

Forecasting the Export and Import Volume of Crude Oil, Oil

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1 Forecasting the Export and Import Volume of Crude Oil, Oil Products and Gas Using ANN

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1 Abstract. The purpose of this study is to see the development of the volume (value) of exports and Imports of oil and gas in Indonesia in the form of estimated results for the coming years. Research data was taken from the Central Statistics Agency and the Indonesian Customs Service. Data is divided into 7 variables, namely; In the year, crude oil exports, crude oil Imports, oil exports, oil Imports, gas exports and gas Imports. The application of the method for estimating the volume of Crude Oil, Oil Products and Gas export Imports is the ANN backpropagation algorithm with 4 network architectural models namely; 12-5-1, 12-8-1, 12-10-1 and 12-14-1. The best network architectural model is 12-5-1 with an accuracy of 83% and MSE 0.0281641257. The minimum error used is 0.001-0.05 with a learning rate of 0.01. While the activation function used is bipolar and linear sigmoid with gradient descent training function.

1. Introducing

Indonesia is a country with abundant natural resources. One of Indonesia's natural resources comes from mining and energy. Mining is one of the mainstay aspects that must be managed properly by Indonesia. Mining is done by exploring minerals contained in Indonesia's earth. One of the mines owned by Indonesia is the oil and gas mine. This oil and gas sector is one of the mainstays for Indonesia to gain foreign exchange in order to support the continuity of development. Therefore, the government is required to manage oil and gas properly. Moreover, oil and gas have become goods that are needed by humans. In fact, almost all facilities enjoyed by humans, especially in Indonesia today must use petroleum and natural gas, such as household needs, transportation, electricity, and industrial or business needs.

The development of the oil and gas sector in Indonesia is very dynamic. Indonesia and the countries of the world are forced to adjust production, consumption, policies both at home and abroad which are caused by changes in world oil prices from time to time, so that people's welfare is still achieved. Moreover, our oil and gas reserves and production are decreasing over time. Although our gas reserves are four times higher than oil, the conversion program from domestic oil to gas is not



smooth. Therefore, there are times when we have to Import oil and gas, sometimes we export. Rising oil and gas exports also contributed to the strengthening of the Rupiah, resulting in a rise in demand for the domestic currency.

In Table 1 it can be seen that there are significant inequalities between exports and Imports, both in terms of crude oil, oil and gas products. The volume of crude oil exports from 1996 to 2016 has decreased considerably, while the volume of Imports has been increasingly high. Likewise for oil and gas products. If this is allowed to continue, it will have an impact on the level of the Indonesian economy in the future.

Table 1. Data on the volume of oil and gas exports and Imports in Indonesia (Thousand tons)

Year	Crude oil		Oil products		Gas	
	Export	Importt	Export	Import	Export	Import
1996	38254.9	9349.9	10689.3	10133.8	29343.6	1.3
1997	38976.5	9125.5	10220.8	11747.7	29015.6	31.6
1998	36914.0	10473.3	8435.9	10941.0	28953.5	86.0
1999	35902.5	11497.4	7825.4	12249.9	30066.3	25.8
2000	29225.9	11473.5	8786.6	13971.0	27615.2	11.2
2001	32857.0	14174.9	7007.8	11750.5	25235.6	30.6
2002	29054.4	15880.0	7574.0	15116.0	27617.7	0.2
2003	26517.5	16817.2	7425.0	13588.6	27613.7	69.3
2004	23467.8	18930.4	6800.4	15971.5	26594.3	18.7
2005	21488.0	15649.7	5994.0	21065.2	24445.4	22.5
2006	18127.9	14642.5	7046.9	18657.8	23116.7	48.6
2007	18175.3	15146.7	6264.8	19475.7	21270.8	116.9
2008	18235.0	12749.0	5724.0	22391.2	20841.9	336.2
2009	17967.1	15303.7	5405.7	19732.0	22700.1	970.8
2010	18132.4	14249.6	7322.8	25123.9	30469.9	1126.0
2011	17819.5	13253.6	6931.5	28840.3	34302.9	1633.9
2012	14973.1	12550.1	5629.5	28534.5	27843.3	3170.4
2013	13016.9	16015.6	5914.5	29612.2	25110.4	3425.9
2014	12400.0	16185.9	5556.9	29093.6	23786.2	3589.9
2015	15554.1	18727.6	4625.8	25404.7	24784.8	4176.8
2016	16955.5	19932.3	2868.1	23958.3	23505.2	4435.2

Therefore, one way that can be done is to reduce the volume of oil and gas exports and Imports in Indonesia to remain stable, namely by predicting the development of oil and gas export and Import volumes in Indonesia for the following year. Thus, as early as possible the central government is expected to be able to determine the right policies to overcome them. But making predictions is not easy, it takes the previous data relating to the problem to be predicted, this is generally complicated and the accuracy of estimation is not easy to achieve, so it requires more advanced techniques [1]–[3]. The technique that is often used to make predictions is the Backpropagation algorithm, because this algorithm is able to predict data using learning rules based on data that has never happened before [4]–[7]. Previous research has been conducted to predict the value of oil and gas exports using Backpropagation Neural Networks with prediction accuracy of 90% with MSE testing of 0.0034417506 [8]. Therefore, based on previous research, this research will use the Backpropagation method to predict the volume of oil and gas exports and Imports in Indonesia..

2. Methodology

2.1. Collection Data

Data on Volume Export and Import of Oil and Gas in Indonesia obtained from the Indonesian Central Bureau of Statistics which is processed based on documents from customs Directorate General of Customs and Excise Year 1996 to 2016.

2.2. Stages of Research

The stages of this study are as follows:

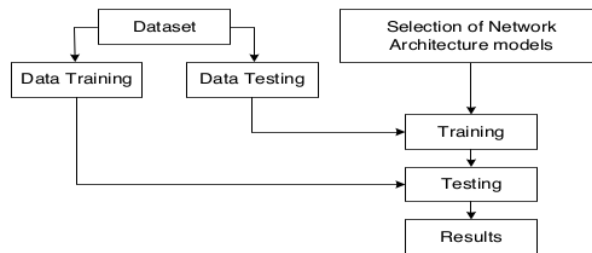


Figure 1. Stages of Research

From Figure 1, it can be explained that the first stage of the research is the selection of datasets, where the dataset used is the volume of oil and gas exports and imports in Indonesia (Thousand tons) in 1996-2016. In this data dataset preprocessing will be done to divide the data into two parts: dataset for training and dataset for testing. The next step is the selection of network architecture to process training data and test data so that the best results will be obtained.

2.3. Normalization

The formula used for the normalization of the initial data is as follows [9], [10]:

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

where x' is normalized data, x is normalized data, a is the data with the smallest value, and b is the maximum data with the largest value.

This data is then divided into 2 (training and testing), Year 1996-2007 is used as input training data, while 2008 data is used as target training data. Year 2004-2015 is used as input testing, while 2016 data is used as target testing. Based on data table 1 will get the normalization results as follows:

Table 2. Normalization of Data Training (Year 1996-2007) / Target Year 2008

Year	Crude oil		Oil products		Gas	
	Export	Import	Export	Import	Export	Import
1996	0.88519	0.29191	0.31940	0.30800	0.70228	0.10002
1997	0.90000	0.28730	0.30978	0.34112	0.69555	0.10064
1998	0.85767	0.31496	0.27315	0.32456	0.69427	0.10176
1999	0.83691	0.33598	0.26061	0.35143	0.71712	0.10053
2000	0.69987	0.33549	0.28034	0.38675	0.66681	0.10023
2001	0.77440	0.39094	0.24383	0.34118	0.61796	0.10062
2002	0.69635	0.42594	0.25545	0.41026	0.66686	0.10000
2003	0.64428	0.44517	0.25240	0.37891	0.66678	0.10142
2004	0.58168	0.48855	0.23958	0.42782	0.64585	0.10038
2005	0.54104	0.42121	0.22302	0.53237	0.60174	0.10046
2006	0.47208	0.47208	0.24464	0.48295	0.57447	0.10099
2007	0.47305	0.41089	0.22858	0.49974	0.53659	0.10240

Year	Crude oil		Oil products		Gas	
	Export	Import	Export	Import	Export	Import
Target	0.47427	0.36167	0.21748	0.55958	0.52778	0.10690

Table 3. Normalization of Data Testing (Year 2004-2015) / Target Year 2016

Year	Crude oil		Oil products		Gas	
	Export	Import	Export	Import	Export	Import
2004	0.64717	0.54129	0.25825	0.47225	0.72012	0.10000
2005	0.60097	0.46474	0.23943	0.59111	0.66998	0.10009
2006	0.52257	0.52257	0.26400	0.53493	0.63898	0.10070
2007	0.52367	0.45300	0.24575	0.55402	0.59590	0.10229
2008	0.52507	0.39705	0.23313	0.62205	0.58590	0.10741
2009	0.51881	0.45667	0.22570	0.56000	0.62926	0.12222
2010	0.52267	0.43207	0.27044	0.68581	0.81056	0.12584
2011	0.51537	0.40883	0.26131	0.77253	0.90000	0.13769
2012	0.44895	0.39241	0.23092	0.76540	0.74927	0.17354
2013	0.40330	0.47328	0.23757	0.79055	0.68550	0.17950
2014	0.38891	0.47725	0.22923	0.77844	0.65460	0.18333
2015	0.46251	0.53656	0.20750	0.69237	0.67790	0.19703
Target	0.49521	0.56467	0.16649	0.65862	0.64804	0.20306

3. Results and Discussion

The network architecture model used in this study has 4 architectures. among others 12-5-1, 12-8-1, 12-10-1 and 12-14-1. Based on the 12-5-1 architectural model it can be explained that 12 is the input neuron neuron data. 7 is a data of hidden layer neurons and 1 is a neuron output layer data. So is the case with other architectural models.

Based on Table 4 can be seen the comparison of each architectural model. The iteration level and time velocity of the 4 architectural models are seen using the Matlab application. The accuracy and MSE value (Mean Squared Error) of the 4 architectural models were obtained using Microsoft Excel. Actually there are 2 architectural models that both produce 83% accuracy, namely 12-5-1 and 12-10-1. It's just that the 12-5-1 architectural model is lower epoch, time and the MSE. So the authors conclude from each of the 4 architectural models that the best architectural model is obtained using 12-5-1.

Table 4. Comparison of accuracy results

Data	Architecture	Training			Testing	
		Epoch	Time	MSE	MSE	Akurasi
1	12-5-1	2582	00:20	0.00099875	0.02816413	83%
2	12-8-1	21154	02:57	0.00099875	0.13335481	50%
3	12-10-1	2820	00:37	0.00099969	0.00256091	83%
4	12-14-1	1145	00:09	0.00099903	0.01124036	67%

The training results from neural networks with backpropagation on 4 architectural models that are processed using the Matlab application can be seen in Figure 2, Figure 3, Figure 4 and Figure 5 below.

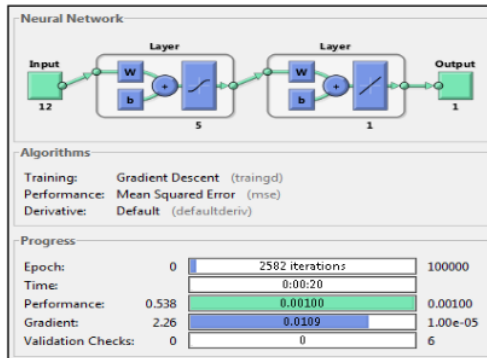


Figure 2. Training with 12-5-1

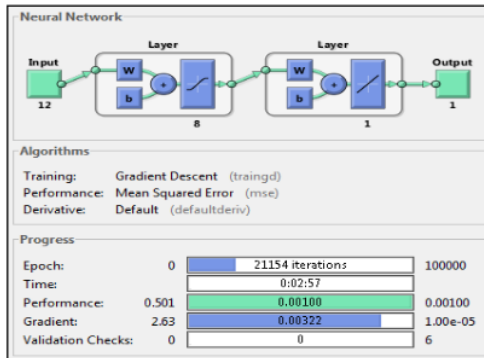


Figure 3. Training with 12-8-1

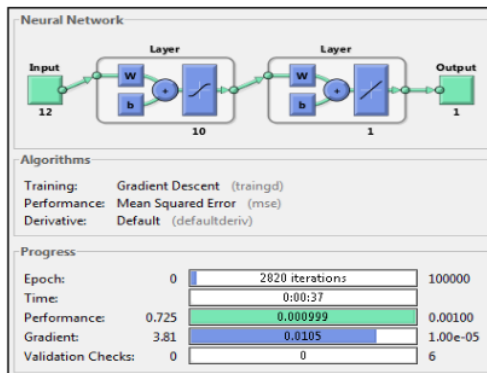


Figure 4. Training with 12-10-1

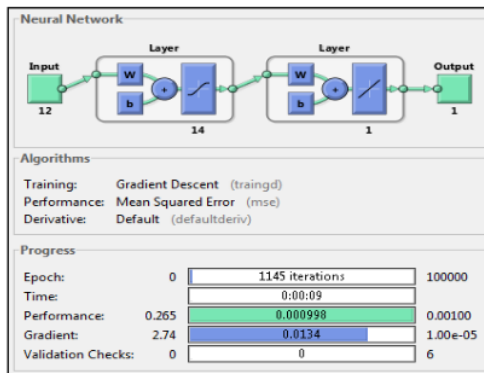


Figure 5. Training with 12-14-1

Table 5. Best Architecture Model 12-5-1

Data	Data Training				Data Testing				Results
	Target	Output	Error	SSE	Target	Output	Error	SSE	
1	0.47427	0.51030	0.03603	0.00130	0.49521	0.57280	-0.07759	0.00602	1
2	0.36167	0.33510	0.02657	0.00071	0.56467	0.78350	-0.21883	0.04789	1
3	0.21748	0.20340	0.01408	0.00020	0.16649	0.24240	-0.07591	0.00576	1
4	0.55958	0.53500	0.02458	0.00060	0.65862	0.60650	0.05212	0.00272	0
5	0.52778	0.50980	0.01798	0.00032	0.64804	0.97360	-0.32556	0.10599	1
6	0.10690	0.16040	0.05350	0.00286	0.20306	0.22780	-0.02474	0.00061	1
			Total	0.00599			Total	0.16898	
			MSE	0.000999			MSE	0.028164	83%

Table 6. Comparison of previous data with prediction results for the next 4 years (thousand tons)

Year	Crude oil		Oil products		Gas	
	Export	Import	Export	Import	Export	Import
2013	13016.9	16015.6	5914.5	29612.2	25110.4	3425.9
2014	12400.0	16185.9	5556.9	29093.6	23786.2	3589.9
2015	15554.1	18727.6	4625.8	25404.7	24784.8	4176.8
2016	16955.5	19932.3	2868.1	23958.3	23505.2	4435.2
2017	13460.7	15382.5	3213.5	16977.4	17844.8	6777.7
2018	9581.7	9045.9	5214.3	10042.6	11227.7	5512.4

Year	Crude oil		Oil products		Gas	
	Export	Import	Export	Import	Export	Import
2019	6848.5	6741.0	5832.2	7299.5	6930.4	6458.3
2020	6158.3	6067.7	6171.5	6157.2	6107.3	6020.7

4. Conclusion

Based on the results of research on the volume of Export and Import of oil and gas in Indonesia, it can be concluded that the 12-5-1 architectural model can predict with an accuracy of 83%. by looking at the results of testing on 4 experiments. Can be seen in Table 4 that the speed and results of accuracy vary greatly. Based on the comparison of preliminary data and prediction data, it can be concluded that the export value of oil and gas decreases over time. while the import value of oil and gas is getting higher and higher. The results of this study are expected to enable the government to anticipate the increase in the volume of oil and gas exports and imports.

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