# SIR epidemics with stochastic infectious periods

Matthieu Simon
Université de Mons (Belgium)

matthieu.simon@umons.ac.be

**Abstract**

SIR epidemic models describe the spread of an infectious disease in a closed homogeneously mixing population subdivided into three classes: the susceptibles, the infected individuals and the removed cases. The class of susceptibles contains the healthy individuals who can become infected. When contaminated, a susceptible is contagious for a random duration, called the infectious period. During this period, he can transmit the disease to the susceptibles, independently of the other infected individuals. Then he becomes a removed case and plays no further role in the spread of the epidemic.

The SIR process which received the most attention in the literature is called the general epidemic model. It assumes that the infectious periods and the intervals between two successive contaminations are exponentially distributed. In this talk, we consider an extension of the general epidemic in which the contamination and removal rates are no longer constant. Instead, they are represented by a Feller process. When an individual gets infected, a version of this process starts to govern his period: the contamination and removal rates are functions of the state occupied by his infection process.

We use a martingale approach to determine the exact final epidemic outcome, that is, the state of the population when there are no more infected individuals. We derive the distribution of two statistics: the ultimate number of susceptibles and the final severity, a measure of the total cumulative cost due to all infected individuals that emerged during the course of the epidemic.

Next, we present an alternative, more stable approach for the final epidemic outcome computation. This approach is based on a link between the final epidemic outcome and the personal outcome of a generic infected individual, which leads to the construction of a discrete-time epidemic model the final state of which is distributed as the final state of the original model.