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Application of Backpropagation Method to Predict Livestock Population in Langkat Regency

Feby Arisya, Yani Maulita, Victor Maruli Pakpahan
STMIK Kaputama, Binjai, Indonesia

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ABSTRACT

Livestock has an important role in the structure of the rural economy, where small livestock is an ideal choice to support the local economy and ensure food security. In Lalat Regency, there is no accurate prediction system to find out the trend of small livestock populations in the future, both increasing and decreasing. To answer this need, this study uses the Artificial Neural Network (JST) technique with the Backpropagation method to predict the small livestock population in the region. This study develops a JST-based prediction system using available training data, training targets, and small livestock population test data. The prediction results for 23 sub-districts in 2023 show that in the first experiment, 18 sub-districts are in accordance with the prediction and 5 sub-districts are not in accordance with the prediction; In the second experiment, 17 sub-districts were compliant and 6 sub-districts were not compliant; And in the third experiment, 21 sub-districts were compliant and 2 sub-districts were not compliant. The prediction process was carried out with a target error of 0.00001, with each experiment using 20 iterations in the first experiment, as well as 4 iterations in the second and third experiments, and the training time was recorded for 00:00 seconds. This system was successfully developed using Matlab software, provides accurate prediction results of small livestock populations, and can be used by the Langkat Regency Agriculture and Food Security Office for better planning in the future.

Email :
febbysyahila999@gmail.com

INTRODUCTION

Livestock plays an important role in the rural economic structure, especially in Langkat Regency, with two main categories, namely large livestock (cows, buffaloes, horses) and small livestock (goats, sheep, pigs). Large cattle require a larger initial investment and infrastructure, while small cattle are more adaptable to local conditions and require smaller investments. Therefore, small cattle are ideal for supporting rural economies and meeting local food needs. The study highlights the importance of smallholder farms in the production of meat, milk and their derivative products, which is very significant for local food security. In addition, small farms also play a role in providing jobs and additional income for farming families. However, effective management is often hampered by the limited knowledge and resources that farmers have, so it requires special attention.

Understanding the small livestock population as a whole is key to effective planning and strategic decision-making in the agricultural sector. Accurate information on small-scale livestock population trends can help farmers and policymakers allocate resources more efficiently, plan vaccination programs, manage feed supplies, and respond quickly to changing market demand. However, often the existing data is incomplete or outdated, making it difficult to make the right decisions.

The problem that occurs in this study is that the exact number or figure of the small livestock population in Langkat Regency is not yet known for the coming years to increase or decrease, but currently there is no prediction system at the Langkat Regency Agriculture and Food Security Office. Therefore, I raised this title to make it easier for the Agriculture and Food Security Service to predict the livestock population in 2023.

To predict the livestock population in Langkat Regency, this study uses the Artificial Neural Network (JST) technique with the Backpropagation method to predict the small livestock population based on data from the Langkat Regency Agriculture and Food Security Office, with this system, it is hoped that the management of small livestock can be carried out better, help farmers anticipate potential problems, and enable the government and related organizations to develop policies that supporting the sustainability and

growth of small farms.

The Backpropagation *method* was chosen as the basis for the predictive algorithm in this study because of its proven ability to learn and adapt to complex patterns. In a study conducted by (Rika Setiana et al. 2023) on "Analysis of *the Backpropagation* Method in Predicting the Amount of Goat Meat Production in Indonesia", it was found that this method has good performance in the context of prediction. The study used several artificial neural network architectures, namely: Architecture 20-25-1 with *Mean Squared Error* (MSE) testing of 0.00447765, Architecture 20-30-1 yielded an MSE of 0.00300466, Architecture 20-35-1 yielded an MSE of 0.00426823, Architecture 20-37-1 yielded an MSE of 0.00357757. Based on the results of the study, the best architecture produced was the 20-15-1 architecture with 90% accuracy and the test MSE of 0.00262384 at 27915 iterations.

A subsequent study by Ayu Artika Fardhani et al. (2018) on "Prediction of Retail Prices of Rice in Traditional Markets in 33 Cities in Indonesia Using Backpropagation Algorithm" showed significant results. This study uses five artificial neural network architectures, namely: 4-25-1, 4-35-1, 4-40-1, 4-42-1, and 4-45-1 with a learning rate of 0.09. Of the five architectures, the best architecture is 4-45-1 with an accuracy rate of 88%, using 12718 iterations (epochs) and taking 1 minute and 14 seconds.

METHOD

In dealing with a problem in research, researchers need to have the right approach or method so that the research problem can be solved effectively and the expected results are achieved. This research method aims to find solutions systematically using scientific approaches and relevant data sources. This research is aimed at the Langkat Regency Agriculture and Food Security Office, especially in terms of predicting the number of small livestock, so that it can provide more meaningful results. The results of this conceptualization will be outlined in the form of a comprehensive research method, including literature studies and data collection necessary to analyze the prediction system. This prediction system was created to estimate the number of small cattle using *the Backpropagation method*

Based on the research methodology used in this study, a research workflow can be created to be carried out. The flow of this activity can be seen in the following image:

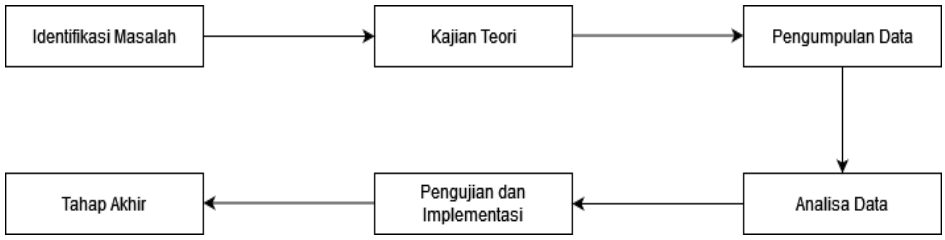

Figure 1. Research Methods

a. **Problem Identification**

The first step in this research is to determine the background of the problem, goals, and benefits so that it remains focused on the thesis discussion. At this stage, the author identified various problems that existed in the chosen research object, namely the office of the Agriculture and Food Security Office of Langkat Regency. When identifying problems in the office, several issues were found that could be solved using artificial neural network techniques, such as predicting the number of small cattle. Therefore, the author conducted research on the agency and used it as part of the implementation of the current final project. Thus, the author can plan the work steps to be carried out and determine the data needed for this analysis and research.

b. Theoretical Studies

At this stage, the author searches for theoretical foundations from various sources such as books, scientific journals, and other references that are relevant to the research title. This aims to complement the research both in terms of concepts and theories so that it has a strong and relevant foundation. The theories collected include artificial neural networks, Backpropagation methods, management of small livestock, the

use of Matlab, flowcharts, and UML (*Unified Modelling Language*).

c. Data Collection

At this stage, the authors gather the data and information necessary for the research. Data collection was carried out through literature studies, field studies, and direct interviews with related parties regarding the data on the number of small livestock at the Langkat Regency Agriculture and Food Security Office.

d. Data Analysis

This stage involves the management and analysis of the data that has been collected so that it can be grouped based on the specified variables. The author processed data to predict the number of small livestock using predetermined stages, such as sub-district variables and data from 2013 to 2023.

e. Testing and Implementation

This stage includes testing the validity and implementation of previously analyzed data as well as the preparation of the program. At this stage, analysis, design, coding, and testing are carried out to produce an accurate prediction of the number of small livestock.

f. Final Stage

This stage is the stage of conclusion and advice that can be included in the preparation of the thesis. The conclusions obtained will help in formulating the right recommendations. the results of the whole are known and it is hoped that with suggestions there will be improvements and benefits for others.

RESULTS AND DISCUSSION

Main Menu

The main page serves as the first and most important access point when the user starts running the goat population prediction application using *the Backpropagation* method. The display of this menu is presented in the image below.

Gambar 2. Menu Utama

Prediction Menu

This prediction menu contains steps to enter the data to be trained and tested using *the Backpropagation method*. The first step is to input the training data and training targets, then select the appropriate activation function. After that, the user must enter the maximum epoch value, *target error*, and *learning rate* before pressing the button to start the training process. Once the training process is complete, the next step is to enter the test data and press the *test data* button. This testing process aims to obtain the results of predicting the goat population generated from the training model. The display of this prediction menu can be seen in the image below.

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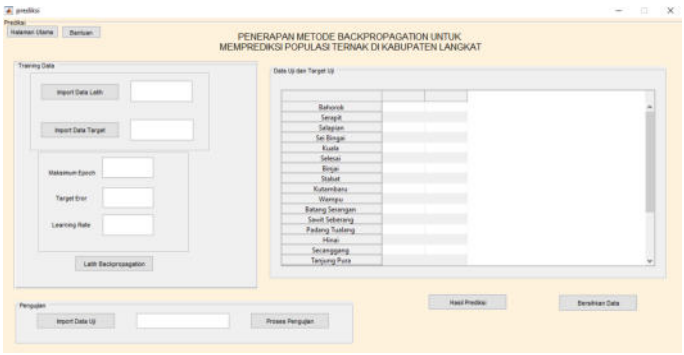

Figure 3. Prediction Menu

Prediction Results

The prediction results menu functions to display the results of the Goat Population predictions that have been made in the previous prediction menu. Users can click on the "View Results" option to bring up the results of the predicted goat population that has been calculated. The display of the menu of the prediction results can be seen in the image below.

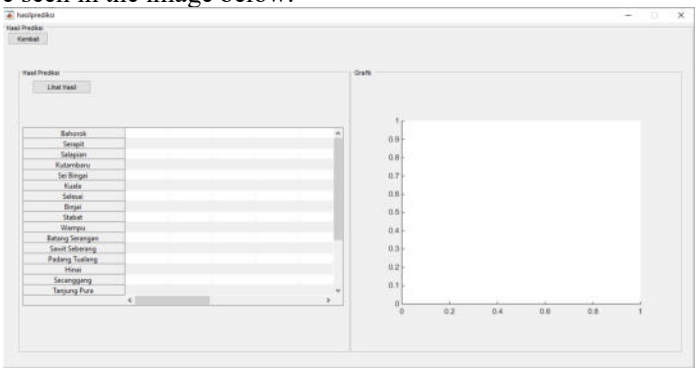

Figure 4. Prediction Results Menu

Help Menu

The help menu provides information on how to use the goat population prediction system. To access the help menu, users can press the "Help" option available on the main menu. After that, the help interface will appear, providing a complete guide on using the system. The display of this help menu can be seen in the image below.

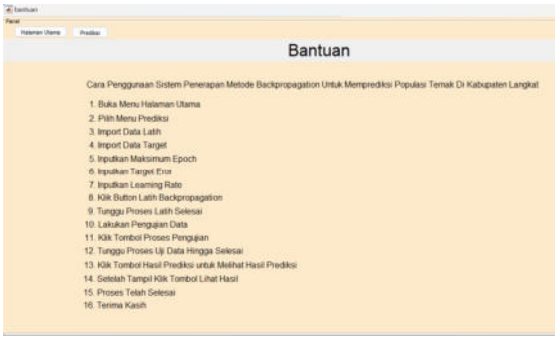

Figure 5. Help Menu

Implementation

In this section, the steps taken in the trial of an artificial neural network program using MATLAB to predict goat populations will be explained. This test aims to determine the extent of the system's performance

in processing data so that it can produce the expected information. The data used in the training consisted of training data and training target data. This data will be trained using artificial neural networks to generate predictions of goat populations. The activation function applied in this system is the activation function used is *logsig* or *sigmoid binner*. The training process is carried out until the results achieved converge or the error target is achieved.

Once the training data reaches convergence, the process continues by inputting test data to start the testing phase. After the test is completed, the results of the goat population prediction can be known. The implementation of the program to predict the goat population is as follows: To predict the goat population, users can input training data, training targets, and test data. After that, the activation function is selected, followed by the input of the maximum value of *the epoch*, *target error*, and *learning rate*. Once all the values have been inputted, the training process button can be pressed. The stages of this process are presented in the following figure.

First Trial

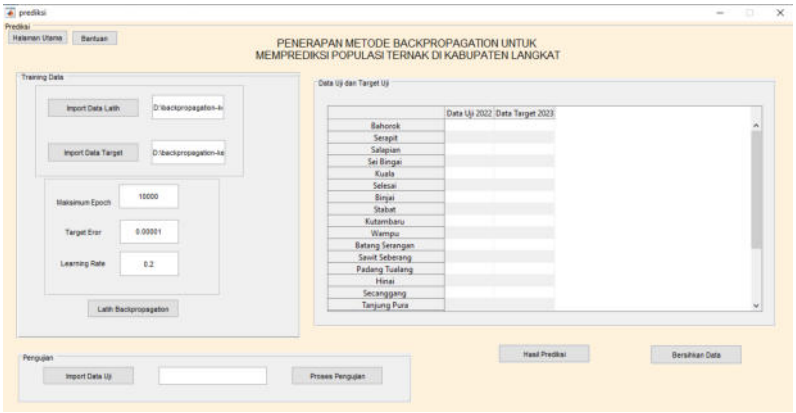

Figure 6. First Training Process

The data trained was a goat population with a maximum input *epoch* of 10,000, *a target error* of 0.00001, and *a learning rate* of 0.2. Once all the data has been inputted, the training process can begin. After the training process button is pressed, the *Neural Network Training* (*nntraintool*) window will appear as shown in the image below.

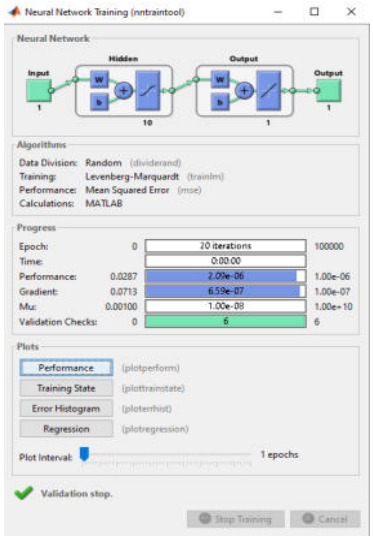

Figure 7. First Neural Network Training

From the image of the training process above, convergent training results are obtained, where the error target is achieved after going through 20 iterations with a training time of 0.00:00 seconds. After the results achieved convergence, the next process can be carried out, after the test data is input and the *data test button* is pressed, the results of the goat population prediction can be known after the test process is completed.

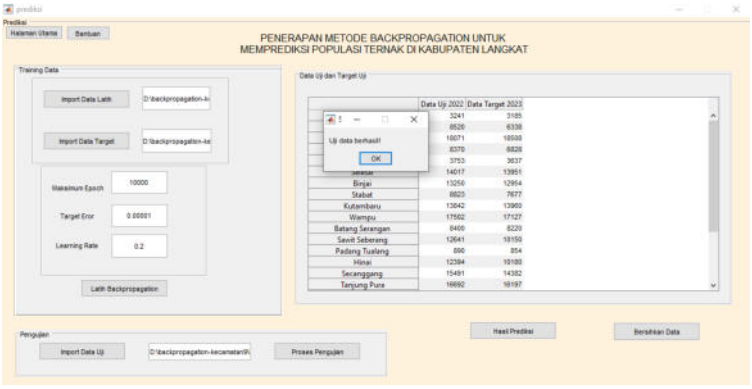

Figure 8. First Testing Process

To view the prediction results, press the "Prediction Results" button. After that, the prediction results will be displayed, as seen in the image below.

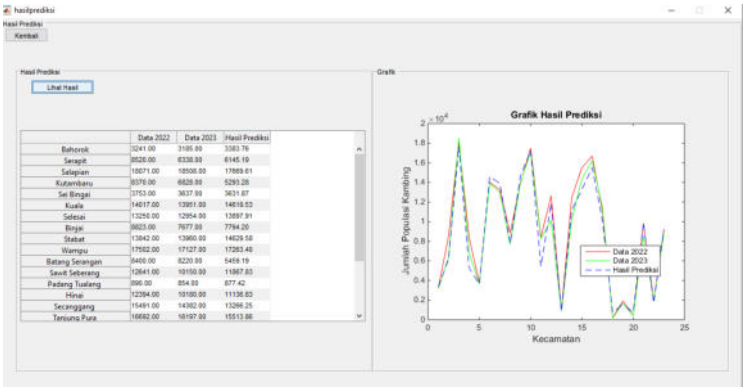

Figure 9. First Prediction Results

Discussion

Based on the previous explanation, the data to predict the small livestock population was trained using an artificial neural network (JST) algorithm with the Backpropagation method. This method is used to predict the small livestock population in Lalat Regency. In this process, the input data, hidden layers, and livestock population output are processed to achieve the best results through several iterations, with variations on the number of hidden layers used. The training process consists of two stages, namely training using historical data and testing with new data that has never been trained before. The input data used came from small livestock population data for five years, namely from 2013 to 2017, which was trained in a network with a 5 x 23 pattern and a target data of 1 x 23 for target data in 2018. The test was conducted with 5 x 23 data, which aimed to test the ability of artificial neural networks to process new data and generate predictions.

The data used is divided into two main categories, namely input data and target data. Input data is used in training and testing the system, while target data serves as a reference or target to measure the success of the process. The data used in this study is the goat population taken from the Langkat Regency Agriculture and Food Security Office, with a data collection period from 2013 to 2023

CONCLUSION

The prediction system using the Backpropagation method was successfully developed with Matlab software and is able to predict the goat population effectively. By using training data, training targets, and goat population test data, this system is able to produce accurate prediction of the goat population. The population prediction for 23 sub-districts in 2023 shows the following results: in the first experiment, 18 sub-districts had appropriate prediction results, while 5 sub-districts were not suitable; In the second experiment, 17 sub-districts were in accordance with the prediction, and 6 sub-districts were not in accordance with the prediction; And in the third experiment, 21 sub-districts were in accordance with the prediction, and 2 sub-districts were not in accordance with the prediction. The prediction process was carried out with an error target of 0.00001, through 20 iterations in the first trial, 4 iterations in the second trial, and 4 iterations in the third trial, with the training duration recorded at 00:00 seconds. Further research is suggested to use methods other than artificial neural networks, such as genetic algorithms or other methods. The use of different algorithms can provide comparisons and allow for the development of more accurate and optimal predictions. It is hoped that future research can apply other methods to produce better predictions. In addition, the study may also consider the use of applications or software other than MATLAB, so that the prediction results can be compared better. More training data is needed to improve the quality and accuracy of training results, as well as more optimal testing.

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