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BACKPROPAGATION ANALYSIS IN SELECTING THE BEST ARCHITECTURE TO PREDICTION THE NUMBER OF POPULATION OF SIANTAR MARTOBA

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Abstract: Basically, this region experiences growth every year. The negative impact of uncontrolled population growth will cause social inequality and poverty and affect the progress and prosperity of the region. Judging from the number of residents registered with the Population and Civil Registration Service, Siantar Martoba District has a fairly high population growth rate, so it is necessary to predict the future population. In making a prediction, a good method is needed to solve a problem. In this research, a backpropagation algorithm was used using five architectures, namely architecture 4-71-1, 4-31-1, 4-16-1, 4-72-1, 4-83-1. From the results of tests carried out using data on the population of Siantar Martoba, the best architecture was obtained, namely architecture 4-31-1 with a mean squared error for training of 0.00009960 and a mean squared error for testing of 0.000099957 and obtained an epoch of 14012 iterations with a time of 01 minutes 40 seconds. It was concluded that this method can predict the population of Siantar Martoba in the future using Matlab R2011a, thus obtaining a population of Siantar Martoba of 36470 people.

Keywords: architecture; backpropagation; pematangsiantar; population; welfare

Abstrak: Pada dasarnya, wilayah ini mengalami pertumbuhan setiap tahunnya. Dampak negatif pertumbuhan penduduk yang tidak terkendali akan menyebabkan kesenjangan sosial dan kemiskinan dan mempengaruhi kemajuan, kesejahteraan daerah tersebut. Dilihat dari jumlah penduduk yang terdaftar pada Dinas Kependudukan dan Pencatatan Sipil Kecamatan siantar martoba mempunyai laju pertumbuhan penduduk yang cukup tinggi, sehingga perlu dilakukan prediksi jumlah penduduk masa depan. Dalam melakukan sebuah prediksi dibutuhkan sebuah metode yang baik dalam menyelesaikan sebuah permasalahan, dalam penelitian ini digunakan algoritma backpropagation dengan menggunakan lima arsitektur yaitu arsitektur 4-71-1, 4-31-1, 4-16-1, 4-72-1, 4-83-1. Dari hasil pengujian yang telah dilakukan dengan menggunakan data jumlah penduduk siantar martoba diperoleh arsitektur terbaik yaitu arsitektur 4-31-1 dengan nilai mean squared error pelatihan 0.00009960 dan mean squared error pengujian 0.000099957 dan memperoleh epoch 14012 iterations dengan waktu 01 menit 40 detik. Disimpulkan bahwa metode ini dapat memprediksi jumlah penduduk Siantar Martoba di masa depan dengan menggunakan Matlab R2011a, sehingga memperoleh jumlah penduduk siantar martoba sebanyak 36470 Jiwa.

Kata kunci: arsitektur; backpropagation; pematangsiantar; kependudukan; kesejahteraan

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INTRODUCTION

Currently, population growth is becoming increasingly explosive. Population is an influential parameter for a country [1]. Population growth, if managed well, can improve regional quality, including economic aspects such as increasing per capita income and innovation aspects such as developing new innovations by encouraging population growth in the region [2]. The population can be said to be one of the supporting factors for development, because increasing the population also means increasing the workforce so that it can increase production and expand the market [3]. A large population also increases consumption demand which has an impact on increasing production demand [4].

The negative impact of uncontrolled population growth will cause social inequality and poverty [5]. Population growth in an area is important because it can affect the progress and prosperity of that area. Judging from the number of residents registered with the Pematang Siantar City Population and Civil Registration Service, Siantar Martoba District is one of the sub-districts in Pematang Siantar City which has a fairly high population growth rate, so it is necessary to choose the best architecture to predict the population. future. Meanwhile, Siantar Martoba District is also facing unemployment. Because it has been repeatedly revealed that many residents still have difficulty finding work. Not to mention the problem of declining welfare due to population growth in Siantar Martoba affecting purchasing power which is influenced by the large number of productive workers who are not yet working, so there is a need to make predictions about this in the future. By making predictions, the Pematang Siantar city government can make decisions to implement appropriate policies to overcome the problems above. Population growth must be estimated to anticipate negative impacts to help governments design the cities of the future [6].

Forecasting is a technique that uses data from the past to estimate its value in the future. These estimates were made so that the government can prepare strategic steps to anticipate the negative impacts of uncontrolled population growth [7]. To overcome the above problems, it is necessary to select the best architecture to predict population growth in Siantar Martoba. The software currently being developed is Matlab software. Another advantage of ANN is that the data input does not have to be the entire data value but only part of it. There are many types of forecasting methods [8]. Based on previous research, The backpropagation algorithm is one that is capable of producing a good level of accuracy. In a study of the application of the back propagation algorithm to predict the population of the Pematang Bandar sub-region, it was found that the back propagation algorithm provided quite good accuracy, with an accuracy rate of 92% [9]. One type of controlled training that uses a weight adjustment model to achieve a minimum error value between predicted results and actual results is called the backpropagation algorithm [10].

In this research, searching for the best architecture requires training data and testing data, training data will start in the 2017-2021 period and testing data will start in the 2018-2022 period. This research aims to find the best architecture to predict the population growth rate of Siantar Martoba based on the best architecture in this research.

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METHOD

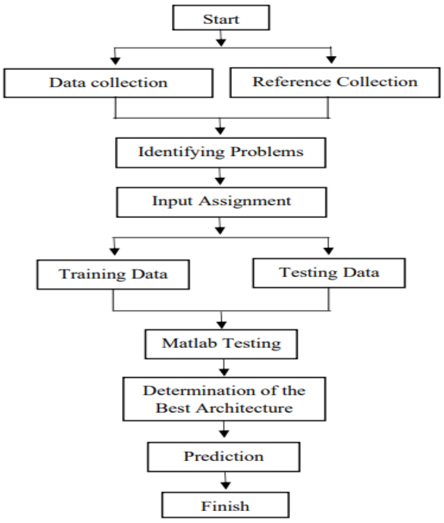

Figure 1. Research Framework

The data collection method used in this research is an artificial neural network using the back-propagation algorithm method. In this research, data collection processing was carried out, data normalization using the sigmoid function, then data transformation. Next, the network architecture was designed using the Mathlab R2011a application. In this research, references were collected through literature study. Literature study is a method of collecting information by reading literature.

This research collects data from the Pematang Siantar Civil and Population Registration Service. This research uses a training dataset from 2017 to 2021 and a testing dataset from 2018 to 2022. This research collects references from various journals on the Internet regarding the Backpropagation algorithm and population growth. The next step after carrying out the reference collection and data collection process is to define the research problem and normalize the data using the sigmoid function, then determine the division of training data and test data. Next, complete the process of determining which model or architecture will be tested on the Mathlab application. After defining the model, data testing and prediction will be carried out.

Artificial Neural Networks

Research on artificial neural networks (ANN) using the back-propagation method in the field of artificial intelligence is being carried out to understand how computers can perform tasks with capabilities that approach or even exceed human capabilities [11].

Backpropagation Algorithm

The backpropagation method is used to train a network to recognize and respond to input patterns correctly, thereby achieving a balance between the ability to recognize patterns during training and the ability to respond to input patterns that are similar but not the same as the training pattern [12]. In the backpropagation training algorithm, the first stage is initialization, where initial values are given to variables such as weight and threshold. The next stage is activation, where the initialized values are used to calculate the actual output on the hidden layer and output layer. The activation function used in this research is a binary sigmoid, which produces an output between 0 and 1. Next, at the weight training stage, gradient error calculations are carried out in the output layer and in the hidden layer. The final stage is iteration, where the process is carried out repeatedly to achieve the smallest error. In this research, the Matlab used is Matlab R2011a and is used as a tool to implement normalized training data and test data.

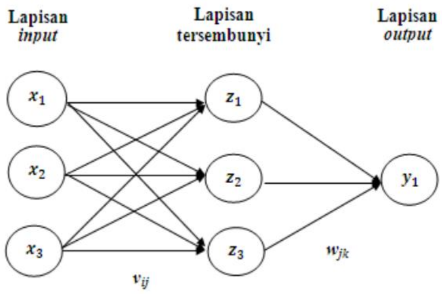

Figure 2. Backpropagation Architecture

RESULTS AND DISCUSSION

The parameters commonly used in Matlab applications that use the standard backpropagation algorithm to obtain results can be seen in the following code.

```
% Creating a Multi Layer Neural Network
(2,3,4,5(Bebas))
net = newff(minmax(p),[47,1],{'tansig','logsig'},'traingd');
% Generating weights and biases
net.IW{1,1}
net.LW{2,1}
net.b{1}
net.b{2}
% Fletcher-Reeves default parameter values (trainrp)
net.trainParam.epochs = 2500000;
net.trainParam.show = 1000;
net.trainParam.showCommandLine = false;
net.trainParam.showWindow = true;
net.trainParam.goal = 0.0001;
net.trainParam.time = inf;
net.trainParam.min_grad = 1e-05;
net.trainParam.max_fail = 6;
net.trainParam.searchFcn = 'srchcha'
% Carrying out Testing
net = train(net,p,t)
% View results when performance is found
[a,Pf,Af,e,perf] = sim(net,p,[],[],t)
% carry out simulations using test data based on training results
[a,Pf,Af,e,perf] = sim(net,p1,[],[],t1)
```

Table 1. List of Siantar Martoba Subdistricts

No	Ward
1	Kel. Naga Pita
2	Kel. Naga Pitu
3	Kel. Pondok Sayur
4	Kel. Sumber Jaya
5	Kel. Tambun Nabolon
6	Kel. Tanjung Pinggir
7	Kel. Tanjung Tongah

The input data used in this research was obtained from data on the population of Siantar Martoba taken from the Population and Civil Registration Office of Pematang Siantar City from 2017 to 2022.

Output Data

This research has output data, and in this research the output data is the minimum error value used to determine accuracy. Output data can be seen in table 2. Before processing, the data is normalized first. Data normalization is carried out so that the network output matches the activation function used. Divide the data into two parts: training data and test data first. Table 3 shows the training data after normalization with the sigmoid function so that the value does not become 1.

Table 2. Output List

No	Amount	Information
1	<=0.02	True
2	>=0.02	False

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Table 3. Normalization of Training Data

2017	2018	2019	2020	2021
0.900	0.8791	0.8437	0.856	0.856
0.3373	0.3301	0.3190	0.325	0.327
0.5448	0.5382	0.5224	0.538	0.544
0.5088	0.5109	0.5005	0.520	0.536
0.4984	0.4975	0.4874	0.494	0.502
0.4094	0.4204	0.4229	0.435	0.447
0.2269	0.2223	0.2174	0.227	0.230

Table 4. Normalization of Testing Data

2018	2019	2020	2021	2022
0.8791	0.8437	0.8561	0.8561	0.403
0.3301	0.3190	0.3251	0.3276	0.142
0.5382	0.5224	0.5382	0.5444	0.253
0.5109	0.5005	0.5200	0.5369	0.260
0.4975	0.4874	0.4942	0.5025	0.234
0.4204	0.4229	0.4357	0.4472	0.212
0.2223	0.2174	0.2274	0.2340	0.100

The normalized training and test data are processed using Matlab R2011a software to get an accurate prediction of the population of Siantar Martoba in 2023.

Best Architecture

Table 6 shows that the 4-31-1 architecture produces a mean squared error of 0.00010024 on training data with 100% accuracy. The output value is determined from the training results using the formula [a,Pf,Af,e,Perf]=sim(net ,P,[],[],T) using Matlab software, and the error value is determined from :target - Output, SSE value taken from: error^2 , the number of SSE is the total value of the number of sse. The MSE value is determined by the number of SSE/7 (existing data), and the result 1 (correct) is determined by the formula =IF(error<=0.02;1;0) on the test data. The accuracy value (%) is calculated as the number of correct / number of data*100.

Table 5. Architecture Training Data 4-31-1

No	Village name	Output	Error	SSE	Accuracy
1	Kel. Naga Pita	0.8536	0.0025	0.00000625	1
2	Kel. Naga Pitu	0.3420	-0.0145	0.00021025	1
3	Kel. Pondok Sayur	0.5511	-0.0067	0.00004489	1
4	Kel. Sumber Jaya	0.5240	0.0129	0.00016641	1
5	Kel. Tambun Nabolon	0.5106	-0.0081	0.00006561	1
6	Kel. Tanjung Pinggir	0.4416	0.0056	0.00003136	1
7	Kel. Tanjung Tongah	0.2208	0.0133	0.00017689	1
	Jlh SSE			0.00070166	100%
	MSE			0.00010024	

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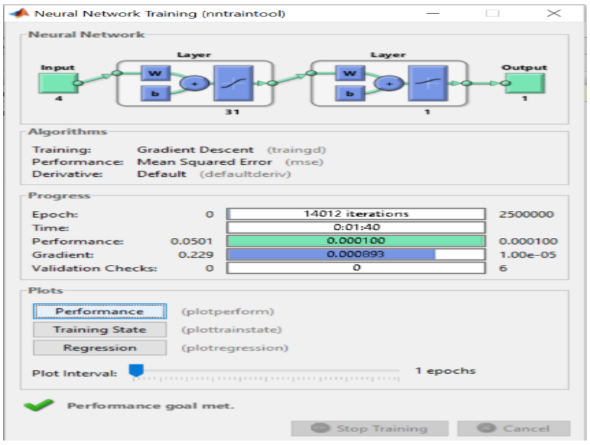

Figure 3. Test Results 4-31-1

Table 6. Testing data for architecture 4-31-1

No	Village name	Output	Error	SSE	Accuracy
1	Kel. Naga Pita	0.4044	-0.0007	0.00000049	1
2	Kel. Naga Pitu	0.1230	0.0196	0.00038416	1
3	Kel. Pondok Sayur	0.2572	-0.0041	0.00001681	1
4	Kel. Sumber Jaya	0.2552	0.0050	0.00002500	1
5	Kel. Tambun Nabolon	0.2359	-0.0012	0.00000144	1
6	Kel. Tanjung Pinggir	0.2157	-0.0037	0.00001369	1
7	Kel. Tanjung Tongah	0.1160	-0.0160	0.00025600	1
	Jlh SSE			0.00069759	100%
	MSE			0.00009965	

In table 7 it can be seen that the 4-31-1 architecture testing data produces high accuracy with an accuracy level of 100% and a Mean Squared Error value of 0.00009966. It can be seen in Figure 4 that the 4-31-1 architecture to achieve the performance required takes 01 minutes 40 seconds. It can be seen that the 4-31-1 architecture produces a gradient value of 0.00089309. From each test data table and training shows that the output and error come from the implementation of the Matlab application, SSE comes from the error results, and the total mean squared error value comes from the number of SSE divided by ^2. To get an accuracy value, a value <=0.02 is worth 1 (true) if a value >=0.02 is false (0) divide the total value of correct counts by the amount of data to get the architectural accuracy.

Table 7. Architect Recapitulation

Training Time	MSE Training	Accuracy	MSE Testing	Accuracy
42 Detik	0.0001003	86%	0.000168	86%
01 M 40 D	0.0000996	100%	0.000099	100%
06 M 38 D	0.0000998	100%	0.000100	100%
02 M 07 D	0.0001000	100%	0.000100	86%
15 D	0.0000999	100%	0.000099	86%

Table 8. Prediction Results of Siantar Martoba Population Number/Year

No	Village name	Real Data	Target	Target Prediction	Prediction
1	Kel. Naga Pita	12078	0.403654	0.4044	7001
2	Kel. Naga Pitu	5032	0.142606	0.123	4118
3	Kel. Pondok Sayur	8012	0.253013	0.2572	5493
4	Kel. Sumber Jaya	8205	0.260163	0.2552	5472
5	Kel. Tambun Nabolon	7517	0.234673	0.2359	5274
6	Kel. Tanjung Pinggir	6904	0.211962	0.2157	5067
7	Kel. Tanjung Tongah	3882	0.1	0.116	4046
		Jumlah			36470

CONCLUSION

Application of optimal network architecture in predicting the future population of Siantar Martoba and creating the best architectural model with high accuracy, namely 100% on architecture 4-31-1 with a mean square error test result of 0.00009966. It was concluded that this architecture was suitable for forecasting the population of Siantar Martoba because it produced the smallest error value and the accuracy level obtained was >=75%, thus obtaining a total population of Siantar Martoba of 36470 people.

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