Math 4MB3 Project Notebook 2018

Sang Woo Park (The Infective Collective)

March 16, 2018 @ 1:08

Friday 9 March 2018

Group Meeting
Approximate Duration: 0.5 Hours

- Decided on a project topic. We will be studying spatial synchrony.

Wednesday 14 March 2018

Group Meeting
Approximate Duration: 1 Hour

- Discussed what papers we should read; spent most of the class time reading over papers.
- We want to come up with a reasonable model by 19 March.

Friday 16 March 2018

Solo work *Approximate Duration: 30 minutes*

- Literature review and brainstorming.

There are number of models we can use for this study. One of the simplest model that we can use is the one used by (Grenfell et al., 1995). We can slightly generalize their model to make it more like the logistic map we studied in class. Assuming identical population size of N across patches, we can write

$$\begin{aligned}
\frac{dS_i}{dt} &= \mu(N - S_i) - \beta(t)\left(\sum_{j=1}^{n} m_{ij} I_j\right) S_i \\
\frac{dE_i}{dt} &= \beta(t)\left(\sum_{j=1}^{n} m_{ij} I_j\right) S_i - (\sigma + \mu) E_i \\
\frac{dI_i}{dt} &= \sigma E_i - (\gamma + \mu) I_i \\
\frac{dR_i}{dt} &= \gamma I_i - \mu R_i
\end{aligned}$$

On the other hand (slightly tangential but relevant to the project), we can write a discrete time model under the tSIR framework (Finkenstädt and Grenfell, 2000; Becker and Grenfell, 2017) and we might be able to apply the analytical result presented in class.

$$S_{i,t+1} = B_{i,t} + S_{i,t} - I_{i,t+1}$$
$$E[I_{i,t+1}] = \beta_{t+1} S_{i,t} \sum_{j=1}^{n} m_{ij} I_{j,t}$$

tSIR model is supposed to be a tool to estimate transmission rate over time using a GLM framework but parameter estimation becomes more difficult when we add spatial structures. Instead, we can try to use estimated transmission rates and compare how synchrony and coherence might vary. This is something I might do for my own interest when I have some extra time...

Total time spent on this project

Group work: n hours

Solo work: m hours

References

Becker, A. D. and B. T. Grenfell (2017). tsir: An r package for time-series susceptible-infected-recovered models of epidemics. *PloS one 12*(9), e0185528.

Finkenstädt, B. F. and B. T. Grenfell (2000). Time series modelling of childhood diseases: a dynamical systems approach. *Journal of the Royal Statistical Society: Series C (Applied Statistics) 49*(2), 187–205.

Grenfell, B., B. Bolker, and A. Kleczkowski (1995). Seasonality and extinction in chaotic metapopulations. *Proc. R. Soc. Lond. B 259*(1354), 97–103.