PREDIKSI HARGA BITCOIN
MENGGUNAKAN METODE HYBRID LSTM-GRU

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ABSTRAK

Pergerakan harga *Bitcoin* yang sangat volatil menimbulkan tantangan dalam proses peramalan, terutama karena karakteristik data deret waktu yang bersifat *nonlinier* dan dipengaruhi oleh berbagai faktor pasar. Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi model prediksi harga penutupan *Bitcoin* menggunakan arsitektur *Hybrid Long Short-Term Memory–Gated Recurrent Unit* (LSTM–GRU) dengan pendekatan optimasi *hyperparameter*. Data yang digunakan merupakan data historis harian *Bitcoin* periode 2020–2025 yang diperoleh dari Yahoo Finance, dengan variabel harga dan volume perdagangan. Metodologi penelitian mengadopsi kerangka CRISP-DM yang meliputi tahap pemahaman bisnis, pemahaman data, persiapan data, pemodelan, evaluasi, dan penerapan. Proses optimasi *hyperparameter* dilakukan menggunakan *Grid Search*, *Random Search*, dan *Bayesian Optimization* untuk memperoleh konfigurasi model terbaik. Evaluasi kinerja model menggunakan metrik *Mean Absolute Error* (MAE), *Root Mean Square Error* (RMSE), dan *Mean Absolute Percentage Error* (MAPE), serta dilengkapi dengan pengujian statistik residual dan interval kepercayaan berbasis *bootstrap*. Hasil penelitian menunjukkan bahwa model *Hybrid* LSTM–GRU mampu menghasilkan tingkat akurasi yang tinggi dengan nilai MAPE sebesar 1,6861% dan interval kepercayaan 95% pada rentang 1,4445%–1,9320%, yang mengindikasikan performa model stabil dan tidak bias secara statistik. Temuan ini menunjukkan bahwa integrasi arsitektur *hybrid* dengan optimasi *hyperparameter* yang sistematis efektif dalam meningkatkan akurasi prediksi harga *Bitcoin*, serta berpotensi menjadi referensi bagi pengembangan model *deep learning* pada peramalan aset *kripto* di masa mendatang.

Kata Kunci: *Bitcoin*, Peramalan Harga, *Hybrid* LSTM–GRU, *Deep Learning*, Optimasi *Hyperparameter*, CRISP-DM.

BITCOIN PRICE PREDICTION
USING THE HYBRID LSTM-GRU METHOD

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ABSTRACT

The highly volatile price movements of Bitcoin pose challenges in the forecasting process, particularly due to the nonlinear characteristics of time series data and the influence of various market factors. This study aims to develop and evaluate a Bitcoin closing price prediction model using a Hybrid Long Short-Term Memory–Gated Recurrent Unit (LSTM–GRU) architecture with a hyperparameter optimization approach. The data used is historical daily Bitcoin data for the period 2020–2025 obtained from Yahoo Finance, with price and trading volume variables. The research methodology adopts the CRISP-DM framework, which includes the stages of business understanding, data understanding, data preparation, modeling, evaluation, and implementation. The hyperparameter optimization process was carried out using Grid Search, Random Search, and Bayesian Optimization to obtain the best model configuration. Model performance was evaluated using the Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE) metrics, supplemented with residual statistical testing and bootstrap-based confidence intervals. The results show that the Hybrid LSTM–GRU model is capable of producing a high level of accuracy with a MAPE value of 1.6861% and a 95% confidence interval in the range of 1.4445%–1.9320%, indicating that the model's performance is stable and statistically unbiased. These findings show that the integration of hybrid architecture with systematic hyperparameter optimization is effective in improving the accuracy of Bitcoin price predictions and has the potential to become a reference for the development of deep learning models for cryptocurrency forecasting in the future.

Keywords: *Bitcoin, Price Prediction, Hybrid LSTM-GRU, Deep Learning, Hyperparameter Optimization, CRISP-DM.*