Modeling the propagation of an epidemic in a stochastic SVIS model when a re-vaccination of the susceptible population is considered

Maria Gamboa Perez[1], *Maria Jesus Lopez-Herrero*

[1]mgamboa@ucm.es, Statistics and Data Science Department, Faculty of Statistical Studies, Complutense University of Madrid

This presentation is focused on the use of continuous-time Markov chains (CTMC) to model the transmission of contagious diseases that do not confer permanent immunity. Population is not isolated and in consequence, the spread of infections may result from either coming into contact with infected individuals within the community or non-community members. A proportion of the population receives an imperfect vaccine that fails with a certain probability in the sense that, some individuals that have been previously vaccinated to prevent disease could be infected.

We describe the evolution of the infectious process in terms of a bi-dimensional CTMC representing the number of vaccinated and infected individuals during the epidemic.

The number of immunized individuals decreases over time due to the imperfect vaccine and external source of infection hypothesis, which can lead to the loss of herd immunity. To prevent this, we establish an alarm threshold for the number of protected individuals, which we refer to as the warning level. The viability of a re-vaccination program is evaluated in order to arise vaccine coverage to the initial situation. To achieve that objective we explore the size of the susceptible population when the alarm threshold for vaccinated individuals is reached. We also quantify the time until a re-vaccination program can be launched. We provide theoretical and algorithmic results to obtain statistical characteristics for both random variables and also present some numerical results for the spread of a diphtheria outbreak.

The talk is based on the following paper:

1. Gamboa, M.; Lopez-Herrero, M.J. *Measures to assess a warning vaccination level in a stochastic SIV model with imperfect vaccine*. Studies in Applied Mathematics 2022, 148(4), p.1411-1438. https://doi.org/10.1111/sapm.12479

Keywords: stochastic epidemic model, imperfect vaccine, eligible group