Estimation of the Epidemiological Parameter for the COVID-19 Outbreak

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Abstract. COVID 19 disease has spread worldwide, disrupting the economy, society, education, and health. It became crucial to understand the transmission curve and identify the best action in combating this highly transmissible epidemic. Epidemiological parameters of the deterministic Susceptible-Infected-Removed (SIR) model are widely used in explaining the characteristics and behavior of the disease spreading. Disease like COVID-19 is highly influenced by the uncontrolled factors of randomness, hence in this paper, the deterministic susceptible-infected-recovered-death (SIRD) model is extended to the stochastic SIRD (SSIRD) model. SSIRD model takes into consideration the noisy behavior of the process which explains the uncontrolled effects of the COVID-19 outbreak. The epidemiological parameter of the model changes throughout the epidemic due to external factors such as enforcement and public obedience to the control measures as well as the changes in healthcare facilities. These parameters need to be estimated. This paper estimates the epidemiological parameters of the SSIRD model using the Markov Chain Monte Carlo (MCMC) method of the Metropolis Hasting algorithm. The COVID-19 data from Malaysia and Indonesia are used and the dynamical behavior of the COVID-19 outbreak in both countries is simulated. The results show the parameter changing due to the uncontrolled factors influencing the trend of the pandemic curve.

INTRODUCTION

Due to the exponential growth of COVID-19 transmission naturally, a global effort has been made to flatten the epidemic trends using multiple non-pharmaceutical interventions (NPIs) measures. The implementation of NPIs causes changes in the epidemiological epidemic parameters, hence contributing to the temporal trend in the epidemic curve. To understand the trend of the epidemic transmission of diseases, most researchers opted for the compartmental model of susceptible (S), infectious (I), and remove (R). This model was first developed in the deterministic form by Kermack and McKendrick [1]. The model excels in adapting the compartments of the model by adding new compartments to reflect the population movement in the disease's transmission. In this paper, we add the death compartment (D), to calculate the fatality of the epidemic by extending the SIR model to the SIRD model.

NPI such as social distancing, wearing masks, premises closure, working from home, and others will affect the infectious rate. The NPIs reduce the contact rate between infected individuals and susceptible, therefore less infectious transmission occurs. While the improvement in healthcare facilities, vaccine availability, and natural immune developments will change recovery and fatality rates as more infected individuals receive better healthcare treatment and have more chance of developing immunity to the epidemic. Other than the changes in the NPI's enforcement which reflect the different values of the epidemiological parameters, there is inherent noise from various external