INTISARI

METODE *LONG SHORT-TERM MEMORY* (LSTM), *GATED RECURRENT UNIT* (GRU), DAN *CONVOLUTIONAL LONG SHORT-TERM MEMORY* (CONV-LSTM) UNTUK PERAMALAN DATA RUNTUN WAKTU (Studi Kasus: Jumlah Kasus Positif Harian COVID-19 di Indonesia)

Oleh

Jesslyn Marcellina

18/430368/PA/18881

Pada penghujung tahun 2019, ditemukan virus corona baru bernama *Coronavirus Disease 2019* (COVID-19) di China. Virus ini sangat mudah menyebar sehingga menjadi pandemi di berbagai negara di dunia, salah satunya Indonesia. Pandemi COVID-19 menjadi permasalahan yang serius, maka pemodelan dan peramalan secara akurat terhadap jumlah kasus positif harian sangat penting untuk memahami dan membantu melakukan manajemen risiko untuk pengendalian terhadap wabah. Data jumlah kasus positif harian COVID-19 memiliki ketidakpastian dan kompleksitas dinamika dalam deret waktu, sehingga metode klasik seperti *Autoregressive Integrated Moving Average* (ARIMA) akan sulit untuk menghasilkan performa peramalan yang baik. Oleh karena itu, para peneliti berusaha mengembangkan beberapa model alternatif dengan pendekatan *machine learning* yang dapat mengatasi permasalahan tersebut, salah satunya adalah model jaringan saraf tiruan.

Dalam skripsi ini, digunakan tiga metode jaringan saraf pengembangan dari arsitektur *Recurrent Neural Network* (RNN) diantaranya *Long Short-Term Memory* (LSTM), *Gated Recurrent Unit* (GRU), dan *Convolutional Long Short-Term Memory* (Conv-LSTM). Arsitektur model dibentuk menggunakan dua lapisan tersembunyi dengan mencari kombinasi terbaik, yaitu pada arsitektur LSTM dan GRU digunakan kombinasi jumlah neuron sebesar 25, 50, 75, dan 100, sedangkan pada arsitektur Conv-LSTM digunakan kombinasi jumlah *convolutional filter* sebesar 32, 64, 128, dan 256. Lebih lanjut, dibentuk kombinasi arsitektur berdasarkan fungsi aktivasi yang digunakan dan penggunaan *dropout*. Berdasarkan analisis yang telah dilakukan, didapatkan bahwa model Conv-LSTM menghasilkan performa yang lebih baik dibandingkan dengan metode lainnya.

Kata Kunci: Jumlah kasus positif harian COVID-19, peramalan, *dropout*, fungsi aktivasi, *Long Short-Term Memory* (LSTM), *Gated Recurrent Unit* (GRU), *Convolutional Long Short-Term Memory* (Conv-LSTM)

ABSTRACT

LONG SHORT-TERM MEMORY (LSTM), GATED RECURRENT UNIT (GRU), AND CONVOLUTIONAL LONG SHORT-TERM MEMORY (CONV-LSTM) METHOD FOR TIME SERIES DATA FORECASTING

(Case Study: Daily New COVID-19 Cases in Indonesia)

By

Jesslyn Marcellina

18/430368/PA/18881

At the end of 2019, a new corona virus named Coronavirus Disease 2019 (COVID-19) was discovered in China. This virus rapidly spreading and becoming a pandemic that happened to various countries in the world, including Indonesia. This pandemic becomes a serious problem, so modeling and forecasting accurately the daily new COVID-19 cases is very important to understand and help carry out risk management for the outbreak control. The daily new COVID-19 cases data has uncertainty and dynamics complexity in the time series, so classic methods such as Autoregressive Integrated Moving Average (ARIMA) will be difficult to produce good forecasting performance. Therefore, the researchers are trying to develop several alternative models with a machine learning approach that can overcome these problems, one of which is an artificial neural network model.

In this thesis, three methods of neural network development from Recurrent Neural Network (RNN) architecture will be used, which are Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), and Convolutional Long Short-Term Memory (Conv-LSTM). The model architecture is formed using two hidden layers by looking for the best combination, LSTM and GRU architectures uses number of neurons combination of 25, 50, 75, and 100 while Conv-LSTM architecture uses number of convolutional filters combination of 32, 64, 128, and 256. Furthermore, combinations of architecture were formed based on the activation function used and the dropout usage. Based on the analysis that has been conducted, it is found that the Conv-LSTM model produces better performance than other methods.

Keywords: Daily new COVID-19 cases, forecasting, dropout, activation function, Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Convolutional Long Short-Term Memory (Conv-LSTM).