

Implementation of artificial neural network to assesment the lecturer's performance

Victor Marudut Mulia Siregar*, Heru Sugara

Politeknik Bisnis Indonesia, Jl. Sriwijaya No. 9 C-E Pematangsiantar, Sumatera Utara, Indonesia

* victor.siregar2@gmail.com

Abstract. The purpose of this research is to assess the performance of lecturers in teaching by using artificial neural network backpropagation. The tests were performed using Matlab software that was tested with some forms of network architecture. The best architecture of artificial neural network (ANN) used is with architectural model 8-3-3-3-2. In the hidden layer used logsig activation function, and in the output layer used pureline activation function. In the first and second hidden layers using Nguyen Widrow weight initialization, the value of learning rate is 0.1, error tolerance value is 0.001, with the maximum epoch is 3094 during training. With this 8-3-3-3-2 model ANN can recognize training data and test data up to 100% according to the desired target.

1. Introduction

To improve the quality of the lecturers in teaching, Business Indonesia Polytechnic Murni Sadar does the assessment of lecturer's performance in teaching in every semester. Through this performance assessment, it is expected that each lecturer can realize the weakness they have in teaching. Assessment of lecturer performance is important to provide direction and input to each lecturer in order to improve the quality of teaching.

Lecturer performance assessment is done by using Artificial Neural Network with backpropagation method. Artificial Neural Network is one of the processing systems that is designed and trained to have ability as it is owned by human being in solving complicated problem by doing the learning process. Artificial neural networks simulate the process structure in the human brain that is the function of the biological nerves and then bring it to new class software that can recognize complex patterns and learn from the experiences of the past.

Artificial neural network has been widely used by researchers to apply to various fields of research objects, such as identification hypertensive retinopathy through retinal fundus image using backpropagation neural network [1], predicting coronary heart disease based on risk factors [2], research to diagnose urinary system disease [3], prediction of rainfall [4], research the credit rating model based on artificial neural network backpropagation uses various activation and error functions [5], classification tree extraction from trained artificial neural networks [6], image classification [7][8], Prediction of suspended sediment discharge in catchments [9], analysis and forecasting currency exchange rate [10][11][12][13], Signal preprocessing of deep-sea laser-induced plasma spectra for identification of pelletized hydrothermal deposits [14], assessment of remaining fatigue life of bridge road decks in service based on their bottom surface cracks [15], and etc.



2. Methods

2.1. Theory

Artificial neural networks are computational systems which the architecture and operations are inspired by the knowledge of the biological neurons in the brain. Artificial neural networks are one of the artificial representations of the human brain that always try to simulate the learning process of the human brain [9].

The neural network model is demonstrated by its ability in emulation, analysis, prediction and association. The capabilities of the Artificial Neural Network can be used to learn and generate rules or operations of some instances or inputs that are filled and make predictions about the likely outputs that will arise or store the input characteristics assigned to the Artificial Neural Network.

Backpropagation is a supervised learning algorithm and is commonly used by multi layer perceptrons to alter the weights associated with neurons present in the hidden layer. Backpropagation algorithm uses output error to change the value of the weights in the backward direction. The forward propagation stage must be done first to get the error value [16][17].

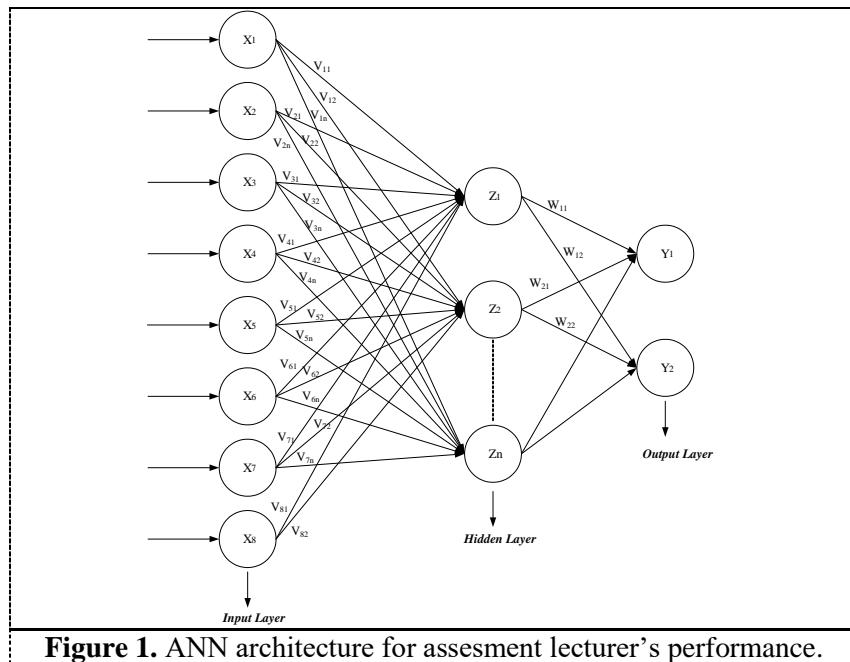
Backpropagation trains the network to recognize the patterns used during the training and the network's ability to respond correctly to similar (but not identical) input patterns to the patterns used during the training.

2.2. Proposed method

Before the training of artificial neural networks is implemented, the first step is to determine the architecture of the neural network which is will be trained. The architecture of a network will determine the success of the target to be achieved because not all problems can be solved with the same architecture. The network architecture that will be used for the assessment of lecturer's performance in teaching is using multilayer net. This model is a network with multiple layers that have one or more layers that lie between the input layer and the output layer.

The artificial neural network architecture used in this case uses the Backpropagation method, which consists of: an input layer of 8 vertices stored in variables X_1 to X_8 . The hidden layer is self-determined by the user of the system through the best trial convergence (trial and error) until the best training convergence results with the smallest number of epochs. Meanwhile the output layer of this artificial neural network consists of 2 vertices.

In figure 1, the architecture of artificial neural network is presented to evaluate the performance of lecturers in teaching.



The data set that is used in this artificial neural network backpropagation is taken from lecturer's performance evaluation in teaching which is distributed in Business Polytechnic Indonesia at the end of each semester to every student. After the data obtained, the data is divided to be used as training data and data testing.

The training phase of artificial neural network backpropagation can be done when the data is ready. Artificial neural network training is carried out using pre-selected training data. At the training stage, Nguyen Widrow method is used to initialize the weights and bias to the hidden layer of the artificial neural network. By using Nguyen Widrow algorithm, the training of artificial neural network backpropagation will produce faster iterations and reduce training time[16].

After the training phase, the next step is testing the artificial neural network. Testing of artificial neural network is using the test data that has been selected previously. After the target is obtained, then the results are analyzed whether the target has been in accordance with the expected or not.

3. Result and Discussion

3.1. Training Neural Network

Data processing the lecturer's performance is done by using 8 input variables that are converted into X1, X2, X3, X4, X5, X6, X7 and X8 formats. Before it is processed the data is normalized first. Normalization of the data is done so that the network output is appropriate to the activation function used. The activation function used to process the data above is a sigmoid activation function. The data must be transformed first because the output range of the sigmoid activation function is [0, 1].

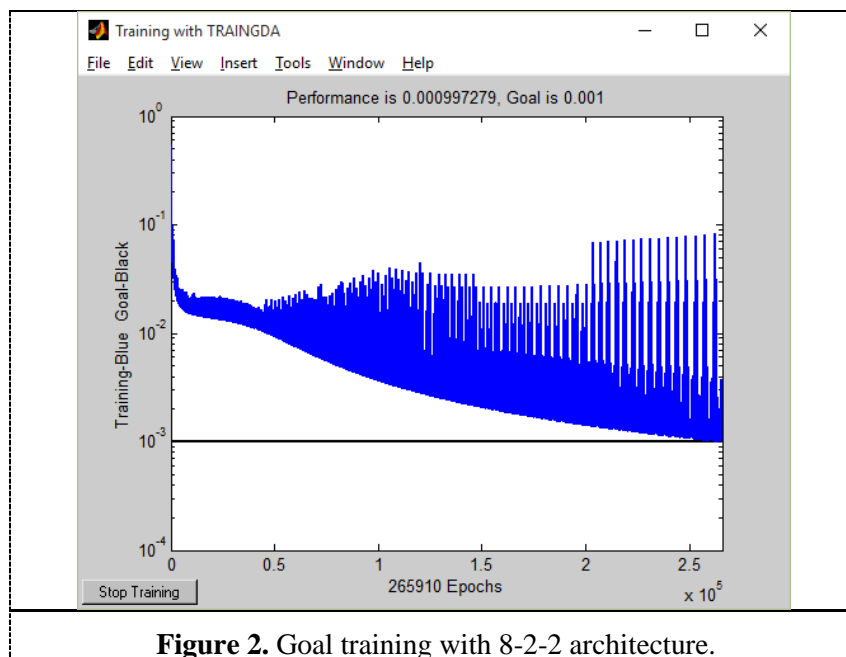
In this training, artificial neural network will be trained by using 8 input variables namely: X₁ to X₈, and using target output variable data sample value as follows:

Table 1. Training Data Sampling

No	X1	X2	X3	X4	X5	X6	X7	X8	Output
1	0,8174	0,7347	0,6245	0,7072	0,6521	0,7623	0,5694	0,7347	11
2	0,6148	0,5970	0,5970	0,5970	0,6148	0,5613	0,4544	0,6504	10
3	0,4076	0,2561	0,4076	0,4455	0,3697	0,5591	0,3318	0,4833	01

The implementation of artificial neural network is done with Matlab software. Initial experiments were performed using architectural pattern 8-2-2, with training data of 35 data. Networks are formed in the following format: matrix of $R \times 2$ order containing minimum and maximum value of input element p . The number of units in layer 1 (hidden layer) is as many as 2 neurons and the number of units on layer 2 (output layer) as many as 2 neurons. The activation function used in layer 1 (hidden layer) is the logsig activation function (binary sigmoid). The activation function used in layer 2 (output layer) is a linear activation function (purelin). And the training function used is the traingda function.

After training on this backpropagation network, we found the minimum error in epoch 265910 as in figure 2.

**Figure 2.** Goal training with 8-2-2 architecture.

The best experiments were obtained using architectural pattern 8-3-3-3-2. In this training, weights and biases initialization is done using the Nguyen-Widrow algorithm. The use of the Nguyen Widrow algorithm resulting in faster iterations.

The command used to form ANN is a newff by the following format:

```
>> net = newff(minmax(p), [3,3,3,2], {'logsig', 'logsig', 'logsig', 'purelin'}, 'traingda');
```

In this training, the Nguyen Widrow algorithm is only used to determine the weights and biases on index layer 1 and layer 2, whereas the weights and biases in index layer 3 do not use initialization weights with the Nguyen Widrow algorithm.

After the training on the backpropagation network with architectural pattern 8-3-3-3-2, then is obtained the minimum error value on epoch 3094 as in figure 3.

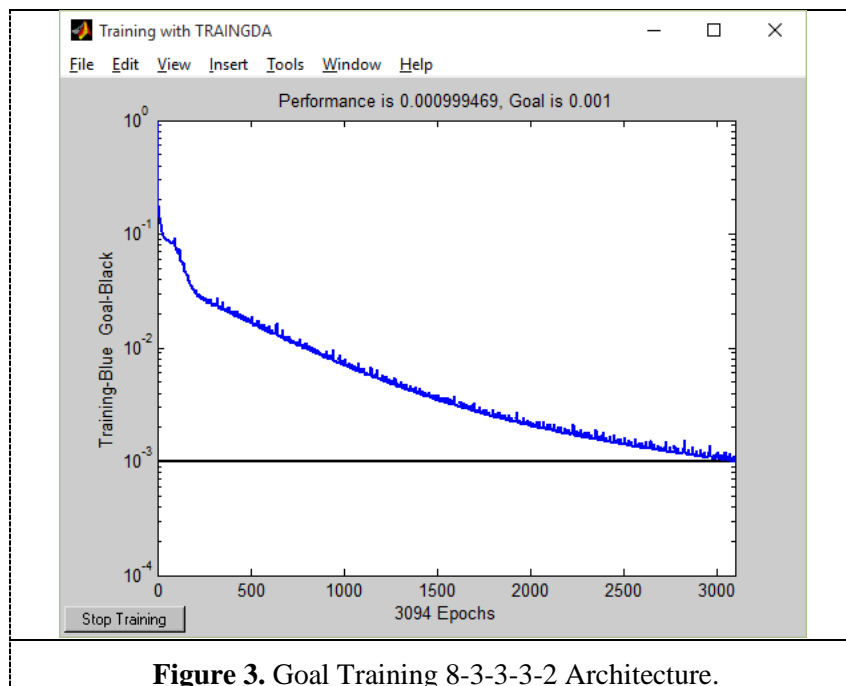


Figure 3. Goal Training 8-3-3-3-2 Architecture.

3.2. Testing Neural Network

After the training phase is done, then is continued with the testing phase by using the test data as many as 21 data assessments of the lecturer performance.

The test results of some architectural models of the artificial neural network can be seen in table 2.

Table 2. Test result

No	Target	ANN8-2-2		ANN8-3-3-3-2	
		Output		Output	
36	10	1.0094	-0.0090	1.0073	-0.0236
37	10	1.0083	-0.0295	1.0162	-0.0321
38	10	1.0014	-0.0304	1.0127	-0.0294
39	01	-0.0169	1.0164	0.3207	0.6741
40	01	0.0294	0.9685	-0.1012	1.1035
41	11	0.9997	0.9990	0.9997	1.0182
42	10	1.0031	0.6315	1.0136	-0.0283
43	11	0.9994	1.0248	1.0005	1.0062
44	10	1.0095	-0.0370	1.0145	-0.0302
45	10	1.0091	0.0376	1.0163	-0.0147
46	10	1.0003	0.9316	1.0169	-0.0098
47	11	0.9995	1.0190	1.0009	1.0222
48	10	1.0097	-0.0349	1.0126	-0.0271
49	10	1.0091	0.0356	1.0161	-0.0198
50	11	0.9993	1.0380	1.0008	1.023
51	11	1.0080	0.1437	1.0039	0.8787
52	11	1.0016	0.7995	1.0016	1.0087

53	11	1.0045	0.5032	1.0038	0.919
54	11	1.0016	0.7995	1.0016	1.0087
55	11	1.0030	0.6645	1.0024	0.9876
56	11	1.0071	0.2376	1.0055	0.9121
<i>Performance</i>		17/21 = 80.95%		21/21 = 100%	

In the table 2 can be seen that the results of the test with the 8-3-3-3-2 architectural pattern have the results corresponding to the test data, but the pattern of 8-2-2 has 4 results which do not match the test data.

4. Conclusion

Application of ANN backpropagation can be used well for the lecturer performance assessment, where the training data and test results can recognize all desired targets. The best artificial neural network architecture used in this case is using the 8-3-3-3-2 pattern with epoch value = 3094 during the training. In this 8-3-3-3-2 pattern, the weights and biases of index layer 1 and layer 2 are determined by using Nguyen Widrow's algorithm.

5. References

- [1] M. F. Syahputra *et al.*, "Hypertensive retinopathy identification through retinal fundus image using backpropagation neural network," *J. Phys. Conf. Ser.*, vol. 978, no. 1, 2018.
- [2] N. M. H.S, "ANN Model to Predict Coronary Heart Disease Based on Risk Factors," *Bonfring Int. J. Man Mach. Interface*, vol. 3, no. 2, pp. 13–18, 2013.
- [3] Q. K. Al-shayea and I. S. H. Bahia, "Urinary System Diseases Diagnosis Using Artificial Neural Networks," *Int. J. Comput. Sci. Netw. Secur.*, vol. 10, no. 7, pp. 118–122, 2010.
- [4] E. Vamsidhar, K. Varma, P. Rao, and R. Satapati, "Prediction of rainfall using backpropagation neural network model," *Int. J. Comput. Sci. Eng.*, vol. 2, no. 4, pp. 1119–1121, 2010.
- [5] M. Al Doori and B. Beyrouti, "Credit Scoring Model Based on Back Propagation Neural Network Using Various Activation and Error Function," *Ijcsns*, vol. 14, no. 3, pp. 16–24, 2014.
- [6] A. Bondarenko, L. Aleksejeva, V. Jumutc, and A. Borisov, "Classification Tree Extraction from Trained Artificial Neural Networks," *Procedia Comput. Sci.*, vol. 104, no. December 2016, pp. 556–563, 2016.
- [7] A. E. Minarno, Y. Munarko, A. Kurniawardhani, and F. Bimantoro, "Classification of Texture Using Multi Texton Histogram and Probabilistic Neural Network," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 105, no. 1, 2016.
- [8] S. KEHUL and M. S. A, "Image Classification Using Neural Network and SVD," *Int. J. Adv. Electron. Comput. Sci.*, no. 6, pp. 139–142, 2015.
- [9] Uca, E. Toriman, O. Jaafar, R. Maru, A. Arfan, and A. S. Ahmar, "Daily Suspended Sediment Discharge Prediction Using Multiple Linear Regression and Artificial Neural Network," *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.
- [10] O. ERDOGAN and A. GOKSU, "Forecasting Euro and Turkish Lira Exchange Rates with Artificial Neural Networks (ANN)," *Int. J. Acad. Res. Accounting, Financ. Manag. Sci.*, vol. 4, no. 4, pp. 307–316, 2014.

- [11] V. Lavanya and M. Parveentaj, "Foreign Currency Exchange Rate (FOREX) using Neural Network," *Int. J. Sci. Res.*, vol. 2, no. 10, pp. 174–177, 2013.
- [12] C. Bal and S. Demir, "Forecasting TRY/USD exchange rate with various artificial Neural Network Models," *TEM J.*, vol. 6, no. 1, pp. 11–16, 2017.
- [13] S. K. Chandar, M. Sumathi, and S. N. Sivanandam, "Forecasting of Foreign Currency Exchange Rate Using Neural Network," *Int. J. Eng. Technol.*, vol. 7, no. 1, pp. 99–108, 2015.
- [14] S. Yoshino, B. Thornton, T. Takahashi, Y. Takaya, and T. Nozaki, "Signal preprocessing of deep-sea laser-induced plasma spectra for identification of pelletized hydrothermal deposits using Artificial Neural Networks," *Spectrochim. Acta - Part B At. Spectrosc.*, vol. 145, pp. 1–7, 2018.
- [15] E. Fathalla, Y. Tanaka, and K. Maekawa, "Remaining fatigue life assessment of in-service road bridge decks based upon artificial neural networks," *Eng. Struct.*, vol. 171, no. February, pp. 602–616, 2018.
- [16] S. Aisyah, M. Harahap, A. Mahmud, H. Siregar, and M. Turnip, "Optimization of training backpropagation algorithm using nguyen widrow for angina ludwig diagnosis Optimization of training backpropagation algorithm using nguyen widrow for angina ludwig diagnosis," *J. Phys. Conf. Ser.*, 2018.
- [17] S. Staub, E. Karaman, S. Kaya, H. Karapınar, and E. Güven, "Artificial Neural Network and Agility," *Procedia - Soc. Behav. Sci.*, vol. 195, pp. 1477–1485, 2015.