Week 6
Multiagent Simulation #1

This lab will introduce you to agent-based simulation modeling to work on one of the most critical health crises of our times. You will be creating a simulation of a society that resembles the real world to study the mobility patterns of community and the spread of COVID-19. The central question we are trying to find an answer to through this simulation is, what are the impacts of following social distancing norms in a society and comparing it with a society that doesn't follow these norms.

One of the most prominent impacts of COVID-19 is reduced social gatherings in public places such as grocery stores, parks, and workplaces. This is necessary to control the spread of the virus but it also adversely affects the economy and especially worsens the situation for industries that rely heavily on social gatherings. Needless to point out, the boredom and psychological impacts of staying at home for prolonged periods make it desirable for most people to be able to get back to life as it was.

Simulation (Agent-Based Simulation Modeling)

We create a simple simulation environment to model a community showing the mobility patterns of people in a society using Mesa (An Agent-Based Modeling framework in Python), which is easy to use and is well documented.

The simulation environment contains:

- People, modeled as agents, of two types
  - Initial population 1,000
- Homes
  - Each person is a resident of one home
  - Each home is the residence of four people
  - 250 homes in total to accommodate 1,000 agents
  - If an agent is infected and stays at home, it infects all other agents living in that home as well
- Parks
  - Two parks
- Grocery stores
  - Five grocery stores

In the simulation, agents visit grocery stores and parks. An agent gets infected (with a given probability) if it is in the same location as some other infected agent at the same time step.

Configuration for the simulation

1. **Mobility Patterns Modeling**

One day is one time step for the simulation. For simplification, we assume each agent is only at one place throughout a given time step, so if someone visits a grocery store we can assume that the agent was in the grocery store for that entire time step (i.e. for the entire day).

Refer to the following table for probabilities of mobility across various infrastructure in the society at the start of each day (the probabilities remain constant on and across all days)

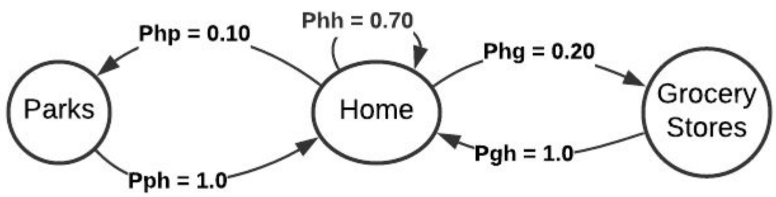

Figure 1. Transition probabilities for agents to visit different places in the society. After each visit to either grocery store or park the agent returns home (in the next time step)

2. Modeling the spread of the virus

Each agent is either infected or non-infected. A non-infected agent transitions to an infected state when it comes in contact with an infected agent. For simplicity, we assume an agent gets infected (i.e., it transitions to the infected-asymptomatic state) on the next time step. Infection has following substates: asymptomatic, symptomatic, critical, cured, and deceased.

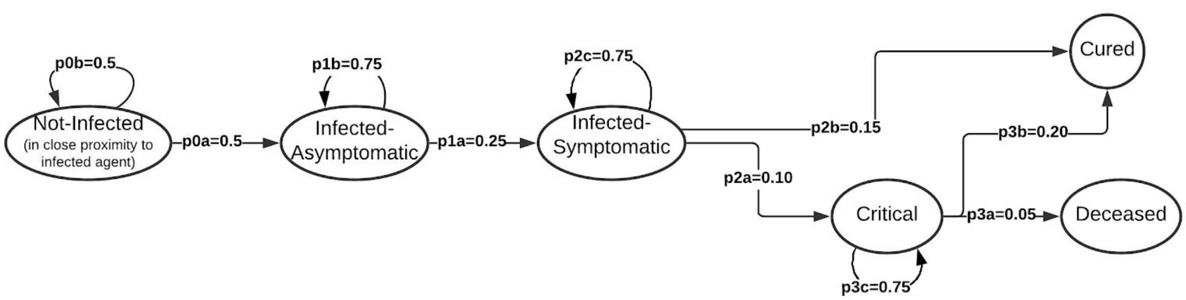

Figure 2. Transition probabilities across various disease states