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Implementation of Predicting the Availability of Chicken Eggs on Christmas Day Using Artificial Neural Network Backpropagation

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Abstract

Prediction can be called a science that is used to predict events that are likely to occur in the future based on past events. One of the other prediction methods in circulation is Backpropagation Neural Network. Backpropagation Neural Network (BPNN) is a Neural Network (NN) that is forward in nature and does not have a loop through which signals flow from input neurons to output neurons. This research aims to determine a prediction of egg supply in 2023, especially during Christmas in Manokwari district to meet market and customer needs. By analyzing the availability of egg supplies in the city of Manokwari from January 2018 to December 2022. From the methods used in this research, starting from data collection methods as well as variables and research stages which include the data collection process, data sharing, then training and data testing and validation crosswise, the prediction pattern for the number of egg stocks is 12-16-1, where there are 12 variables in the input layer, then 16 variables in the hidden layer, 1 variable in the output layer, the learning rate value is 0.9 and the value the momentum is 0.1, resulting in a prediction of egg stock in 2023, especially in December, of 131053 eggs. With a MAPE value of 27.4767%. with the results of a feasible prediction model value. With the predicted results, the number of egg stocks in 2023, especially in December (during Christmas celebrations) in Manokwari Regency is 131,053 eggs during December 2023.

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A. Introduction

Due to the country's rapid population growth, basic necessities are currently in high demand in Indonesia, particularly during religious holidays when the country's food supply can occasionally reach extremely high levels. Costs and people's demands for basic necessities are significantly influenced by the availability of these goods. Religious holidays are often marked by extreme scarcity, including the supply of chicken eggs. It can be very challenging to find chicken eggs in some parts of Indonesia. There is a comparatively high demand for eggs during the Christmas season, particularly in Manokwari Regency. Consumers in general as well as owners of restaurants and grocery stores are among the egg customers. The Manokwari Regency Central Statistics Agency (BPS) reports that there is still an extremely limited supply of chicken eggs, particularly around Christmas. In 2018, 2,854,665 eggs were anticipated to be in complete supply, particularly in the Masni district alone. [1]

Finding intriguing trends in massive data sets and drawing conclusions from them are accomplished using data mining techniques. Numerous sources, including databases, data warehouses, the internet, repositories, and information included into operating systems, are possible places to find this data.[2]. Aside from that, data mining is connected to a number of disciplines, such as database technology, statistics, machine learning, pattern recognition, and high-performance computing.[14]

This forecasting or prediction approach, which aims to reach the best level of accuracy possible, makes use of prior data and information in an organized and systematic way.[3]. Rather than offering a conclusive response, the aim of prediction-making is to provide the most accurate assessment of the future. Three categories of forecasts are made based on time division: short-term, medium-term, and long-term predictions.[5] There are still a number of issues or challenges with this artificial neural network, the most significant of which is its inadequacies, which include the challenge of figuring out how many neurons and layers are required and suffering halts throughout the learning process.[6] Numerous application domains, including simplification, recognition, and decision, use backpropagation techniques. [8]

In a multilayer network with multiple hidden layers, the Backpropagation Algorithm also performs supervised learning with the goal to minimize errors in a network that generates output data.[9] The backpropagation algorithm consists of four stages: initialization, activation, training, and iteration.[15] Activated skills are a means to obtain neurons. There are three types of actuation capabilities: straight immersion, bipolar sigmoid, and parallel sigmoid.[10] An artificial neural network, or FNN, is a structure in which information flows from input to output neurons. [11] The preparation portion of this test makes use of a backpropagation neural network. with the use of feedforward capabilities. by inputting the load and the learning rate, MSE, and number of hidden units estimations are included in order. [4]. Through the following steps, the underlying loads in the Backpropagation strategy will be ready to receive error results. The optimal goal result is then obtained by using the result error as a regressive step to determine the proper weight value to restrict the error value. [8].

B. Research Method

1. Data Collecting Method

Documents from the Manokwari Class II Agricultural Quarantine Station from 2018 to 2023 are used in the data collecting process.

2. Research Variable

The independent variable and the dependent variable are the two test factors utilized in this study.

1. Independent Variable One of the 10 independent factors in this study was the number of Egg Stocks from month one (X1) to month twelve (X12).
2. Dependence Variable One dependent variable—the value of the number of egg stocks in Manokwari Regency—was found in this study.

3. Research Stage

The flowchart below provides an explanation of the research stage in this study.

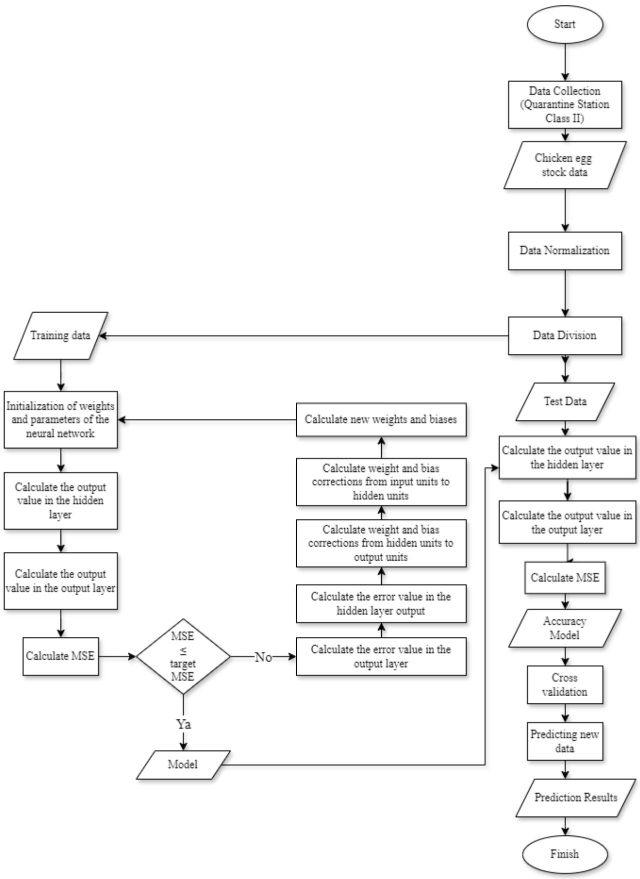

Figure 1. Research Flowchart

C. Result and Discussion

1. Data

The Class II Agricultural Quarantine Station of Manokwari Regency provided the egg stock data, which was utilized for the years 2018 to 2022.

Table 1. Manokwari Regency Egg Stock Data from 2018 to 2022

Month	Year				
	2018	**2019**	**2020**	**2021**	**2022**
January	123900	164050	128440	208510	174480
February	83350	182380	176800	144340	187594
March	127820	85320	120250	116820	173900
April	117900	152940	104310	117780	158500
May	106640	299880	181000	114820	104620
June	153970	92250	132880	127960	147820
July	113070	165130	152320	164040	183240
August	166750	140930	109000	117140	105140
September	72600	116310	199340	115320	127500
October	191740	205860	169840	161670	133820
November	145020	107410	153510	147090	155820
December	134940	162920	170710	186460	133000

2. Simulation/Training

In this study, the Backpropagation Neural Network algorithm is trained manually and deployed for the first iteration of the egg availability forecasting process in January 2018. This procedure aims to show and explain how the Backpropagation Neural Network technique is used to calculate forecasts.

3. Feedforward

Initialize the weights and parameters, including determining the learning rate, which is 0.1, then the momentum is 0.-0.9 with the maximum iteration being 100,000, then the MSE is 0.001 and also the hidden unit is 12. After that, act Using the current formula, the input output weight value is calculated, and the following outcomes are obtained:

Table 2. Calculation Result z_{inj}.

Calculation Result z_{inj}			
z_{in1}	-0,2260	z_{in7}	4,9385
z_{in2}	-1,0701	z_{in8}	2,7241
z_{in3}	2,0987	z_{in9}	0,6305
z_{in4}	10,47849	z_{in10}	-2,0756
z_{in5}	-5,09733	z_{in11}	-4,0764
z_{in6}	-0,0510	z_{in12}	-2,26023

Next, we get the following values by using the bipolar sigmoid activation function formula:

Table 3. Calculation Result z_j

Calculation Result z_j			
z_1	-0,1125	z_7	0,9858
z_2	-0,4892	z_8	0,8769

z_3	0,7816	z_9	0,3052
z_4	0,9999	z_{10}	-0,7770
z_5	-0,9878	z_{11}	-0,9666
z_6	-0,0254	z_{12}	-0,8110

The process of calculating the MSE value is then completed.

4. Backpropagation

To determine the error value, each output unit (y) will be given a pattern that is connected to the input pattern used in training. Therefore, the following outcomes are attained:

$$\delta_1 = -0{,}0962$$

Subsequently, the weight and bias correction computation procedure is executed, yielding the subsequent outcomes:

Table 4. Calculation Result Δw_{jk}

Calculation Result Δw_{jk}			
$\Delta w_{1,1}$	0,0108	$\Delta w_{1,7}$	-0,0948
$\Delta w_{1,2}$	0,0471	$\Delta w_{1,8}$	-0,0844
$\Delta w_{1,3}$	-0,0752	$\Delta w_{1,9}$	-0,0294
$\Delta w_{1,4}$	-0,0962	$\Delta w_{1,10}$	0,0747
$\Delta w_{1,5}$	0,0950	$\Delta w_{1,11}$	0,0930
$\Delta w_{1,6}$	0,0024	$\Delta w_{1,12}$	0,0780

In order to determine the error value, the input value from the unit is changed to the output by adding up each concealed layer in (= 1, 2, 3,..., q). The outcomes that were attained are as follows:

Table 5. Calculation Result δ_{inj}

Calculation Result δ_{inj}			
δ_{in1}	0,0572	δ_{in7}	-0,0686
δ_{in2}	-0,0309	δ_{in8}	-0,0131
δ_{in3}	0,1229	δ_{in9}	-0,0147
δ_{in4}	0,0603	δ_{in10}	-0,0022
δ_{in5}	0,0420	δ_{in11}	0,0151
δ_{in6}	0,0133	δ_{in12}	-0,0149

Next, determine the output layer's and hidden layer's new weights and biases to acquire the following:

Table 6. New Weight and Bias Values of the Hidden Layer to the Output Layer

New Weight		New Weight	
W1	-0,5931	W7	0,7038
W2	0,3261	W8	0,1280
W3	-1,2847	W9	0,1496
W4	-0,6362	W10	0,0302
W5	-0,4270	W11	-0,1481
W6	-0,1380	W12	0,1623
Bias		1,9723	

5. Constructing Models

At this point, a range of models or patterns are tried or tested, from 12-10-1 to 12-17-1. In the meantime, the tested learning rate values varied in multiples of 0.1 from 0.1 to 0.9. Consequently, the anticipated outcomes are as follows:

Table 7. Input Layer Weight Value to Hidden Layer

Input Layer Weight Value to Hidden Layer							
Weight	Z1	Z2	Z3	Z4	Z5		Z12
V1	-1.4061	0.3980	0.3831	-0.2249	-1.4503		2.5013
V2	2.7370	-2.9425	-1.6332	-0.5453	3.2211		0.3155
V3	-0.7539	-2.5944	2.5246	-0.0938	3.4226		-2.4138
V4	-3.1654	-1.2846	-2.4952	-1.5923	0.2133		-2.0130
V5	1.7655	2.0655	1.2351	0.0876	0.6091		2.9540
V12	3.3022	-0.2716	2.0006	0.2225	-2.1427		-0.3009
Bias	6.2258	1.2407	2.4759	9.2358	4.4149		-0.7425

Table 8. Results of Iteration and MSE Training and Testing Values Based on Patterns and Learning Rate

Paterns	**Learning Rate**	**Iteration**	**MSE Training**
12-16-1	0.1	6949	0.0009996
	0.2	4837	0.00099646
	0.3	4229	0.00099944
	0.4	5739	0.00099987
	0.5	2821	0.00099838
	0.6	3722	0.00099982
	0.7	6026	0.00099906
	0.8	4980	0.00099862
	0.9	2318	0.00099872

Based on calculations and patterns, the optimal pattern for a learning rate of 0.9 is 12-16-1, which yields a training MSE value of 0.00099872. Finding the Momentum value that can result in the lowest MSE is the next stage, as table 10 illustrates:

Table 9. Iteration Value, MSE Training and Testing Based on Momentum

Momentum	Iteration	MSE Training
0	19532	0.00099908
0.1	16772	0.0009988

0.2	15287	0.00099978
0.3	6932	0.00099975
0.4	14563	0.0009999
0.5	9809	0.00099947
0.6	9135	0.00099993
0.7	14760	0.00099987
0.8	8027	0.00099987
0.9	4927	0.00099728

The model tested in this study is a 16-unit neural network with learning rate and momentum values of 0.9 and 1, respectively, based on the training results. An example of the Neural Network design in use is provided below:

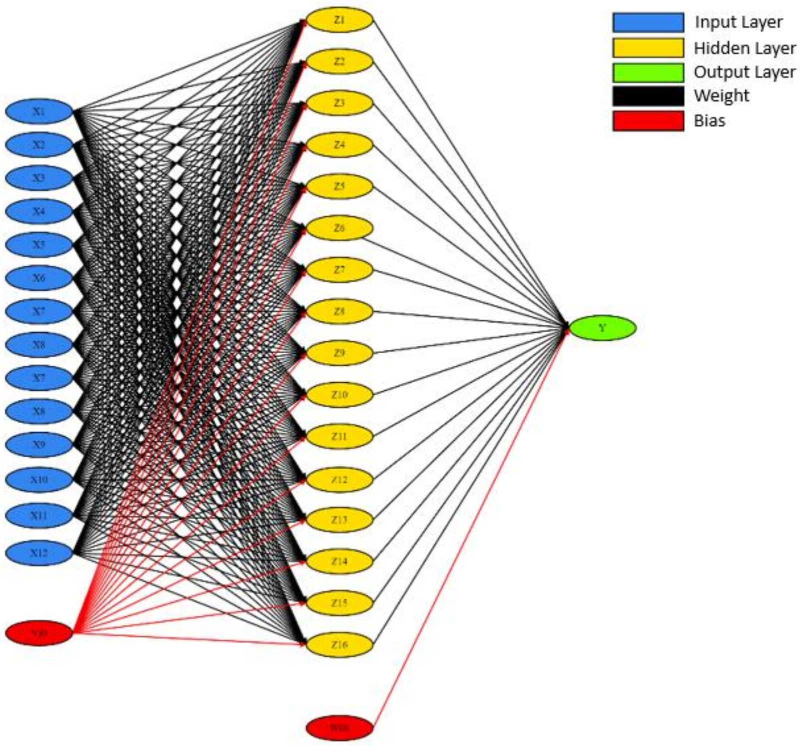

Figure 2. Neural Network Architecture

6. Testing

This model is used to conduct a feedforward procedure during the testing phase. Additionally, it provides a test MAPE score of 27.4767% and an MSE of 0.3352084.

7. The bacpropagation neural network model's accuracy

After that, the validation procedure is completed. Fourfold cross validation is the method of cross validation that is applied. Table 11's tabular data leads to the conclusion that the 4-fold has the lowest MSE value. As a result, the 4-fold approach with an MSE of 0.3352084 and a MAPE of 27.4767% will be used in this study. As a result, this model is suitable and worthy of implementation.

Table 10. Result 4 – Fold Cross Validation

Cross Validation	MSE Training
1 – Fold	0.3268871
2 – Fold	0.3342825
3 – Fold	0.3338971
4 – Fold	0.3352084

8. Prediction Outcomes

The most optimal model is applied during the feedforward step to predict the amount of eggs in stock in 2023. hence the following outcomes are attained:

Table 11. Prediction Result

Month	Prediction Results
January 2023	210076
February 2023	156492
March 2023	167181
April 2023	174060
May 2023	126021
June 2023	162718
July 2023	215795
August 2023	111009
September 2023	126739
October 2023	127432
November 2023	90547
December 2023	131053

D. Conclusion

According to the study's findings, a model with one hidden unit, a learning rate of 0.9, and a momentum of 1 is the most effective Backpropagation Neural Network approach for forecasting the quantity of egg stocks in the Manokwari district in 2023—particularly in December. Given that the BPNN model's MSE accuracy is 0.3352084 and its MAPE value is 27.4767%, it can be considered feasible. The model's prediction of the number of egg stocks in 2023—particularly in December, when the Regency Manokwari celebrates Christmas—is 131053 items in December 2023.

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