



UNDERGRADUATE THESIS

**PERFORMANCE ANALYSIS OF LSTM
ALGORITHM IN HISTORICAL DATA BASED
BITCOIN PRICE PREDICTION WITH MULTI
PRECIOUS METAL PRICE COMPARISON
VARIABLES**

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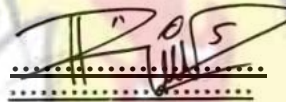
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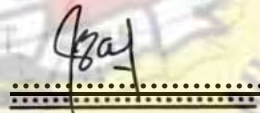
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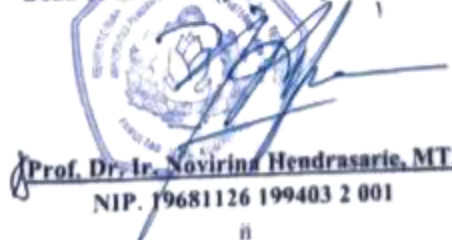
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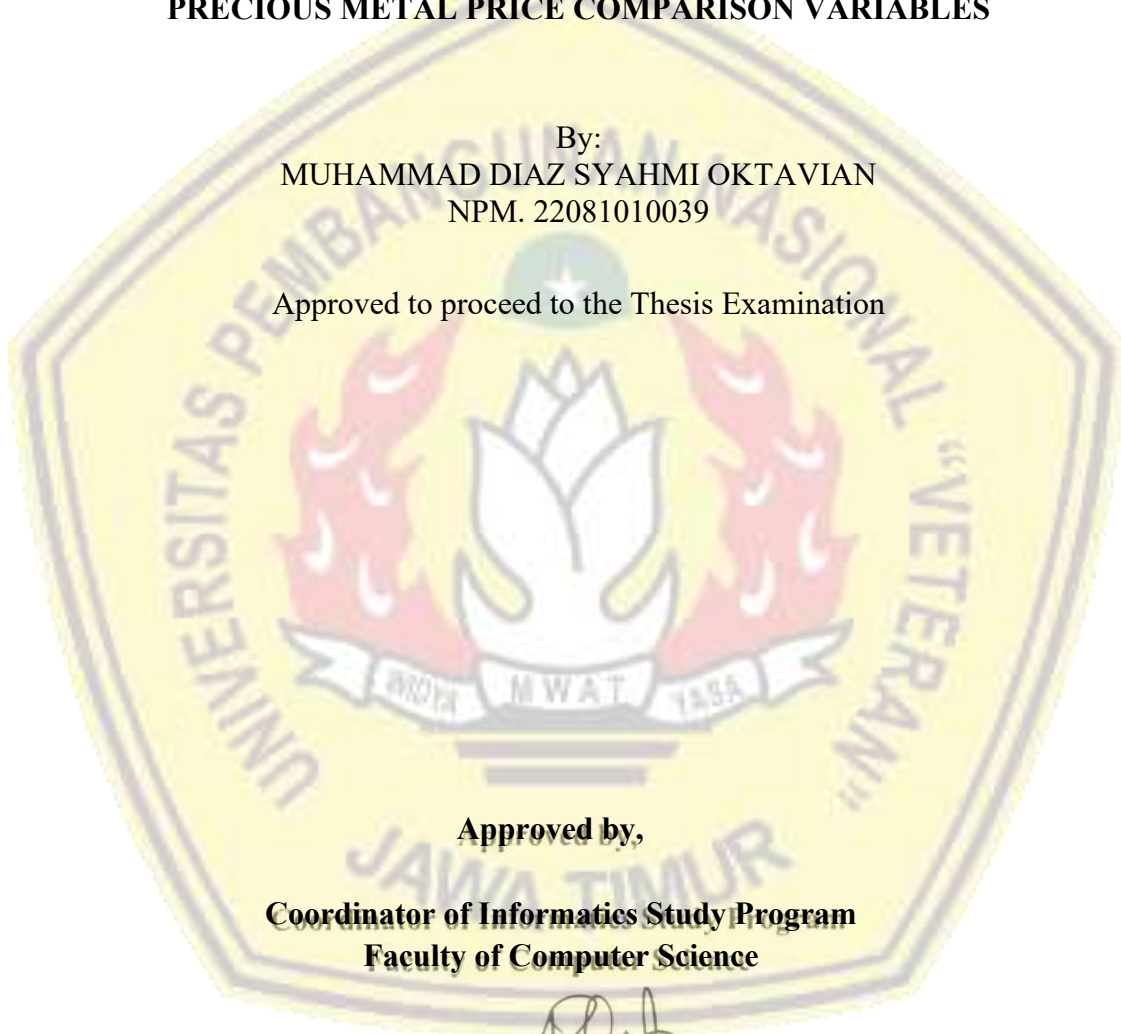
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ABSTRACT

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The extreme volatility of Bitcoin prices at high frequencies demands a highly responsive forecasting system. Traditionally, cryptocurrency fluctuations are solely associated with gold as a safe-haven asset; however, this approach often experiences a lagging phenomenon when responding to micro-market anomalies. This study aims to analyze the performance of the Long Short-Term Memory (LSTM) algorithm in predicting Bitcoin prices by comparing two architectures: a Bivariate scenario (utilizing Bitcoin and Gold variables) and a Multivariate scenario (integrating Multi-Precious Metal variables including Gold, Silver, Platinum, Palladium, and Rhodium). The evaluation was executed using time-series data with a 60-minute computational observation window. The experimental results indicated that the Bivariate model achieved an accuracy of 99.77% with a Mean Absolute Error (MAE) of 181.12 USD. In contrast, the Multivariate model demonstrated its superiority by increasing the accuracy to 99.84% and suppressing the MAE value to 130.24 USD (an error gap reduction of 50.88 USD). This reduction in computational error provides empirical confirmation that industrial metals (Platinum Group Metals) carry crucial predictive feature weights regarding cross-asset correlation. For operationalization, the algorithmic model was successfully implemented into a web-based Decision Support System using the Flask framework. This integrated system is capable of automating asynchronous API data fetching, facilitating interactive forecasting computation, and providing dynamic backtesting features to validate algorithmic transparency in real-time.

Keywords: Bitcoin, Crypto Price, Decision Support System, Deep Learning, LSTM, Multi-Precious Metal, , Web Dashboard.

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Muhammad Diaz Syahmi Oktavian

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LIST OF NOTATIONS

Symbol	Description
x_t	: Input data at time step t
h_{t-1}	: Output (hidden state) from the previous time step
h_t	: Output (hidden state) at time step t
C_{t-1}	: Cell state from the previous time step
C_t	: New cell state at time step t
\tilde{C}_t	: Candidate value for the new cell state
f_t	: Forget gate
i_t	: Input gate
o_t	: Output gate
W	: Weight matrix
b	: Bias vector
σ	: Sigmoid activation function
\tanh	: Hyperbolic Tangent activation function
N	: Total number of data samples (Samples)
T	: Length of the time window (Time Steps)
F	: Number of feature variables (Features)
x'	: Data value after normalization
$\min(x)$: Minimum value of the training data
$\max(x)$: Maximum value of the training data
n	: Number of testing data
Y_i	: Actual Bitcoin price value
\hat{Y}_i	: Predicted Bitcoin price value
MAE	: Mean Absolute Error
RMSE	: Root Mean Squared Error
MAPE	: Mean Absolute Percentage Error