

Singapore COVID-19 Outbreak Report

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1 Introduction

Singapore is notably vulnerable to the COVID-19 disease outbreak due to high travel and tourist attraction. Changi airport in Singapore according to BBC News is called "one of the most interconnected hubs in the world." [2] In Singapore, "a flight is taking off and arriving every 80 seconds here," making it more connected than JFK Airport in New York City and Dubai International Airport in the United Arab Emirates. Additionally, a large percentage of the population are currently non-residents (1.9 million); tourists and residents who travel often make up a significant percentage of the population. Singapore experienced its first cases after a meeting at a luxury hotel involving over 100 people from Malaysia, South Korea, UK and Spain. [2] Two Singapore nationals and a permanent resident were the first confirmed cases. As of February 13th, 58 people in Singapore are sick with COVID-19. [1] However, 0 deaths have been reported so and 15 people have recovered from the disease.

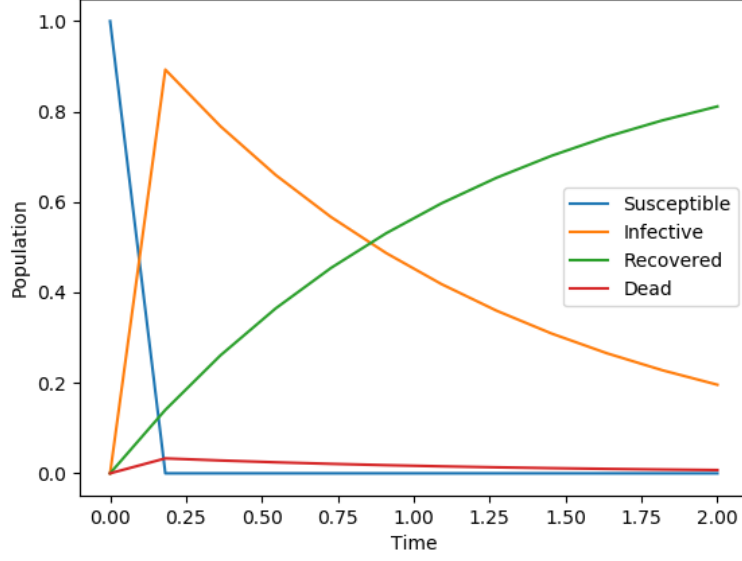


Figure 1: COVID-19 Model

2 Model and Data Analysis

Our objective is to model the spread of the COVID-19 infection using infection and recoveries rates to project how many people the disease affects over time.

We model the rates of change of susceptible, infected, and recovered people based on the following a sum of three differential equations:

$$\frac{dN}{dt} = \frac{dS}{dt} + \frac{dI}{dt} + \frac{dR}{dt} = -\delta I$$

For our model, we consider the entire population of Singapore as susceptible to COVID-19. Since Singapore is such a dense population with high rates of travel and traffic, it is reasonable to assume that anyone in Singapore can be infected with the disease. The rate of susceptible people is given by

$$\frac{dS}{dt} = -\alpha SI$$

Where α is our rate of infection multiplied by the number of susceptible (S) and infected (I) people.

$$\frac{dI}{dt} = \alpha SI - \beta I - \delta I$$

The rate of change in infected over time is given above. The first term is the growth term as more susceptible people interact with infected people, thus becoming infected themselves. The second term is the probability that an infected person recovers and happens at a rate of β while the third term is the rate that an infected person passes away which occurs at the rate δ .

$$\frac{dR}{dt} = \beta I$$

The last equation gives the rate of change of the number of recovered. The only term here is the rate that infected become recovered. There is no need for any rates for the recovered dying or becoming susceptible again as we assume that once you recover, you are immune to becoming sick again or dying from the virus.

3 Conclusion

The main concern with Singapore is not only slowing the spread of further outbreak in its own country, but preventing the disease from reaching other

countries. In taking steps to solve these issues, Singapore shut its borders from China and is enforcing a strict 14-day leave of absence for Chinese nationals. However, due to Singapore's connectivity to the rest of the world, Singapore has no choice but to be extra vigilant and transparent in its fight against this disease.

4 Updated Conclusion

Currently, Singapore has 9,125 total cases, 820 recovered and 11 deaths.

Previously in our model, our initial conditions had 58 people infected on February 13th. Fast forward to April 21st, There are now 9,125 total cases and 7,202 active cases with 11 deaths. Interestingly enough, the daily number of new cases has fluctuated over the past few days, with a recent spike of cases of 1,426. Singapore hasn't reached its peak of cases, but the number of active cases won't begin to decline until likely the late summer.

Our current model has only tracked up to the .25 time step. In other words, we modeled the number of cases past its peak all the way to when more than 80% of the population already had COVID-19 and then recovered from it. Our model has effectively graphed an infection rate that is accurate with the current data. Before, we talked about the importance of Singapore to be extra vigilant in restricting international travel from its most active airport. Unfortunately, since February, this virus has spread worldwide; and now scientists will look to see how Singapore flattens the curve to prevent additional spikes in cases.

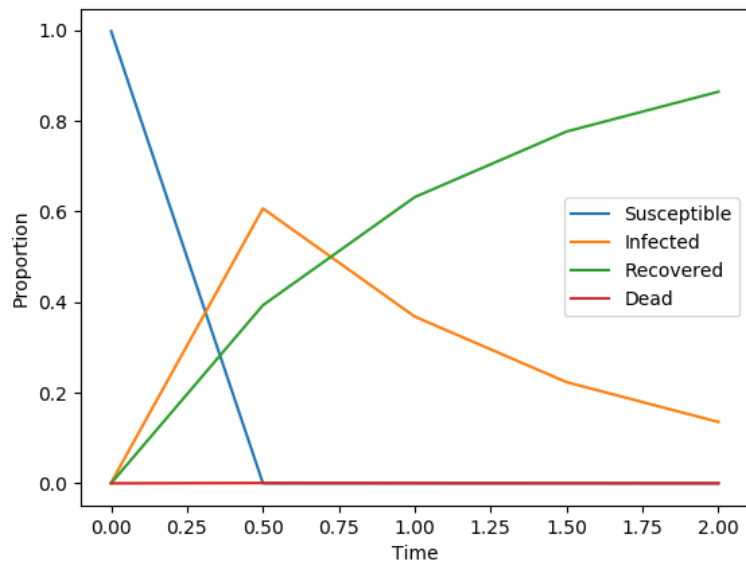


Figure 2: Updated COVID-19 Model

References

- [1] Tracking coronavirus: Map, data, and timeline.
- [2] Karishma Vaswani. Coronavirus: Why singapore is so vulnerable to coronavirus spread.