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Analysis of Backpropagation Algorithm Using the Traingda Function for Export Prediction in East Java

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Abstract

Exports are significant for a country's economic development, especially in regions that carry out export activities because not all countries and regions have the same natural and human resources. Therefore this study aims to predict the level export of oil, gas and others in the province of East Java and to understand the forecast for the number of exports in the coming year. This is important to provide information to the East Java provincial government so that later it can make policies so that the export value can be increased, at least so that the export value remains stable. The prediction algorithm used is the Backpropagation Neural Network algorithm using the Gradient Descent training function with Adaptive Learning rate. The research data is data on Export of oil, gas and others in East Java Province from 2008 to 2019. The prediction process analysis uses 3 network architecture models, namely: 5-10-1, 5-15-1, and 5-20-1. Based on the analysis results, the 5-10-1 model is the best compared to the other two models with an accuracy rate of more than 90% and MSE testing 0.0012454304, which means that this model is good for predicting export of oil, gas and others.

Keywords: *Backpropagation, Traingda, Export, Prediction, East Java*

1. Introduction

Exports are sales of goods and services abroad using a payment system, quality, quantity, and other terms of sale that have been approved by exporters an [1]. Since the onset of the economic crisis in July 1997, which continued into a multidimensional crisis experienced by the Indonesian nation, it has significantly affected the decline in various sectors' export performance, especially in the regions in each province. To increase the value of exports, the government in each province needs to maintain a real exchange rate that can encourage exports [2]. This research will discuss the prediction of export of oil, gas and others in East Java province. According to the Central Statistics Agency, the export value of East Java in August 2020 decreased by 9.48 percent compared to the previous month, namely from US$ 1.57 billion to US$ 1.43 billion, according to the records of the local Central Statistics Agency (BPS), Tuesday, September 15, 2020. The decline in East Java's export value was due to the declining performance of export of oil, gas and others. The non-oil and gas sector exports fell by 6.36 percent, from US$ 1.46 billion to US$ 1.37 billion. Even though the non-oil and gas sector exports contributed 96.05 percent of the total exports in August 2020. For oil and gas exports in August 2020, it decreased by 49.99 percent compared to the previous month, namely from US$ 112.67 million to US$ 56.35 million [3].

In table 1, it can be seen that the export value in East Java (US$) from 2008 to 2019. Based on table 1, the value of oil and gas exports in East Java from 2008 to 2019 experienced a significant decline. Meanwhile, the value of non-oil and gas has increased. This needs to be a concern for the provincial government of East Java so that the export value does not decrease in the future to maintain economic stability in the province.

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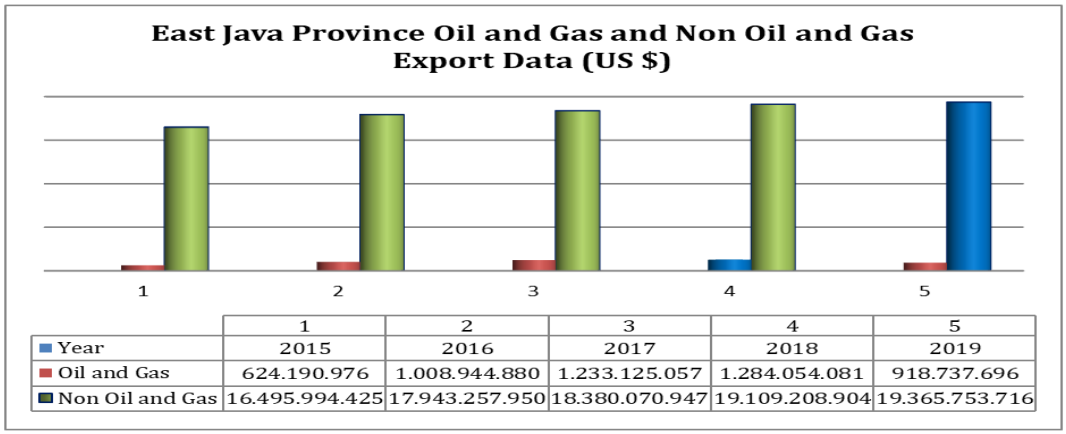
Table 1. East Java Province Oil and Gas and Non Oil and Gas Export Data (US$)

Export Type	Exports (US$) / Year				
	2008	2009	…	2018	2019
Oil and Gas	544.077.059	685.597.221	…	1.284.054.081	918.737.696
Non Oil and Gas	10.051.178.328	10.106.340.299	…	19.109.208.904	19.365.753.716

Source: Central Bureau of Statistics of East Java Province [3]



	1	2	3	4	5
Year	2015	2016	2017	2018	2019
Oil and Gas	624.190.976	1.008.944.880	1.233.125.057	1.284.054.081	918.737.696
Non Oil and Gas	16.495.994.425	17.943.257.950	18.380.070.947	19.109.208.904	19.365.753.716

Figure 1. Export of oil, gas and others Chart (last 5 years)

Based on Figure 1, it can be seen that the export value of the non-oil and gas sector has increased every year. Meanwhile, the export value of oil and gas in 2019 experienced a significant decline. Broadly speaking, it can be concluded that the highest export value for the oil and gas sector (blue graph) occurred in 2018, while for the non-oil and gas sector occurred in 2019 (blue graph).

Due to the importance of the value of export of oil, gas and others for the economy in East Java Province, it is necessary to predict the level of exports in the future so that it can become information and input as well as a reference for the East Java regional government to determine policies or make strategic steps right so that the export value in East Java Province does not decrease. The algorithm used to carry out the prediction process in this paper is the Backpropagation algorithm using the Gradient Descent training function with Adaptive Learning Rate (Traingda). Because based on research conducted by Wanto, et al. (2020), traingda is the best training function that can be used to predict times series data [4].

Several previous studies related to this research, including research conducted by Wanto, et al. (2z018) [5] which discusses the prediction of Export and Import Volume of Crude Oil, Oil, and Gas Products in Indonesia using the Backpropagation algorithm. The best architectural model in this study is 12-5-1, with a predictive accuracy rate of 83%. Furthermore, research conducted by Saputra, et al. (2019) [6] which discusses the prediction of fuel consumption based on the type of power plant. In this study, the best architectural model is 8-23-1 with an accuracy rate of 88%. Next research conducted by Windarto, et al. (2020) [7] about the Neural Network Architecture Model with the Combination of K-Medoids and Backpropagation in the COVID-19 Pandemic case in Indonesia. The purpose of this study is to create a predictive model for the best neural network architecture by combining k-medoids and backpropagation methods in the case of the COVID-19 pandemic in Indonesia. This study's best architectural model is 3-2-1 with an accuracy value of 94.17% and learning_rate = 0.696. These related studies are the background for predicting oil and gas and non-oil exports in East Java province. This study's results are in the form of predictive information on export of oil, gas and others in

East Java province, which is expected to provide input and information for the East Java City government to maximize further efforts to increase export value in the future.

2. Research Methodology

2.1. Method of collecting data

Data collection uses quantitative methods, namely data on Export of oil, gas and others of East Java Province in 2008-2019, which were obtained from the Central Statistics Agency of East Java Province.

2.2. Research Flowchart

The following will present a flowchart or stages in this research.

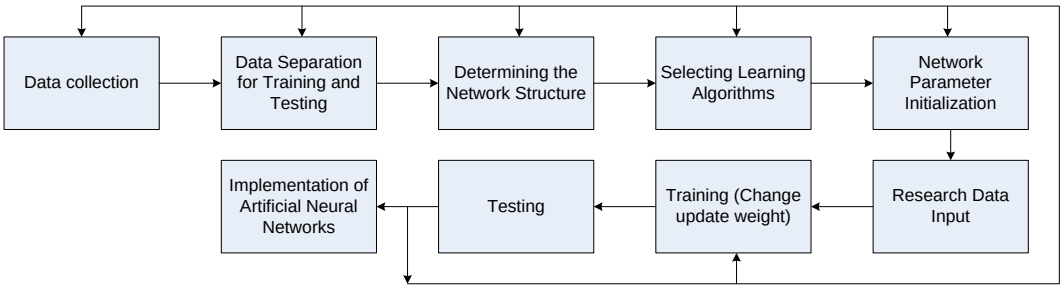


Figure 2. Research Flowchart

3. Results and Discussion

3.1. Data Normalization

Before the data is processed, the data must first be normalized using equation (1) [8]–[26] :

$$x' = \frac{0.8(x-a)}{b-a} + 0.1 \quad (1)$$

Explanation :

x' = Normalization results
x = Data to be normalized
a = The lowest data from the dataset
b = Largest data from the dataset

Data that has been normalized using equation (1) can be seen in table 2.

Table 2. Normalization of Training Data

Preliminary Data		
Exports (US$) / Year	Export Type	
	Oil and Gas	Non Oil and Gas
2008	544.077.059	10.051.178.328
2009	685.597.221	10.106.340.299
2010	1.534.945.702	13.805.530.773
2011	1.639.040.921	17.423.730.184
2012	725.048.436	15.524.173.322
2013	453.172.583	15.055.241.558
2014	77.381.982	1.480.600.481
2015	624.190.976	16.495.994.425
2016	1.008.944.880	17.943.257.950
2017	1.233.125.057	18.380.070.947
2018	1.284.054.081	19.109.208.904
2019	918.737.696	19.365.753.716

Normalized Data		
Exports (US$) / Year	Export Type	
	Oil and Gas	Non Oil and Gas
2008	0,11936	0,51367
2009	0,12523	0,51596
2010	0,16045	0,66939
2011	0,16477	0,81945
2012	0,12686	0,74067
2013	0,11559	0,72122
2014	0,10000	0,15820
2015	0,12268	0,78097
2016	0,13864	0,84100
2017	0,14794	0,85912
2018	0,15005	0,88936
2019	0,13490	0,90000

The normalization results in table 2 will be divided into 2 parts, namely, training data and testing data. The training input data uses data from 2008 to 2012 with a target of 2013. The test input data uses data from 2014 to 2018 with a target of 2019. For more details, see table 3 below.

Table 3. Separation of Training Data and Testing Data

Data	Training Data					
	2008	2009	2010	2011	2012	Target
1	0,11936	0,12523	0,16045	0,16477	0,12686	0,11559
2	0,51367	0,51596	0,66939	0,81945	0,74067	0,72122

Data	Testing Data					
	2014	2015	2016	2017	2018	Target
1	0,10000	0,12268	0,13864	0,14794	0,15005	0,13490
2	0,15820	0,78097	0,84100	0,85912	0,88936	0,90000

3.2. Best Architectural Model

There are 3 architectural models used in this study, namely: 5-10-1, 5-15-1, and 5-20-1. Based on these 3 models, the 5-10-1 model is the best model chosen because of the higher level of accuracy than the other models, which is 100%. The way to determine the best architectural model with the Backpropagation algorithm is to look at each model's highest level of accuracy. The error parameters used were 0.01-0.001. The analysis process uses Matlab and Microsoft Excel tools. Data training using Matlab can be seen in Figure 3 and Figure 4.

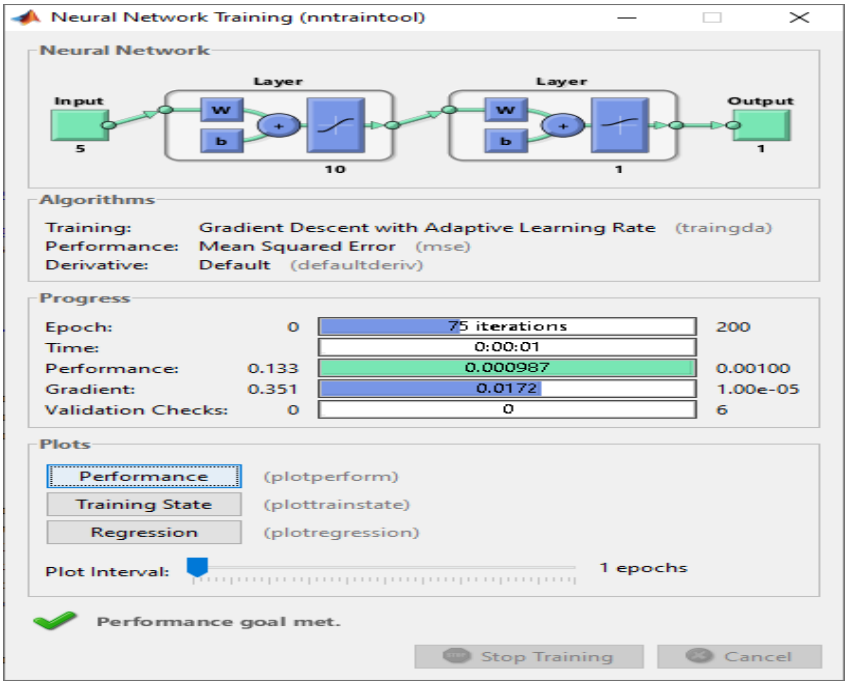


Figure 3. Neural Network Training

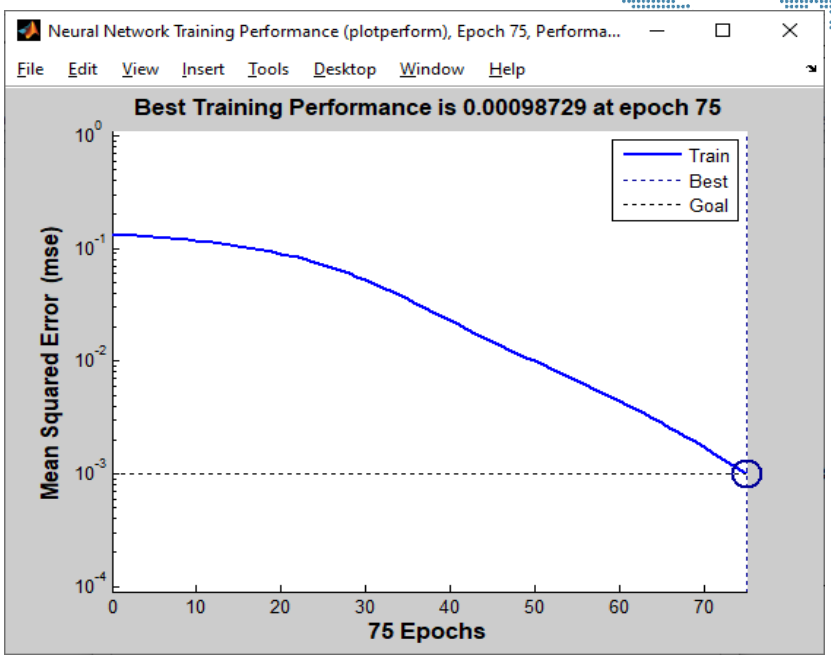


Figure 4. Best Training Performance

The results of the training and testing process for the 5-10-1 model using Microsoft Excel can be seen in table 4 and table 5.

Table 4. Training Data Model 5-10-1

Data	Target	Output	Error	SSE
1	0,11559	0,15910	-0,04351	0,0018934505
2	0,72122	0,71220	0,00902	0,0000813280
			Sum SSE	0,0019747785
			MSE	**0,0009873893**

Table 5. Testing Data Model 5-10-1

Data	Target	Output	Error	SSE	Result
1	0,13490	0,17860	-0,04370	0,0019100507	1
2	0,90000	0,92410	-0,02410	0,0005808100	1
			Sum SSE	0,0024908607	**100 %**
			MSE	**0,0012454304**	

3.3. Comparison of Architectural Models Used

The comparison of the results of the training and testing process with the architectural model used can be seen in table 6.

Table 6. Comparison of Architectural Models

Backpropagation Algorithm uses the Traingda function				
Architecture	**Epoch**	**MSE Training**	**MSE Testing**	**Accuracy**
5-10-1	75	0,0009873893	0,0012454304	100%
5-15-1	72	0,0009542948	0,1877026368	50%
5-20-1	72	0,0006019681	0,3212881097	50%

In table 3, we can see the comparison of each of the architectural models used. Of the 3 trained and tested architectural models, the 5-10-1 architectural model is the best architectural model with the lowest MSE of 0.0012454304 and an accuracy rate of 100% (the highest compared to the other 2 architectural models).

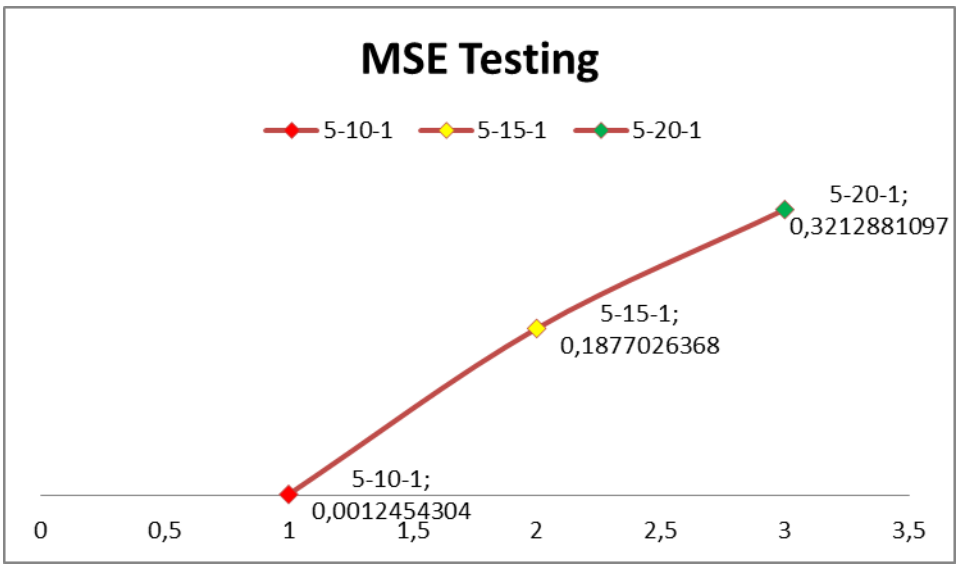


Figure 5. MSE Testing masing-masing model

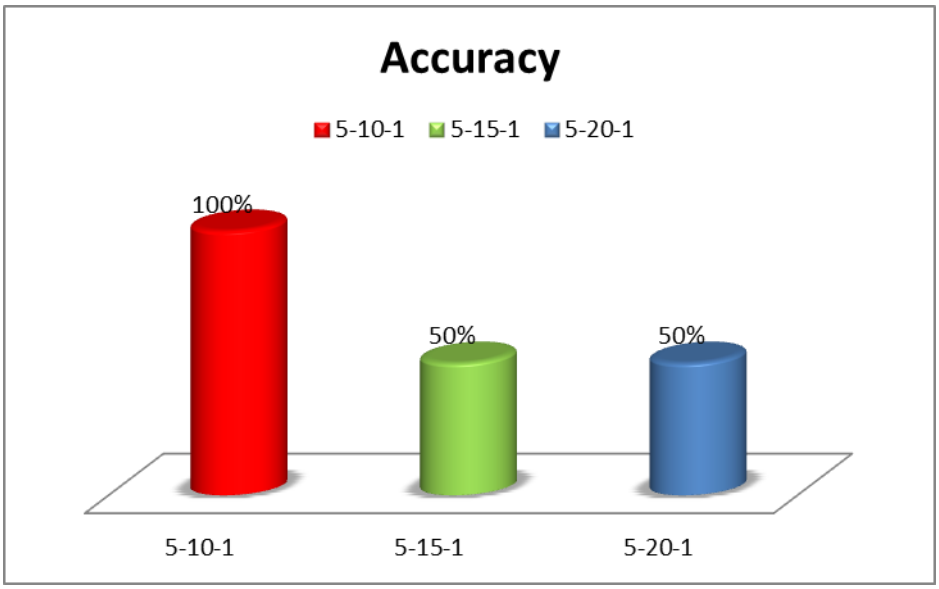


Figure 6. Grafik akurasi masing-masing model

3.4. Prediction Results

Furthermore, predictions will be made with the 5-10-1 model using the equation (2) which is the formula for returning the value:

$$x_n = \frac{(x - 0,1) * (b - a)}{0,8} + a \quad (2)$$

Explanation:

x_n = Prediction Results
x = Predicted Target
a = The lowest data from the dataset
b = Largest data from the dataset

For the prediction results for 2020 can be seen in table 6.

Table 7. Comparison of Initial Export Data (2008-2019) with Predictive Data (2020)

Exports (US$) / Year	Export Type	
	Oil and Gas	Non Oil and Gas
2008	544.077.059	10.051.178.328
2009	685.597.221	10.106.340.299
2010	1.534.945.702	13.805.530.773
2011	1.639.040.921	17.423.730.184
2012	725.048.436	15.524.173.322
2013	453.172.583	15.055.241.558
2014	77.381.982	1.480.600.481
2015	624.190.976	16.495.994.425
2016	1.008.944.880	17.943.257.950
2017	1.233.125.057	18.380.070.947
2018	1.284.054.081	19.109.208.904
2019	918.737.696	19.365.753.716
2020 (Prediction)	1.723.393.607	18.706.272.893

4. Conclusion

Based on the results and discussion described in this article, it can be concluded that the Backpropagation method can be used to predict the value of export of oil, gas and others in East Java province. Based on the comparison of the initial export data in 2019 with the predictive data for exports in 2020, there was a significant decrease in oil and gas export data, as well as non-oil and gas exports Comparison of the Initial Export Data (2008-2019) with Prediction Data (2020).

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