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Efficient binary grasshopper optimization based neural network algorithm for bitcoin value prediction

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Abstract

Digital currency plays a vital role in the process of trading as it helps the sellers and buyers to earn more profit. In today's world, many categories of cryptocurrencies exist and each one of them employs its own security algorithms. Bitcoin price prediction is a complex problem that needs advanced algorithms to solve exactly. In this paper, swarm-based intelligence algorithms are applied in order to solve the bitcoin value prediction problem. In particular, Ant Colony Optimization and Binary Grasshopper Optimization algorithms are combined as a hybrid framework to select the most critical features in the dataset for bitcoin value prediction. The extracted features from the hybrid model are given as input to the convolutional neural network to predict the price of the bitcoins. As per the experimental results, the proposed hybrid algorithm produces better results when compared with the stand-alone version of grasshopper and neural network algorithms.

Keywords: Bitcoin, Value Prediction, Optimization Algorithm, Binary Grasshopper Algorithm, CNN Algorithm
2020 MSC: 92B20; 68T05

1 Introduction

1.1 Background

Digital currency concept based model which is called Bitcoin and it was introduced by Nakamoto in 2008. Bitcoin is working based on concepts of peer-to-peer networking and cryptography. It can run on any online decentralized network and doesn't depend on any government or legal entity [18]. Forecasting plays a major role in most of the financial sectors because financial loss will create more problems for capital of an industry. Some of the applications of forecasting are weather prediction, stock market prediction, floods and earthquake prediction etc. Blockchain technology is a background for bitcoin crypto currency model [20]. Currently bitcoin leads the top in the list of crypto currencies category. The various categories of crypto currencies include Litecoin, Ripple, Bitcoin and Etherum. Each of these crypto currencies use the same algorithms for transactions and are highly secure. Also, each crypto currency has its own enforcing rules and regulations at certain point of time in order to attract large number of investors [7].

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Bitcoin price can vary based on many factors at sometimes. The causing factors are divided into two major sub categories. Recently developing market and government regulations are the basic two categories of factors. Recently developing markets may cause the price of bit coin to increase or decrease based on the economic factors like demand and supply and the process of bitcoin mining. Government regulation includes the enforcement of various rules and policies at the time of bitcoinprice calculation. Stock market price prediction is difficult and it takes more time to predict the correct price. In the past years, investors are investing more in the stock market [8]. Various data mining and machine learning algorithms [17] have been used to predict the price of stocks at various point of time. As a result, there occurs some deviation in the prices of stock due to its volatile nature. As bitcoin is new and evolving, the price prediction of bitcoin requires some research and many researchers are focussing on the price prediction process. Also bitcoin has acquired more than 50% of the crypto currencies market share due to its uniqueness characteristics [12].

1.2 Objective

The main aim of this research is to predict the price of bitcoin automatically everyday on the basis of various characteristics that determine the price of bitcoin. Some of those attributes include cost of bitcoin production, demand for bitcoin, mining process, durability, utility and price volatility. In order to get accurate bitcoin price prediction, machine learning algorithms are employed. The proposed system uses a combination of ant colony optimization, grass hopper optimization and neural network algorithm to predict the bitcoin price [5].

The paper is organized into two categories: Section 2 focuses on works done by various researchers for bitcoin value prediction and Section 3 focuses on the proposed framework for bitcoin price prediction.

2 Review of Literature

S M Raju [16] proposed a framework using recurrent neural networks with combination of Long Short term memory (LSTM) for the prediction of bitcoin price. The framework was trained using standard bitcoin price dataset collected from github library. The total number of tuples is 634 from which 70% of the dataset is used for training purpose and 30% of the dataset were used for testing.The proposed LSTM model gives high accuracy when compared with ARIMA model.The main advantage of using LSTM is to avoid the errors that occurs during learning process in different LSTM cells and long term dependency recognition property.

LokeshVaddi [19] used machine learning and deep learning model to predict the market price of bitcoin for future purposes. Linear Regression with features and without features was used to train the developed model. Only historical datasets was used for the training and testing purposes. The prediction accuracy was compared with standard RNN model in which 93% accuracy was achieved with the proposed model. The main drawback of the work includes small dataset size and less prediction accuracy when used for large sized dataset.

Jigar Patel [14] used a combination of support vector regression (SVR), random forest and artificial neural network (ANN) at various stages to predict the process of stocks. Ten years old historical data were collected to perform the experiment with the proposed methodology. A fusion approach named as two stage fusion was used in which SVR was applied at the first stage to prepare the input for the second stage. In second stage, prediction models namelyrandomforest and artificial neural network was used to get high prediction accuracy and to reduce the error in the process of prediction. SVR ANN gives better prediction results when compared with SVR RF. The main drawback this work includes more time for tuning theSVR parameters to get less prediction error.

Jethin Abraham [1]used linear regression algorithm to predict the bitcoin price by using twitter tweets data. The dataset was divided into 80% for training and 20% for testing. Since price of bitcoin is heavily dependent on the tweet of the customer, twitter tweets were employed to get good results. One drawback of the proposed approach includes non-inclusion of cross validation process.

Jing-Zhi Huang [6] used a tree based prediction model for predicting the prices of bitcoin. BTC-USD dataset was used which was collected from investing website. The dataset has 2100 tuples after the preprocessing step. Data set was divided into three groups in which two of them were used for training and one group was used for testing. Totally 124 indicators of price were used in the prediction process in order to get good prediction accuracy.

Almeida [2] proposed a artificial neural network (ANN) based prediction model to find the bitcoin price. Since the bitcoin dataset has less errors, neural network algorithm works best for prediction of bitcoin prices. The dataset were divided into 70% for testing and 30% for testing pruposes. The main drawback of the proposed methodology is the requirement of large sized datasets to yield high prediction rate.

Prosper Lamothe-Fernández [8] proposed a deep recurrent convolutional neural network (DRCNN) to predict the proce of bitcoin. Data was collected from world bank for the period 2011 to 2019. The dataset contains a combination of dependent and independent variables. The dependent variable includes bitcoin price and independent variable includes demand, supply and some economic financial variables. The dataset was divided into three parts:70% of data for training, 10% of data for validattion and 20% of dataset for testing prurposes. The proposed DRCNN model yields an accuracy of 95%. The main disadvantage of the proposed framework is the requirement of large amount of datasets.

Patrick Jaquart [15] proposed a framework using a combination of recurrent neural network (RNN) and gradient boosting classifiers (GBC). The dataset was collected from blockchain.com website which includes past six month block chain price. Important features from the dataset was collected by employing data preprocessing methods in order to identify the feature that helps in bitcoin price prediction. The main issue with the proposed method is usage of less amount of data for prediction process which may corresponds to inaccurate prediction accuracy when employed for large sized data.

Zheshi Chen [3] proposed a highly efficient machine learning framework to predict the bitcoin price. Two types of dataset were used: one from from conmarketcap.com website which consists of combination of high dimension and low dimension features and other from binance, one of the top cryptocurrency exchange in the world. Various machine learning algorithms namely Logistic regression, XGBoost, Support vector machine (SVM) and Long short term memory (LSTM) were applied to the two types of dataset in-order to evaluate the performance of all the classifiers.LSTM performed best when compared to other classifiers and gave an accuracy of 68% for binance dataset. The main problem with the proposed framework is the usage of dataset with less number of dimensions in-order to give high predicition accuracy.

Mohammed Mudassir [13] proposed a framework for bitcoin prediction using regression and machine learning models. The dataset was collected from bitinfocharts.com which has more than 700 attributes. Data preprocessing techniques and feature selection methods were applied in-order to clean the errors and to find the important attributes form the available attributes. The proposed framework was trained using 70% of the available dataset and remaining 30% of them were used for testing pruposes. LSTM gives high accuracy of 68% when compared with regression models. The main problem with the proposed method lies in the correct selection of feature seletion techniques in-order to give high prediction accuracy.

Yan Li [10] proposed a hybrid framework using a combination of Convolutional neural network (CNN) and LSTM for predictiong the price of bitcoin. Dataset (Transactional data) was collected from quandl.com which has more than 600 tuples. 80% of the dataset was used for training purpose and remaining 20% of them was used for testing purpose. Initially CNN was used to extract the critical features from the dataset and then those extracted features were given as input to LSTM inorder to predict the bitcoin price. The proposed CNN-LSTM framework gives an accuracy of 80%.The proposed framework works only for the standard dataset which is the main drawback.

3 Proposed Methodology

3.1 Data Collection

The dataset for the proposed framework was collected from blockchain.com which is the most commonly used site for gathering crypto currencies information with different type of stock exchange values.Some of the attributes in the dataset includes transaction cost, market price and total volume. Another dataset was also collected from kaggle.com which contains the historical price information for various crytpo currencies. Some of the attributes in the dataset includes coin name, symbol, high value of the coin, start value and end value.

The collected dataset was preprocessed to remove the noisy values for the price prediction. Dataset was also normalized in-order to apply as an input for neural network to get high prediction rate. The processed dataset was divided into 70% for training and 30% of them was used for testing work.

The proposed framework is built using a combination of optimization algorithms and neural networks. First, the pre-processed dataset is given as an input to the ant colony optimizer and then to the grass hopper optimizer which will select the important features and then finally given as an input to the convolutional neural network which gives the future price of the USD bitcoin as an output. The flow chart of the proposed framework is given in Figure 1.

3.2 Ant Colony Optimization algorithm

Ant colony optimization (ACO) is a meta heuristic optimization algorithm which is profounded by Dorigo in 1990 [4]. The algorithm is formulated based on the activity of ants and is one of the optimal travelling plan strategy. Ants

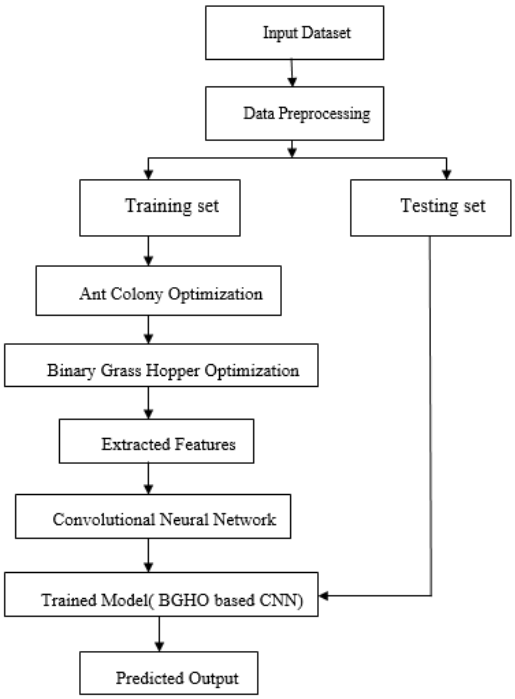

Figure 1: Flowchart of the proposed model

found their food path by following pheromones, a substance generated by ants which help to find their movement for other ants. The ACO can be applied to combinatorial problems like travelling salesman problem, graph coloring problem and assignment problem which helps to find the optimal solutions. This algorithm belongs to graph problem which comes under the swarm intelligence concept. The pseudocode for the ACO is given as follows:

Initialize the parameters and pheromone trail values.
While *the stopping crierion is not reached do*
    for $i = 1$ to total number of ants do
        find the solution
        update the pheromone values
    End for *loop*
    Update the pheromone values for optimal solution
End *while loop*
End the problem

Here all the agents(ants) are correlated to bitcoin price data and the attributes of ACO algorithm is mapped to attributes in the pre-processed dataset. Also, ACO enables to pre-process the input data weel before applying to the next phase.

3.3 Binary Grass hopper Optimization algorithm

Binary Grass hopper Optimization (BGHO) proposed by Mafarja [11] belongs to the family of swarm intelligence algorithms which can be used for feature selection process. There are two main phases in the alogorithm namely exploitation and exploration. Sigmoid transfer function and V-shaped transfer function are the two mechanisms used in the algorithm to find the search space. The exploration search strategy was improved using the mutation operator in-order to find the best subset of features from the available set of the features in the standard dataset. The pseudocode for the BGHO is given as follows:

Initialize the swarm $X_i (i = 1, 2, \ldots, n)$
Initialize cmax, cmin, and maximum number of iterations
Calculate the fitness of each search agent
$T =$ *the best search agent*
while $(l <$ *Max number of iterations*$)$
    Update c
    for *each search agent*
        Normalize the distances between grasshoppers in $[1, 4]$
        Update the position of the current search agent
        Bring the current search agent back if it goes outside the boundaries
    end for
    Update T if there is a better solution
    $l = l + 1$
end while
Return T

The extracted feature set which is the outcome of the BGHO is given as an inout to the CNN model to get the bitcoin prediction. BGHO works better due to its better convergence property.

3.4 Convolutional Neural Network

Convolutional Neural Network (CNN) belongs to the family of artifical neural network which has multiple layers of perceptron (MLP). In MLP, each neuron in the current layer is connected to the neurons in the succeeding layers in-order to form a network of layers. This neuron to neuron connection hepls to avoid the problem of overfitting. There are three layers in the CNN namely: convolutional layer, pooling layer and fully connected layer. Convolutional layer helps to intrepret the given inputs, pooling layer helps to reduce the features to in-order to find themost important features and the fully connected layer performs the classification and prediction process which is the output layer of CNN. The architecture of CNN is given in Figure 2:

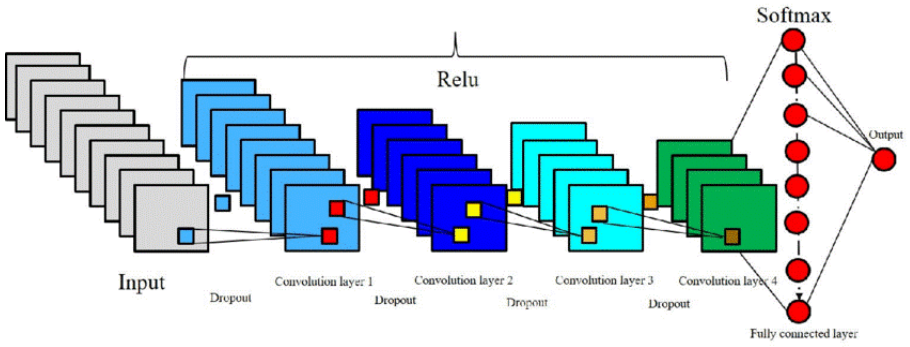

Figure 2: Structure of CNN

4 Experimental results

The proposed framework is implemented using pycharm IDE in which the dataset is split into 70% for training and 30% for testing purposes.The proposed system accuracy is evaluated in terms of Root Mean Square Error (RMSE) and Mean Absolute Percentage Error (MAPR) in order to find whether the proposed system works better in terms of accuracy. The formula to calculate RMSE and MAPR is given in Equation (4.1) and (4.2) as follows:

$$RMSE = \sqrt{\sum_{i=1}^{n} \frac{(\hat{y}_i - y_i)^2}{n}} \tag{4.1}$$

where $\hat{y}_1, \hat{y}_2, \hat{y}_3, \ldots \hat{y}_n$ are predicted values,

$y_1, y_2, y_3, \ldots y_n$ are observed values,

n is the total number of observations.

$$M = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{A_t - F_t}{A_t} \right| \tag{4.2}$$

where A_t is the actual value, F_t is the predicted value and n is the total number of observations.

Figure 3 shows the actual and predicted price of CNN and proposed BGHO based convolutional neural network algorithm during training process.

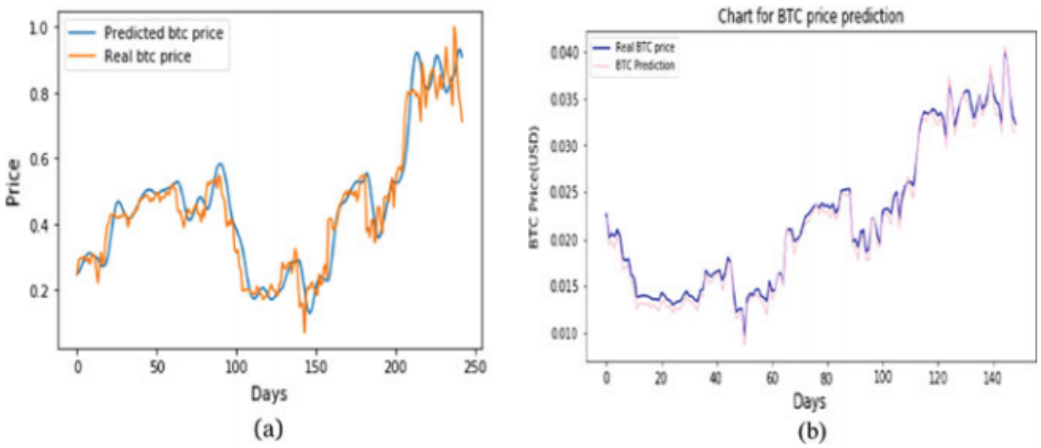

Figure 3: Comparison of actual and predicted price for (a) BGHO based CNN (b) Simple CNN

Table 1 shows the comparison details for the proposed framework BGHO based CNN and simple CNN in terms of precision, recall and F1 score. Precision is calculated by dividing the true positives with sum of true positives and false positives. Its formula is given in Equation (4.3).

$$Precision = \frac{True\ Positive(TP)}{True\ Positive(TP) + False\ Positive(FP)} \tag{4.3}$$

Recall is the total number true positives that are correctly identified by the system. Its formula is given in Equation (4.4).

$$Recall = \frac{True\ Positive(TP)}{True\ Positive(TP) + False\ Negative(FN)} \tag{4.4}$$

F_1 score also called as F score is calculated by considering both the precision and recall and its formula is given in Equation (4.5).

$$F_1\ Score = 2 \times \frac{Precision \times Recall}{Precision + Recall} \tag{4.5}$$

Table 1: Comparison between various framework prediction values

Model	Precision	Recall	F_1 score
CNN	0.58	0.57	0.54
Particle Swarm Optimization	0.62	0.60	0.58
Grass Hopper Optimization	0.66	0.64	0.56
BGHO based CNN	0.74	0.90	0.80

From the Figure 4, it is found that the proposed BGHO based CNN model outperforms the CNN, PSO and GHO algorithms in terms of precision, recall and accuracy values. The optimization algorithms like PSO and GHO gives

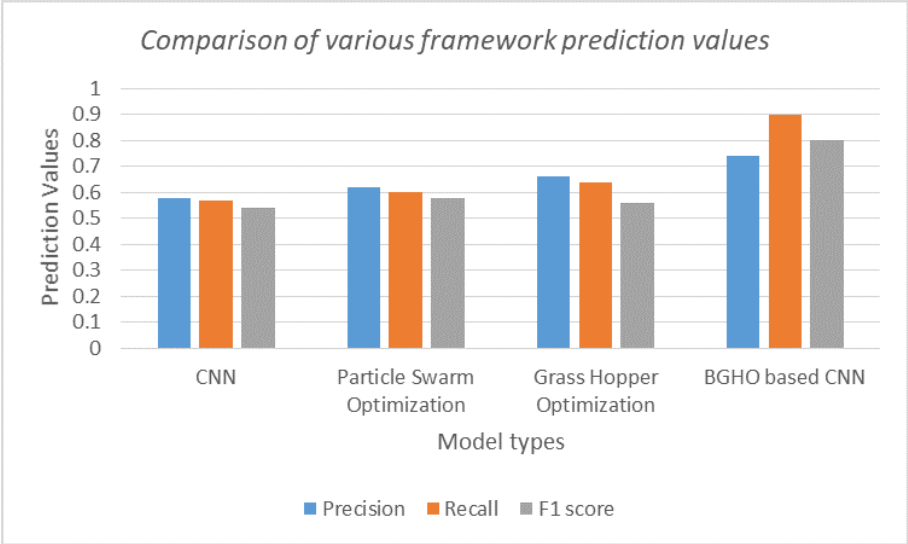

Figure 4: Graph showing performance of different models

less accuracy due to the absence of feature selection methods during the prediction process.Also, stand-alone CNN gives less accuracy when compared with the proposed model due to its inability to select the optimal features. The proposed BGHO based CNN framework yields an accuracy of 80%. The proposed framework shows that, it has high prediction rate when compared with existing models.

5 Conclusion and future work

In the recent days, bitcoin plays a major role in the crypto currency market in which many investors are investing in the different type of bit coins to get more profit. Also, in many countries are accepting bitcoin from their customers to pay for their purchased products. In the proposed work, we have used combination of optimization algorithms and Convolutional neural network to predict the price of bitcoin which results in high accuracy rate when compared with simple CNN and optimization algorithms.

The future work can focuses on employing large amount of datasets to predict the price of bitcoin by employing some big data frameworks. Also, different combination of ML algorithms can be used in map-reduce environment to predict the bitcoin prices.

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