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Prediction of the Dollar Exchange Rate Against the Rupiah Based on Indonesian Economic Growth using the Long Shortterm Memory (LSTM) Method

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Abstract

This study aims to predict the Dollar-Rupiah exchange rate based on Indonesia's economic growth using the Long Short-Term Memory (LSTM) method. Exchange rate fluctuations that occurred from 1997 to 2024 have had a significant impact on national economic stability, so a predictive model capable of accurately interpreting historical patterns is needed. Research data was obtained from the Central Bureau of Statistics (BPS), Bank Indonesia (BI), and global economic sources with variables used including the Dollar-Rupiah exchange rate, Gross Domestic Product (GDP), inflation, and interest rates. The research stages include data preprocessing, LSTM architecture development, training, and testing using Google Colab. The results show that the LSTM model is able to produce exchange rate predictions that are close to actual data with a relatively low error rate. Thus, the LSTM method can be used as an effective approach to assisting in the analysis of exchange rate movements and supporting economic policymaking in Indonesia.

Keywords: *Prediction, LSTM, Exchange Rate, Economic Growth, Time Series*

1. Introduction

LSTM is one of the architectures of RNN (Recurrent Neural Network) designed to solve problems in RNNs, namely gradient explosions (exploding gradients) and vanishing gradients when learning data stored in long-term memory. So LSTM is suitable for prediction and classification cases that have to do with time. [1]In this study, the Long Short-Term Memory (LSTM) method was used to predict the exchange rate of the rupiah against the US dollar until 2045. By understanding the historical pattern of the exchange rate and the economic factors that affect it, this study is expected to provide insight into the direction of the movement of the rupiah exchange rate in supporting the achievement of Indonesia Gold 2045.This study aims to predict the exchange rate of the dollar against the rupiah based on macroeconomic variables such as Gross Domestic Product (GDP), inflation, interest rates, world oil prices, and others, using the LSTM model. The predicted results are expected to provide useful insights for investors, policymakers, and the general public in understanding the direction of exchange rate movements and their implications for the Indonesian economy in the future.

1.1. Problem Formulation

The scope of the problems discussed in this report is as follows:

1. The data used in this study comes from official sources such as the Central Statistics Agency (BPS), Bank Indonesia (BI), and other global economic institutions.
2. The data period used is January 1997 to December 2024 with monthly data resolution.
3. The variables used in this study include: Rupiah exchange rate against USD, Gross Domestic Product (GDP), Inflation, Interest rate, Foreign exchange reserves, Trade balance, World oil prices, Composite Stock Price Index (JCI), US Dollar Index (DXY).
4. The method used in the prediction is Long Short-Term Memory (LSTM), without comparing it to other methods such as regression or ARIMA.

1.2. Research Objectives

Through this research, it is hoped that the following goals will be achieved:

1. Analyzing the historical pattern of the rupiah exchange rate against the US dollar based on data from 1997-2024.
2. Evaluate the accuracy of the Long Short-Term Memory (LSTM) method in predicting the rupiah exchange rate.
3. Identify the trend of the rupiah exchange rate based on the prediction results using the LSTM method.
4. Analyze whether the predicted rupiah exchange rate trend supports Indonesia's economic growth and competitiveness targets as designed in the Golden Indonesia 2045 vision.

2. Literature Review

2.2. Exchange Rate

The exchange rate is an important factor in the economic stability of a country. Money, investment and international trade policies are greatly influenced by changes in the exchange rate of the dollar and rupiah [2]. Based on this, this study uses the Long Short Term Memory (LSTM) method to predict the exchange rate of the dollar against the rupiah by considering economic growth data.

2.3. Gross Domestic Product (GDP)

GDP is one of the elements that functions as the main indicator of a country's economic stability and the total added value generated by all business units in a given country, or the total final goods and services produced by all economic units. In this study, GDP is used as a representation of Indonesia's economic growth which is an important variable in predicting the exchange rate of the dollar against the rupiah using the Long Short Term Memory (LSTM) method.

2.4. Inflation

Inflation is a condition in which overall prices increase that continue at certain intervals of time. Inflation is related to changes in the value of a country's money that tend to decline when compared to goods and services that can be purchased [3]. This condition is closely related to the rupiah exchange rate against the dollar, so in this study inflation is considered as one of the important factors in predicting exchange rate movements using the Long Short Term Memory (LSTM) method.

2.5. Foreign Exchange Reserves

The benefits of foreign exchange reserves owned by a country are to maintain exchange rate stability and to fund shortfalls in the balance of payments as it develops [4]. This study utilizes the Long Short Term Memory (LSTM) method to predict the movement of the dollar exchange rate against the rupiah by considering the influence of economic growth as one of the main indicators.

2.6. Long Short Term Memory (LSTM) Method

Long Short Term Memory is a type of RNN that has been modified by adding memory cells that are able to store information for a long time. Long Short Term Memory studies which information will be stored and which information will be discarded, because each neuron of Long Short Term Memory has several gates that regulate memory on each of these neurons.[5]

The advantages of LSTM can be explained as follows : designed to store information over the long term without experiencing vanishing gradient problems, can recognize patterns in historical data and make predictions based on patterns, with the forget gate feature, LSTMs can automatically eliminate information that is no longer relevant, making it more efficient in processing long-term data and operate effectively on non-stationary data. [6]

3. Research Methods

This study uses a quantitative approach with the Long Short Term Memory (LSTM) method as the main technique in predicting the exchange rate of the dollar against the rupiah. The research process is carried out systematically to ensure that each stage runs in accordance with the research objectives. In general, the methodological stages of this research include data collection, data pre-processing, data processing, model training, model evaluation, and system interface creation.

3.1. Justification for Choosing the LSTM Method

The Long Short-Term Memory (LSTM) method was chosen in this study because it has superior ability to process and study complex time series data patterns. LSTMs are part of the Recurrent Neural Network (RNN) family that are specifically designed to recall long-term information, overcome vanishing gradient problems common in classical RNNs, and are particularly suitable for predicting volatile and time-sensitive exchange rates. Therefore, LSTM is a more effective solution because:

1. Capable of handling multi-variate time series data.
2. Be able to study the cause-and-effect relationship between economic variables over a long period of time.
3. Suitable for both temporal and dynamic data such as currency exchange rates.

3.2. Flowchart

The flowchart illustrates the process of building a Long Short-Term Memory (LSTM) model to predict the exchange rate of the dollar against the rupiah by taking into account various Indonesian economic indicators.

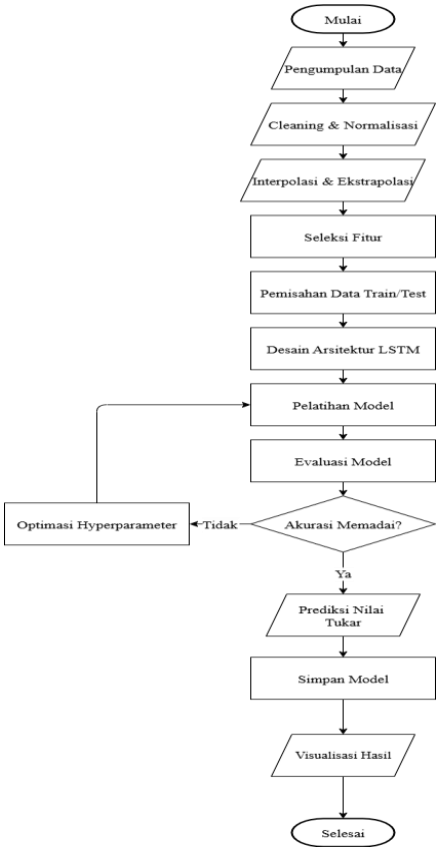

Fig. 1: Illustrates the process of building a Long Short-Term Memory (LSTM)

4. Conclusion Results and Discussion

Before the modeling process is carried out, the data goes through the preprocessing stage. This stage includes data cleansing to overcome missing values and outliers, as well as normalization using the Min-Max Scaler method so that the scale of each variable is in the same range. This is important so that the Long Short-Term Memory (LSTM) model can learn optimally without the dominance of one of the variables with a larger scale value.

After the data is normalized, the dataset is divided into two parts, namely the training set of 70%, validation of 15% and the testing set of 15%. This division aims to enable the LSTM model to study patterns from historical data as well as test its performance using data that has never been seen before. With this step, the level of accuracy of the model can be measured more objectively.

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Year | Prediction
--------------------
2025 | 16090.00
2026 | 16572.70
2027 | 17069.88
2028 | 17581.98
2029 | 18109.44
2030 | 18652.72
2031 | 19212.30
2032 | 19788.67
2033 | 20382.33
2034 | 20993.80
2035 | 21740.78
2036 | 22677.24
2037 | 23647.04
2038 | 24647.64
2039 | 25671.79
2040 | 26714.71
2041 | 27773.76
2042 | 28847.33
2043 | 29934.43
2044 | 31035.14
2045 | 32149.85

=== Model Evaluation ===
Monthly RMSE: 306.79
Monthly MAE: 237.18
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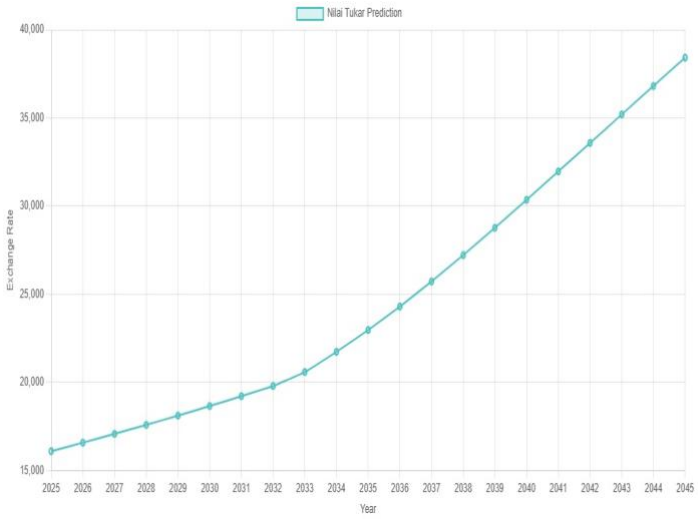

Fig. 2: Prediction

In general, the results of data processing show fluctuations in the dollar-rupiah exchange rate in line with Indonesia's economic growth conditions. For example, when economic growth slows down, the rupiah exchange rate tends to weaken, on the other hand, when economic growth increases steadily, the rupiah shows a strengthening tendency. This condition supports the hypothesis that macroeconomic variables, particularly economic growth, have an important role in exchange rate movements.

5. Conclusion

Based on the results of the research that has been conducted, several conclusions can be drawn as follows:

1. An exchange rate prediction model built using variables [name your variables, for example: inflation, interest rates, exports, imports, foreign exchange reserves] is able to provide an overview of the direction of exchange rate movements in the study period.
2. The predictions obtained are still estimates, as they are only based on historical data and certain variables used in the research.
3. Future exchange rates are greatly influenced by various external factors that are not covered by the model, such as geopolitical conditions, wars, sudden monetary policies, global crises, and natural disasters. Therefore, the results of this study are more appropriate to be used as a decision-making tool, not as absolute certainty.
4. Overall, the study shows that the use of methods (e.g., LSTM, regression, or the method you use) is quite effective at predicting exchange rate trends, although it still has limitations in the face of global uncertainty.

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