EpiModel Web

Introducing Stochastic Mathematical Models for Epidemics

Network Modeling for Epidemics

Day 1

EpiModel Web

- Web-based interface for simulating basic epidemic models
  - Currently available for deterministic and stochastic models
  - This tutorial will demonstrate modeling deterministic compartmental models and a stochastic “individual contact” model
    - Math and other details for ICM to come this afternoon
- We will launch this through the EpiModel package

Open Rstudio

```
library("EpiModel")
```

```
epiweb("dcm")
```

Deterministic SIR Model

- Use the following parameters for your first model
  - Model type = SIR
  - S = 1000; I = 1; R = 0
  - Transmission probability per act = 0.2; act rate = 1.4; recovery rate = 0.1
  - Press “Run Model” button
- Questions
  - What is R_0 for this infectious disease system? Does the epidemic “take off”?
  - What is the time step of peak incidence? Eyeball it with the Plot Selection set to Disease Incidence. Lookup the exact value in the Data tab. Hint: you can sort the columns, and si.flow is disease incidence.
  - Now do the same for disease prevalence (i.num). Why is the peak prevalence later than the peak time of disease incidence?
  - The net production number, R_n, is the natural reproduction number of the epidemic under conditions of I > 1. It tells us how close the epidemic is to the persistence threshold of over the course of the epidemic. It is calculated as: $R_n = R_0 * (S_t/N_t)$
    - Calculate that Rn for this epidemic at time steps 1, 20, the time of peak prevalence, and 60.

Deterministic SIR Model

- Change the model parameters
  - Model type = SIR
  - S = 1000; I = 1; R = 0
  - Transmission probability per act = 0.2; act rate = 1.4; **recovery rate = 0.4**
  - Press “Run Model” button
- Questions
  - What is R_0 for this infectious disease system? Does the epidemic “take off”?
  - What is the time of peak incidence and prevalence now?
  - Explain the logic (in words) why the epidemic trajectory changed related to parameter that you changed.

Deterministic SIS Model

- Change the model parameters
  - **Model type = SIS**
  - S = 1000; I = 1
  - Transmission probability per act = 0.2; act rate = 1.4; **recovery rate = 0.1**
  - Press “Run Model” button
- Questions
  - What is R_0 for this infectious disease system? Does the epidemic “take off”? How does this epidemic signature look vs an SIR?
  - Pick a time when the prevalence has reached an “equilibrium state” (i.e., the slope of the prevalence curve is flat).
    - Under the Summary tab, enter this time step. Looking at the summary statistics in the table, and the flow diagram, explain why an equilibrium state for an SIS is occurring (hint: look at the flows!)

Deterministic SIS Model

- Change the model parameters
  - Model type = SIS
  - **S = 1; I = 0.001**
  - Transmission probability per act = 0.2; act rate = 1.4; recovery rate = 0.1
  - Press “Run Model” button
- Questions
  - What did we just do? How did scaling the population size down by a factor of 1000 substantively change your evaluations about the epidemic?
  - What would happen if we scaled up by a factor of 1000 (S = 1 mil, I = 1000)?

Open Rstudio

```
library("EpiModel")
```

```
epiweb("icm")
```

Stochastic SI Model

- Replicate the Poker Chip SI model
  - Set number susceptible to 9 and number infected 1
  - Set time steps to 50 and simulations to 1
  - Set transmission probability to 1 and act rate to 0.2
  - Under the plot window, uncheck mean line and move quantile slider to 0
  - Press “Run Model” button, and again…, and again…
  - What changes? What stays the same? What parameters changed each time you hit “Run Model”?
- Run lots of simulations
  - Set number of simulations to 25
  - Check the mean line box
  - What are different ways that we could summarize this set of simulations?
  - Eyeball when the S and I lines cross. Enter that time step under the Summary tab. For the disease incidence, what’s the relative standard deviation of the incidence against the mean of the incidence? What does that tell you about the uncertainty in the outcomes?

Stochastic SI Model

- Model epidemic on larger population
  - Set number susceptible to 90 and number infected to 10
  - Run 25 simulations again
  - Gradually turn up the quantile band. What does this show at 50%?
  - Eyeball when the S and I lines cross. Enter that time step under the Summary tab. For the disease incidence, what's the relative size of the standard deviation of the incidence against the mean of the incidence? What does that tell you about the uncertainty in the outcomes?