Public Opinion Prediction of Tweets on BitCoins Using Hybrid of Deep Learning

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Abstract

Bitcoin has emerged as one of the most widely discussed and adopted forms of cryptocurrency, capturing the attention of individuals, investors, and stakeholders across the globe. In recent years, its growing popularity has sparked interest in its potential as an alternative to traditional currencies. However, the highly volatile and unpredictable nature of Bitcoin and other cryptocurrencies raises concerns about financial risks, making their adoption a matter that requires careful evaluation. The integration of Bitcoin with blockchain technology has revolutionized the concept of digital transactions, encouraging users to consider cryptocurrency as a substitute for physical currency. In response, many businesses are now exploring the feasibility of accepting cryptocurrency as a payment method for goods and services. Like any financial innovation, cryptocurrencies present both opportunities and challenges, and understanding public perception is crucial for their broader acceptance. To support informed adoption and policy-making, it is essential to analyze public sentiment toward Bitcoin. Social media platforms, especially Twitter, offer a valuable source of real-time user opinions and discussions. This study aims to explore public sentiment on Bitcoin in the Indian context by analyzing tweets using a hybrid Deep Learning approach. The findings are expected to provide insights into public attitudes, which can help guide the future of cryptocurrency adoption in India.

Keywords: Bitcoin, Cryptocurrency, Clustering, Deep Learning, Sentiment Analysis

Introduction

The first cryptocurrency, known as Bitcoin, introduced in year 2008 by Satoshi Nakamoto. This is unlike government-issued money; the Bitcoin system works on a decentralized peer-to-peer network and assure to have affordable transaction cost than conventional online payment systems. A Bitcoin's market significance reached higher in 2021 at around $63,400 (Abhinand G, & Uma Maheswari V, 2021). When it is appeared in 2010, Bitcoin is lesser than five cents. The Indian

government announced that during the Union Budget 2022 on February 1st, 2022, such that 30% of fixed tax fee on all wealth made by cryptocurrency trading. This is considered by the public as the most recent development in the Indian cryptocurrency market (Derya Guler, 2021).

Investors rendering a lot of attention to buy and sell the Bitcoin. Though it is being volatility as cryptocurrency, becoming most popular and offers considerable profit. This increases the popularity among the public and trade market. Besides, individuals and small business people are the most Bitcoin investors. Despite public, investors, and stakeholders have different opinion regarding this Bitcoin. Indeed the prediction of Bitcoin price is highly correlated with public opinion of the Bitcoin. If public opinion can be predicted then Bitcoin price prediction will be easier for stakeholder and investors to take decision. The individual sentiment or opinion can impact in stake market and investment. To measure the investors, public or individual's sentiment or opinion of the Bitcoin, this research helps by using deep learning methods.

This raises the need of opinion mining or sentiment analysis regarding Bitcoin. Besides, other than many blogs and social networks, across the world Twitter paid more attention among the public as well as investors. For the purpose of this work Twitter Tweets used as the data sources and public opinion predicted by the hybrid deep learning model. Opinion mining is generally categorizing the text into negative opinion, neutral opinion and positive opinion. Though some researchers predicted Bitcoin price but lacking in efficiency. Artificial intelligence and machine learning techniques applied in stock market forecasting over the years. The most researchers have chosen Deep learning methods, Random Forest (RF), Support vector machines (SVM), and Neural Networks (NN) for forecasting of Digital Cash and Bitcoin price (Lahmiri S and Bekiros S, 2019).

The remaining of this work is structured as follows: Section 2 shows related works on Bitcoin, section 3 describes the methodology of the proposed work's procedure in detail, section 4 discusses the experimental results and discussion, and section 5 summarizes the proposed work's conclusion.

Related Works

Numerous studies take into account cryptocurrency in expressions of prediction and risk management. The most significant studies that have an impact on this subject are presented in this section. Since written or unstructured data connected to cryptocurrencies is readily available,

alternate data sources are needed since structured data is not as easily accessible (Nasekin & Chen, 2020) This highlights the necessity for Natural Language Processing techniques to unstructured or text data to forecast the cryptocurrency utilizing sentiment analysis, topic modeling (Loginova, Tsang, van Heijningen, Kerkhove, & Benoit, 2021), and semantic analysis (Kraaijeveld & De Smedt, 2020; Ortu, Uras, Conversano, Bartolucci, & Destefanis, 2022). This study concentrates on sentiment analysis, which is a branch of natural language is processing that aims to identify a word or token's polarity score (Pang, Lee, & others, 2008). Models for opinion mining developed using lexicon-based methods (Mishev, Gjorgjevikj, Vodenska, Chitkushev, & Trajanov, 2020).

Existing unquantifiable experimental results demonstrate that sentiment scores obtained from investment-related social networks and other online platforms reveal that individual investors' opinions are revealed. Various studies look at the potential value of including related features in (cryptocurrency) return forecasting models. Nasekin and Chen (2020) investigated a variety of cryptocurrencies, using new domain-specific tokens as evidence for the sentiment from StockTwits that was extracted using BERT to give return predictability. A return forecasting model's need for opinionated features is demonstrated by Chen et al. (2019) using data from StockTwits and Reddit. According to Polasik et al. (2015), news broadcast volume and news are very important factors in Bitcoin values. Opinion scores can be found in news stories over the previous seven days, as demonstrated by Vo et al. (2019). An LSTM model performs better in predicting bitcoin price trends over the course of seven days.

According to Ortu et al., features based on BERT-based feeling categorization of Reddit and GitHub comments significantly improve the daily and hourly return track preventability of Ethereum and Bitcoin. According to Zhang, Wang, and Liu (2018), the state-of-the-art in opinion classification emphasised lexicon-based approaches to the exclusion of all others since they are too domain-dependent and lack contextual perception (Basiri & Kabiri, 2020). Pretrained embeddings from Word2Vec (Rybinski, 2021) or BERT are commonly used to extract features from text data (Jiang, Lyu, Yuan, Wang, & Ding, 2022). They are effective embeddings.

The chaotic behavior of three cryptocurrencies utilized LSTM technique of deep learning, which leads to improved prediction in the digital currency market (Lahmiri & Bekiros, 2019). (Altan, Karasu & Bekiros, 2019) utilized deep learning integrated with the optimization algorithm for the digital currency price prediction. To increase performance, (Lamothe-Fernández et al, 2020)

proposed a novel model to predict Bitcoin based approach on a large dataset with stochastic gradient descent model utilized for deep learning techniques to learn the parameters employed. (Rizwan, 2019) introduced a new approach based on genetic algorithms for Bitcoin price prediction with facilitate of python scikit-learn package as the training dataset.

Deep learning models have highly developed appreciably in opinion mining or sentiment analysis as part of NLP. The primary goal of conventional machine learning techniques namely Naïve Bayes (NB) (Tang et al, 2016), SVM (Goudjil et al, 2018), etc to train a piece of the text data with target variables in progress to get the feelings classifier and constantly improved the model by fine-tuning parameters to attain the finest performance. The sentiment polarity of all words or texts then classified using the pre-trained sentiment classifier. In contrast, (Mahajan et al, 2018) employed Google Translate to increase accuracy while using Recurrent Neural Network (RNN) to detect sentiment in text data. However, the conventional RNN has issues including long-term reliance and the removal of gradient. (Hochreiter et al, 1997) presented LSTM, a unique RNN with a chain topology that can precisely assess sentiments, as a solution to these issues. (Li et al, 2016), for instance, successfully obtained whole information using LSTM to attain multi-classification of sentiment present in text. Additionally, LSTM demonstrated strong performance in sentiment categorization on texts written in several languages, including Chinese (Wang et al, 2017), Arabic (Alayba et al, 2018), and others.

From these investigation of the above research works can understand that many of the research work carried out on the Twitter dataset of the Bitcoin currency with the help of python and NLP. But the developed model being various, maximum number of researchers developed deep learning model for find the forecast of Bitcoin risk, public opinion, returns and price. The above research works have some issues that are mentioned below. (i) Price predictions lacking in when investor or public face the real price in market. (i) Some research works carried out based on the minimum volume of data. This proposed carried out to help the removing issues and give the best public opinion prediction of Bitcoin. Which will helpful to the public and investors to know and predict whether Bitcoin price will increase or decrease. In addition, to improve the performance of Bitcoin price prediction outliers removed by the clustering approach, no other existing works followed this kind of outlier removal in opinion mining or sentiment analysis.

Methodology of the Proposed Work

Bitcoin related Tweets have been collected in real time manner by facilitate of Twitter API and Tweepy Python Library. Collected Tweets are preprocessed by the Natural Language Processing and Python Libraries. Python preprocessing methods are Tokenization, Stemming, and Part of Speech Tagging. Then sentiment score or polarity score has been calculated for each words or tokens of the preprocessed Tweet. Total sentiment score of each Tweet also calculated. Finally Tweets ha1ve been classified as positive, negative and neutral based on the calculated total sentiment score of Tweets. One hot encoded applied on the Tweets. Then public opinion forecasted by the hybrid of deep learning model, in which outliers have been removed from the tweets by the Agglomerative clustering method. Outliers removed tweets and their sentiment score used as input to the Deep learning model. Then public opinion is predicted about the Bitcoin by using the Bidirectional-LSTM Deep Learning model.

Following are the steps involved in Methodology shown in the Figure 1:

- ❖ Indian Bitcoin related around 5000 volume of Tweets collected by python libraries and Twitter API
- ❖ Tweets sanitized with the help of python libraries and Natural Language Processing
- ❖ Polarity score identified from the available python dictionary libraries such as Senti Word Net and Vader Sentiment
- ❖ Based on the formed conditions sentiment score calculated for each kind of word or token in Tweet, by the help of polarity score
- ❖ Overall sentiment score of each Tweet determined
- ❖ Tweets classified as negative, neutral and positive based on the generated rules
- ❖ Classified Tweets encoded by the one hot method
- ❖ Outliers identified and removed from the classified Tweets by the K-Means clustering method
- ❖ Outliers removed Tweets involved into the Bi-LSTM Deep Learning model
- ❖ Public opinion of the Bitcoins predicted from the Tweets by the Deep Learning model

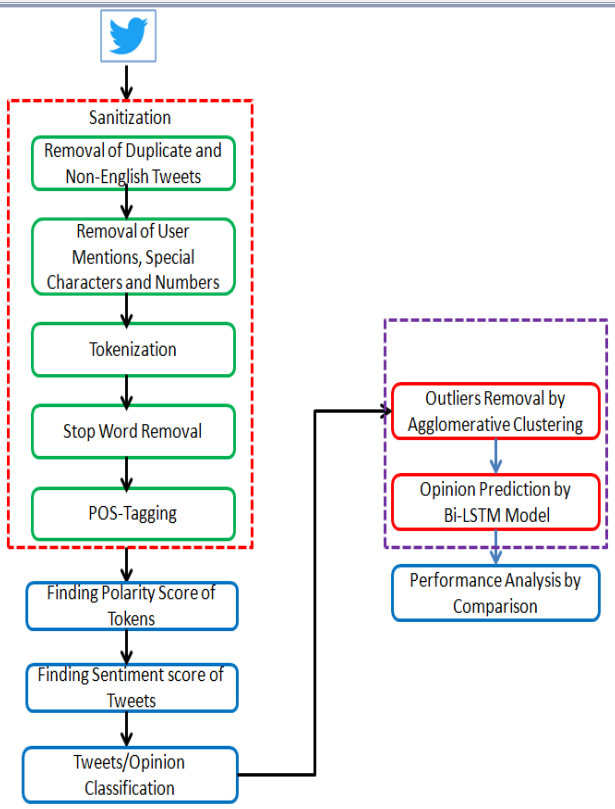

Figure 1. Architecture of the Proposed Methodology

Data Collection

The Tweets related to the Bitcoin collected in real time manner by using the keywords such as BTC INR, Bitcoin IND, BTC IND, Bitcoin INR in Twitter API and Python. Nearly 5000 retrieved from Twitter. Tweets dataset collected with attributes such as Timestamp, User ID, Tweet, Re-Tweets, Replies and Likes Count. This dataset collected from time period of May -2022 to October 2022.

Sanitization

Tweets sanitized by the following steps:

- ❖ Duplicate Tweets and Non-English Tweets removed by the python library namely pandas
- ❖ User mentions (@), unwanted symbols or characters (/, \, {, }, …), numbers (0-9) removed by the python libraries
- ❖ Tweets splitted as words or tokens (Public, Opinon, of, the, Bitcoin, etc.,) by the python library namely Tokenization
- ❖ Meaningless words or tokens (of, the, they, a, an,..) removed by the python method namely stop word removal
- ❖ Part of Speech identified and retrieved from the Tweets by the python POS-Tagging method

Finding Polarity Score

Word corpus namely SentiWordNet utilized to find the polarity score of the tokens or words. Opinion word of the tweet is determined by the corpus based on the following formula.

synset_score = ((1 - W.obj_score()) * (W.pos_score() - W.neg_score())) ---> (1)

Where, Synset_score defines the polarity score of the opinion word.
W.obj_score defines the objective score of the opinion word.
W.pos_score, and W.neg_score defines the positive and negative score of the word respectively.

For the purpose of this proposed work words with special symbols such as #, !, and @, retained. Special words such as capitalized words (BITCOIN) and repeated lettered words (Tooooo), Conjunction words such as ("but", "accept", "although", "while"), #Bitcoin, @Bitcoin, and Bitcoin!, considered as most expressive words since these words leads most impact on opinion classification and prediction. By the Part of Speech Tagging Noun, Verb, Adverb, and Adjective words discovered from the Tweets and their polarity scores determined.

To handle the negation opinion words polarity shifting method is utilized. By this method, if the word or token embed with negation words or tokens such as not bad, not good, not much, etc. Also if the opinion word's polarity score is positive then threshold value will be subtracted from the polarity score. If the polarity score of the opinion word is negative then threshold value will be added to the polarity score. Then all the calculated above mentioned score aggregated together and named as final or total score.

['total_score'] = ['exclam_score'] + ['hash_score'] + ['at_score'] + ['repeat_score'] + ['upper_score'] + ['cont_score'] + ['adj_score'] + ['negation_score'] --> (2)

If the Re-Tweet, Likes and Replies count is positive and the final/total score of Tweet is positive then final/total score is incremented by 1, otherwise final score is decremented by 1.

Finding Sentiment Score

After recognized the polarity score or calculated the sentiment score for each word or token, Total score of each tweet is calculated by the following formula.

Sentiment Score of the Tweet = Final score of a Tweet / Total Number of Words in a Tweet--> (3)

Classification of Tweets

After determined the sentiment score of the Tweet, classified the Tweets as negative, neutral and positive based on the following generated rules.

If sentiment score of the Tweet is >0 then Tweet is positive

If sentiment score of the Tweet is <0 then Tweet is negative

If sentiment score of the Tweet is =0 then Tweet is neutral

Outlier Detection

The novelty of this proposed work is, classified tweets encoded by the one hot encoding method. By which the string data is converted into binary vectors, in other words numerical representation as 0s and 1s. From the encoded Tweets wrongly classified Tweets or outliers removed by the Agglomerative clustering method. Agglomerative is the hierarchical clustering algorithm and which is most widely used method for anomaly detection or outlier detection.

Prediction of Opinion on Bitcoin Based on Deep Learning Model

Outlier removed Tweets encoded by the one hot encoding method. These encoded Tweets fed into the hybrid of Bidirectional Long Short Term Memory Deep Learning model. For the purpose of this proposed work 4 hidden layers utilized, with relu activation function, soft max activation function, binary cross entropy loss function and adam optimizer are utilized. Finally encoded Tweets trained and tested by the Hybrid of Bidirectional-LSTM model. Public opinion of Bitcoin relates to the Indian currency predicted by this Deep Learning process.

Experimental Results and Discussion

In this research work Tweets relates to the Indian Bitcoin crypto currency collected as .CSV file and processed by the python and NLP. Processed tweet's opinion classified and classified tweets passed as input into the hybrid of Agglomerative and Bi-LSTM model. From the classified tweets anomalies removed. Public opinion of the Indian Bitcoin predicted by the Bi-LSTM model with facilitate of python libraries and evaluated by the confusion matrix, sensitivity, specificity, precision, f1-score, accuracy, and, false positive rate. Also to check the performance of this proposed methodology, the obtained results of performance analysis report is compared with the CNN (Livieris et al, 2021; Li and Dai, 2020; Kwon et al, 2019), RNN (pant, 2018) and Bi-LSTM, and simple LSTM (Serafini et al, 2020).

Table.1. Performance Analysis Report on 2000 Tweets

Techniques	Accuracy (%)	Sensitivity (%)	Specificity (%)	Precision (%)	F1-Score (%)	False Positive Rate
CNN	80.77	64.52	85.86	58.82	61.54	0.1414
RNN	83.45	68.21	88.67	63.12	65.58	0.1225
LSTM	85.32	69.74	91.9	67.74	69.74	0.1215
Bi-LSTM	88.82	72.1	93.43	70.5	72.8	0.1212
Hybrid Bi-LSTM	90.3	75.58	94.44	72.69	74.33	0.1121

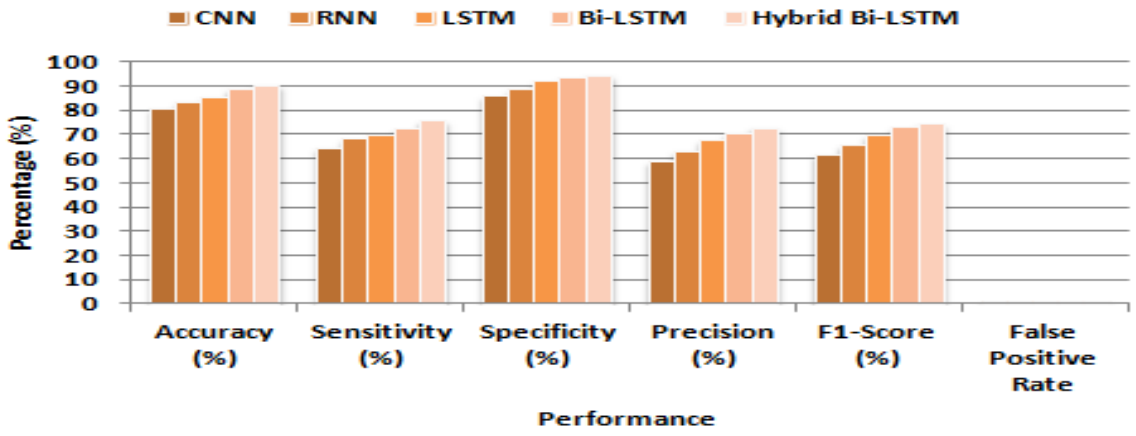

Figure 2. Comparison of Deep Learning Models on 2000 Tweets

In Table 1, opinion mining processed on 2000 volume of Tweets about Indian Bitcoin currency, and performance analysis report generated and which shows the performance metrics such as specificity, sensitivity, accuracy, precision, f1-score, and false positive rate. In which the results provided by the Convolutional Neural Network, Recurrent Neural Network, Long Short Term Memory, and Bi-Directional Long Short Term Memory, are compared with the proposed Hybrid of Bi-Directional Long Short Term Memory. This report clearly says that the proposed Hybrid method achieved accuracy 90.3%, sensitivity 75.58%, Specificity 94.44%, Precision 72.69%, F1-Score 74.33%, False Positive Rate 0.1121, which is superior to other deep learning models. Figure.2 depicts the comparison in graphical representation.

Table.2. Performance Analysis Report on 4000 Tweets

Techniques	Accuracy (%)	Sensitivity (%)	Specificity (%)	Precision (%)	F1-Score (%)	False Positive Rate
CNN	82.24	67.9	87.87	60.3	63.5	0.1333
RNN	84.92	69.99	90.1	65.66	67.3	0.1121
LSTM	87.88	71.69	93.11	69.69	71.45	0.1114
Bi-LSTM	88.82	74.6	95.6	72.9	74.5	0.1111
Hybrid Bi-LSTM	92.44	77.57	96.15	74.3	76.8	0.1109

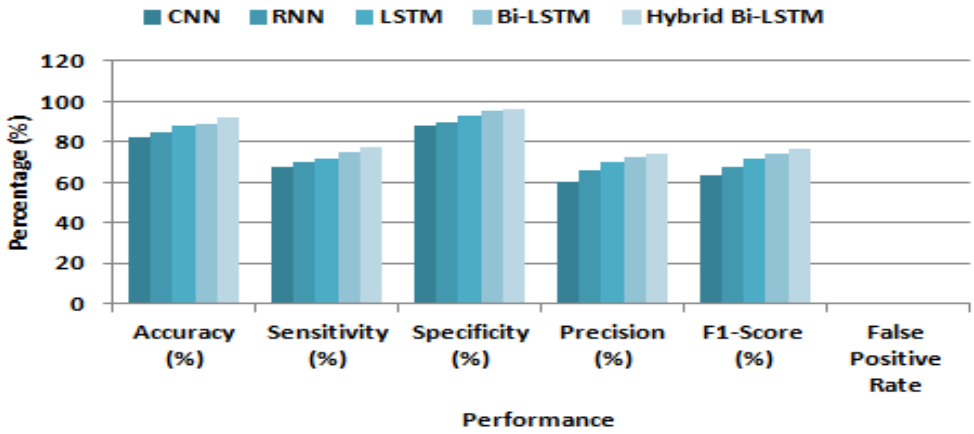

Figure 3. Comparison of Deep Learning Models on 4000 Tweets

In Table 2, opinion mining carried out using 4000 volume of Tweets, and performance metrics utilized to generate the analysis report. In which the proposed Hybrid method achieved accuracy 92.44%, sensitivity 77.57%, Specificity 96.15%, Precision 74.3%, F1-Score 76.8%, False Positive Rate 0.1109, these scores proves that performed better than other deep learning models. This comparison represented in Figure.3.

Public opinion of Bitcoins predicted using 5000 volume of Tweets. Performance analysis comparison of the proposed Hybrid deep learning model with other deep learning models illustrated in Table 3. The proposed hybrid model achieved accuracy 93.22%, sensitivity 79.35%, Specificity 97%, Precision 74.84%, F1-Score 77.9%, False Positive Rate 0.1068, which shows that proposed model performed better than all other models. Performance analysis report depicted in figure.4.

Table.3. Performance Analysis Report on 5000 Tweets

Techniques	Accuracy (%)	Sensitivity (%)	Specificity (%)	Precision (%)	F1-Score (%)	False Positive Rate
CNN	84.62	66.66	87.31	60.6	63.3	0.1319
RNN	87.45	70.17	92.3	67.11	69.42	0.111
LSTM	89.74	72.89	95.2	71.88	72.93	0.1101
Bi-LSTM	90.66	76.8	96.22	72.43	76.7	0.1085
Hybrid Bi-LSTM	93.22	79.35	97	74.84	77.9	0.1068

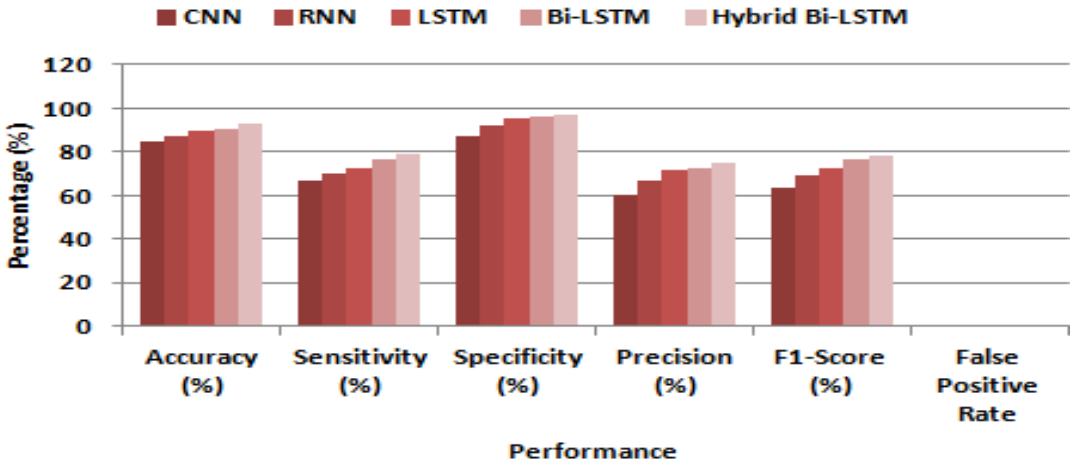

Figure 4. Comparison of Deep Learning Models on 5000 Tweets

Conclusion

To find the forecasting of public opinion on Bitcoins this work investigated by the different kinds of volume such as 3000, 4000, and 5000 real time Twitter Tweets of individuals. For the purpose of this work tweets cleaned, analyzed, and classified by the python libraries. Classified data is fed into the hybridization of Agglomerative clustering with Bi-Directional Deep Learning model. And to remove the anomalies hybrid clustering mechanism namely agglomerative clustering utilized, then opinion of the Bitcoin predicted by the Bi-Directional Deep Learning model. Then the dataset is tested on Deep Learning models such as CNN, RNN, LSTM, and Bi-LSTM. These results compared with proposed hybrid model by the performance analysis systems. An obtained result proves that the proposed mechanism attained higher than the other deep learning models. This investigation and

experimental analysis conclude that public positive opinion of the Bitcoin price is higher than the negative opinion. This says that public and investors are interested in Bitcoin currency system. This forecasting helps to individuals and investors to predict the Bitcoin price opinion of the public also can take decision regarding selling and buying the Bitcoin, according to the public opinion of Bitcoin price.

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This proposed work did not receive any fund from external resources.

Data Availability

Data collected in real time manner from twitter. Data will be provided for the data requisition.

Conflict of Interest

The authors declare that they have no conflict of interest.

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