There are 0 regular points and 100 extra points possible on this assignment.

1. (90 pts *extra credit*) Recall the Watts et al. (2003) hierarchical metapopulation model of epidemics described in Lecture Notes 10. In this model, we take a set of c communities, each of which runs its own local SI-X compartmental model on n/c individuals, and then we allow individuals to relocate from one community to another. If we place a hierarchical structure "on top" of these communities, and let the probability of relocating from community i to community j be inversely related to the distance (in the hierarchy) of i and j, the community-level epidemics will tend to spread mostly "locally" across the hierarchy, but with occasional large leaps, in a way that mimics the ups and downs of real epidemics.

   - Implement the Watts et al. model as described in the lecture notes (consult the original paper as needed), with a binary tree hierarchy and SIR model dynamics.

   - Using $c = 1024$ communities and $n/c = 100$ nodes per community, run the model with $\lambda = 0$ (this choice "zeros out" the role of the hierarchy). Replicate the D panel in Figure 2 of Lecture Notes 10 showing $\Delta I(t)$, and write a brief note explaining why this parameterization produces the result you observe.

   - For the same network size, explore choices of $\lambda > 0$ and p, and document your findings using figures showing $\Delta I(t)$ (like the E,F,G panels in Fig. 2 in Lecture Notes 10). Briefly explain what you learned about the roles of λ and p in shaping $\Delta I(t)$. Be thorough.

   - For some λ and p that produces nice ups and downs in $\Delta I(t)$, plot $\Delta I(t)$ *and* mark (i) each time at which a *first infection* occurs in a previously fully susceptible community (all nodes in that community were S), and (ii) each time at which a last infection occurs in a community (all nodes either I or R). Plot only the first time each of these events occurs in a given community. Hence, test the prediction that the ups and downs of the epidemic are driven by the "discovery" of naive subpopulations (ups) and the exhaustion of susceptible individuals (downs). Discuss your findings, and connect your conclusions back to the parameter values you chose and the structure of the model.

2. (10 pts *extra credit*) Reading the literature.

   Choose a paper from the Supplemental Reading list on the external course webpage . Read the whole paper. Think about what it says and what it finds. Read it again, if it's not clear. Then, write a few sentences for each of the following questions in a way that clearly summarizes the work, and its context.

   - What was the research question?
   - What was the approach the authors took to answer that question?
   - What did they do well?
   - What could they have done better?

- What extensions can you envision?

Do not copy text from the paper itself; write your own summary, in your own words. (Using terminology from the paper is okay, of course.) Be sure to answer each of the five questions. The amount of extra credit will depend on the accuracy and thoughtfulness of your answers.