Stochastic Anlysis and Statistical Inference for SEIR Models of Infectious Diseases

Andrés Ríos-Gutiérrez[1,*], Viswanathan Arunachalam[1], and Anuj Mubayi[2]

[1] *Department of Statistics, Universidad Nacional de Colombia, Bogotá, Colombia*
[2] *Simon A. Levin Mathematical Computational Modeling and Science Center, School of Human Evolution and Social Change, Arizona State University, Tempe, Arizona, USA*

varunachalam@unal.edu.co

The present study develops and analyzes a stochastic SEIR epidemic model (Susceptible-ExposedInfectious-Recovered) with random perturbations. The random perturbations in the model capture the impact of stochastic variations due to external factors such as changes include such as environmental fluctuations and social behavior that may impact the dynamics of an infectious disease. In this paper we analyze four fundamental aspects of its dynamics (existence and uniqueness of the solution, eventual extinction of the infection states, persistence of infection in the mean, and existence of the stationary distribution of the infectious state) and discussed. The analytical results are verified via numerical simulations of different scenarios in the parameters' region. Inference on the model parameters was carried out using the procedure that uses the discrete-time approximations based on the Euler-Maruyama method, maximum likelihood technique, and empirical information. Finally, we illustrated using date from the 2003-2004 SARS outbreak in China, and briefly, we analyze data from Colombia for the recent SARS-CoV-2 outbreak.

Keywords: *Stochastic perturbations, Infectious diseases, Distribution of infection over time, Compartmental model, Brownian Motion, Expected disease prevalence and extinction*