Bitcoin Price Alert and Prediction System using various Models

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Abstract. From last many years it has been a trend to invest in cryptocurrency especially (Bitcoin) because it is one of the most popular and decentralized digital currency. However, its prices keep on fluctuating very much that makes it difficult to predict. So, our research aim is to find the less time consuming and accurate model for the prediction of Bitcoin price from different machine learning models like (Multivariate Linear Regression, Theil-Sen Regression, Huber Regression) and deep learning algorithms like (LSTM, GRU). The dataset that we will use for our prediction purpose will be stored in MongoDB (Big-Data Tool) because it consists of huge data points. We have also implemented IOT in our system to create an alert system, which alerts user when the value of bitcoin price reaches a threshold value.

Keywords— Big Data, IOT, Machine Learning, Deep Learning, Price Prediction, Price Alert, Bitcoin, Cryptocurrency.

1. Introduction

In the modern era, cryptocurrency is a trendsetter. Within the finance sector, with the passing of time Bitcoin has emerged as one of the popular digital decentralized cryptocurrencies. It was introduced by Satoshi Nakamoto in January 2009 [1]. The ratio of Bitcoin users to the total cryptocurrency users is 3:4. In the starting of 2017, the transaction count of alone Bitcoin exceeds all other cryptocurrencies transaction by 286,419 [2]. More than 40 countries (Germany, Croatia, Switzerland, Canada etc.) accepts Bitcoin as cryptocurrency [3]. To perform risk analysis before investing in bitcoin is recommended to the users because it is very difficult to predict its prices, which can be proven by the fact that in 2007, its price was 1,000 USD and in December 2017, it was 16,000 USD [1] [2]. Therefore, our research aim is to find the less time consuming and accurate model for the prediction of Bitcoin price from different “machine learning and deep learning algorithms” [4]. There are various factors like gold price, economic crisis, social media tweets that are continuously affecting the bitcoin price [5]. Factors open, close, high and low bitcoin price for a day are used in prediction work [6]. The dataset that contains per day interval rate, in US dollars from January 1, 2015 to July 8, 2020 was
taken from Crypto Compare website and stored in JSON format in MongoDB (Big-Data Tool), and after that, some different regression and deep learning models are implemented. We have also developed a bitcoin price alert system using IOT, so that when the price of the bitcoin reaches the threshold value (the price at which user wants to sell his/her bitcoin) then it will send an alert to user through different ways like by sending the text message, and mail to the user and will also activate the buzzer.

This research uses six libraries. We used MongoDB, which is a Big-Data Tool, as a No-SQL database, because to have a greater accuracy of the designed models we need huge data points, and to handle such a big data we need a Big-Data Tool like MongoDB [7].

i). NumPy
This library provides various methods to perform different operations on large datasets, n-dimensional arrays and matrix. [8].

ii). Pandas
This high-level library provides various methods to perform different operations on data frames [9].

iii). Matplotlib
A library that provides various methods to plot different types of graphs.

iv). SciKit-Learn
This library provides various algorithms for predictive data analysis [10].

v). Keras
This library provides functionalities for developing different deep learning models and if required we can also use Tensorflow, CNTK, and Theano libraries with keras for developing high-level neural network program [11].

vi). Bolt
This library provides an easy to use interface of Bolt Cloud API’s. It is used to communicate between Bolt Cloud API to Wi-Fi Module (Buzzer) and also to send SMS alert to the user.

vii). MongoDB
Eliot and Dwight developed MongoDB in 2007. It is a cross-platform, open-source, schema-less, NoSQL database which stores the data in document oriented approach in the form of key-values pairs and because of this the retrieval of data is also fast [12].
2. Related Work

Phaladisailoed et al [1] applies and compares various regression models like Theil-Sen Regressor, Huber Regressor and different deep learning approaches like GRU, LSTM on the 1-minute interval trading exchange dataset from kaggle. The results show that GRU has highest R² of 99.2% while Huber Regression has lowest execution time of 0.0002 seconds. Aggarwal et al [2] applied and compared different models of deep learning on different parameters that are affecting bitcoin price. The results show that LSTM has least RMSE value, sentimental analysis shows a positive correlation, and gold price analysis shows a negative correlation with the bitcoin price prediction. Rane PV et al [3] performs Bitcoin price prediction accuracy analysis by applying various models like ARIMA, LSTM, SVM, Latent Source model, Regression model, NARX model etc. The results show that NARX model has best accuracy. Greaves et al [13] uses Bitcoin transaction graph data for the prediction of Bitcoin prices. The exchange behaviour is not included in the transactions due to this the accuracy is 55%. McNally et al [14] has taken the data from Coin Desk and applies different models like ARIMA, LSTM and RNN. The result shows that highest achieved accuracy is 52.77% whereas the achieved RMSE value is 5.44%. Singh H et al [15] compares Support Vector regression (linear regression model) and KNN regression (polynomial regression model) based on root mean square error, and the result shows that KNN performs better than SVM.

3. Methodology

3.1. Data Collection
The 1-day interval trading dataset was collected from the crypto-compare website. The dataset contains 1501 data points from August 6, 2016 to September 14, 2020 in US Dollars.

3.2. Feature Selection
By calculating the correlation coefficient of all features and observing the pair-plot and heat-map correlation graph as shown in Fig 2, 3 and Table 1, we have selected the following features: close (closing value of bitcoin), open (opening value of bitcoin), high (highest value of bitcoin in a day), low (lowest value of bitcoin reached in a day). Next, we divide our dataset (1501 data-points) randomly in

![Figure 1. System Flow Diagram](image-url)
the ratio of 80:20 using train-test split. So, training dataset contains 1200 data points and the test dataset contains 301 data points.

![Figure 2. Correlation Pair-plot graph for each feature](image)

![Figure 3. Heat-map plot of features](image)

Table 1: Correlation coefficient matrix for each feature
3.3. Data preparation

To adjust the data in the range of 0 to 1 we have used Min-Max Scaler \[16\] of scikit learn library and the equation it uses is:

\[
X_{\text{new}} = \frac{X_i - \text{min}(X)}{\text{max}(X) - \text{min}(X)}
\]

Then time dimension was added to convert the 2-dimensional data into 3-dimensional data, to use it for “LSTM and GRU models” \[3\].

3.4. Modeling

As the Bitcoin prices are sequential in nature, so we have implemented and compared “machine learning models like Theil-Sen Regressor, Multivariate Linear Regression and Huber Regressor” \[1\] and for this purpose, scikit library was used, and deep learning models like “long-short term memory, gated recurrent unit” \[7\] and for this purpose we have used Keras library \[1\].

3.4.1. Multivariate Linear Regression

It is a parametric approach used to find how a response variable and several predictor variables are linearly related. Model estimates the coefficients of values. Exclusion of wrong values by various techniques helps to improve the efficiency of model \[5\]. Equation of multivariate linear regression is:

\[
Y = b_0 + b_1X_1 + b_2X_2 + \ldots + b_nX_n
\]

Y - response variable

X1, X2,Xn - predictor variables

b0 – y-axis intercept

b1, b2 – coefficients of predictor variables

n – no. of observations

3.4.2. Theil-Sen Regression
It is a non-parametric statistical method that tries to fit a best fit line in a 2-dimensional graph in such a way that the slope of the best fit line will be equal to the “median of the slopes of all lines possible through pairs of data points” [2]. It is strong against outliers because it can allow 29.3% outliers [17].

3.4.3. **Huber Regression**

It is a statistical regression technique that is robust to outliers. To distinguish between the outliers and inliers it uses a linear loss function rather than the least-square function. An inlier’s weight is greater than outlier’s weight [18].

3.4.4. **Long-Short term memory**

“It is a type of artificial recurrent neural network” [6] that has feedback connections. “Input gate, output gate, forget gate” [6] and a cell together makes a LSTM unit. LSTMs were “designed to overcome the vanishing gradient problem of traditional RNNs” [8]. The advantage of using a rolling window LSTM is that it recognises the sequential feature in the time series data that remains unnoticed by other algorithms. [4].

The equations of LSTM are:

\[
F_t = \sigma_g(W_f x_t + U_f h_{t-1} + B_f) \\
I_t = \sigma_g(W_i x_t + U_i h_{t-1} + B_i) \\
O_t = \sigma_g(W_o x_t + U_o h_{t-1} + B_o) \\
F_t = F_t o C_{t-1} + I_t o c_t(W_c x_t + U_c h_{t-1} + B_c) \\
H_t = O_t o (C_t)
\]

where the values of C0 and h0 are equal to zero and the operator o is called Hadamard-product and t in the subscript denotes the time step.
3.4.5. **Gated Recurrent Unit**

Kyunghyun Cho in 2014 introduced Gated recurrent units (GRUs) in recurrent neural networks [20]. GRU are less complex than LSTM because they do not have an output gate but they contain a forget gate. The update vector and reset vector decides the flow of information. They can store the information for a long time, without washing it with the passage of time or removing the irrelevant part of it.

![Figure 5. Structure of GRU cell](image)

Equations of GRU:

\[ Z_t = \sigma(g(W_z X_t + U_z H_{t-1} + B_z)) \]
\[ R_t = \sigma(g(W_r X_t + U_r H_{t-1} + B_r)) \]
\[ H_t = O H_{t-1} Z_t + (1-Z_t) O \sigma(h(W_h X_t + U_h (R_t O H_{t-1}) + B_h)) \]

Variables:

- \( X_t \): input vector
- \( H_t \): output vector
- \( Z_t \): update gate vector
- \( R_t \): reset gate vector
- \( W, U \) and B parameter matrices and vector

E. **IOT Implementation**

Wifi Module
3.4.6. ISM 2.4GHz

PA +25dBm: This is used as GPIO (General Purpose Input Output) device, mainly output device and uses UART(Universal Asynchronous Receiver Transmitter), SPI and I2C protocols. During this whole research we use only UART protocol for communication with buzzer attached with this Wifi module.

4. Results

Table 2 tells about the accuracy and execution time of all the implemented machine learning models whereas Table 3 tells about the MSE, R2 value and execution time of all the deep learning implemented models. The results show that among ml implemented models, Huber regression has the better accuracy and linear regression has best execution time, while among dl implemented models, GRU has better MSE and R2 value but execution time of LSTM is better than GRU.

| Model_Applied         | Accuracy  | Execution Time |
|-----------------------|-----------|----------------|
| 0 Linear_Regression   | 0.998647  | 0.011677       |
| 1 TheilSen_Regression | 0.998507  | 1.762166       |
| 2 Huber_Regression    | 0.998668  | 0.078603       |

| Model_Applied | MSE    | R2      | Execution Time |
|---------------|--------|---------|----------------|
| 0 GRU         | 0.000085 | 0.997855 | 43.991490     |
| 1 LSTM        | 0.000087 | 0.997797 | 38.761662     |

5. Future prospects and Conclusion

The result of our research is, all models have same accuracy, but Linear Regression model has best execution time. However, there are several other factors like twitter sentiment analysis, gold price analysis, economic crisis, setting parameters, different policies and laws of different countries which can affect the results. Therefore, to obtain the best results always collect the updated data. In future, there is further scope in our research like “the accuracy of various models can be increased” [4], by applying new models, by using more features to predict the bitcoin price.

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