FORECASTING APPLICATION FOR SIMPATI TELKOMSEL CARD USING BACKPROPAGATION (CASE STUDY IN BANGKALAN MADURA-INDONESIA)

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ABSTRACT

Artificial intelligence is a field that uses human abilities biologically as well as knowledge, a decision-making technique for clearing problems either in terms of computing and control. A forecasting could be accurate if it has the proper planning. Application of propagation methods can be used to generate a prediction of how much the number of users of a sim card provider. This method is able to produce a level of accuracy that is better than the conventional methods to obtain accurate prediction based on the value of MSE (Mean Square Error).This study discusses the method of propagation with backward and forward functions in predicting simcard users during a certain time interval which can produce the smallest MSE value. When the stationary nature of the data produces the smallest value, then the proven performance of a method in forecasting could be accurate enough. Forecasting system has the number of users which uses backpropagation with a hidden layer parameter amounted to 30, 10,000 E-Poch and momentum 0.1. The maximum point reaches the best value. During the system testing, these parameters generate an error value, MSE, of 0.00143 which shows a fairly good accuracy level of prediction.

Keywords: Forecasting, backpropagation, the number of users

INTRODUCTION

Artificial Neural Network (ANN) can be used to simulate the structure and function of the human brain. It has layers of interconnected neurons thatare used in various fields. It is able to map the complex models of non-linear byfinding the best weight (Panos Liatsis, 2007). In essence, an artificial neural network consists of an input layer which has a function or any combination of data. Therefore, an artificial neural network is one of the suitable method for solving a problem.Telecommunications is very important in everyday life.It would require a forecasting as a process for estimating the number of users in the future,forcovering service needs and planning appropriate marketing strategies to get a greaternumber of users. With the increasing number of users, service-providers will be more focused toimprove their performance in terms of marketing and supply of cards and services that can later be beneficial for the progress of the service provider.

The first thing that must be done in building a model of Neural Network is preparing the data. Without a good, adequate and representative data collection it is not possible to develop a predictive model of Neural Network (Rohman, 2016). Prediction analysis of time series data by using conventional methods is proved to be difficult matter (Pei-Chann Chang a, 2009). However ANN is able to work in parallel with variable input so that it can handle the use of large data sets quickly. The main capabilities of the ANN is to find data patterns and detect multidimensional non-linear connection in the data. The ANN can be used to solve problems in pattern formation and linear regression.Moreover, ANN has excellent ability to solve problems technically primarily in predicting the stationary data (H. Hasan Örkcü, 2011). ANN backpropagation algorithm is the method most widely used in training a neural network.

According to another study, ANN has several advantages, which have the ability to represent the condition of linear and nonlinear (Nirjhar Bar, 2010). Besides ANN also have the ability to study the data directly, the historical data can be used as input to determine the predictive results which were not known before. Another ANN ability is that it is very fast in data processing. With these advantages ANN architecture must be clarified in advance so that the resultcould reach the optimal targets (lam, 2004) by specifying the parameter combinations of network architecture, the momentum , the pace of learning (learning rate), training and testing.

Under these conditions, this research will focus on predicting the number of users-provider. Predictions in this study can be used as an alternative method of prediction of growth across the communications provider in Indonesia. The development of this method is used a forecasting backpropagation process called Multilayer Feedforward Network.

METHODOLOGY

One form of ANN models which is widely used for various applications isMultilayer Feedforward Neural Networks

(MLFN). The general form of MLFN which is used for forecasting time series is MLFN with one hidden layer and one neuron unit in the output layer. Estimated weightof this model is done by applying an optimized backpropagation algorithm on Nonlinear Least Squares.

ANN is a method of conducting an information processing system inspired by biological neural cells (Maria Agustin, 2012) (Maria Agustin, 2012).ANN is formed as a generalization of mathematical models of biological neural networks, assumes that:

1. Information processing occurs in a lot of simple elements (neurons).
2. The signals are transmitted between neurons via the link.
3. Connecting between neurons have weights that will strengthen or weaken the signal.
4. To determine the output, each neuron which uses activation function (usually not a linear function) is paid on received sum inputs. The magnitude of this output is then compared with a threshold.

This algorithm can work well in determining the best architecture which is applied for time series forecasting based on the results of empirical studies. These results are related to forecast accuracy comparison between MLFN models and the other time-series models. However, there is no guarantee that MLFN will always give the best results. Moreover, empirical studies on the initial processing of data also have to demonstrate that the selection of the initial processing methods and proper data are required in order to improve the prediction accuracy of MLFN.

Backpropagation

MLFN method is a simple method using single inputs and outputs, and hidden neurons which are structured as well as a formulation that can produce many accurate values; so that the userscan make an informed decision (Manoj Kumar, 2011). This may happen because the neural network method has the ability to estimate the situation and reduce error rates that will come with unsupervised conditions.

ANN method that includes Process Training and testing process can produce the desired forecasting value (Kusumadewi, 2003).Each neuron can have multiple inputs and has a single output. The input layer in a neuron may contain raw data or processed previous neuron. While the results in an output layer neuron is the final result or as an input for the next neuron. Time series analysis is a better method than the other methods to make a prediction (Pei-Chann Chang a, 2009). Backpropagation algorithm is forecasting techniques thatcalculate its resultsbased on ANN for measuring the error rat bye using a multilayer network, steepest descent approaches, and measurements of root which is means square error (Rachmad, 2016).

Input on the network will be processed by a function that will add up the values of all weights. The results of the sum will be compared to a threshold value through the activation function of each neuron. One function of activation on neural network is a binary sigmoid function. This function has a value in the range of 0 to 1, which is expressed as:

$$\square = \square(\square) = \frac{1}{1+\square^{-\square\square}} \tag{1}$$

Backpropagation methodis selected because it is a multi-layer method that matches the nature of the data that is non-linear and time series. Each input on the network layer backpropagation is always connected to the units in the hidden layer as well as any hidden unitswhich is always connected to the unit at the output layer. Backpropagation network consists of many layers (multilayer network), ie. Input layer which consists of 1 to n input unit. Hidden layer (at least 1) consists of 1 to p hidden units. The output layer (1 piece) consists of 1 to m units of output. Before the data is processed into propagation, input data should be normalized first, as seen in Figure 1.

In the training phase propagation, there are 3 steps that must be done, namely, feed-forward (feedforward) phase, feed backward (propagation) phase, and the weights and biases of repair phase. Some changes of weights can reduce the error. Then the cycle of weight change (epoch) was performed on each set of training so that the stop condition is achieved, ie when it reaches the desired number of epochs or until itreachesa specified threshold value

One of the most important things on a neural network is training or learning process on the network. The training process is a process to find the optimal parameters (Maria Agustin, 2012) (Maria Agustin, 2012). At the time of the training process, there are two classes of correcting problems and determining the gradient of the method. When determining the gradient ANN is often trapped in local issues, the establishment of optimum network structure is needed. ANN has a weakness in overfitting due to large data processing, therefore it has to use simple network architecture and minimalizesubjective measures on estimation and selection (Teo Jasic, 2003).The data must be normalized first for propagation,by recognizing the value range (0.1) ascan be seen in equation (1). It can reduce the prediction error by adjusting the weight of the nodes in the training phase

Figure 1. Flowchart forecasting using backpropagation

Size Errors Forecasting

Size forecasting is done in order to know how accurate is the forecasting calculation that has been done.The bestforecasting parameters is the methodthat gives the smallest value of forecasting error. Selection of the best forecasting method should be based on the level of prediction errors. Measurement error is made to see if the methods that have been used are adequate for predicting a data, because there is no forecasting method to predict future data appropriately. The smaller the margin of error is generated, the more precise a method in generating predictions. There are different sizes that errors can be classified into standard size in statistics and relative size. The size of the error, including statistical standard size is the average value of squared errors, Mean Squared Error.

Below are equations that can be used to calculate the size of each errorfor forecasting (Nila Yuwida, 2012) (Nila Yuwida, 2012). The the accuracy level of forecasting results are used to calculate the error value of the calculation process based onthe initial value, in accordance with the original data using the average of squared errors. Mean Squared Error (MSE) suggests what is the actual minimum value of the predicted results with the actual value. The average error is in root square or called Root Mean Squared Error (RMSE), as shown in equation (2):

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(X_t - F_t)^2}{n}} \qquad (2)$$

RMSE is obtained from the roots number $X_t$which has the value of forecasting. It

expects period t can be reduced F_t as the value of the forecasting system in period t which is squared and then averaged for n number of data.

RESULTS AND DISCUSSION

At the time of testing, one matter thatshould be considered is the use of data (Shamsul Faisal Mohd Hussein, 2011). Since it is oftendifficult to obtain data, a good preparation to searchthe main data is fundamental .The data used in this research is secondary data that is quantitative. The source of the data was obtained from Bangkalan branch of Grapari-Simpati outlets. In consideration of the relatively more stable condition, this study used the study period 2010-2012. Training data that were used in this study were of number of users in Bangkalan for 24 months, from January 2010 - December 2011 and January 2012 - December 2012. Total of 12 data were used as the testing process which were conducted to determine the accuracy of the system in the process of predicting the number of users based on MSE and some criteria.

Table 1. Users provider Sympathy in Bangkalan in 2012

No	Districts	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nop	Dec
1	BANGKALAN	7.257	8.023	8.129	8.636	8.636	8.600	9.245	9.620	9.332	9.435	9.966	12.119
2	AROSBAYA	6.175	6.941	7.013	7.554	7.554	7.562	7.682	7.865	7.743	7.775	8.306	9.379
3	BLEGA	4.819	4.842	5.657	5.473	5.473	5.463	5.528	5.711	5.588	5.654	6.185	6.188
4	BURNEH	5.000	5.023	5.838	5.636	5.636	5.583	6.409	6.592	6.469	6.535	7.066	8.136
5	GALIS	4.792	5.243	6.058	5.856	5.856	5.903	5.011	5.194	5.072	5.138	5.669	6.739
6	GEGER	4.419	4.442	5.257	5.055	5.055	5.192	5.203	5.386	5.264	5.330	5.861	6.937
7	KAMAL	5.165	5.188	6.003	5.801	5.801	5.903	5.993	6.176	6.053	6.119	6.650	7.723
8	KLAMPIS	4.209	4.232	5.047	4.845	4.845	4.566	5.893	6.076	5.953	6.019	6.550	7.623
9	KOKOP	5.330	5.354	6.169	5.967	5.967	5.924	5.873	6.055	5.933	5.999	6.530	7.603
10	KONANG	3.485	3.663	4.478	4.276	4.276	4.276	6.309	6.493	6.369	6.435	6.966	8.036
11	KWANYAR	5.436	5.450	6.265	6.063	6.063	6.063	6.983	7.166	7.043	7.109	7.640	8.716
12	LABANG	4.019	4.042	4.857	4.655	4.655	4.655	5.839	6.022	5.899	5.965	6.496	7.569
13	MODUNG	5.114	5.137	5.952	5.750	5.750	6.250	6.134	6.317	6.194	6.260	6.791	7.862
14	SEPULU	4.909	4.932	5.747	5.545	5.545	6.045	6.904	7.087	6.955	7.021	7.552	8.625
15	SOCAH	6.021	6.043	6.858	6.656	6.656	5.632	5.938	6.121	5.998	6.064	6.595	7.668
16	TANAH MERAH	5.359	5.384	6.199	6.014	6.014	5.093	6.983	7.166	7.045	7.111	7.642	8.712
17	TANJUNG BUMI	3.519	3.542	4.357	4.155	4.155	4.095	5.875	6.058	5.935	6.002	6.533	7.609
18	TRAGAH	4.756	4.352	5.167	4.352	4.054	4.000	5.982	6.165	6.042	6.108	6.640	7.710

ANN modeling using four layers, namely an input layer, two hidden layers and one output layer. Node architecture used in the input layer, hidden layer and output layer, among others : 12-15-1 , 12-20-1 , 12-25-1 , 12-30-1 . The input neurons was set up as 12 since one year consists of twelve months and the input data was the monthly users.

In the process of testing, the data is collected from Bangkalan sub district, and the following parameters were defined, such as: changes in the number of node hidden layer, and changes in range epoch.

a. Scenario 1 = change neuron hiden layer 15, 20, 25, 30, 35
b. Scenario 2 = change of epoch 10, 100, 1000, 10000

Process Test Scenario 1

At trial Backpropagation (Trials with changes hidden layer), trial data were 4 run in which in each run multiples5 to change the hidden layer. The best results from Backpropagation method is obtained from 30 neuron hidden layer with MSE of 0.00143. In a short, the more hidden layer the better the results of forecasting.

Tabel 2. (change neuron *hidden layer*) BP

Momentum	*HiddenLayer*	E-poch	*MSE*
0,1	15	10000	0,00238
0,1	20	10000	0,00172
0,1	25	10000	0,00151
0,1	30	10000	0,00143

Process Test Scenario 2

At the trial data sets Backpropagation (Trial Data ELM with change Epoch), trial data were run 4 times in which during each run data was partitioned into multiples of 10 for Epoch desired changes, until itobtaines a favorable MSE accuracy value.

Table 3. (Epoch desired changes) BP

Momentum	*HiddenLayer*	E-poch	*MSE*
0,1	30	10	0,246
0,1	30	100	0,00987
0,1	30	1000	0,00475
0,1	30	10000	0,00143

Based on the results of the comparison of the Epoch in Table 3, which shows the result of MSE backpropagation, it can be said that if the iteration/Epoch is bigger then the value of the error will be smaller because the propagation will be looking for the best value in accordance with the expected target output.

CONCLUSION

The conclusion that can be drawn from this study are:

1. In forecasting using Backpropagation, the best scenario ofneuron hidden layer parameter that give the best value is the setup of amount of 30,10000 E-Poch, andthe momentum setting of 0.1. During the system running tests, these parameters generate aminimum error value, MSE, of0.00143.
2. Based on the test results of feedforward and backward propagation process, it shows that iteratively regulated learning algorithm and each parameter input weights as well as hidden bias is interconnected with the other layers.

ACKNOWLEDGMENT

We would like to thank our fellow researchers in the university of Trunojoyo Madura-Indonesia, the entire team at the lab Multimedia and Networks that have helped the completion of this research, and Multimedia Engineering Program and the Network which has provided an opportunity to use laboratory equipment.

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