

# Comparative Study

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# A Comparative Study between the Facebook Prophet Model and SARIMA for Bitcoin Price Prediction

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**ABSTRACT:** The volatile nature of cryptocurrency markets, particularly Bitcoin, has led to an increased interest in developing accurate forecasting models for price predictions. In this study, we conduct a comparative analysis between two widely used time series forecasting models, the Facebook Prophet Model and SARIMA (Seasonal Autoregressive Integrated Moving Average), to assess their effectiveness in predicting Bitcoin prices. Based on the conducted tests, the results indicate that the Facebook Prophet model performs less favourably compared to SARIMA for daily Bitcoin predictions. However, the Facebook Prophet model yields better results than SARIMA in monthly predictions. The Mean Absolute Percentage Error (MAPE) for daily Bitcoin predictions is 6.7% when using the Facebook Prophet model, whereas the MAPE for daily Bitcoin predictions with the SARIMA model is 4.5%. The MAPE for monthly Bitcoin predictions using the Facebook Prophet model is 2.6%, while the MAPE for monthly Bitcoin predictions with the SARIMA model is 8.4%.

**KEYWORDS:** Bitcoin Prediction, Facebook Prophet Model, SARIMA model.

## I. INTRODUCTION

Cryptocurrency markets are known for their dynamic and unpredictable nature, making accurate price predictions challenging yet essential for investors and traders. Bitcoin is one of the cryptocurrencies highly favoured as an investment tool by investors. It is the most popular cryptocurrency with a total market capitalization of \$319.787 billion, according to data from Yahoo Finance at the end of 2022. Bitcoin was launched in early 2009 and created by an individual named Satoshi Nakamoto [1]

Bitcoin itself is decentralized, meaning no entities such as banks and governments control it. Due to its decentralized nature, everyone is responsible for their own transactions. Every transaction history of Bitcoin is stored in the blockchain as a ledger. The blockchain is a system that provides reliable services to parties that do not fully trust each other [2]. The blockchain will permanently store every digital transaction history[3].

Bitcoin can be traded at any time. This is because the crypto market does not have closing periods or holidays. The price movements of Bitcoin are highly volatile, so profits or losses can be substantial within a specific timeframe. The fluctuating price of Bitcoin is influenced by several factors such as government regulations, monetary policies, currency inflation, news related to Bitcoin itself, and many more. Bitcoin can be considered as an investment instrument that promises significant profits but also comes with substantial risks.

Due to the significant risks involved, it is necessary to take action to minimize the risks. One way to reduce the associated risks is by accurately predicting the price of Bitcoin.

The Facebook Prophet model is a time series forecasting tool developed by the research team at Facebook [1]. It is designed to handle time series data with daily observations that display patterns such as trends, seasonality, and holidays. Prophet was specifically created to provide a robust and user-friendly solution for forecasting tasks in a variety of industries.

Facebook Prophet model is well-suited for datasets with strong seasonal patterns, and its ease of use makes it accessible to both researchers and practitioners. Ongoing research continues to contribute to the understanding of its capabilities and potential areas of improvement.

SARIMA, which stands for Seasonal Autoregressive Integrated Moving Average, is a statistical time series forecasting model that extends the capabilities of the ARIMA model to account for seasonality[4]. The SARIMA model is designed to handle time series data that exhibits recurring patterns or seasonality at fixed intervals.

SARIMA is particularly useful for forecasting tasks where the data exhibits both trend and seasonality[5]. It is widely applied in various domains, including finance, economics, and environmental science, to make predictions based on historical time series data.

This study aims to compare the forecasting performance of the Facebook Prophet Model and SARIMA in the context of Bitcoin price prediction.

## II. RELATED WORK

Several studies have been conducted to predict the price of Bitcoin. One of them is the **analysis and implementation of the Long Short-Term Memory neural network for Bitcoin price prediction**[6]. In this research, the research team analysed price patterns in historical Bitcoin data using the Long Short-Term Memory neural network method. The analysis results indicate that the developed system can predict Bitcoin prices effectively, achieving an average accuracy rate of 93.5% in testing.

Another study involves predicting cryptocurrency prices using the K-Nearest Neighbours (KNN) method. This research focuses on forecasting the closing prices of Bitcoin, Ethereum, and Ripple over specific time periods. The results of this study indicate that the KNN method can achieve a high level of accuracy for Bitcoin, Ethereum, and Ripple. Additionally, the study compares several methods such as Linear Regression, Decision Tree, Random Forest, and Neural Network. The comparison results show that the accuracy level of KNN is the best among the compared methods.

In Indonesia, there is a researcher who predicts the stock prices of BCA Bank using the Facebook Prophet Model[5]. In this study, accuracy testing is conducted on the Prophet method for stock price prediction. The research covers the period from 2017 to 2020, with the addition of adjustment features such as holiday effects, as during that time frame there were large-scale social restrictions (PSBB) due to the pandemic. The research results indicate a good level of accuracy for the Facebook Prophet model with a Mean Absolute Percentage Error (MAPE) value of 5.4%.

The work in this paper is divided into three stages. First, predicting the price of Bitcoin using the Facebook Prophet Model (FPM). Since the FPM has proven to be capable of making accurate predictions for time series data with strong seasonal effects and various seasons, such as historical Bitcoin price data. FPM also performs well in making short-term predictions. FPM is employed to examine patterns in the movement of Bitcoin prices. The research results will be tested using a 30-day timeframe for daily data testing and a 1-year timeframe for monthly data testing.

Secondly, the research will use the SARIMA model to predict the price of Bitcoin. This is because the SARIMA model has been widely used for predictions with a reasonably good accuracy level in several previous studies. The research results will be tested using a 30-day timeframe for daily data testing and a 1-year timeframe for monthly data testing.

Thirdly, the testing results from both models will be compared based on the Mean Absolute Percentage Error (MAPE) values. The predicted values and actual values in this study are the predicted Bitcoin prices and the actual Bitcoin prices. The smaller the value produced in the MAPE calculation, the more accurate the predictions generated by each model.

## III. METHODOLOGY

The data to be used in the pre-processing stage is the daily and monthly Bitcoin price data with a time range from September 17, 2014, to the end of the year 2022. The total number of data points is 3028 for daily data and 99 for monthly data. This data includes the following fields: date, open, high, low, close, adj. close, and volume. The fields to be used in the forecasting stage are the date and close fields. The Date field contains consecutive dates, months, and years, while the close field contains the closing prices of Bitcoin. Fields other than date and close will be discarded, and the names of the date and close fields will be changed to DS for date and Y for close. This name format change is done as a standardization of field naming. The date field must exist and be of date type because it will later be converted into a computable value.

The current data used has **date** field with a date type, so the only necessary action is to change the field name. In the next process, the data is **divided into two** groups: **Data Training** and **Data Testing**. **Data training** will use a period starting from September 17, 2014, to November 30, 2022, while **Data Testing** will use a period starting from December 1, 2022, to December 31, 2022. The **Data training** will be used to build the predictive model, and the **Data Testing** will be used to evaluate the accuracy of the predictive model.



#### IV. EXPERIMENTAL RESULTS

Figure 1 displays the pre-processed data obtained from the Yahoo Finance website for daily data, while Figure 2 illustrates the pre-processed data for monthly data.

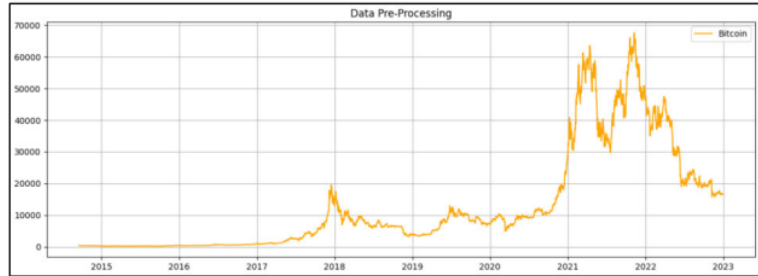


Fig. 1. Plot of Data Pre-Processing from Daily Bitcoin Price

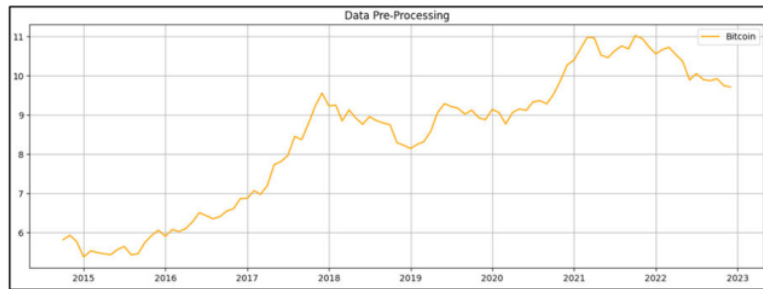


Fig. 2. Plot of Data Pre-Processing from Monthly Bitcoin Price

In Figure 1, the movement of daily Bitcoin prices experienced a surge around the years 2017 and 2021, but anomalies are noticeable in 2021. One of the causes is negative issues originating from Elon Musk, leading to a sharp decline in Bitcoin prices between May and August. In Figure 2, the overall movement of monthly Bitcoin prices from around 2014 to 2022 shows a continuous upward trend with a significant price surge in 2017. In 2021, the movement of Bitcoin prices does not show a spike, but a noticeable surge can be seen during the year 2020.

The determination of parameters for each model is carried out by using an iterative system of parameter combinations that will be input into the model. These parameters will be examined for their accuracy using the available Training Data. Parameters for the FPM involve combinations of changepoint\_prior\_scale, changepoint\_range, seasonality\_prior\_scale, and seasonality\_mode. The model with the best parameter values will be determined based on the resulting MAPE values. The smaller the MAPE value produced, the closer the fit of the model to the actual values.

The parameters for FPM can be seen in Table 1, while the parameters for SARIMA can be seen in Table 2.

TABLE 1. PARAMETER OF FACEBOOK PROPHET MODEL

Parameter	Value
Changepoint_range	0.7, 0.8, 0.9
changepoint_prior_scale	0.1, 0.25, 0.5
seasonality_prior_scale	1.0, 5.0, 10.0
seasonality_mode	'additive', 'multiplicative'

TABLE 2. PARAMETER OF SARIMA MODEL

Paramater	Value
p	1, 2
q	1, 2
P	1, 2
Q	1, 2

The testing results from FPM for daily Bitcoin prices can be seen in Table 3.

TABLE 3. DAILY BITCOIN PRICE USING FPM (THE 10 EACH SEASONALITY MODE)

changepoint_prior_scale	seasonality_prior_scale	changepoint_range	seasonality_mode	mape_train (%)
0,25	5	0,9	multiplicative	13,18142323
0,5	5	0,8	multiplicative	13,20719195
0,5	10	0,8	multiplicative	13,22715467
0,5	1	0,8	multiplicative	13,27027199
0,25	1	0,9	multiplicative	13,33359369
0,25	10	0,9	multiplicative	13,34779148
0,5	10	0,9	multiplicative	13,39134864
0,5	1	0,9	multiplicative	13,4941632
0,5	5	0,9	multiplicative	13,67202885
0,25	1	0,8	multiplicative	13,95522887
0,5	1	0,9	additive	63,50999483
0,5	5	0,9	additive	63,82586371
0,25	5	0,9	additive	64,12712664
0,5	10	0,9	additive	64,27363903
0,25	10	0,9	additive	64,5046843
0,25	1	0,9	additive	64,69296185
0,5	5	0,8	additive	65,17434642
0,5	10	0,8	additive	65,401115
0,5	1	0,8	additive	65,93448568
0,1	1	0,9	additive	68,09334935

The results of the Training Data using FPM can be seen in Figure 3.

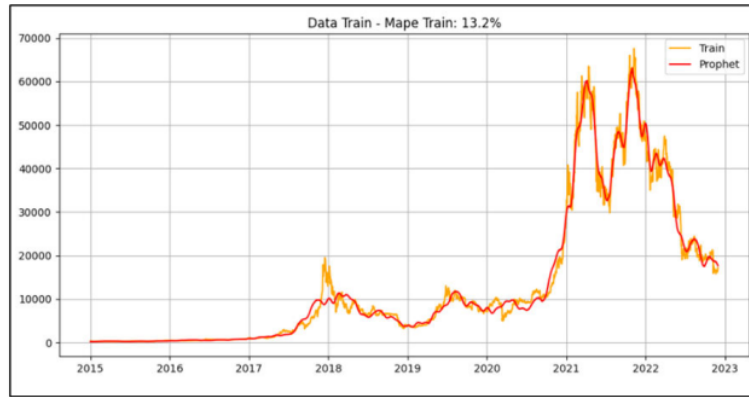


Fig. 3. Data Training of Facebook Prophet Model Daily

The parameters used in Figure 3 indicate that FPM can follow the direction of changes in daily Bitcoin price movements. This can be observed from 2020 until the end of 2022, where the Bitcoin price movement is highly volatile, and FPM can follow these movements quite well. However, from 2017 to 2018, FPM fails to follow daily Bitcoin movements adequately because the movements made by this model differ from the actual daily Bitcoin price movements.

The prediction results from FPM for daily Bitcoin data are not quite satisfactory due to a significant difference in price range generated by this predictive model compared to the actual daily Bitcoin data. However, for monthly Bitcoin price predictions, the Facebook Prophet Model produces fairly accurate predictions because the price differences generated are not too large.

The prediction results from FPM can be seen in Figure 4 and Figure 5.

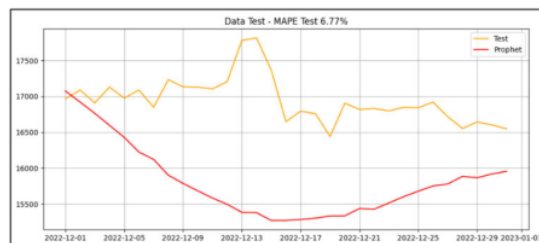


Fig. 4. Testing Result of FPM Daily

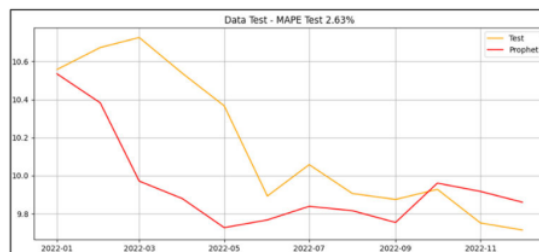


Fig. 5. Testing Result of FPM Monthly

The prediction using the SARIMA model covers a time range of 31 days in December 2022 for daily Bitcoin data and 1 year in 2022 for monthly data. The model used for predictions is the one from training that has the smallest MAPE value, both for daily and monthly Bitcoin data predictions. The prediction results from the SARIMA model for daily

Bitcoin data can be considered quite good because the difference in price range generated by the predictive model compared to the actual daily Bitcoin data is not too large. However, the monthly Bitcoin price predictions from the SARIMA model are less accurate due to a significant difference in the generated price range. The price movements produced by this model differ from the monthly Bitcoin price movements.

The prediction results of the SARIMA model for daily and monthly Bitcoin data can be seen in Figure 6 and Figure 7.

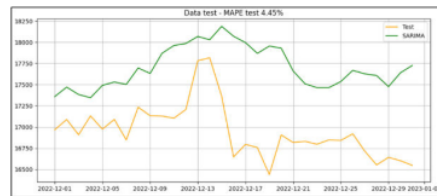


Fig. 6. Testing Result of SARIMA Daily

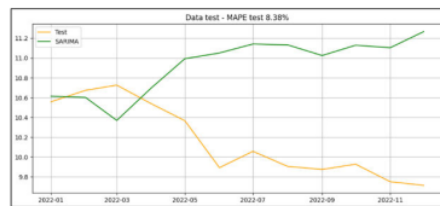


Fig. 7. Testing Result of SARIMA Monthly

The testing results of SARIMA and FPM, considering the MAPE values generated by both models in the testing of daily and monthly Bitcoin data predictions, can be seen in Table 4.

TABEL 4. COMPARISON RESULTS OF SARIMA AND FPM

	MAPE-SARIMA	MAPE-FPM
Daily	4.5%	6.7%
Monthly	2.6%	8.4%

In Table 4, it can be observed that the MAPE generated by FPM differs significantly from SARIMA in the prediction of daily Bitcoin data. The MAPE value produced by FPM is worse compared to SARIMA. However, FPM yields a much better MAPE value than SARIMA in the prediction of monthly Bitcoin data.

## V. CONCLUSION

The MAPE value for daily Bitcoin data generated by FPM is not as good as SARIMA; however, the predictions produced by FPM for monthly Bitcoin prices are better compared to SARIMA.

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