SIRS Equations

We will be solving the stochastic version of the three equations for S_i, I_i and R_i

$$S_{i,t+1} = S_{i,t} - N_{i,S,t}^{inf} + N_{i,t}^{lst}$$

$$I_{i,t+1} = I_{t,i} + N_{i,S,t}^{inf} - N_{i,I,t}^{rec}$$

$$R_{i,t+1} = R_{i,t} + N_{i,t}^{rec} - N_{i,t}^{lst}$$

where we will calculate the probability of population *i* to be infected as:

$$p_i^{inf} = 1 - \exp(-\lambda_i \cdot \Delta t)$$

(see above for the definition of λ_i), the probability of this population to recover as:

$$p_i^{rec} = 1 - \exp(-\Delta \mathrm{t} \cdot \gamma_i)$$

and the probability to lose immunity as:

$$p_i^{lst} = 1 - \exp(-\Delta \mathrm{t} \cdot w_i)$$

with Δt being the time step. The force of infection, λ_i is given by:

$$\lambda_i = \beta_i \sum_j m_{ij} \frac{I_j}{N_i}$$

Using these three probabilities we can calculate the number of infected/recovered for each country as:

$$N_{i,S,t}^{inf} = rbinom\left(1, S_i, p_i^{inf}\right)$$

$$N_{i,I,t}^{rec} = rbinom(1, I_i, p_i^{rec})$$

$$N_{i,I,t}^{lst} = rbinom\left(1, R_i, p_i^{lst}\right)$$