A Mathematical Modelling Approach in the Spread of the Novel 2019 Coronavirus SARS-CoV-2 (COVID-19) Pandemic

Pratyush Sudhakar

Class- XII, Sarvodaya Sr. Sec. School, Kota, India

Abstract: ***Today the world fights against an invisible enemy COVID-19. COVID-19, widely known as the coronavirus, emerged in the city of Wuhan in China towards the end of December 2019. In a very short time, the virus has spread around the world. This paper aims to discuss the recovery rate, death expectancy, and spread of the virus. The epidemic has been modelled using differential equation of first order. The results show the graph of the infected and removals(recovered) people against time depicting the spread of covid-19 over months.***

Keywords: coronavirus, pandemic progression, mathematical modeling, differential equation

1. Introduction

Coronavirus disease is an infectious disease. It has spread to over 200 countries all around the globe, it was declared a global pandemic by the WHO (World Health Organization) on March 11, 2020. The virus attacks the respiratory track and the nervous system. It causes mild infections, very similar to common cold. The incubation period is generally, up to two weeks. Some researchers have claimed that the cross-transmission may be bet*w*een snake and humans. The common symptoms include fever and dry cough, nasal congestion, head cache, struggling for breath, a change in sense of normal taste or smell, or symptoms of pneumonia, and acute respiratory distress. A diagnostic test has been developed. It is diagnosed using a reverse polymerase chain reaction (RT-PCR) tests. It has been found that sometimes the test shows negative for some people, but the clinical findings may show a positive result. In such cases, the test done on the following day will give positive results. Since, the incubation period is assumed to be two weeks, the test done after 14 days will give the most accurate results. Hence, the appropriate quarantine period is fourteen days. People who are tested positive for coronavirus are then tested for antibodies. This is an infectious disease and spreads from person to person People can get affected if they touch a surface such as doorknobs, tables touched by an infected person and then touching their face, nose or mouth. It is possible to catch the virus from someone who is in initial stages and has mild flu and doesn't feel sick. It has been shown that people not showing any symptoms can also transmit the virus. It is important to keep washing hands at regular intervals and maintain social distance. Research has been going on in different parts of the world to find a vaccine for the virus. The described model provides a medical plan, and the long-term effect of the pandemic and the relation between time and the rate of infected and removals.

2. Model

Mathematical modeling has provided us with tools to model the situation to forecast the future of the spread of the pandemic. Here, we consider a model which consists of one order differential equations. We plot the graph between the number of infected people and time, and the number of removals and time. The graphs will help in analyzing the situation and plan for the future accordingly.

First, we define the variables.
s(t) = number of susceptible individuals
l(t) = number of infected individuals
R(t) = number of removals

The susceptible equation:

$$\frac{dS}{dt} = -bS(t)I(t)$$

The number of susceptible depends on the number of already susceptible, the number of infected people, and on the amount of contact between the people. Here, b is representative of the amount of contact between two people.

The recovered equation:

$$\frac{dR}{dt} = kI(t)$$

Here, k represents the fraction of people in infected group that will recover in a day.

The infected equation:

We know that at any point of time

$$\frac{dS}{dt} + \frac{dR}{dt} + \frac{dI}{dt} = 0$$

And hence,

$$\frac{dI}{dt} = bS(t)I(t) - kI(t)$$

W*e* *c*onsider the data for India from April 2*7*, 2020. And hence, the initial values of the variables can be given by
S(0) = 1568
I(0) = 930
R(0) = 580
We take b = 1.5 considering that anaverage person meets 1.5 other people in a day. So,
b = 1.5

3. Result

Figure 1 has been plotted assuming k being 0.01, which means that 1% of peopleinfected get recovered in 1d and b being 1.5. The graphs show a sudden decline innumber of infected people and then a gradual decline and a gradual increase in number of recovered people.

Figure 2 has been plotted assuming k being 0.47 which means that 47% of infectedpeople get recovered in 1d and b is still assumed to be 1.5. The graph shows suddenincrease and decrease in recovered and infected people suddenly respectively.

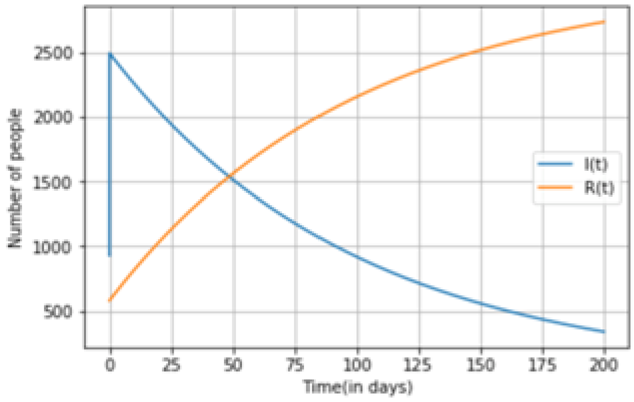

Figure 1

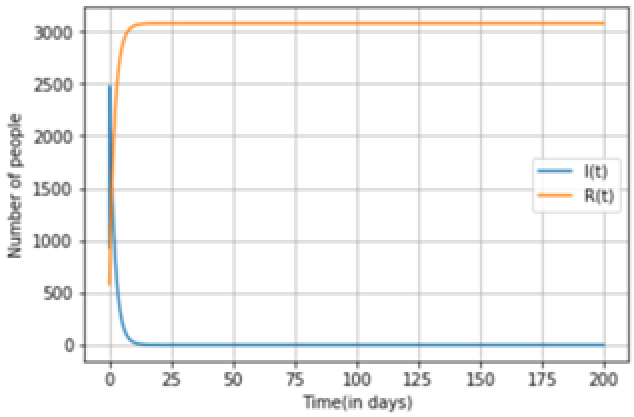

Figure 2

4. Discussion

Coronavirus is a huge, enveloped RNA virus. It spreads very quickly, and no cure has been found yet. There is no specific treatment available. The vaccine is in the process of development. But it is believed that the vaccine might fail. It has killed almost 4% people affected by it. It has a devastating effect on people with weak immunity systems like senior citizen, children, people affected by cancer or diseases which have severely affected their immunity. Clinical laboratory analyses and imaging methods are used for the diagnosis of a COVID-19 infection. It is aimed to make the diagnosis at the laboratory by RT-PCR and routine biochemical analyses and direct lung radiography and computerized tomography in radiological imaging. It does not have an effective vaccine or an exact and effective treatment scheme. It shows a destructive effect especially in individuals with weak immune systems. Intensive care and mechanical ventilation may be required in the treatment process (1-5, 7). Various precautions are applied to prevent it from spreading. All over the world, a lot of precautions have been taken to stop the spread of this pandemic. The result of the model shows how important it is to take appropriate precautions and how drastic affect it can have on the spread of the pandemic. The graphs display the significance of increased testing and precautions that should be taken. The analysis done gives some insights about what could be done to reduce its effect.

5. Conclusion

According to the results, it is evident that it is very important to keep the k value high which means increasing the number of recovered patients in a day. In the first graph, we see that if this value is very low, which means that not enough precautions are been taken, the number of recovered after two hundred days is less compared to when the k value is high. To keep the value of k high, we need to take action like maintaining social distancing, increasing the number of tests being done per million so that infection can be diagnosed at an early stage, quarantining people diagnosed positive is also very important, and improving the immunity systems.

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