Pandemic Simulation via Cellular Automata

Scientific Computing II
Fundación Universitaria Konrad Lorenz
October 25, 2023

- The deadline to sent this assignment through Aula Virtual is November 1st, 2023, 23.59.
- You can ask any question of this assignment during class or through email: julian.jimenezc@konradlorenz.edu.co.

In this assignment you are expected to fully simulate the behavior of a pandemic over a population by applying cellular automata. For this task you should do most of your calculations using numpy and cython to compile your native python code into C.

Here are a few things you should know:

- In this model, there are three types of cells:
  - susceptible, this class is susceptible to be infected by the cells that are infected,
  - infected, which can infect susceptible cells and
  - remnant, which were infected cells before getting recovered from the infection.
- Infected cells can infect susceptible cells with a probability of $p \in [0, 1]$ if they are at a distance of at most $R > 0$ of them. This calculation is done in each iteration of the system.
- Infected cells can become remnant with a probability of ρ in each iteration.
- At the beginning there are a total of $N = 1000$ cells, distributed uniformly across the space, and a fraction t of them are infected. These initial infected cells are chosen randomly from the set of all cells.
- All cells move a distance of $d \in \mathbb{R}$ in a random direction.
- The place where the simulation occurs is a square region with side length $L >> d$. The cells cannot abandon this region, so that if one of them is on the verge of exiting this region, the boundary should act as a mirror and reflect its movement.

Your task is to graph the number of remnant, infected and susceptible cells as a function of the number of iterations, choosing an adequate set of parameters so that in the long term you can see the classical behavior of a pandemic, *i.e.*, there is a small fraction of infected individuals, that infect most of the population, and after some time all cells become recovered.