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APPLICATION OF ARTIFICIAL NEURAL NETWORK BACKPROPAGATION TO PREDICT HOUSEHOLD CONSUMPTION OF ELECTRICITY IN AMBON

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ABSTRACT

Electricity is one of the energy most widely used in the universe. Electric power demand in Ambon city tends to increase due to the growing of population in Ambon. The necessary of electricity power in Ambon City by utilizing two systems are interconnected such as: PLTD Poka and PLTD Hative Kecil (Galala). In this research forecast the demand for household electricity consumption in 2016 based on validation data from 2011-2015 using Application of Neural Networks Backpropagation method. The validation data are using in JST-Backpropagation training, with the best network architecture that is 20 10 5 1 neurons and 0.8 learning rate, can produce the best pattern with the accuracy is 75% and the value of Mean Square Error is 0.298335.

Keywords: *Artificial neural networks; Backpropagation method; Forecasting of household electricity consumption*

1. INTRODUCTION

One of the problems that cannot be separated from human life, is electricity. Electricity is the flow of energy or power that is a fundamental part of the universe and one of the most widely used energy. Demand for electrical power in Ambon City tends to increase due to the increase of population. Electrical energy needs in Ambon City done by using two systems are interconnected, namely diesel Poka and diesel Hative Kecil (Galala). To know the demand of electric energy in the future, need to predict the electricity demand in the next few years. The prediction of demand electrical load is useful to predict the magnitude of the actual load that will happen. Based on the time period there are known three types of electrical load forecasting, such as: the forecasting

short term, medium term and long term. Each type of electrical load forecasting has application in the planning and operation.

Medium-term electric load forecasting is one of the important type in the allocation of planning the addition of a new power station, expansion of network distribution and planning needs of the scheduling operation of electric generator. Several methods have been frequently used as a facility to help the prediction of an object, therefore these methods will be able to provide more accurate results to address the limitations or problems. One of them is the method of Artificial Neural Networks (ANN) Backpropagation. Backpropagation method was first formulated by Werbos and popularized by Rumelhart and McClelland for use in Artificial Neural Networks (ANN) [1-5], [9].

Artificial Neural Networks is the processing of information systems on certain characteristics as artificial representatives based on human neural networks [12]. Artificial neural networks are introduced as biological neural models and as concepts of parts on circuits that can perform computational tasks. The network has weights that set to perform simple logic functions [5]. According to Tarassenko (2004) mentions artificial neural networks have unique characteristics, among others: have the ability to learn and the ability to generalize. Azadekh [2], conducts annual Power Consumption Forecasting study using Artificial Neural Networks with Perceptron Based Approach in Industrial Sector.

In this case, Backpropagation method has the advantage to predict the load demand using a simple forecasting model in recognize pattern of electrical load. Thus the forecasting demand of electricity become an important issue for the PT. PLN (Persero) of Ambon City.

2. METHOD

The collected data is a secondary data. This data is about electricity consumption (KWh) in household sector for five years or 60 months. Because the data is single data then can determine input variables and the output variable, like the following table:

Table 1. Simulation Input Data ANN for Prediction.

Data	Input	Output
1	Data at 1st month to 12th month	Data at 13th month
2	Data at 2nd month to 13th month	Data at 14th month
3	Data at 3rd month to 14th month	Data at 15th month
⋮	⋮	⋮
48	Data at 47th month to 59th month	Data at 60th month

So that the number of data for this study is 48 data, such as:

- 36 data (year 2011-2013) as training data = 75%
- 12 data (year 2014-2015) as testing data = 25%

Data analysis technique conducted in this research is through 3 stages of phase such as: Feedforward phase, backward phase and the last phase update weight and bias.

3. RESULTS AND DISCUSSION

3.1. Plot of Time Series

Based on the data obtained from PT. PLN (Persero) Maluku and North Maluku, there are 60 points of observation, then can be shaped Time Series Plots as in Figure 1 can be seen that the graph as a whole is a pattern of variation Randomized where there is a several points on the data consumption of electricity that unexpected conditions.

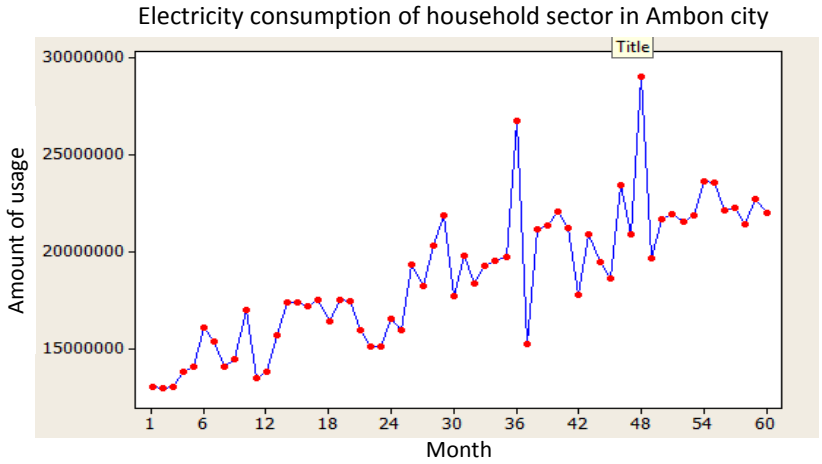

Figure 1. Electricity Consumption Pattern Period on January 2011-December 2015.

3.2. Research Analysis

In Backpropagation method, the architecture of a network will determine the success of the achieved targets, because not all problems can be solved with the same architecture. The number of hidden layer is determined by the users of the system, with the best convergence trial (trial and error) to obtain results of best training.

Parameter input system for pattern formation is formed, like following:

Net Size:

Input Layer: 12 neuron

Hidden Layer: 20 10 5 1 neuron

Output Layer: 1 neuron

Max epoch / iteration: 30000

Show Epoch: 25

Error: 0.001

From 36 training data and 12 testing data, we obtained the following analysis. For each variation of learning rate (α) value, the number of maximum iterations is the number of iterations (epochs) 30000. The result of the analysis is provided in Table 2 below.

Table. 2. The Data Analysis Results of Backpropagation Method.

No	Alpha	Epoch	MSE	Training result		Testing result	
				Recognize data	Accuracy	Recognize data	Accuracy
1	0.1	3236	0.000999	35	97.22%	2	16.66%
2	0.2	1649	0.000999	34	94.44%	2	16.66%
3	0.4	1425	0.000999	35	97.22%	6	50%
4	0.5	591	0.000997	35	97.22%	2	16.66%
5	0.55	1078	0.000996	33	91.66%	8	66.66%
6	0.65	975	0.000998	34	94.44%	7	58.33%
7	**0.8**	**608**	**0.000993**	**35**	**97.22%**	**9**	**75 %**
8	0.85	523	0.000996	34	94.44%	5	66.66%
9	0.86	728	0.000996	35	97.22%	5	41.66%
10	0.87	504	0.000995	35	97.22%	7	58.33%

Based on the Table 2, the best result in the training and testing process is when α (learning rate) is 0.8 with the maximum of iterations is 9742, the MSE 0.000993 and the level of data accuracy for the training phase and for testing phase are 97% and 75%, respectively.

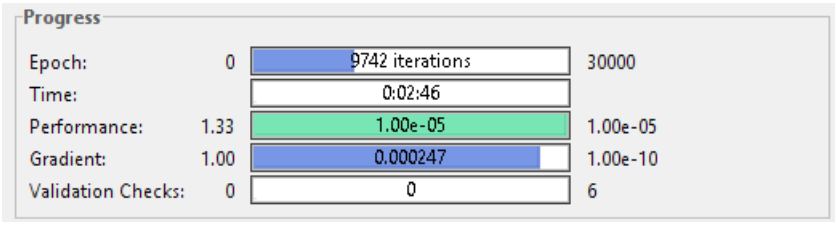

Figure 2. Progress of Neural Network Training.

In the next figure 3, show the result of data analysis of the learning rate (α) is 0.8.

- The training phase

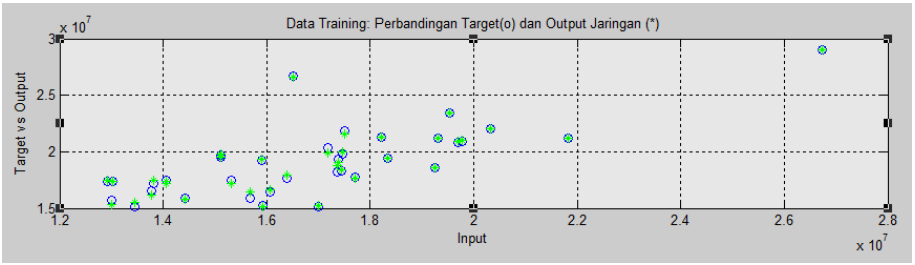

Figure 3. Graph of Training Result.

Figure 3 shows a comparison between the target and output network in the training data. In the figure can be seen that most of the network output (o) and the target (*) is almost in the same position. The best results occur when the position (o) and (*) right in the same position, but there are several others do not have the same position between targets and predictions, because a significant error level during training.

- The testing phase :

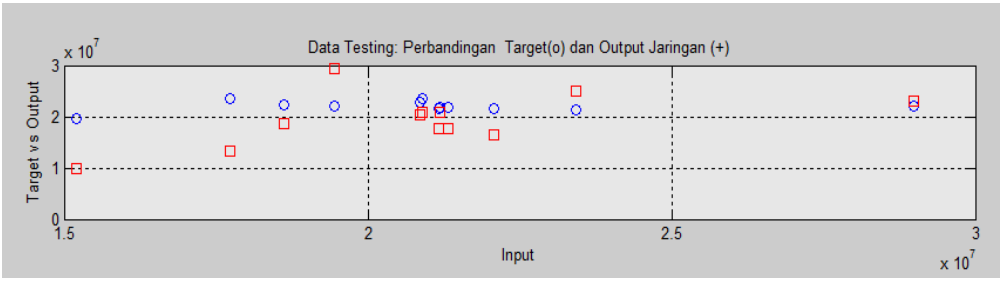

Figure 4. Graph of Testing Result.

Figure 4 shows a comparison between the target and output network of the data testing. In the Figure 4, can be seen that most of the network output (o) and the target (s) is almost the same position. The best results occur when the position (o) and (s) right in the same position, it means the network is able to predict exactly.

It can be seen from results of visualization, that the results of the data pattern recognition by Backpropagation neural networks would be better if using a smaller degree of error. This proves that Artificial Neural Networks is powerful in recognizing patterns of data. This means that the smaller error of desired targets, means the smaller deviations forecast of desired results, so that the accuracy of forecasting models of network training results will be higher.

The forecasting results are shown in the following table:

Table 4. Results of Electricity Consumption Forecasting in 2016 (KWh).

Target	**Prediction**	**error**	**e^2**
19624835	17380000	0.9645	0.93026
21673471	23204000	0.4071	0.16573
21937447	21783000	0.4349	0.189138
21518053	26357000	0.5157	0.265946
21871286	26273000	0.0983	0.009663
23586833	21938000	1.0325	1.066056
23528550	27059000	0.2728	0.07442
22110836	24129000	-0.7392	0.546417
22281021	19116000	0.3625	0.131406
21432737	22129000	-0.3565	0.127092
22731965	25283000	0.2455	0.06027
21974247	24615000	-0.1167	0.013619
Mean Square Error			0.298335

From Table 4 the results forecasting of electricity consumption, explained that the class of household electricity consumption in 2016 was not much different from previous years. This is due to an error that is obtained when training and testing is too small, that cause the prediction is quite good, after repeated training in order to get a good error.

4. CONCLUSION

It can be concluded that the results of the data pattern recognition by JST-Backpropagation is pretty well, where the target pattern (o) all nearly approaching the output (*). In addition, the prediction results to be achieved fully met with a small error rate and the level of accuracy is 75%, which the results demonstrate the value of Mean Square Error for forecasting electricity consumption in 2016 is 0.298335. This means forecasting using Backpropagation ANN is good enough.

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