

Sentiment-Driven LSTM Analysis of Bitcoin Price: Uncovering Insights from

Tweets and Macroeconomics Data

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Abstract

This project uses LSTM and NLP, to analyze Bitcoin price using Bitcoin tweets and macroeconomic indices like S&P 500, USDINDEX, and GOLD. The main objective is to use sentiment analysis and LSTM to identify patterns in the cryptocurrency market, especially in relation to Bitcoin price movements. This can help in making informed financial decisions. By combining multiple data sources and deep learning methods, the project aims to provide insights into the relationship between social media sentiment, financial indicators, and Bitcoin price dynamics. It also demonstrates the effectiveness of deep learning models for time series analysis in the cryptocurrency field.

Motivation

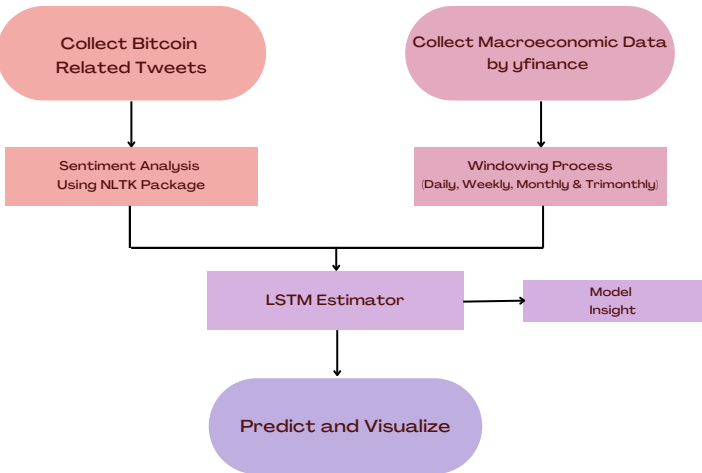
Unraveling complex dynamics: The project aims to understand the intricate factors that influence Bitcoin's price. We go beyond social media sentiment and incorporates macroeconomic indicators such as the S&P 500 index and USDINDEX. By considering these factors, the project aims to capture the broader contextual influences that shape Bitcoin's price. This integration allows for a comprehensive analysis of the interplay between sentiment, social media, macroeconomic indicators, and Bitcoin price dynamics.

Related Work

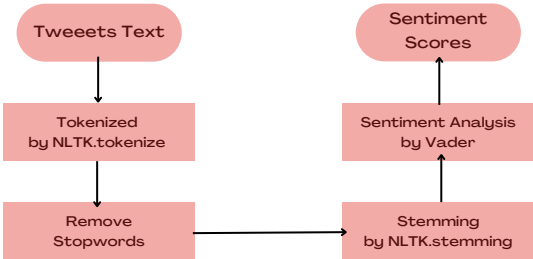
Literature Review

- Study [1] predicts Bitcoin prices using historical prices, tweet sentiment, volume, user following, and verification status, achieving a 9.06 MAPE on the FinBERT model.
- Study [2] establishes a correlation between Google Trends search volume, tweet volume, and cryptocurrency prices, and reveals that tweet volume is a better predictor of price direction.
- Study [3] utilizes random forest and LSTM to predicts the price of Bitcoin for the next day. Between 2015 and 2018, the research finds NASDAQ, DJI, and S&P 500, oil price, and ETH price have an influence on Bitcoin prices.
- Study [4] introduces the Twitter Financial Sentiment Index, showing similarities to traditional economic metrics like the U. Michigan Consumer Sentiment Index and Excess Bond Premium.

Work Flow



NLP Sentiment Analysis



Reference

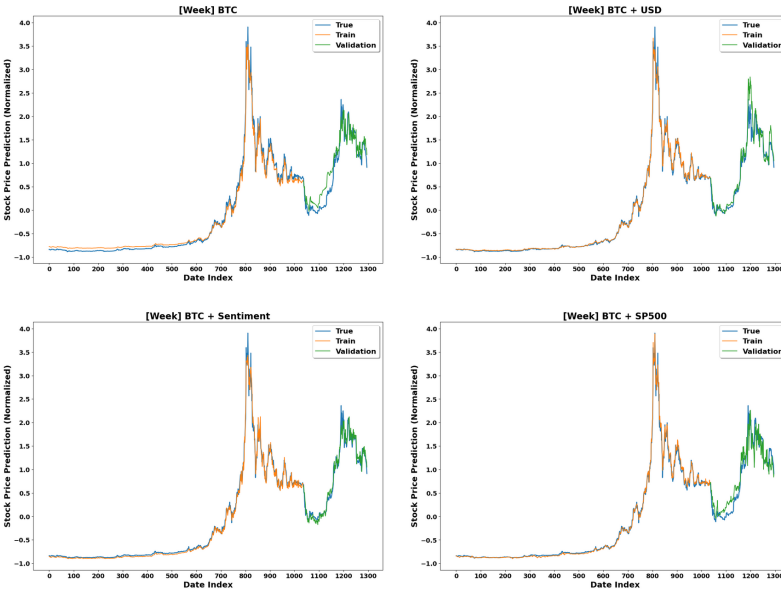
[1] Haritha G B and Sahana N B, "CRYPTOCURRENCY PRICE PREDICTION USING TWITTER SENTIMENT ANALYSIS" 2023
[2] Jethin Abraham, Daniel Higdon, Jack Nelson, Juan Ibarra, "Cryptocurrency Price Prediction Using Tweet Volumes and Sentiment Analysis" 2018
[3] Junwei Chen, "Analysis of Bitcoin Price Prediction Using Machine Learning" 2023
[4] Federal Reserve Board, Washington, D.C., "More than Words: Twitter Chatter and Financial Market Sentiment" 2023

Results

[Time window: 1 week] BTC Price Prediction – Regression Evaluation								
Features (# of features)	LSTM				CNN-LSTM			
	Train		Validation		Train		Validation	
	RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
BTC (6)	0.09	0.07	0.21	0.18	0.07	0.04	0.22	0.18
BTC + USD (12)	0.05	0.03	0.21	0.13	0.09	0.05	0.19	0.15
BTC + Sentiment (7)	0.06	0.04	0.12	0.09	0.06	0.05	0.16	0.12
BTC + SP500 (12)	0.05	0.03	0.21	0.18	0.07	0.04	0.20	0.15
BTC + USD + Sentiment (13)	0.08	0.04	0.17	0.14	0.07	0.05	0.16	0.12
BTC + USD + SP500 (18)	0.05	0.03	0.23	0.20	0.05	0.04	0.17	0.14
BTC + Sentiment + SP500 (13)	0.04	0.03	0.20	0.16	0.04	0.02	0.19	0.16
BTC + USD + Sentiment + SP500 (19)	0.04	0.03	0.19	0.17	0.03	0.02	0.19	0.15

[Time window: 1 month] BTC Price Prediction – Regression Evaluation								
Features (# of features)	LSTM				CNN-LSTM			
	Train		Validation		Train		Validation	
	RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
BTC (6)	0.11	0.05	0.26	0.21	0.07	0.06	0.18	0.14
BTC + USD (12)	0.08	0.05	0.15	0.11	0.06	0.04	0.16	0.12
BTC + Sentiment (7)	0.08	0.04	0.12	0.09	0.04	0.03	0.15	0.11
BTC + SP500 (12)	0.06	0.04	0.35	0.31	0.08	0.06	0.20	0.17
BTC + USD + Sentiment (13)	0.07	0.04	0.16	0.11	0.08	0.07	0.14	0.11
BTC + USD + SP500 (18)	0.05	0.03	0.43	0.39	0.07	0.04	0.21	0.17
BTC + Sentiment + SP500 (13)	0.07	0.04	0.32	0.29	0.08	0.06	0.18	0.15
BTC + USD + Sentiment + SP500 (19)	0.07	0.06	0.34	0.30	0.09	0.05	0.19	0.15

[Time window: 3 months] BTC Price Prediction – Regression Evaluation								
Features (# of features)	LSTM				CNN-LSTM			
	Train		Validation		Train		Validation	
	RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
BTC (6)	0.07	0.05	0.11	0.08	0.08	0.04	0.11	0.08
BTC + USD (12)	0.07	0.04	0.14	0.11	0.06	0.03	0.16	0.11
BTC + Sentiment (7)	0.06	0.03	0.15	0.10	0.05	0.04	0.13	0.09
BTC + SP500 (12)	0.08	0.05	0.18	0.13	0.09	0.05	0.13	0.09
BTC + USD + Sentiment (13)	0.06	0.03	0.15	0.11	0.10	0.06	0.12	0.09
BTC + USD + SP500 (18)	0.09	0.07	0.17	0.13	0.07	0.04	0.12	0.09
BTC + Sentiment + SP500 (13)	0.11	0.09	0.18	0.12	0.08	0.05	0.12	0.09
BTC + USD + Sentiment + SP500 (19)	0.04	0.02	0.16	0.12	0.08	0.06	0.15	0.12



Conclusion & Discussion

Sentiment features improved the model's ability to capture Bitcoin price trends and demonstrated higher adherence to ground truth prices. In the 1-month time window, SP500 can significantly decrease the model's performance. Tweets' real-time nature and social media's influence have significant implications for short term Bitcoin price prediction, which capture immediate reactions and sentiments related to Bitcoin events, enabling quick reflection of market sentiment and impacting short-term price movements. LSTM is sufficient to achieve good performance in simple feature combinations. CNN-LSTM can be widely applied to various combinations of features. By examining different time window size and feature combinations in two commonly used models (LSTM vs. CNN-LSTM), in the future, we can provide investors with more comprehensive recommendations to enhance investment performance.