Accuracy Level of Backpropagation Algorithm to Predict Livestock Population of Simalungun Regency in Indonesia

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Abstract. The development of livestock agribusiness includes all activities that begin with the procurement and regulation of production and marketing suggestions. With the many types of livestock found in Simalungun Regency, Indonesia should be able to increase the potential for livestock agribusiness development. In this study, the authors will analyze the best architecture that can be used to predict the number of livestock populations according to the type of livestock in Simalungun District Indonesia so that certain parties can make improvements to the development of livestock agribusiness in Simalungun District Indonesia. In this study, there are five 5 architectural models namely, 3-5-1 architecture, 3-6-1, 3-7-1, 3-8-1, and 3-9-1. Of the five architectural models, the best architectural model is 3-7-1 with 75% accuracy and 1693 epochs. While the error rate is 0.001-0.01. It is expected that this architectural model can help academics in the process of predicting the number of livestock populations in Simalungun Regency in the coming year.

1. Introduction

Facing the era of global competition, development must be able to realize advanced, efficient and resilient farms, where existing resources (capital, nature, labor, and technology) can be utilized optimally so that the products produced can meet market demands both regionally and globally [1]. Farming that uses the concept of agribusiness must pay attention to two critical things. First, trying to strengthen subsystems in a system that is vertically integrated into management unity. Second, creating efficient agribusiness companies in each subsystem, so that if this can be achieved the livestock products, namely: meat, eggs, and milk will increase their competitiveness, especially in the face of global markets [2]. Livestock agribusiness includes all activities that begin with the procurement and distribution of production facilities, livestock business production, and marketing of livestock business products or their processed products [3].

Simalungun Regency Indonesia is one of the areas producing various types of livestock in North Sumatra Indonesia. Based on the kind of animals provided, Simalungun Regency should be able to improve the development of livestock-based agribusiness adequately. Increasing the results of livestock populations with aspects that have been determined can achieve commercial goals, namely the benefits for the perpetrators of activities. Based on data obtained through the Central Statistics Agency Simalungun, there are 8 livestock results produced, namely: Cows, buffaloes, horses, dairy cows, goats, sheep, pigs, and rabbits. With an unstable amount with each other.
In this study, the author will analyze the best architecture and the level of accuracy that can be used to predict the number of livestock populations in Simalungun District Indonesia by using the backpropagation algorithm method. Backpropagation is one method in Artificial Neural Networks that is quite reliable in solving problems [4], moreover, backpropagation has been many and thriving in various applications, such as pattern recognition, forecasting, site selection, and job evaluation [5]–[7]. In the manufacturing phase, the backpropagation algorithm passes through two (2) processes, namely the training process and the testing process [8][9].

2. Methodology

2.1. Data Used

The data used in this study is the data of livestock population according to the type of livestock in Simalungun District of Indonesia in 2011-2015 (Table 1). Data obtained from the Simalungun Indonesia Central Statistics Agency.

| No | Livestock | 2011  | 2012  | 2013  | 2014  | 2015  |
|----|-----------|-------|-------|-------|-------|-------|
| 1  | Cow       | 98335 | 99515 | 99603 | 100798| 139100|
| 2  | Buffalo   | 7453  | 7542  | 7631  | 7723  | 8109  |
| 3  | Horse     | 226   | 89    | 231   | 234   | 241   |
| 4  | Dairy cows| 37    | 37    | 37    | 37    | 47    |
| 5  | Goat      | 63510 | 64272 | 65043 | 65824 | 75824 |
| 6  | Sheep     | 10190 | 10312 | 10435 | 10560 | 11230 |
| 7  | Pork      | 105341| 106605| 107881| 109176| 124176|
| 8  | Rabbit    | 3602  | 3646  | 3689  | 3733  | 3845  |

Source: Simalungun Indonesia Central Statistics Agency

2.2. Research Steps

The first thing to do is to collect data on livestock populations according to the type of livestock obtained from the Simalungun Statistical Center in 2011-2015. After the data is received, it will identify the problem [10]. In conducting research, the authors need references as reference material obtained from the books of Artificial Neural Networks and journals and other writings. After that, the data was tested using Matlab R2011b software. And until the final stage, which is evaluating the data that aims at whether the results obtained are as expected.

2.3. Normalization Data

Before being processed, the data is normalized first using the Sigmoid function (never reaches 0 or 1), then the data transformation is carried out at smaller intervals, namely [0.1; 0.9]. Data normalization aims to adjust the value of the data range with the range log sigmoid threshold function in the backpropagation system [11]–[13]. Normalization formula used:

\[
x' = \frac{0.8(x - a)}{b - a} + 0.1
\]

Explanation:

\[x':\] Transformed data
\[x: \] The data will be normalized
\[a: \] Minimum data
\[b: \] Maximum data
Livestock population data is divided into two parts, namely training data and testing data. The training data uses 2011-2013 with the 2014 target, and data testing uses 2012-2014 with the 2015 target.

### Table 2. Normalization of Training Data (2011-2013) / Target (2014)

| No. | Livestock   | 2011        | 2012        | 2013        | Target      |
|-----|-------------|-------------|-------------|-------------|-------------|
| 1   | Cow         | 0.82053     | 0.82918     | 0.82983     | 0.83859     |
| 2   | Buffalo     | 0.15436     | 0.15501     | 0.15566     | 0.15634     |
| 3   | Horse       | 0.10139     | 0.10038     | 0.10142     | 0.10144     |
| 4   | Dairy cows  | 0.10000     | 0.10000     | 0.10000     | 0.10000     |
| 5   | Goat        | 0.56526     | 0.57085     | 0.57650     | 0.58223     |
| 6   | Sheep       | 0.17442     | 0.17532     | 0.17622     | 0.17713     |
| 7   | Pork        | 0.87189     | 0.88115     | 0.89051     | 0.90000     |
| 8   | Rabbit      | 0.12613     | 0.12645     | 0.12677     | 0.12709     |

### Table 3. Normalization of Data Testing (2012-2014) / Target (2015)

| No. | Livestock   | 2012        | 2013        | 2014        | Target      |
|-----|-------------|-------------|-------------|-------------|-------------|
| 1   | Cow         | 0.67228     | 0.67278     | 0.67966     | 0.90000     |
| 2   | Buffalo     | 0.14317     | 0.14369     | 0.14422     | 0.14644     |
| 3   | Horse       | 0.10030     | 0.10112     | 0.10113     | 0.10117     |
| 4   | Dairy cows  | 0.10000     | 0.10000     | 0.10000     | 0.10006     |
| 5   | Goat        | 0.46953     | 0.47397     | 0.47846     | 0.53599     |
| 6   | Sheep       | 0.15911     | 0.15982     | 0.16054     | 0.16439     |
| 7   | Pork        | 0.71306     | 0.72040     | 0.72785     | 0.81415     |
| 8   | Rabbit      | 0.12076     | 0.12101     | 0.12126     | 0.12191     |

### 3. Results And Discussion

This study uses 5 architectures, 3-5-1 (3 are input layers, 5 are hidden layer neurons and 1 is the output layer), 3-6-1 (3 is the input layer, 6 is the hidden layer neuron and 1 is the output layer), 3-7-1 (3 is the input layer, 7 are hidden layer neurons and 1 is the output layer), 3-8-1 (3 is the input layer, 8 are hidden layer neurons and 1 is the output layer) and 3-9-1 (3 is the input layer, 9 is the hidden layer neuron and 1 is the output layer). From these five architectural models, one of the best architectural models is obtained, with 75% accuracy, namely the 3-7-1 architectural model.
From Figure 1 it can be explained that the 3-7-1 architectural model is the best architecture with an epoch occurring 1693 iterations in 24 seconds.

Table 4. Best Architectural Results with Models 3-7-1

| No | Data Training | Data Testing |
|----|---------------|--------------|
|    | Target | Output | Error | SSE   | Target | Output | Error | SSE | Results |
| 1  | 0.83859 | 0.84230 | -0.00371 | 0.00001376 | 0.90000 | 0.79990 | 0.10010 | 0.01002001 | 0 |
| 2  | 0.15634 | 0.15210 | 0.00424 | 0.00001798 | 0.14644 | 0.13960 | 0.00684 | 0.00004679 | 1 |
| 3  | 0.10144 | 0.09940 | 0.00204 | 0.00000416 | 0.10117 | 0.10000 | 0.00117 | 0.00000137 | 1 |
| 4  | 0.10000 | 0.09960 | 0.00040 | 0.00000016 | 0.10006 | 0.09960 | 0.00046 | 0.00000021 | 1 |
| 5  | 0.58223 | 0.64740 | -0.06517 | 0.00042713 | 0.53599 | 0.40580 | 0.13019 | 0.01694944 | 0 |
| 6  | 0.17713 | 0.17660 | 0.00053 | 0.00000028 | 0.16439 | 0.15770 | 0.00669 | 0.00004476 | 1 |
| 7  | 0.90000 | 0.83930 | 0.06070 | 0.00368449 | 0.81415 | 0.81150 | 0.00265 | 0.00000702 | 1 |
| 8  | 0.12709 | 0.12220 | 0.00489 | 0.00002391 | 0.12191 | 0.11710 | 0.00481 | 0.00002314 | 1 |

SSE 0.00799188  
MSE 0.00199797  

Table 5. Comparative Results of Accuracy of Backpropagation Algorithm

| No | Architecture | Training | Testing |
|----|--------------|----------|---------|
|    | Epoch | Time | MSE | MSE | Accuracy |
| 1  | 1058 | 0:21 | 0.00099767 | 0.000997672 | 37.5 % |
| 2  | 5579 | 1:18 | 0.00099854 | 0.035200352 | 37.5 % |
| 3  | 1693 | 0:24 | 0.00012482 | 0.003386591 | 75.0 % |
| 4  | 2600 | 0:42 | 0.00001560 | 0.014848462 | 62.5 % |
| No | Architecture | Training | Testing |
|----|--------------|----------|---------|
|    |              | Epoch    | Time    | MSE     | MSE     | Accuracy |
| 5  | 3 - 9 - 1    | 2619     | 0:36    | 0.00000195 | 0.008281126 | 37.5 % |

Based on Table 5, it was concluded that the five architectures above obtained the best architecture, namely 3-7-1 architecture with epoch which occurred 1693 iterations in 24 seconds, MSE 0.00440004 with 75% accuracy.

4. Conclusion
The conclusions that can be drawn from this research are:
a. Of the five architectural models used for training, one of the best architectures is the 3-7-1 architectural model with an accuracy rate of 75%.
b. The 3-7-1 architecture model is also the fastest compared to the other 4 models because it only takes 24 seconds.
c. However, the MSE level with the 3-7-1 architectural model is not too small, there is still a smaller 3-5-1 architectural model with an MSE level of 0.000997672.

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