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Forecasting of stock prices on the Indonesian Sharia Stock Index (ISSI) using backpropogation artificial neural network

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Abstract

Forecasting is a method for estimating a value in the future by looking at data in the past. In this study, the author will discuss the results of forecasting the price of the Islamic stock index using a backpropagation artificial neural network. The results show that the forecasting value of the stock closing price at ISSI for the next 1 period April 2018 is an average of 192,6842. After getting the forecast value, then it is compared with the actual average data, which is 185.4748. the amount of error generated greatly affects the number of inputs and the selection of the right network architecture pattern.

INTRODUCTION

Indonesia is one of the largest Muslim-majority countries in the world, meaning that Indonesia is a good place to develop the Islamic finance industry. As a benchmark for the performance of the Islamic capital market in Indonesia, the Jakarta Islamic Index (JII) has 30 liquid sharia stocks based on sharia principles. The development of the Islamic capital market increased significantly marked by the birth of the Islamic stock index on May 12, 2011. The Indonesian Sharia Stock Index (ISSI) is a composite index of Islamic stocks listed on the Indonesia Stock Exchange (IDX). ISSI is an indicator of the performance of the Indonesian Islamic stock market. ISSI constituents are all sharia shares listed on the IDX and included in the Sharia Securities List issued by the OJK.

The index data issued by ISSI is stock trading activity data that has a periodic nature, meaning that the data is presented within a certain period of time. The index data does not rule out fluctuations in the form of price increases and decreases. This is due to the demand and supply of shares in the capital market. Fluctuations in stock prices can make it difficult for market participants/investors to see how the prospects for investing in a company's shares in the future can reduce the risk for investors in investing so that the expected profits do not turn into losses or are much smaller than expected. The solution that is expected to overcome this problem is by forecasting techniques.

Forecasting stock prices is very useful to see the prospect of a company's stock investment in the future. This forecasting is also expected to reduce the risk for investors in investing in a company in order to avoid losses (Riyanto, 2017).

Artificial Neural Network (ANN) is one part of artificial intelligence that can be used in prediction or forecasting systems. The ANN method that is often used in forecasting or prediction is the Backpropagation method. From several previous studies, the Backpropagation neural network gives good results for solving cases that use complex data such as prediction or forecasting cases, for example, stock price forecasting, tourism visitor forecasting, export product forecasting and unemployment prediction (Andrijasa & Mistianingsih, 2010).

The Backpropagation neural network algorithm is used to predict the Indonesian Islamic Stock Index and provide useful information for the government and market players/investors in the Indonesian Islamic capital market related to anticipating or taking business actions. The use of the Backpropagation method in the prediction process is expected to produce a more accurate prediction value.

MATERIAL AND METHODS

Stock Price

According to Sartono (2008), stock prices are formed through the mechanism of supply and demand in the capital market. Stock prices tend to rise, if the stock is in excess demand. On the other hand, the stock price tends to fall if the stock is oversupplied. Then according to Jogiyanto (2008), the price of a share that occurs in the stock market at a certain time is determined by market participants through the demand and supply of the relevant shares in the capital market. stock exchange according to the demand and supply of shares made by market participants.

The types of stock prices according to Widoatmojo (2005) are as follows: a) Nominal Price. The nominal price is the price listed in the share certificate, which is determined by the issuer to value each share issued. The amount of the nominal price gives importance to the stock because the minimum dividend is usually set based on the nominal value. b) Prime Price. The initial price is the share price that is first recorded by the stock exchange, which is determined by the underwriter and the issuer. Thus it will be known at what price the issuer's shares will be sold to the public and used to determine the next initial price. c) Market Price. The market price is the stock price that has been recorded on the stock exchange at that time, in other words, the market price is the selling price from one investor to another. The transaction here no longer involves the issuer from the underwriter and this price truly represents the price of the issuing company. d) Opening Price. The opening price is the price asked by the seller or buyer at the time the exchange is open on that day. The opening price can be the market price, and vice versa the market price may also be the opening price. But it doesn't always happen. e) Closing Price. The closing price is the price asked by the seller or buyer at the end of the trading day. Exchange day closes in the afternoon exactly at 16:00 WIB. f) Highest Price. The highest price is the highest price that occurs on the stock day. This price can change more than once per day on a stock. g) Lowest Price. The lowest price is the lowest price that occurs on the stock day. This price can change more than once per day on a stock. In other words, the lowest price is the opposite of the highest price. h) Average Price. The average price is the average of the highest and lowest prices.

Indonesian Sharia Stock Index (ISSI)

The Sharia Stock Index (ISSI) is an indicator that shows the performance/movement of the Islamic stock price index on the IDX/IDX. To date, there are three sharia stock price indices, namely the Jakarta Islamic Index (JII), the Indonesian Sharia Stock Index (ISSI), and the Jakarta Islamic Index70 (JII70). The Indonesian Sharia Stock Index (ISSI) is a composite index of Islamic stocks listed on the IDX. ISSI is an indicator of the performance of the Indonesian Islamic stock market. ISSI constituents are all sharia shares listed on the IDX and included in the Sharia Securities List issued by the OJK. This means that the IDX does not select sharia shares that are included in the ISSI. ISSI constituents are re-selected twice a year, every May and November, following the Sharia Securities List review schedule. Therefore, every selection period, there are always sharia shares that come out or enter into ISSI constituents. The ISSI calculation method follows other IDX stock index calculation methods, namely the weighted average of market capitalization using December 2007 as the base year for ISSI calculations.

Development Method

1. System analysis
   System analysis is analyzing the needs of the system to be built related to the architecture that will be made.
2. System Planning
   At this stage, the design is carried out as follows: The data will be divided into two, namely training data and the pattern used is day 1-19 data as input data, then day 20 data as target data, then the second pattern is data on day 2-20 as input data and day 21 data as data. target and so on until day 19-37 data as input data and data to 38 as target data, so x=57 and y=1.
3. System Creation
   At this stage, implementing the results of the system design in the form of a program by using the mathlab R2016a application, the steps include normalizing, forecasting, denormalizing, and seeing the error value.
4. System Testing
   The test was conducted to test the performance of the Backpropagation neural network algorithm by comparing the actual ISSI data with the resulting ISSI value and the prediction of the next month by the program.
5. Conclusion
   After going through the system testing stage, the last stage is drawing conclusions

Artificial Neural Network

Artificial Neural Network (ANN) is one of the information processing systems designed to imitate the workings of the human brain in solving a problem by carrying out the learning process through changes in the weight of its synapses. Artificial neural networks are able to recognize activities based on past data. The past data will be studied by the artificial neural network so that it has the ability to make decisions on data that has never been studied (Hermawan 2006).

According to Hermawan (2006) ANN is an architectural form that is distributed in parallel with a large number of nodes and the relationships between these nodes. Each connection point from one node to another has a value associated with a weight. Each node has a value associated with the activation value of the node.

The characteristics of ANN are determined by the following things (according to Fausett 1994): a. The pattern of relationships between neurons is called the network architecture. b) The method of determining the weights of the connection is called training or network learning process. c) Activation function.

Network Architecture

The relationship between neurons or commonly referred to as network architecture. These neurons are collected in layers called neuron layers. The layers that make up the ANN are divided into three, namely according to (Noon 2009): a) Input Layer The units in the input layer are called input units in charge of receiving input patterns from outside that describe a problem. B) Hidden Layer The units in the hidden layer are called hidden units whose output values cannot be observed directly. c) Output Layer The units in the output layer are called output units, which are ANN solutions to a problem.

Backpropagation Method

Backpropagation method is one type of Artificial Neural Network that is often used in solving forecasting problems. This is possible because the Backpropagation method is one type of ANN training method with supervision. The network is given a pair of patterns consisting of the input pattern and the desired pattern. When a pattern is given to the network, the weights are changed to minimize the difference between the output pattern and the desired pattern. This exercise is done repeatedly so that all patterns issued by the network can meet the desired pattern. This network architecture consists of an input layer, a hidden layer, and an output layer. Backpropagation architecture can be seen in the following figure (Fausett, 1994).

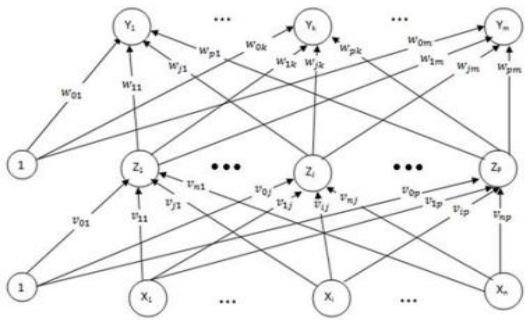

Fig 1. Backpropagation Network Architecture with one hidden layer

Data normalization formulation

To reduce computational calculations that are too large, data normalization is carried out in the range 0.1 to 0.9 using the following equation:

$$x' = \frac{0{,}8(x-b)}{a-b} + 0{,}1$$

Where

x' : normalized data

x : original data

a : maximum value of original data

b : minimum value of original data

Evaluation of Forecasting Results

The evaluation of forecasting results is used to determine the accuracy of the forecasting results that have been carried out on the actual data. There are many methods for calculating forecasting errors. Some of the methods used are:

Root Mean Square Error The method that is quite often used in evaluating forecasting results is by using the Mean Squared Error (MSE) method. By using MSE, the error shows how big the difference between the estimation results and the results to be estimated is. The thing that makes it different is because of the randomness in the data or because it doesn't contain a more accurate estimate.

$$MSE = \frac{\sum_{t=1}^{n}(At - Ft)^2}{n}$$

MSE = Mean Square Error
N = Number of Samples
At = Index Actual Value
Ft = Index Prediction Value

$$RMSE = \sqrt{\frac{(At - Ft)^2}{n}}$$

RMSE is the root of the value of the MSE that has been searched previously. RMSE is used to find the accuracy of forecasting results with historical data using a formula (Makridakis, 1999). The smaller the resulting value, the better the forecasting result.

RESULT AND DISCUSSION

Artificial Neural Network data processing begins with determining the input data and target data. The data used is daily data from January 2018-March 2018 and will predict stock prices in April 2018. The data to be processed in Table 1.

The pattern model in this study is as follows, which explains the input data and target data. In conducting training and determining network parameters, first form a pattern for identification based on stock prices from January 2018 to March 2019. The variables used in building this network include, iterations (epochs), learning rate, number of neurons in the network. Each hidden layer epochs and learning rate

is determined by looking at the Mean Square Error (MSE) during the training, the smaller the MSE, the better the work of the Artificial Neural Network. At the beginning of the training, parameters were set with a network architecture of 19 inputs, 1 hidden layer and 1 output.

In the Output test data results in March 2018, it appears that the smaller MSE value is 0.414, meaning that the artificial neural network has worked better. However, on day 10-19, the ISSI value is constant at 198.

Table 2. input and target data

Pattern	Input Data	Target data
1	Data for day 1-19	Data for day 20
2	Data for day 2-20	Data for day 21
3	Data for day 3-21	Data for day 22
4	Data for day 4-22	Data for day 23
.	.	.
.	.	.
19	Data for day 19-37	Data for day 38

By using the normalization formula, the data to be normalized will form the following 19*19 matrix:

0.312354719	0.36256392	0.47634821	0.53324035	0.50151093	0.51307531	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591
0.362563924	0.47634821	0.53324035	0.50151093	0.51307531	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735
0.47634821	0.53324035	0.50151093	0.51307531	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927
0.533240353	0.50151093	0.51307531	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774
0.501510925	0.51307531	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951
0.513075314	0.52998605	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909
0.529986053	0.48320549	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179
0.483205486	0.50586936	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702
0.505869363	0.60820549	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802
0.608205486	0.66806137	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897
0.668061367	0.67149	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1
0.671490005	0.69148071	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348
0.691480707	0.69020223	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848
0.690202232	0.8489656	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977
0.848965597	0.88115993	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977	0.84966295
0.881159926	0.93195026	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977	0.84966295	0.79561832
0.931950256	0.9219549	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977	0.84966295	0.79561832	0.83833101
0.921954905	0.96379591	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977	0.84966295	0.79561832	0.83833101	0.8387378
0.963795909	0.82920735	0.6356927	0.73436774	0.74354951	0.68444909	0.69514179	0.77841702	0.8275802	0.85070897	1	0.89952348	0.87627848	0.80049977	0.84966295	0.79561832	0.83833101	0.8387378	0.85727569

Fig 2. Normalization Results

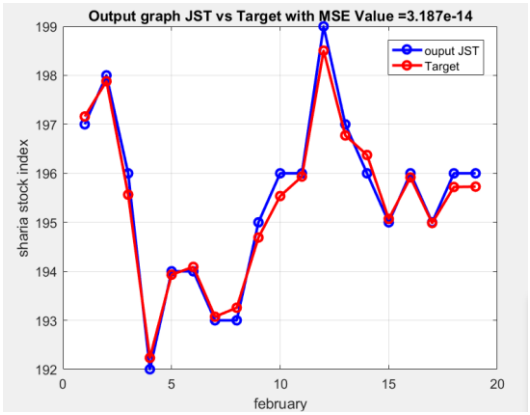

Fig 4. Training Data Output (February 2018)

In the output graph, the training data used is January data to predict February data, it can be seen that it has a good pattern with MSE = 3.187.

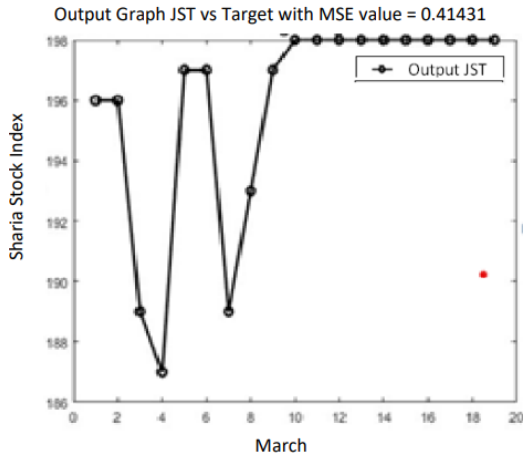

Fig 5. Output of test data (March 2018)

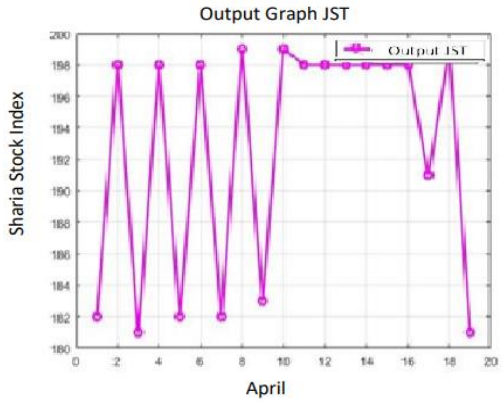

Fig 6. Testing data output (April 2018 Prediction)

The formula used to determine the test with parameters in this prediction using mathlab R2016a is described as follows:

```
result_prediction_norm =
sim(network,data_prediction_norm); %day 1 month of
april
for n = 1:18
   data_prediction_norm = [data_prediction_norm(end-
17:end); result_prediction_norm(end)];
   result_prediction_norm =
[result_prediction_norm,sim(network,data_prediction_n
orm)];
end
   % denormalizes
   result_prediction_origin =
round(result_prediction_norm*(max_data-
min_data)+min_data);
```

Table 1. ISSI data January-March 2018

Month	day 1	day 2	day 3	day 4	day 5	.....	day 16	day 17	day 18	day 19
January	189.73	189.73	186.67	187.53	189.49	.....	193.17	195.90	196	197
February	197.16	197.88	195.56	192.23	193.93	.....	195.92	194.99	196	196
March	196.05	194.71	194.21	192.57	188.46	.....	183.92	182.87	183	181

Based on figure 6, it can be seen that the forecast value for the closing price of shares at ISSI for the next 1 period in April 2018 is an average of 192,6842. After getting the forecast value, then it is compared with the actual average data, which is 185.4748. Based on table 2, the difference between the two values is not good enough because the MSE value is still quite large between the predicted and actual data.

Based on Table 2, it is possible that the results are not good because the number of inputs is inadequate or not enough, so the prediction results are not good. The smallest error values occur at the starting and ending points, namely on the 1st and 19th days. So this type of research that uses daily data is only good when predicting the start and end days, which is indicated by a small error value. The suggestions that can be submitted by the author are as follows:

1. This research is still far from perfect, for that it is necessary to do further research by increasing the number of input variables.
2. Prediction using Artificial Neural Networks with the Backpropagation algorithm is very influential with the amount of data used for training and testing. For this reason, it is necessary to carry out further development using ISSI data more than 3 years and selecting network architecture patterns.

From the input data and target data that have been presented, based on the table above, the max value is 198.50 and the min data is 181.29.

Table 2. ISSI Prediction Data for April 2018

Day	Prediction	Actual
Day 1	182	183.52
Day 2	198	184.99
Day 3	181	184.67
Day 4	198	187.58
Day 5	182	189.43
Day 6	198	190.46
Day 7	182	188.60
Day 8	199	186.84
Day 9	183	187.18
Day 10	199	187.57
Day 11	198	187.68
Day 12	198	189.15
Day 13	198	188.85
Day 14	198	187.99
Day 15	198	186.03
Day 16	198	182.97
Day 17	191	175.59
Day 18	199	174.00
Day 19	181	180.93

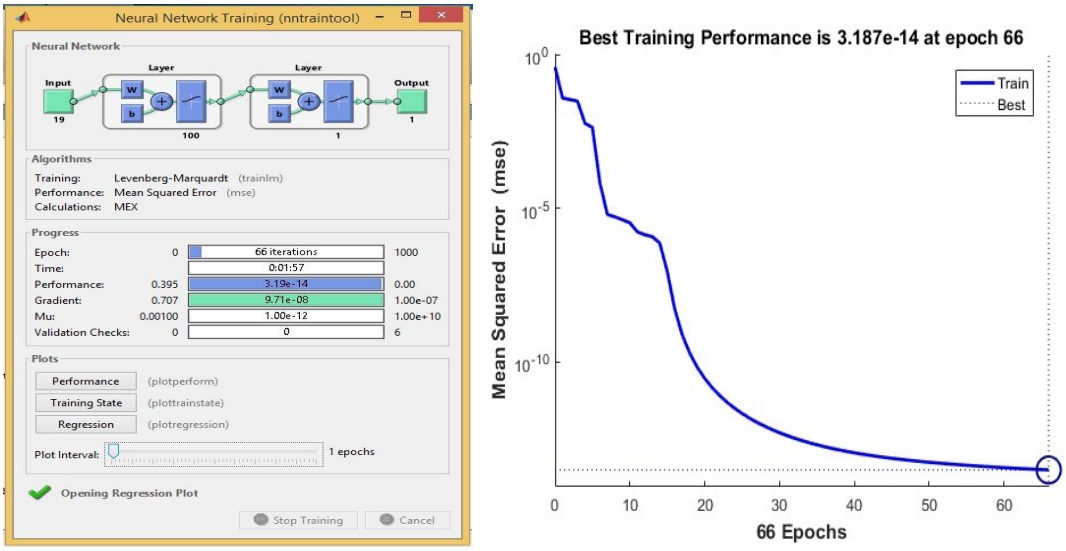

Fig 3. Results of Neural Network Training Design and MSE Graph

Process Form for calculating sharia stock index price predictions is a form that displays the calculation process to achieve accuracy, MSE error and Prediction training data results. The figure shows the smallest MSE value in the 66th iteration with a time of 1 minute 57 seconds.

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