MATH / PUBH-EPI 5421
Lab #3

The purpose of this lab is to explore stochastic disease dynamics using the Gillespie algorithm. Relevant code on Carmen: `gillespie_SIR.m`, `goGillespieSIR.m`.

L3.1. Consider the basic SIR model without vital dynamics:

$$\begin{aligned} \dot{S} &= -bSI \\ \dot{I} &= bSI - \gamma I \end{aligned} \tag{1}$$

Implement a stochastic version of system (1) with $N = 100$, $\mathcal{R}_0 = 2$, $\gamma = 1/3$ days$^{-1}$, and initial conditions $S(0) = 99$, $I(0) = 1$. (a) Plot several trajectories of $I(t)$ for this stochastic system. (b) Now increase the population size to $N = 1000$. How do the trajectories of $I(t)$ compare with those from $N = 100$? To the deterministic ODE system?

L3.2. Simulate 50 realizations of the stochastic model. Plot a histogram of the final outbreak sizes. Do you observe any interesting features in the histogram? Does $\mathcal{R}_0 > 1$ guarantee that an outbreak will occur in the stochastic model?

L3.3. Based on your findings from L3.2, can you make a conjecture on how the probability of occurrence of a large outbreak depends upon $\mathcal{R}_0$?