

## COMPARATIVE ANALYSIS OF MACHINE LEARNING MODELS FOR PREDICTING BITCOIN PRICE RATE

Abhirami P Kumar\*<sup>1</sup>, Shoby Sunny\*<sup>2</sup>

\*<sup>1</sup>Department Of MCA, SCMS School Of Technology And Management,  
Ernakulam, Kerala, India.

\*<sup>2</sup>Associate Professor, Department Of MCA, SCMS School Of Technology And Management,  
Ernakulam, Kerala, India.

### ABSTRACT

Bitcoin, the first digital decentralized cryptocurrency that has gained significant importance within the market. Its price keeps on fluctuating greatly that creates it difficult to predict. To predict the market value and stability of Bitcoin, a Machine Learning based time series analysis has been applied. Three forms of Machine Learning models namely ARIMA, Facebook Prophet and XGBoost has been used for this purpose. We have conducted experiments on these techniques and therefore the results are formulated on two parameters, Mean Absolute Percentage Error (MAPE) and R-Squared ( $R^2$ ). After conducting the analysis, Facebook Prophet is considered to be the best model for predicting Bitcoin price rate with MAPE score of 3.2% and  $R^2$  score of 0.99.

**Keywords:** Bitcoin, Machine Learning, Prediction.

### I. INTRODUCTION

Bitcoin, a cryptographic money which is employed worldwide. It's a form of digital currency which is formed & held electrically. Bitcoin uses a peer-to-peer system and also the transaction happens between the users directly without an intermediary. These transactions are verified by network nodes & recorded in a public distributed ledger called blockchain. Since the system works without a central repository, Bitcoin is named the first decentralized digital currency. Within the process of Bitcoin transaction, the participants are called miners. As no bank is involved, when someone X transfers a Bitcoin to person Y, all the information is recorded in blockchain. The new block is added to the ledger at every 10 minutes. For transferring Bitcoin, person X has its own private key for his/her wallet & gets the public key of person Y's wallet. Every Bitcoin will have one or more public keys for his or her wallet which is distributed among people but can only have one private key which only the owner of the wallet can know. It's impossible that the 2 wallets have the identical key combination. The Bitcoin's value varies like several other stocks. There are numerous algorithms applied on exchange data for price prediction. The parameters affecting Bitcoin are different. So, it's necessary to forecast the worth of Bitcoin so correct investment decision is made. The value of Bitcoin doesn't depend upon the business or government. Thus, to foresee the worth it's important to use Machine Learning models to forecast the value of Bitcoin.

### II. METHODOLOGY

Multiple models were assessed on the task of forecasting Bitcoin price in terms of month. Machine Learning models like Auto Regressive Integrated Moving Average (ARIMA), Facebook Prophet & XG Boost were implemented and tested. All of these models were assessed on how well they performed on the task of prediction, and the results are analyzed. The methods underlying these models are briefly summarized below:

#### Auto Regressive Integrated Moving Average (ARIMA)

ARIMA is a Machine Learning model used for statistical analysis & forecasting. The model is employed on time series data which is able to be transformed into a stationary series. The predictions are a linear regression whose features include time differences and moving average. In ARIMA, the information is different, i.e., the value features are transformed to the difference between prices.

$$\left(1 - \sum_{k=1}^p \alpha_k L^k\right) (1 - L)^d X_t = \left(1 - \sum_{k=1}^q \beta_k L^k\right) \epsilon_t$$

- p: number of auto regressive term
- d: number of non seasonal differences needed for stationary
- q: number of logged forecast errors in the prediction equation.

Let L be the lag operator, in the above equation p,d,q are hyper-parameters over which we optimized. At each time t, we train the model using the price to predict the price at time t.

#### Facebook Prophet

Prophet is a procedure for forecasting time series data based on an additive model where non-linear trends are fit with yearly, weekly, and daily seasonality, plus holiday effects. It works best with time series that have strong seasonal effects and several seasons of historical data. Prophet is robust to missing data and shifts in the trend, and typically handles outliers well.

$$y(t) = g(t) + s(t) + h(t) + \epsilon t$$

- Trend  $g(t)$  : models non-periodic changes.
- Seasonality  $s(t)$ : represents periodic changes.
- Holiday component  $h(t)$  : contributes information about holidays & events.

#### XGBoost

XG Boost models is being used in pure Machine Learning approaches, where we completely care about quality of prediction. XG Boost regressors can be used for time series forecast. This model is a transformed model of gradient boosting algorithm.

### III. MODELING AND ANALYSIS

The aim is to predict the bitcoin price rate monthly with the help of Machine Learning models. The data set used to retrain the models is the historical Bitcoin Price rate from Kaggle website. The data set contains Bitcoin price rate from 2012 to February 2021. Initially the data is cleansed to get rid of duplicate data , unwanted fields etc.. Dickey-Fuller test , Box-cox transformation & Seasonal Differentiation were conducted to train and transform the information into a stationary time series data. Afterwards , the dataset has been divided into two : train dataset and test dataset . Then the Machine Learning models is been applied to predict the Bitcoin price rate. The results has been formulated on the basis of MAPE &  $R^2$  and the change between the predicted & weighted price is clearly visualized in graphical form.

### IV. RESULTS AND DISCUSSION

Performance of the proposed models has been measured by calculating MAPE ( Mean Absolute Percentage Error) and  $R^2$ . These parameters has been widely used in research studies.

#### Mean Absolute Percentage Error

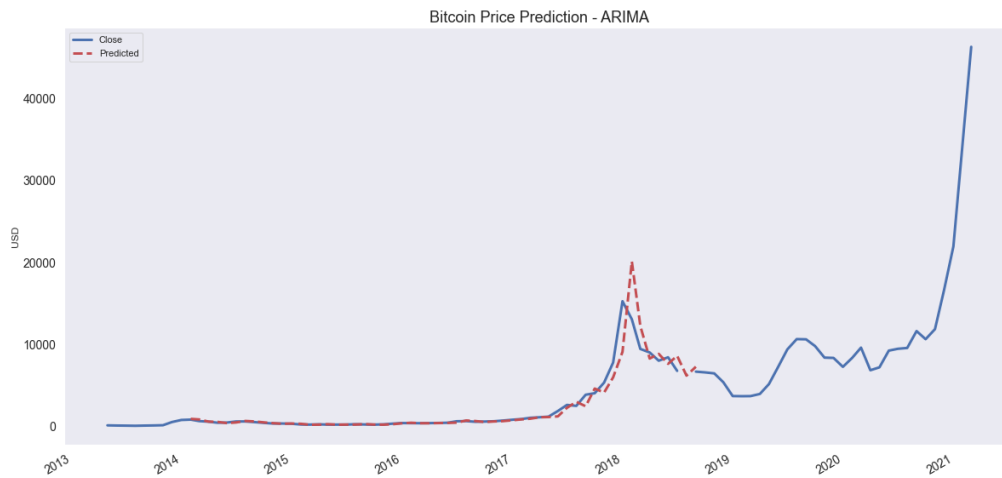
MAPE could be a measure of how accurate a forecast system is. It measures accuracy as percentage, and may be calculated because the average absolute percent error for every fundamental quantity minus actual values divided by actual values.

#### R-Squared

S-squared says how good your model fits into the data. R-squared closer to 1.0 says that the model fits the information quite well, whereas closer 0 means model isn't that good. It's a proportion of variance between actual and predicted value.

#### Performance of ARIMA Model

The Figure 1 shows the weighted observed and predicted time forecast for the bitcoin price rate.



**Figure 1.** Bitcoin Price Prediction using ARIMA

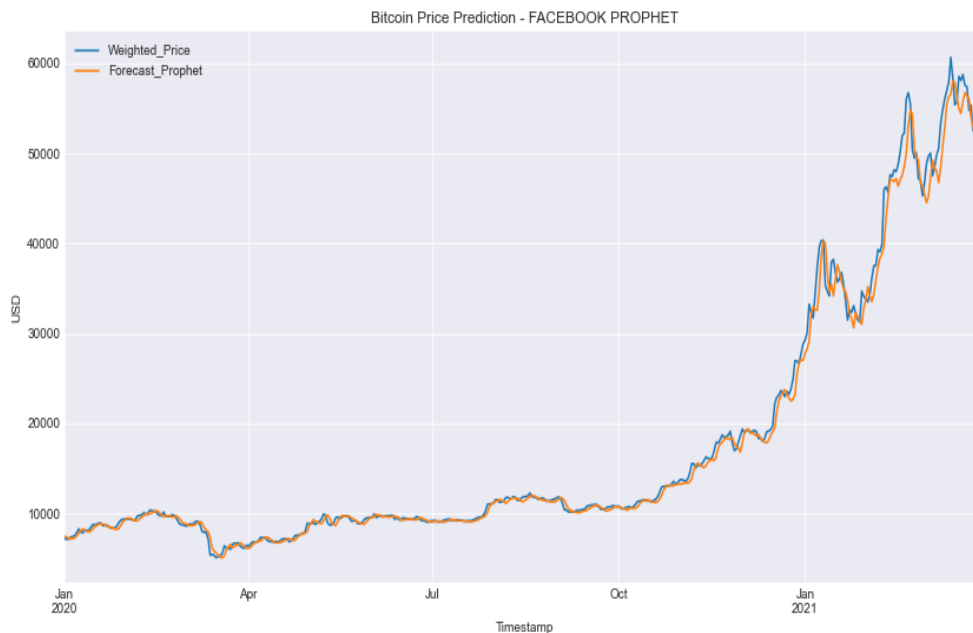
The model has been evaluated on the basis of MAPE and R<sup>2</sup>. The Table 1 shows the performance of ARIMA on the basis of above mentioned parameters.

**Table 1.** Performance analysis of ARIMA

MODEL	MAPE	R <sup>2</sup>
ARIMA	14.333904524468199 ≈ 14.3%	0.48

**Performance of Facebook Prophet Model**

The Figure 2 shows the weighted observed and predicted time forecast for the bitcoin price rate.



**Figure 2.** Bitcoin Price Prediction using Facebook Prophet

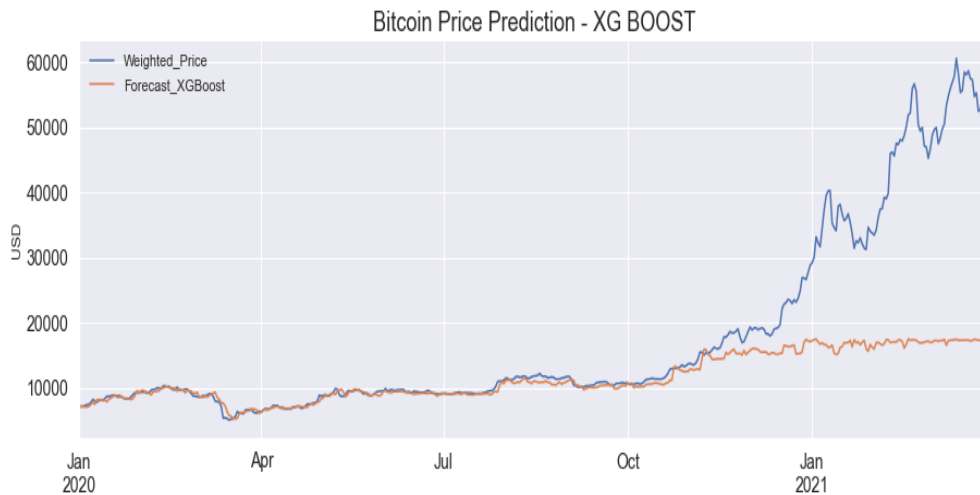
The model has been evaluated on the basis of MAPE and R<sup>2</sup>. The Table 2 shows the performance of Facebook Prophet on the basis of above mentioned parameters.

**Table 2.** Performance analysis of Facebook Prophet

MODEL	MAPE	R <sup>2</sup>
FACEBOOK PROPHET	3.1870627700236596 ≈ 3.2%	0.99

**Performance of XGBoost Model**

The Figure 3 shows the weighted observed and predicted time forecast for the bitcoin price rate.



**Figure 3.** Bitcoin Price Prediction using XgBoost

The model has been evaluated on the basis of MAPE and R<sup>2</sup>. The Table 3 shows the performance of XGBoost on the basis of above mentioned parameters.

**Table 3.** Performance analysis of XGBoost

MODEL	MAPE	R <sup>2</sup>
XG BOOST	17.415625021437563 ≈ 17.4%	0.155

The Table 4 shows the tabulated summary of the results obtained.

**Table 4.** Summarized result of all the three Machine Learning models

MODELS	MAPE	R <sup>2</sup>
ARIMA	14.3%	0.48
FACEBOOK PROPHET	3.2%	0.99
XGBOOST	17.4%	0.155

From these we can conclude that the most effective model for predicting bitcoin price rate is Facebook Prophet because by comparing the algorithm based on the parameters its MAPE is 3.2 % which is less than 10% and the value of R<sup>2</sup> is 0.99 which is close to 1. The other two models scored 14.3 % and 17.4 % MAPE respectively and R<sup>2</sup> value of 0.48 and 0.155 respectively which is far less than Facebook Prophet model.

**V. CONCLUSION**

Machine Learning is that the study of computer algorithms that improve automatically through experience and by the utilization of information. it's seen as an element of AI. Machine Learning algorithms build a model supported sample data, referred to as "training data", so as to form predictions without being explicitly programmed to try and do so.

In this study, we attempted to predict the bitcoin price rate using three Machine Learning models : ARIMA , Facebook Prophet and XGBoost . we pre-processed the information in line with the requirement , and applied the above mentioned models for time series forecasting of the bitcoin prices within the market. The result obtained concludes that Facebook Prophet is the best model to predict the bitcoin price rate within the market with R2 of 0.99.

## VI. REFERENCES

- [1] SM Raju and Ali Mohammad Tari, "Real-Time Prediction of BITCOIN Price Using Machine Learning Techniques and Public Sentiment Analysis", June 2018.
- [2] Muhammad Amjad and Devavrat Shah, "Trading Bitcoin and Online Time Series Prediction", 2017, p. PMLR 55:1-15.
- [3] Neha Mangla, "Bitcoin price prediction using Machine Learning", Volume 6, Issue 5, 2016.
- [4] S. McNally, "Predicting the price of Bitcoin using Machine Learning" Diss. Dublin, National College of Ireland, 2016
- [5] B. Scott, "Bitcoin academic paper database," suitpossum blog, 2016.
- [6] Phaladisailoed T, Numnonda T (2018) "Machine learning models comparison for bitcoin price Prediction". In: 2018 10th international conference on information technology and electrical engineering (ICITEE). IEEE, pp 506-511
- [7] I. Madan, S. Saluja and A. Zhao. "Automated Bitcoin Trading via Machine Learning Algorithms," 2015.
- [8] A. Greaves, B. Au, "Using the Bitcoin Transaction Graph to Predict the Price of Bitcoin," 2015.
- [9] A. Bernal, S. Fok and R. Pidaparathi. "Financial Market Time Series Prediction with Recurrent Neural Networks." 2012.
- [10] H. Jang and J. Lee, "An empirical study on modeling and prediction of bitcoin prices with bayesian neural networks based on blockchain information," IEEE Access, vol. 6, pp. 5427-5437, 2018.
- [11] Saxena A, Sukumar TR (2018) Predicting bitcoin Price using lstm and compare its predictability with Arima model. Int J Pure Appl Math 2591-2600
- [12] Nivethitha P, Raharitha P (2019) Future stock price prediction using LSTM machine learning algorithm. Int Res J Eng Technol (IRJET) 1182-1186
- [13] Suhwan Ji, Jongmin Kim, Hyeonseung Im, "A Comparative Study of Bitcoin Price Prediction Using Deep Learning" Mathematics Received: 12 July 2019; Accepted: 23 September 2019; Published: 25 September 2019.
- [14] J. Rebane, I. Karlsson, S. Denic, and P. Papapetrou, "Seq2Seq RNNs and ARIMA models for cryptocurrency prediction: A comparative study," in FinTech-KDD, 2018
- [15] Azim Muhammad Fahmi, Noor Azah Samsudin, Aida Mustapha, Nazim Razali, Shamsul Kamal Ahmad Khalid, "Regression based Analysis for Bitcoin Price Prediction" December 2018 International Journal of Engineering & Technology
- [16] A. Mittal, V. Dhiman, A. Singh, and C. Prakash, "Short-Term Bitcoin Price Fluctuation Prediction Using Social Media and Web Search Data," 2019 Twelfth Int. Conf. Contemp. Comput., pp. 1-6, 2019.
- [17] X. Li et al., "Empirical analysis: stock market prediction via extreme learning machine," Neural Comput. Appl., vol. 27, no. 1, pp. 67-78, 2016, doi: 10.1007/s00521-014-1550-z.