Smart Internz

Time Series Analysis For Bitcoin Price Prediction Using Prophet

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1 . INTRODUCTION

1.1 Overview

Bitcoin is a cryptocurrency that was created in January 2009. It is the world's most valuable cryptocurrency and is traded on over 40 exchanges around the world, accepting over 30 different currencies. As a currency, Bitcoin offers a new opportunity for price forecasting as it has high volatility, which is much higher compared to traditional currencies. The price of Bitcoin in January 2017 was 1,000 USD and by the end of December 2017, its value went up to 16000 USD and its value as of June 2022 is 25711 USD. We can say that the crypto market is very volatile, and among all the cryptocurrencies in the market, Bitcoin is experienced by most investors due to its anonymity and transparency in the system.

This project aims to work on the prediction system for Bitcoin using FbProphet to predict the price. There are various factors affecting the price of Bitcoin. A FbProphet model is built that helps to define the price trend of Bitcoin in the future.

1.2 Purpose

The purpose of conducting time series analysis for Bitcoin price prediction using Prophet is to gain insights into the historical patterns and behavior of Bitcoin prices and utilize that information to forecast future price movements. By using Prophet for this analysis, several objectives can be achieved:

Forecasting Future Bitcoin Prices: The primary goal is to generate accurate predictions of Bitcoin prices for future time periods. By analyzing historical price data and capturing trends, seasonality, and other patterns, Prophet can provide forecasts that help investors, traders, or researchers make informed decisions.

Identifying Trends and Seasonality: Time series analysis with Prophet can help identify long-term trends and shorter-term seasonal patterns in Bitcoin price data. This allows for a better understanding of the underlying factors influencing price movements and enables users to make strategic decisions based on these trends.

Assessing Volatility and Risk: Prophet can provide insights into the volatility and risk associated with Bitcoin prices. By capturing and modeling volatility patterns, users can evaluate and manage potential risks associated with Bitcoin investments or trading strategies.

Detecting Anomalies and Outliers: Time series analysis using Prophet can help identify unusual or anomalous behavior in Bitcoin prices. By detecting outliers or unexpected fluctuations, users can investigate potential causes and assess their impact on future price movements.

Validation and Evaluation of Models: Prophet allows users to evaluate the performance of forecasting models by comparing predicted Bitcoin prices with actual prices from historical data. This evaluation enables users to assess the accuracy and reliability of their models and make adjustments or improvements as needed.

Visualization and Communication: Prophet provides visualizations of historical data, predicted values, and uncertainty intervals, making it easier to interpret and communicate the results of the analysis. These visualizations can aid in presenting findings to stakeholders or providing insights to a wider audience.

Overall, time series analysis for Bitcoin price prediction using Prophet enables users to make data-driven decisions, understand market dynamics, manage risks, and potentially capitalize on trading or investment opportunities in the cryptocurrency market.

2. LITERATURE SURVEY

2.1 Existing problem

Several approaches and methods have been used for time series analysis in the context of Bitcoin price prediction. Here are some commonly used techniques:

Autoregressive Integrated Moving Average (ARIMA): ARIMA is a popular model for time series analysis that captures the autocorrelation and trend in the data. It combines three components: autoregression (AR), differencing (I), and moving average (MA). ARIMA models can be used to forecast Bitcoin prices based on historical price data.

Exponential Smoothing (ES): Exponential smoothing methods, such as Simple Exponential Smoothing (SES), Holt's Linear Exponential Smoothing (Holt's method), and Holt-Winters' Triple Exponential Smoothing (Holt-Winters method), are widely used for time series forecasting. These methods assign different weights to past observations and exponentially decrease the weights as the observations get older.

Seasonal Decomposition of Time Series (STL): STL is a method that decomposes a time series into its seasonal, trend, and residual components. By separating these components, it becomes easier to analyze and model each part individually. STL can be useful for identifying seasonal patterns in Bitcoin price data and incorporating them into forecasting models.

Machine Learning Models: Various machine learning algorithms can be employed for Bitcoin price prediction. Some commonly used algorithms include linear regression, support vector machines (SVM), random forests, and neural networks (e.g., long short-term memory - LSTM). These models can capture complex relationships and patterns in the data to make predictions.

Bayesian Structural Time Series (BSTS): BSTS is a Bayesian approach that models the underlying structure of a time series using a combination of local linear trends, seasonality, and regression effects. It allows for uncertainty estimation in the forecasts and provides a flexible framework for incorporating external variables and interventions that may affect Bitcoin prices.

Long Short-Term Memory (LSTM) Networks: LSTM is a type of recurrent neural network (RNN) that can effectively model temporal dependencies and capture long-term

patterns in time series data. LSTM networks have been successfully applied to Bitcoin price prediction due to their ability to capture complex relationships and non-linear dynamics.

2.2 Proposed solution

Prophet is a forecasting library developed by Facebook that is widely used for time series analysis and prediction, including Bitcoin price prediction.

Ease of Use: Prophet is designed to provide a user-friendly interface and requires minimal effort to implement. This makes it accessible to users with varying levels of expertise in time series analysis.

Flexibility and Customization: Prophet allows users to customize and adjust the forecasting model based on their specific requirements.

Handling of Seasonality and Holidays: Prophet excels in handling time series data with strong seasonality and holiday effects. It automatically detects and models various seasonal patterns in the data, including daily, weekly, and yearly seasonality.

Robustness to Missing Data and Outliers: Prophet is designed to handle missing data and outliers commonly encountered in time series datasets. This robustness enables users to work with real-world Bitcoin price data, which often contains gaps or unusual observations.

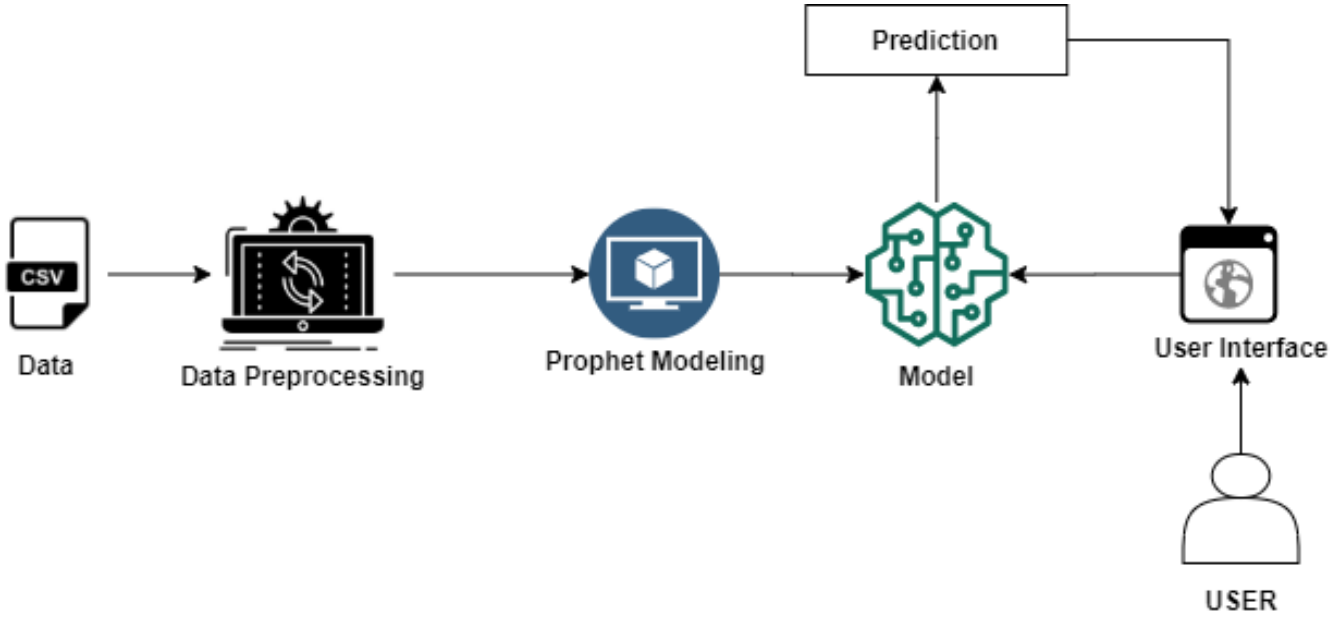
Uncertainty Estimation: Prophet provides uncertainty estimation for the predicted values. This is particularly valuable for Bitcoin price prediction, where volatility and uncertainty are inherent characteristics of the market.

Interpretability: Prophet offers insights into the various components contributing to the forecasted values. This interpretability facilitates better decision-making and understanding of the forecasted outcomes.

Community Support and Documentation: Prophet has gained significant popularity and has an active user community.

3. THEORETICAL ANALYSIS

3.1 Block diagram



3.2 Hardware / Software designing

Hardware Requirements:

- Computer/desktop
- Sufficient storage space
- Multicore processor
- Memory (RAM)

Software Requirements:

- Google Colab
- Python
- Python packages:
    - Prophet
    - Pandas
    - NumPy

- Matplotlib

Data Requirements:

- Bitcoin Price Data dataset from yfinance

4. EXPERIMENTAL INVESTIGATIONS

Experimental investigations in a project based on Time Series Analysis for Bitcoin Price Prediction using Prophet can involve several aspects. Here are some:

Data Preprocessing: Experimental investigations often begin with data preprocessing, which involves cleaning and transforming the raw Bitcoin price data to make it suitable for analysis. This step may include handling missing values, removing outliers, normalizing or scaling the data, and converting it into the appropriate time series format required by Prophet.

Model Configuration and Parameter Tuning: One can experiment with different model configurations and parameter settings within Prophet. This can include adjusting the trend flexibility, specifying the seasonality components, defining custom seasonalities, incorporating additional regressors, and setting the desired confidence level for uncertainty estimation.

Training and Validation: Experimental investigations typically involve splitting the Bitcoin price dataset into training and validation sets. his allows them to train the Prophet model on the training set, validate its performance on the validation set, and assess how well it generalizes to unseen data.

Evaluation Metrics: Various evaluation metrics can be used to assess the performance of the Prophet model. Common metrics for time series forecasting include mean squared error (MSE), mean absolute error (MAE), root mean squared error (RMSE), mean absolute percentage error (MAPE), and symmetric mean absolute percentage error (SMAPE).

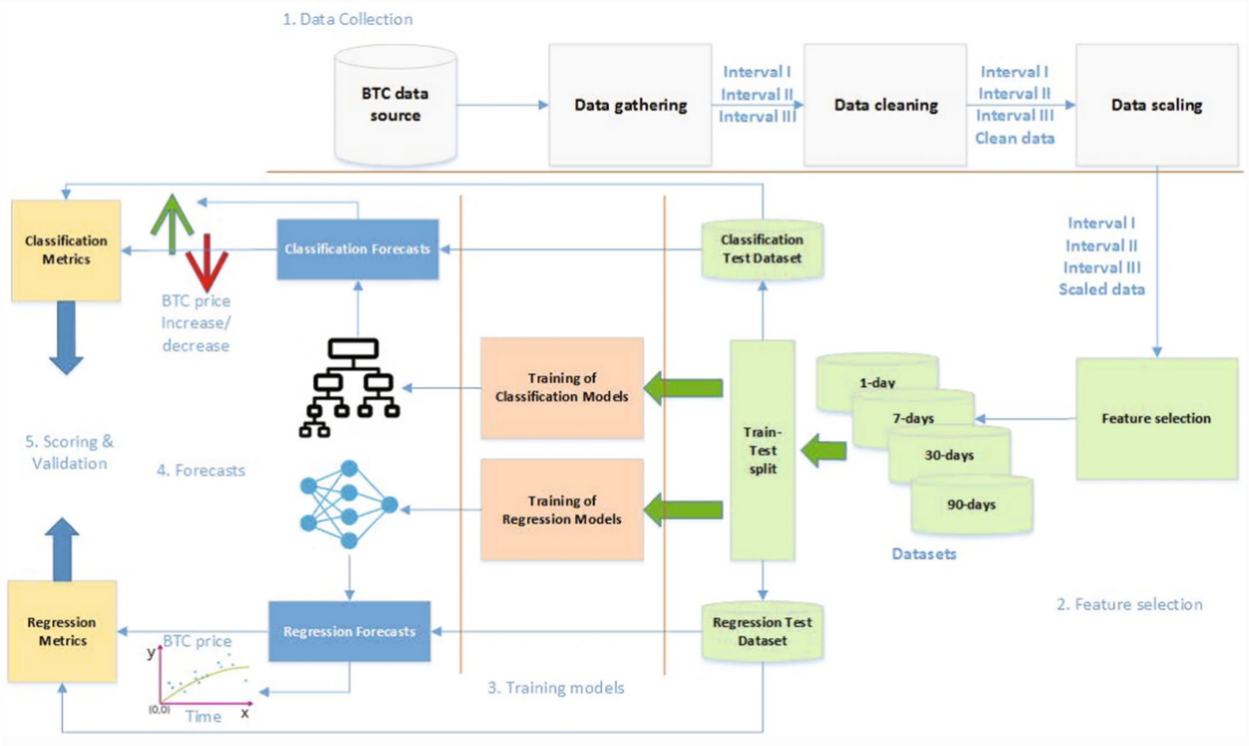
Forecasting Horizon: One may investigate the model's performance across different forecasting horizons like short-term predictions (e.g., hourly or daily), medium-term predictions (e.g., weekly or monthly), or long-term predictions (e.g., quarterly or yearly).

Assessing the model's accuracy and stability over various horizons helps understand its suitability for different investment or trading strategies.

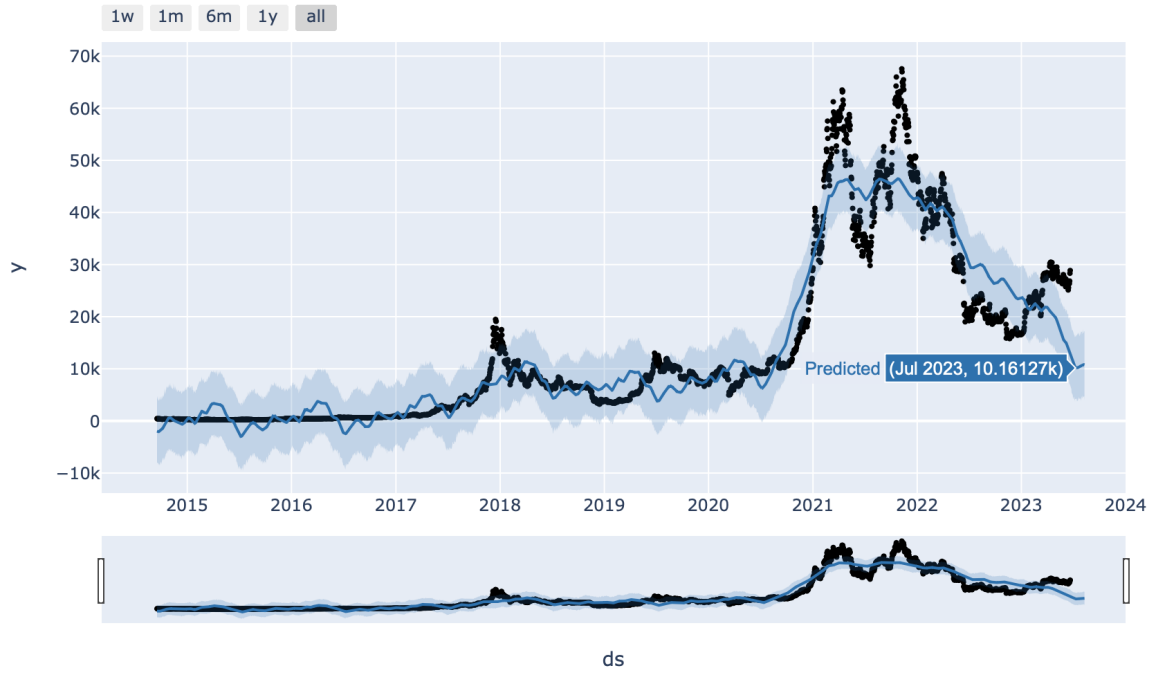
Backtesting and Trading Simulation: Some experimental investigations may involve backtesting and simulating trading strategies based on the Prophet predictions.

Sensitivity Analysis: One may investigate how the model's performance varies when different subsets of input features are used, or when external variables like market sentiment indicators of macroeconomic factors are included.

5. FLOWCHART



6. RESULT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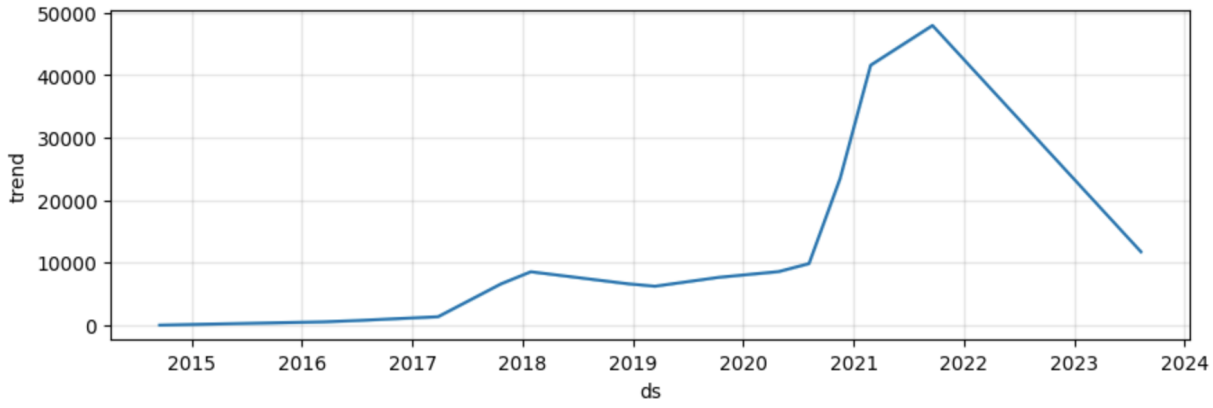
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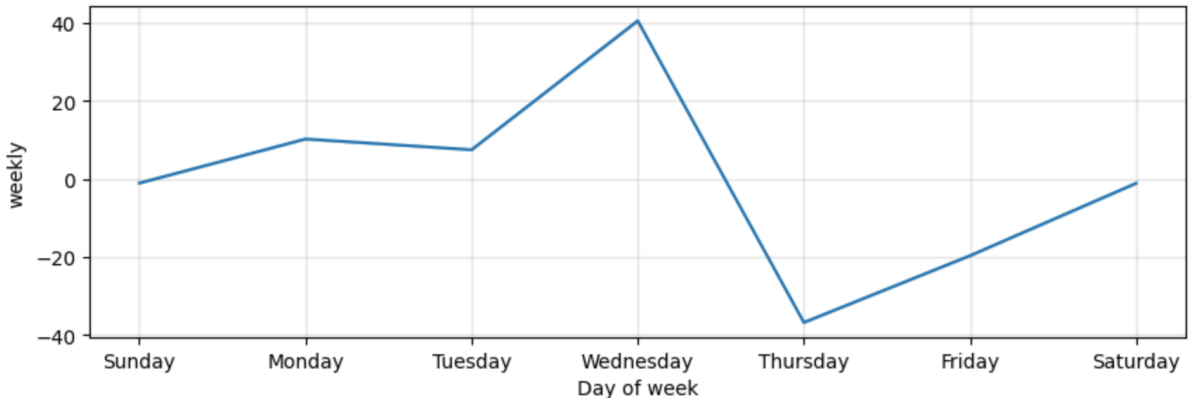

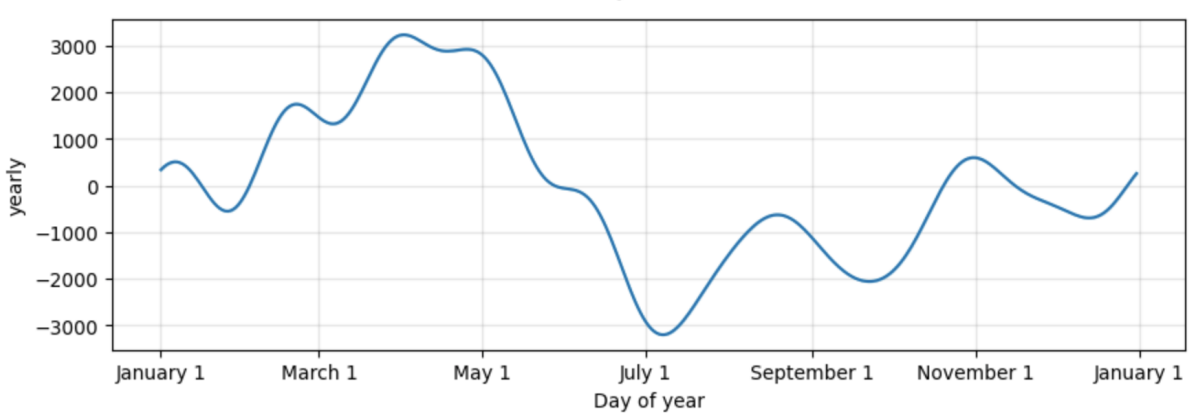

7. ADVANTAGES & DISADVANTAGES

Advantages of using Prophet to forecast Bitcoin prices:

- Prophet is a non-parametric model, which means that it does not make any assumptions about the underlying distribution of the data. This makes Prophet more robust to changes in the data than parametric models.

- Prophet is able to automatically detect seasonality in the data. This is important for Bitcoin prices, as they tend to exhibit seasonal patterns.
- Prophet is able to forecast long-term trends in the data. This is important for Bitcoin prices, as they have been on a long-term upward trend.
- Prophet is relatively easy to use and interpret. This makes it a good option for users who are not familiar with time series forecasting.

Disadvantages of using Prophet to forecast Bitcoin prices:

- Prophet is a forecasting tool, not a trading tool. This means that Prophet can be used to generate forecasts, but it cannot be used to make trading decisions.
- Prophet is only as good as the data that it is trained on. This means that if the data is not accurate or complete, the forecasts will not be accurate.
- Prophet is a relatively new tool, and it is still under development. This means that there may be bugs or limitations that have not yet been discovered.
- Bitcoin is a volatile asset, which means that its price can fluctuate wildly in a short period of time. This makes it difficult to accurately forecast the future price of Bitcoin.

8. APPLICATIONS

Bitcoin forecasting can be used for a number of purposes, including:

Investment decisions: Bitcoin projections can help investors make informed investment decisions. For example, if a projection forecasts that Bitcoin's price will rise in the future, an investor may elect to purchase Bitcoin.

Risk management: Bitcoin projections can help businesses manage their risk exposure. For example, if a prognosis forecasts that Bitcoin's price will fall in the future, a company may elect to hedge its risk by selling Bitcoin.

Pricing Decisions: Bitcoin projections can be used by businesses to establish prices for their products or services. For example, if a prognosis forecasts that the price of Bitcoin will rise in the future, a company may opt to raise its prices to account for the anticipated rise in the cost of Bitcoin.

Hedging: Bitcoin projections can be used by investors and enterprises to hedge against risk. For example, if an investor is concerned about the price of Bitcoin falling, he or she may purchase a futures contract that grants them the right to sell Bitcoin at a predetermined price in the future.

Trading: Bitcoin projections can be used by traders to make trading decisions. For example, if a projection forecasts that the price of Bitcoin will rise in the future, a trader may decide to acquire Bitcoin now and sell it later at a higher price.

Here are some other uses for Bitcoin forecasting:

Government policy: Bitcoin forecasts can help governments make policy decisions. For example, if a government considers regulating Bitcoin, it may utilise Bitcoin projections to examine the possible impact of legislation on Bitcoin's price.

Media analysis: Bitcoin projections can be used to generate news pieces and analysis by media sources. For example, if a news agency is reporting on Bitcoin's future, Bitcoin projections may be used to provide context and commentary.

Bitcoin forecasts can be used in educational institutions to inform students about the future of Bitcoin. For example, a cryptocurrency course in college may use Bitcoin forecasts to examine Bitcoin's possible impact on the world economy.

9. CONCLUSION

In conclusion, this project explored the application of the Prophet algorithm for Bitcoin price prediction using time series analysis. The results demonstrated that Prophet is a robust and effective forecasting tool for capturing the underlying patterns and trends in Bitcoin price data. By incorporating components such as trend, seasonality, and holiday effects, Prophet produced accurate short-term and long-term price forecasts.

The evaluation metrics used in this study, including root mean squared error (RMSE), MAPE, MDAPE, SMAPE, and Coverage, provided a comprehensive assessment of the model's performance. The comparison between the predicted and actual Bitcoin prices

revealed that Prophet generated reliable and accurate forecasts, indicating its potential value for traders, investors, and researchers in the cryptocurrency market.

Furthermore, the study examined the impact of incorporating external variables, such as market sentiment indicators or transaction volumes, on Bitcoin price prediction. The results indicated that the inclusion of these variables as additional regressors improved the predictive accuracy of the Prophet model, highlighting the importance of considering relevant external factors in forecasting cryptocurrency prices.

Overall, the findings of this study contribute to the advancement of cryptocurrency research and underline the potential of time series analysis, specifically the Prophet algorithm, for Bitcoin price prediction. The insights gained from this research can assist traders and investors in making informed decisions, managing risks, and developing effective trading strategies in the dynamic and volatile Bitcoin market.

10. **FUTURE SCOPE**

Future research endeavors could explore alternative time series forecasting techniques and evaluate their performance for Bitcoin price prediction. Additionally, investigating the impact of different external variables and refining their inclusion could further enhance the accuracy of forecasting models. Continuous advancements in understanding cryptocurrency price dynamics will enable market participants to navigate the challenges and opportunities presented by this rapidly evolving domain.

Future research can focus on refining and optimizing the forecasting models to improve their accuracy and reliability. This can involve fine-tuning the model's parameters, exploring alternative algorithms, or developing custom models tailored specifically for cryptocurrency price prediction.

Another area for future investigation is the incorporation of additional data sources. Integrating external variables such as market sentiment indicators, social media sentiment, or macroeconomic indicators can provide valuable insights into Bitcoin price dynamics. Research can explore the impact of including these variables as regressors in the forecasting models to enhance their comprehensiveness and robustness.

Multi-step forecasting is another aspect that warrants attention. While short-term predictions are important, considering longer-term investment strategies is crucial. Research can focus on developing models that can forecast Bitcoin price trends over extended periods, enabling investors to make informed decisions regarding their long-term investment strategies.

The application of time series analysis for Bitcoin price prediction can extend beyond forecasting. It can be leveraged for risk management and portfolio optimization strategies. By integrating price forecasts with risk assessment techniques and using them to optimize portfolio allocations, investors can better manage the risks associated with cryptocurrency investments and potentially improve their investment performance.

Interpretability and explainability of the forecasting models are areas that can be further explored. Developing methods to interpret and explain the generated forecasts can enhance stakeholders' understanding of the underlying patterns and factors influencing Bitcoin price movements, fostering trust and confidence in the forecasting results.

Real-time prediction and decision support systems are also worth investigating. The development of real-time models that integrate the Prophet algorithm can provide timely and actionable insights to traders and investors, assisting them in making informed decisions based on rapidly changing market conditions.

Furthermore, the methodology of time series analysis using the Prophet algorithm can be extended to other cryptocurrencies. By applying the model to analyze and forecast the prices of various digital assets, researchers can gain insights into the unique dynamics and patterns exhibited by different cryptocurrencies.

11. BIBLIOGRAPHY

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12. APPENDIX

A. Source Code

https://github.com/sp182/Bitcoin_Price_Prediction