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COM4062 PROJECT REPORT

FORECASTING BITCOIN PRICES

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ABSTRACT

Bitcoin is a digital currency introduced in 2009 as an open source software, developed by non-governmental organizations. Bitcoin promises lower transaction costs and is operated by a decentralized authority, unlike government-issued real currencies. Most of the rules in the Bitcoin network are applied based on open source software code. Bitcoin is usually issued as a reward for the mining process. Bitcoin's prices have experienced significant changes over the years, and it is a very challenging job to forecast the changes occurring in prices. This study tries to forecast Bitcoin price fluctuations using an ANFIS model in price time series. The data set used for the project includes past price movements of Bitcoin. This data set includes basic features such as date, opening price, closing price, highest price, lowest price. Correction of missing or abnormal values, scaling and other pre-processing steps were performed on the dataset. The ANFIS model was trained to learn features in the dataset and predict future Bitcoin prices. The structure of the model includes a mechanism that appropriately combines input variables and adapts weights. The model is iteratively optimized on training data. We provide the result of a standard ANFIS forecast as a baseline.

Index Terms: *Bitcoin, ANFIS model, Price Prediction.*

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1.INTRODUCTION

Bitcoin is a crypto currency which is used worldwide for digital payment or simply for investment purposes. Before bitcoin, several digital cash technologies were released, starting with David Chaum`s ecash in the 1980s. [19] Bitcoin is the first ever cryptocurrency invented since 2009 by an anonymous entity, namely Satoshi Nakamoto. It was made public as open-source in 2009. Bitcoin has revolutionized the modern transaction system due to decentralization and the application of blockchain technology. On the other hand, the investment and trading system for Bitcoin is also developing very fast. The biggest concerns about Bitcoin trading are the high volatility and the price elasticity. Limited inherent value and regulatory uncertainty make Bitcoin prices very sensitive to market news. As the market lacks strong fundamentals to value cryptocurrency, the price of Bitcoin is more or less determined by the market demand and supply, similar to financial assets such as stocks. Thus, it is interesting to study the Bitcoin price movement to facilitate value enhancement trading. Investment can be done through various marketplaces known as “bitcoin exchanges”. These allow people to sell/buy Bitcoins using different currencies. Considering all these factors, fluctuations in Bitcoin prices are of critical importance for investors.The biggest cryptocurrency due to its market value and its processing volume, Bitcoin affords great advantages to its users by separating itself from traditional bank transfers.[20] Bitcoin’s price is determined based on the supply-demand relationship in the market where it is involved.[20]

Bitcoin first entered a formalized allotment in 2008 with an article written by a person named Takamoto. Bitcoin prices, which are determined by the supply and demand dynamics in a stock exchange, are directly affected by speculative expectations. The change in Bitcoin prices may also be subject to manipulation activity performed by specific platforms in the trading volume and total turnover contexts. This, in addition to the activity performed by miners who validate transactions made within the network and provide benefit to the system's security, has been used directly for the formalization of the behavior of bitcoin prices. Such relevance allows us to understand the identification as to the functional behavior of the components. It is possible to withdraw from the evolution in such a way as to clarify the options that platform

management has managed to incorporate into their functions while safeguarding the equal treatment offered to all users.

Bitcoin price prediction is made using various methods. Some of these methods are statistical methods, artificial neural networks, fuzzy logic, deep learning chaotic neural networks and ANFIS models. Although there are such demand forecasting methods, the ANFIS method was used in this application. Because, ANFIS stands out as a model that combines artificial neural networks (ANN) and fuzzy logic systems. These features make it possible for ANFIS to adapt to non-linear and complex relationships, thus increasing its ability to model complexities in financial markets. In addition, ANFIS is an advantageous artificial intelligence method due to its ability to create rules on its own. ANFIS regulates the membership function parameters using the input/output data set; That is, it adapts itself according to the data it will model; Therefore it is adaptive.

This work aims to present an alternative forecasting model using the ANFIS when doing this for the Bitcoin price. Since people betting on Bitcoin plays a big role in how the price moves, having a solid forecasting model can help with making good deals. In 2017, the price of Bitcoin shot up by 1200%, grabbing the attention of individuals in the technology and financial sectors have undertaken the task of gathering information regarding the patterns exhibited by Bitcoin. This data has the potential to be transformed into chronological sequences. One advantageous aspect of ANFIS is its ability to integrate numerical data with human expertise in a highly beneficial manner. The ultimate objective is to provide professionals in the technology and financial fields with a dependable instrument that is applicable to various cryptocurrencies and financial markets. This tool can aid in making informed decisions when engaging in the purchase or sale of digital currencies. The handy thing about ANFIS is that it combines stats with human knowledge in a practical way. The goal here is to give tech and finance enthusiasts a reliable tool that can be used for any cryptocurrency or financial market. It can help with making useful choices when buying or selling coins.

The data, sourced from Investing.com, includes daily records of Bitcoin's opening price, closing price, high and low prices, and trading volume. The preprocessing stage involved normalizing the data and correcting any missing or erroneous values. The ANFIS model utilizes a Sugeno-type fuzzy inference system, known for its efficiency in modeling nonlinear systems. Our model comprises multiple layers, including input

fuzzification, membership functions, rule creation, inference, and aggregation. The training process involved optimizing membership functions and fuzzy rules using backpropagation and the least squares method. The model was evaluated on test data, demonstrating significant predictive accuracy.

2.METHODOLOGY AND IMPLEMENTATION

The Adaptive Neuro-Fuzzy Inference System (ANFIS) model which is proposed by Jang (1993) is one of the neural fuzzy approaches that combine the learning ability of neural networks and fuzzy logic models' ability to ensure decision making like humans and providing expert knowledge. ANFIS method is known as one of the intelligence techniques that can produce very successful results for prediction problems.[21]

Basic Components of ANFIS (with Sugeno Model)

There are some components in the ANFIS model's architecture. You can see the architecture of layers in the Figure 1.

- Input Layer: Input variables (e.g. date, trading volume, previous day's closing price) are fuzzified. Membership functions are used at this stage.
- Membership Functions: Input variables are partitioned into fuzzy sets using specific membership functions (usually triangular, trapezoidal or Gaussian functions).
- Rule Layer: Sugeno-type fuzzy rules are created in the format "If ... then ...". However, in the Sugeno model, the output of each rule is expressed as a linear function or a constant value.
- Inference Layer: The weight of each rule is calculated and linear or constant output functions are applied using these weights.
- Defuzzification (Clarification of Fuzzy Inference): In the Sugeno model, this stage is usually unnecessary because the results are already clear since the output functions are linear or constant.

- Aggregation and Normalization Layer: The final output value is calculated by summing and normalizing the weighted outputs of the rules.

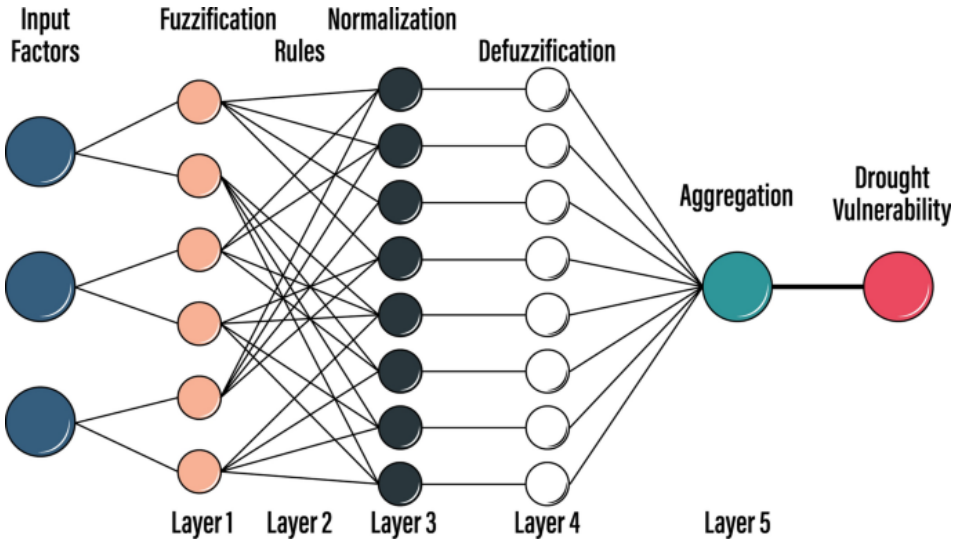

Figure 1

Data Collection and Preprocessing:

In this study, the data required for Bitcoin price prediction is based on daily values from Investing.com. The data consists of components such as date, opening price, closing price, high and low prices, and trading volume. The collected data was preprocessed by normalization and correction of missing or incorrect values.

Model Design and Training:

The ANFIS model is designed using factors such as opening price, closing price, high and low prices and trading volume as inputs. In this model, Sugeno type fuzzy inference system is used. Sugeno type fuzzy inference system works similar to Mamdani type fuzzy inference system but the output functions are different. In the Sugeno model, the outputs are usually defined as linear or constant functions. This provides high performance, especially in modeling nonlinear systems. In the model, fuzzy rules are created corresponding to these inputs and the output of each rule is defined as linear functions or constant values. The model we use is the ANFIS model that creates a 3-cluster (3 3 3 3) and the architecture of the model is shown in Figure 2.

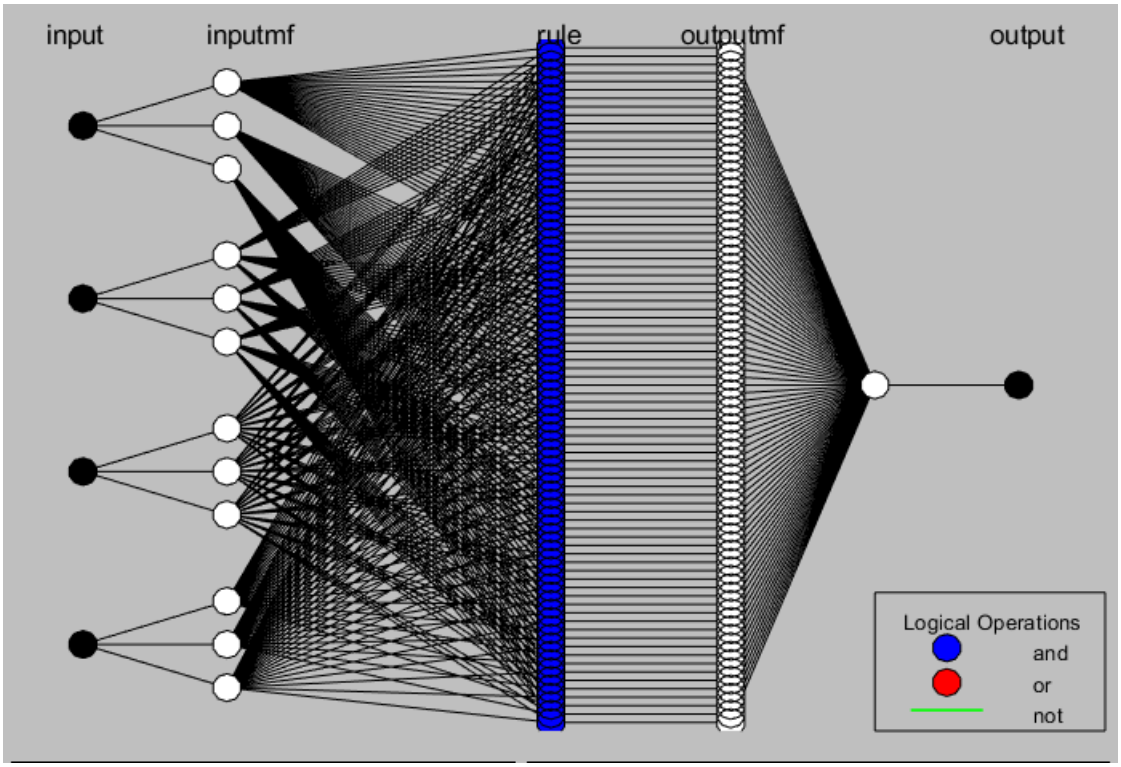

Figure 2

The information of the ANFIS we use is as follows:

- Number of nodes: 193
- Number of linear parameters: 81
- Number of nonlinear parameters: 36
- Total number of parameters: 117
- Number of training data pairs: 45
- Number of checking data pairs: 0
- Number of fuzzy rules: 81

All the rules in the fuzzy inference system include all the four variables (opening price, high and low prices and trading volume). These rules are shown in Figure 3.

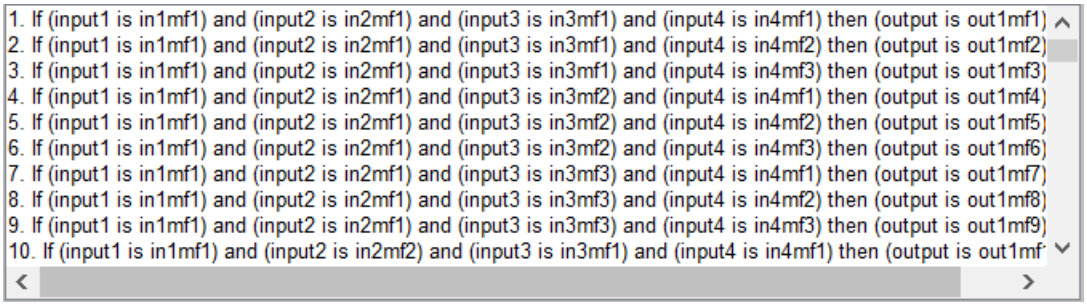

Figure 3

We used the data of the last one year in our model. We assigned 300 of these data for the training part. During the training process of the model, the membership functions and fuzzy rules were optimized using the backpropagation algorithm and least squares method. In this way, the ANFIS model achieved the best prediction performance by learning from the data. The performance of the model was evaluated on test data.

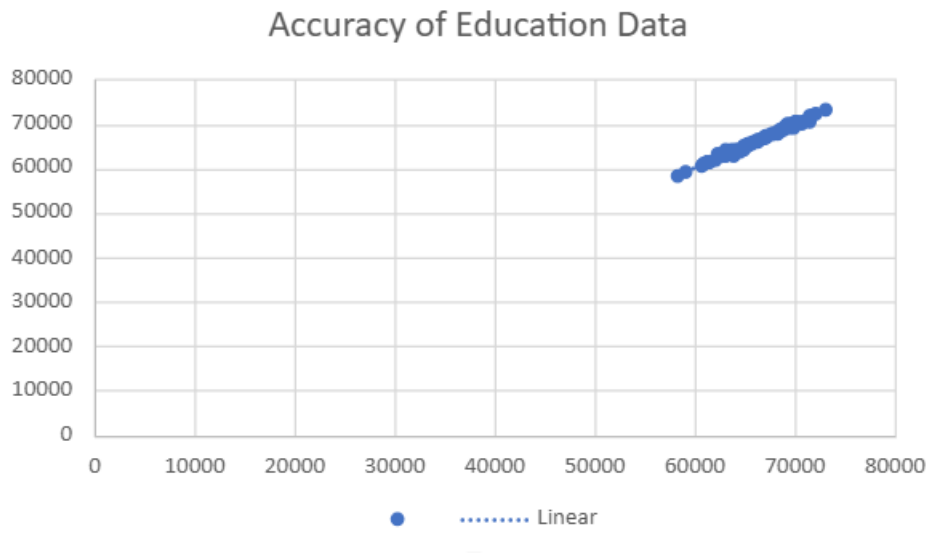

Figure 4

As can be seen in Figure 4, the accuracy of our training dataset is 0.9905 based on the R-square metric.

Model Testing and Evaluation:

We used the data of the last three months in our model. We assigned 67 of these data for the testing part. The performance of the trained model was evaluated by applying it on test data. The prediction performance of the model was analyzed by evaluating the differences between actual and predicted prices using statistical measures (RMSE,

R^2). In order to visualize the accuracy of the model, price predictions and actual prices were compared with graphs.

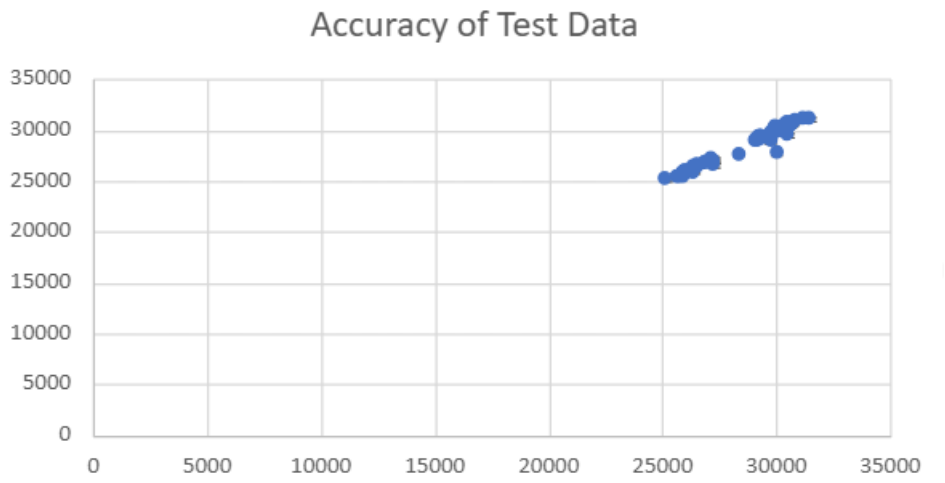

Figure 5

As can be seen in Figure 5, the accuracy of our testing dataset is 0.9617 based on the R-square metric.

Also, the surface viewer is a three-dimensional curve showing the mapping of two input parameters to an output to obtain a Bitcoin price prediction. Figure 6 shows the result surface after training. Here it gives two input parameters, high price (yüksek) and opening price (açılış) as input parameters and closing price (kapanış) parameter as output.

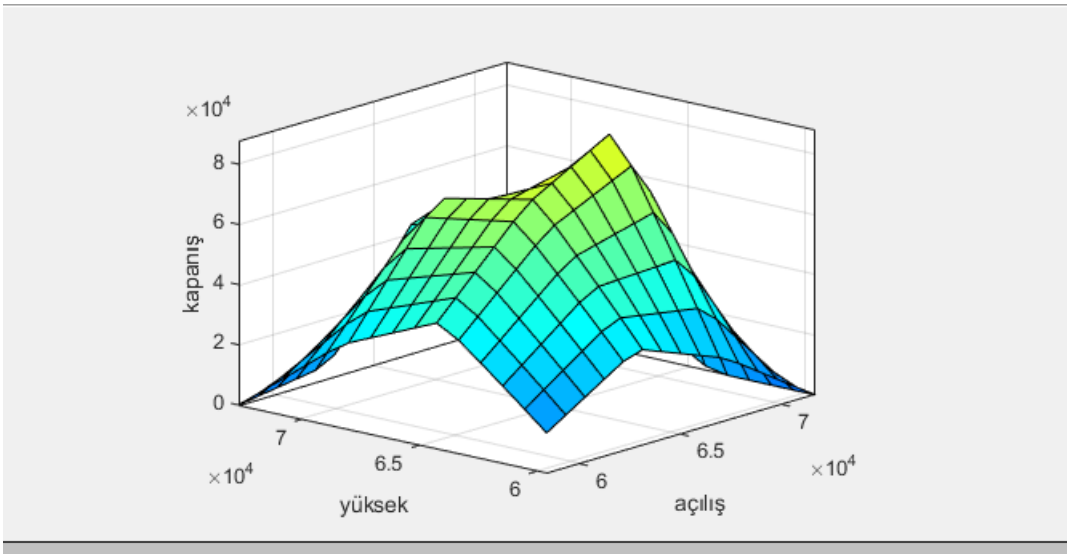

Figure 6

3.RESULTS AND COMPARISON

In order to get better results from our model, we tried one method, which was to change the clustering method. Here, we first tried the 3 3 3 3 3 ANFIS model as a clustering method, then the 4 4 4 4 4 and 5 5 5 5 methods. The RMSE results for the training phase and R^2 results for the testing phase of these methods are shown in the table below.

CLUSTERING	DATASET	
	RMSE	R-SQUARE
3 3 3 3 ANFIS MODEL	367.082	0.9617
4 4 4 4 ANFIS MODEL	341.065	0.903
5 5 5 5 ANFIS MODEL	311.900	0.9249

We have tried different methods to determine which data set and which clustering method is more successful for our model, and comparing the results we have obtained, we found that the most successful method is to make a cluster method of 3 3 3 3 using the data for the last three months.

4.LITERATURE SURVEY

The topic of predicting Bitcoin prices is commonplace among spectators in the cryptocurrency market. The sudden price fluctuations in the bitcoin market cause great concern in both owners and miners because it can represent large profits or heavy

losses. Many experiments are being done to predict the behavior of Bitcoin prices, but among those found, better results are always based on deep learning techniques which heat a lot of computational time. The application of machine learning techniques has been growing, especially in the financial market. However, despite the progress observed in the stock market, the literature on Bitcoin's price forecasts with hybrid models is scarce or non-existent. The main works in the area have been performed with models on the stock market and, more particularly with Forex. The aims of these forecasts are mainly used to create trading strategies from the information extracted from the forecasts.

There are various application areas in which ANN and FL have been successfully implemented whether individually or complementing each other‟s strengths. A combined neuro-fuzzy approach has seen enormous preferences recently from researchers working in different domains. A comprehensive study of existing work in assorted areas using soft computing methodologies specifically focusing on neural networks and fuzzy logic can be found in [1] . A computational technique to deal with non-linear and complex problem was discussed by J.R Jang . This study involves fuzzy inference system implemented in the construction of adaptive networks. The proposed ANFIS can generate an input-output mapping based on human knowledge and predetermined input-output data pairs using the hybrid algorithm.

Morever, when the literature is investigated, it can be easily seen that there exist diverse types of studies based on fuzzy and ANFIS methodologies [2-6,13]. In [7], Malhotra and Malhotra introduced an ANFIS based smart predictive model for screening potential defaulters on consumer loans. Furthermore, in [8] Soyguder and Alli employed ANFIS method to build an expert system for the humidity and temperature control in HVAC systems. In [3], Sungging et al. designed and developed an ANFIS based artificial intelligence system for lung cancer diagnosis. On the other hand, in [9] a fuzzy rule based expert system was implemented for asthma diagnosing. Likewise, Ucar et al. [10] carried out a study about tuberculosis disease diagnosis by using adaptive neuro fuzzy inference system and rough sets. In [16], Negar Ziasabounchi designed and developed ANFIS Based Classification Model for Heart Disease Prediction. There have also been prediction studies on bitcoin prediction in [11,12]. In [11], bitcoin price prediction was made with machine learning. Karabiyik and Ergün (2021) investigated the forecasting of Bitcoin prices using the ANFIS model [17].

Their study contributes to the understanding of cryptocurrency price prediction through the application of advanced computational techniques.

5.CONCLUSION

The experimental examination of conventional time series models for cryptocurrency has been the main topic of the literature on finance. These models are not very good at predicting the price of Bitcoin, especially during times of extreme volatility. Artificial intelligence models, particularly neural networks and fuzzy inference systems, are flexible according to financial literature. They don't call for presumptions about the underlying model's functional structure. These adaptable forms can approximate complicated nonlinear interactions throughout the model estimate process.

To predict Bitcoin values, we suggest using an Adaptive Neuro Fuzzy Inference System (ANFIS). The suggested ANFIS model generates complex nonlinearities and does not need functional form assumptions.

To predict Bitcoin values, we suggest using an Adaptive Neuro Fuzzy Inference System (ANFIS). The suggested ANFIS model generates complex nonlinearities and does not need functional form assumptions. It combines the human-interpretable rule structure of fuzzy systems with the flexibility of neural networks. We find that the ANFIS models provide good forecast performance in our case studies regarding finance. We found that the suggested ANFIS models offer better prediction performance in the face of significant nonlinearity and historical delay when compared to competing benchmark models like autoregressive models, basic fuzzy inference systems, and neural network models. The ANFIS model designed in this study effectively predicted Bitcoin prices, leveraging a Sugeno-type fuzzy inference system with high performance in nonlinear modeling. Our results show that the model achieved an R-square accuracy of 0.9905 on the training dataset, indicating a strong fit. At the same time, the accuracy of the test dataset was also quite high at 0.9617. The following conclusion follows from this: The model's architecture and training methodology provide valuable insights for future improvements in predictive modeling for financial markets. Visual comparisons between actual and predicted prices further underscore the model's predictive

capabilities, with the surface viewer offering a clear representation of the input-output relationships post-training.

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