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Implementation of Artificial Neural Networks For Predicting Percentage Growth Goat Meat Production In Indonesia

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Abstract

When people are aware of the fulfillment of nutritious food, the demand for foods that are high in protein increases, such as milk, eggs, and meat. This study discusses the prediction of the percentage growth of goat meat production in Indonesia using an artificial neural network using the backpropagation method. This research data was taken from goat production data in 2016-2020. The data is taken from data from the Central Statistics Agency of Indonesia. The process uses 6 variables, namely 2015 (X1) data, 2016(X2) data, 2017(X3) data, 2018(X4) data as input data, and 2019(T) data as target data. While the testing process uses 6 variables, namely data for 2016(X1), data for 2017(X2), data for 2018(X3), data for 2019(X4) as input data, and data for 2020(T) as target data. The results of this study are predictions of the number of goat meat production data for the following year and the percentage growth of Indonesian goat meat production.

Keywords: *Artificial Neural Network, Backpropagation, Prediction, Goat Meat Production*

1. Introduction

Increased public awareness of the need for nutritious food and drinks affects the demand for high protein foods and drinks, one of which is eggs, milk, and meat. Goats are animals that have a fairly high protein. Goat meat production data by the province in Indonesia has increased and decreased. There are provinces that experienced increases, such as Jambi, South Sumatra, Lampung, West Java, Central Java, DI Yogyakarta, Banten, South Kalimantan, North Sulawesi, Gorontalo, Maluku and North Maluku. In addition, experiencing declines such as Aceh, North Sumatra, West Sumatra, Riau, and other provinces in Indonesia. Open unemployment is the labor force that does not have a job at all. This unemployment occurs because the workforce has not got a job even though they have tried their best or due to lazy factors to find work or lazy to work. The problem of growing goat meat production is serious. The government must increase the production of goat meat in Indonesia to meet the people's need for high protein foods. To deal with the above problems, it is necessary to make a study on the prediction of goat meat production data in each province in Indonesia. Based on the above problems, a method is needed to predict goat meat production data in Indonesia and the percentage growth of goat meat production. This study uses goat meat production data for 2015-2020 using an artificial neural network using the backpropagation method.

2. Research Methodology

2.1. Related Work

The backpropagation algorithm uses a layered hierarchical architecture of simple neurons or nodes with a high level of connectivity between layers. Only inter-layer connections are allowed in the 'simple' non-recursive network described here[1].

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Research[2], This paper analyzes the application of an iterative network to predict stock market returns in contrast to the backpropagation network. Experimental results show that learning temporal information is not substantial on predictive accuracy for stock market returns. Research [3], this study shows an accuracy rate of 80% using an alpha of 0.7, an epoch of 10000, and an MSE value of 0.022 using monthly rainfall data from 2011 to 2015 and parameters such as air temperature, speed air, and air pressure to predict precipitation. Research [4], modeling results and physical experiments of hybrid meander systems show that it is possible to increase the pass-band and input impedance of slow-wave systems using a hybrid meander system with inductors at the periphery of the winding electrode. Research[5], This research paper develops an artificial neural network system to predict heart disease. Researchers propose 13 medical attributes for the prediction of heart disease. Research[6], in this paper we use a backpropagation neural network model to predict rainfall based on humidity, dew point, and pressure in INDIA country. Training shows an accuracy of 99.79% and in the test obtained an accuracy of 94.28%. Research [7], the researcher demonstrates the model's learning ability in regression and classification tasks and shows analytically that the model approximates the error of the backpropagation algorithm. Research[8], In this paper, we explore one step forward and several steps forward predictions and compare with previous work. Research [9]. In this paper, we propose a machine learning student failure prediction model based on student profiles built across programming classes by continuously monitoring and evaluating student activity. Research [10], the IGA-BPNN model can solve finite effects optimization problems and local convergence, increasing the prediction accuracy and stability of the model regardless of the scenario, i.e., sudden flooding or periods of less rainfall.

Research [11] results show that the revised BPNN modeling can be used to predict and calculate erosional deformation, accelerate network learning speed, and improve prediction precision. Research [12] shows that the combination of the Ribiere conjugate gradient backpropagation method using the sigmoid and binary activation functions can improve performance, in this case, the prediction accuracy of time series data approaching the target data with an MSE value of 0.0000054846. Research [13], the researcher demonstrated the learning ability of the model in regression and classification tasks and showed analytically that the model approximates the error of the backpropagation algorithm. Research [14] results show that backpropagation operating in the probabilistic domain can be used to train networks that naturally map to neuromorphic hardware with very low precision neuron spiking and synapses. Research [15], this article shows that genetic algorithms can give better results to train feedforward neural networks than traditional backpropagation techniques.

Research [16], researchers explored a simple neural model called CommNet, which uses continuous communication for fully cooperative tasks. This model consists of several agents, and the communication between them is studied and their policies. Research [17], the resulting MSE value is relatively small, and the validity value of prediction accuracy is relatively high, so this system can be used to predict the number of tourists in Kaliadem Merapi, Sleman. Research [18] on artificial neural networks obtained the highest accuracy using TF-IDF of 78.76%. We also found that data quality affects performance. Research [19], the results of the comparison of testing the DIARETDB0 dataset with a total of 130 fundus images using the backpropagation method after randomizing the data 30 times, the results of the accuracy value are higher than before randomization of the data, namely the accuracy value is 83.07%, the precision value is 71, 39%, the recall value is 83.07%, and the f-measure value is 76.78%. The tests carried out are included in the goods classification. Research [20], the introduction method used is BackPropagation Neural Network. The results of this study can be used as a reference for analysis using similar objects or further research with the same thing in developing ready-to-use applications.

2.2. Modelling Neural Network

In this study, the author uses an artificial neural network with the backpropagation method to complete the prediction of goat meat production in Indonesia. The model used uses the 4-2-1, 4-3-1, 4-4-1, and 4-5-1 architectures. The following is an architectural drawing of 4-2-1, namely 4 input layers, 2 hidden layers, 2 hidden layers, and 1 output layer.

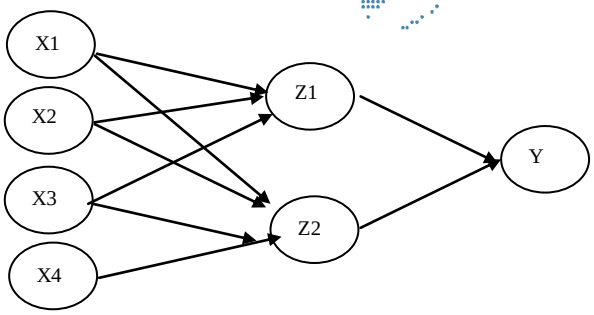

Figure 1. Architectural Model 4-2-1

3. Result and Discussion

3.1. Defining Input and Target

Goat meat production data in Indonesia is processed using Backpropagation Algorithm Artificial Neural Networks. Goat Meat Production Data is represented in numerical form between 0 to 1. The activation function used is binary sigmoid (log sig) whose range is from 0 to 1. The input data is taken from the 2015-2019 Goat Meat Production Data, while the target data is taken from Goat Meat Production Data in 2020. The following is Goat Meat Production Data for 2015-2020 from the National Statistics Center Data from the website URL: www.bps.go.id can be seen in table 1:

Table 1. Goat Meat Production Data in Indonesia

Province	2015	2016	2017	2018	2019	2020
Aceh	2604.18	2786.42	2710.23	2841.48	2209.48	2275.78
North Sumatra	3546.08	3959.07	3980.83	1212.96	1118.44	1187.11
West Sumatra	685.56	692.04	751.42	825.10	718.17	732.53
Riau	648.24	652.28	729.62	826.61	685.16	705.25
Jambi	657.62	759.56	802.24	1293.63	1649.49	1141.13
South Sumatra	1300.24	1395.37	1868.25	1999.20	1713.28	1696.70
Bengkulu	547.45	257.92	94.89	99.93	94.91	114.47
Lampung	1806.76	2108.31	2115.61	1821.76	2157.71	1920.51
Kep. Bangka Belitung	94.12	56.26	76.77	90.03	76.03	76.51
Kep. Riau	328.58	343.91	348.33	299.94	465.91	471.95
DKI Jakarta	870.34	1109.52	1207.81	1299.79	841.59	841.59
West Java	8475.75	7384.43	9396.71	10136.57	7280.44	4453.76
Central Java	11050.51	11668.90	11857.42	11819.85	12548.90	12177.28
Yogyakarta	1598.03	1653.01	2159.41	1601.79	1920.32	1769.09
East Java	16465.38	17950.34	18680.54	21529.70	25360.52	25994.53
Banten	3498.59	2298.14	2544.91	3564.15	4694.65	4331.12
Bali	2599.49	3402.93	2911.72	858.08	901.25	991.35
West Nusa Tenggara	184.40	222.32	275.58	269.67	304.68	322.79
East Nusa Tenggara	1733.30	1763.26	2018.13	2107.29	2433.27	2921.38
West Kalimantan	264.43	358.07	463.92	411.43	417.18	421.34
Central Kalimantan	343.99	205.26	200.11	223.76	215.26	222.45
South Kalimantan	565.28	550.69	440.86	361.36	317.80	270.91
East Kalimantan	441.36	499.04	584.78	623.19	556.02	572.69
North Kalimantan	43.19	41.82	50.45	50.91	87.64	101.23
North Sulawesi	397.25	242.69	186.94	187.05	188.09	131.23

Province	2015	2016	2017	2018	2019	2020
Central Sulawesi	1607.56	2860.64	1354.31	1116.53	1396.09	1408.89
South Sulawesi	970.60	1039.43	1023.44	1124.76	1109.24	1142.51
Southeast Sulawesi	317.01	317.76	365.84	356.49	312.73	313.77
Gorontalo	157.95	198.33	266.18	316.99	251.86	229.37
West Sulawesi	503.05	211.17	210.66	212.74	167.78	184.49
Maluku	169.65	341.69	217.57	196.28	237.31	234.68
North Maluku	98.67	121.74	114.03	130.28	82.09	78.08
West Papua	157.04	158.24	62.77	73.98	70.93	73.84
Papua	215.97	234.15	281.23	271.47	268.10	293.25

Goat Meat Production Data is transformed to data between 0 to 1 before training and testing are carried out using the backpropagation method of Artificial Neural Networks with the formula:

$$x' = \frac{0.8(x-a)}{b-a} + 0.1 \quad (1)$$

The results of data transformation with the above formula can be seen in Table 2:

Table 1. The results of data transformation

Province	2015	2016	2017	2018	2019	2020
Aceh	0.1790	0.1846	0.1823	0.1863	0.1668	0.1689
North Sumatra	0.2080	0.2208	0.2214	0.1361	0.1332	0.1353
West Sumatra	0.1198	0.1200	0.1219	0.1241	0.1208	0.1213
Riau	0.1187	0.1188	0.1212	0.1242	0.1198	0.1205
Jambi	0.1190	0.1221	0.1234	0.1386	0.1496	0.1339
South Sumatra	0.1388	0.1417	0.1563	0.1603	0.1515	0.1510
Bengkulu	0.1156	0.1067	0.1016	0.1018	0.1016	0.1022
Lampung	0.1544	0.1637	0.1639	0.1549	0.1652	0.1579
Kep. Bangka Belitung	0.1016	0.1004	0.1011	0.1015	0.1011	0.1011
Kep. Riau	0.1088	0.1093	0.1094	0.1080	0.1131	0.1133
DKI Jakarta	0.1255	0.1329	0.1359	0.1388	0.1247	0.1247
West Java	0.3600	0.3263	0.3884	0.4112	0.3231	0.2360
Central Java	0.4393	0.4584	0.4642	0.4631	0.4855	0.4741
Yogyakarta	0.1480	0.1497	0.1653	0.1481	0.1579	0.1532
East Java	0.6063	0.6520	0.6745	0.7624	0.8805	0.9000
Banten	0.2066	0.1696	0.1772	0.2086	0.2434	0.2322
Bali	0.1788	0.2036	0.1885	0.1252	0.1265	0.1293
West Nusa Tenggara	0.1044	0.1056	0.1072	0.1070	0.1081	0.1087
East Nusa Tenggara	0.1521	0.1531	0.1609	0.1637	0.1737	0.1888
West Kalimantan	0.1069	0.1097	0.1130	0.1114	0.1116	0.1117
Central Kalimantan	0.1093	0.1050	0.1049	0.1056	0.1053	0.1056
South Kalimantan	0.1161	0.1157	0.1123	0.1098	0.1085	0.1071
East Kalimantan	0.1123	0.1141	0.1167	0.1179	0.1159	0.1164
North Kalimantan	0.1000	0.1000	0.1003	0.1003	0.1014	0.1018
North Sulawesi	0.1110	0.1062	0.1045	0.1045	0.1045	0.1028
Central Sulawesi	0.1483	0.1869	0.1405	0.1331	0.1417	0.1421
South Sulawesi	0.1286	0.1308	0.1303	0.1334	0.1329	0.1339
Southeast Sulawesi	0.1085	0.1085	0.1100	0.1097	0.1084	0.1084
Gorontalo	0.1036	0.1048	0.1069	0.1085	0.1065	0.1058
West Sulawesi	0.1142	0.1052	0.1052	0.1053	0.1039	0.1044
Maluku	0.1039	0.1092	0.1054	0.1048	0.1060	0.1059
North Maluku	0.1018	0.1025	0.1022	0.1027	0.1012	0.1011
West Papua	0.1036	0.1036	0.1006	0.1010	0.1009	0.1010
Papua	0.1054	0.1059	0.1074	0.1071	0.1070	0.1078

3.2. Data Processing

Goat Meat Production data processing using Mathlab 2011 software. This data is used for the training and testing process using several specified architectures to find the best architecture. The architecture used in the training process and predictive testing of Goat Meat Production Data in Indonesia uses 4 architectures, with binary sigmoid activation and a learning rate of 0.1. The architecture used is 4-2-1, 4-3-1, 4-4-1, and 4-5-1. The training process uses 6 variables, namely 2015 data(X1), 2016(X2) data, 2017(X3) data, 2018(X4) data as input data, and 2019(T) data as target data. While the testing process uses 6 variables, namely data for 2016(X1), data for 2017(X2), data for 2018(X3), data for 2019(X4) as input data, and data for 2020(T) as target data.

C. Categorization of training and test output

The category for the output is determined by the minimum error rate of the target. The limit for this category is true error between 0.0001 to 0.05 and wrong error > 0.05.

D. Selection of the Best Artificial Neural Network Architecture. The results of the training of several models can be seen on figure below :

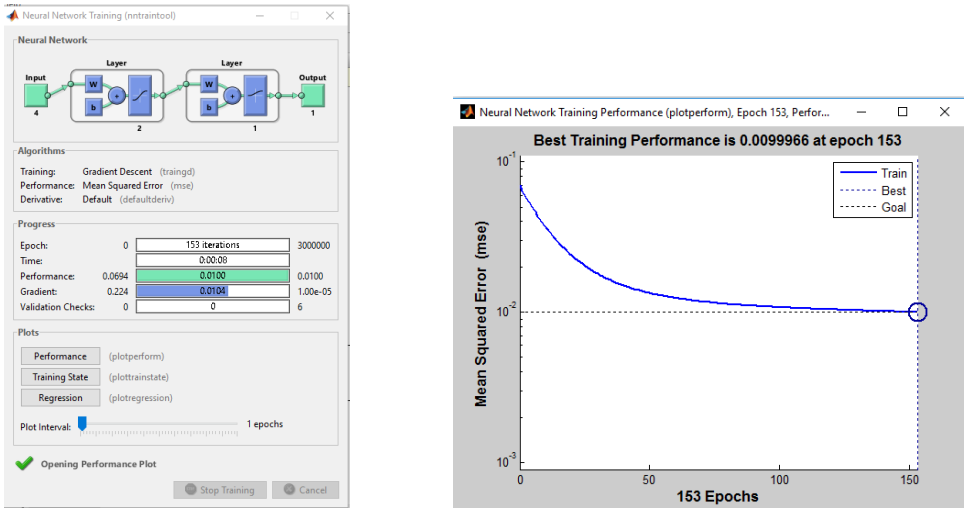

Figure 2. Training Model 4-2-1

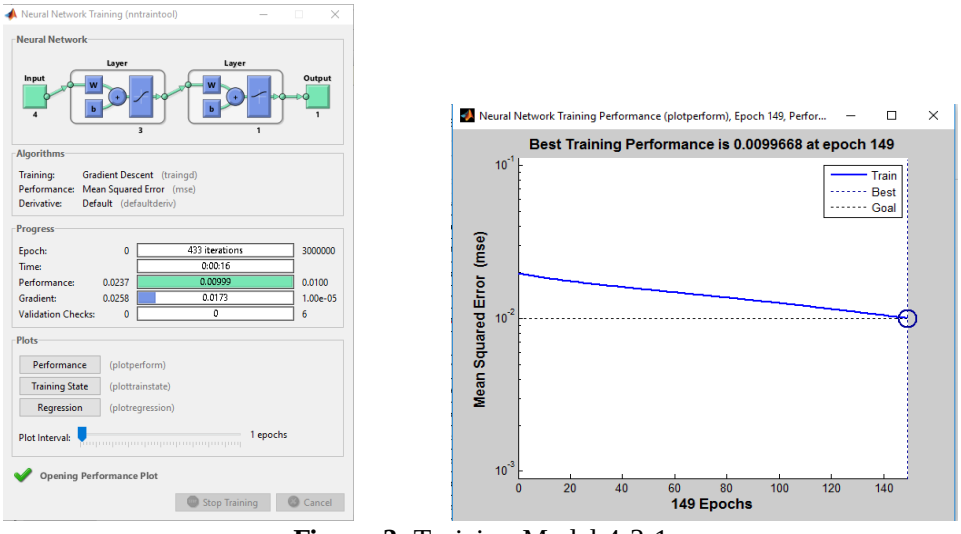

Figure 3. Training Model 4-3-1

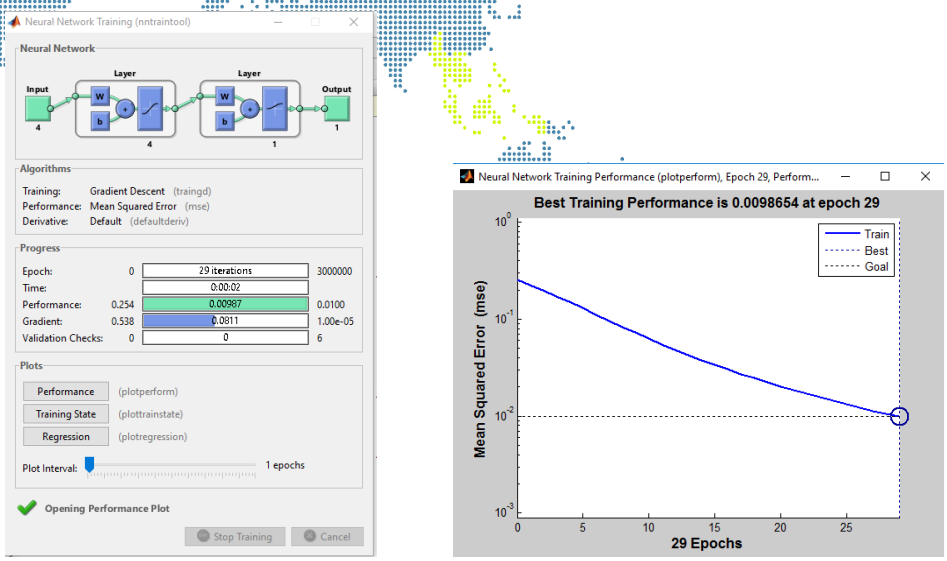

Figure 4. Training Model 4-4-1

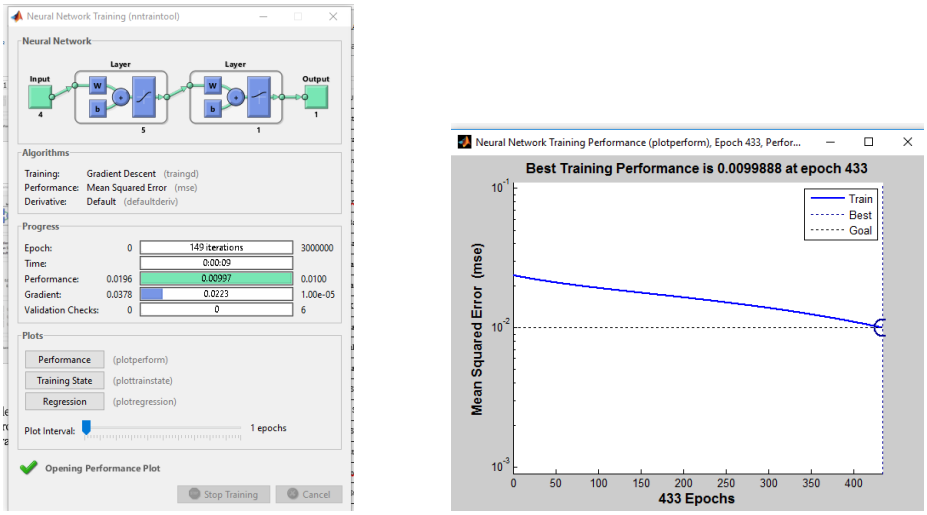

Figure 5. Training Model 4-5-1

Selection of the best architecture based on the test results of each architecture. Selection of the best architecture based on the error value, epoch and accuracy of each architecture.

Table 3. Architectural Model Recapitulation

Model	4-2-1	4-3-1	4-4-1	4-5-1
Epochs	153	433	29	149
MSE	0,0029	0,0774	0,0861	0,0170
Accuracy	74,41%	47,60%	2,94%	85,29%

From Table 3 it can be seen that the best architectural model that will be used to make predictions from a series of model trials is 4-5-1 with epoch 149, MSE 0.0170, and an accuracy rate of 85.29%.

Table 4. Prediction of Percentage Growth Goat Meat Production In Indonesia

Province	Goat Meat Production in 2020 (Tons)	Prediction of Goat Meat Production in 2021 (Tons)	Growth (%)	Normalization Y Actual	Error

Province	Goat Meat Production in 2020 (Tons)	Prediction of Goat Meat Production in 2021 (Tons)	Growth (%)	Normalization Y Actual	Error
Province	2275.78	685.28	69.89	0.1198	0.049
Aceh	1187.11	1250.43	5.33	0.1373	-0.002
North Sumatra	732.53	684.09	-6.61	0.1198	0.0015
West Sumatra	705.25	686.03	-2.73	0.1199	0.0006
Riau	1141.13	489.98	-57.06	0.1138	0.0201
Jambi	1696.7	567.63	-66.55	0.1162	0.0348
South Sumatra	114.47	855.32	647.20	0.1251	-0.0228
Bengkulu	1920.51	594.84	-69.03	0.117	0.0409
Lampung	76.51	860.75	1025.02	0.1252	-0.0242
Kep. Bangka Belitung	471.95	772.59	63.70	0.1225	-0.0093
Kep. Riau	841.59	660.34	-21.54	0.1191	0.0056
DKI Jakarta	4453.76	17291.41	288.24	0.6317	-0.3957
West Java	12177.28	22818.68	87.39	0.8021	-0.328
Central Java	1769.09	645.28	-63.52	0.1186	0.0346
Yogyakarta	25994.53	22409.46	-13.79	0.7895	0.1105
East Java	4331.12	1365.39	-68.47	0.1408	0.0914
Banten	991.35	1078.29	8.77	0.1319	-0.0027
Bali	322.79	801.27	148.23	0.1234	-0.0147
West Nusa Tenggara	2921.38	582.39	-80.06	0.1167	0.0721
East Nusa Tenggara	421.34	780.56	85.26	0.1228	-0.0111
West Kalimantan	222.45	819.51	268.40	0.124	-0.0184
Central Kalimantan	270.91	814.46	200.64	0.1238	-0.0168
South Kalimantan	572.69	727.12	26.97	0.1211	-0.0048
East Kalimantan	101.23	860.75	750.29	0.1252	-0.0234
North Kalimantan	131.23	837.93	538.52	0.1245	-0.0218
North Sulawesi	1408.89	622.08	-55.85	0.1179	0.0243
Central Sulawesi	1142.51	605.89	-46.97	0.1174	0.0165
South Sulawesi	313.77	798.51	154.49	0.1233	-0.0149
Southeast Sulawesi	229.37	805.36	251.12	0.1235	-0.0178
Gorontalo	184.49	834	352.06	0.1244	-0.02
West Sulawesi	234.68	824.48	251.32	0.1241	-0.0182
Maluku	78.08	857.4	998.10	0.1251	-0.024
North Maluku	73.84	862.83	1068.51	0.1253	-0.0243

Province	Goat Meat Production in 2020 (Tons)	Prediction of Goat Meat Production in 2021 (Tons)	Growth (%)	Normalization Y Actual	Error
West Papua	293.25	809.61	176.08	0.1237	-0.0159
MSE					0,0156
Akurasi					85,29 %

4. Conclusion

Based on the results and discussion above, After training in the system testing process using the Matlab 2011 application software and the Artificial Neural Network model used is 4-2-1, model 4-3-1, model 4-4-1 and model 4-5- 1, good results can be obtained with an accuracy of 85.29% is the 4-5-1 model. With the 4-5-1 architectural model, it is possible to predict goat meat production in Indonesia. The accuracy of the prediction of goat meat production in Indonesia is to get an accuracy of 85.29% and an MSE of 0.015. From the predictions of goat meat production in Indonesia, the authors can find out the prediction of the percentage growth of goat meat production in each province in Indonesia.

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