Scenario I - Representation of the Current Condition and Spread of the Pandemia

Given a TxT grid as in Figure 1, we have N people in the population that are located on the grid randomly. Initially, each cell must contain only one individual, and Δ_1 % of N people (Denoted by N_s) are assumed to be infected.

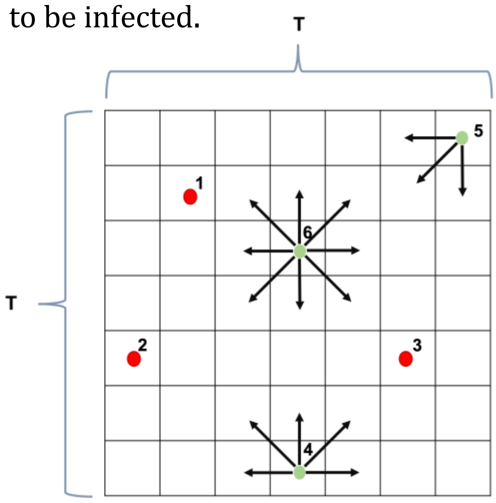

Figure 1: Representation of the problem. Green and red points represent healthy and infected people, respectively.

Each individual (for the rest of the text, **point** refers to an individual) can randomly move in eight directions with equal chances; see Point 6 in Figure 1. In each direction, a point can move with a random amount of step(s) distributed with U[0,3]. While moving, if a point hits a boundary or a corner, it cannot move along these directions; it can move to other available directions with equal chances in the next move. (In Figure 1, Points 4 and 5 have five and three available directions, respectively).

Each infected point will be healed with a 0.95 probability after M iterations. In this Scenario I, vaccination has not started yet; and initially it is assumed that Δ_2 % of the infected people are isolated until they are getting healed (for M iterations). Isolation means that an infected point can only move to neighbors of the cells where it gets infected. For example, as shown in Figure 2, a point infected at cell-A can only be found in cells A to I with equal probability in any iteration until it gets healed.

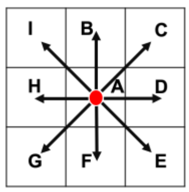

Figure 2: Representation of the isolation.

If an infected and a non-infected point coincide at a cell, the non-infected point will be infected with a probability of p. A newly infected point will be isolated with a probability of q_s, and stays isolated for M iterations. It may ignore the isolation rule with $(1 - q_s)$ probability and continue to move around as regular individuals.

New infections will occur at any iteration, but it is impossible to put all newly infected ones under isolation as explained above. Once a point is infected but not isolated, it will not be isolated in the following iterations. The point that cannot be healed after M iterations will be dead. Once an infected point is healed, it will not be infected again.

Scenario II - Spread Under Vaccination

In this scenario, isolation strategy in Scenario I will not be applied. Instead, after t_s iterations vaccination starts. At each iteration after t_s, Δ_3 of healthy individuals at that time, who have not been vaccinated yet, will be vaccinated. The individuals are vaccinated only once. However, even though they get vaccinated they can be infected with probability r_s in the following iterations. Rest of the conditions given in Scenario I are also valid in this scenario.

Scenario III - Spread Under Isolation and Vaccination

This scenario contains both Scenario I and II. That is, infected people are isolated with the same probability in Scenario I and healthy people get vaccinated as in Scenario II.

Scenario IV - Spread Under Isolation and Double Vaccination

In this scenario, individuals that are vaccinated once are able to have a second vaccination after t_{sec} period of their first vaccination with probability w. After the second vaccination, an individual's infection probability will reduce to 0 and s/he will be considered as fully protected. As in Scenario II an individual with one vaccination can be infected with probability r_s until having the second vaccination. If an individual have not vaccinated for the second time after t_{sec} period, its infection probability will increase to p. Note that, if an individual is infected after the first vaccination s/he will not be vaccinated for the second dose. Rest of the conditions for isolation given in Scenario III are still valid in this scenario.

Model Parameters

Model parameter values are given in the Table 1 below.

Table 1: Model Parameters

Parameter	Explanation	Initial Value
T:	grid size (single edge)	20
N:	population size	240
Δ_1:	percentage of infected people initially	5%
p:	infection probability in scenario of encounter	0.5
Δ_2:	percentage of isolated infected people at the initialization	50%
q_s:	isolation probability of a newly infected person	0.5
M:	infection duration (in number of iterations)	30
t_s:	iteration number where vaccination starts	20
r_s:	infection probability of vaccinated healthy people	0.05
t_{sec}:	number of iterations between two vaccinations	3
w:	second vaccination probability of healthy people	0.8
Δ_3:	rate of vaccination of healthy people	$\frac{1}{2(t_v - 19)}$, for $t_v = t_s, t_s+1, t_s+2, \ldots$

Reporting

Write scripts to simulate each scenario explained above for t = 120 iterations. In your scripts, report the following statistics for each scenario using charts:

- number of newly infected people in each iteration,
- total number of infected people in the system in each iteration,
- number of newly healed people in each iteration,
- total number of healed people in the system in each iteration,
- number of people that are died in that iteration.
- total number of dead people in the system in each iteration,

For Scenario II, III, and IV, make some further analysis to see the effect of the vaccination strategy. Report the following in your scripts using charts:

- number of vaccinated people in each iteration,
- total number of vaccinated people in the system in each iteration,
- number of infected people although they get vaccinated in each iteration,
- number of dead people who got vaccinated.