CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results of the research and discussion conducted regarding the development and optimization of the Hybrid LSTM-GRU model for predicting banking stock prices, the following conclusions can be drawn to address the research questions:

1. This study successfully developed a Hybrid LSTM-GRU model that integrates technical data (daily historical prices) and internal company fundamental data (ROA and ROE) as multivariate input variables. This model is designed to capture long-term dependencies through the LSTM layer and computational efficiency through the GRU layer. Application of the model to six LQ45 index banking stocks (BBCA, BBNI, BBRI, BBTN, BMRI, and BRIS) shows that this hybrid architecture is capable of learning stock price movement patterns well, accommodating varying data characteristics ranging from stable trends to high volatility.
2. The implementation of the Genetic Algorithm (GA) has proven capable of significantly improving prediction accuracy, as the use of GA successfully improved the accuracy for the six banking stock issuers that were the subjects of this study. This improvement in prediction quality is the result of a structured evolutionary mechanism that ensures consistent and targeted improvement of solutions across each generation. Through the Selection mechanism (Tournament Selection), the algorithm does not take random samples but intelligently "selects" the best individuals (parents) with high accuracy to survive. This ensures that only promising model architectures are given the opportunity to reproduce. Through the Crossover mechanism, the superior traits of these "already good parents" are inherited and combined into their offspring. This creates a pattern of trait inheritance, where new generations do not start the search from scratch but build upon the solid foundation laid by previous generations (building blocks). Consequently, the search process becomes highly convergent and stable. The algorithm successfully maps specific architectures: 64/64 units for Big

Banks and 32/16 units for volatile stocks, proving that the solutions found are the result of the accumulation of the best genetic traits, not mere coincidence.

3. Quantitatively, the optimized Hybrid LSTM-GRU model demonstrated significantly superior performance compared to the unoptimized baseline model. The effectiveness of the Genetic Algorithm (GA) application is marked by a cumulative reduction in the average error values across all evaluation metrics, namely 18.42% for RMSE, 20.61% for MAE, and 19.80% for MAPE. These results demonstrate that the Genetic Algorithm-based optimization strategy is a valid and robust method for improving prediction accuracy in capital market analysis. Through the processes of selection, crossover, and mutation, the model successfully reached a global convergence point, enabling an architecture that is more adaptable to the various characteristics of stock price movements in the Indonesian banking sector.

5.2 Recommendations

Based on the research findings and the research limitations outlined above, several recommendations can be made for future research to ensure that the predictive results are more comprehensive and accurate:

1. Given that this study is limited to the use of historical numerical data and internal financial ratios, future research is recommended to incorporate external variables such as news sentiment analysis or social media sentiment analysis. Market psychological factors often have a significant impact on short-term stock price fluctuations that are not detected by technical or fundamental data alone.
2. This study limits the fundamental factors to the company's internal ratios (ROA and ROE). For future research, it is recommended to include macroeconomic indicators such as the inflation rate, the benchmark interest rate, and the exchange rate (Rupiah rate). The inclusion of these variables is expected to help the model predict the impact of monetary policy on the banking sector more accurately.

3. Although Genetic Algorithms have proven to be effective, further research could compare their performance with other metaheuristic algorithms, such as Particle Swarm Optimization (PSO) or Bayesian Optimization. Such a comparison would be useful for assessing computational efficiency and the quality of the solutions produced in the search for optimal hyperparameters.

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