IE 206 - Term Project I

Spring 2022

Deadline: May 29, until 11:59 pm

Soft-copy report and codes should be submitted via ODTUClass. LATE submissions will not be accepted.

General Rules about Term Project

This project is a group work and each group should have ***two members****. Make sure you make only* *one submission as a group* *and name properly according to the provided instructions, see the last page.*

Please adhere to METU Code of Academic Integrity. Here "you" refers to "your group." You may discuss background issues and general strategies with your instructor and TAs and seek help from them, but the work that you submit must be your own. It is **NOT OK** for you to see or hear another student's code and it is certainly **NOT OK** to copy code from another person or from published/Internet sources.

METU - New Corona Virus Modelling

As an Industrial Engineer, you are hired as consultants by the government to study on recent Corona Outbreak. Your task is to create a computational framework for the outbreak conditions and prevention by simulation. The government wants to understand the spread and develop some policies. There are 4 different scenarios that you are expected to simulate and perform analysis. You are required to present a report based on your findings.

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.

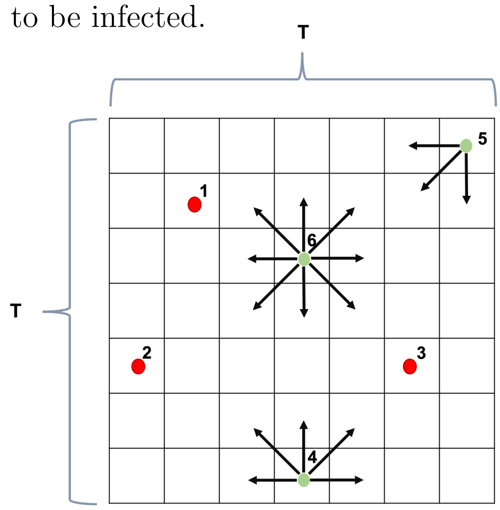

Figure 1: Representation of the problem. Green and red points represent healthy and infected people, respectively.

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 $\Delta_2\,\%$ 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.

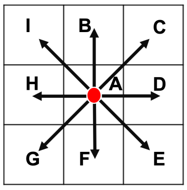

Figure 2: Representation of the isolation.

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 $t_v = t_s, t_s + 1, t_s + 2, ...$

Reporting

Write scripts to simulate <u>each scenario</u> explained above for $t = 120$ iterations. In your scripts, report the following statistics <u>for each scenario</u> 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, you are required to 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.

Note that for plotting the statistics, you can use line chart, bar chart, or similar ones.

Your report should consist of two parts:

- In Part I, you should present the plots of the statistics listed above. Using these plots, you should make comparisons between the scenarios and comment on your findings. For each statistics compare the scenarios. You are expected to present your findings considering the plots of the statistics. In your plots, different visualization properties can be used.

- In Part II, you are expected to make more analysis using the computational environment that you generated above and improve our understanding about the dynamics of the spread under different scenarios. Analyze the following cases and present your results with providing related graphs.

  – Under only the isolation policy is implemented, the impact of isolation probability on total number of infected and dead people in the system through the iterations.

  – Under only the vaccination policy, the impact of the vaccination rate on total number of infected and dead people in the system.

  – Under the policy of isolation and vaccination together, the impact of different vaccination rates for a given isolation probability on total number of infected and dead people in the system.

  – Under again the policy of isolation and vaccination, the impact of different isolation rates for a given vaccination rate on total number of infected and dead people in the system.

  – Under the double vaccination scenario, given the isolation probability as in Scenario I, the impact of different rate of second vaccination on total number of infected and dead people in the system through the iterations.

What to submit?

You are going to submit all your files (including the project report) to ODTUClass. As a comment, at top of each file you submit, please write each member's

- name and surname

- studentID

and <u>submit only one file</u> as a group of two. You need to follow the same submission regulations as you follow in the homework. However, since this is a group work, you need to write both members' student ID numbers.

Please, put your all files in a one folder and compress them as a .zip folder as below:

Project1_ID1234567_ID9876543.zip

i. Create 4 folders and name them as Scenario 1, Scenario 2, etc. Put your Matlab files for the scenarios in the corresponding folders.

ii. Put your report, named as Project1_ID1234567_ID9876543.pdf

iii. Add other files with appropriate naming (if exists)

Project Report

You are required to write a short project report for presenting your results and discussing your findings. Project report should be at most 10 pages.

Hint: In this project, you are supposed NOT to use Object-Oriented Programming.