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# Backpropagation neural network prediction for cryptocurrency bitcoin prices

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**Abstract.** The value of bitcoin currency is very volatile, hard to guess for every hour, so many of the bitcoin traders suffer losses because they are wrong in managing their bitcoin assets. Changes in the price of bitcoin itself are influenced by many things such as the closing of the bitcoin market in a country, the occurrence of hacker attacks on the bitcoin blockchain and the emergence of new coins that use technology similar to bitcoin. But when a stable market situation changes the price of bitcoin is purely influenced by market forces. By implementing an artificial neural network using backpropagation method, it will be able to predict the price of bitcoin by giving a form of predictive results that are strengthened with a fairly good value of accuracy. This research begins by determining prediction variables with target values that can be determined based on previous bitcoin prices. This artificial neural network process is able to conduct training and testing of data based on network patterns that have been formed, then the results of training and testing of the network will be analysed again, so that at the last stage the best network patterns will be used in the prediction process.

## 1. Introduction

Intelligence can be defined as wisdom and ability; what is called artificial intelligence (AI) is a variety of human intelligent behaviours, such as perception, memory, emotion, judgment, reasoning, proof, recognition, understanding, communication, design, thinking, learning, forgetting, creating, and so on, which can be realized artificially by machine, system, or network. Over the past 60 years, there has been great progress in AI. However, machine intelligence, built on the basis of certainty or accuracy, is severely limited by its formal axiom system, the precision of which is unable to simulate the uncertainty of human thought processes [1]. Backpropagation is a systematic method for multilayer training in Artificial Neural Networks. This method has a strong and objective mathematical basis, besides this algorithm has the form of equations and coefficient values by minimizing the number of squared error errors through training sets. This network model is widely used to be applied to solve problems related to identification, prediction, pattern recognition and so on. In repetitive exercises, this algorithm will produce better performance [2].

Cryptocurrency is a virtual currency that is used as a decentralized alternative currency. This means that there is no governing party either from the government or the originator of Cryptocurrency itself. Therefore, the value of Cryptocurrency cannot be affected if there is inflation caused by the central bank. The crypto currency value is determined by interest, supply and demand in the market, as well



as gold or other precious metals. The basic concept of bitcoin is to make the transaction system a decentralized authority without third parties who can verify using the concept of digital signatures on each transaction. Electronic coins are nominal values that can be traded, where these digital coins are connected digital signature series [3].

Predicting Is Specifically Predicting What Will Happen in Future Observations or Estimating Future Events or Conditions Expected to Occur. By Predicting We Will Get a Picture of Something or Value in the Future. Here the author will predict the price of cryptocurrency, bitcoin. This Bitcoin Price Prediction Study Will Use Artificial Neural Networks with the Backpropagation Method. Research intends to be used as a reference for the development of the world economic system in the future, where people no longer invest as usual, but will switch to investment using bitcoin. The simple reason for the author to try to apply the basic concept of artificial intelligence to using artificial neural networks is where artificial neural networks are able to forecast certain objects by adopting variables in building networks to make predictions in seeing the movements of the value of bitcoin itself.

Bitcoin has advantages in terms of value which tends to increase and a more stable exchange rate. The Bitcoin Value Tends To Be More Influenced By The Amount Of Market Demand And Supply And Is Not Affected By The Politics Of Certain Countries, Because That Bitcoin Can Be Regarded As An Interesting Investment Tool. Viewed from the presentation given [4]. With the discussion discussed, the problem that can be formulated from this research is how the backpropagation method can predict the price of bitcoin and how the predictive application system with neural networks using the backpropagation method can help investors get information about the price of Bitcoin.

## 2. Research Method

### 1. Artificial intelligence

Intelligence can be defined as wisdom and ability; what is called artificial intelligence (AI) is a variety of human intelligent behaviors, such as perception, memory, emotion, judgment, reasoning, proof, recognition, understanding, communication, design, thinking, learning, forgetting, creating, and so on, which can realized artificially by machine, system, or network. [1]

### 2. Artificial Neural Network

Definition Artificial Neural Networks is information processing for certain jobs that resemble neural biological networks. The following forms the structure of artificial neural networks :

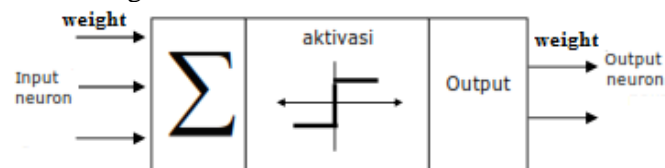


Figure 1. Structure of Neuronal Neural Networks [7]

### 3. Backpropagation method

Backpropagation is one of the algorithms that is often used in solving complex problems. Training is carried out repeatedly so that a network is generated that gives the correct response to all of its inputs. The backpropagation network consists of three layers or more processing units, the input layer consists of input variables for nerve cell units, hidden layers and outputs. As shown in Figure 2, the three layers are fully connected [2].

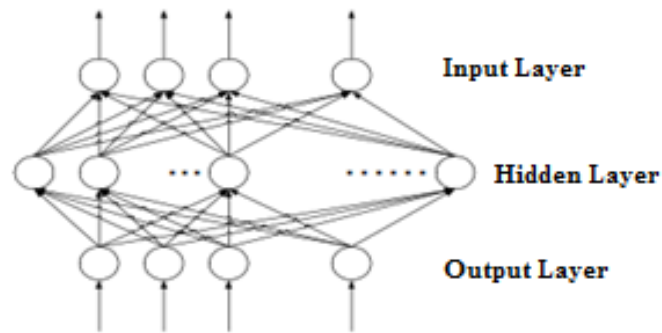


Figure 2. Backpropagation Network Layer [2]

#### 4. Activation Function

The activation function used must meet several conditions: continue, ter-differential, easily and functions that do not go down. One function that fulfils these three conditions so often used is the binary sigmoid function which has a range (0,1) [2].

$$f'(x) = f(x)(1-f(x)) \quad (1)$$

Another function that is often used is the bipolar sigmoid function whose function is similar to the binary sigmoid function, but with a range (-1,1). [6]

$$f'(x) = f'(x) = 1 + \frac{f(x)(1-f(x))}{2} \quad (2)$$

#### 5. Backpropagation algorithm

Training algorithms for networks with one hidden layer (with binary sigmoid activation functions) are as follows [2]:

Step 0: Initialization.

Step 1: If the process is not fulfilled, do steps 2-9.

Step 2: For each pair of training data, do steps 3-8.

##### Phase I: Advanced Propagation

Step 3: Each input unit receives a signal and continues to the hidden unit above.

Step 4: Calculate all outputs in hidden units  $z_j$  ( $j = 1, 2, \dots, p$ ).

$$z_{netj} = v_{jo} + \sum_{i=1}^n x_i v_{ji} \quad (3)$$

$$z_j = f(z_{netj}) = 1 / (1 + e^{-(z_{netj})}) \quad (4)$$

Step 5: Calculate all network output in units  $y_k$  ( $k = 1, 2, \dots, m$ ).

$$y_{netk} = w_{ko} + \sum_{j=1}^p z_j w_{kj} \quad (5)$$

$$y_k = f(y_{netk}) = 1 / (1 + e^{-(y_{netk})}) \quad (6)$$

##### Phase II: Propagation backwards

Step 6: Calculate the factor  $\delta$  the output unit based on the error in each output unit

$$\delta_k (k = 1, 2, \dots, m) = (t_k - y_k) f'(y_{netk}) = (t_k - y_k) y_k (1 - y_k) \quad (7)$$

$\delta_k$  is a unit of error that will be used in changing screen weights below (step 7) calculate the rate of change in weight  $w_{kj}$  (which will be used later to change the weight of  $w_{kj}$ ) with the acceleration rate  $\alpha$ .

$$\Delta w_{kj} = \alpha \delta_k z_j; \quad (8)$$

$$k = 1, 2, 3, \dots; j = 0, 1, \dots, p \quad (9)$$

Step 7: Calculate the factor  $\delta$  hidden units based on errors in each hidden unit  $z_j$  ( $j = 1, 2, 3, \dots, p$ )

$$\delta_{netj} = \sum_{k=1}^m \delta_{kwj} \quad (10)$$

factor  $\delta$  hidden unit:

$$\delta_j = \delta_{netj} f'(z_{netj}) = \delta_{netj}^{-z_j} (1-z_j) \quad (11)$$

Calculate the rate of change in  $v_{ji}$  weight (which will be used later to change the  $v_{ji}$  weight).

$$\Delta v_{ji} = \alpha \delta_j x_i; \quad (12)$$

$$j = 1, 2, \dots, p; \quad (13)$$

$$i = 0, 1, \dots, n \quad (14)$$

Phase III: Change in weight

Step 8: Calculate all changes in weight Change in line weight leading to output unit:

$$W_{kj} (new) = w_{kj} (old) + \Delta w_{kj} \quad (k = 1, 2, \dots, m; j = 0, 1, \dots, p) \quad (15)$$

Changes to the gaaris weight leading to the hidden unit:

$$V_{ji} (new) = v_{ji} (old) + \Delta v_{ji} \quad (j = 1, 2, \dots, p; i = 0, 1, n) \quad (16)$$

After the training is complete, the network can be used for pattern recognition. In this case, only advanced propagation (steps 4 and 5) are used to determine network reliability.

## 6. Bitcoin

Bitcoin is digital money that is not regulated by any central bank and any country. Bitcoin is formless money that can only be seen from the balance connected to the server that stores data on digital money. Although the bitcoin property information is stored on the server, no one else can spend bitcoin without the owner's knowledge because each owner has their own secret key [4]. There are 2 types of networks in the bitcoin system that have the same way the system works, but are not interconnected. Mainnet is the main network where bitcoin transactions are carried out. While testnet is a network used for testing. Tesnet is currently the third version called Testnet3 [4].

## 3. Result And Analysis

### 1. System Analysis

System analysis is a process that is needed in carrying out a study. this form of analysis can be described from the whole system formed. in this study the system analysis process was carried out in predicting Artificial Neural Networks using Backpropagation to determine the price movements of bitcoin. the attributes used are as follows:

1. Open Graph Movement.
2. High Graph Movement.
3. Low Graph Movement.
4. Amount of Bitcoin.
5. Request Bitcoin.

Later the movement of the open chart is symbolized at x1, the high chart movement is symbolized by x2, the movement of the graph is low with x3, the number of bitcoins is symbolized by x4 and the request for bitcoin is symbolized by x5. The data used are as follows:

#### a. Data for Training

**Table 1.** Bitcoin Data 26 april 2018 [11]

<i>open</i>	<i>high</i>	<i>low</i>	<i>volume</i>	<i>Request</i>
125210000	126459000	124850000	5,06	Top
126965000	126965000	125303000	6,5	Dwon

124977000	126291000	124977000	2,74	Dwon
125761000	127500000	125761000	2,76	Top
127745000	128498000	127744000	0,87	Top
128990000	128999000	127861000	4,6	Top
126000000	126118000	124872000	9,12	Dwon
124792000	124792000	122503000	22,34	Dwon
123499000	124488000	122508000	13,77	Top
122747000	124152000	122503000	6,87	Top
124250000	124273000	124000000	5,32	Top
123791000	124200000	123000000	5,19	Dwon

## b. Data for Testing

**Table 2.** Bitcoin Data 26 april 2018 [11]

<i>open</i>	<i>high</i>	<i>low</i>	<i>volume</i>	<i>Request</i>
108360000	108495000	108359000	0,75	Top
108506000	108608000	108506000	0,72	Top
108578000	108643000	108578000	0,38	Top
108506000	108638000	108506000	0,43	Dwon
108566000	108888000	108262000	3,11	Top
107805000	107807000	106999000	11,24	Dwon
106095000	106499000	106095000	3,45	Dwon
106284000	106314000	105025000	14,18	Dwon
105101000	105803000	105101000	5,17	Top
105897000	106286000	105820000	1,98	Top
105980000	106197000	105599000	3,65	Dwon
105898000	106086000	105717000	1,98	Dwon

## 2. Transformation Process

in this study the authors used the sigmoid (binary) activation function. this process aims to transform data first because the output of the sigmoid activation function is [0,1]. for example at intervals [(0.1), (0.8)] are:

$$X = (0.8 (x-a)) / (b-a) + 0.1 \quad (17)$$

Where:

- x: value
- a: minimum data
- b: maximum data

With this transformation, the smallest data will be 0.1 and the biggest will be 0.8. The search below shows the results of the transformation for training data which will later be used as backpropagation training data. After the transformation calculation is done, the results are as follows:

## a. Result Transformation Testing

**Table 3.** For Result Transformation Training Data [11]

<b>X1</b>	<b>X2</b>	<b>X3</b>	<b>X4</b>	<b>X5</b>	<b>T</b>
0,4334	0,5872	0,3890	0,2561	0,9000	0,5868
0,6495	0,6495	0,4448	0,3098	0,1000	0,5276
0,4047	0,5665	0,4047	0,1697	0,1000	0,5156
0,5012	0,7154	0,5012	0,1704	0,9000	0,6525
0,7456	0,8383	0,7454	0,1000	0,9000	0,7861
0,8989	0,9000	0,7599	0,2390	0,9000	0,8060
0,5307	0,5452	0,3917	0,4074	0,1000	0,3917
0,3819	0,3819	0,1000	0,9000	0,1000	0,1000
0,2227	0,3445	0,1006	0,5807	0,9000	0,2826
0,1300	0,3031	0,1000	0,3236	0,9000	0,2830
0,3151	0,3180	0,2844	0,2658	0,9000	0,3148

0,2586	0,3090	0,1612	0,2610	0,1000	0,2844
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b. Result Transformation Testing

**Table 4.** For Result Transformation Training Data [11]

X1	X2	X3	X4	X5	T
0,7907	0,8186	0,7904	0,1214	0,9000	0,8184
0,8209	0,8420	0,8209	0,1197	0,9000	0,8420
0,8358	0,8493	0,8358	0,1000	0,9000	0,8493
0,8209	0,8482	0,8209	0,1029	0,1000	0,8406
0,8333	0,9000	0,7704	0,2583	0,9000	0,8569
0,6757	0,6761	0,5088	0,7296	0,1000	0,5985
0,3216	0,4053	0,3216	0,2780	0,1000	0,4009
0,3607	0,3669	0,1000	0,9000	0,1000	0,1052
0,1157	0,2611	0,1157	0,3777	0,9000	0,2191
0,2806	0,3611	0,2646	0,1928	0,9000	0,3607
0,2978	0,3427	0,2189	0,2896	0,1000	0,3001
0,2808	0,3197	0,2433	0,1928	0,1000	0,2994

1. Network Algorithms and Architecture

Artificial Neural Network architecture used to predict consists of [10]:

a. Input layer

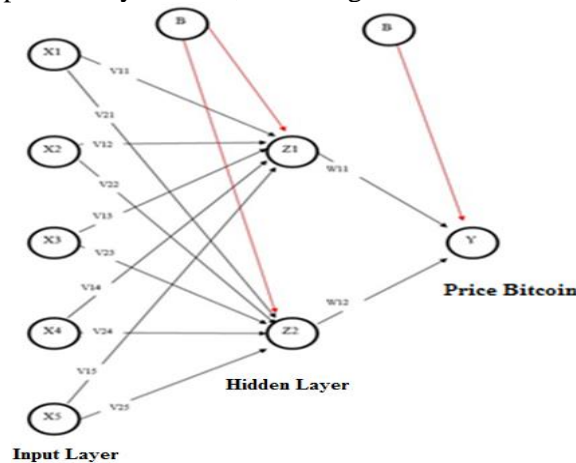
With 5 variable is each for open (x1) graph movement, high (x2) graph movement, low graph movement (x3), bitcoin (x4) volume, Request bitcoin (x5).

b. Output layer

With 1 node, that is the end result in the form of a bitcoin price (pattern obtained) (t) as a value that predicts the movement of the price of bitcoin.

c. Hidden Layer

With a number specified by the user, following the architectural results.



**Figure 3.** Architecture Neural Network [10]

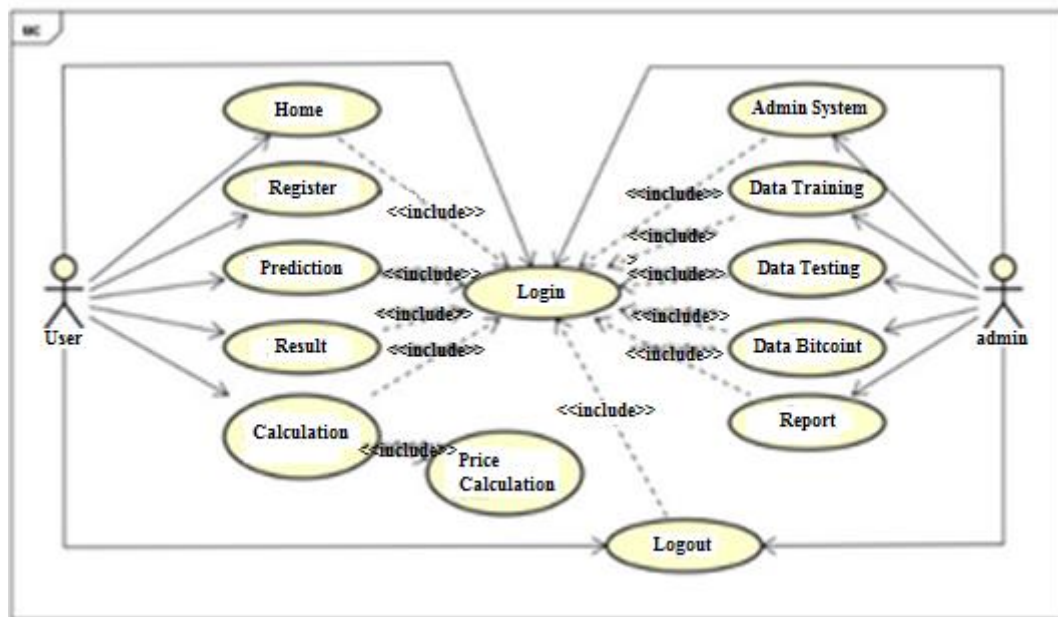
The process of calculating the artificial neural network with the backpropagation method can find out the bitcoin price movements based on open graph movements, high graph movements, low graph movements, bitcoin volumes, bitcoin requests and next hour bitcoin prices as a result of the prediction process

$$\begin{aligned}
 X &= y * (x_{max}-x_{min}) + x_{min} \\
 &= 0.8377 * (128999000 - 122503000) + 122503000 \\
 &= 127944699.2
 \end{aligned}$$

the research process will be continued at the testing stage of the prediction process using MATLAB software as a form of process to ascertain whether artificial neural networks are capable of making predictive processes. the purpose of the process of using MATLAB software is to get a prediction process in order to get better results.

## 2. System Design

This application is designed using a tool in the form of UML (Unified Modeling Language) to make it easier to move the concept of the system designed into a program. UML used one of them is Use case diagram. Use case diagram is an abstraction from the interaction between the system and the actor. Use case diagram describes an interaction between one or more actors with the system to be created. The use case is used to find out every function of the system and who can access or use the function. The following is the Use Case Diagram of the Artificial Neural Network to be built:



**Figure 4.** Usecase Diagram System

In the Use case the diagram illustrates where the Admin will only be able to manage data such as deleting bitcoin data and deleting user data that is problematic, while the user can perform a prediction process, view a list of all data and see the detailed calculation.

## 3. Implementation System

Implementation is carried out by implementing a system that has been built into an application. Later this implementation also sees whether the application runs according to the purpose of this application.

### a. Display of Prediction Results

In this view the prediction results will be shown.



Figure 5. Result Prediction System

#### b. Calculation Detail Display

This view contains details of the calculation of the selected data.

Figure 6. System Calculation Details

## 4. Conclusion

From a series of research processes carried out by the author on the topic of this research, the authors can conclude that:

1. By designing Artificial Neural Networks can be used to process the price of bitcoin.
2. By building Artificial Neural Networks using the backpropagation method can be used to predict the price of bitcoin.
3. By implementing a web-based Artificial Neural Network application application system can help bitcoin traders to get information about bitcoin prices for the next hour

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