SIR MODEL FOR NEW YORK COVID-19 DATA

Abdul Rehman, Rishabh Shanbhag, Yashvin Jagarlamudi

Introduction

- SIR model is an epidemiological model which divides the population into various states of health to determine the number of people impacted by a disease over time
- SIR models explain the rate of change of people who need medical attention related to a certain disease
- For our model, we have considered COVID-19 and a subset containing only New York state's data
- Our SIR model will forecast the immunity of New York residents across 148 days

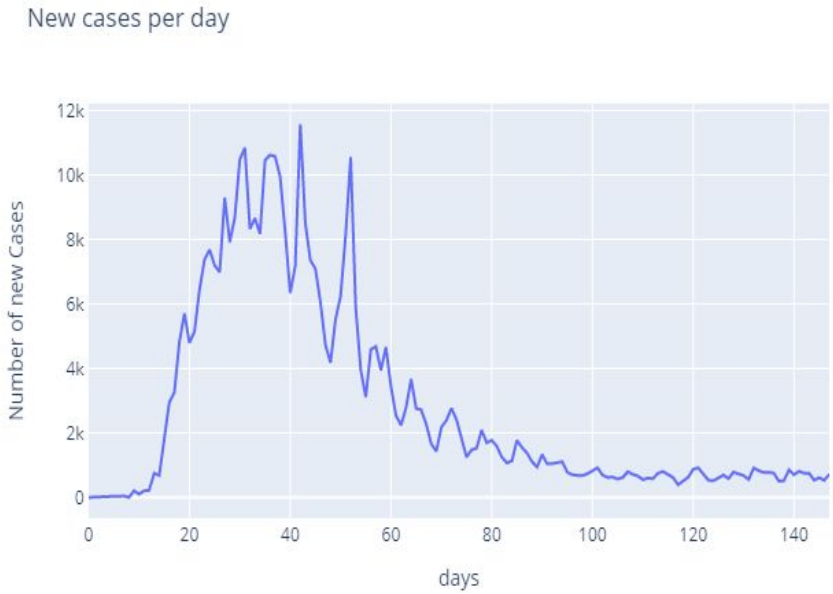
Limitations of SIR Models

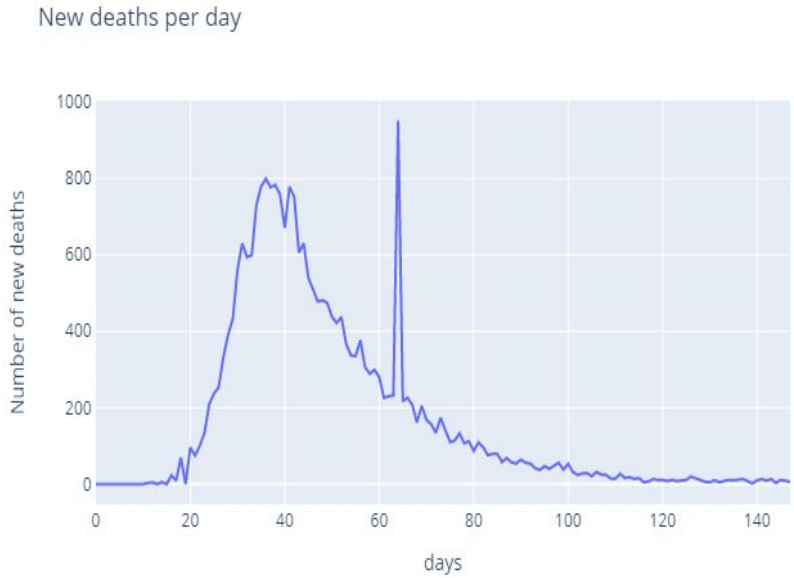
1. Time varying infectivity
    a. causes infective rate of a disease to change over a period of time leading to sporadic predictions
2. Super Infection Rate
    a. super infection occurs when a patient contracts a heterologous strain of a disease without recovering first
    b. Super infection makes it difficult to model recovery rate
    c. Ex: HIV and tuberculosis
3. Latency period
    a. SIR models don't account for the period between between individual is exposed to a disease and when that individual becomes infected and contagious.

Overview of SIR Model

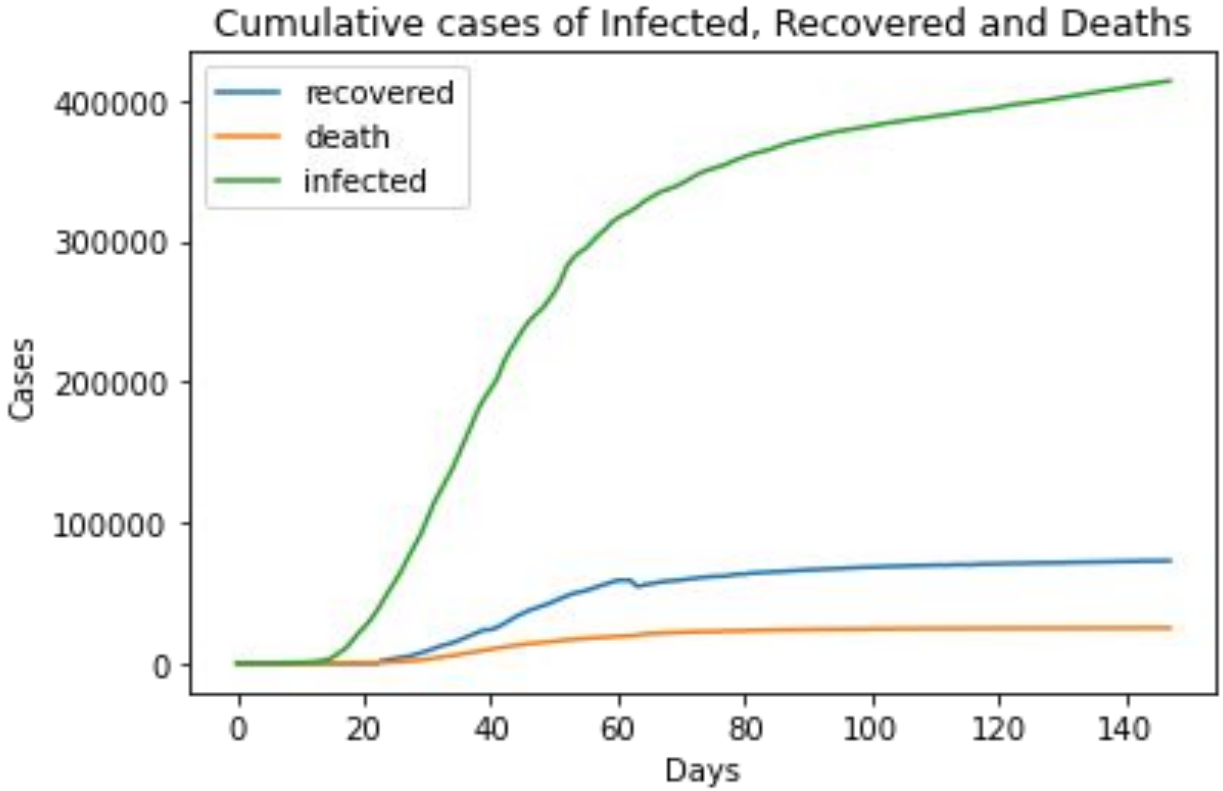
- SIR models contain 3 states: Susceptible, Infected, and Recovered
    - Susceptible : number of people who haven't contracted the disease but are likely to in the future
    - Infected: number of people who have contracted the disease
    - Recovered: the number of people who have survived and hence achieved immunity from the disease
- SIR models also contain various hyperparameters such as :
    - γ : proportion of infected recovering per day
    - β : amount of people an infected person will infect per day
    - R_0 : total number of people an infected person infects
    - Σ : rate of change of exposed per infected

EDA


New cases per day
Number of new Cases
12k
10k
8k
6k
4k
2k
0
0
20
40
60
80
100
120
140
days

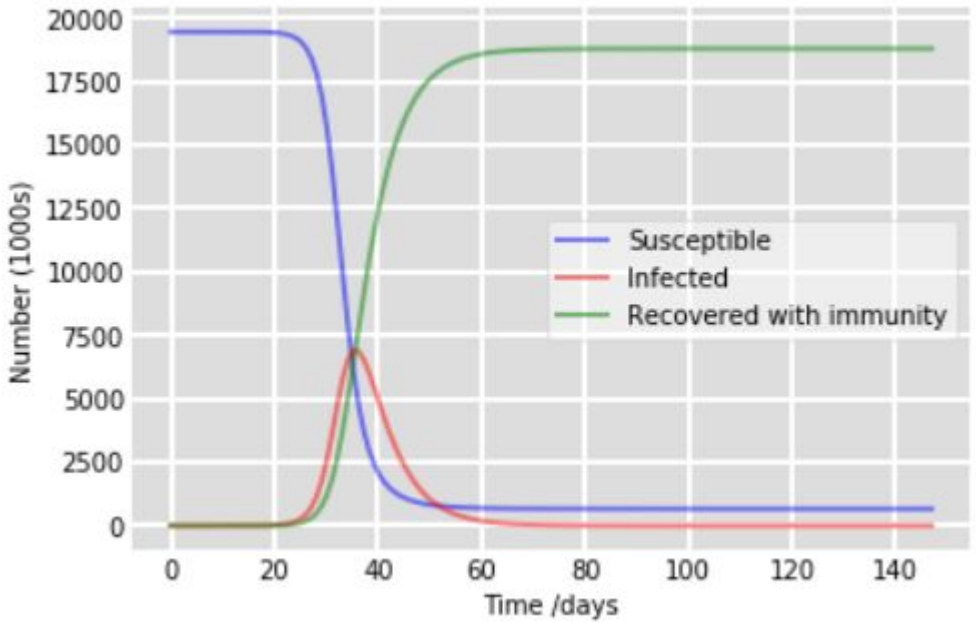

New deaths per day
Number of new deaths
1000
800
600
400
200
0
0
20
40
60
80
100
120
140
days

EDA

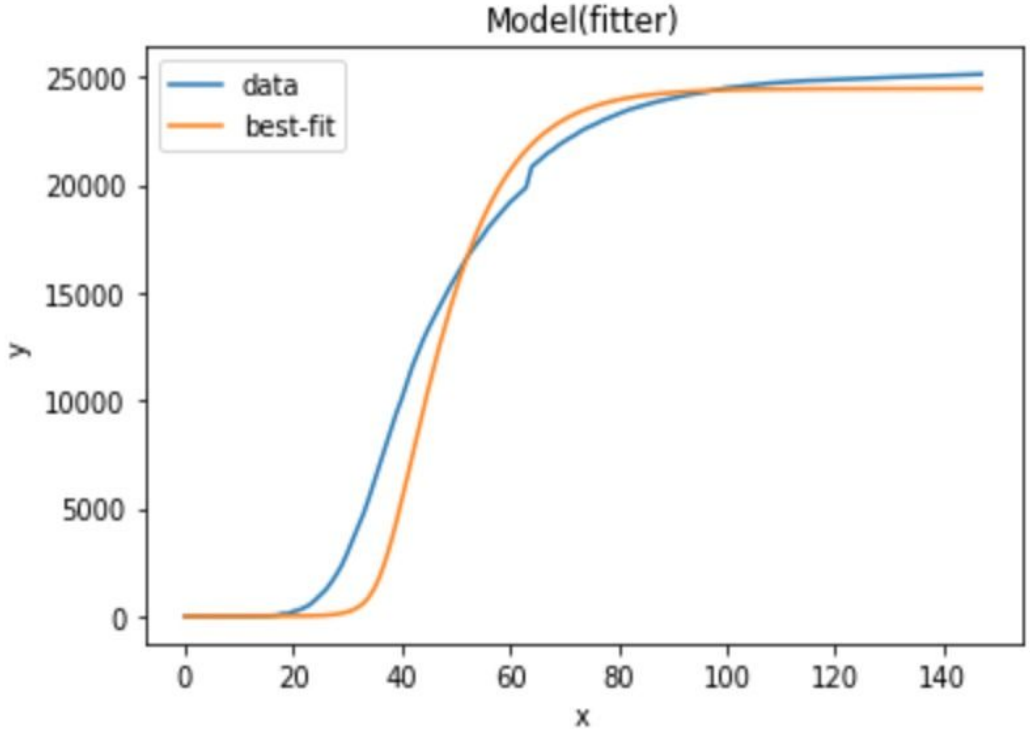

Cumulative cases of Infected, Recovered and Deaths
recovered
death
infected
Cases
400000
300000
200000
100000
0
0
20
40
60
80
100
120
140
Days

Basic SIR model with estimated parameters

SIR Curve for γ=0.7 and β=0.2



SEIRCD model fit to deaths data



Rate of change from Exposed to Infected: 0.49

Rate of change from Infected to Recovered: 0.19

Rate of change from Infected to Critical: 0.099

Rate of change from Critical to Recovered: 0.125

Rate of change from Critical to Death: 0.16

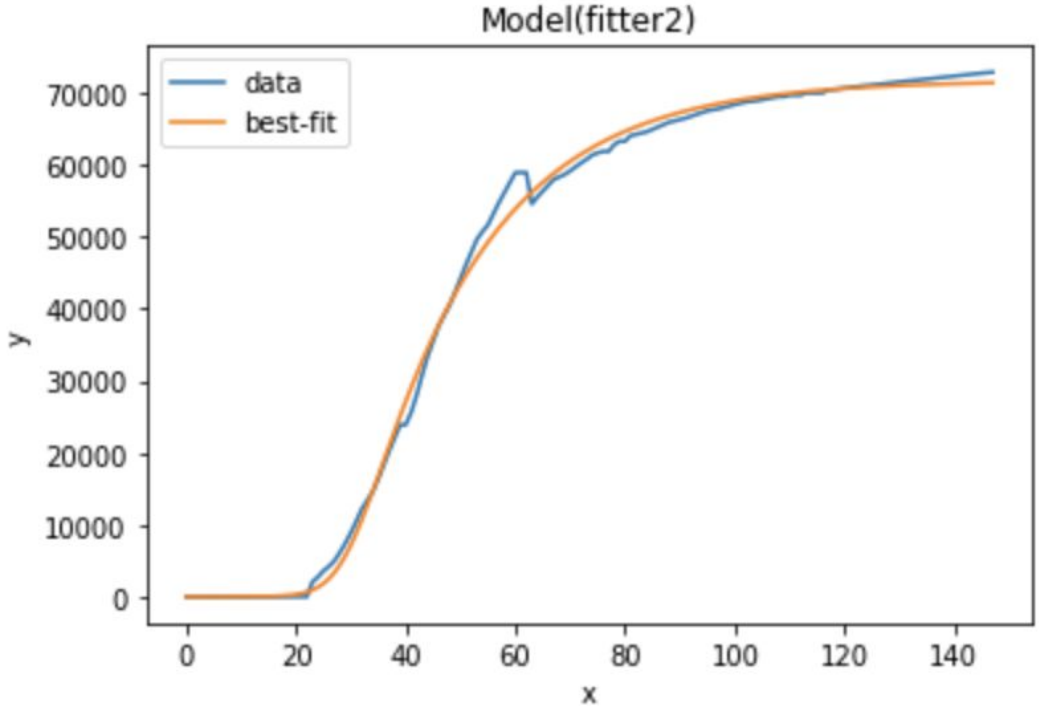
Probability from Infected to Critical: 0.09

Probability from Critical to Death: 0.79

Probability from Infected to Recovered: 0.91

Probability from Critical to Recovered: 0.21

SEIRCD model fit to recovered data



Rate of change from Exposed to Infected: 0.49

Rate of change from Infected to Recovered: 0.19

Rate of change from Infected to Critical: 0.076

Rate of change from Critical to Recovered: 0.19

Rate of change from Critical to Death: 0.16

Probability from Infected to Critical: 0.09

Probability from Critical to Death: 0.05

Probability from Infected to Recovered: 0.91

Probability from Critical to Recovered: 0.95

Conclusion and Future Scope of SEIRCD Model

- SEIRCD model can be enhanced to include other components like Hospitalized (H) and on Ventilator (V)
- The current SIR model can be generalized to other states in the United States or other countries.
- Instead of displaying short-term statistics of COVID-19 for 148 days , the model can be extended to forecast rate of infection until 2021.
- Compare SIR predictions using various deep learning models