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Prediction of Corn Crop Yield Using Backpropagation Neural Network Algorithm

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Abstract. Corn is one type of food crop commodity in Indonesia. Malang Regency is one of the producers that ranks 10th in corn production in the East Java region. People are very interested in planting corn because this crop commodity has many benefits so as to make the demand for production increase. There was a significant increase in market demand, but the uncertain amount of production made the supply of corn plants unable to be fulfilled properly. In this study, it predicted the demand for corn by using the Backpropagation Neural Network algorithm in Malang Regency. The data in this study were obtained from the Department of Agriculture and Food Security of East Java Province starting from 2007-2020 every month using maize data from the Malang area. The results showed that the backpropagation algorithm produced an MSE value of 0.00004178.

INTRODUCTION

Indonesia is a maritime country where each region is a producer of food crops, one of which is Malang Regency which is located in the province of East Java. One of the food crops commodities in Malang Regency is corn. Palawija crops are usually referred to as seasonal crops which can be used as food crop rotations when the climate and weather are not favorable. The existence of palawija plants is also an effort to create a diversity of food types in Indonesia. With the diversity of food crops in Indonesia, it can increase food security when the main commodity, namely rice, experiences a decline in prices. In addition, in 2019 the amount of rice production in East Java decreased by 0.62 million tons [1]. This instability in rice production is one proof why the government must maintain the production of other food crops in order to stabilize the country's food security.

Malang Regency was ranked 10th in corn production in the East Java region in 2020 with a total production of 289,900 tons. Corn is the main food crop commodity in Indonesia [2]. Corn is a food crop that contains carbohydrates other than rice and is a food crop commodity with the largest production after rice. Corn seeds can be used as food, animal feed, industrial raw materials and can be processed into various types of food. The benefits of the corn food crop make the demand for production increase, but the uncertain amount of corn food crop production will be a problem for the Department of Agriculture and Food Security of East Java Province in determining a policy in Malang Regency [3].

An artificial entity that has the ability or intelligence can be expressed as artificial intelligence. In general, it is in the system on computer equipment. This intelligence is created and put into a machine in the hope of doing work like humans do [4]. There are several methods that are often used to make predictions, such as research for prediction of

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inflation in Indonesia using the Moving Average, Single Exponential Smoothing and Double Exponential Smoothing methods. This study used data from Bank Indonesia from January 2015 to May 2020. The results of this study indicated that the superior method was Single Exponential Smoothing [5]. Research comparing the Double Exponential Smoothing (DES) and Artificial Neural Network (ANN) methods have been carried out for forecasting the development of COVID-19 in Indonesia. The research data was obtained from the official website of the Indonesian government's COVID-19 task force. The results of this study indicate that the ANN method is better than DES [6].

In addition to the research above, there are other studies that compare the method of Exponential Smoothing and Backpropagation Neural Networks in prediction systems. The results of their research show that Backpropagation Artificial Neural Networks are superior to Exponential Smoothing [7][8]. And from several studies that have been mentioned above, the main contribution of this research is to predict the production of corn food crops in Malang, East Java using Backpropagation Algorithm Artificial Neural Networks.

METHODS

This study used data from the Department of Agriculture and Food Security of East Java Province, starting from 2007-2020. The food crop commodity used in this study was a dataset of corn food crop production in Malang, East Java.

Table 1. Example of Maize Production Data in Malang Regency in 2007

No	Month	Production (tons)
1	January	13774,56
2	February	14559,35
3	March	15315,85
4	April	16044,04
5	May	16743,95
6	June	17415,56
7	July	18058,88
8	August	18673,9
9	September	19260,62
10	October	19819,06
11	November	20349,19
12	December	20851

1.1.Backpropagation

Time Series or time series is defined as a sequence of variable values at the same time interval [9][10]. In other words, time series is a collection of data at a certain time period. The typical topology of the Backpropagation algorithm has 3 layers, namely the input layer where the data was entered. The hidden layer where the data was processed and the output layer as the result of the given input [11]. Before getting to know more about the Backpropagation algorithm, it would be better to know the architecture of the Backpropagation algorithm. An example of Backpropagation algorithm architecture coulds be seen in the image below.

Figure 1 shows an architecture with the number of neurons in the input layer = 4, the number of neurons in the hidden layer = 3 and neurons in the output layer = 1. The number of weights V depends on the number of neurons in

the input layer and hidden layer. If the number of neurons in the input layer = 4 and the number of neurons in the hidden layer = 3, then the number of weights V that connects the two layers is (4x3=12). If there is a bias between the input layer and the hidden layer, the total weight of V is ((4+1) x 3 = 15). This also applies to the weights that connect between the hidden layer and the output layer.

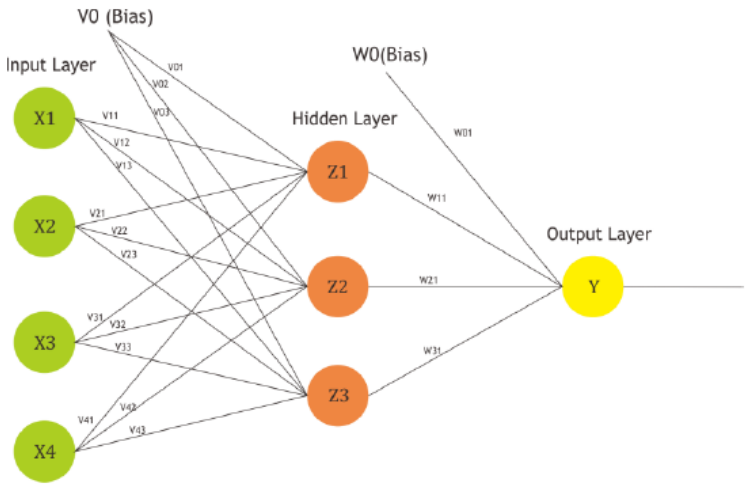

Figure 1 Backpropagation Algorithm Architecture

There are 2 processes in the Backpropagation algorithm [12]:

1. Training Process (Training)
   This process aims to recognize data patterns. In this process, it can be interpreted as an iteration of the forward and backward propagation processes aimed at obtaining trained weights and biases. Backpropagation algorithm uses error output to change the value of its weights in backward propagation. To get this error, the forward propagation step must be done first.
2. Testing Process (Test)
   This process is a process that is carried out on test data, in the Backpropagation testing process only the forward propagation process is carried out.

II. RESULT

The architecture of the number of layers and the neurons of the Backpropagation algorithm had 3 layers, they are an input layer, a hidden layer, and an output layer. Each layer has a number of input neurons 1, hidden neurons 5, and output neurons 1. At this stage the researcher made a test scenario to make it easier to draw conclusions. It was implemented by conducting the test scenarios shown in Table 2.

Table 2. Backpropagation algorithm trial scenario

No	Scenario	Trials
1	Sharing training data and test data	90:10
2	Maximum iterations	2000
3	Learning rate	0.1-0.9
4	Error limit	0.00001
5	Activation Function	Sigmoid biner

Figure 2 explains the experimental value using a test scenario using 90% data sharing for training and 10% for testing which produces MSE values in the Backpropagation algorithm as shown above. So, it could be concluded that the MSE Backpropagation value at a learning rate of 0.1 - 0.4 increases and at a learning rate of 0.5 - 0.7 the value decreases, then at a learning rate of 0.8-0.9 the value increases. The optimal value of learning rate on the Backpropagation algorithm is 0.7. The smallest value is obtained when using a learning rate of 0.7 with an MSE value of 0.00004178.

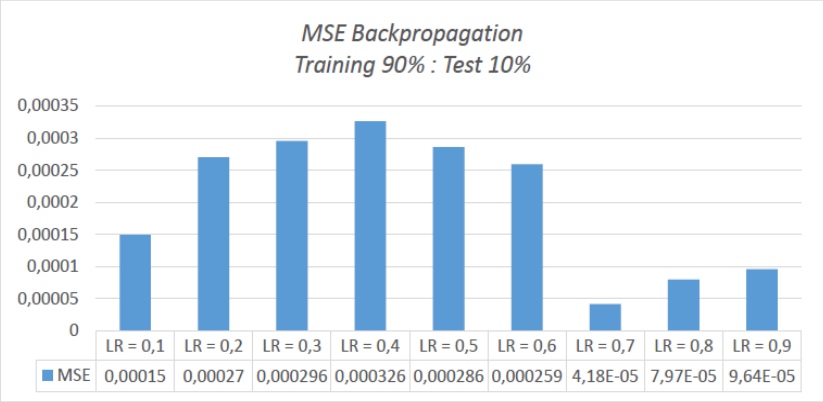

Figure 2. MSE Backpropagation

III. CONCLUSIONS

Based on the system testing that has been done, there are two conclusions, they are:

1. Determination of the number of neurons, learning rate parameters, error limits, and weight values are factors that can affect the error rate of predictions on Backpropagation.
2. Based on the results of training and testing of artificial neural networks, the architectural model that has the smallest RMSE value is the 4-3-1 architecture with an RMSE error value of 0.00004178.

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