Bitcoin Price Prediction App Using Deep Learning Algorithm

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***Abstract*—Bitcoin runs on a peer-to-peer basis and is a decentralized cryptocurrency. It uses encryption and anonymity for cryptography. Bitcoin is the top-ranking cryptocurrency centered on the internet. The People most encounter Bitcoin due to anonymity and transparency in the system, among the widespread cryptocurrencies available on the market. Bitcoin becomes popular because of its price fluctuations. Cryptocurrency has emerged as a crucial element in companies and stock sector opportunities in the stock industry over the last decade. The accurate and consistent forecast will help investors in cryptocurrency make the right investment decisions and lead to future higher income. Nevertheless, due to its chaotic and quite complex existence, cryptocurrency price prediction is considered a difficult job. Correspondingly, several researchers have examined different factors that influence the price of Bitcoin and the trends behind its fluctuation, using a various machine learning algorithm. In this study, the most powerful and commonly used deep learning algorithm is implemented for forecasting bitcoin prices. The real-time dataset is collected to the current date with the Bitcoin value of Open, Close, Low, High, Volume to and from price details. The purpose of this work is to use the LSTM algorithm to extract the accurate price of Bitcoin. The results obtained provide valuable evidence that LSTM can solve this problem efficiently and effectively.**

Keywords— Bitcoin, Prediction, Time-Series, Predictive Model, Deep Learning, Long-Short Term Memory (LSTM), Recurrent Neural Network (RNN), Real-time Data, Mean Absolute Error (MAE), Accuracy

I. INTRODUCTION

Bitcoin is the collection of concepts and technologies that form the foundation of an ecosystem of digital money. Bitcoin is a revolutionary network for transfers and a new kind of money. The decentralized network, Bitcoin enables users to transact directly, peer to peer, without an intermediary to handle the exchange of funds. In return for products and services, the digital currency bitcoin has used another currency. Bitcoin is conveniently portable, divisible, and immutable, unlike conventional currencies and properties.

By the end of 2017, when Bitcoin price increased most significantly to 1600 US Dollars for 1 Bitcoin, the Bitcoin had gained enormous popularity. Many experiments have carried out using time series analysis to forecast the price of Bitcoin. Predicting is the challenging aspect and it is one of the greatest obstacle to human insight and every human craves for it. Investors must forecast Bitcoin values. Instead of being damaged by chance while making a purchase when the value is high, Bitcoin users must be observant in managing any price adjustments to profit. The unpredictable price of Bitcoin can be predicted through forecasting or forecasting the Bitcoin price in the foreseeable future. Users can decide when to purchase bitcoin with predictions.

This paper implements Long-Short Term Memory (LSTM) Neural Network, from time-series data of quantitative factors influencing Bitcoin prices to predict the changes. The idea aims to introduce a framework adept to processing data in real-time and providing investors with a guide to assist to settle the plan in action. The program will take the data from the real world and undergo a series of data reshaping to make it ready to be fed into the neural network model.

LSTM Neural Network architecture is a part of the Deep Learning field. LSTM has feedback links, unlike casual feedforward neural networks. It is capable of processing not only single points (such as images) but also whole data sequences (such a speech or video). For instance, LSTM refers to tasks such as unsegmented recognition of related handwriting, speech recognition, and identification of anomalies in network traffic or IDSs (Intrusion Detection System).

LSTMs solves the vanishing gradient issue that is encountered during the training of RNN. LSTM neural network is based on three gates; input gate, output gate and forget gate. Over arbitrary time intervals, the cell recalls values, these gates control the information incoming and outgoing of a cell.

LSTM networks are well suited to make predictions based on time series data as uncertainty can straggle,

Based on Time-Series data, LSTM networks are well suited to classifying, processing, and making predictions, as there can be lags of uncertainty, the length among the main occurrence of time series data.

The inspiration for this project was taken from [14].

In the rest of the paper, in Section 2 Related Work is discussed, following to this Section 3 defines Methodology and in Section 4 shows the Results of conducted experiment, Section 5 gives the Conclusion.

II. RELATED WORK

The high volatility feature of Bitcoin has attracted many researchers from the field of economics, machine learning, and cryptography. The various machine learning algorithms are utilized for Bitcoin price prediction. [8] discovered the influence of Bayesian Neural Network (BNN) by evaluating the Bitcoin's time series system. Using Blockchain and macroeconomic variables the forecasted Bitcoin prices and contrasted the prediction success of BNN methods with linear regression methods and SVRs. They notice that in terms of RMSE and MAPE BNN model outperform other models for predicting the

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Bitcoin log prices. Their SVR model indicates low performance in training and testing stages. [9] investigate the accuracy of the prediction of Bitcoin using a machine learning algorithm and compare the performance with ARIMA. The paper followed CRISP data mining technology. The dataset of Bitcoin was collected for 3 years of timestamp. The closing price of Bitcoin was used as an independent variable. The results showed that LSTM achieved an accuracy of 52%, whereas RMSE achieves 8% accuracy. The performance of ARIMA based on error was significantly worse than neural network models. The LSTM outperformed RNN marginally, not remarkably. [10] presented the project on predicting the bitcoin price using two deep learning technologies. Historical data was collected from 2015. They filtered the data to get the relevant features. CNN and RNN models were tested with 2-layers, 3-layers, and 4-layers approach. The result shows that 4-layers outperformed 2-layers but not optimal for 3-layers. The models were integrated on web pages designed on the Django web framework. [5] proposed a model called ConvLSTM which is a combination of Convolutional Network and Recurrent Neural Network. This model is based on the architecture of LSTM. Historical data of a total of 10 stocks had been collected of daily basis transaction. The proposed architecture was compared with the pure LSTM. LSTM predicted better for several stocks than the proposed architecture. However, the proposed architecture was more stable and showed an optimal error rate in multiple stocks. But the accuracy of the proposed network still needs to be improved.

III. METHODOLOGY

The model is built using the sequential time series algorithm LSTM of RNN. This paper implements the LSTM neural network with dropout value of 0.2 and linear activation function. This model uses Adam optimizer for compilation and MSE as loss function.

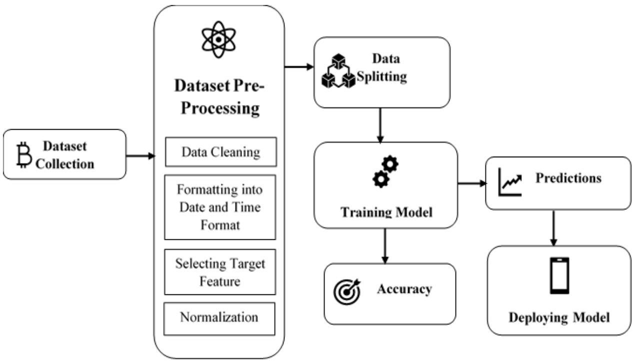

Fig. 1 Workflow Diagram of Model

Dataset

The real-time dataset is taken from the website cryptocompare. The table shows the description parameters of the dataset.

TABLE 1. FEATURE DESCRIPTION OF DATASET

Features	***Description***
Open (O)	An open price of the currency in a market.
Close (C)	The nearest price to the market price of currency.
High (H)	The highest price of the currency in a market.
Low (L)	The lowest price of the currency in a market.
Volume	The volume of currency traded for that day.

For our project, we have targeted the close price of Bitcoin. 80% of the dataset is for training and 20% for testing.

A. Data Visualization

From figure 2, we can observe that from April 2019, the price rapidly went up in July 2019 and has attained the highest peak that is above 12000 USD. Then the curve slowly goes down and, from January 2020 to April 2020, there is a visible dip in the graph. The Lockdown period has also affected the Bitcoin price. In April 2020, the price again goes up. Since April, the price is continuously going up with slight fluctuations.

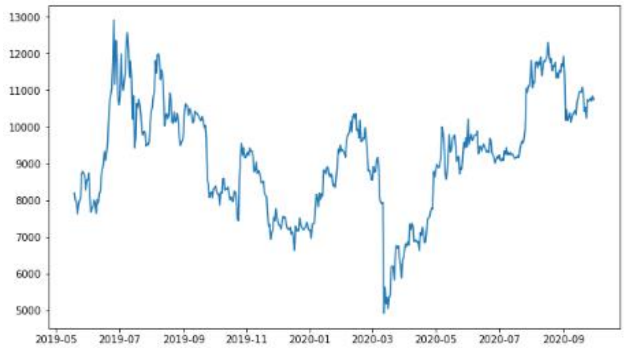

Fig.2 Data Visualization

B. Normalization,

The next phase is to normalize the data. Normalization is the process of rescaling original data without changing its behavior or nature. Here Min-Max Normalization technique is used.

1) Min-Max Normalization

On actual data, it performs linear transformation. It maintains the relationship between the values of real records. If the input values go past the range of normalization in the future, an error known as an out-of-bound-error can occur. [11]

C. Long Short Term Neural (LSTM) Network

Recurrent Neural Network is neural network with directed graph sequence that links the output to the input. That input connects the results of number point to the next point in time, and tracks the neuron related information, so that the next event results. The value is related to the production value of earlier time points.

Long-Short Term Memory (LSTM) is a type of Recurrent Neural network that can learn the data of long sequences, a challenge that conventional RNNs are struggling with, which is useful for some forms of prediction that enable the network to maintain knowledge over lengthy periods. LSTM is to mitigate the vanishing and the exploding gradient problem.

A sequence of RNN modules has the shape of all repeating neural networks. This repeating module would have a simple structure with regular RNN, as in a layer of tanh. Also, LSTMs have shape like this chain, but the repetitive module has a different structure. Instead of a single layer, there are four uniquely interacting.

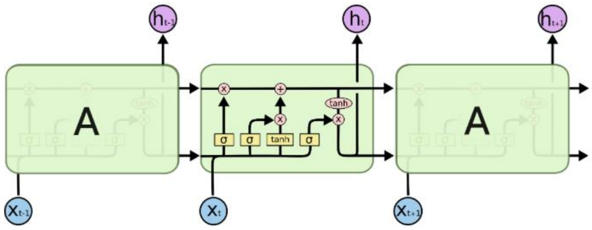

Fig. 3 Repeating Module in an LSTM contains four interacting layers

1) *Working of LSTM*

Each of the memory cells in the LSTM network has three types of gates- forget gate, input gate, and the output gate.

The 1st Step of LSTM specifies what data to throw away from the cell state. This decision is made by the forget gate layer. One means retaining this information and zero implies discarding this information.

$$f_t = \sigma(W_f . [h_{t-1} . x_t]+b_f) \quad (1)$$

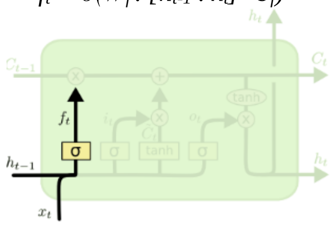

Fig. 4 Forget Gate Layer

2nd Step decides what information to the store in the cell state. It has two parts: the first input gate layer that selects the value to update. Next, a new candidate value Ct is created by adding the tanh layer in the state. Then, these two values are combined to create an updated condition.

$$i_\tau = \sigma(W_i . [h_{t-1} . x_t]+b_i) \quad (2)$$

$$c_\tau = \sigma(W_c . [h_{t-1} . x_t]+b_c) \quad (3)$$

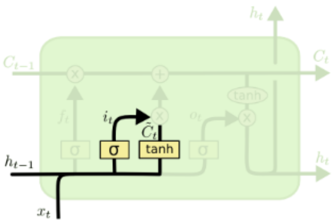

Fig. 5 Input Gate Layer

To update the old cell state, Ct-1 into new state Ct, the old state is multiplied by ft the (it * ct) is added.

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

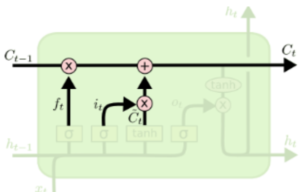

Fig. 6 Updating Cell State

The third Step decides the output. A filtered representation of the cell state is the basis of the output. Next, what areas of the cell state are going to reveal is determined by sigmoid. The cell state then positions tanh and multiplies it by the production of the sigmoid gate that generates the determined parts of the tanh.

$$o_t = \sigma(W_o . [h_{t-1} . x_t]+b_0) \quad (5)$$

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

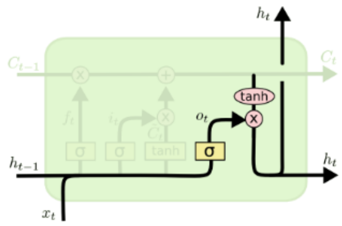

Fig.7 Output Gate Layer

D. *Evaluation Metric*

Mean Absolute Error (MAE) is a metric for performance measurement. MAE is more interpretable metric which is the rationale for preferring MAE over Root Mean Square Error(RMSE). RMSE in itself does not depict an average error and is thus much more difficult to comprehend. Since we want to describe a model quickly to the non-technical audience, MAE seems like a better alternative.

1) *Mean Absolute Error (MAE)*

Mean Absolute Error is a model evaluation metric used with regression models. The mean absolute error of a model concerning a test set is the mean of all values of individual prediction errors over all instances in the test set. Each prediction error is the difference between the actual value and the predicted value for the occurrences. [13]

E. *Deployment*

Model is deployed on an android platform. Deploying models to android with TensorFlow mobile involves three steps:

- The Conversion of the trained model into TensorFlow.
- Adding TensorFlow Mobile as a dependency on the Android App.
- Developing Java code to perform inference in application with the TensorFlow Model

TensorFlow has TensorFlow Mobile and TensorFlow Lite libraries. The Lite version is extremely limited in size, with just about 1 Mb of total dependence. Also, the templates are better configured.

TensorFlow Lite supports converting TensorFlow RNN models to the fused LSTM operations of TensorFlow Lite. Fused operations optimize the efficiency of the underlying kernel implementations and provide a higher-level interface to define complex transformations such as quantization.

Since TensorFlow has several variants of RNN APIs, the most common approach has been two-fold:

- Provide native support like Keras LSTM for standard TensorFlow RNN APIs.
- Provide the user-defined RNN implementations with an interface to the conversion infrastructure to plug in and convert to TensorFlow Lite. By using Lingvo's LSTM Cell Simple and Layer Normalized LSTM Cell Simple RNN interface.

IV. RESULTS AND DISCUSSIONS

The model is implemented using the LSTM algorithm. It is the 3-stacked layer model with a linear activation function each layer contains 500 neurons and a dropout value of 0.2. The input data split into the first 80% for training and the last 20% for testing. The model was trained on real-time data that keeps the record of 400 days from the latest date. The performance is measured using MAE evaluation metrics, and loss is measure using MSE.

TABLE 2 MODEL SUMMARY

Model Summary		
Layer (type)	***Output Shape***	***Param #***
lstm_1 (LSTM)	(None, 1, 500)	1004000
lstm_2 (LSTM)	(None, 1, 500)	2002000
lstm_2 (LSTM)	(None, 500)	2002000
dropout_1 (Dropout)	(None, 500)	0
activation_1 (Activation)	(None, 1)	0
dense_1 (Dense)	(None, 1)	501
Total params: 5,000,501, Trainable params: 5,008,501 Non-trainable, params: 0		

Figure 9 shows that from the 5th epoch, the loss during training and testing of data reduced to zero.

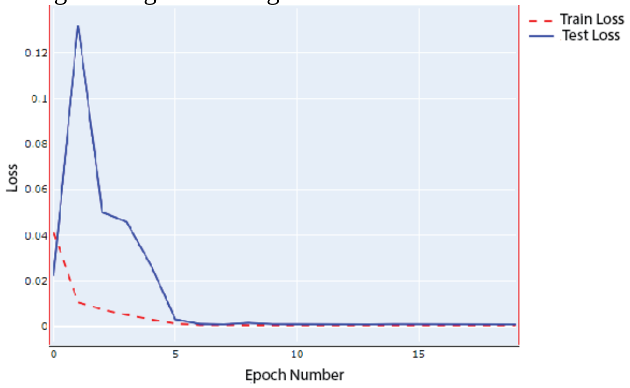

Fig. 9 Train and Test Loss

Figure 10 represents Mean Absolute Error during training and testing of data. From the given figure, we can see, an error rate is reduced below 0.05 after five epochs show good accuracy

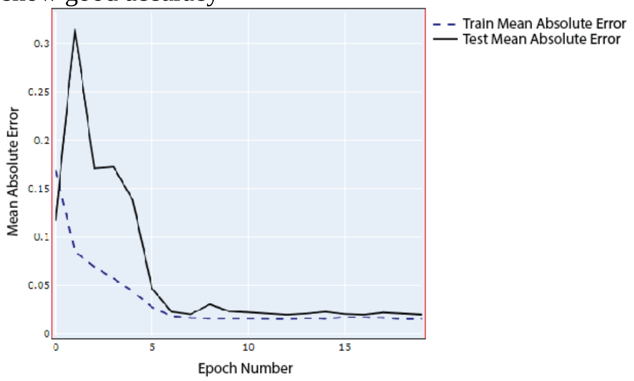

Fig. 10 Mean Absolute Error

Figure 11 represents a graph that shows the predicted values and actual values. As this model is using a real-time dataset, the plot starts from the latest date and gives a prediction for up to 100 next days. It is noticeable that the predicted labels are accurate to actual labels and showing 99% accuracy.

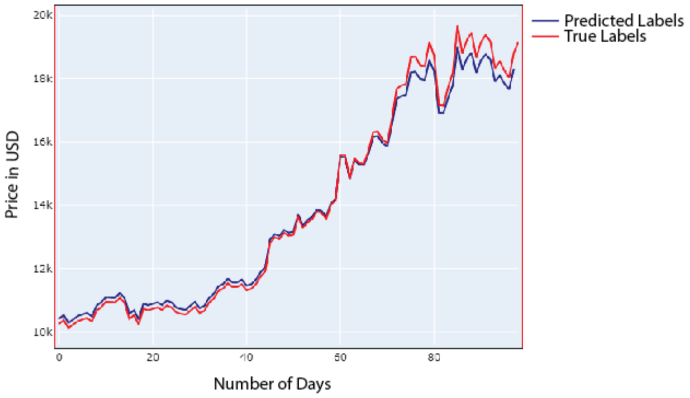

Fig.11 Predicted Graph

It is to observe that from the 70th day to the 80th day, the bitcoin price reaches its maximum price that is around 20k US Dollars.

After tuning the model, by setting the learning rate of Adam optimizer to 0.01, activation sigmoid, mean squared error as metrics, and categorical_crossentropy as the loss, there seems a big difference in training and testing validation also, it left a significant impact on the prediction graph.

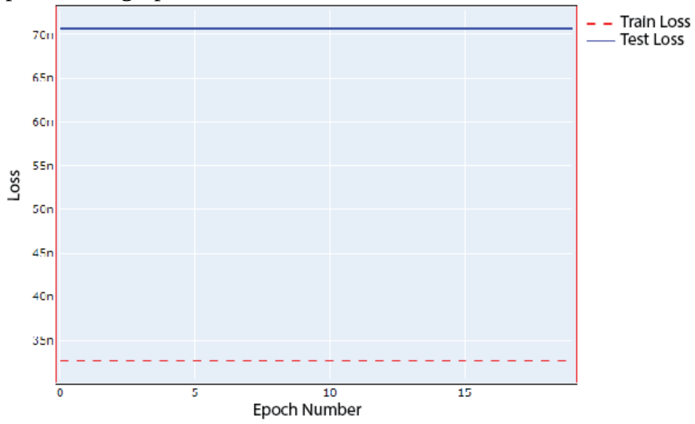

Fig. 12 Train and Test Loss

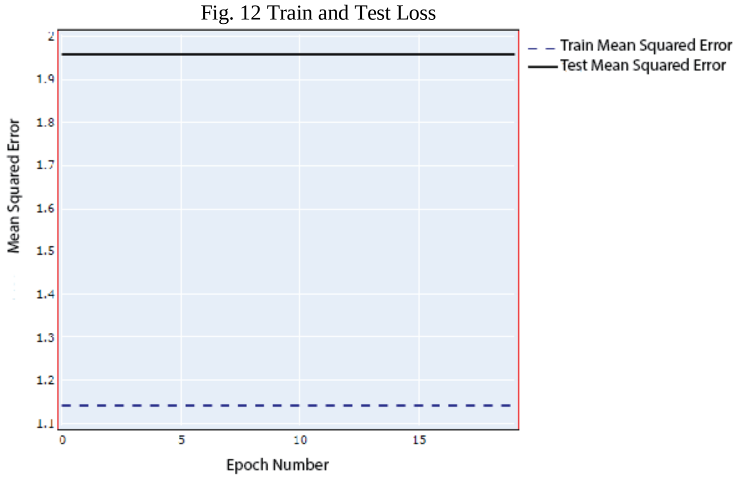

Fig. 13 Mean Squared Error

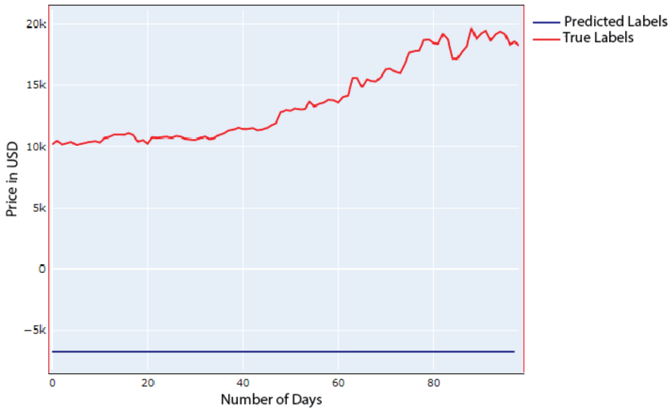

Fig. 14 Prediction Results

From the above figures, it can be assured that the parameters which were selected before turns out best for the model by giving a highly accurate prediction, whereas the parameters which were set for experimental analysis turn out to be too bad for the model.

V. CONCLUSION

Bitcoin is a decentralized cryptocurrency that works on a peer-to-peer system. It uses cryptography security and anonymity. Unlike traditional currencies, bitcoins are entirely virtual. Just like a stock, the value of Bitcoin varies. For forecasting of price, there are many algorithms used on stock market value. The criteria affecting Bitcoin are distinct. In order to make the best investment decision, the valuation of Bitcoin must also be expected. This paper is implemented on 3-Layer LSTM Model using real-time data to predict the future price of Bitcoin for the next 100 days from the current day. The model gives an excellent prediction and an error rate lower than 0.5. The concept was to incorporate a framework that could analyze real-time data and provide investors a sense of direction to aid in decision making.

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