**Group Project Report**

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***Section – I***

Our purpose for this project was to create a simulator which recreates events of an epidemic in a close-knit community of 1000 people. Let’s say few people in this community have been infected by a virus, we see how the virus spreads through this community, how long it takes for people to recover and how long does it finally take for the virus to die down.

Here, we explore this spread with the help of epidemic models. These models divide a population into compartments. We can add or remove compartments to these models according to how we want approach the epidemic. The most commonly used of these models is the SIR model.

The SIR model divides a given population into three groups: susceptible, infectious, and removed. As time passes by, the number of people in each of these groups changes. The number of susceptible people is highest at the very beginning of an epidemic, since everyone who is not or has not been infected is considered susceptible in most cases. On the other hand, the number of infectious individuals is at its lowest during the beginning of an epidemic. As time passes by, the number of susceptible people decreases, and the number of infectious people increases.

We first approached our epidemic with the help of the SEIR model. It is similar to the SIR model but with one added compartment called exposed. Here, we are exploring how the virus is spread in our close knit community of 1000 people once you have been exposed to it. We considered alpha as the rate at which people got exposed to the virus and beta as the infection transmission rate. Also, we add a condition here stating that if a person has been infected, they stay infected for 5 days after which they become immune forever.

*(Question 4)*

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### *(Question 5)*

### Assuming α=0.005 and β=0.01, to generate the curve of total infection as a function of 2000 rounds.

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*(Question 6)*

Assuming infectious period= 5 after which an individual becomes non-infectious and immune forever. Here, we plot the graph for this condition and see how the curve changes after 50 days and then again after 2000 days.

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Here, we notice that once an individual becomes infectious, the spread of the virus in the community rises sharply, infecting majority of the population. Since, we are assuming that people become immune forever after they recover from the virus, the virus dies down within a year because there is no one left to infect.

The patterns that we notice here imitates what we’ve seen in the past two years with COVID-19. The spread started out slow but once more people got exposed the virus, the infection increased, and it reached a peak. After the peak , everything started going downhill.

Next, we try out the next epidemic model SIRS and focus on recovery. Here, we want to see how good your immunity is; Assuming that you’re non-infectious or you have recovered from the virus, how would the virus spread once you’ve been exposed to the virus again after 20 days

*(Question 7)*

*Chart, line chart

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Since we do not explicitly state about the immunity of the population, we do not know how the individual would react to the virus once they’ve been re-exposed to the virus. Thus , we can see that all the components do not go downhill after a period of time but keep fluctuating once they have been re-exposed . In this case few of the individuals in our population are getting infected again, making the curve go uphill and then down again once they have recovered.

*(Question 8)*

Now, R0 is a parameter describing the average number of new infections due to a sick individual i.e., it gives us the values of how many people is one particular infected individual further infecting. An epidemic will cease to exist once R0<1 because if R0 becomes less than 1 it means that the virus has become dormant, and we are not further infecting anyone else. We calculate the R0 for all our epidemic models to see how the R0 value changes in different scenarios. We got an R0 value of 7 for our SIRS model (one infected individual is infecting 7 people when he comes in contact with them) and R0 values of 4 for our SEIR model(one infected individual is infecting 4 people when he comes in contact with them).

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***Section – II***

Next, we created a random graph of 1000 individuals with a fixed set of connections. We repeat the whole process again but with a different transmission rate and we compare and see how the spread of infection differs with different transmission rates when the connections have been fixed. Here, we take the edge probability as 2% i.e., an individual might have a connection with at least 2% of the total population.

A picture containing tree, sky, outdoor, plant

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In our random graph, we notice that once we run our simulation, we obtained a similar pattern as before (as in Question 6) but here we observe that there are a lot more fluctuations in pattern than before. This is due to the fact that we have a fixed set of connections. Since, an individual is interacting only with a fixed set of connections and his connections are interacting with their connections, the virus spreads differently giving us a much more rather realistic picture of how actually an epidemic spreads.

Chart, line chart

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Another simulation we try out is How would the epidemic be affected in a place of mass gathering. Let’s say there is a concert taking place in town, this even would put a lot of people in close contact with each other than any other day. We now take a look at how this event would accelerate the spread of the virus. Due to the high density of people concentrated in one place, even if a few people who are infected are present there, the virus spreads like wildfire.

Chart

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**Conclusion**

In this project, we explored the different epidemic models and saw how the virus spread within a community with different transmission rates and with different approaches on how to handle the epidemic. The trends that we found here were similar to those of the real life pandemic that we have experiences for the past 3 years. After individuals got infected, recovered , infected again and then finally recovered, gaining “herd immunity” the virus eventually simmers down after a year. We also looked into how the virus spread accelerates when a huge gathering takes place in a concentrated environment.

**References**

1. https://ndlib.readthedocs.io/en/latest/index.html
2. https://networkx.org/documentation/stable/reference/functions.html
3. https://docs.bokeh.org/en/latest/