN modeling for predicting closing prices on the Bombay Stock Exchange (BSE)	Performance metrics used: Mean Relation Proportion Failure (MRPF), Mean Relation Deviation, Roots Mean Squared Error
Peter Adebayo Idowu et al. [8]	ANNs for predicting market indices on the Nigerian Stock Exchange (NSE)	Demonstrates validation of forecasting stock prices using neural networks
David Enke et al. [9]	Knowledge gain method in machine learning algorithms for economic forecasting	Evaluates efficacy of neural network models for value forecast, cross-validation used to enhance generalization
Bello et al. [10]	ANN model for forecasting final price in the Nigerian Securities Market	Technical data from previous trading years used, performance evaluation based on test sets
Mustain Billah et al. [11]	Enhanced Levenberg Marquette (LM) synthetic NN training technique for stock price prediction	Reduced error and computational requirements compared to ANFIS and conventional LM methods
Bing Yang et al. [12]	Deep neural network ensemble for modeling and predicting the Chinese stock market index	Bagging strategy used to lower generalization error, combination of part networks for prediction

Suraiya Jabin et al. [13]	ANN method for forecasting stock market, emphasizing stable pricing linkages in short run	Demonstrates efficacy of ANN in forecasting stock price movements, particularly during periods of low volatility
P. V. Chandrika et al. [14]	ANN and ML method for forecasting stock index trajectories	Framework evaluated using precision, recall, and F1-score performance criteria
Kumar Abhishek et al. [15]	Neural network for forecasting share prices based on historical data	Feed-forward neural network trained on historical data, successful in predicting market movements
Richa Handa et al. [16]	ANN with researcher-suggested technical markers for stock market prediction	Impact of feature selection on ANN model effectiveness noted

III. Proposed Methodology

This study proposes using a neural network (NN) based prediction to forecast closing prices in the stock market. First, the basic NN-based stock market prediction (SMP) technique is validated by the presented methodology. Subsequently, the moving average window range is adjusted to assess the performance of the prediction. As clear from the proposed methodology flow shown in Figure 2, the moving average window is changed during preprocessing for accurate prediction.

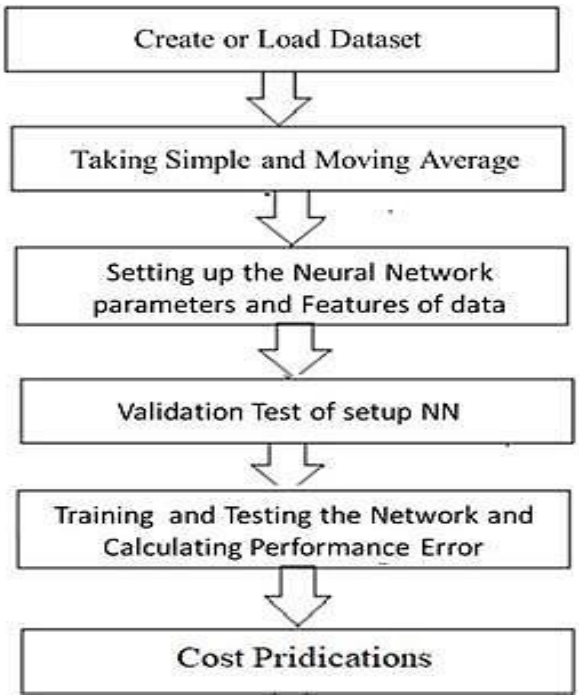


Figure 2: Flowchart of the proposed methodology.

The basic NN-based system is validated first, and then parameters are changed for accurate prediction. The window of the epoch size is also tuned for better accuracy. Although the prediction time is more for ANN, the minimization of prediction error is the prime goal of any forecasting approach. Thus, the error is plotted as results for each epoch.

IV. EXPERIMENTAL RESULTS & DISCUSSION

In this section, the results and the outcomes of the proposed research are presented. Initially, the input stock cost data for the opening and closing costs of the stocks are plotted, as shown in Figure 3. There is a close normal correlation in both costs. Now, using this time series data, it is required to predict the future cost. The proposed method uses the ANN for closing cost prediction. The 10-layer ANN with moving average features is used for the prediction. The results of the closing cost prediction are plotted in Figure 4. For the 100 random samples, the closely approximate predicted values for the next day represent the effectiveness of the proposed method. Results of actual and predicted closing cost during testing of the stock market data for Microsoft and FB are plotted in figure 5.

The mean absolute error (MAE) is calculated as

$$MAE = \frac{1}{N}\left[\sum (Actual - Close)\right] \qquad (1)$$

The mean square error (MSE) is calculated as

$$MSE = \frac{1}{N}\sum (Actual - Close)^2 \qquad (2)$$

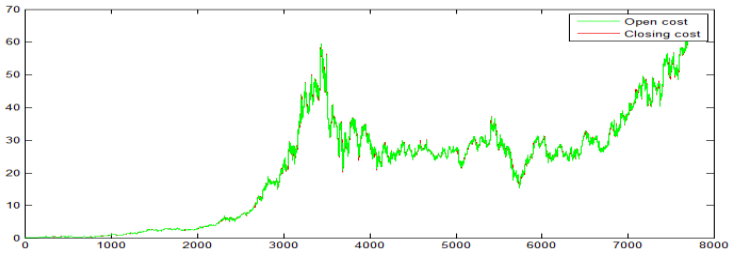


Figure 3: Input open and closing cost data.

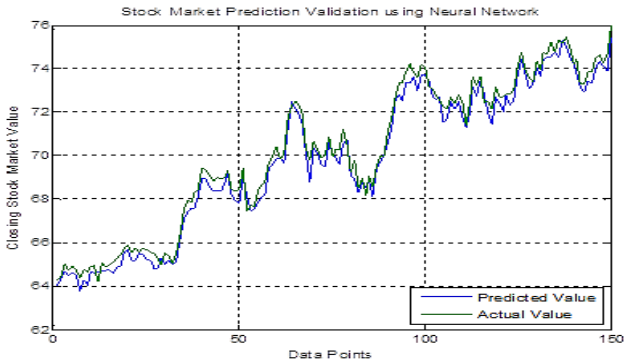
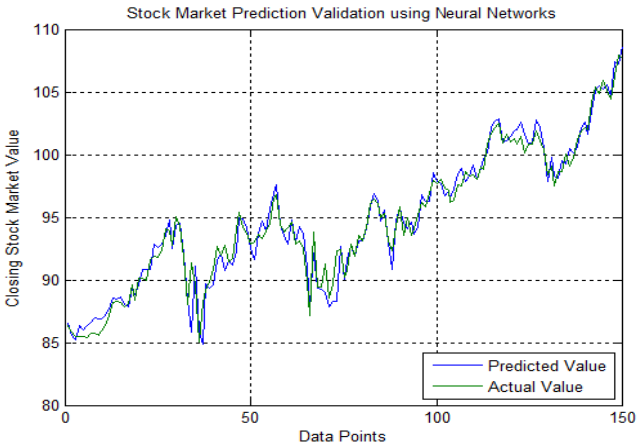
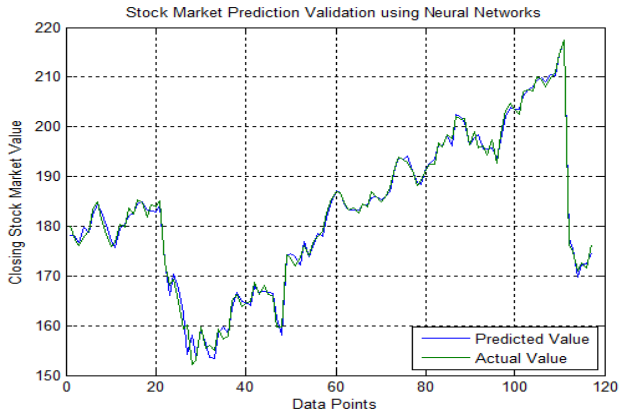


Figure 4: Results of actual and predicted closing cost during training of the stock market data.



(a) For Microsoft



(b) For FB Data

Figure 5: Results of Actual and Predicted closing cost during testing of the stock market data.

The Mean Absolute Error and Mean Square Error during the training and testing phases for random experiments are presented in Table 2. The proposed method demonstrates significantly lower error performance. An example of the training error is illustrated in Figure 6.

Table 2: Parametric Evaluation of errors.

Company	Training		Testing	
	MAE	MSE	MAE	MSE
Micro Soft	0.4765	0.3157	0.6977	0.9637
FB	0.9353	1.6873	0.9358	1.6873

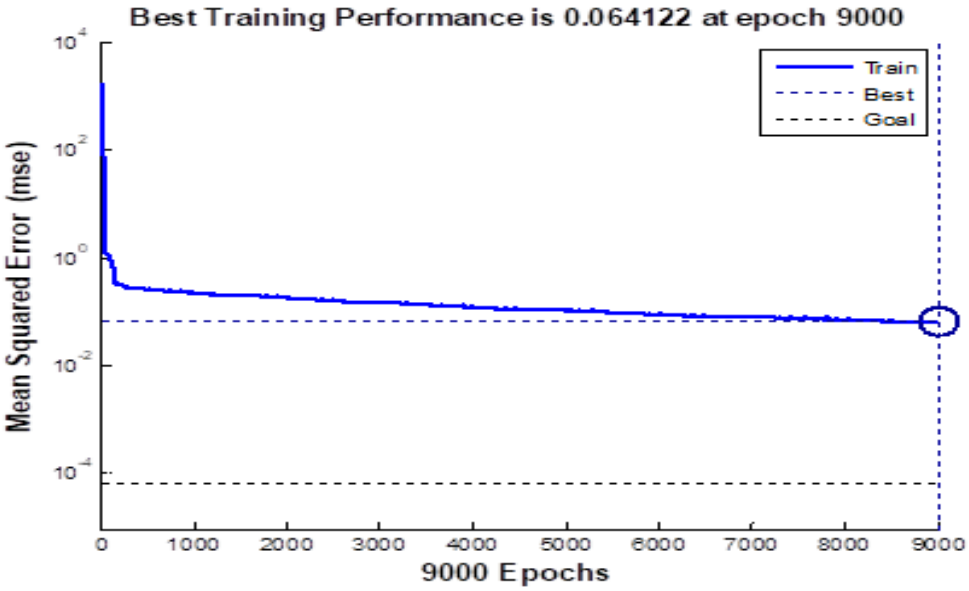


Figure 6: Best training error performance for NN.

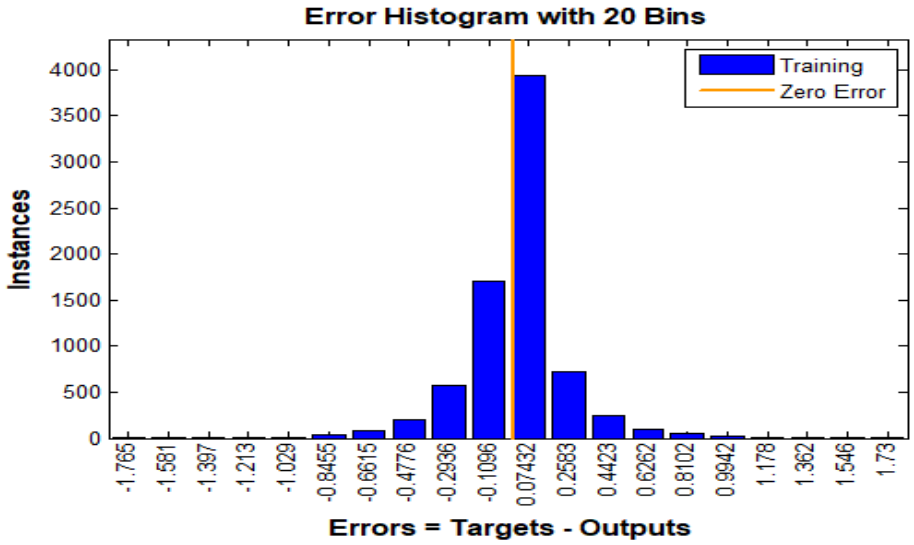


Figure 7: Histogram of error for evaluation.

The respective set of error histogram bins is shown in Figure 7. Results of the learning rates during the validation process is also shown if figure 8. It can be clearly observed that the prediction accuracy of nearly 99.9% is observed for the Microsoft and nearly 99.7% is observed for the FB database.

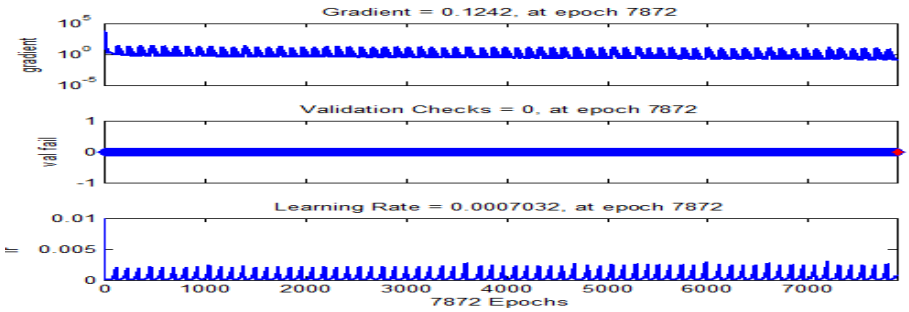


Figure 8: Results of the learning rates during the validation process.

V. CONCLUSIONS AND FUTURE SCOPES

This study presents a neural network (NN)-based approach for forecasting closing prices in the stock market, showcasing a sophisticated method for addressing the challenges of stock price prediction. The core objective of this research is to assess and validate the efficacy of neural networks in predicting stock prices, while exploring how different feature adjustments can influence predictive accuracy. The methodology begins with the validation of the fundamental neural network-based stock market prediction (SMP) technique. A series of experiments are conducted to confirm the robustness and accuracy of this technique in the context of stock price prediction. Specifically, the moving average feature range is carefully adjusted in the model to optimize the prediction performance. Moving averages are critical indicators used in financial analysis, and adjusting their range allows the model to smooth out fluctuations and better capture price trends. The results achieved through this NN-based approach are highly promising. For Microsoft stock data, the model demonstrates an impressive accuracy rate of 99.987%, indicating its remarkable precision in forecasting stock prices. Similarly, for the Facebook (FB) stock data, the proposed method achieves a notable accuracy of 99.63%. These results underline the effectiveness of the suggested methodology across different datasets, showcasing its adaptability to varying stock market behaviors. Looking ahead, there is significant potential for improving the model and expanding its applicability. Future research can focus on utilizing larger-sized datasets, which would enable a more comprehensive evaluation of the model's performance across diverse market conditions.

References:

[1]. Mahdi Pakdaman Naeini "Stock Market Value Prediction Using Neural Networks" 2010 International Conference on Computer Information Systems and Industrial Management Applications (CISIM) 978-1-4244-7818-7/10/$26.00 c 2010 IEEE.

[2]. Shen, J., Shafiq, M.O. Short-term stock market price trend prediction using a comprehensive deep learning system. J Big Data 7, 66 (2020). https://doi.org/10.1186/s40537-020-00333-6.

[3]. Birgul Egeli "Stock Market Prediction Using Artificial Neural Networks" s publication at: https://www.researchgate.net/publication/228407623.

[4]. Xiongwen Pang "An innovative neural network approach for stock market prediction",Article in The Journal of Supercomputing · March 2020 DOI: 10.1007/s11227-017-2228-y publication at: https://www.researchgate.net/publication/322444003.

[5]. Erkam Guresen "Using artificial neural network models in stock market index prediction" Article in Expert Systems with Applications · August 2011 DOI: 10.1016/j.eswa.2011.02.068 · Source: DBLP publication at: https://www.researchgate.net/publication/220219343.
[6]. Chang Sim Vui "A Review of Stock Market Prediction with Artificial Neural Network (ANN)" 2013 IEEE International Conference on Control System, Computing and Engineering, 29 Nov. - 1 Dec. 2013, Penang, Malaysia978-1-4799-1508-8/13/$31.00 ©2013 IEEE.
[7]. A. Victor Devadoss "Stock Prediction Using Artificial Neural Networks" International Journal of Data Mining Techniques and Applications Vol:02, December 2013, Pages: 283-291Integrated Intelligent Research (IIR).
[8]. Peter Adebayo Idowu "Prediction of Stock Market in Nigeria Using Artificial Neural Network" I.J. Intelligent Systems and Applications, 2012, 11, 68-74 Published Online October 2012 in MECS (http://www.mecs-press.org/) DOI: 10.5815/ijisa.2012.11.08.
[9]. David Enke "The use of data mining and neural networks for forecasting stock market returns" Expert Systems with Applications 29 (2005) 927–940doi:10.1016/j.eswa.2005.06.024.
[10]. Bello "Utilizing Artificial Neural Network For Prediction In The Nigerian Stock Market Price Index" GESJ: Computer Science and Telecommunications 2011|No.1(30) ISSN 1512-1232.
[11]. Mustain Billah "Stock Market Prediction Using an Improved Training Algorithm of Neural Network" 2nd International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE) 8-10 December 2016, Rajshahi-6204, Bangladesh978-1-5090-5785-6/16/$31.00 2016 IEEE.
[12]. Bing Yang "Stock Market Index Prediction Using Deep Neural Network Ensemble" Conference Paper · July 2017 DOI: 10.23919/ChiCC.2017.8027964 publication at: https://www.researchgate.net/publication/320121681.
[13]. Suraiya Jabin "Stock Market Prediction using Feed-forward Artificial Neural Network" Article in International Journal of Computer Applications · August 2014 DOI: 10.5120/17399-7959 International Journal of Computer Applications (0975 – 8887) Volume 99– No.9, August 2014 publication at: https://www.researchgate.net/publication/268152880.
[14]. P. V. Chandrika "Predicting Stock Market Movements Using Artificial Neural Networks" Universal Journal of Accounting and Finance 9(3): 405-410, 2021 http://www.hrpub.org DOI: 10.13189/ujaf.2021.090315.
[15]. Kumar Abhishek "A Stock Market Prediction Model using Artificial Neural Network" Conference Paper · July 2012 DOI: 10.1109/ICCCNT.2012.6396089publication at: https://www.researchgate.net/publication/261493493 IEEE-20180.
[16]. Richa Handa "Stock Market Prediction with Various Technical Indicators Using Neural Network Techniques" www.ijraset.com Volume 3 Issue VI, June 2015 IC Value: 13.98 ISSN: 2321-9653 International Journal for Research in Applied Science & Engineering Technology (IJRASET) publication at: https://www.researchgate.net/publication/321625081.