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Physics of Complexity Science

Project 2 Part 3 Writeup

**Re-Creating the Washington Post’s Disease Model**

For the first part of this assignment, the “Simulitis” agent-based model of disease spread from <https://www.washingtonpost.com/graphics/2020/world/corona-simulator/> has been recreated. This version of the model is contained in “BenSimulitis.py.” The results of this-recreation are shown below:

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| --- | --- | --- | --- |
| **Free for All** | **Attempted Quarantine** | **Moderate Isolation** | **Major Isolation** |

**Comparing Simulitis to Schelling’s Model**

Let us begin by discussing Schelling’s model. In Chapter 9 of *Think Complexity,* Downey describes the model as a collection of dots on a grid. Those dots have a certain color. The dots prefer not to be outnumbered by dots of the opposite color, so they will move to a different square if the percentage of opposite-colored neighbors exceeds a certain number. As a result, a simulation that starts as a homogeneous mix of the two colors will become completely segregated, despite the dots only having a preference not to be extremely outnumbered. An example of this simulation, taken from <https://www.r-bloggers.com/animating-schellings-segregation-model/>, is shown below.

A close up of a logo

Description automatically generated

Like Schelling’s model, Simulitis is an agent-based model. In both, agents have certain properties, they make decisions based on those properties, and those decisions affect the properties of the other agents. As a result, both simulations demonstrate an emergent property, separate from the rules of the simulation itself. Schelling’s model creates segregated living communities, and Simulitis creates an epidemic, with curve-flattening properties dependent on the input parameters. However, Schelling’s model differs from Simulitis in the particulars. Schelling’s agents are restricted to a grid; Simulitis agents can float around a square, colliding with other agents and the box. Schelling’s agents have a race property, which is permanent; Simulitis agents have an infection property, which changes based on circumstances. Schelling’s agents all make the same decisions; Simulitis agents pull randomly from a bank of decisions.

**Improving Simulitis**

The Simulitis simulation is not perfect. Models are always simplifications, and it is up to the model-designer to include (and only include) the properties necessary for simulating the desired emergent property. In particular, Simulitis can be improved for modeling certain scenarios of COVID-19 in these ways:

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| * Incubation periods can be accounted for by switching from an SIR model to an SEIR model. * If agent decisions depend on the seriousness of the virus, compliance with self-isolation could be made dependent on the number of infected individuals. * Public policy regarding a disease changes over time. This can be modeled by either a time-dependent isolation parameter or a time-dependent rate of infection. |

In order to model a scenario where agents decide to isolate depending on how bad they perceive the epidemic to be, we will implement a reactionary isolation parameter. In particular, the isolation parameter will be a piecewise function, with zero isolation when less than 5% of the population is infected, proportional isolation after 5%, and then a maximum isolation of 90%, like so:

Running a simulation with this reactionary isolation, and comparing it to both the moderate and major isolation cases, we see that the reactionary isolation performs worse than major isolation and marginally better than moderate isolation.

|  |  |  |
| --- | --- | --- |
| **Moderate Isolation** | **Reactionary Isolation** | **Major Isolation** |

Based on this observation, we see that it is essential to be proactive in ordering isolation in an epidemic. By these results, government shutdowns are justified, even before a significant percentage of citizens have been infected.