Comparative Analysis of Backpropagation With Learning Vector Quantization (LVQ) to Predict Rainfall in Medan City

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Abstract. Rainfall is a very important factor in agriculture and development planning. This study aims to predict rainfall and rainfall properties in Medan using a multilayer neural network with Backpropagation and Learning Vector Quantization (LVQ) algorithms. Rainfall data used for training is rainfall data for the last 30 years. The parameters used in this study consisted of two inputs namely the month and the volume of rainfall. The training process produces the best architecture with 3 layer three for Backpropagation and two layers for Learning Vector Quantization with learning rate 0.5. From the prediction results obtained Backpropagation algorithm more accurate in predicting rainfall data last 30 years compared with LVQ with an average difference of 21.99%. Backpropagation and LVQ algorithms have better accuracy in the dry season, with accuracy for Backpropagation algorithm between 75 - 99% and LVQ algorithm of 60 - 82%. For both algorithms, the influence of El-Nino and La-Nina phenomena is not so significant.

1. Introduction
Artificial Neural Network (ANN) is a non-linear statistical data modeling tool. ANN can be used to model the complex relationship between input and output to find patterns on the data. Artificial Neural Network is one information processing system designed by mimicking the workings of the human brain in solving a problem by doing the learning process through changes in the weight of its synapses. An ANN is configured for a particular application such as pattern recognition or data classification, through a learning process. In the learning process, into the artificial neural network enter input or output patterns and the network will be taught to provide an acceptable answer.

Yuniar et al (2013) conducting research to improve weather forecasting using neural network Backpropagation algorithm [1]. This research aims to forecast wind speed and rainfall at Abdulrahman Saleh Airport Malang using multilayer neural network with Backpropagation algorithm. The parameters used in this study consist of three inputs namely air temperature, air humidity, air pressure and two outputs ie wind speed and rainfall. The training process produces the best architecture with hidden layer 5 and learning rate 0.9. From the forecast graph, it is known that the forecast output is close to the target value. The model has successfully performed the forecast process well with the MSE value of wind speed forecast of 0.0086 and the MSE forecasted precipitation value of 0.004846.

In Silvia's research (2007), Artificial neural network designed to predict the quality of white crystal sugar [2]. The system is built using Artificial Neural Network (ANN) in an easy-to-understand interface called Sugar Quality Prediction (SQP). The ANN learning algorithm used is Backpropagation (BP) and Learning Vector Quantization (LVQ).

The SQP system uses the design of ANN with the best Backpropagation and LVQ network architecture based on trial and error in the training process. The best BP network architecture is the
configuration of 35 neurons in the input layer, 20 neurons in hidden layers and 1 neuron in the output layer or [35 20 1], purelin activation function, training trainlm algorithm, momentum 0.05, set goal error 0.01 and set number of epoh 1000 where the MSE value is 0.0098684 on the 2nd epoh and R is 1,000. The best LVQ network architecture is the configuration of 35 neurons in the input layer, 10 neurons in the competitive layer and 3 neurons in the output layer, the selected training algorithm is learn lv1, learning rate 0.1, set goal error 0.0001 and set number of epoh 1000, where the MSE value is 0 in the 2nd epoch and R is 1,000. SQP system testing process shows the output results have a high suitability of the targets that have been determined. Implementation of SQP using actual data for 2005 period shows that based on BP prediction for 70 periods there are 61 periods produced quality white sugar (GKP) 1 and 9 periods of quality 2, whereas prediction with LVQ shows that for 70 periods there are 62 periods where GKP resulting in quality 1 and as many as 8 quality period 2. This shows the system can be grouped into GKP quality classes.

LVQ is an adaptive data classification method based on training data with desired class information [3]. LVQ is a training method on a supervised competitive layer that will automatically learn to classify input vectors into specific classes. The resulting classes depend on the distance between the input vectors. If there are 2 identical input vectors the competitive layer will classify the two input vectors into the same class.

Backpropagation is a gradient decreasing method to minimize the square of output error with three steps that must be done in network training that is forward propagation stage, back propagation step, and phase of weight change and bias. This network architecture consists of input layer, hidden layer and output layer. As there are three inputs and two outputs, the numbers of variables in the input and output layer had to be set to 3 and 2 respectively [5].

From the previous research, we intend to do analysis and comparison of Backpropagation and LVQ algorithm to predict rainfall. The data that we used in this research is Medan city rainfall data that we obtained from BMKG Sumatera Utara [4].

2. Method

2.1 Flowchart

In analyzing Backpropagation algorithm with Learning Vector Quantization to predict rainfall in Medan city, the writer prepare the steps - steps that will be done in this research which can be seen as flow chart Figure 1.

![Flowchart](image-url)
3. Test and Result

Based on the training and simulation results can be obtained comparison of speed and accuracy between Backpropagation algorithm and Learning Vector Quantization (LVQ).

The initial process for the operation of the built application is to input the training data in the form of rainfall data. The training data input process is done by preparing rainfall data for 30 years to be trained. Next select the algorithm used to do the training (learning) and prediction of rainfall that has been selected.

3.1. Results of Data Experiments in April of 2010

We try five times to train and test the data using combination of epoch and error rate. The experiment given the training and rainfall prediction in April 2010 using two algorithms, Backpropagation and Learning Vector Quantization (LVQ) with 4000 epoch and the error rate was 0.1. The result as shown in Table 1.

| Process      | Backpropagation | LVQ              | Comparisons |
|--------------|-----------------|------------------|-------------|
| Training     | 19 seconds      | 16 seconds       | 3 seconds   |
| Prediction   | 146.03 mm (Normal) | 170.03 mm (Above Normal) | 24 mm      |
| Accuracy     | 86.66 %         | 56 %             | 30.66 %     |

The full results are conducted for the year 2010 as much as 12 months as in Table 2.

| Month | BP    | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|-------|-------|---|---|---|---|---|---|---|---|---|----|----|----|
| BP    | 96.66 | 98.77 | 98.33 | 98.66 | 98.88 | 99.04 | 99.16 | 99.25 | 99.33 | 99.39 | 99.44 | 99.48 |
| LVQ   | 53.33 | 76.66 | 84.44 | 88.33 | 90.66 | 92.22 | 93.33 | 94.16 | 94.81 | 95.33 | 95.75 | 96.11 |

The results in Table 2 are plotted in graphs resulting in Line Graphs as can be seen in Figure 2.
4. Conclusions

From the results of experimental network with 3 layers for Back Propagation algorithm and 2 layers for LVQ input input neuron in the form of moon and rainfall volume, it can be made conclusion as follows:
The LVQ algorithm is faster in training the rainfall data for the last 30 years compared to Back Propagation with an average time difference of 3 seconds. Back Propagation algorithm is more accurate in predicting rainfall data for the last 30 years compared to LVQ with an average difference of 21.99%.
The average accuracy for Back Propagation algorithm is 86.66% and for LVQ is 66.66%.

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