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The COVID-19 pandemic in Indonesia has created a harrowing situation with surges in cases overwhelming healthcare facilities, the implementation of strict social restrictions, and significant impacts on the economic and social lives of the population. From the data on COVID-19 cases in Jakarta, it can be observed that the accumulation of positive cases since the onset of COVID-19 in Jakarta until April 2, 2023, is very significant. This study uses COVID-19 data from January 17, 2022, to April 17, 2022. This research conducted two simulation experiments using the Suspect-Infection-Recovered (SIR) and fourth-order Runge-Kutta models. The first experiment divides the dataset into three periods based on the trend of increasing and decreasing infection cases. The second experiment uses the entire dataset. Both experiments use the L-BFGS-B optimization method to find the optimal values of infection transmission rate and recovery rate. The performance results for the first experiment show a suspect value of 0.0112, an infection value of 0.0112, and a recovery value of 0.0017. Meanwhile, the performance results for the second experiment show a suspect value of 0.0204, an infection value of 0.0161, and a recovery value of 0.0097. Based on these results, it can be concluded that both the first and second experiments were able to simulate infections effectively. Still, the first experiment excelled in simulating suspects and recoveries. By conducting experiment in two experiments and using the L-BFGS-B optimization method to find the values of infection transmission rate and recovery rate, it is expected to achieve higher performance results and simulate the spread of COVID-19 in Jakarta more effectively.

**Keywords:** COVID-19, SIR Model, fourth-order Runge-Kutta, L-BFGS-B

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