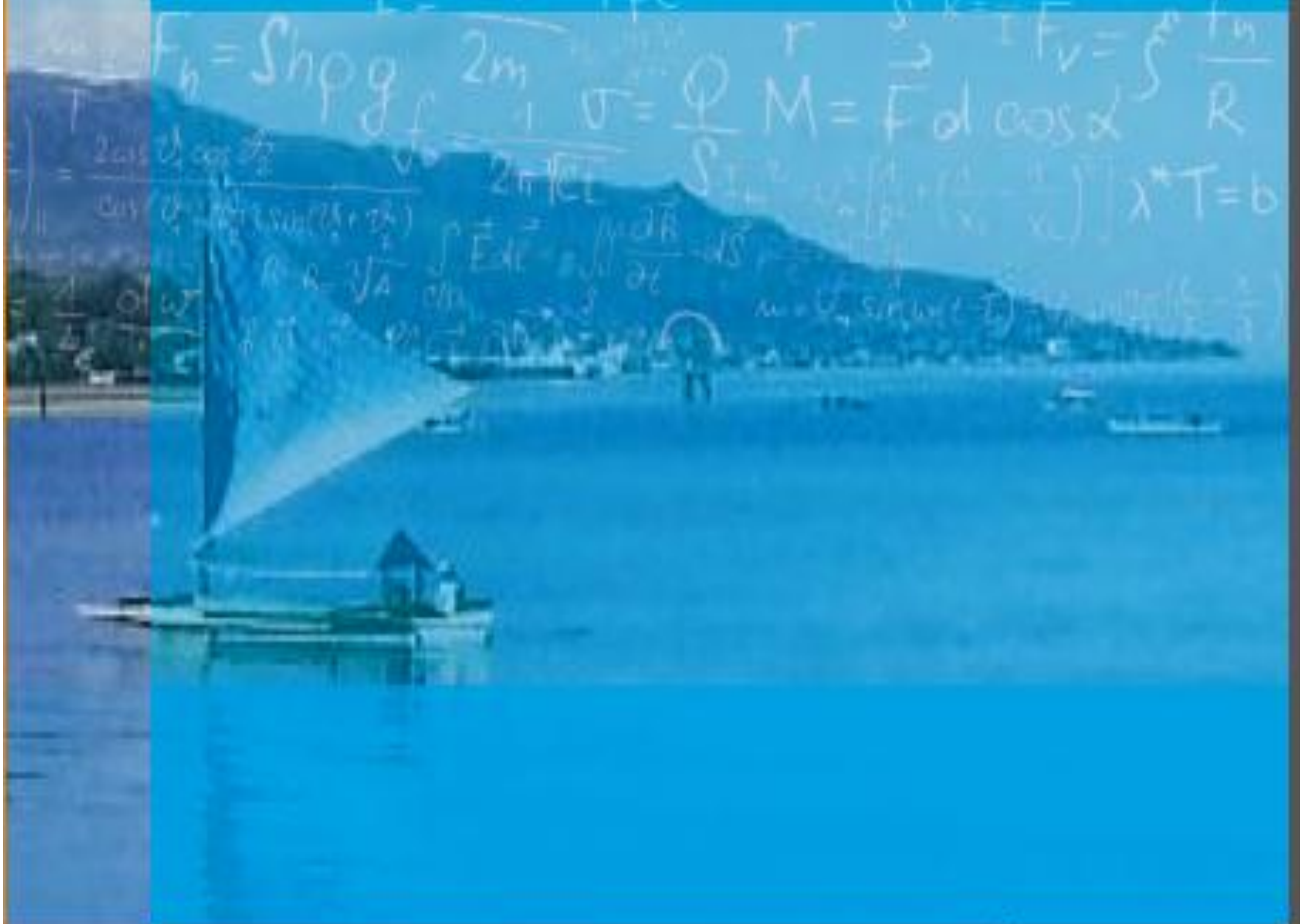
Basic Science
for Sustainable Marine Development

PROCEEDING
INTERNATIONAL SEMINAR 2015

Ambon, 3-4 June 2015



Organized by
Faculty of Mathematics and Natural Sciences
Pattimura University

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Welcoming Address by The Organizing Committee

The honorable, the rector of Pattimura University
The honorable, the vice rector of academic affair, Pattimura University
The honorable, the vice rector of administration and financial affair, Pattimura University
The honorable, the vice rector of planning, cooperation and information affair, Pattimura University
The honorable, all the deans in Pattimura University
The honorable, the key note speakers and other guests.

We have to thank The Almighty God for the blessings that allow this International seminar can be held today. This is the first seminar about MIPA Science in which the Faculty of MIPA Pattimura University becomes the host. The seminar under the title Basic Science for Sustainable Marine Development will be carried out on 3 June 2015 at Rectorate Building, the second floor. There are 250 participants from lecturers, research institute, students, and also there are 34 papers will be presented.

This International seminar is supported by the amazing people who always give financial as well as moral supports. My special thanks refer to the rector of Pattimura University, Prof. Dr. Thomas Pentury, M.Si, and the Dean of MIPA Faculty, Prof. Dr. Pieter Kakissina, M. Si. I also would like to express my deepest gratitude to Dr. Kotaro Ichikawa, the director of CSEAS Kyoto University, Prof. Bohari M. Yamin, University of Kebangsaan Malaysia, Prof. Dr. Budi Nurani Ruchjana (Prisident of Indonesian Mathematical Society/Indo-MS), Dr. Ir. A. Syailatua, M.Sc (Director of LIPI Ambon), and Hendry Ishak Elim, PhD as the key note speakers. We expect that this international seminar can give valuable information and contribution especially in developing basic science for sustainable marine development in the future.

Last but not least, we realize that as human we have weaknesses in holding this seminar, but personally I believe that there are pearls behind this seminar. Thank you very much.

Chairman
Dr. Netty Siahaya, M.Si.

Opening Remarks
By Dean of Mathematic and Natural Science Faculty

I express my deepest gratitude to The Almighty God for every single blessing He provides us especially in the process of holding the seminar until publishing the proceeding of International Seminar in celebrating the 17th anniversary of MIPA Faculty, Pattimura University. The theme of the anniversary is under the title Basic Science for Sustainable Marine Development. The reason of choosing this theme is that Maluku is one of five areas in Techno Park Marine in Indonesia. Furthermore, it is expected that this development can be means where the process of innovation, it is the conversion of science and technology into economic value can be worthwhile for public welfare especially coastal communities.

Having the second big variety of biological resources in the world, Indonesia is rich of its marine flora and fauna. These potential resources can be treated as high value products that demand by international market. Basic science of MIPA plays important role in developing the management of sustainable marine biological resources.

The scientific articles in this proceeding are the results of research and they are analyzed scientifically. It is expected that this proceeding can be valuable information in terms of developing science and technology for public welfare, especially people in Maluku.

My special thanks refer to all researchers and reviewers for your brilliant ideas in completing and publishing this proceeding. I also would like to express my gratefulness to the dies committee-anniversary of MIPA Faculty for your creativity and hard working in finishing this proceeding, God Bless you all.

Dean of Mathematic and Natural Science Faculty

Prof. Dr. Pieter Kakisina, M.Si.

Contents

Applied of Backpropagation Algorithm to Analyzing and Forecasting of Currency Exchange Rate Rupiahs and Dollar

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ABSTRACT

Exchange rate or currency exchange rate is very important in the economy. There are three kinds of exchange rate type, namely the selling rate, buying rate and the middle rate. The exchange rate is needed to determine something that needs to be done with regard to the exchange rate eg short-term investment decisions, capital budgeting decisions, long-term financing decisions, and profit assessment. Therefore, it is necessary to attempt forecast the magnitude of the exchange rate for some time to come. The problem faced is how to predict the magnitude of the exchange rate that produces the predicted value with minimal error rate.
Forecasting is a process to predict events or changes in the future. In a process activity, the forecasting process is the beginning of a series of activities, and as a starting point the next activity. Modeling of time series is often associated with the process of forecasting the certain of characteristic value in the period ahead, to control a process, or to identify patterns of behavior of the system. By detecting patterns and trends in the data, and then formulate a model, then the data can be used to predict the future. Models with high accuracy will cause the predictive value valid enough to be used as a support in the decision making process.
One of the forecasting method developed at this time is using Artificial Neural Network (ANN), which have been the interesting object of ANN research and widely used to solve the problem in some areas of life, one of which is for the analysis of time series data, on the problem Forecasting (Loh, 2003). One of the networks that are often used for the prediction of time series data is Backpropagation neuron network. In this research will be discussed on the use of back propagation neural network to predict the selling rate Rupiah (IDR) per 1 US Dollar (USD).
In this study will be shared as much as 70% of existing data as training and 30% of the data as the test data. And in this study used the data of exchange rate in October 2013-January 2014, which is taken from Bank Indonesia site. In research process, Learning rate that used for daily data is 0.5, the process stops at iteration 27088 for daily data, with the gradient achievement is 0.0081822 and the value of R for the training data is 0.99494 which means very good. Furthermore, the data in the test and obtain R value is 0.48638, which means still said to be good in forcasting test data. Some things that affect the results of the research is historical data used for variable ANN enter a lot less, the data used to predict the exchange rate can not be represented as the main factors affecting the exchange rate, and less value of error boundary and suitability weights in the network architecture.

Keywords: Backpropagation, Artificial Neural Networks, Exchange rate

INTRODUCTION

The exchange rates is also known as the exchange rate is the ratio of exchange between two different currencies state. Or in other words the exchange rate can be interpreted as the price of one unit of foreign currency expressed in domestic currency. Central Bank of each country can choose different exchange rate systems. Fixed exchange rate determined by the Central Bank (an institution that decides the price of the currency). There are various factors that affect exchange rates, such as interest rates, inflation, and political and economic circumstances in each country. Usually in the forex market, or in the international currency trading market, consisting of a network of interconnected agents. And involves many agents, such as individual investors, institutional investors, central banks, commercial banks, etc.

LITERATURE REVIEW

Artificial neural networks have been developed since 1940. In 1943, McCulloch and W. H. Pitts introduce modeling of mathematically neurons. In 1949, Hebb Trying to assess learning processes conducted by neurons. This theory is known as Hebbian Law. In 1958, Rosenblatt introduced the concept of perceptron a network consisting of multiple layers of interconnected through a feed-forward. This concept is intended to illustrate the basics of intelligence in general. The important work Rosenblatt is perceptron convergence theorem (1962) which proved that if every perceptron can sort out two different patterns, the cycle training can be done in a limited amount.

In 1960 Widrow and Hoff find ADALINE (Adaptive Linear Neuruon). This tool can be adapted and operates linearly. This discovery has widened the application of artificial neural networks not only for the selection of patterns, but also for the transmission of signals, especially in the field of adaptive filtering. In 1969, Minsky and Papert threw a criticism of weakness Rosenblatt-perceptron in sorting out non-linear patterns. Since that time research in the field of neural networks has experienced a period of vacuum for approximately a decade. In 1982, Hopfield has expanded the application of neural networks to solve optimization problems. Hopfield has managed to take into account the energy function in a neural network is that the network has the ability to remember or take into account an object by object ever known or remembered earlier (associative memory). Such network configuration is known as recurrent network. One application is the Travelling Salesman Problem (TSP).

In 1986 Rumelhart, Hinton and William created a learning algorithm known as back propagation. When this algorithm is applied to perceptron which have many layers (multilayer perceptron), it can be proved that the sorting patterns that are not linearly can be resolved, so the criticism by Minsky and Papert missed.

Definition of Artificial Neural Network

Artificial neural networks are information processing systems that have characteristics similar to biological nerve [Siang 2005 in Maru'ao, 2010]. According to [Sekarwati 2005 in Maru'ao 2010], artificial neural network is a computing system that is based on modeling of biological nervous system (neurons) through the approach of computational biological properties (biological computation). According to [Subiyanto, 2002 in Maru'ao 2010], neural network computing system is to create a model that can mimic the workings of biological neural networks. Besides [Siang, 2005 in Maru'ao, 2010), artificial neural networks are formed as a generalization of mathematical models of biological neural networks with the following assumptions:

a. Information processing occurs in a lot of simple elements (neurons).
b. Signals transmitted between neurons via some link.
c. Connections between neurons have weights that will strengthen or weaken the signal.
d. To determine the output, each neuron using activation function which is charged on the sum of the input received. The magnitude of the output is then compared with a threshold.

Neuron is information processing units which becomes the basis for the operation of artificial neural networks (Siang, 2005). Neurons consist of the three forming elements, as follow:

a. The set of units that are connected to the connection point.
b. Summing unit which will add input signals that have been multiplied by its weight.

Activation function which will determine whether the signal from the input neuron will be forwarded to other neurons or not.

Architecture Network (Network Configuration)

Based architecture, artificial neural network models are classified into:

a. (Single Layer Network)

In this network, a set of input neurons directly connected to a set of outputs. The signal flow in the direction of the input layer to the output layer. Each node is connected to the other node that is above and below, but not with nodes that are on the same layer. Models in this category include: ADALINE, Hopfield, Perceptron, LVQ, and others. In the network architecture shown in Figure 2.2 single layer with n inputs ($x_1, x_2, ..., x_n$) and m pieces of output ($y_1, y_2, ..., y_m$).

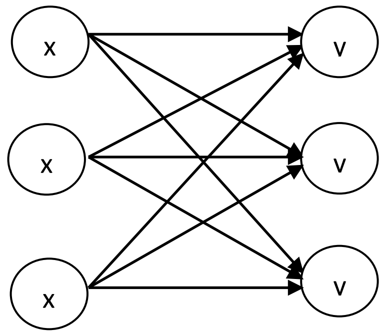

Figure 1. Single Layer Network

b. Multiple Layer Network

This network is an extension of the single layer network. In this network, in addition to the input and output units, there are other units (called hidden layer). It is also possible there are some hidden layer. some of example model are: Madaline, backpropagation. On the network shown in Figure 2 with *n* input unit ($x_1, x_2, ..., x_n$), a hidden layer that consists of m pieces of unit ($z_1, z_2, ..., zm$) and 1 output unit.

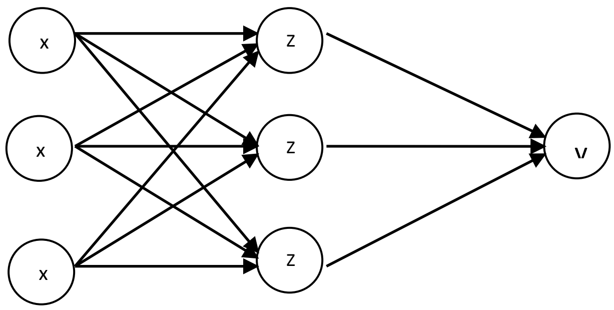

Figure 2. Multiple Layer Network

c. Reccurent Network

Reccurent network model is similar to the single or multi layer network. However, there is output node that sending signals to the input unit (called feedback). In other words, the signal flowing in both directions, ie forward and backward. Examples: Hopfield network, Jordan network, Elmal network.

Backpropagation Neural Networks

Backpropagation is an artificial neural network model with multiple layers. As with any other model of neural networks, backpropagation train the network to obtain a balance between the ability of the network to recognize patterns used during training as well as the network's ability to provide the correct response to the input pattern similar (but not equal) to the pattern used during the training.

a. Activation function on Backpropagation

In backpropagation, the activation function used must comply with the following requirements.

1. Continuous.
2. Easily differentiable
3. Not down Function.

One of the functions that fulfill the three conditions that often used is a binary sigmoid function which has range (0.1). Binary sigmoid function is defined as follows.

$$f_1(x) = \frac{1}{1+\exp(-x)}$$

with

$$f_1'(x) = f_1(x)[1 - f_1(x)]$$

Another function that is often used is a bipolar sigmoid function with range (-1,1) which is defined as follows.

$$f_2(x) = \frac{2}{1+\exp(-x)} - 1$$

with

$$f_2'(x) = \frac{1}{2}[1 + f_2(x)][1 - f_2(x)]$$

Sigmoid function has a maximum value is 1. To pattern the target of more than 1, the pattern of inputs and outputs must first be transformed so that all patterns have the same range as the sigmoid function which use.

Another alternative is using sigmoid activation function on the layer which is not an output layer. On the output layer, the activation function used is the identity function *f (x) = x*.

b. Backpropagation Training

Backpropagation training include three phases. The first phase is a forward phase. input pattern is calculated from the input layer to output layer using The activation function which specified. The second phase is a backward phase. The difference between the output of the network with the desired target is an error that occurred. The error propagation backwards, starting from the line that relates directly to the unit in the output layer. The third phase is the modification of the weights for lowering error occurred. Backpropagation training include three phases as follows:

1. *Feed Forward propagation phase*

During the forward propagation, the input signal (xi) propagated to the hidden layer using activation function which specified. output from each hidden layer unit (zj) are propagated forward again to the hidden layer on it using activation functions which specified . And so on to produce the network output (yk). Next, the network output (yk) compared with the target to be achieved (tk). Difference tk-yk are errors that occur. If this error is smaller than the specified tolerance limits, then the iteration will stopped. However, if the error is still greater than the tolerance limit, then the weight of each line in the network will be modified to reduce the errors which occurred.

2. *Backward propagation phase*

Based of error *tk - yk*, calculated factor δ_k ($k = 1,2, ..., m$) that is used to distribute the error in the unit y_k to all hidden units are connected directly to y_k. δ_k also be used to change the line weights that are directly related to the output unit.

In the same way, counted δ_j factors in each hidden layer unit as the basis weight change all the lines emanating from hidden units on the layer below it. And so on until all the factors of δ in hidden units that are directly related to the input unit is calculated.

3. *Weights update phase*

After all factors δ is calculated, the weight of all the lines are modified simultaneously . Changes in weight of a line based on the factor δ neurons layer it. For example, changes in the weight of the lines leading to the output layer based on the existing δk output unit.

The third phase is repeated continuously until the stopped condition filled. Generally, the stopped condition that is often used is the number of iterations or error. Iteration will be terminated if the number of iterations performed has exceeded the maximum number of iterations is specified, or if the error that occurs is smaller than the allowable tolerance limits.

Backpropagation training algorithm to network with one hidden layer(with a binary sigmoid activation function) are as follows.
Step 0 : Initialize weights (set to small random values).
Step 1 : while stopping condition is false, do steps 2-9.
Step 2 : for each training pair, do steps 3-8.

Feedforward :
Step 3: each input unit (X_i , i=1,…,n) recieves input signal x_i and broadcast this signal to all units in the layer above (the hidden units).
Step 4: each hidden unit (Z_j, j=1,…,p) sums its weighted input signals,

$$z\_in_j = \upsilon_{0j} + \sum_{i=1}^{n} x_i \upsilon_{ij}$$

Applies its activation function to compute its output signal,

$$z_j = f\ (\ z\_in_j\ )$$

and sends this signal to all units in the layer above (output units).

Step 5: each output unit (Y_k, k=1,..,m) sums its weighted input signals,

$$y\_in_k = w_{0k} + \sum_{j=1}^{p} z_j w_{jk}$$

And applies its activation function to compute its output signal,

$$y_k = f(y\_in_k)$$

Backpropagation Of Error

Step 6: each output unit (Y_k, k=1,..,m) recieves a target pattern corresponding to the input training pattern, computes its error information term.

$$\delta_k = (t_k - y_k) f^{'}(y\_in_k)$$

Calculates its weight correction term (used to update $w_{jk.}$ Latter) :

$$\Delta w_{jk} = \alpha \delta_k z_j$$

Calculates its bias correction term (used to update $w_{0k.}$ Latter) :

$$\Delta w_{0k} = \alpha \delta_k$$

And sends δ_k to units in the layer below.

Step 7: each hidden unit (Z_j, j=1,…,p) sums its delta inputs (from units in the layer above):

$$\delta\_in_j = \sum_{k=1}^{m} \delta_k w_{jk}$$

Multiplies by the derivative of its activation function to calculate its error information term,

$$\delta_j = \delta\_in_j f^{'}(z\_in_j)$$

Calculate its weight correction term (used to update υ_{ij} latter),

$$\Delta \upsilon_{ij} = \alpha \delta_j x_i$$

And calculates its bias correction term (used to update υ_{oj} latter),

$$\Delta \upsilon_{oj} = \alpha \delta_j \ .$$

Update weight and biases :

Step 8 : each output unit (Y_k, k=1,…,m) updates its bias and weights (j=0,…,p):

$$w_{jk}(new) = w_{jk}(old) + \Delta w_{jk}$$

Each hidden unit (Z_j, j=1,…,p) updates its bias and weight (i=0,…,n)

$$\upsilon_{ij}(new) = \upsilon_{ij}(old) + \Delta\upsilon_{ij}$$

Step 9 : Test stoping condition.

The parameter of α is the learning rate that determines the speed of iteration. α value lies between 0 and 1 ($0 \le \alpha \le 1$). The greater the value of α, then number of iterations required is reduced. However, if the value of α is too large, it will spoil correct pattern so learning rate becomes slow. A training cycle that involves all the patterns called epoch.

Selection of the initial weight greatly affects the neural network to achieve global minimum (or perhaps local only) to the value of the error (errors) and rapidly whether or not the training process towards convergence.

If the initial weight is too large, then the input to hidden layer or the output layer will fall on the area where sigmoid function derivative, will be very small. If the initial weight is too small, then the input to hidden layer or the output layer will be very small. This will lead the training process is running very slow. Usually the initial weights randomly initialized with a value between -0.5 to 0.5 (or between -1 and 1 or any other interval).

After training is completed, the network can be used for pattern recognition. In this case, only the forward propagation (steps 4 and 5) are used to determine the network output.

Flowchart of system

Flowchart system are used to describe the work steps of system that will be created, and also be used by the authors to determine the next steps. The data used are secondary data from the exchange rates of IDR and USD. data input of exchange-currency based on the variables data of the opening price, closing price, highest price, lowest price, volume. Figure 3 shows a flowchart of training neural networks to one network architecture, to other architectures are also the same way. Training done with a lot of data that can represent the state of the exchange rate which occur.

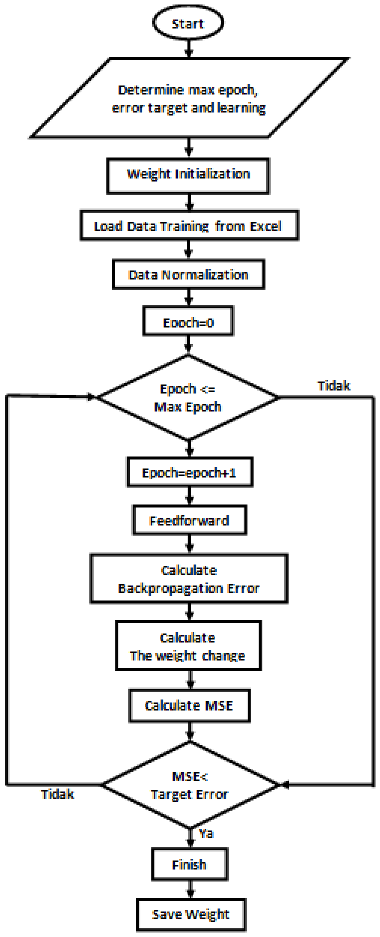

Figure 4. Backpropagation algorithm Flowchart

RESULTS AND DISCUSSION

Data Collection

The data used in this study are not taken directly from the field, but was taken from existing data (recorded) on a website and in this study used the data exchange in October 2013 until January 2014, which is taken from Bank Indonesia site, which provides historical data of various foreign currency exchange rates. The data used in this research is exchange rate data between US Dollar (USD) dan Indonesian Rupiah (IDR).

Architectural Design Network

Number of Hidden Cells

The theoretical results obtained show that the network with a hidden layer is sufficient for backpropagation to recognize any relation between the input and the target with a specified level accuracy. However, addition of hidden layer sometimes makes training easier.

The number of hidden layers and the number of cells should be tried repeatedly starting from small. Network architecture consists of number of an input layer neuron as many as 10, hidden layer neuron as many as 5, the output layer consisting of one neuron. Transfer function using tansig for input layer, hidden layer using logsig, and purelin used at output layer

Model Training

Input data will be processed using palatihan Artificial Neuron Network (ANN) with backpropagation method. Input from this training is data - historical data exchange rate of USD / AUD accessed through the bank's website http://www.bi.go.id/Indonesia . In this study will be shared as much as 70% of existing data as training and 30% of the data as the test data. And in this study used the data exchange in October 2013 until January 2014, which is taken from Bank Indonesia site.

Analysis Training Results

In the training process of the research,Learning rate used for daily data is 0.5, the process stops at iteration epoch-27 088 for daily data, with the achievement of gradient is: 0.0081822 and the value of coeficient determinant (R) for the training data at 0.99494 (Fig. 5) that means very well because approaching a value of 1.

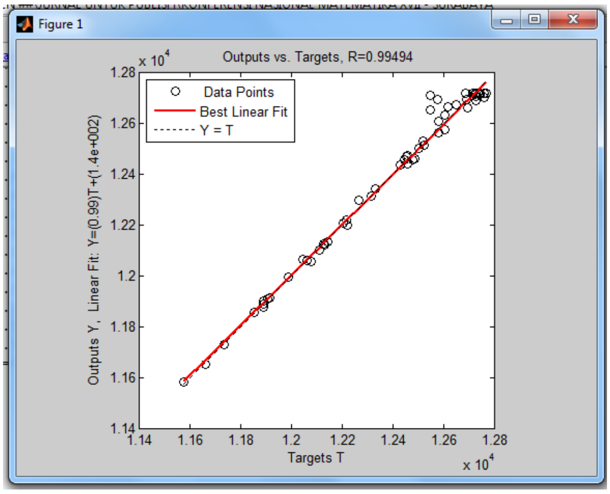

Figure 5. Training data Resault

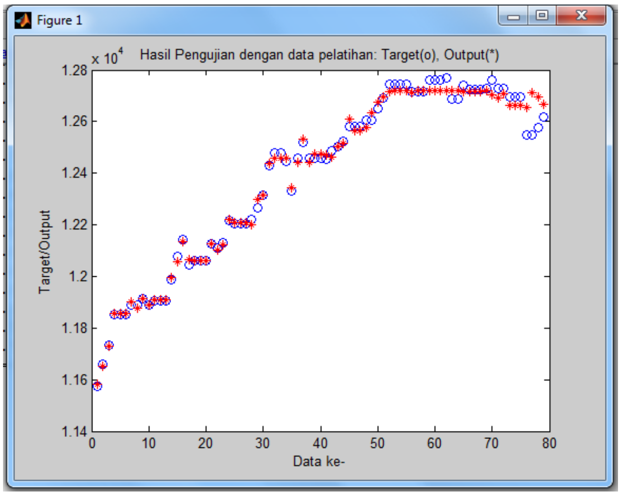

Figure 6. Test data Resault

Furthermore, the data in the test and obtain the R value of 0.48638, which means still said to be good for test data forecasting.

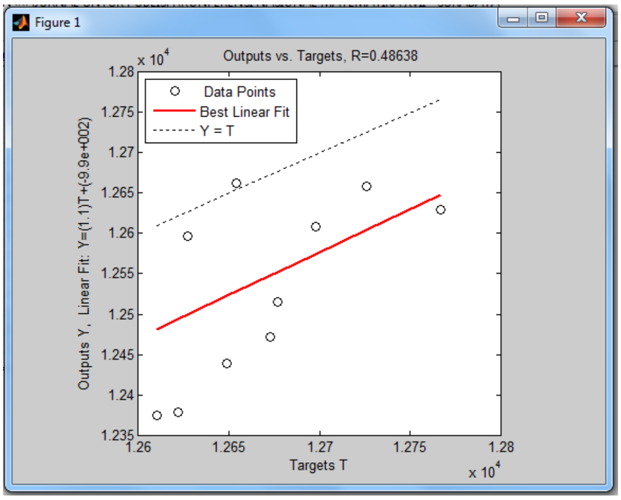

Figure 7. Output vs Target data test

CONCLUSIONS

Backpropagation algorithm can perform a prediction process, but whether or not the resulting value is strongly influenced by the determination of parameters such as the amount of learning rate and the number of neurons in the hidden layer. To produce a good parameter configuration takes quite a long time in doing experiments searching for the best parameters that will be the new parameter can be used for the prediction process.

In the training process of the research Learning rate used for daily data is 0.5, the process stops at iteration epoch-27 088 for daily data, with the achievement of gradient 0.0081822 and the value of R for the training data at 0.99494, which means very well because approaching the value of 1. Furthermore, the data in the test and obtain R at 0.48638, which means still said to be good for test data forecasting.

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