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Forecasting Closing Price of Bitcoin Using a CNN-GRU Hybrid Neural Network Model

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Abstract : Cryptocurrency market has grown to excess. In the last period, many companies and large investors have started to allocate part of their portfolio in digital currencies. This has aroused even more interest among the population. To date, the cryptocurrency market is highly volatile and large price changes can occur in hours, sometimes even minutes. Given the growing interest, numerous strategies for predicting the price of cryptocurrencies, or its trend, are placed under the lens of scholars and researchers. One of which is the application of Machine Learning techniques. The following work is aimed at studying the possible use of machine learning techniques, in the context of forecasting the closing price. The general idea is to implement models such as GRU, LSTM, CNN-GRU Hybrid neural network for predicting market trends as to maintain and safeguard the capital, thus protecting it from large losses and large negative fluctuations. In this study we will concentrate on one of the most renowned Cryptocurrency currently available in the market i.e., Bitcoin.

IndexTerms **- Bitcoin, Crypto currency, Machine Learning, Neural Network.**

I. INTRODUCTION

The term cryptocurrency refers to a digital representation of value intended as a currency. It is a system based on the cryptography, aimed at providing a means of exchange. Bitcoin (short for BTC) is the first developed cryptocurrency, born in January 2009. The idea was presented the year before by Satoshi Nakamoto (pseudonym of developer or team of developers) in the white paper "Bitcoin: A Peer-to-Peer Electronic Cash System" [1]. Today Bitcoin is first by market capitalization and by value, despite numerous other digital currencies have been minted and developed. Bitcoin was born as a response to the crisis financial year 2007-2008, with the aim of conducting transactions without intervention financial institutions and the government, detaching themselves from fiat currencies, proposing a non-trust based electronic transaction system [1]. Not being recognized by any national authority, these digital currencies/ cryptocurrencies have a value given only by what users are willing to attribute to it through the "supply-demand" rule. Recent years, because of the potential for high returns, crypto-market attracts great attention of financial investors. However, the price changes are on a greater scale than that of the traditional financial assets such as stock and bonds, which entails a high risk. Therefore, the study of effective price forecasting methods is of great practical importance to investors, researchers around the world.

Our study focuses on predicting the Bitcoin closing price, we hope to identify a good model with the smallest percentage error. Few of the models that we will look into are Gated Recurrent Units (GRU), Long Short-Term Memory (LSTM), and a CNN-GRU hybrid model, which we will train to forecast the future Bitcoin closing price

II. Literature Review

The trend or price prediction for bitcoin has been the subject of countless incisive and in-depth conversations among academics from various nations. Despite varying opinions, the majority of studies demonstrate that adopting a hybrid strategy tend to produce superior outcomes. In 2019, Cocco, Tonelli, and Marchesi compared the performance of the single stage frameworks, formed by an NN, finally pointing out that the two stages hybrid frameworks perform better [2]. In 2019, Iman, Fabio, Gianluca, Tullio, and shiva compared the HMM-based hybrid LSTM model with stand-alone LSTM model's performance and a conventional ARIMA model. The HMM-based hybrid LSTM model outperformed the other models in terms of performance [3].

Sean McNally, Jason Roche and Simon Caton have developed RNN and LSTM models, again demonstrating better results than ARIMA, obtaining an accuracy of almost 53% in the case improve [4].In 2020 Li, Yan, and Wei DaiIn. . The following year Temesgen, Minakhi, Lipika and suresh proposed a methodology which considers two different deep learning-based prediction models to forecast daily price of bitcoin, long short-term memory (LSTM) and gated recurrent unit (GRU). From this study, we found that the GRU-based forecasting model is more appropriate in order to forecast time series data of highest price volatility and more efficient compared to LSTM [5]. A similar study done by Dutta, Aniruddha, Saket and Meheli. suggested that if correctly trained with critical and significant data, the GRU model can be more effective than other sophisticated machine learning models [6].

Multiple scaled Residual Block (MRC)-LSTM model proposed by Guo, Lei, Ye, and Fang is able to effectively learn patterns and interactions of multivariate time series and produce highly expressive features, it surpasses the single structured algorithm [7]. Li, Dai investigated how to predict the price of bitcoin using CNN, LSTM, Back Propagation (BP) neural networks, and a CNN-LSTM hybrid model, . The CNN model was able to produce results with the lowest MAPE loss [8]

III. METHODOLOGY

In this work, we will compare the performance of CNN-GRU model with models such as LSTM, GRU for predicting closing price of Bitcoin.

TABLE 1: RAW DATASET DESCRIPTION

Variables	Description
Open	Earliest price/opening price on a particular day .
Close	Latest price/closing price on a particular day.
High	Highest price recorded on a particular day.
Low	Lowest price recorded on a particular day.
Volume	Trade volume during the day.
Market Cap	Market Capital recorded at the end of the day.

3.1 Raw Dataset and Features

We obtained the original data set from CoinCodex.com . The raw data on the price of Bitcoin is organized chronologically and encompasses 2737 data points. The record starts from January 1, 2015 to June 29,2022 . The raw data contains 6 variable containing market trading information as shown in TABLE 1.

3.2 Data Preprocessing

There is no missing data, hence missing data handling is not required. In order to normalize the data, we used the Sklearn MinMaxscaler.also called Min-Max Scaling, it is a method where data is scaled over a fixed interval. The classic version reduces the data in the range between 0 and 1, below is the formula for same here Xmax and Xmin correspond respectively to the maximum value and the minimum value for that feature. We do this inorder reduce the influence of of different dimensions. The prediction period used in this study is five days and we will use MAPE as a metric for evaluation

$$X' = \frac{X - Xmin}{Xmax - Xmin.} \quad (1)$$

3.3 LSTM Neural *Network*

The LSTM is an improved RNN model, which can effectively solve the problem of gradient disappearance and gradient explosion in the RNN model [9]. It is appropriate for processing long-term sequences and also data with long-term dependencies. Its basic unit is the memory module, containing the memory unit and three gates controlling the memory unit, namely Input Gate, Output Gate and Forget Gate [8]. Batch size, time stamp, and features are the three dimensions that the model accepts as input. To forecast the close price at T, the previous five days open, high, low, close, and volume data are given as inputs.

3.4 GRU Neural *Network*

The Gated Recurrent Unit (GRU) is the newer generation of recurrent neural networks and is pretty similar to an LSTM. GRU got rid of the cell state and used the hidden state to transfer information [5]. Batch size, time stamp, and features are the three dimensions that the model accepts as input. In GRU, there are two gates, reset gates and forget gates. There is no output gate, in contrast to LSTM.

3.5 CNN-GRU Hybrid *Neural Network*

The structure of the CNN-GRU hybrid model is shown below.

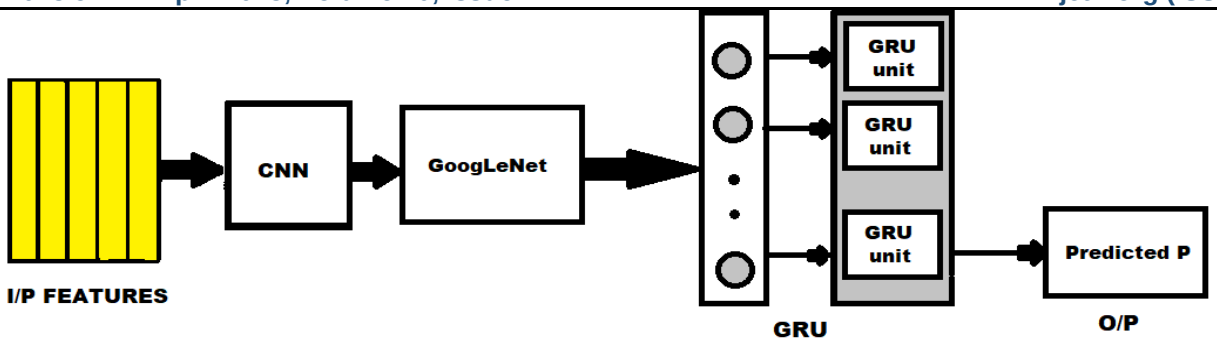

Fig. 1. CNN-GRU Hybrid Neural Network

The input features open, high, low, close, and volume are passed to CNN layer consisting of 16 1D Conv filters , which is mainly responsible for data input and feature extraction. Then it is passed to the GoogLeNet with 4 branches , each branch has a jump connection from prior CNN layer, and 16 Conv1D Conv layers with k =1,3,5 . It is followed by a GRU to finally get the predicted price .

IV. Results And Discussion

We have selected MAPE as a metric for model evaluation. Below are the results for all the models, we can see that overall hybrid model performs the best and is able to extract trends and hidden information with different time period through GoogLeNet CNN structure first then a GRU with a memory hidden cell further extracts information .The hybrid model shows promising results over the singular models and we are sure that it has huge potential in providing useful insights to investors.

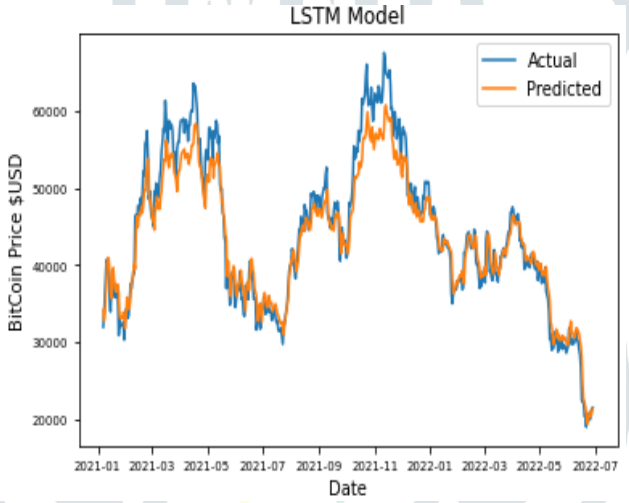

Fig 2. Actual and Predicted Price of LSTM

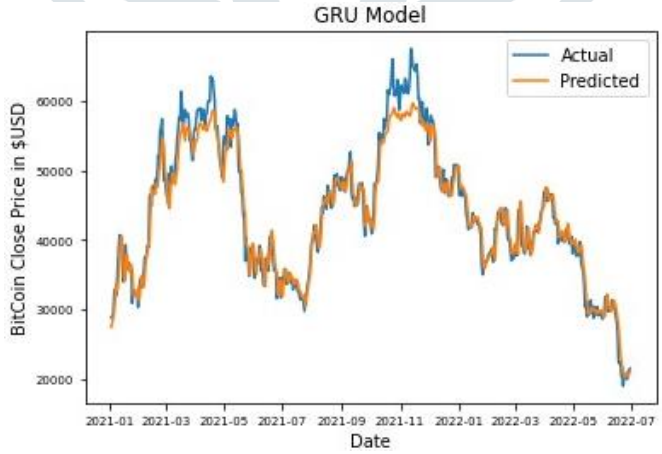

Fig 3. Actual and Predicted Price of GRU

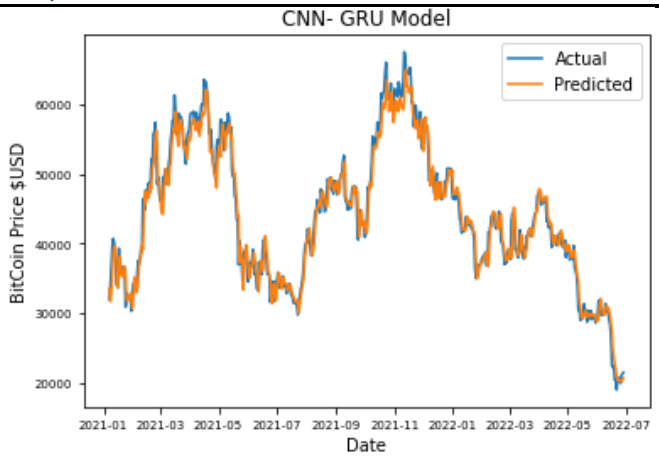

Fig 4. Acutual and Predicted Price of CNN-GRU

TABLE 2: MODEL PREDICTION PERFORMANCE SUMMARY

Model	MAPE (%)
LSTM	4.4224
GRU	4.0875
CNN-GRU Hybrid NN	3.4109

V. CONCLUSION

In this study we compared three models namely LSTM, GRU and CNN-GRU Hybrid neural network using MAPE as the metrics for model evaluation. We can see that our CNN-GRU Hybrid NN outperforms other models (LSTM and GRU) and we strive to improve the model's predictive capability even more. A better model performance might be achieved by enhancing hyper-parameters, fine tuning and adding market sentiment data i.e., to include market reaction to news and government regulations relating to cryptocurrencies, to increase forecast accuracy. Also, using more extensive examples to train our model might also help to increase overall accuracy.

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