
Application of Artificial Neural Networks to Predict Monthly Targets for Receiving Section at PT. Indako Trading Coy Using the Backpropagation Method

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ABSTRACT

PT. Indako Trading Coy is a company engaged in the sale of motorcycles and spare parts with 1000 employees who are given work targets every month. Through the targets given, it can be predicted whether employees can be rewarded or not. Prediction is an important tool in determining everything to be effective and efficient. So far, a lot of forecasting is done intuitively using statistical methods. The choice of the method depends on various influencing aspects, namely aspects of time, data patterns, type of system model being observed, level of forecast accuracy or desired prediction and so on. The forecasting method used is using an artificial neural network (ANN) with the Backpropagation method.

Keywords: *Artificial Neural Network, Backpropagation, Prediction.*

1. Introduction

Prediction is an important tool in determining everything so that it is effective and efficient. So far, many forecasts have been made conjecturally using statistical methods. The choice of the method depends on various influencing aspects, namely aspects of time, data patterns, type of system model being observed, level of forecast accuracy or desired prediction and so on. Therefore, a problem will arise if the observation or testing is carried out on a dynamic system that has a data pattern system with a constantly changing formulation, such as a computer sales prediction system. The forecasting method used is using an artificial neural network (ANN) with the Backpropagation method.

This study aims to describe the monthly target of the Receiving section at PT. Indako Trading Coy is based on the Backpropagation method on Artificial Neural Networks and describes the causes of not achieving the monthly target. This type of research is descriptive qualitative research. The subject of this research is the incoming goods data in the form of spare parts for Honda motorcycles. Data collection is done by testing, observation, and documentation. Data analysis is done by data reduction, data presentation, and drawing conclusions.

Efforts that can be made to achieve the monthly target are in the form of calculating container unloading time, calculating the time for inputting incoming goods data, calculating container waiting times, and applying appropriate correction techniques.

2. Methodology

2.1 Initialization of Initial Weight and Bias

Weight is one of the important factors so that the network can generalize well to the data that is trained into it. The selection of initial weights determines whether the network reaches the global minimum or only the local minimum and how fast the network converges. The updating between two neurons depends on the two derivatives of the activation function used in the neurons in the layer above it and also the activation function for the neurons in the lower layer. The value for initialization of initial weights should not be too large, or the signal for each hidden or output neuron will most likely be in the region where the derivative of the sigmoid function has a very small value. In other words, if the initialization weight is too small.

2.2. Feed Forward

Feed-forward, sometimes written forward, is an element or pathway in a control system that passes a controller signal from a source in the external environment to a load elsewhere in the external environment. This is often a command signal from an external operator.

2.3. Backpropagation Error

Backpropagation Algorithm or Backpropagation is an algorithm to carry out a directed learning process on an artificial neural network to find the load on each neuron that produces a minimum error value through the given learning data.

2.4. Update Weights and Bias

Updating all weights and biases during Backpropagation, we do the above process for all weights and biases. But don't be afraid, because we already have the derivative formula, we can immediately see the formula pattern. If we calculate the error, there will be a change in the value from before Backpropagation was done.

2.5. Criteria Fulfilled

To determine the criteria for the best artificial neural network model to be used in predicting, this study takes the criteria that the best architecture is the one with the smallest average error value.

2.6. Prediction Results

The lowest average error value that can be generated by the system after testing the number of iterations as the last test is 0.00205284 while the highest average error value is 0.01778293. It can be concluded that the system is good enough in making predictions based on the resulting error value.

3. Results and Discussion

3.1. Calculation of the Backpropagation Method Training Manual

Initialization of initial weight, number of epochs, learning rate, number of hidden layer neurons. The calculation is carried out using the 1st training data with a stop condition based on the specified number of epochs. *Epoch* = 1000 Learning Rate = 0.9



Table 1.

Employee performance index for May, week I of 2020

Group	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Employee I	0.224602	0.227065	0.348039	0.22327	0.219484	0.30908

Table 2.

Employee performance index for May, week II of 2020

Group	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Employee II	05.55	06.02	05.54	05.51	05.47	06.32

Table 3.

Employee performance index for May, week III of 2020

Group	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Employee III	0.234892	0.232497	0.2363	0.223373	0.345594	0.249209

Table 4.

Input Data Used

Year	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
first week	0.224602	0.227065	0.348039	0.22327	0.219484	0.30908
second week	05.55	06.02	05.54	05.51	05.47	06.32
3rd week	0.234892	0.232497	0.2363	0.223373	0.345594	0.249209

3.2. Normalization Process

In backpropagation, the activation function used must meet several conditions, namely: continuous, easily differentiable and a non-degrading function. One of the functions that meet these three conditions, so that it is often used is the binary sigmoid function which has a range (0, 1) and bipolar which has a range (-1.1). The binary sigmoid activation function is almost the same as the bipolar sigmoid function, because it is often used by researchers in the prediction (forecasting) process, but the sigmoid bipolar function is only suitable for prediction (forecasting) that uses data that is not volatile (stable) and uses a range between -1 to 1 .

$$x^1 = \frac{0.9(x - a)}{b - a} + 0,1$$

Information :

- x' : Transformed data
- x : Data to be normalized
- a : Minimum data
- b : Your maximum datam

3.3. Data Processing (Normalization)

Table 5.

Initial Data for Week I – Week III Training Using Rotation

Data	Input Data						Target
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Pattern 1	0.224602	0.227065	0.348039	0.22327	0.219484	0.30908	05.50
Pattern 2	0.227065	0.348039	0.22327	0.219484	0.30908	05.50	06.02

Pattern 3	0.348039	0.22327	0.219484	0.30908	05.50	06.02	05.54
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Explanation :

The Training Data Week I – week III is carried out using rotary rotation, meaning that each dataset has the same right to achieve the target. The data value in pattern 1 is taken from the IPP target in week I. While the Target value is taken from the IPP target for Week II in July 2020. The data value in pattern 2 is taken from the IPP target week I to week II in July 2020. The target value in pattern 2 is taken from the IPP target week II in July 2020. The data value in pattern 3 is taken from the IPP target Sunday I 2020 July 2020. The target value in pattern 3 is taken from the IPP target for the second week of July 2020. And so on until all values have been rotated. The maximum value (b) from the dataset is 06.02 while the minimum value (a) is 0.348039. By using the binary sigmoid function, the normalized data will be obtained as follows:

$$x' = \frac{0,9(0,224602 - 0,348039)}{06,02 - 0,348039} + 0,1$$

Then the results of the Normalization pattern 1 will be obtained for Week I 0.080414 . And so on for all data, normalized using the same function.

Table 5.
 Results of Normalization of Training Data Week I – Week III

Data	Input						Target
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
Pattern 1	0.080414	0.080804	0.1	0.080195	0.079601	0.093818	0.917489
Pattern 2	0.080804	0.1	0.080195	0.079601	0.093818	0.917489	1
Pattern 3	0.1	0.080202	0.079601	0.093818	0.917489	1	0.923836

Explanation :

The dataset values in table 5. are the results of normalization based on table 4. using the binary sigmoid function.

Table 6.
 Initial Data for Testing Weekly Attendance I to Week III Using Rotation

Data	Input						Target
	July	August	September	October	November	December	
Pattern 4	0.22327	0.219484	0.30908	05.50	06.02	05.54	05.51
Pattern 5	0.219484	0.30908	05.50	06.02	05.54	05.51	05.47
Pattern 6	0.30908	05.50	06.02	05.54	05.51	05.47	06.32

Explanation :

The test data for week I-week III is carried out using rotary rotation, meaning that each dataset has the same right to achieve the target. The data values in pattern 4 are taken from the 2020 target IPP. While the Target value is taken from the July 2020 target IPP. The data values in pattern 5 is taken from the IPP target for 2020 in July,



Sunday I and Week II and the dataset for July 2020. The target value in pattern 2 is taken from the IPP target for week II in July 2020. The data value in pattern 6 is taken from the target IPP for the second week of 2020 in July, the third week of 2020. The target value in pattern 3 is taken from the IPP for the sector in July 2020. And so on until all values have been rotated. The maximum value (b) of the dataset is 06.32. While the minimum value (a) is 0.30908. By using the binary sigmoid function, the normalized data will be

obtained as follows:

$$x' = \frac{0,9(0,22327 - 0,30908)}{06,32 - 0,30908} + 0,1$$

Then the results of normalization pattern 7 will be obtained for the month of July 0.34597. And so on for all data, normalized using the same function.

Table 7.
 2020 Test Data Normalization Results

Data	Input						Target
	Monday	Tuesday	Wednesdy	Thursday	Friday	Saturday	
Pattern 4	0.087152	0.086585	0	21.03	0.955082	0.883213	0.878721
Pattern 5	0.086585	0	21.03	0.955082	0.883213	0.878721	0.872732
Pattern 6	0	21.03	0.9550	0.883213	0.878721	0.872732	1

Explanation :

The dataset values in table 7 are the results of normalization based on table 6 using the binary sigmoid function.

Step 0

Initialize all weights with a small random number.

Table 8.
 Weight From Input Screen To Hidden Screen = V_{ji}

	Z1	Z2	Z3
X1	0.2	0.3	0.1
X2	-0.4	-0.2	0.3
X3	0.5	0.1	-0.3
B	-0.2	0.5	-0.4

Table 9.
 Weight From Input Screen To Hidden Screen = W_{kj}

	Y
Z1	0.5
Z2	0.2
Z3	0.3
B1	0.4

Step 1

If the termination condition is not met, perform steps 2 to 9

Step 2

For each pair of training data, do steps 3 to 8, Phase I: Forward Propagation

Step 3

Each input unit receives the signal and forwards it to the hidden unit

Step 4

Count all outputs in hidden units Z_j ($j = 1, 2, \dots, p$):

$$Z_{netj} = V_{j0} + \sum_{i=1}^p X_i V_{ji}$$

$$\begin{aligned} Z_{net1} &= V_{10} + \sum_{j=1}^2 X_i V_{ji} = V_{10} + X_1 V_{11} + X_2 V_{12} \dots X_i V_{ji} \\ &= -0.2 + (0.2 * 0.2) + (0.5 * -0.4) + (-0.4 * 0.5) \\ &= -0.56 \end{aligned}$$

$$\begin{aligned} Z_{net2} &= V_{10} + \sum_{j=1}^2 X_i V_{ji} = V_{10} + X_1 V_{21} + X_2 V_{22} \dots X_i V_{ji} \\ &= 0.5 + (0.2 * 0.3) + (0.5 * -0.2) + (-0.3 * -0.1) \\ &= 0.49 \end{aligned}$$

$$\begin{aligned} Z_{net3} &= V_{10} + \sum_{j=1}^2 X_i V_{ji} = V_{10} + X_1 V_{31} + X_2 V_{32} \dots X_i V_{ji} \\ &= -0.4 + (0.2 * 0.1) + (0.5 * 0.3) + (-0.3 * 0.4) \\ &= -0.35 \end{aligned}$$

Activation :

$$Z_j = \frac{1}{1 + e^{-z_{inj}}}$$

$$Z1 = \frac{1}{1 + e^{-0.56}} = 0.636453$$

$$Z2 = \frac{1}{1 + e^{-z_{in2}}}$$

$$Z2 = \frac{1}{1 + e^{0.49}} = 0.379894$$

$$Z3 = \frac{1}{1 + e^{-z_{in3}}}$$

$$Z3 = \frac{1}{1 + e^{-0.35}} = 0.586618$$

Step 5

Count all networks in output units (Y_k)

$$Y_{netk} = W_{k0} + \sum_{j=1}^p Z_j W_{kj}$$

$$Y_{net1} = W_{10} + \sum_{j=1}^p Z_j W_{kj} = W_{10} + Z_1 W_{11} + Z_2 W_{12} + Z_3 W_{13} \dots Z_j W_{kj}$$



$$= 0,4 + (0.636453 * 0.5) + (0.379894 * 0,2) + (0.586618 * 0,3) = 0.970190257$$

$$Y_k = f(Y_{netk}) = \frac{1}{1 + e^{-Y_{netk}}} = \frac{1}{1 + e^{-0.970190257}} = 0.274843$$

Phase II : Backward Propagation

Step 6

$$k = (t_k - Y_k) f'(Y_{netk}) = (t_k - Y_k) Y_k(1 - Y_k) = (0 - 0.970190257) * 0.970190257 * (1 - 0.970190257) = -0.02806$$

k is the unit of error that will be used in changing the weight of the layer below it (step 7).

Weight change rate W_{kj} (with $\alpha = 0.9$)

$$W_{kj} = \delta_k z_j$$

$$W_{10} = \delta_0(1) = 0.9 * (-0.02806) * (1) = -0.02525$$

$$W_{11} = \delta_1(z_1) = 0.9 * (-0.02806) * (0.636453) = -0.01607$$

$$W_{12} = \delta_2(z_2) = 0.9 * (-0.02806) * (0.379894) = -0.0128$$

$$W_{13} = \delta_3(z_3) = 0.9 * (-0.02806) * (0.586618) = -0.0128$$

Step 7

Calculate the sum of the errors of hidden units ($= \delta$)

$$\delta_{netj} = \sum_{k=1}^m \delta_k W_{kj}$$

Since the network has only one output unit, $netj = W_{ij}$

$$net1 = k.W_{11} = (-0.02806) * (-0.01) = 0.000281$$

$$net2 = k.W_{12} = (-0.02806) * (-0.02) = 0.000561$$

$$net3 = k.W_{13} = (-0.02806) * (-0.01) = 0.000281$$

Error factor in hidden unit : δ

$$\delta_j = \delta_{netj} f'(Z_{netj}) = \delta_{netj} Z_j(1 - Z_j)$$

$$\delta_1 = \delta_{net1} Z_1(1 - Z_1) = 0.000281 * (0.636453) * (1 - (0.636453)) = 0.000126$$

$$\delta_2 = \delta_{net2} Z_2(1 - Z_2) = 0.000561 * (0.379894) * (1 - (0.379894)) = 0.0003$$

$$\delta_3 = \delta_{net3} Z_3(1 - Z_3) = 0.000281 * (0.586618) * (1 - (0.586618)) = 0.00013$$

Weight change rate to hidden unit : $\Delta V_{ji} = \alpha \delta_j x_i$

Table 10.
 Weight Change Tribe To Hidden Unit

	Z1	Z2	Z3
X1	0.0	0.0	0.0
X2	0.0	0.0	0.0
X3	0.0	0.0	0.0
B1	0.0	0.0	0.0

Phase III: Weight Change

Step 8

Calculate all weight changes. Output unit weight change:

$$W_{kj}(\text{new}) = W_{kj}(\text{old}) + W_{kj}$$

Table 11.

Output Unit Weight Change			
	Y	W _{kj} (old)	W _{kj} (new)
Z1	0.5	-0.01	0.49
Z2	0.2	-0.02	0.22
Z3	0.3	-0.01	0.31
B1	0.3	-0.03	0.33

Weight change of hidden unit : $V_{ji}(\text{new}) = V_{ji}(\text{old}) + V_{ji}$

Table 12.

Hidden Weight Change						
	Z1	Z2	Z3	Z4	Z5	Z6
X1	0.2	0.3	0.1	0.5	-0.3	-0.1
X2	-0.4	-0.2	0.3	0.3	-0.4	0.6
X3	0.5	0.1	-0.3	-0.4	-0.1	0.3
B1	-0.2	0.5	-0.4	0.6	0.2	0.5

3.4. Network Training

In this step, the learning rate of network work will be observed with the parameters of the level of accuracy, learning time, MSE during the training process and the length of iteration time (Epoch). The main objective of this step is to obtain the optimal level of accuracy of the learning rate. By using the best network architecture in training, the learning rate will be observed on network performance. The architecture used for training is 3 patterns. These 3 architectural patterns use a learning rate of 0.1, a target error (goal) of 0.01 and a maximum epoch of 1000 iterations. produces the lowest error using traingd.

In training architecture 1, using an input layer of 6 neurons, a hidden layer of 3 neurons and an output layer of 1 neuron. In training 1 this resulted in training with epochs of 5308 iterations, time of 00.32, MSE of 0.009999 and an accuracy rate of 58%. 2 uses an input layer of 3 neurons, a hidden layer of 6 neurons and an output layer of 1 neuron. In training 2 this results in training with 821 iterations of epoch, 00.05 time, 0.009982 MSE and an accuracy rate of 67%. input as many as 6 neurons, hidden layer as much as 6 neurons and output layer 1 neuron. In training 3 this resulted in training with epochs of 4999 iterations, time 00.31, MSE 0.009996 and an accuracy rate of 67%. In training architecture 4 uses an input layer of 6 neurons, a hidden layer of 33 neurons and an output layer of 1 neuron. In training 4 this results in training with epochs of 961 iterations, time 00.06, MSE 0.009975 and an accuracy rate of 67%. 5 using an input layer of 6 neurons, a hidden layer of 34 neurons and an output layer of 1 neuron. In training 5 this resulted in training with epochs of 1491 iterations, time 00.09, MSE 0.009996 and an accuracy rate of 67%. hidden layer as many as 34 neurons and output layer 1 neuron. In training 5 this resulted in training with epochs of 1491 iterations, time 00.09, MSE 0.009996 and an accuracy rate of 67%. hidden layer as many as 34 neurons and output layer 1 neuron. In training 5 this resulted in training with epochs of 1491 iterations, time 00.09, MSE 0.009996 and an accuracy rate of 67%.



3.5. Testing Process (Testing)

Networks that have been trained and achieve the desired results need to be tested to determine their ability when studying the training data provided. Testing can be done using data sets that have been trained to see the performance of the application system that has been made by looking at the minimum error value. In addition, testing can also be carried out using data sets that have not been trained before to see the level of accuracy of the system that has been made. MSE in the first training test is 0.022873. MSE in the second training test is 0.0142803. MSE on the 3rd training test is 0.020554. MSE on training test 4 is 0.036615 and MSE on training test 5 is 0.017577

4. Conclusion

Application of Artificial Neural Networks on target prediction at PT. Indako Trading Coy Medan using the Backpropagation Algorithm can provide a level of accuracy that suits the data needs. The results of the decisions provided by the system in the form of reports that are easily obtained. This ANN application is just a tool that relies heavily on data inputted by a programmer so that this Artificial Neural Network application must always be developed.

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