### Forecasting Using Back Propagation with 2-Layers Hidden

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**Abstract.** A critical indicator of government policy in economics is based on high inflation because it implicates the welfare of the society in a region. Therefore, it is necessary to have a computing system to see the inflation trend or pattern by looking at monthly data each year. This research aims to predict the rate of inflation using the ANN Back Propagation method based on GUI MATLAB with two hidden layers. Input data is the inflation data of NTB province by using monthly data for the last 11 years, the activation function is LOGSIG, and the training function is TRAINRP. The results of training and testing were obtained an average prediction of 0.213 with MSE of 0.0053. These results proved that inflation rate of 0.5% decreased, therefore categorized on medium inflation, with the highest inflation in April and the lowest one in July. The results showed that the Back Propagation method can be used as an alternative in predicting the rate of inflation in order to support sustainable economic growth so as to improve people's welfare in the future.

**Keywords:** Forecasting; ANN Back Propagation; Inflation Rate.

### 1. Introduction

Inflation is one of important indicators in analyzing the economy of a country and has a very wide impact on economic growth, external balance, competitiveness, interest rate, and even distribution of income. Inflation is a frequent problem that haunts the economy of every country. Its ever-increasing development provides barriers to economic growth towards the better [1]. Inflation is a tendency of the increasing price of goods in general that occurs continuously. Indonesia's economic condition will decline if inflation is not well controlled, and will cause the pros and cons of a country [2].

Every country in the world expects for a good economic growth, but there are definitely inhibitory factors in achieving better growth. A research shows that high level of inflation could be one of the inhibitory factors for a nation in achieving its growing economy because inflation increases the price of goods and services that are the basic needs of society continuously [3]. The price level in economy can be seen from two sides i.e. (1) When the price rises, the community must pay more than the previous price to buy an item; and (2) Price increase means the value of money becomes lower because it cannot be used to buy goods.

Stability of inflation becomes a requirement for sustainable economic growth, which then expected to provide benefits for improving people's welfare [4], [5]. The importance of inflation control is based on the consideration that high and unstable inflation can lead to a negative impact on the socio-economic condition of the community [6]. As for the negative impacts of inflation instability are: first, the decline of society real income due to the growing weight of society perceived life,
because it makes the price of goods and services increased. Of course, it greatly impacts on the community, especially those in middle-down society. Second, creating uncertainty that makes economic actors difficult to make decisions, consumption, production, and investment. Third, a higher domestic inflation rate when compared to the level of inflation in neighboring countries makes the real domestic interest rate uncompetitive, which can put pressure on the value of the rupiah (Amrin, 2014). Economic experts identify two types in inflation cause, which are the Demand-pull Inflation and the Cost-push Inflation. Demand-Pull Inflation occurs in the event of a large surge of government from the public against goods or services, but not balanced by the availability of required goods or services [6]. While the Cost-push Inflation is caused by increased production costs that usually caused by the increasing price of raw materials needed for industrial production processes.

Forecasting comes from a word of prophecy that means a situation or condition expected to occur in the future. It is the form of activity or approximate future value (Nusantara & Subanji, 2019). Forecasting is basically an activity that estimates what will happen in the future, and it is necessary to do so because of the time-lag between the realization of a new policy with the time needed for implementing the policy. If the time difference is long, then the role of forecasting becomes important and much needed, especially relates to the timing of when something will happen, so necessary actions can be prepared. Forecasting methods will assist in conducting an analysis approach to behaviour or patterns from the past data, to provide a systematic and pragmatic way of thinking, workmanship and solving, and providing a higher level of confidence in the accuracy of divination made. Generally, forecasting is done in the data time series managed by the Central Statistics Agency (BPS) in district, provincial, and national because it affects the policy determination made by the Government [9]. One of the most frequently used approaches to forecast is the Artificial Neural Network (ANN).

ANN is a form of artificial intelligence that has been widely applied in the field of computer, electrical engineering, physics, financial, and others. It is a computational method that mimics ANN biologically, so it is very similar to the nervous system in humans (Pramita et al, 2019). Its network determined by 3 things, namely (1) The pattern of Interneuron relations (called Network architectures); (2) The method to determine the connective weight (called training/learning method); and (3) The activation function, which is a function used to determine the output of a neuron. It is a flexible non-linear model class that can find adapted patterns from data. Theoretically, it has been demonstrated that it can provide an appropriate amount. Forecasting by using ANN, design of artificial neural network model, selection of input data, and testing & training using forecasting. ANN used as approaches to technical analysis. The advantage of artificial neural networks is to produce better results when applied to non-linear data from other non-linear methods such as bilinear and regression tree models. Neural Network Back Propagation is a multilayer that is trained by the error Back Propagation algorithm. Back Propagation consists of 3 layers, namely the input layer, hidden layer, and output layer. Back Propagation is a development of the previous form called a single-layer network that only has 2 layers, namely the input layer and output layer. The discovery of Back Propagation that has more than two layers is an innovation in the technological world. Moreover, with a lot of assisted applications, Back Propagation is increasingly interested than before. The previous Back Propagation has only one layer certainly weaker than the current because it contains many weaknesses, namely the limitation in the introduction of the pattern. This weakness can be solved by adding one or more hidden layers between the input layer and the output layer. In general, people will start trying with a hidden layer first [11]. Back Propagation neural network can study and store the mapping of input-output. The Back Propagation is chosen as a learning algorithm while the transfer function for both the hidden layer and the sigmoid layer output functions. Forecasting performances compared to these two models. The results show that the number of squared errors of the multilayer feed-forward neural network is the lowest then the multilayer neural network context is the better model (Irawan et al, 2013).

To predict data on the monthly inflation rate in NTB province, which is classified by the NTB Statistical Center, the authors use the Back Propagation method, which is a model of neural networks (JST) using multilayer architecture that is often used by finding the optimal weight in artificial tissue
ANN is an information processing system that has the same performance characteristics as the human neural network [14]. Back Propagation is the most widely applied method of neural network architecture, where the hallmark of this method is minimizing errors in the output generated by the network. It trains the network to get a balance of tissue recognizing patterns used during training, as well as networking capabilities to provide a correct response to similar (but not equal) input patterns to the pattern used during training. Neural network Back Propagation has an advantage because the learning done repeatedly so that it can realize a system resistant to damage and consistently works well.

2. Methodology

In this stage, the authors collect data from the last 11 years to be used as training and testing data, where the inflation data of NTB Province in 2009-2019 is to be easily understood. Furthermore, the accuracy parameters used in this forecasting consist of Mean Absolute Deviation (MAD), Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE), and Root Mean Squared Error (RMSE). As for the formula as follows:

\[
MAD = \frac{1}{n} \sum_{t=1}^{n} |X_t - F_t| 
\]

\[
MSE = \frac{1}{n} \sum_{t=1}^{n} (X_t - F_t)^2 
\]

\[
MAPE = \left( \frac{1}{n} \right) \sum_{t=1}^{n} \left| \frac{X_t - F_t}{X_t} \right| \times 100\% 
\]

\[
RMSE = \sqrt{\frac{1}{n} \sum_{t=1}^{n} (X_t - F_t)^2} 
\]

With the \( X_t \) is the actual data on the \( t \) period, \( F_t \) is the forecasting value in the \( t \)-period, \( n \) is the amount of data, and \( t \) is the time series (period). The process of training, testing, and prediction of NTB inflation data using the Back Propagation method follow the following groove.

3. Result and Discussion

3.1 Initial Conditions

In this stage, the author collects monthly data from the last 11 years. The amount of data taken will be the matrix size of the input. In training and testing data used as much as 10 years consisting of 12 months, so that the size of data input as much as \( 10 \times 12 = 120 \) data, while in the prediction data used by 11 years so that the size of input matrix as much as \( 11 \times 12 = 132 \) data. Because ANN Back Propagation uses two hidden layers, then the amount of data on the layers hidden 1 as much as 20 data and on the layers hidden 2 as much as 5 data.
This architecture design ANN Back Propagation to determine the best architecture by using certain parameters through training and testing data that has been shared before. The architectural parameters used in this research are: (1) Activation function each layer is LOGSIG, (2) number of neuron at input layer 120 for training and testing, and 132 for prediction, (3) training method is TRAINRP, (4) maximum epoch is 1,000, (5) goal or error is 0.0001, and (6) learning rate is 0.9.

3.2 Results of Training and Testing

The number of input neurons used as much as 120, the layer hidden-1 as much as 20, the layer hidden-2 as much as 5, and the output layer as 1. The results of the simulation are obtained forecasting chart results and regression value of 0.99454. Graphs of the actual data approach and prediction data are shown in Figure 2 and Figure 3 below.

3.3 Results Simulation

From the experiments done, we can see that the training method TRAINRP has the highest level of accuracy and has the result of good error parameters namely MSE 0.0053018 and Regression (R) of 0.99454. The smaller the outcome of the MSE obtained, the better because the closer the predictions are sought. Therefore, the ANN Back Propagation method is suitable to determine the rate of inflation because it is closer to the sought and has combined the training method, activation function, and complete error parameters therefore it provides output with a very small error. This is proved by the results of simulated data performance (regression) of 0.99454. From the simulation above the author can make predictions and know the result of the predictions of the next 12 months of inflation rate cases in the NTB, in January is 0.1426%, February is 0.0155%, March is 0.251, April is 1.3083, May is 0.524, June is -0.0466, July -0.0581, August is -0.8241, September is 0.8241, October is 1.2343, November is -0.1905, and December is -0.5046. If compared with the data in 2019, then there is the noticeable decline in January of 72%, the increase in February of 104%, the increase in March amounted to 214%, the decline in April amounted to 227%, the decline in May of 36%, the decline in June of 186%, the decline in July amounted to 55%, the decline in August amounted to 111%, the increase in September amounted to 116%, the increase in October by 180%, the decrease in November by 179% and the decline in December amounted to 240%. Based on the data, we can see the average trend data each year from the inflation data in the NTB province as in Figure 4 below.
Each year shows the progress of increasing or decreasing inflation in NTB province, the government always anticipates by making policy preparation to maintain the economic stability of the community. The Government and Bank Indonesia (BI) policies agreed to take three strategic steps to maintain the inflation rate of the Consumer Price Index (CPI) in the range of 3.5% ± 1% as per the target year 2019 [15]. This decision taken in the coordination meeting between the institutions and the ministries incorporated in the Central Inflation Control Team (called TPIP). The three strategic steps agreed are: (1) maintaining inflation within the target range, especially supported by the maximum volatile food inflation control in the range of 4-5%. This strategy is done through four key policies related to (1) affordability, (2) supply availability, (3) smooth distribution, and (4) effective communication. Referring to national inflation Control roadmap 2019-2021, this policy is taken by giving priority to supply availability and smooth distribution, backed by a more conducive ecosystem and accurate data availability; (2) Strengthening the implementation of the road map of national inflation control 2019-2021 by also conducting the implementation of the road map of inflation control at the provincial level; and (3) Strengthening coordination of the central and local governments in the control of inflation through national coordination meeting of inflation control in July 2019 with Synergy theme and innovation of inflation control for inclusive economic strengthening [16], [17]. Next will be followed up by the regional inflation control team (called TPID). From this strategic policy if relying on Table 2 prediction results, then NTB province is still within the targeted range, meaning it is still under normal conditions.

4. Conclusion

From the results of simulation data and the above discussion, we can find out the results of forecasting data on the inflation rate in the province of NTB by using one function activation of each layer is "LOGSIG" and the training method is TRAINRP. The training method TRAINRP is the best method with the highest accuracy value that results in a good error parameter with the value of MSE 0.0053018 and Regression (R) of 0.99454. So this ANN Back Propagation method is suitable for
simulating the prediction of inflation rate data. The predicted results of the inflation average in 2020 in NTB province amounted to 0.188%. The results of this prediction are also known to be the highest increase in Feb, March, April, July, September, October. In January, May, June, November, and December, there is a decline. This trend does not show that the inflation rate in the NTB province is out of the interval limit set by the central government. So, throughout the year the state of inflation in NTB province is still relatively normal.

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