Implementation of Product Sales Forecast Using Artificial Neural Network Method

Cholid Fauzi¹, Aly Dzulfikar²

¹ Politeknik Negeri Bandung

² Universitas Nurtanio

¹ cholid.fauzi@polban.ac.id*; ² dzulfikar@gmail.opm

Abstract

Product sales forecasting is used by companies to estimate or predict future sales levels using sales data in the previous year. The Artificial Neural Network Backpropagation Algorithm can forecast the sales of goods for the next period for each item in the company. The forecasting process begins by determining the variables needed in the network pattern, and then the established network pattern continued in the network training process using the backpropagation algorithm. After carrying out the network training process, the researcher comparisons with several network patterns formed. This research was conducted to discuss the forecasting analysis of PT XYZ products on spiral and leaf springs. Forecasting carried out on Toyota 48210-25290 R3 type leaf springs using the Artificial Neural Network Backpropagation method with a learning rate weight value of 0.1 hidden layers four and an error of 0.01. From the data processing analysis that has been carried out based on the weight parameters selected, the prediction of sales in April.

Keywords: Sales Forecasting, Artificial Neural Network, Prediction, Backpropagation

1. Introduction

PT. XYZ is a manufacturer of car springs equipment that sells both retail and wholesale. PT. XYZ itself more or less has about 50 products per. PT. XYZ markets its products to distributors spread across several regions in Indonesia. These distributors serve customers directly, so the existence of these distributors has a significant role in determining future business strategies. Based on the results of interviews with PT. XYZ that the product distribution process was carried out after the distributor asked PT. XYZ. Then the product will be distributed to distributors depending on the inventory in the warehouse. Product distribution to distributors depends on product inventory in the warehouse, so PT XYZ needs to predict sales of goods in the following month. Prediction is an essential part of every business company in making management decisions. Prediction is the process of using past data from a variable or set of variables to estimate future values. Product sales prediction is used by companies to estimate or predict sales by using sales data in the previous year. Various prediction models have progressed quite rapidly, one of which is an Artificial neural network used by researchers and recognizes historical data patterns, which can predict a problem. The application of artificial neural networks in the field of forecasting and prediction has been in almost all scientific studies in recent years because it has better accuracy than statistical and mathematical models besides that Artificial Neural Networks have flexibility, both in design and use [1]. Based on the description above, this writer focuses on the naive Bayes classifier method, which is implemented to predict product sales of PT. XYZ. This study uses an artificial neural network with the backpropagation method because of its simplicity and good performance. The backpropagation algorithm has a way of working by adjusting the interconnected weights between neurons to achieve a minimum error between the predicted output and the actual output [2]. This artificial neural network backpropagation

has other advantages than other ANN methods, namely ANN backpropagation using supervised learning, where the expected output is known [3]. This backpropagation artificial neural network can be used to solve problems in various areas and fields.

2. Research Methodology

This research approach to the stages in the ANN and is combined with software development. The following steps :

- a. Business Process Analysis
At this stage, the data used is obtained from data on the number of sales of PT. XYZ products.
- b. Literature Study
Literature study is the first step in this research, and this literature study was conducted to complete the basic knowledge and theories used in this research. The literature study used comes from books, journals, and seminars
- c. Identifying Problems
At this problem identification stage, it is carried out after all the data is met, and then the appropriate dataset is obtained to be processed at the conversion stage of the data obtained following the specified weight.
- d. Preprocessing
The steps taken are to make changes to several data types in the dataset attributes to make it easier to understand the record contents and make selections by paying attention to data consistency.
- e. Determining Pattern
The results of this stage are several artificial neural network models with the Backpropagation method to determine patterns.
- f. Testing the Results of Data Processing
After the pattern determination process is complete, a trial phase is carried out on data processing results using Matlab R2011b Software and exported to CSV.
- g. Predicting
Prediction is made to compare the number with the most accurate Backpropagation algorithm model.
- h. Final Evaluation
The final evaluation is done to determine whether the testing of data processing results is as expected.

The method used is the ANN backpropagation method. The stage is to enter product sales data at PT XYZ before, then the data that has been entered is processed so that later it can display product sales predictions at PT XYZ in the future. In the software to predict product sales at PT XYZ that will be built, there are two user roles: Administrator and Owner.

Here's the process of how the software works for Administrators:

1. Administrators are asked to input data on product sales of PT. XYZ in previous years in excel format.
2. After the input process is complete, the application process the inputted excel data, and then the data is stored in the database.
3. The Administrator then moves to the sales prediction menu, and the Administrator fills in the parameters needed so that the data can be trained
4. Then click the Perform Training button to start training the data and get the best prediction calculation weights.
5. After finding the best weight value, the Administrator enters the Sales Prediction Results menu, clicks the calculate prediction button to calculate the predicted sales results for PT. XYZ in the future

6. After the counting process is complete, the results of the prediction of product sales at PT. XYZ in the future.

Figure 1. Research Methodology

Then Process how the software works for the owner:

1. Owners are asked to input data on product sales of PT. XYZ in previous years already in excel format.
2. After the input process is complete, the application process the inputted excel data, and then the data is stored in the database.
3. The owner selects the Sales Prediction Results menu, clicks the calculate prediction button to calculate the predicted sales results for PT. XYZ in the future.
4. After the counting process is complete, it displayed the prediction results of product sales of PT. XYZ in the future.

So that it is functional in the application, described in the table below

Table 1. Functional Requirement

No	Functional Requirement	Description
KF01	Login	Owners and users use it to use the features in the sales prediction application by entering the specified username and password data.
KF02	Data Import	Owners and administrators use it to initiate data for training data and test data before normalizing the data first and then saving it to the database.

No	Functional Requirement	Description
KF03	Data Training	Administrators use them to conduct training with training data taken from the database to get the best weight with predetermined parameters, namely learning rate, max epoch, hidden layer, and target error.
KF04	Data Testing	Administrators perform tests with test data taken from the database and calculate the prediction results' accuracy value.
KF05	Prediction Output	Owners and administrators used them to see the predicted results of future sales.

3. Result and Discussion

Use Case Diagram is a textual and graphic description of how the system or software functions from the user's point of view.[25] In this use, the case will be known what functions are in the system created. An Entity-Relationship (ER) Diagram used to illustrate how "entities" such as people, objects, or concepts relate to each other within a system of prediction of sales

Figure 2. Use Case Diagram of Forecast Sales PT XYZ

Figure 3. Entity Relationship Diagram of Forecast Sales PT XYZ

The implementation of functional requirements is made on one page called the prediction page. On this page, there are sub-pages of data import, sales prediction, and sales prediction results. A document select menu on the data import page where previous sales data in .xls format can be entered and saved into the database. On the sales

prediction page, two tables will be formed. The first table is the previous sales data that has not been normalized, and the second table is the normalized sales data. Prediction steps, the data training parameters must be filled in first with an explanation of the parameters, namely the learning rate is a parameter to calculate the weight correction value when the training process is filled with a number range from 0.1 to 1. The hidden layer is a hidden layer between the input and output layers. This serves to assist the data training process, the more hidden layers used, the better the output obtained, but the data training time will be longer. Max Epoch is the maximum number of epochs carried out in a data training (1 epoch is a series of Artificial Neural Network learning). Target Error is the error value determined in one data training where the smaller the error value, the longer the data training process is carried out. Then if the button does the training is clicked, then the data training process carried out. The length of the data training process depends on the specifications of the hardware used. After the data training is completed, the parameters stored in the parameter select menu. To make a prediction, select the parameters made previously, select ok and select the calculate prediction button. The prediction results displayed on the sales prediction results page. The image in UI-01 consists of three images. Figure UI-01a is an implementation of the data import interface design.

Figure 4. Data Import Page [UI-01a]

Figure UI-01b is an implementation of the sales prediction interface design. The graphic shows how data from CSV are import to the application.

Figure 5. Sales Prediction Interface [UI-01b]

The UI-01c image is an implementation of the sales prediction result interface. The graphic shows how to process the prediction based on data imported. In this feature, first step data trained is used to create a prediction. Results show the figure below.

Figure 6. Sales Prediction Result Page [UI-01c]

After the prediction result came out, two tests were carried out: testing the backpropagation algorithm and testing the software function. A trial process was carried out in testing this method to apply PT XYZ product sales prediction using the Artificial Neural Network backpropagation method. The trial was conducted to determine the accuracy of the application made in providing predictions on the sales of PT XYZ products in the following month. In this Artificial Neural Network backpropagation method, to predict PT XYZ products in the following month, the first step is to determine the number of input layers, the number of hidden layers, and the number of output layers. The number of input layers is 2, which represents each variable from the selling price of the product and the number of goods sold, then the hidden layer itself determined after experiments with 3, 4, and 5 layers, for the output layer, there is 1 which represents the total sales variable.

Table 2. Initiation Input Layer

No	Total Variable Sales	Initiation Layer Input
1	Selling Price	X1
2	Quantity (number)	X2

The following steps determine the training data that used in the program as it is known that Artificial Neural Network backpropagation trains the network to get a balance between the network's ability to recognize the patterns used during training and the network's ability to respond correctly to input patterns that are similar (not the same) to the patterns used during training. For this reason, training data is needed that is used in the program to study patterns. The sales training data is as follows:

Table 3. Data Training

No	Month	X ₁	X ₂	Target
1	Agustus 2017	Rp 190.000	564	Rp 107.160.000
2	September 2017	Rp 190.000	552	Rp 104.880.000
3	Oktober 2017	Rp 195.000	603	Rp 117.585.000
4	November 2017	Rp 195.000	644	Rp 125.580.000
5	Desember 2017	Rp 195.000	612	Rp 119.340.000
6	Januari 2018	Rp 200.000	533	Rp 106.600.000
7	Februari 2018	Rp 200.000	592	Rp 118.400.000
8	Maret 2018	Rp 205.000	599	Rp 122.795.000
9	April 2018	Rp 205.000	625	Rp 128.125.000
10	Mei 2018	Rp 205.000	586	Rp 120.130.000
11	Juni 2018	Rp 210.000	611	Rp 128.310.000
12	Juli 2018	Rp 210.000	630	Rp 132.300.000

No	Month	X_1	X_2	Target
13	Agustus 2018	Rp 210.000	597	Rp 125.370.000
14	September 2018	Rp 210.000	618	Rp 129.780.000
15	Oktober 2018	Rp 220.000	621	Rp 136.620.000
16	November 2018	Rp 220.000	598	Rp 131.560.000

After that, determine the test data used in the Artificial Neural Network backpropagation method to predict the sales of PT XYZ products for the next month.

Table 4. Data Testing per Month

No	Month	X_1	X_2	Target
1	Desember 2018	Rp 220.000	580	Rp 127.600.000
2	Januari 2019	Rp 220.000	576	Rp 126.720.000
3	Februari 2019	Rp 225.000	590	Rp 132.750.000
4	Maret 2019	Rp 225.000	603	Rp 135.675.000

Furthermore, the determination of the appropriate initial weights, learning rates, and hidden layers for applying Artificial Neural Network with the backpropagation method predict PT XYZ products' sales per month. Therefore, a test case was made to determine the number of epochs passed and the actual error results. In making one able io test case, the initial weight determination is done by randomizing the numbers between 0.1 to 0.9. Experiments were carried out by changing the learning rate from 0.1, 0.3, 0.5, 0.7, and the maximum number of epochs achieved by the program. Each learning rate has experimented with 3, 4, and 5 hidden layers. The results of the able io test case can be seen in table five.

Table 5. Test Case Scenario

Learning Rate	Hidden Layer	Total Epoch	Maksimal Epoch	Target Error
0.1	3	1000	1000	0.001
	4	400	1000	0.001
	5	893	1000	0.001
0.3	3	350	1000	0.001
	4	354	1000	0.001
	5	204	1000	0.001
0.5	3	237	1000	0.001
	4	110	1000	0.001
	5	150	1000	0.001
0.7	3	140	1000	0.001
	4	97	1000	0.001
	5	77	1000	0.001

From table 5, it can be seen that, for a learning rate with a value above 0.5, the number of epochs passed to reach or approach the target error is decreasing, and for a learning rate below 0.5, the number of epochs passed to reach the target error is increasing. Next, the data in table four were tested with the results from the test case table in table five. The results of data testing can be seen in table sixth below.

Table 6. The results of data testing

Learning Rate	Hidden Layer	Bulan Penjualan	Target Aktual	Target Prediksi	Error
0.1	3	Desember 2018	127.600.000	110.013.255	17.586.745
		Januari 2019	126.720.000	109.518.008	17.201.992
		Februari 2019	132.750.000	109.398.465	23.351.535

Learning Rate	Hidden Layer	Bulan Penjualan	Target Aktual	Target Prediksi	Error
	4	Maret 2019	135.675.000	110.218.185	25.456.815
		Desember 2018	127.600.000	129.122.978	-1.522.978
		Januari 2019	126.720.000	128.832.660	-2.112.660
		Februari 2019	132.750.000	128.764.350	3.985.650
		Maret 2019	135.675.000	129.242.520	6.432.480
	5	Desember 2018	127.600.000	132.436.013	-4.836.013
		Januari 2019	126.720.000	132.162.773	-5.442.773
		Februari 2019	132.750.000	132.094.463	655.537
		Maret 2019	135.675.000	132.640.943	3.034.057
0.3	3	Desember 2018	127.600.000	128.303.258	-703.258
		Januari 2019	126.720.000	128.217.870	-1.497.870
		Februari 2019	132.750.000	128.200.793	4.549.207
		Maret 2019	135.675.000	128.644.808	7.030.192
	4	Desember 2018	127.600.000	121.557.645	6.042.355
		Januari 2019	126.720.000	121.164.863	5.555.137
		Februari 2019	132.750.000	121.079.475	11.670.525
		Maret 2019	135.675.000	121.694.265	13.980.735
	5	Desember 2018	127.600.000	143.895.015	-16.295.015
0.3	5	Januari 2019	126.720.000	143.485.155	-16.765.155
		Februari 2019	132.750.000	143.399.768	-10.649.768
		Maret 2019	135.675.000	143.963.325	-8.288.325
0.5	3	Desember 2018	127.600.000	112.301.640	15.298.360
		Januari 2019	126.720.000	112.165.020	14.554.980
		Februari 2019	132.750.000	112.130.865	20.619.135
		Maret 2019	135.675.000	112.404.105	23.270.895
	4	Desember 2018	127.600.000	145.090.440	-17.490.440
		Januari 2019	126.720.000	144.765.968	-18.045.968
		Februari 2019	132.750.000	144.697.658	-11.947.658
		Maret 2019	135.675.000	145.158.750	-9.483.750
	5	Desember 2018	127.600.000	145.346.603	-17.746.603
		Januari 2019	126.720.000	144.987.975	-18.267.975
		Februari 2019	132.750.000	144.902.588	-12.152.588
		Maret 2019	135.675.000	145.397.835	-9.722.835
0.7	3	Desember 2018	127.600.000	119.849.895	7.750.105
		Januari 2019	126.720.000	119.405.880	7.314.120
		Februari 2019	132.750.000	119.303.415	13.446.585
		Maret 2019	135.675.000	120.242.678	15.432.322
	4	Desember 2018	127.600.000	146.815.268	-19.215.268
		Januari 2019	126.720.000	146.627.415	-19.907.415
		Februari 2019	132.750.000	146.576.183	-13.826.183
		Maret 2019	135.675.000	146.917.733	-11.242.733
	5	Desember 2018	127.600.000	137.405.565	-9.805.565
		Januari 2019	126.720.000	136.995.705	-10.275.705
		Februari 2019	132.750.000	136.910.318	-4.160.318
		Maret 2019	135.675.000	137.405.565	-1.730.565

From table sixth, it can be seen that the prediction target that is almost close to the actual target is in the test case scenario with a learning rate of 0.1 and hidden layer 4. So from table five, it is determined that for testing the prediction of PT XYZ product sales with a learning rate of 0.1 and hidden layer 4. The results of the prediction calculations as follows:

Table 7. Prediction Results from Selected Test Cases

Month	Total Sales	Total Sales Prediction	Accuration (%)	Error
Agustus 2017	Rp107.160.000		0	-
September 2017	Rp104.880.000	Rp126.697.973	80,2	-Rp21.817.973
Oktober 2017	Rp117.585.000	Rp126.424.733	92,48	-Rp8.839.733
November 2017	Rp125.580.000	Rp127.825.088	98,21	-Rp2.245.088

Month	Total Sales	Total Sales Prediction	Accuracian (%)	Error
Desember 2017	Rp119.340.000	Rp128.559.420	92,27	-Rp9.219.420
Januari 2018	Rp106.600.000	Rp127.978.785	79,94	-Rp21.378.786
Februari 2018	Rp118.400.000	Rp126.697.973	92,99	-Rp8.297.973
Maret 2018	Rp122.795.000	Rp127.910.475	95,83	-Rp5.115.475
April 2018	Rp128.125.000	Rp128.337.413	99,83	-Rp212.413
Mei 2018	Rp120.130.000	Rp128.781.428	92,8	-Rp8.651.428
Juni 2018	Rp128.310.000	Rp128.098.328	99,84	Rp211.672
Juli 2018	Rp132.300.000	Rp128.815.583	97,37	Rp3.484.417
Agustus 2018	Rp125.370.000	Rp129.122.978	97,01	-Rp3.752.978
September 2018	Rp129.780.000	Rp128.576.498	99,07	Rp1.203.502
Oktober 2018	Rp136.620.000	Rp128.935.125	94,38	Rp7.684.875
November 2018	Rp131.560.000	Rp129.481.605	98,42	Rp2.078.395
Desember 2018	Rp127.600.000	Rp129.122.978	98,81	-Rp1.522.978
Januari 2019	Rp126.720.000	Rp128.832.660	98,33	-Rp2.112.661
Februari 2019	Rp132.750.000	Rp128.764.350	97	Rp3.985.650
Maret 2019	Rp135.675.000	Rp129.242.520	95,26	Rp6.432.480
April 2019		Rp129.447.450	-	-

Table seven shows that the average accuracy of the prediction application for PT XYZ product sales is 97%, with MAPE = 3.35%.

Figure 7. Total Sales Comparison with Predicted Total Sales

Testing on the software functions built in this study used the black box testing method. This method focuses on the functionality of the application to be built. Testing is done based on the use case that has been made. Based on the results of implementation and testing in this study, it can be concluded that the implementation of PT XYZ product sales forecasting using Artificial Neural Network was successfully implemented with an average forecasting accuracy of 97%. Based on the discussion that has been described in the previous chapter, suggestions that can be given for the development of sales predictions for PT XYZ products are as follows:

- They applied methods to initiate initial weights, not to use random numbers such as the Genetic Algorithm or the Nguyen method.
- Add attributes for product sales data such as stock, damaged goods, and returned goods.

- c) They are using other methods to make sales predictions, such as Linear Regression.

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