**Synopsis**

The models examined in the course so far have been deterministic – i.e. they have not accounted for the inherent randomness of epidemiological processes. In this lecture and practical we will introduce stochastic models which do attempt to capture such random behaviour in order to further understand the range of outcomes that may arise and their dependence on the model parameters.

Stochastic models are typically much harder to analyse algebraically and require more computing power. However, they are particularly important when numbers are small – for example at the start of an epidemic when there are only a few seeding cases. When the number of infected individuals is small, there is a finite probability that the infection will become extinct. In deterministic models this is reflected by a very small number (<1) of infected individuals. Stochastic models allow us to quantify the probability of extinction. We explore the critical community size for seasonal diseases and how stochasticity impacts predictions from SIR and SIS models.

**Learning objectives**

After this session, students should be able to:

1. Describe the concept of stochasticity within the context of epidemiological models and how it arises;
2. Discuss key differences between stochastic and deterministic models;
3. Describe what new types of phenomena arise in stochastic models as opposed to their deterministic counterparts and under what circumstances these phenomena are important;
4. Implement a stochastic model on a computer.

**Core reading**

Keeling and Rohani. *Modelling Infectious Diseases*. Chapter 6.

Vynnycky and White. *An introduction to Infectious Disease Modelling*. Chapter 6.

**Suggested further reading**

Allen LJS. A primer on stochastic epidemic models: Formulation, numerical simulation, and analysis. Infect Dis Model. 2017;2(2):128–42

Bolker, B. M. and B. T. Grenfell (1995). "Space, persistence and dynamics of measles epidemics." Proc. Roy. Soc. Lond. B 348: 308-320.

Roberts M, Andreasen V, Lloyd A, Pellis L. Nine challenges for deterministic epidemic models. Epidemics. 2015;10:49–53.