

Analysis of ANN Backpropagation Ability to Predict Expenditure Group Inflation

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Abstract

The Covid-19 pandemic that has hit the world, especially Indonesia, has greatly disturbed the stability of the inflation rate. Inflation that continues to increase will disrupt the economy in this country. Therefore this study aims to analyze the ability of ANN backpropagation which will be applied to predict the development of inflation in Indonesia during the Covid-19 pandemic so that later it can be useful information for the government and society. The research data used is inflation data according to expenditure groups obtained from CBS (Central Statistics Agency) in January-May 2020. Prediction is done using the backpropagation neural network algorithm. This paper uses four network architectures, namely: 3-5-1, 3-10-1, 3-25-1 and 3-50-1. Based on the training and testing of the four models, the 3-10-1 model is the best architectural model that is suitable for predicting the development of inflation in Indonesia with an accuracy of 75%. In addition, this model performs an iteration of 25303 and an MSE test of 0.0362820326. Based on the prediction results in June-August 2020 and real data obtained from the Central Statistics Agency, ANN using the backpropagation method is highly recommended to be used to predict the development of Indonesian Inflation according to the Expenditure Group.

Keywords: ANN, Backpropagation, Predict, Expenditure Group, Inflation

1. Introduction

Inflation is a general propensity to raise the prices of goods and services, which persists permanently. Inflation increases as the country's price of goods and services rise. Rising costs of goods and services cause the value of money to fall. Inflation may thus also be defined as a decline in the value of money compared with the value of goods and services in general [1]. The inflation rate refers to the percentage rise or decrease in the price of goods or services at a given time, which can usually be seen in each year [2]. The Covid-19 pandemic that has hit the world to date, is feared that it will disrupt the stability of the inflation rate in each country. Inflation that continues to increase continuously will result in disruption of the country's economy. Because of catastrophic events and disease outbreaks such as Covid-19 in general, this will drive inflation. This can be understood because disasters usually hamper the supply of basic necessities so that prices rise.

In Indonesia alone, in fact, Based on March-May 2020 data from the Central Bureau of Statistics, Covid-19 which was feared to be a trigger for rising inflation actually did not occur, even the inflation rate could be said to be declining and stable compared to January and February. This could be possible because of the restrictions that have been set by the government that forced people to reduce economic activity. The aim is to break the chain of transmission of the Covid-19 virus. This limitation has a very big impact on the



economy, especially on the development of inflation. For further explanation about inflation in Indonesia in 2020 especially in the Covid-19 pandemic

Table 1. Inflation Data in Indonesia January-May 2020 According to Expenditures Group

No	Expenditures Group	Month				
		Jan	Feb	Mar	Apr	May
1	Food, Beverage and Tobacco	1,62	0,95	0,10	0,09	-0,32
2	Clothing and Footwear	0,12	0,21	0,12	0,04	0,09
3	Housing, Water, Electricity and Household Fuels	0,13	0,09	0,02	0,09	0,04
4	Household Equipment, Equipment and Routine Maintenance	0,09	0,06	0,28	0,09	0,10
5	Health	0,42	0,34	0,21	0,23	0,27
6	Transportation	-0,89	-0,37	-0,43	-0,42	0,87
7	Information, Communication and Financial Services	0,04	-0,01	-0,09	-0,34	0,08
8	Recreation, Sports and Culture	0,18	0,07	0,02	0,03	0,06
9	Education	-0,14	0,02	0,00	0,00	0,00
10	Food and Beverage Provider / Restaurant	0,19	0,17	0,36	0,18	0,08
11	Personal Care and Other Services	0,46	0,41	0,99	1,20	0,12
12	General	0,39	0,28	0,10	0,08	0,07
Average		0,22	0,19	0,14	0,11	0,12

Source : Central Bureau of Statistics [3]

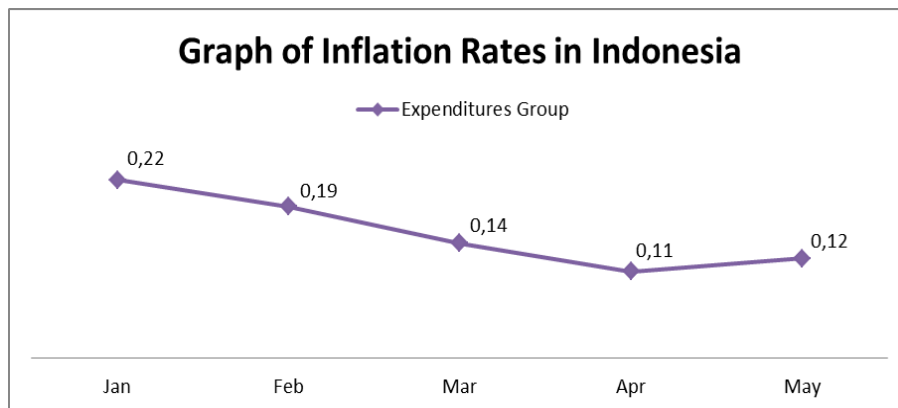
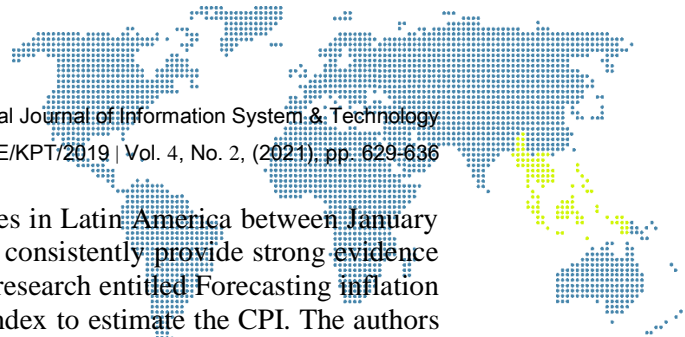


Figure 1. Inflation Charts in Indonesia January-May 2020 Based on Expenditures Group

Based on the data presented in Table 1 and Figure 1, it can be seen that the inflation rate in Indonesia during the Covid-19 (Mar-May) pandemic was relatively declining and stable compared to when the Covid-19 pandemic (Jan-Feb) had not yet occurred. However, it is feared that from June onwards the inflation rate will increase, because the New Normal has already been enacted, which means that the community has gradually started to work as usual. Therefore this research is carried out so that the predicted results of inflation development can later become useful information for the government and the public, especially the Inflation Control Team both at a national and regional scale to maintain commodity price stability in the community so that the inflation target set can be achieved, due to low inflation and stable is a reflection of a fairly healthy economy. The predictive algorithm used is backpropagation, one of the ANN algorithms commonly used to forecast [4]–[6].

There are a number of previous studies underlying this research, including: [7] Research to predict inflation rates uses the New Keynesian Phillips Curve, with various variations in time. This research yields theory-implied predictions for trends and components of the inflation cycle and combines them to obtain overall inflation estimates. [8] Next is the study entitled Forecasting inflation in Latin America with core measures. This research examines the potential of core inflation to estimate annual CPI headline



inflation data for a group of eight developed countries in Latin America between January 1995 and May 2017. The results of the sample used consistently provide strong evidence against predictions in four countries. [9] Next is the research entitled Forecasting inflation with online prices. This paper uses an online price index to estimate the CPI. The authors of this paper found that more than a month ago, the online price index predicted shifts in official inflation rates.

2. Research Methodology

This research uses quantitative methods, which are collecting data sets and making generalizations to explain the specific phenomena experienced by the population. The prediction algorithm used to see the level of inflation development in Indonesia according to expenditure groups is the backpropagation, which is one of the ANN algorithms that is often used to predict.

2.1. Data Collection

According to the CBS Expenses Community this study uses inflation data in Indonesia in January to May 2020 [3]. The inflation data is divided into 6 variables, including 1. Expenditures Group, 2. January inflation 3. February inflation, 4. March inflation, 5. April inflation, 6. May inflation.

2.2. Research Stages

Stages of research carried out to forecast the level of inflation growth in Indonesia based on expenditure groups include:

- a) Collect the Research dataset to be used.
- b) Preprocessing. The knowledge is then normalized using the following equation [10]–[13]:

$$x' = \frac{0,8(x-a)}{b-a} + 0,1 \tag{1}$$

Formula description : x' is the normalization result, x: is the normalized info, a: is the lowest value, and b: is the highest value.

Then the data is split into two sections, namely training and testing.

- c) Determine the concept of the network architecture to be used for the training and testing process.
- d) Analyze the architectural model used, and then choose the best architectural model.
- e) Allow predictions using the best available architectural model.
- f) Make a prediction report

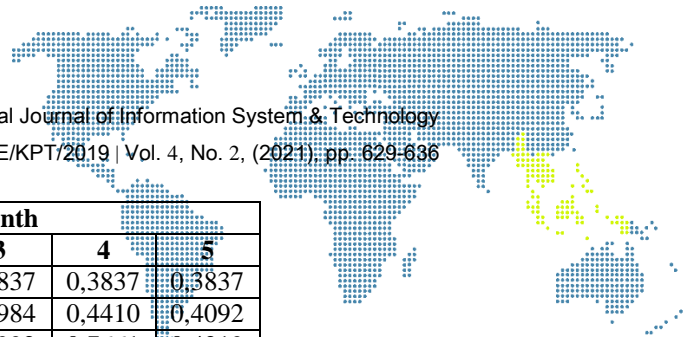
3. Results and Discussion

3.1. Normalizing data

Until entering the next stage, the analysis results in Table 1 must first be standardised. The effects of standardisation can be found in the table below.

Table 2. Normalization of Inflation Data in Indonesia According to Expenditures Group

Expenditures Group	Month				
	1	2	3	4	5
1	0,9000	0,6865	0,4155	0,4124	0,2817
2	0,4219	0,4506	0,4219	0,3964	0,4124
3	0,4251	0,4124	0,3900	0,4124	0,3964
4	0,4124	0,4028	0,4729	0,4124	0,4155
5	0,5175	0,4920	0,4506	0,4570	0,4697
6	0,1000	0,2657	0,2466	0,2498	0,6610
7	0,3964	0,3805	0,3550	0,2753	0,4092
8	0,4410	0,4060	0,3900	0,3932	0,4028



Expenditures Group	Month				
	1	2	3	4	5
9	0,3390	0,3900	0,3837	0,3837	0,3837
10	0,4442	0,4378	0,4984	0,4410	0,4092
11	0,5303	0,5143	0,6992	0,7661	0,4219
12	0,5080	0,4729	0,4155	0,4092	0,4060

The data is then broken down into two pieces. The January-March data with the April target data is used as the training data. Although the data from February-April are used as test data with the target May data. The Matlab 2011b method assists in the data analysis to decide the perfect model for architecture. This analysis was evaluated using four Models: 3-5-1, 3-10-1, 3-25-1, and 3-50-1, respectively. The way to decide the best architectural with the Backpropagation is to look at each model's highest degree of accuracy. The parameters used include the activation function tansig and logsig as well as the training function of the maximum limit of epoch 100000 and Lr 0,01. While the minimum error is 0,03-0,001.

3.2. Best Architectural Model

The best architecture model of the four models used is 3-10-1 based on the outcomes of the training and checking using the MATLAB program and measurements using Microsoft Excel. The results of Model 3-10-1 preparation and development process can be seen in the table 3 and table 4.

Table 3. Data Training Model 3-10-1

Data	Target	Output	Error	SSE
1	0,4124	0,4100	0,0024	0,0000055253
2	0,3964	0,3985	-0,0021	0,0000043500
3	0,4124	0,3815	0,0309	0,0009517594
4	0,4124	0,4444	-0,0320	0,0010271642
5	0,4570	0,4460	0,0110	0,0001203872
6	0,2498	0,2348	0,0150	0,0002250239
7	0,2753	0,3418	-0,0665	0,0044224090
8	0,3932	0,3886	0,0046	0,0000214100
9	0,3837	0,3160	0,0677	0,0045785981
10	0,4410	0,4647	-0,0237	0,0005599917
11	0,7661	0,7581	0,0080	0,0000645686
12	0,4092	0,4077	0,0015	0,0000021414
		Sum SSE		0,0119833286
		MSE		0,0011983329

Table 4. Data Testing Model 3-10-1

Target	Output	Error	SSE	Results
0,2817	0,4487	-0,1670	0,0278979163	1
0,4124	0,3910	0,0214	0,0004558480	1
0,3964	0,3920	0,0044	0,0000194864	1
0,4155	0,3940	0,0215	0,0004638789	1
0,4697	0,4248	0,0449	0,0020179066	0
0,6610	0,2080	0,4530	0,2051692967	0
0,4092	0,2646	0,1446	0,0208985612	0
0,4028	0,3751	0,0277	0,0007666721	1
0,3837	0,3567	0,0270	0,0007271295	1
0,4092	0,4320	-0,0228	0,0005215127	1
0,4219	0,7442	-0,3223	0,1038693290	1
0,4060	0,4024	0,0036	0,0000127885	1
		Sum SSE	0,3628203259	75%
		MSE	0,0362820326	

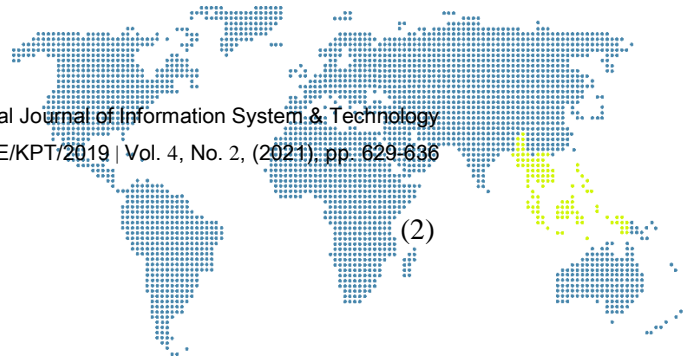
The following table provides comparisons of the outcomes of the preparation and assessment process with the architecture model used.

Table 5. Architectural Models

Models	Iterations	Time Finished	Training MSE	Testing MSE	Accuracy
3-5-1	23129	01.59	0,0011989470	0,0519604585	67%
3-10-1	25303	02.15	0,0011983329	0,0362820326	75%
3-25-1	22677	01.54	0,0011995743	0,0339720217	50%
3-50-1	10553	00.48	0,0011992075	0,0330532305	50%

3.4. Prediction Results

Predictions will be made using architectural models 3-10-1 using the formula to return the value:



$$x_n = \frac{(x - 0,1) * (b - a)}{0,8} + a \quad (2)$$

Explanation:

x_n = Prediction Results

x = Predicted Target

a = The lowest data from the dataset

b = Largest data from the dataset

The outcomes of forecasts can be seen in the table 6.

Table 6. Comparison of Preliminary Data with Inflation Prediction Results in Indonesia

Expenditures Group	Preliminary Data					Predictions		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	1,62	0,95	0,10	0,09	-0,32	0,41	-0,53	-0,80
2	0,12	0,21	0,12	0,04	0,09	0,01	0,05	0,09
3	0,13	0,09	0,02	0,09	0,04	-0,06	-0,04	0,02
4	0,09	0,06	0,28	0,09	0,10	0,03	0,12	0,04
5	0,42	0,34	0,21	0,23	0,27	0,18	0,23	0,21
6	-0,89	-0,37	-0,43	-0,42	0,87	0,44	-0,28	-0,21
7	0,04	-0,01	-0,09	-0,34	0,08	-0,02	0,04	0,01
8	0,18	0,07	0,02	0,03	0,06	0,13	0,15	0,02
9	-0,14	0,02	0,00	0,00	0,00	0,00	0,19	0,51
10	0,19	0,17	0,36	0,18	0,08	0,25	0,21	0,21
11	0,46	0,41	0,99	1,20	0,12	-0,04	0,85	1,20
12	0,39	0,28	0,10	0,08	0,07	0,19	-0,20	-0,01
Average	0,22	0,19	0,14	0,11	0,12	0,13	0,07	0,11

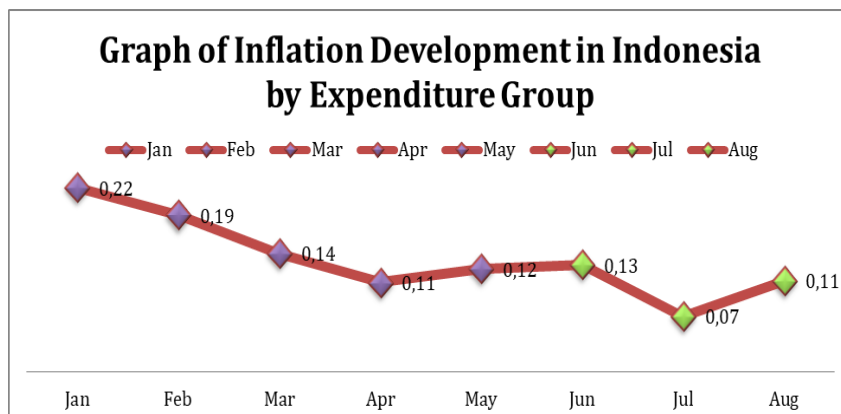


Figure 2. Comparison of Initial Data Charts with Predictions of Inflation Development in Indonesia

Based on the comparison of inflation data according to expenditure groups for January-May with the prediction results for June-August which are presented in table 6 and figure 2, it is estimated that there will be an increase in inflation in June of 0.01 compared to May, a decrease in inflation of 0.06 in July compared to June and increase back in August of 0.04 compared to July. There are interesting things that can be obtained from the data in table 6 and figure 2, in April-May the inflation rate tends to be stable, even though March was the month of the Covid-19 outbreak in Indonesia. Even in April-May inflation fell 0.2 and 0.3 compared to March. Meanwhile, based on the prediction results in June-August inflation experienced instability. This probably happened because of the impact of Covid-19 which greatly affected the economy in Indonesia. However,



based on the real data obtained from CBS, the resulting predictive data is not too different from the real data. For more details, see table 7.

Table 7. Comparison of real data with predictive data

Expenditures Group	Real Data (CBS)			Prediction Data			Difference Value		
	Jun	Jul	Aug	Jun	Jul	Aug	Jun	Jul	Aug
1	0,47	-0,73	-0,86	0,41	-0,53	-0,80	0,06	-0,20	-0,06
2	0,02	0,09	0,07	0,01	0,05	0,09	0,01	0,04	-0,02
3	-0,04	-0,01	0,02	-0,06	-0,04	0,02	0,02	0,03	0,00
4	-0,03	0,10	0,08	0,03	0,12	0,04	-0,06	-0,02	0,04
5	0,13	0,29	0,06	0,18	0,23	0,21	-0,05	0,06	-0,15
6	0,41	-0,17	-0,14	0,44	-0,28	-0,21	-0,03	0,11	0,07
7	-0,06	0,02	0,03	-0,02	0,04	0,01	-0,04	-0,02	0,02
8	0,13	0,15	0,05	0,13	0,15	0,02	0,00	0,00	0,03
9	0,00	0,16	0,57	0,00	0,19	0,51	0,00	-0,03	0,06
10	0,28	0,15	0,13	0,25	0,21	0,21	0,03	-0,06	-0,08
11	-0,08	0,93	2,02	-0,04	0,85	1,20	-0,04	0,08	0,82
12	0,18	-0,10	-0,05	0,19	-0,20	-0,01	-0,01	0,10	-0,04

Based on table 7, it can be illustrated that each comparison of the real data value with the predicted data in June-August 2020 is not too different, or in other words, the predicted value is close to the real data value. For more details, see figure 3, figure 4 and figure 5.

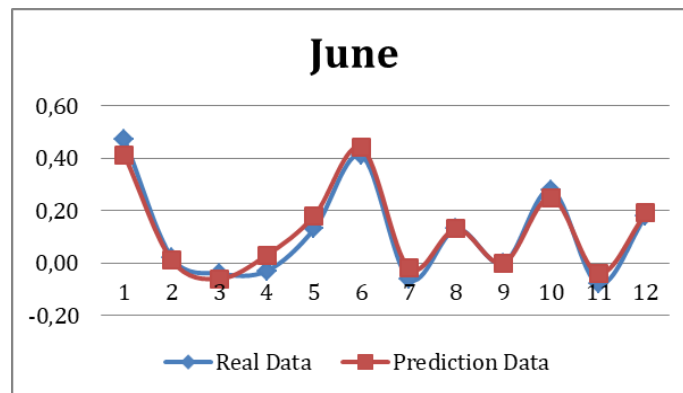


Figure 3. Graph comparing real data with predictive data (June 2020)

Based on the graph in Figure 3, it can be seen that real data with the prediction results for June 2020 are not too different (the prediction results are close to real data). Thus ANN Backpropagation is able to predict well.

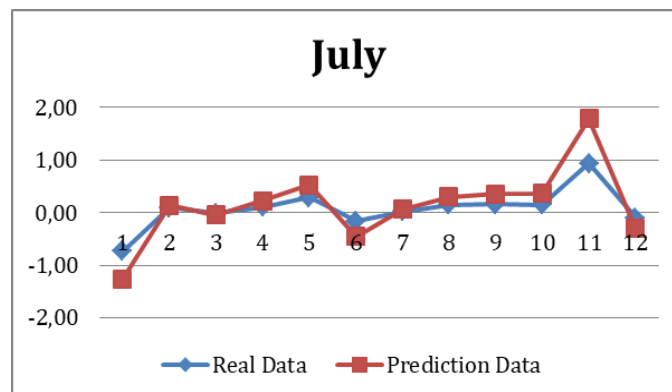
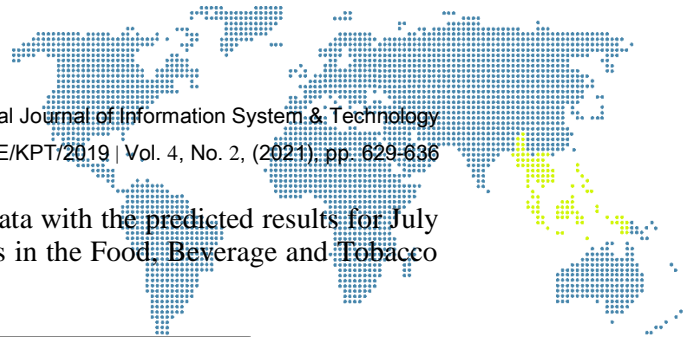


Figure 4. Graph of real data comparison with predictive data (July 2020)



Based on figure 4, it can be explained that the real data with the predicted results for July 2020 are not too different. The only big difference is in the Food, Beverage and Tobacco and Personal Care and Other Services groups.

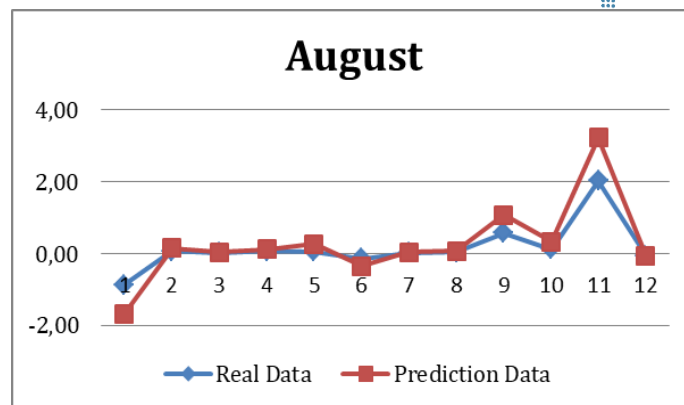


Figure 5. Graph comparison of real data with predictive data (August 2020)

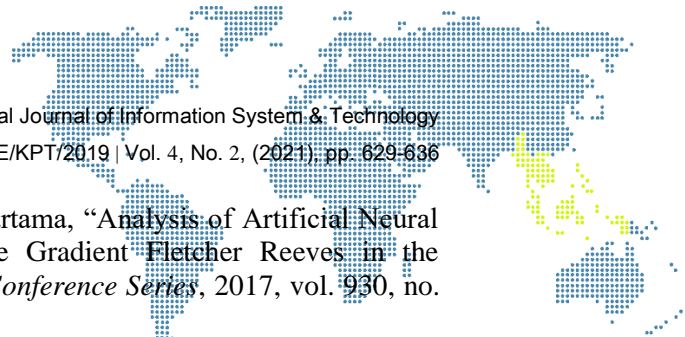
Based on figure 5, it can be explained that the real data with the predicted results for August 2020 are not too different (almost the same as in June and July 2020). The only big difference is in the Food, Beverage and Tobacco and Personal Care and Other Services groups.

4. Conclusion

ANN Backpropagation can be used to forecast inflation growth in Indonesia on the basis of expenditure classes. Centered on an overview of four architectural used in this research (3-5-1, 3-10-1, 3-25-1 and 3-50-1), the best 3-10-1 architectural model with a predictive accuracy of 75%. Based on the comparison of the prediction results with real inflation data in Indonesia based on expenditure classes in June-August 2020, the values are not too different. So that the ANN algorithm using the backpropagation method is highly recommended to be used to solve prediction problems, especially to predict the development of Indonesian inflation according to the Expenditure Group.

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