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Abstract

*Keywords:*

# Introduction

The rapid developments in the field of technology and information have driven continuous breakthroughs in Financial Technology. This has led to the improvement and innovation of financial models, reshaping supply chains and value chains for the financial industry [1]. As a new alternative electronic currency exchange system, cryptocurrencies have been widely recognized to have significant consequences for emerging markets and the global economy[2].

According to Google Trends, the term "cryptocurrency" reached its peak popularity in May 2021. With the popularity of cryptocurrencies among the public, many investors see profit opportunities. One of the most popular cryptocurrencies is Bitcoin[2]. Data from coingecko also shows that the price of Bitcoin, one of the most popular cryptocurrencies, increased by 405% in 2020 and 161% in 2021, with a market capitalization reaching 1.28 trillion dollars on November 9, 2021. Not only that, cryptocurrencies offer various attractive features. Ease of use, security, and decentralization. They can be accessed through various devices, providing secure and transparent identities. At the same time, transactions are anonymous, recorded on the underlying blockchain without involving intermediaries such as banks[3].

The high price volatility of cryptocurrencies is one of the reasons why some investors are reluctant to enter it’s market[4]. For instance, the price of Bitcoin has experienced more than 10% declines precisely 59 times in a single day. The most significant drop occurred on March 13, 2020, with a decrease of 35.19%. In the context of the stock market, it is noteworthy that the price of Bitcoin exhibits significant volatility. It is pertinent to mention that the stock market incorporates a Short Sale Price Test Circuit Breaker mechanism, triggered when the price experiences a decline exceeding 10% within a single trading day [1]. Therefore, a model that can predict cryptocurrency prices in the future is needed to assist investors in maximizing profits and minimizing losses.

Many studies have been conducted to predict time series using various techniques and data. For example, the use of Google Trends data with statistical models and Machine Learning techniques such as Vector Autoregression and Random Forest to forecast the movement of Bitcoin prices based on its price and popularity[5]. These studies indicate that search data can also be a predictor variable for investment assets. Furthermore, the use of Google Trends to predict retail sales, automotive sales, real estate, and tourist destinations has also reached similar conclusions[12]. Similarly, research on the relationship between the price of Bitcoin and its trends has also yielded positive results[2]. The relationship between the price and market volume of Bitcoin has also been proven to have correlation[10]. Based on this research, it can be concluded that the popularity and volume of cryptocurrencies are correlated with their prices.

In the realm of multivariate time series analysis, it is found that using multivariate models to predict stock prices yielded better results than univariate approaches[13]. Multivariate analysis has been applied for forecasting cryptocurrencies as well, by comparing three approaches using recurrent neural networks (RNNs): Long Short-Term Memory (LSTM), Bidirectional LSTM (Bi-LSTM), and The Gated Recurrent Unit (GRU). Using five variables: closing price, opening price, highest price, lowest price, and volume for five cryptocurrencies, including Bitcoin, Ethereum, Cardano, Tether, and Binance Coin. The results showed that Bi-LSTM and GRU performed similarly with an average Mean Absolute Percentage Error (MAPE) of 0.0465712 for Bi-LSTM and 0.0446512 for GRU, while LSTM had a MAPE of 0.0529916. Although LSTM outperformed in the USDT and BNB datasets, it had higher variance compared to Bi-LSTM and GRU[14]. Relationship between Bitcoin prices and sentiment too have been used to predict bitcoin price, with a Mean Absolute Error (MAE) of 0.245, Mean Square Error (MSE) of 0.2528, and Root Mean Squared Error (RMSE) of 0.5028 [6].

These studies indicate that the use of deep learning techniques and sentiment analysis can significantly contribute to predicting Bitcoin price movements. However, with technological advancements especially in artificial intelligence, more sophisticated and effective models have emerged. One of the most advanced models as of 2023 is the transformer model with it’s self-attention mechanism, which has gained popularity with the emergence of Chat GPT (Chat Generative Pre-Trained Transformer) that has captured global attention. According to Google Trends, the keywords "Transformer Deep Learning" and "Transformer Model" have increased in popularity since early 2022, reaching their peak in March and June 2023.

"Attention is All You Need" is the title of a scientific paper presented by A. Vaswani, et al. from Google in 2017. They proposed a novel model that is an improvement over recurrent-based models for Natural Language Processing (NLP) using self-attention mechanism, named Transformer[7]. With it’s architecture, transformer can understand language surpassing other model before it in various benchmark (i.e. Machine Translation, English Constituency Parsing). One of the model that uses transformer are Bidirectional Encoder Representations from Transformers (BERT) which has been used for text translation, text classification, and other use case.

One of the subfield of text classification are sentiment analysis, before the discovery of transformers there were many sentiment models using recurrent mechanism for various fields, including social, health, and political aspects. But there are still few sentiment analysis model specifically targeted at the cryptocurrency field, especially using transformer infrastructure. Some examples include CryptoBERT by ElKulako, trained using 3.2 million social media posts from platforms like StockTwits, Telegram, Reddit, and Twitter about cryptocurrencies[9]. Another is CryptoBERT by kk08.

Transformer models have been used in various fields, not only to determine sentiment scores from sentences but also for forecasting time series data. For example, the ability of transformer models to predict Bitcoin and Ethereum prices using sentiment analysis. Comparing them with LSTM models the results showed that LSTM models outperformed transformer models. The transformer model trained using Bitcoin data had an MSE of 0.00037, MAPE of 0.05816, and MAE of 0.01432, while LSTM had an MSE of 0.00032, MAPE of 0.04613, and MAE of 0.01346. This study also found that models trained with Bitcoin data showed improvement in predicting Ethereum prices compared to models trained with Ethereum data alone[15]. In 2020, another scientific paper titled "A Transformer-Based Framework for Multivariate Time Series Representation Learning" proposed using the same architecture for time series forecasting and found that the transformer model outperformed other models (Rocket, Long-Short Term Memory, XGBoost, etc.)[8].

Inspired by the mentioned studies, this research aims to further explore the use of transformer models in predicting Bitcoin prices by considering sentiment analysis and popularity using data from Twitter, Reddit, and Google Trends. The integration of transformers in analyzing sentiment up to predicting Bitcoin prices with obtained variables will be explored. Due to hardware limitations, Google Colab is used partly to run the program, and natural language processing tokenization is limited to 256 tokens..

# The Proposed Method/Algorithm (Optional) (bold, 11 pt)

## Selecting a Template (Heading 2)

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

## Units

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive.”

## Units

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* Do not mix complete spellings and abbreviations of units: “Wb/m2” or “webers per square meter,” not “webers/m2.” Spell units when they appear in text: “...a few henries,” not “...a few H.”
* Use a zero before decimal points: “0.25,” not “.25.” Use “cm3,” not “cc.” (*bullet list*)

## Equations

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled.

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in

*a* + *b* = g (1)

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## Some Common Mistakes

* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum *m*0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o.”
* In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
* A graph within a graph is an “inset,” not an “insert.” The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
* Do not use the word “essentially” to mean “approximately” or “effectively.”
* In your paper title, if the words “that uses” can accurately replace the word using, capitalize the “u”; if not, keep using lower-cased.
* Be aware of the different meanings of the homophones “affect” and “effect,” “complement” and “compliment,” “discreet” and “discrete,” “principal” and “principle.”
* Do not confuse “imply” and “infer.”
* The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
* There is no period after the “et” in the Latin abbreviation “et al.”
* The abbreviation “i.e.” means “that is,” and the abbreviation “e.g.” means “for example.”

An excellent style manual for science writers is [7].

# Results and Discussion

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

## Authors and Affiliations

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## Identify the Headings

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include ACKNOWLEDGMENTS and REFERENCES, and for these, the correct style to use is “Heading 5.” Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract,” will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named “Heading 1,” “Heading 2,” “Heading 3,” and “Heading 4” are prescribed.

## Figures and Tables

Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. 1,” even at the beginning of a sentence.

1. Table Styles

| Table Head | Table Column Head | | |
| --- | --- | --- | --- |
| Table column subhead | Subhead | Subhead |
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1. Sample of a Table footnote. *(Table footnote)*

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1. Example of a figure caption. *(figure caption)*

Figure Labels: Use 10 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization,” or “Magnetization, M,” not just “M.” If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization (A ( m(1),” not just “A/m.” Do not label axes with a ratio of quantities and units. For example, write “Temperature (K),” not “Temperature/K.”

# Conclusion

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

##### Acknowledgment *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g.” Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

##### References

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors’ names; do not use “et al.”. Papers that have not been published, even if they have been submitted for publication, should be cited as “unpublished” [4]. Papers that have been accepted for publication should be cited as “in press” [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

[1] U.S. Security and Exchange Commission, “Division of Market Regulation.” [Online]. Available: https://www.sec.gov/divisions/marketreg/mrfaqregsho1204.htm

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