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MODELLING TRANSMISSION DYNAMICS OF COVID-19 DURING PRE-VACCINATION PERIOD IN MALAYSIA: A GUI-BASED SEIRD PREDICTIVE MODEL USING STREAMLIT

(Pemodelan Dinamik Penyebaran COVID-19 Sebelum Tempoh Pemvaksinan di Malaysia: Model Peramalan SEIRD Berasaskan GUI Menggunakan Streamlit)

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ABSTRACT

Coronavirus disease (COVID-19) is a major health threat worldwide pandemic, first identified in Malaysia on 25 January 2020. This outbreak can be represented in the mathematical expressions of a non-linear system of ordinary differential equations (ODEs). With the lack of a predictive SEIRD model in terms of Graphical Users Interface (GUI) in Malaysia, this paper aims to model the COVID-19 outbreak in Malaysia during the pre-vaccination period using the Susceptible-Exposed-Infected-Recovered-Death (SEIRD) model with time-varying parameters, then develop a GUI-based SEIRD predictive model using Streamlit Python library. The GUI-based SEIRD predictive model called GUI-mSEIRDsr predictor considers various values for the proportion of the quarantine-abiding population (r) and three different decisions regarding the MCO lifting date to forecast the number of active cases (I) on 15 October 2020. This information provides insightful information not only to government agencies but public as well, in understanding the effects of population behaviour to COVID-19 spread. The mathematical model is solved using the Scipy odeint function, which uses the Livermore Solver for Ordinary Differential Equations with an Automatic method switching (LSODA) algorithm. The time-varying coefficients of the SEIRD model that best fit the real data of COVID-19 cases are obtained using the Nelder-Mead optimisation algorithm. This extended SIRD model with exposed (E) compartment becoming SEIRD, leads to a robust model. It adequately fitted two datasets of Malaysian COVID-19 indicated by the slightest average values of Root Mean Square Error (RMSE) as compared to other existing models. The results highlight that the larger the values of the proportion of the quarantine-abiding population (r) and the later the date of the lifted MCO, the lower the spread of COVID-19 which eventually helps Malaysia to reach disease-free equilibrium in a shorter duration.

Keywords: COVID-19; GUI-SEIRD predictive model; pre-vaccination; Malaysia

ABSTRAK

Penyakit Coronavirus (COVID-19) merupakan ancaman kesihatan utama yang telah menjadi pandemik di seluruh dunia, pertama kali dikenal pasti di Malaysia pada 25 Januari 2020. Wabak ini boleh diwakili dalam ungkapan matematik sistem persamaan pembezaan biasa (ODE) bukan linear. Dengan kekurangan model SEIRD yang boleh meramalkan dalam penggunaan antara muka pengguna grafik (GUI) di Malaysia, makalah ini bertujuan untuk memodelkan wabak COVID-19 di Malaysia semasa tempoh pra-vaksinasi menggunakan model Susceptible-Exposed-Infected-Recovered-Death (SEIRD) dengan parameter yang berubah-ubah mengikut masa, kemudian membangunkan model ramalan SEIRD berasaskan GUI menggunakan perpustakaan Streamlit Python. Model ini juga dikembangkan menjadi model ramalan SEIRD berbasis GUI menggunakan perpustakaan Streamlit Python. Model ramalan SEIRD berasaskan GUI yang dipanggil sebagai peramal GUI-mSEIRDsr ini mempertimbangkan pelbagai nilai untuk bahagian penduduk yang mematuhi kuarantin (r) dan tiga keputusan berbeza mengenai tarikh pengangkatan Perintah Kawalan Pergerakan (MCO) untuk meramalkan bilangan kes aktif (I) pada 15 Oktober 2020. Maklumat ini memberikan

pandangan yang kepada agensi Kerajaan. Model matematik ini diselesaikan menggunakan fungsi Scipy odeint, yang menggunakan Penyelesaian Livermore untuk Persamaan Pembezaan Biasa dengan algoritma Automatic method switching (LSODA). Parameter-parameter dalam model SEIRD yang paling sesuai dengan data sebenar kes COVID-19 diperoleh dengan menggunakan algoritma pengoptimuman Nelder-Mead. Model SIRD yang diperluaskan dengan kompartmen terdedah (*E*) menjadi SEIRD, menghasilkan model yang kukuh. Berdasarkan analisis terhadap dua set data COVID-19 di Malaysia, ditemukan bahwa model ini memiliki nilai Purata Akar Ralat Min Kuasa (RMSE) yang paling rendah berbanding dengan model-model yang sedia ada. Hasil ini menunjukkan bahwa semakin tinggi bahagian penduduk yang mematuhi kuarantin (*r*) dan semakin lewat tarikh MCO diangkat, maka semakin sedikit penyebaran kes COVID-19 yang akan membantu Malaysia mencapai keseimbangan bebas wabak dengan lebih cepat.

Kata kunci: COVID-19; GUI-SEIRD model ramalan; pra-vaksinasi; Malaysia

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