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Predicting Medicine-Stocks by Using Multilayer Perceptron Backpropagation

The Prediction Medicine Stock based Multilayer Perceptron Backpropagation

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Abstract: Artificial neural network has a lot of ability in controlling the error rate to formulate some of its functions as a supervised method. Medicine is one of the major needs for each patient, so that every hospital should know how much inventory of drugs is used and needed by patients every day. This study uses artificial neural network with multilayer perceptron backpropagation as a solution for predicting drug stocks. Prediction of drug stocks using medicine prior period stock data for three years is used to get the predicted results with a small error rate. Backpropagation algorithm using the error output is used to change the weights in the backward direction. To get this error, forward stage should be done first. The results of experiments using backpropagation with the configuration of 0.04 mementum which has training rate of 0.001 gets the value of MSE of 0.00001.

Keywords: artificial neural network, backpropagation, medicine stocks, hospital, predictions

1. INTRODUCTION

Neural networks have been shown to be effective in modelling and forecasting nonlinear time series with or without noise [1]. There are several works which has been done for time series prediction based on neural network for prediction of stock price, financial and economic time series, stock exchange. Medicine is one of the essential needs of a hospital. Health patient at a hospital depends on the availability of drugs, especially for patients who are hospitalized and in a worrying condition. Therefore, the hospital must provide the drug in sufficient quantities for their patients [2]. However, having medicine in a very big-stock is not good enough because the medicine is composed of chemicals that if the expiration runs, it would be dangerous to consume. Data stock of drugs is one of the data which is included in the time series data. Various studies time series, especially statistical time series forecasting has become the most popular technique for a short time scale [3]. Smoothing of time series data is a task that occurs in many applications and is used for prediction or forecasting.

Data preparation is an important step in building a successful model of Neural Network. Without good data collection, adequate and representative, it is not possible to develop a predictive model of Neural Network useful. Thus, the reliability model of Neural Network depends on the extent of how much the quality of data [4].An artificial neural network (ANN), another powerful mathematical tool, is capable in making extremely complex – modeling and non-linear systems with many inter-related parameters, and does not require detailed information on the physical parameters of the system [5].

This paper will be focusing on objective forecasting method. We proposed to apply neural network of backpropagation to predict the medicine stock. There are 3 categories of prediction methods [6], they are:

• Objective forecasting method (quantitative prediction methods) – based on mathematical and statistical calculations
• Subjective forecasting method (qualitative prediction methods) – based on expert opinions
• Prophecy (educated guessing)

2. SYSTEM DESIGN

Prediction or forecasting is an activity which predicts the recurrence in the future through a testing-state in the past. In social life, everything is uncertain, it is difficult to accurately predict. In this case there should be a forecasting. Forecasting is always made in order to minimize the effect of this uncertainty of an issue. In other words, the prediction aims to get results that can minimize errors in the predicted future (forecast error) which is usually measured by the mean square error, mean absolute error, and so forth.

A good prediction has several important criterion, such as accuracy, cost, and convenience, they are described as follows::

- **Accuracy**.Accuracy of a forecasting results measured by habits and consistency forecasting. A forecasting may results bias, if is too high or too low compared with the fact that actually happened. Forecasting result is said to be consistent if the magnitude of forecasting error is relatively small.
- **Costs.** The cost required for the manufacture of a forecast depends on the number of items which are predicted, the length of the forecast period, and the forecasting method used**.**
- **Easy.** The use of forecasting methods which are simple, easy to make and easy to apply will benefit the company.

In this case the medicine by the time stock data will be processed with the formula to obtain the autocorrelation time lags which make the time could be significant for the predicted time. Then the significance of medicine stock data at a time will be the input data in the process of training the neural network backpropagation ANN.

To evaluate price forecasting parameters, we can use the size of the forecast error. The best price of forecasting parameters is the price that gives the smallest value of forecasting error. There are different sizes that errors can be classified into standard size in statistics and relative size.

Artificial neural network information is a paradigm of information processing that is inspired by biological nervous systems, such as information processing in the human brain [7]. Each neuron can have multiple inputs and has a single output. Input lines on a neuron may contain raw data or processed data from the previous neuron. While the output of a neuron can be the end result or input to the next neuron.

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:

$$y = f(x) = \frac{1}{1+e^{-\sigma x}} \quad (1)$$

$$f(x) = \text{SIN}\, x = [-1, 1] \quad (2)$$

The value of y = f (x) uses the value of sin x because based on the research [8] , this value can be better than the sigmoid function [0,1] because the share value is 0, which do not have a significant value. The methodwhich is used to perform Predictive stock prices in this study is Backpropagation method. This method is selected because it is a method of ANN multi-layer that matches the nature of the data which is non-linear and time series.

Once the efficient parameter values are specified, prediction performances of ANN and SVM models can be compared to each other. This performance comparison was performed on the entire data set considering the parameter values specified using the parameter setting data set. That is, the prediction models must be re-trained using a new training data set which must be a new part of the entire data set and must be larger than the training subset of parameter setting data set [9]. After re-training, out-of-sample evaluation of models must be carried out using a new holdout data set, which is the remaining part of entire data set.

The training stage shown in Figure 1 is a step to process data patterns that have been through the process of autocorrelation and normalization for the system to determine the weights that can map between the input data with target data output is desired. After the feedforward and backward, it will get the best weights according to the target error and epoch maximal or maximal iterations desired.

Before the data is processed into the ANN which the aim is to normalize the data input of medicine stock. Stock data must be normalized first, because ANN can only recognize the value range of (0.1) which the equation can be seen in equation (1). It can reduce the prediction error by adjusting the weight of the node-node when the training phase.

One form of analysis in Statistics theory is the analysis of time series data, that is the analysis of data is a function of time or place. Analysis of time series data is a special analysis of the regression analysis, because the time series data involves a quantity which is called autocorrelation. The existence of autocorrelation can be a periodic autocorrelation, which the period of autocorrelation value is more than one. It is also widely available in time series data that has periodic seasonal component.

Backpropagation is a method in conducting the production solutions for the basic number of neurons (n) in the hidden layer, value of learning rate, momentum and number of iterations. Those are ANN model parameters which must be efficiently determined [9].

The architecture of the three-layered feedforward ANN is one neurons input, four ouput layers, one output layers with 0.001 learning rate, the momentum of 0.02 and the maximall iterations 10000.

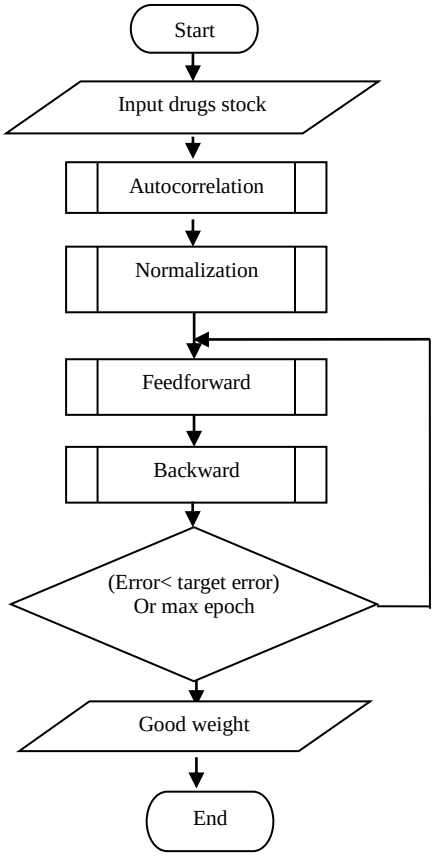

Figure 1. Flowchart Training

Autocorrelation formulates together with the formulation of the correlation between two variables. In the method of Statistics, the sample holds on bivariate data (X, Y).

Autocorrelation process is performed to find the closeness of the data and is used to find data patterns stationary or non-stationary. Once the weights are the best at this stage of training which could be obtained, then the weighted value is used to process the input data to generate the appropriate output. It is used to test whether the ANN can work well to predict patterns of data that has been drilled with a small error rate.

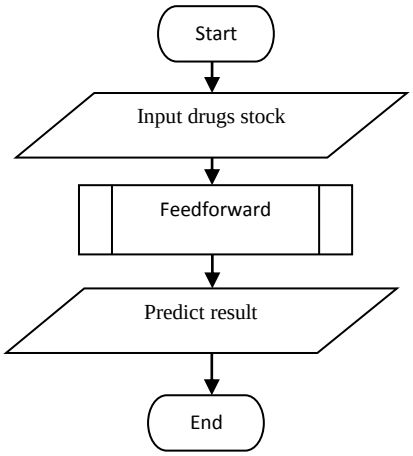

Figure 1. Flowchart Testing

Weighting is done on the training process, if the number of neurons and the number of lower layer lead to a low value

to weight the training process [10]. The architectural design for the number of neurons in each layer is instrumental in improving accuracy.

Feedforward process is performed to obtain the output error by summing the input weights and the weight bias shown in Figure 2. And the performance of the activation functions for hidden summing the weights and the bias. Once the best weights at this stage of training is obtained, then the value of the weights are used to process the input data to generate the appropriate output. It is used to test whether optimal ANN can work to predict patterns of data that have been trained with a small error rate. This process continues until the epoch value is reached. When the price-stock could be obtained, then it can calculate the fitness value. The value which is used is the RMSE.

2.1 Normalization and Denormalization

Normalization process used in this system uses normalized minimum-maximum. Denormalization existing data is done by dividing the value of that data with the value of the data range (maximum data value-minimum data value). The aim of data input normalization is to adjust the value range of data with the activation function in a propagation system. This means that the value of the square of the input should be in the range of 0 to 1. So the input range that qualifies is the input data which values from 0 to 1 or from -1 to 1. Therefore the resulting output will be in the range of 0 to 1. Then image to get the true value of output is necessary to normalize the process.

Normalization of data using the formula in equation (3):

$$f(x) = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}} \quad (3)$$

X_i is the i-th of data, while theX_{min}, is the minimum value data and X_{max} is the maximum value of data.

In the testing process, the output is produced by the network which ranges from 0 to 1. So it is necessary to normalize it to be useful to convert the output result of the network back into normal medicine-stocks. After all it will do a comparison between the actual data with the data from predictive, so it can the error and its percentage could be calculated.

The image of normalizing the data by using the formula in the equation (4):

$$X_i = y(X_{\max} - X_{\min}) + X_{\min} \quad (4)$$

2.2 RMSE (Root Mean Squared 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.

Size accuracy of forecasting results are used to calculate the error value of the calculation process by the system to the initial value in accordance with the original data using the average of squared errors. RMSE is the square root of the Mean Squared Error (MSE). Error suggests how minimum predicted results with the actual value. This is the formula of the average error square root or Root Mean Squared Error (RMSE) with equation (5):

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(X_t - F_t)^2}{n}} \quad (5)$$

RMSE is obtained from the roots number X_t is the value of forecasting the expected period t is reduced F_t as the value of the forecasting system in period t is squared and then averaged for n number of data.

3. RESULT AND DISCUSSION

The data which are used in this research is secondary data that is quantitative (show in Table1). The source of the data were obtained from hospitals Syarifah Ambami Bangkalan. In consideration of the relatively more stable condition, this study used the study period 2007-2009. Historical data were chosen because it reflects the actual condition of medicine-stocks, so that this research results will be used as valuable information for the hospital.

Training data that will be used in this study to training is as many as 500 on data from January 2007 - December 2008. And since January 2009 - December 2009, the total of 119 data is used as a test

Table 1. Medicine-stock data in December 2008.

NO	DRUGS NAME	DRUGS Stock Desember 2008	Drug Price
1	ACTAZOLAM 0,5 MG TAB/ BOX 30	-	1,300.00
2	ACTRAPID HM PENFILL 100 INJ/10	-	181,830.00
3	ACTRAPID INJ	-	290,000.00
4	ACTRAPID NOVOLET 5X3ML INJ	-	84,813.00
5	ACYCLOVIR 200 TAB (50/BOX)	90	320.00
6	ACYCLOVIR 400 MG (100/BOX)	125	535.46
7	ACYCLOVIR 400 MG (50`S/BOX)TAB NOVELL	-	650.00
8	ACYCLOVIR KRIM 5 % 5 G (TUBE) INDO	12	2,646.48
9	ADALAT OROS 20 MG TAB/DOS 30`S	-	2,700.00
10	ADALAT OROS 30 MGTAB/BTL 30`S	-	3,300.00
11	ADALAT TAB 10 MG/BOX 50`S	44	2,120.00
12	ADALAT TAB 5 MG/BOX 50`S	-	1,420.00
13	ADULT OXIGEN MASKER AMS	-	70,000.00
14	AERIUS/30	-	5,311.33
15	AGNUCASTON TAB 30`S	-	4,500.00
16	ALBAPURE 20% 100 ML	-	517,335.00
17	ALBOTHYL 100 CC	-	
18	ALBOTHYL CONC 10 ML (BTL)	-	17,325.00
19	ALBUMIN 25%	-	
20	ALBUMIN BEHRING 20% - 100 ML	-	1,310,000.00
21	ALDIAB TAB / BOX 40`S	-	750.00
22	ALGANAX TAB 0.5	-	1,430.00
23	ALINAMIN INJ - BOX 5 AMP	-	7,630.00
24	ALINAMIN TABLET	21	
25	ALKOHOL 70% /LT	15,000	25.00
26	ALKOHOL 95%	6,000	30.80
27	ALKOHOL 96%	-	19.80
28	ALKOHOL SWAB / BOX @ 200 SACHET	600	200.00
29	ALLOPURINOL 100 MG TAB/100`S	1,616	100.00

Bacpropagation has the training phase which is aimed to find the best weights on each layer.Network is trained with medicine sales data from the years 2008-

2009 as many lags which were obtained by autocorrelation and normalization before.

Artificial neural network architecture consists of an input layer, four hidden layer (hidden layer) and an output layer (1-4-1).The number of input and output node in accordance with the number of lags arise from the process of autocorrelation.While the number of hidden layer were obtained from the trial itself.The condition of the system will stop if the generated-error value is smaller than the tolerances error or the number of iterations which had been stated.

The process of propagation neural network with 4acyclovir medicine code 200 TAB (50 / BOX) produces some value, among others:

Table 2. The results of Bacpropagation Trial in the change of momentum

hidden	Iterasi	(δ)/mom	(a)/Lrate	Error	MSE
4	9000	0.04	0,001	0.0006	0,000001
4	9000	0.035	0.001	0.0006	0,000001
4	9000	0.03	0.001	0.0006	0,000001

Table 3. Results of Trial Backpropagation rate changes Training

hidden	Iterasi	(δ)/mom	(a)/Lrate	Error	MSE
4	9	0.02	0,1	0.008	0,083
4	969	0.02	0.001	0.008	0,083
4	31	0.02	0.025	0.008	0,083

4. CONCLUSION

Implementation of the results of experiments which was conducted five times to get the RMSE is getting smaller.Table 1 and table 2 are the result of an experiments on the change in momentum and also the experiments on the changes learning rate. The conclusions are as follows:

1. By adding the stock prices of medicine with Backpropagation neural network, it can be used as a solution for and determine the initial stock of drugs.
2. From the test results in determining the forecasting model parameters, it can be concluded that the best performance can be obtained by using the parameters of the artificial neural network with as many as 9000 the number of iterations, mementum parameter of 0.04 learning rate of 0.1, fault tolerance error of 0.0001 and a target at 0.0006. For all types of medicine- stocks daily data, it uses structures 1-4-1 BPNN architecture (one neuron in the input layer, four in the hidden layer, and a single neuron in the output layer).

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