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Stock Price Prediction Using Recurrent Neural Network Architecture

O. E. Taylor*[1], P. S. Ezekiel[2], F. B. Deedam-Okuchaba[3]
[1, 2, 3]Department of Computer science, Rivers State University, Port Harcourt, Nigeria
*Corresponding Author's email: tayonate @ yahoo.com

Abstract— *The financial market is a concept where financial commodities such as golds, silver, valuables and other essential commodities are traded in terms of proceedings between buyers and stockist. Due to the present condition of the stock market, machine learning and deep learning algorithms have been implemented to help buyers and sellers to predict the possible outcome of the financial market. The stock market is sensitized to the political economy atmosphere. However, both types of information are too complex and unstable to gather. The above information that cannot be included in features is considered as noise. This paper presents a Recurrent Neural Network Architecture in predicting stock prices. The dataset used in this study consists of stock price starting from the year 2011-2019; and contains 8 columns. The dataset was preprocessed by transforming them into understandable format, and also removing inconsistence and thereafter scaled and normalized to (0,1) values by creating a scaler object using MinMaxScaler (feature_range (0,1)). We transformed the data to matrix format with rows and columns and reshaped the data to arrays before transforming. The data was being reshaped to a 3D array in other for the Long-Term Short Memory Algorithm to read and train the model. After building and training our Recurrent Neural Network model, we downloaded a test dataset, append it to our trained model and made prediction, we plotted a line graph of the actual stock price and the predicted stock price against time. The plotted graphs shows the original profits made by the company during a stock exchange versus the predicted profits the company will have in future.*

Keywords— *Stock Price, Recurrent Neural Network, Long-Short Term Memory (LSTM)*

I. INTRODUCTION

The financial market is a concept where financial commodities such as golds, silver, valuables and other essential commodities are traded in terms of proceedings between buyers and stockist. Due to the present condition of the stock market, machine learning and deep learning algorithms have been implemented to help buyers and sellers to predict the possible outcome of the financial market. The stock market is sensitized to the political economy atmosphere. However, both types of information are too complex and unstable to gather. The above information that cannot be included in features is considered as noise. The acceptance proportion of the financial data is controlled by real-world transaction documentation. On the hand, a larger acceptance proportion refers to a longer season of transaction documentation; on the other hand, large acceptance proportion increases the wavering of financial atmosphere during the 2 sample periods. [1]. The stock market has become a crucial market in increasing the economy of country by promoting capital creation and supporting economic increase in most economies across the world. Stock markets are beyond trading securities; they work as a coordinator between savers and users of capital by mode of putting funds together, risk-free and resettling wealth. Stock markets are important for the economic increase as they make sure they pass resources to the most productive investment opportunities. [2]. It is important to be aware that stock prices all over the world including Nigeria is classified by upward and downward movements. [3] describes the Nigerian stock market as market operated by intensities which could be in place for years. Therefore, affecting the price of a particular asset to rise or fall over a longer period. While on the other hand, in a bear market, a weak view gives rise to also [4] defined the stock market as a sophisticated market place where stocks and shares are the traded commodities. Stock market is also a central to the creation and development of a strong and competitive economy. Information on stock market provides investors with the status of the market value of their assets, and this serves as a guide to businessmen on their investments. Since people are rational, they would rather invest in gainers than losers. The transaction activities in stock market are extremely imperative for the generation of capital within the economy. Stock market is important for decisions on business investment, because financing investment spending is affected by share prices. In this paper, we proposed a Recurrent Neural Network Architecture using Long Short-Term Memory Algorithm in predicting stock prices.

II. RELATED WORK

Automated Stock Price Prediction Using Machine Learning [5] developed a computerized trading system that combine machine learning, mathematical functions and other extrinsic features such as news' idea for the motive of attaining a better accuracy in predicting stock market price and giving out useful trades. Particularly, they aimed to regulate the stock price of a particular stock for the coming end of day deliberating the first divers trading hours of the day. In other to attain their goal, they trained some algorithms using machine learning and various deep learning models was taking into deliberation. They carried out diverse assessment. They got an accuracy of 82.91% using Support Vector Machine which is their highest accuracy result

A Comprehensive Evaluation of Ensemble Learning for Stock-Market Prediction [6] carried out a large modified survey of ensemble methods such as blending, bagging, super

learners and boosting using Support Vector Machine, Decision Trees Classifier, and Artificial Neural Network. They constructed 25 different ensemble regressors and classifiers, compared their execution times, accuracy, and error metrics over stock-data from Ghana Stock Exchange, Johannesburg Stock Exchange, New York Stock Exchange (NYSE) and Bombay Stock Exchange (BSE-SENSEX) from January 2012 to December 2018. The study outcome shows that stacking and blending ensemble techniques offered higher prediction accuracies (90–100%) and (85.7–100%) respectively, compared with that of bagging (53–97.78%) and boosting (52.7–96.32%).

National Stock Exchange Stock Market Prediction Using Deep-Learning Models [7] used three types of deep learning architectures namely Multilayer Perceptron (MLP), Recurrent Neural Networks (RNN), and Convolutional Neural Network (CNN) in predicting the stock price of a company based on the historical prices available. They trained their network using the stock price of a single company from National Stock Exchange and five different companies from both National Stock Exchange and New York Stock Exchange was predicted. They compared their acquired results with ARIMA model in which some observations show that the neural networks outperform the existing linear model (ARIMA).

A Machine Learning Model for Stock Market Prediction [8] proposed a machine learning model that desegregate Particle Swarm Optimization (PSO) algorithm and LS-Support Vector Machine in predicting stock market price by employing financial technical indicators. These indicators include relative strength index, money flow index, exponential moving average, stochastic oscillator and moving average convergence/divergence. The PSO was used constantly as general optimization algorithm to optimize LS-Support Vector Machine for stock price prediction. Also, PSO algorithm used in selection of LS-Support Vector Machine free parameters C (cost penalty), ϵ (insensitive-loss function) and γ (kernel parameter). The proposed LS-Support Vector Machine and PSO model convergence to the general minimum. The performance of their proposed model outperforms that of the LS-Support Vector Machine algorithms. LS-Support Vector Machine-Particle swarm optimization (POS) achieves the lowest error value followed by single LS-Support Vector Machine.

Stock Market Prediction Using Machine Learning Classifiers and Social Media, News [9] employed financial news and social media data algorithm. They used spam tweets reduction and feature selection in enhancing predictions and performance on the data sets. They compared results of different algorithms to find a consistent classifier. They employed a deep learning algorithm and ensembled some classifiers in achieving maximum prediction accuracy. Accuracies of 80.53% and 75.16% were attained by employing financial news and social media separately. Random forest classifier was found to be consistent and highest accuracy of 83.22% was attained by its ensemble.

Performance Forecasting of Share Market using Machine Learning Techniques: A Review [10] introduced a structured analysis of the last fifteen years on various machine learning techniques in order to analyze share performance accurately. They provided a survey of the machine learning techniques that have been used to forecast share performance. They also highlight how the prediction algorithms can be used to identify the most important variables in a share market dataset.

Forecasting banking sectors in Indian stock markets using machine intelligence [11] analyzed stock market index closing from myriad set of scientific and elemental review variables gotten from real market data to help in predicting market closing. The forecasted model performance of index closing using numerical methods were simulated and reviewed.

Artificial Neural Network Model to Predict Stock Prices at Stock Exchange Markets [12] proposed the use of Artificial Neural Network that is feedforward multi-layer perceptron with error back propagation and developed a model of configuration 5:21:21:1 with 80% training data in 130,000 cycles. Their study initiates a prototype and tested it with 2008-2012 facts from stock markets e.g. The prediction results show Mean Absolute Percentage Error (MAPE) of between 0.71% and 2.77%. Validation done with Encog and Neuroph realized comparable results.

III. DESIGN METHODOLOGY

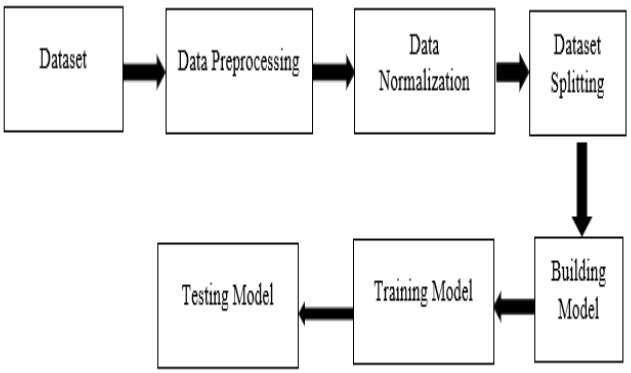

Figure 1: Architectural Design of the proposed system

The design methodology and the system implementation process are as follows:

Dataset: This study used a National Stock Exchange of Indian dataset to predict the future of a Tata Global Beverages company (NSE-TATAGLOBAL). The dataset consists of stock price starting from the year 2011-2019 and consists of 8 columns. The Open, Close and Last columns represent the starting and final price at which the stock is traded on a particular day. High and Low columns represent the maximum, minimum and last price of the share for the day, Total Trade Quantity represent the number of shares bought or sold in the day and lastly the Turnover column represents the turnover of the particular company for each day.

Data pre-processing: This has to do with transforming the dataset into an understandable format, and also removing all inconsistencies.

Data Normalization: Scaling and normalizing is an important activity in the formation of a Neural Network Architecture, the dataset is being scaled and normalized to (0,1) values by creating a scaler object using MinMaxScaler (feature_range

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(0,1)). We transform the data to matrix format with rows and columns and reshaped the data to arrays before transforming. The data was being reshaped to a 3D array in other for the Long-Term Short Memory Algorithm to read and train the model.

Split Dataset into X_train and Y_train: The datset was being splited into X_train and Y_train variables which contains some array of numbers.

Building the Model: The model was built using a Long-Short Term Memory (LSTM) algorithm with units=50 and a total input_shape = (60,1), Dropout= 0.2

Training the Model: The model was trained using a Long Term Short Memory with an epoch of value of 50 and a batch size of 32.

Testing the Model: The trained model was tested using a Tata global dataset which was appended to the training dataset and a chart plotted with the real stock price and the predicted stock prices against time.

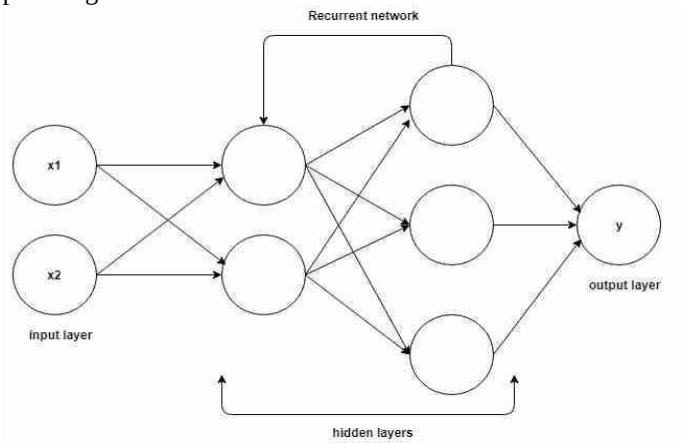

Figure 2: A Recurrent Neural Network Architecture

	Date	Open	High	Low	Last	Close	Total Trade Quantity	Turnover (Lacs)
0	2018-09-28	234.05	235.95	230.20	233.50	233.75	3069914	7162.35
1	2018-09-27	234.55	236.80	231.10	233.80	233.25	5082859	11859.95
2	2018-09-26	240.00	240.00	232.50	235.00	234.25	2240909	5248.60
3	2018-09-25	233.30	236.75	232.00	236.25	236.10	2349368	5503.90
4	2018-09-24	233.55	239.20	230.75	234.00	233.30	3423509	7999.55

Figure 3: Showing training dataset of National Stock Exchange of Indian dataset to predict the future of a Tata Global Beverages company (NSE-TATAGLOBAL

IV. Result and Discussion

In this paper, a NSE-TATAGLOBAL stock market price dataset was used in training our model to predict stock market prices. The dataset consists of stock prices between 2011-2019 inclusive consisting of8 columns. This dataset contains 8 columns which are Date, Open, Close, High, Low, Last, Total Trade Quantity and Turnover. The dataset was scaled and normalized using MinMaxScaler with a feature range of (0,2), the dataset was then scaled and transformed into a 3D array with rows and columns. After transformation, the dataset was splitted into X_train, and Y_train, the X_train and Y_train holds an array of values. The model was built with four hidden layers and one output layer. The model was trained using model.fit function with an epochs value of 50 and a batch size of 30, the total trainable parameter was 71,051. After training, the model was tested using a Tata test dataset which we append to the training dataset and make possible prediction on the stock prices to determine the possible lost and profit the company will get when they trade on a particular day.

	Date	Open	High	Low	Last	Close	Total Trade Quantity	Turnover (Lacs)
0	2018-10-24	220.10	221.25	217.05	219.55	219.80	2171956	4771.34
1	2018-10-23	221.10	222.20	214.75	219.55	218.30	1416279	3092.15
2	2018-10-22	229.45	231.60	222.00	223.05	223.25	3529711	8028.37
3	2018-10-19	230.30	232.70	225.50	227.75	227.20	1527904	3490.78
4	2018-10-17	237.70	240.80	229.45	231.30	231.10	2945914	6961.65
5	2018-10-16	237.10	237.70	233.05	234.40	235.45	1723113	4052.25
6	2018-10-15	229.70	237.00	226.80	234.80	234.90	1224339	2845.68
7	2018-10-12	226.25	232.35	225.50	228.70	229.10	1165527	2675.91
8	2018-10-11	215.00	229.70	215.00	225.60	224.60	1293881	2890.85
9	2018-10-10	215.00	229.65	215.00	228.25	228.40	2919278	6557.95
10	2018-10-09	215.50	219.15	209.60	215.00	216.50	1844462	3940.70
11	2018-10-08	208.00	222.25	206.85	216.00	215.15	4642146	10062.83
12	2018-10-05	217.00	218.60	205.90	210.25	209.20	3519515	7407.06
13	2018-10-04	223.50	227.80	216.15	217.25	218.20	1728786	3815.79
14	2018-10-03	230.00	237.50	225.75	226.45	227.60	1708590	3960.27
15	2018-10-01	234.55	234.60	221.05	230.30	230.90	1534749	3486.05

Figure 4: Showing test dataset of National Stock Exchange of Indian dataset to predict the future of a Tata Global Beverages company (NSE-TATAGLOBAL)

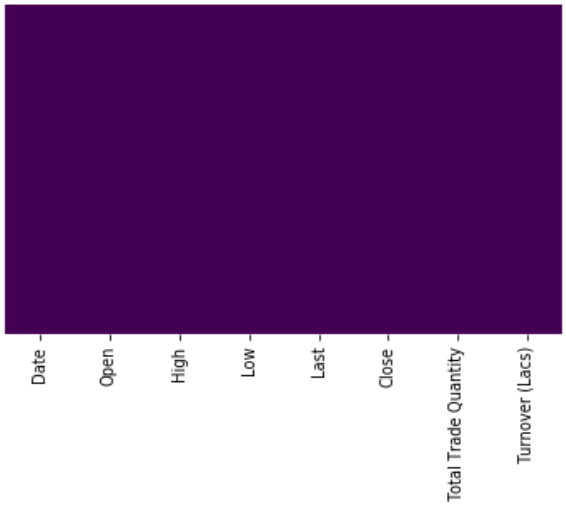

Figure 5: Shows that there are no null or missing values in the dataset

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Figure 6: Shows the profit/loss the company made from 2011-2019

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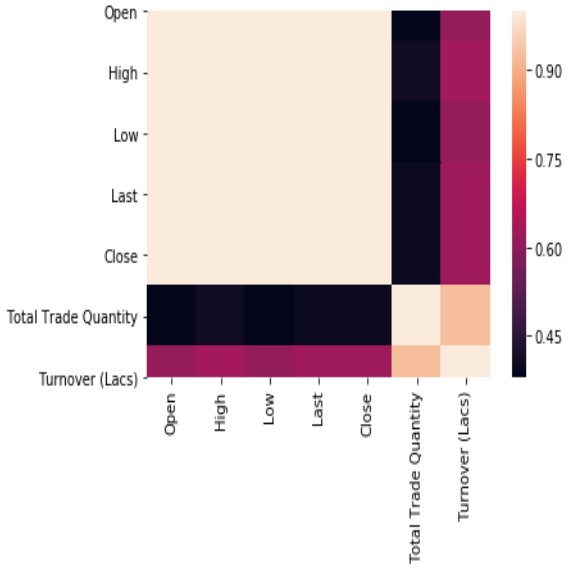

Figure 7: Shows Correlation matrix of the dataset

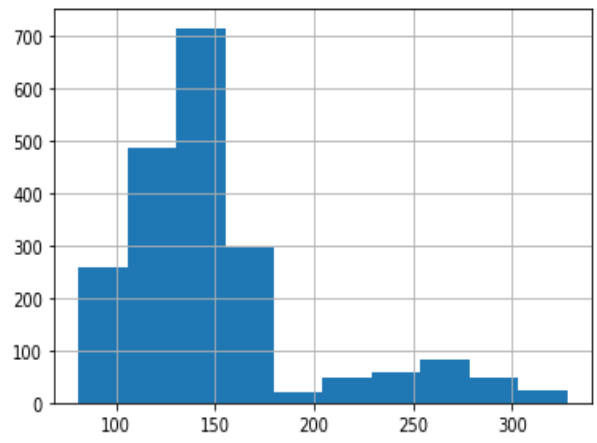

Figure 8: Shows the open price of the dataset

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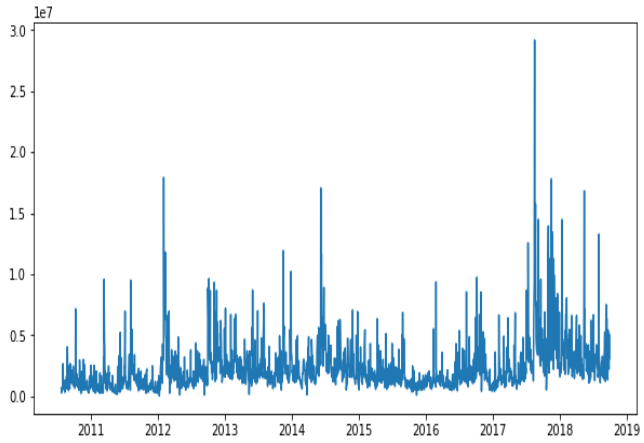

Figure 9: Shows the total trade quantity in each year. Total trade quantity represents the number of shares bought or sold in the day

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[<matplotlib.lines.Line2D at 0x22e247ae208>]
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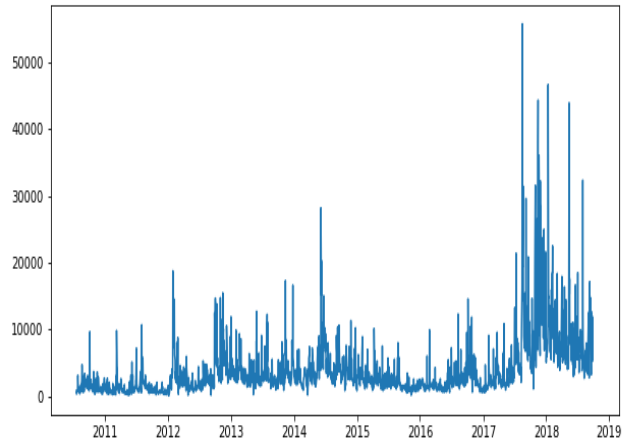

Figure 10: Shows the Turnover of the company in a particular year

Layer (type)	Output Shape	Param #
lstm_1 (LSTM)	(None, 60, 50)	10400
dropout_1 (Dropout)	(None, 60, 50)	0
lstm_2 (LSTM)	(None, 60, 50)	20200
dropout_2 (Dropout)	(None, 60, 50)	0
lstm_3 (LSTM)	(None, 60, 50)	20200
dropout_3 (Dropout)	(None, 60, 50)	0
lstm_4 (LSTM)	(None, 50)	20200
dropout_4 (Dropout)	(None, 50)	0
dense_1 (Dense)	(None, 1)	51

Total params: 71,051
Trainable params: 71,051
Non-trainable params: 0

Figure 11: Model Summary of the Long-Short Term Memory

```
Epoch 1/50
1975/1975 [==============================] - 72s 37ms/step - loss: 0.0131
Epoch 2/50
1975/1975 [==============================] - 51s 26ms/step - loss: 0.0028
Epoch 3/50
1975/1975 [==============================] - 51s 26ms/step - loss: 0.0029
Epoch 4/50
1975/1975 [==============================] - 51s 26ms/step - loss: 0.0025
Epoch 5/50
1975/1975 [==============================] - 38s 19ms/step - loss: 0.0021
Epoch 6/50
1975/1975 [==============================] - 28s 14ms/step - loss: 0.0022
Epoch 7/50
1975/1975 [==============================] - 28s 14ms/step - loss: 0.0022
Epoch 8/50
1975/1975 [==============================] - 28s 14ms/step - loss: 0.0019
Epoch 9/50
```

Figure 12: Shows the training process of the first 9 epochs

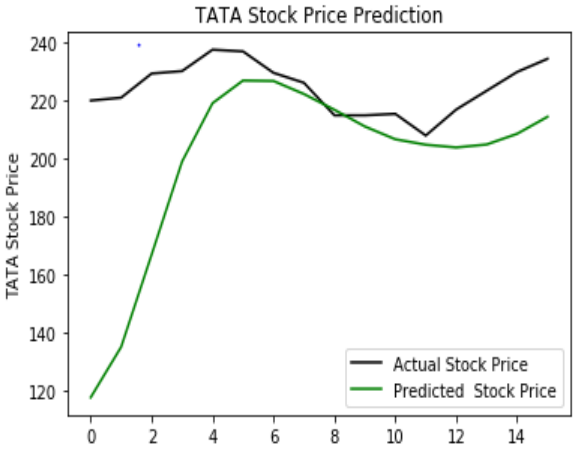

Figure 13: Shows a line representation of the actual stock price of the company and the predicted stock price

V. CONCLUSION

This paper presents a Recurrent Neural Network Architecture using Long-Short Term Memory model in predicting stock prices. We used a National Stock Exchange of Indian dataset to predict the future of a Tata Global Beverages company (NSE-TATAGLOBAL). The dataset consists of stock price from the year 2011-2019 inclusive consisting of 8 columns. The Open, Close and Last columns represent the starting and final price at which the stock was traded on a particular day, High and Low columns represent the maximum, minimum and last price of the share for the day, Total Trade Quantity represent the number of shares bought or sold in the day and lastly the Turnover column represents the turnover of the particular company on a particular day. After building and training our Recurrent Neural Network model, we downloaded a test dataset, append it to our trained model and made predictions. Then, we plotted a line graph of the actual stock price and the predicted stock price against time. The plotted graph shows the original profits made by the company during a stock exchange vs the predicted profits the company will have in future during a stock exchange. This paper can be further extended by increasing the number of training epochs and/or using another Deep learning algorithm to see if further improvements can be obtained in the profit margin predicted.

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