Techno-Science

Scientific Journal of Mehmet Akif Ersoy University
www.dergipark.gov.tr/sjmakeu

Original Research Article

hosted by Turkish JournalPark ACADEMIC

FORECASTING OF BITCOIN PRICE USING THE MULTILAYER PERCEPTRON TECHNIQUE

Furkan ATLAN[1*], İhsan PENÇE[2]

[1]*Management Information Systems, Burdur Mehmet Akif Ersoy University, Turkey*
[2]*Department of Software Engineering, Burdur Mehmet Akif Ersoy University, Turkey*

ARTICLE INFO

Article History
Received : 26/08/2021
Revised : 28/08/2021
Accepted : 29/08/2021
Available online : 31/08/2021

Keywords
Cryptocurrency, Artificial Intelligence, Multilayer Perceptron, Price Estimation

ABSTRACT

Cryptocurrencies, whose popularity is increasing day by day today, affect the real economy, financial sector and daily life of countries due to the increase in demand and technological developments. In this study, it is aimed to estimate the value of Bitcoin (BTC), which has the most popular and dominant effect among cryptocurrencies, in Turkish Lira (TL) by using the United States Dollar (USD) / (TL) rate and date attributes and with the model to be created, present a generalized forecast model for other cryptocurrencies. The data feature used in the study covers the date range of 08.12.2016 and 08.12.2018. The multilayer perceptron techniqueis used for BTC/TL price estimation. As a result of the cross-validation test, estimation results of the multilayer perceptron technique are found to be successful and important. With the successfully developed model, it is possible to estimate price for BTC, Ethereum and Ripple with instant data in the future.

1. INTRODUCTION

Artificial intelligence, in its broadest form, is the effort to imitate the intelligent behavior of humans by machines.In other words, it is a wide research area that aims to copy the cognitive abilities of speech recognition (discrimination), learning behaviors, perception of developments in the environment, problem solving style to machines [1].

Machine learning is a sub-branch of artificial intelligence and is defined as giving computers the ability to learn by themselves without the need for programming. The basic idea behind machine learning is the development of algorithms that learn from data and have the ability to make predictions about it[1].

Bitcoin (BTC) is a cryptocurrency that was introduced to the world by the person or people known as Satoshi Nakamoto after the 2008 financial crisis with an article called “Bitcoin: Peer-to-Peer Cash Payment System” [2].Although BTC was put forward as an idea in 2008, the first transfer transaction regarding BTC was made in 2009 and the first commercial transaction regarding BTC was made in 2010. BTC met the real economy in 2010 [3].

As of 2020, it has been created to be a serious alternative to BTC financial systems [4], which has the largest volume, awareness and transaction among a total of 11,393 cryptocurrencies in the market. BTC is a cryptocurrency that is subject to very serious price changes due to the lack of any center to which it is connected.

Developments such as the increase in the volume of the cryptocurrency stock market day by day, the profitable return of artificial intelligence technology to the countries investing in this field and the contribution of close to 14% of the global gross national product in the near future [5], have brought both crypto money and artificial intelligence technologies into the real economy. The fact that it has become an integral part of the economy has brought the changing parameters of the economy to a level where it is important to make healthy and accurate estimations of these factors by using scientific and

* Corresponding Author: furkanatlann@gmail.com

To cite this article: Atlan, F. and Pençe, İ. (2020). Forecasting of Bitcoin Price using the Multilayer Perceptron Technique. Techno-Science, vol. 4, no. 2, p. 68-74

e-ISSN 2651-3722

modern techniques.For this reason, the estimation of cryptocurrency values is among the issues that should be emphasized in terms of countries, companies and individuals.

The aim of this study is to perform the price estimation of BTC in TL with the multilayer perceptron (MLP) from machine learning algorithms and to provide an estimate of different cryptocurrency values in TL with instant data in the future, thanks to the model created. The developed model uses the USD/TL rate as well as the BTC price, which includes different time intervals, and cross-validation was used to determine the best parameters and time intervals of the model.

Value estimation of cryptocurrencies is discussed in the literature in two different areas as price direction and price value. In the studies in which BTC price direction and/or price predictions were made, the factors of the blockchain technology as an attribute [6,7], the BTC system's parameters [8, 9], the relationship of social media or news headlines with the BTC price direction or price prediction [10-12], and the equivalent of USD as the real currency were obtained. Statistical methods and artificial intelligence methods are used [13, 14] in these studies. Especially the studies with MLP[15-18] and the comparison of other methods used with MLP give quite remarkable results.

Although there has been an increase in price prediction researches of cryptocurrencies with artificial intelligence methods in the literature and the effect of BTC on other cryptocurrencies is known [4], there is no parameter optimized model that will give the best results for different time periods and studies with TL equivalent.

In this study, a model has been created by performing parameter optimization with MLP, which is one of the popular artificial intelligence techniques, for the price prediction of BTC in TL. The developed model uses the USD/TL rate as well as the BTC price, which includes different time intervals, and cross-validation was used to test the best parameters and time intervals of the model.

2. MATERIALS AND METHODS

In this study, the price prediction of BTC, which has the largest volume and popularity among cryptocurrencies [19], in TL rate was performed. Date and USD/TL rate were used as attributes in the study. The features used were combined and processed in a total of 6 data sets. The study aims to make a BTC price prediction with two attribute information. In this study, where BTC price estimation is made in TL, the data were processed using MATLAB R2018b and JetBrains PyCharm Community Edition 2019.1 programs.

The data were tested with MLP which is an artificial intelligence method in the form of cross-validation. Cross-validation is commonly known as k-fold cross-validation. K-fold cross-validation divides the data or dataset into k equal sub-partitions [20]. As a result of this separation process, one of the pieces is considered as 'test' data and the remainder as 'training' data.

Training data is the data on which the model is applied and trained; test data is the data where the performance of the model is seen on the data on which the model is not trained. Root Mean Squared Error (RMSE) was also used as a performance measure. In Equation 1, the RMSE equation is given.

$$RMSE = \sqrt{\frac{\sum_{j=1}^{n} e_j^2}{n}} \quad (1)$$

In Equation 1, the 'e' represents the difference between the target and predicted values. The RMSE measures the performance of a model's prediction process by showing how close a regression curve is to a point. The closer the RMSE to zero the better the predicted ratio performs.

In this study, in which Python [21] programming language, which is the most preferred one in the use of artificial intelligence in recent years, is used and a virtual environment is also created in Python 3.6 version using Anaconda3-2018.12 program was used to ensure coordination between the programs used and the operating system. The models and training algorithms offered by the Tensorflow library [22], which is an open-source library developed by Google, are used in machine learning processes of Python in the virtual environment, and the Keras library under it has been utilized.

2.1. Obtaining Crypto Currency and Attribute Data

In the study, BTC/TL data used in BTC price prediction analysis is divided into 6 data sets in terms of time interval. In order to make a comparison between the predictions to be made later, that is, to find out in which time intervals the BTC/TL estimation gives the best results, each of these 6 data sets, which were created, was divided into 4 different parts and a total of 24 data sets have analyzed.The date and USD/TL rate data used as attributes were also created to have the same date range as the BTC data. The BTC/TL data used in the study were created based on the daily opening values on 10.12.2018

from the USD/TL rate web addresses. The date attribute was created according to the first and last date ranges and was determined as a consecutive numeric number in the study. Table 1 shows which time intervals BTC/TL and USD/TL price data correspond to in a total of 24 data sets created in 6 main headings and time intervals covering the dates between 08.12.2016 and 08.12.2018.

Table 1. Information and explanations of data set groups

Dataset	Explanation	Starting Date	End Date
1_1	1 day data of 1 hour periods	08.12.2018	08.12.2018
1_2	1 day data of half an hour periods	08.12.2018	08.12.2018
1_3	1 day data of 15 minutes periods	08.12.2018	08.12.2018
2_1	1 week data of 4 hours periods	01.12.2018	08.12.2018
2_2	1 week data of 2 hours periods	01.12.2018	08.12.2018
2_3	1 week data of 1 hourperiods	01.12.2018	08.12.2018
3_1	2 week data of 12 hours periods	24.11.2018	08.12.2018
3_2	2 week data of 6 hours periods	24.11.2018	08.12.2018
3_3	2 week data of 3 hours periods	24.11.2018	08.12.2018
4_1	1 month data of 24 hours periods	08.11.2018	08.12.2018
4_2	1 month data of 12 hours periods	08.11.2018	08.12.2018
4_3	1 month data of 6 hours periods	08.11.2018	08.12.2018
5_1	1 year data of 12days periods	08.12.2017	08.12.2018
5_2	1 year data of 1week periods	08.12.2017	08.12.2018
5_3	1 year data of 3days of 1 year data	08.12.2017	08.12.2018
6_1	2 year data of 4weeks periods	08.12.2016	08.12.2018
6_2	2 year data of 2weeks periods	08.12.2016	08.12.2018
6_3	2 year data of 1week periods	08.12.2016	08.12.2018
6_4	2 year data of 2days periods	08.12.2016	08.12.2018

2.2. Method

In this study, MLP, one of the popular artificial intelligence techniques in the literature, has been used.

2.2.1. MLP

MLPs are computer systems developed that aim to automate the features of the human brain such as learning, deriving new information from what it has learned, and discovering it without outside help. In current artificial intelligence studies, if a machine is made that will correspond to a very small proportion of the capacity of the human brain, it is considered possible to gain the ability to process and control wonderful information. The performance and potential of biological neural networks have a talent that cannot be underestimated. The purpose of using MLP is to transfer this capability to computers. Biological neural networks send the information obtained from the environment through the 5 sense organs to the neural cells of the brain and thus enable people to perceive the environment, as well as learn the relationships between events [23, 24].

2.2.1.1. Artificial Neural Cell (Process Element)

Biological neural networks have biological neural cells, as well as artificial neural cells in MLPs. Another name for artificial neural cells is process elements. There are 5 basic elements belonging to each process element. Figure 1 shows the structure of an artificial neuron.

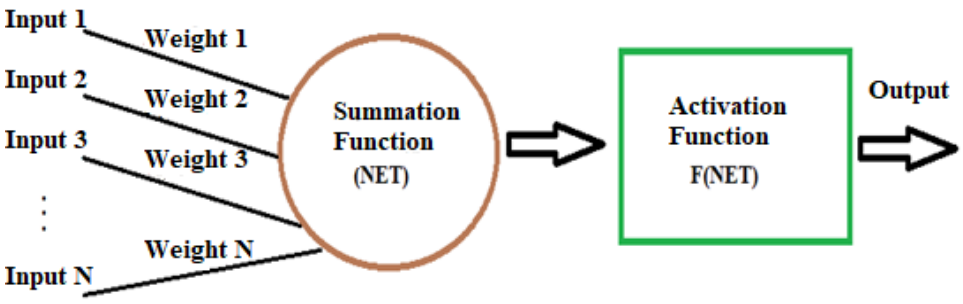

Fig 1. Structure of Artificial Neural Cell

Inputs: Information given to an artificial neural cell from the environment. Inputs are determined by the examples that the network wants to learn. The information given as an input to an artificial neural cell is not only taken from the environment, but also other cells, and even information can be transferred to a cell from itself.
Weights: Weights correspond to the importance of the information sent to the artificial neuron and its effect on the cell. The size or smallness of the weights does not mean that they are important or unimportant. A weight's value minus or plus only means it's positive or negative. Weights can be fixed or variable.
Summation Function: Addition function is used to calculate the net inputs sent to an artificial neuron. The most commonly used for this purpose is the weighted sum operation. In the weighted sum, the inputs to the cell are summed by multiplying their weights. In this way, the net number of inputs to the network is obtained. The weighted sum is given in Equation 2.

$$NET = \sum_{i}^{n} G_i A_i \quad (2)$$

The "G" given in Equation 2 corresponds to the inputs, "A" to the weights, and "n" to the total number of inputs sent to the artificial neuron. There are also functions different from the summation functions given in Equation 2.
Activation Function: The activation function processes the net input sent to the cell and is used to determine the output that the cell will produce as a result. Just like in the addition function, different methods and different mathematical calculations are used in the activation function. Some models require the activation function to be a differentiable function. Elements of the network do not have to use the same function. While some elements use the same function, other elements may use different functions. The most suitable function for the problem is a situation that only the person who trains the network can decide.
Cell Output: It is the output value of the inputs determined using the activation function. The output value produced here is sent to the environment or other cells. The output of a cell can also be the input of that cell [23-25].

3. RESULTS AND DISCUSSION

In this study, a total of 24 different data sets were used between 08.12.2016 and 08.12.2018 to predict the BTC price in TL using MLP which is one of the artificial intelligence techniques. USD/TL rate and date information were used as attributes, and all training and testing processes were repeated 5 times. For the methods applied to 24 data sets, it was emphasized that the best values should be determined as models and parameters. As the BTC price changes periodically and in unpredictable ways, it is of great importance to determine the model that gives the best results in general.

To determine the most suitable parameters, MLP was run 5 times with 5-fold cross validation as a statistical method. Grid search [26] method was used to determine the best parameters of artificial intelligence methods. According to the grid search method, the whole network is trained in the interval determined by different iterations and neuron numbers. The combination that gives the best result is considered as a hyperparameter. The final parameters were determined by considering the total of the RMSE values in the 24 data sets of the test results, which were less than approximately 100,000, and the parameters that found the most minimum errors in total in the data sets.

3.1. Determination of the Most Appropriate Parameters of the Methods

Three different algorithms were used to train the datasets with MLP. These algorithms are respectively; Scaled Conjugate Gradient (SCG), Bayesian Regularization (BR) and Levenberg-Marquardt (LM) algorithms. For MLP, [100, 500, 1000] is used as the first parameter of the grid search, which includes iteration, while [30, 20, 10] and [20, 10] are used as the second and third parameters, which include the number of neurons in the first and second hidden layers respectively.

In order to determine the best algorithm among the 3 different algorithms used in MLP and the number of iterations and neurons associated with it, algorithms and parameters with test errors of 24 data sets less than 100,000 were considered. In Table 2, the total errors of the algorithms and parameters of MLP are given.

Table 2. Total test errors of algorithms and parameters in MLP

Algorithm	Number of Iteration	Number of First Hidden Layer Neurons	Number of Second Hidden Layer Neurons	Total Test Error (RMSE)
SCG	100	30	20	137899.4
		30	10	136956.3
		20	20	138862.8
		20	10	133730.0
		10	10	132966.6
	500	30	20	131741.2
		30	10	127505.9
		20	20	131021.4
		20	10	125403.7
		10	10	123196.3
	1000	30	20	126322.8
		30	10	126580.0
		20	20	122183.6
		20	10	124569.4
		10	10	116192.5
BR	100	30	20	113284.7
		30	10	115128.9
		20	20	108792.9
		20	10	113974.4
		10	10	111081.9
	500	30	20	97695.5
		30	10	100906.4
		20	20	89698.4
		20	10	101932.5
		10	10	95424.2
	1000	30	20	93099.4
		30	10	96253.0
		20	20	86300.2
		20	10	94874.9
		10	10	93949.8
LM	100	30	20	128773.2
		30	10	135307.0
		20	20	120837.1
		20	10	129565.9
		10	10	127742.8
	500	30	20	125466.3
		30	10	133745.4
		20	20	121297.0
		20	10	130179.8
		10	10	127986.5
	1000	30	20	129527.0
		30	10	132920.8
		20	20	122570.6
		20	10	132551.8
		10	10	126731.1

When Table 2 is examined, it is seen that the BR algorithm gives the best values as total test error in 500 and 1000 iterations in 24 data sets. It was seen that all parameters of the BR algorithm running in 1000 iterations gave the lowest total test error values, and the number of iterations for the BR algorithm was determined as 1000 to obtain more stable results. In addition, when the total test errors of the neuron numbers were compared, 20 and 10 neurons were determined as the number of

neurons in the hidden layers of the MLP. Accordingly, the best parameters obtained by testing the BR algorithm 5 times in total in the MLP method and their total test errors are given in Table 3.

Table 3. Best parameters and total test errors for BR algorithm in MLP method

Number of Iteration	Number of First Layer Neurons	Number of Second Layer Neurons	Total Test Error
1000	20	20	86300.2
1000	10	10	93949.8

According to the results in Table 3, it can be thought that the best algorithm among the MLP algorithms used in model training is BR, and the number of iterations should be high but the number of neurons should not be too high for model training success.

4. CONCLUSION

In this study, price prediction was made with MLP technique as an artificial intelligence algorithm by using USD/TL rate and date attributes of BTC/TL price. The time range of the selected data is 08.12.2016 and 08.12.2018, the period when the BTC/TL price started to make a big jump. The data were run 5 times using MLP with 5-fold cross validation.

This study, in which different algorithms of MLP are used, also allows comparing the success rates of more than one algorithm of the same method in terms of cryptocurrency price prediction. In the study, the result obtained by using very little feature information is quite meaningful. Again, this result of the BR algorithm with a small number of neurons suggests that the number of iterations should be reduced and the model should be improved by including different attribute information about BTC in order to bring optimum success in terms of speed and hardware.

It has been concluded that this model, which has achieved successful results when applied to BTC, which is strong enough to influence (dominate) the existing cryptocurrency exchanges, can also be applied to Ethereum and Ripple from other cryptocurrencies.

In future studies, it is planned to develop a system that can predict the price of BTC, Ethereum and Ripple in TL with instant data on a website developed with Python language supported by Django framework. In addition, it is predicted that adding the information of technical analyzes applied in the field of economics as an attribute to the model, will increase the success of the forecast.

REFERENCES

[1] Gulli A, Kapoor A, Pal S. (2019). Deep learning with TensorFlow 2 and Keras: Regression, ConvNets, GANs, RNNs, NLP, and more with TensorFlow 2 and the Keras API. 2nd ed. Birmingham, United Kingdom, Packt.
[2] BITCOIN. "Bitcoin: A peer-to-peer electronic cash system". https://bitcoin.org/bitcoin.pdf (08.08.2021)
[3] Koçoğlu Ş, Çevik YE, Tanrıöven C. (2016). "Efficiency, Liquidity and Volatility of Bitcoin Markets". *Journal of Business Research*, 8(2), 77-97.
[4] COINMARKETCAP. "Indicator about market values of cryptocurrencies". https://www.coinmarketcap.com (02.08.2021).
[5] DÜNYA Newspaper. "16 trillion dollars contribution from artificial intelligence to the square economy". https://www.dunya.com/sektorler/teknoloji/yapay-zekadan-kuresel-ekonomiye-16-trilyon-dolarlik-katki-haberi-370017 (02.08.2021)
[6] Greaves A, Au B. (2015). "Using the bitcoin transaction graph to predict the price of bitcoin". Department of Computer Science, Stanford University, California, United States of America, Scientific Report, 68.
[7] Akcora CG, Dey AK, Gel YR, Kantarcioglu M. (2018). "Forecasting bitcoin price with graph chainlets". In Pacific-Asia Conference on Knowledge Discovery and Data Mining, Melbourne, Australia.
[8] Madan I, Saluja S, Zhao A. (2015). "Automated bitcoin trading via machine learning algorithms". Department of Computer Science, Stanford University, California, United States of America, Scientific Report, 176.
[9] Yang SY, Kim J. (2015). "Bitcoin market return and volatility forecasting using transaction network flow properties". IEEE 2015 Symposium Series on Computational Intelligence, Cape Town, South Africa, 7-10 December.
[10] Matta M, Lunesu I, Marchesı M. (2015). "Bitcoin spread prediction using social and web search media". The 23rd Conference on User Modelling, Adaptation and Personalization, Dublin, Ireland, 29th June-3rd July.
[11] Ceyhan K, Kurtulmaz E, Sert OC, Özyer T. (2018)."Bitcoin movement prediction with text mining". 2018 26th Signal Processing and Communications Applications Conference (SIU), Cesme, Izmir, 2-5 May.

[12] Polat M, Akbıyık A. (2019). "Analyzing The Relationship Between Social Media and Investment Tools: Bıtcoın". Journal of Academic Inquiries, 14(1), 443-462.
[13] Indera NI, Yassin IM, Zabidi A, Rizman ZI. (2017). "Non-linear autoregressive with exogeneous input (NARX) bitcoin price prediction model using PSO-optimized parameters and moving average technical indicators". Journal of Fundamental and Applied Sciences, 9(3S), 791-808.
[14] Guo T, Bifet A, Antulov-Fantulin N. (2018). "Bitcoin volatility forecasting with a glimpse into buy and sell orders". 2018 IEEE International Conference on Data Mining (ICDM), Singapore, 7-10 November.
[15] Jang H, Lee J. (2017). "An empirical study on modeling and prediction of bitcoin prices with bayesian neural networks based on blockchain information". IEEE Access, 6, 5427-5437.
[16] McNally S, Roche J, Caton S. (2018). "Predicting the price of bitcoin using machine learning". 2018 26th Euromicro International Conference on Parallel, Distributed and Network-based Processing (PDP), Cambridge, United Kingdom, 21-23 March.
[17] Gullapalli S. (2018). Learning to predict cryptocurrency price using artificial neural network models of time series. MSc Thesis, Kansas State University, Manhattan, United States of America.
[18]Şahin, E. E. (2018). Crypto Money Bitcoin: Price Estimation With ARIMA and Artificial Neural Networks .Fiscaoeconomia , 2 (2) , 74-92 . DOI: 10.25295/fsecon.2018.02.005
[19] BLOCKCHAIN. "Up-to-date information on cryptocurrency exchanges". http://www.blockchain.com (04.08.2020)
[20] Kohavi R. (1995). "A study of cross-validation and bootstrap for accuracy estimation and model selection". In Ijcai. 14(2). 1137-1145.
[21] IEEE SPECTRUM. "Top Programming Languages". https://spectrum.ieee.org/at-work/innovation/the-2018-top-programming-languages (02.08.2021)
[22] GOOGLE. "Tensorflow Library". https://www.tensorflow.org/ (06.08.2021)
[23] Öztemel, E. YapaySinirAğları. 2nd ed. İstanbul, Turkey, Papatya, 2006.
[24] Caner M, Akarslan E. (2009) "Estimation of Specific Energy Factor in Marble Cutting Process Using ANFIS and ANN". Pamukkale University Journal of Engineering Sciences, 15(2), 221-226.
[25] Yegnanarayana B. (2006). Artificial neural networks. 1st ed. New Delhi, India, PHI Learning.
[26] Thisted RA. (2000). "Elements of statistical computing: Numerical computation". 1st ed. Boca Raton, United States of America, Chapman& Hall/CRC.

Techno-Science*Paper ID: 987519*