Fitting_2

Lisa Rosenthal

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Simple SIR model

Let's say there are 3 types of plants: those that are inoculated/challenged (C), susceptible (S), and infected (I). We can observe the states of individuals $i = 1...n$ at times $t = 1...T_f$. The total number of individuals in each state at time t are C_t, S_t, and I_t. Challenged individuals can become infected either through inoculum-plant transmission at a rate α or plant-plant transmission at a rate βI. Since we assume that inoculum can only infect individuals a short distance away (i.e. the "challenged" individuals), susceptible individuals can only be infected through plant-plant transmission.

We need to model the transitions $C \rightarrow I$ and $S \rightarrow I$. For now, I'm going to model the population and in the next model, I'll track transitions in individuals. The approximated probability of either a challenged or susceptible individual i becoming infected at time t conditional upon I_{t-1}, the infectious population from the previous time step, are

$$\mathrm{P}(i \in I_t | i \in C_{t-1}, I_{t-1}) = 1 - \exp(-(\alpha + \beta I_{t-1})) \tag{1}$$
$$\mathrm{P}(i \in I_t | i \in S_{t-1}, I_{t-1}) = 1 - \exp(-\beta I_{t-1}). \tag{2}$$