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MODIFICATION OF MULTILAYER PERCEPTRON USING DETECTION RATE MODEL FOR PREDICTION OF NOMINAL EXCHANGE RATE

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ABSTRACT
An artificial neural network (ANN) is a network of a group of units to be processed which is modeled based on the behavior of human neural networks. ANN has one of its tasks, namely prediction. Multilayer perceptron (MLP) is one of the ANN methods that can be prediction all of data. Where the prediction needs to be reviewed because the prediction process does not always run normally. So, it takes a good measurement accuracy in order to get an accuracy sensitivity. The accuracy technique in this paper is carried out using Mean Absolute Percentage Error (MAPE) based on absolute error and detection rate. The results obtained with absolute error achieve an accuracy of 99.73% while the accuracy based on the detection rate achieves an accuracy of 99.49%. this can be seen in the case of the prediction of (Indonesian Rupiah) IDR exchange rate against United State Dollar (USD) with the MLP algorithm by testing using MAPE to achieve sensitivity with absolute error.
Keywords: *Prediction, MLP, MAPE, Detection Rate.*

1. Introduction

Data mining is a technique used to gain new knowledge from data (A.R. Lubis et al., 2019)(Al-Khowarizmi, 2017). One technique in data mining is prediction (Khowarizmi et al., 2020). Prediction is a technique used to find new models for specific purposes by utilizing data (Arif Ridho Lubis et al., 2020). (A.-K. Al-Khowarizmi, 2020) predicted the object image by testing the authenticity of Indonesian Rupiah (IDR) using one of the neural network methods.

Prediction accuracy is measured as the difference between the predictions produced by the model and reality, and a good level of accuracy occurs when approaching 100% with the meaning that the resulting model outputs closely approximate the data (Prayudani et al., 2019). The accuracy value calculated by error will change if there is a world movement or world chaos (Laszlo, 2014). Many factors affect world chaos such as virus outbreaks (Phua & Lee, 2005).

With the world pandemic, the first factor that will decline is the economy of a developing country (Shurui et al., 2020)(A Ridho Lubis et al., 2020). Many developing countries, of course, still use the United State Dollar (USD) exchange rate as a benchmark (Bakri et al., 2019)(Dai et al., 2020). In Indonesia, the movement of money is still following the USD exchange rate, so with the third occurrence of a worldwide viral outbreak, the USD movement increases (Setyani, 2017). For this reason, prediction in nominal exchange rates is needed if an outbreak occurs in order to predict future rates.

In doing prediction, an appropriate method is needed, namely artificial neural network (ANN) (A. Al-Khowarizmi et al., 2017). ANN is a network of a group of processing units that are modelled based on the functioning of biological neural networks and nervous systems (Guiné et al., 2020)(Kheirollahpour et al., 2020). (Hutagalung et al., 2020) conducted research by applying human habits to determine the best rice to be consumed by the community. In addition, (Arif Ridho Lubis et al., 2019) also detected someone's blood sugar with Markov chain probability based on human habits. Many researchers who use ANN such as (Al-Khowarizmi, 2014) examine to detect a person's psychological disorders by using the Analytical Hierarchy

Process (AHP) method. So, the application of ANN is able to assist in the prediction which is then useful for forecasting or prediction (Rahmat et al., 2016)(Clarina & Fitriany, 2019).

Research related to this prediction is also useful as a development in the field of data but the business sector in order to create the concept of business intelligence (BI) (F, Fauzi; Al-Khowarizmi, 2020)(Bakri et al., 2019). As (Al-Khowarizmi et al., 2020)(Al Khowarizmi, Rahmad Syah, Mahyuddin K. M. Nasution, 2021) is carried out classification to predict future Crude Palm Oil (CPO) prices by using Simple Evolving Connectionist System (SECoS) and K-Nearest Neighbor (KNN). So, all concepts of ANN must be applied in various applications because the effects of the application must touch to all fields of education, economics, social, health and other sciences.

2. Literature Review

ANN is a replica of the nervous system found in biological brain and nervous systems. The human brain is composed of billions of neurons where each neuron will be connected to tens of thousands of other neurons. A neuron is composed of 3 main components namely (Schikuta, 2008)**:**

1. *Dendrites, are input signal channels whose connection strength is affected by a synaptic strength or weight.*
2. *Cell Body, is a place for computing the weighted input signal to produce an output signal that will be sent to neurons.*
3. *Axon, is the part that sends output signals to other neurons that are connected to neurons*.

One ANN model is the Multilayer Perceptron (MLP) which is a perceptron with two or more trainable weight layers. A Single layer Perceptron can linearly divide the input space with a single hyperplane, while MLP can divide the input space into complex polygons by positioning multiple intersecting hyperplanes. MLP are universal function approximators. An n-layer perceptron is an n-variable weight layer and n + 1 neuron layer with layer 1 neurons as the input layer. The form of MLP can be seen in Fig. *1*. below (Marques & Creus, 2012):

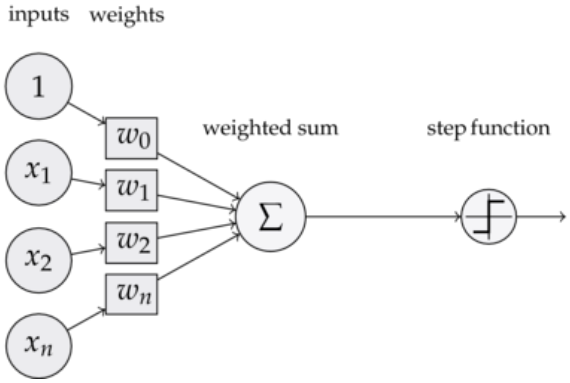

Fig. 1. Multilayer Perceptron

Fig. *1* above shows the application of ANN for data to be used for prediction. Then it will simply be obtained by multiplying each sample data input with a weight value then adding it up, then the result of the sum being the input for the activation function to produce parameters. The activation function can be either a sigmoid function (1) or a hyperbolic tangent function (2) like the following equation:

$$f(x) = \frac{1}{1 + e^{-1}}$$

$$f(x) = \tan(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} \quad (2)$$

Where:
e is error value
x is input layer value

3. Material and Methods

3.1. Dataset

The data were obtained from IDR/USD Historical data website: www.investing.com. The datasets in this paper are IDR to USD Exchange and US Dollar index. The datasets are recorded during the period of January 1st 2020 to May 20th 2021. The dataset was partitioned into a training dataset and a testing dataset. The training dataset covers the period from January 1st 2019 to January 1st 2021, and the testing dataset covers from January 2nd 2021 to May 20th 2021.

3.2. General Research Architecture

General research architecture is very important for explaining research. This research is an optimization with modifying the MLP algorithm in measuring accuracy in MAPE by inserting a detection rate model. The general architecture in this paper is shown in Fig. *2*:

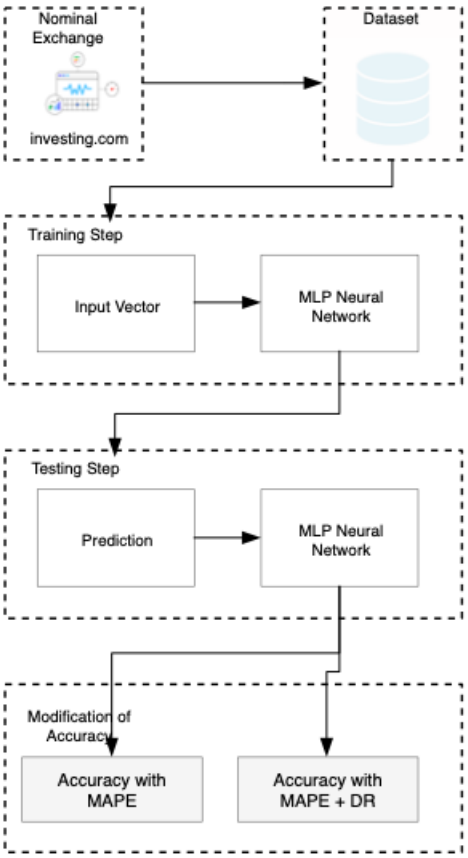

Fig. 2. General Architecture

In Fig. *2* it can be seen that the dataset is in the form of IDR to USD exchange, then data training and data testing are carried out using the MLP algorithm. From the results of data testing, accuracy measurement is carried out. where to get accuracy by using MAPE. but in this paper MAPE is tested twice. the first uses absolute error and the second uses detection rate. The MAPE uses absolute error as follows (Lasisi et al., 2016):

$$MAPE = \frac{\sum_{t=1}^{n} \left| \frac{a-b}{a} \right|}{n} \times 100\% \quad (3)$$

And secondly, the Mean Absolute Percent Error (MAPE) Accuracy based on the Detection Rate is shown in Equation (4) as follows (A. Al-Khowarizmi et al., 2017):

$$MAPE(Mod) = \frac{\sum_{t=1}^{n} |DR|}{n} \times 100\% \quad (4)$$

and,

$$DR = \frac{a}{a+b} \quad (5)$$

Where:
a = actual data
b = result data
n = lots of data.

4. Results and Discussions

The prediction in this paper uses large-capacity data so that the process is more accurate. Data is real data obtained from www.investing.com. The data was taken from January 1st, 2021 to May 20th, 2021 and in general it is known that February 25th, 2020 in Indonesia has been exposed to the World outbreak or Corona Virus Disease (COVID 19). Determine the impact on economic activity and an increase in the nominal exchange rate. When there is an increase in the price of the US dollar, a prediction process is needed for business people, stack holders, and the government to take a stand. The nominal exchange rate data is shown in Table 1 below:

Table 1 - Dataset of Nominal Exchange rate.

Date	1 USD to IDR
May 20th, 2021	14,397.5
May 19th, 2021	14,275.0
May 18th, 2021	14,270.0
May 17th, 2021	14,280.0
May 11th, 2021	14,195.0
May 10th, 2021	14,195.0
May 07th, 2021	14,280.0
…..	…..
…..	…..
…..	…..
Jan 13th, 2020	13,668.0
Jan 10th, 2020	13,762.5
Jan 09th, 2020	13,850.0
Jan 08th, 2020	13,892.5
Jan 07th, 2020	13,875.0
Jan 06th, 2020	13,940.0
Jan 03rd, 2020	13,925.0
Jan 02nd, 2020	13,889.0
Jan 01st, 2020	13,882.5

From Table 1 it can be seen that there was an increase in the price of the USD when the pandemic (COVID 19) was experienced by Indonesia. From the complete data that is summarized in Table 1, we produced the plot in Fig. *3*:

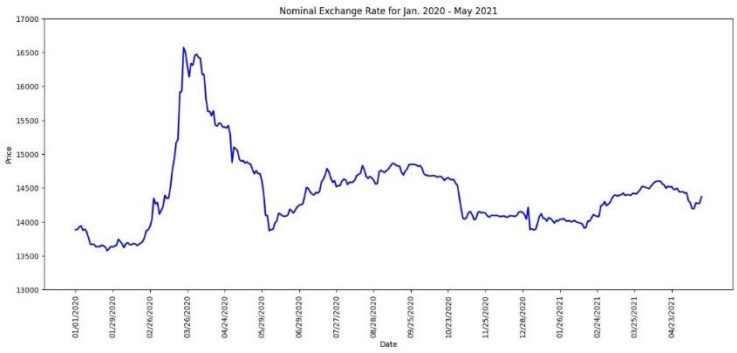

Fig. 3. IDR-USD exchange rate

Fig. *3* graphically shows the increase in the nominal exchange rate of USD against IDR. From this process, prediction is carried out using ANN in this case using MLP so that the prediction results can predict the nominal exchange rate of IDR against USD in the future where the evaluation results produce accuracy techniques with MAPE besides that MAPE is modified with a detection rate to get the smallest error results. Prediction using the process provided in

Fig. *1* based on equations (1) and (2) with various iterations and epochs. The results of the prediction can be seen in Fig. *4*:

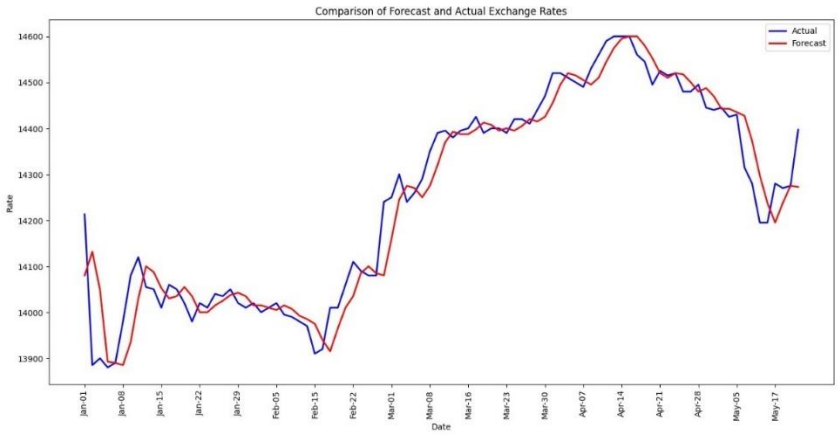

Fig. 4. Prediction Result with MLP

Fig. *4* shows the results of the prediction using MLP algorithm. In accordance with the purpose of this research, and the results of Fig. *4* can also be seen that the prediction runs from January 1, 2020 to January 1, 2021, while the test is from January 2, 2021 to May 20, 2021. The prediction process is going well where the results of testing need to measure accuracy to get good sensitivity. The accuracy process uses MAPE based on the absolute value of the error and uses the detection rate. where MAPE which involves absolute error uses equation (3) while MAPE which uses detection rate uses equation (4). Accuracy results with absolute error and detection rate are shown in Table 2:

Table 2 – Summary of Prediction results.

Actual Values	Predict Values	Absolute Error	Detection Rate
14397	14272.5	0.008647635	0.502171297
14275	14275	0	0.5
14270	14237.5	0.002277505	0.500570025
14280	14195	0.005952381	0.501492537
14195	14237.5	0.002994012	0.499252616
14195	14297.5	0.007220852	0.498201281
14280	14372.5	0.006477591	0.49838583
14315	14427.5	0.007858889	0.498042968
14430	14435	0.0003465	0.49991339
14425	14442.5	0.001213172	0.499696891
14445	14442.5	0.00017307	0.500043271
14440	14470	0.002077562	0.499481148
14445	14487.5	0.002942195	0.499265532
14495	14480	0.00103484	0.500258844
14480	14500	0.001381215	0.499654934
13970	13985	0.001073729	0.499731712
13980	13992.5	0.000894134	0.499776566
13990	14007.5	0.001250893	0.499687472
13995	14015	0.001429082	0.499642985
14020	14005	0.0010699	0.500267618
14010	14010	0	0.5
14000	14015	0.001071429	0.499732286
14020	14015	0.000356633	0.500089174
14010	14035	0.00178444	0.499554288
14020	14042.5	0.00160485	0.499599109
14050	14037.5	0.00088968	0.500222519
14035	14025	0.000712504	0.50017819
….	….	….	….
….	….	….	….
….	….	….	….
13980	14035	0.003934192	0.499018383
14020	14055	0.002496434	0.49937667
14050	14035	0.001067616	0.500267046

14060	14030	0.002133713	0.500533998
14010	14052.5	0.003033547	0.499242762
14050	14087.5	0.002669039	0.499333629
14055	14100	0.003201708	0.499200852
14120	14030	0.006373938	0.501598579
14080	13935	0.010298295	0.502587899
13980	13885	0.006795422	0.501704647
13890	13890	0	0.5
13880	13892.5	0.000900576	0.499774957
13900	14049	0.010719424	0.497334431
13885	14131.5	0.017752971	0.495600807

The absolute error for each prediction by date is plotted in Fig. *5*:

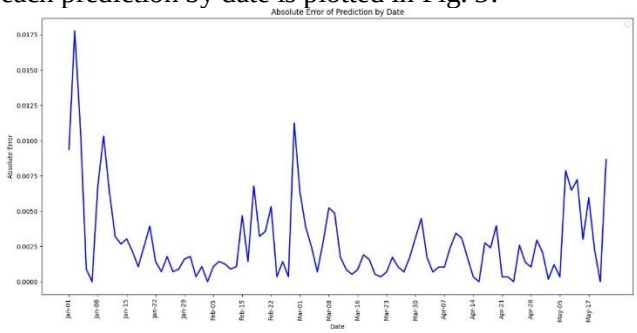

Fig. 5. absolute error

The Detection Rate (DR) by date is plotted in Fig. *6*:

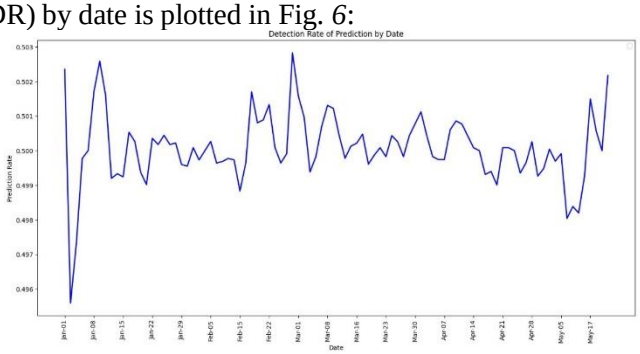

Fig. 6. detection rate

After prediction based on Table 2, the next step is to calculate the accuracy measurement with MAPE. The MAPE is based on absolute error through equation (3) as follows:

$$MAPE\ (Abs\ Error) = \frac{0.243611}{93} \times 100\%$$

$$MAPE(Abs\ Error) = 0.02\%$$

From these calculations, it can be seen that the MAPE results are based on an absolute error of 0.02%. Then calculations are also carried out with MAPE to obtain accuracy based on the detection rate as follows:

$$MAPE\ (Mod) = \frac{46.002}{93} \times 100\%$$

$$MAPE\ (Mod) = 0.51\%$$

From the calculation achieved by MAPE based on the detection rate rain the value of 0.51%. MAPE which is the average error value which in this paper is calculated twice which will be used as a comparison. so based on this, the accuracy produced can be seen in Fig. *7*.

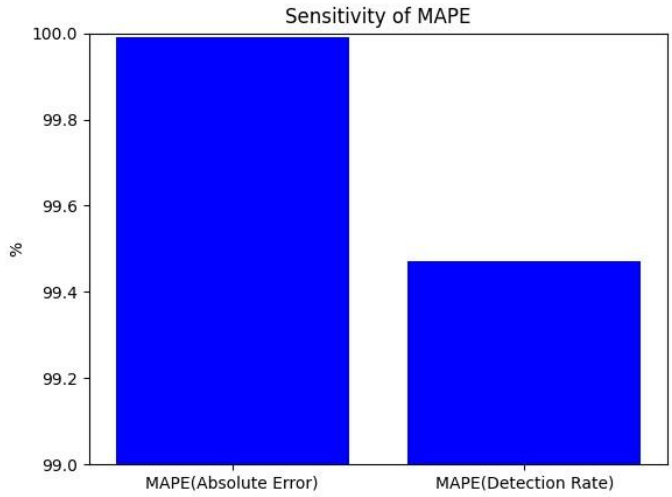

Fig. 7. Sensitivity of MAPE

From Fig. *7* it is clear that the accuracy generated from MAPE with an absolute error of 0.02% is an accuracy of 99.97%. while MAPE is generated with a detection rate of 0.51% so the resulting accuracy is 99.49%. this shows that MAPE based on absolute error and MAPE based on detection rate has a sensitivity that is not much different but very accurate accuracy in this study using MAPE based on absolute error. Thus it can be stated that the modified algorithm can run well in various fields and can adapt to various circumstances.

5. Conclusion

This paper predicted the USD to IDR exchange rate with ANN applying the MLP algorithm. The prediction process ran well and accuracy has been calculated with MAPE. MAPE results based on Absolute error reached a value of 0.002% so that the accuracy reached 99.73%. while MAPE based on Detection rate reached 0.51% so that the accuracy achieved was 99.49%. These results are very optimal by obtaining MAPE sensitivity based on absolute error values so that research can be applied to be used by the public to predict the rupiah exchange rate against the USD.

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