BIOLOGY 101

# EPIDEMIOLOGY REPORT ON SARS-COV-2

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## ABSTRACT-

We explore a standard epidemiological model, known as the SIRD model, to study the COVID-19 infection in Virginia.The time-dependent parameters are set in the model to obtain the best fit with the available data. The model is simulated aiming to project the probable features of the infection in Virginia,US.We find that with the current infection rate and containment measures, the total active infection in Virginia would be maximum at the end of  July 2020. With proper containment measures such as social distancing, the infection is expected to fall considerably from August.

## Introduction-

There is a current worldwide outbreak of the novel coronavirus Covid-19 (coronavirus disease 2019; the pathogen called SARS-CoV-2; previously 2019-nCoV), which originated from Wuhan in China.

## METHOD-

The epidemiological model employed for this analysis -

- SIRD MODEL
- MODIFIED SIRD MODEL

## DATA SOURCES-

https://covidtracking.com/data/state/virginia

https://www.vdh.virginia.gov/coronavirus/

## FITTING THE MODEL-

The ODEINT function from the SCI-PY library has been used to solve the equation for the SIRD model.

Then the parameters have been estimated using the least-squares minimization technique (from SCI-PY).

On analyzing the solution we came to a realization that the fit is poor because the parameters kept on changing with time i.e. that is they are time dependent.

So we modified the model and assumed that the parameters($\beta, \gamma,$ ) follow this relationship-

$$f(t) = c + o/(1 + e^{pt})$$

So the final equations are now as follows-

$$R0 = \beta(t)/(\gamma(t) + (t))$$

$$dS/dt = -\beta(t)IS/N$$

$$dI/dt = \beta(t)IS/N - \gamma(t)I - (t)I$$

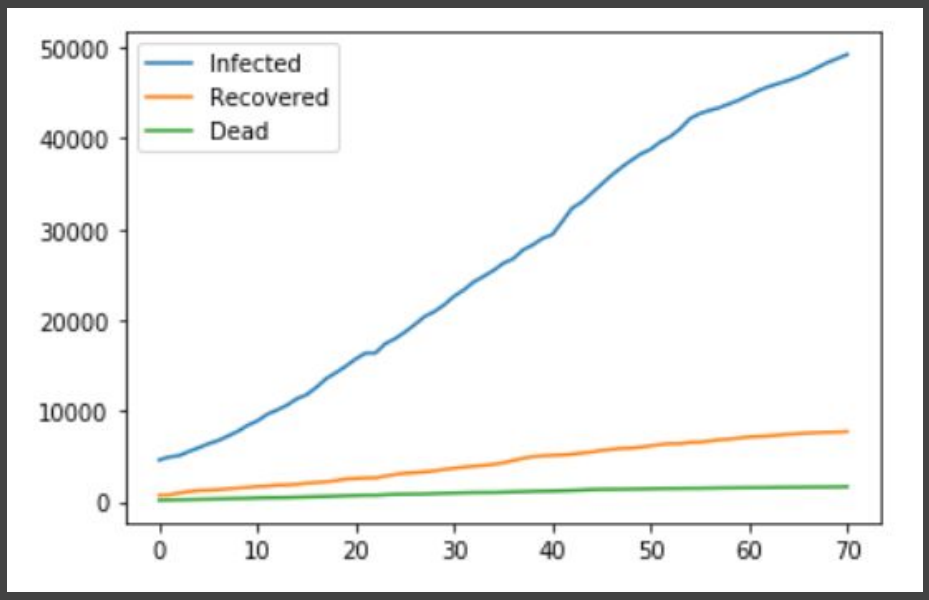
$$dR/dt = \gamma(t)I$$

$$dD/dt = (t)I$$

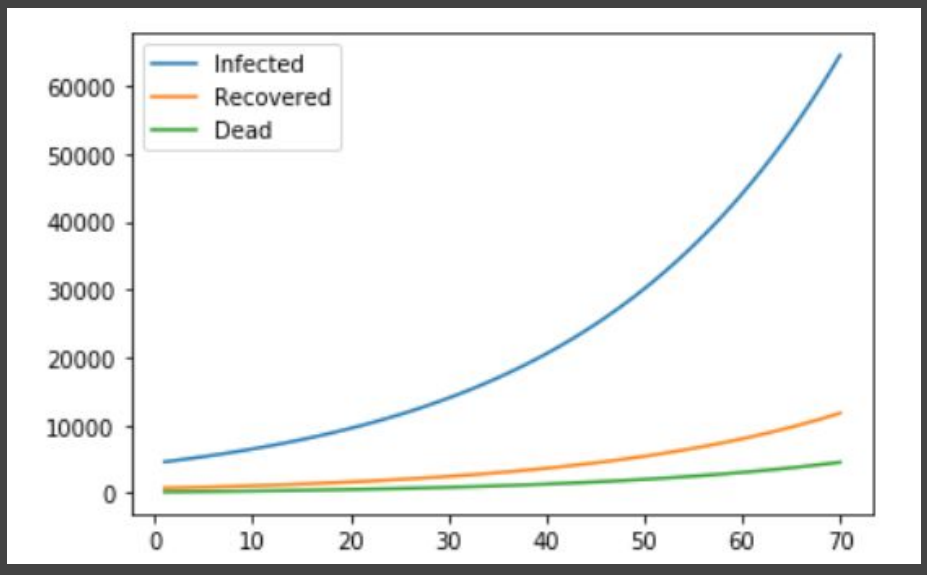
- N: - Total population
- S(t): - Number of people susceptible on day t
- I(t): - Number of people infected on day t
- R(t): - Number of people recovered on day t
- β(t): - Expected amount of people an infected person infects per day
- D(t): - Number of deaths on day t
- μ(t): - Mortality rate on day t
- γ(t): - The proportion of infected recovering per day
- $R_0$: - The total number of people an infected person infects

# RESULT-

**Graph of Actual Data:-**



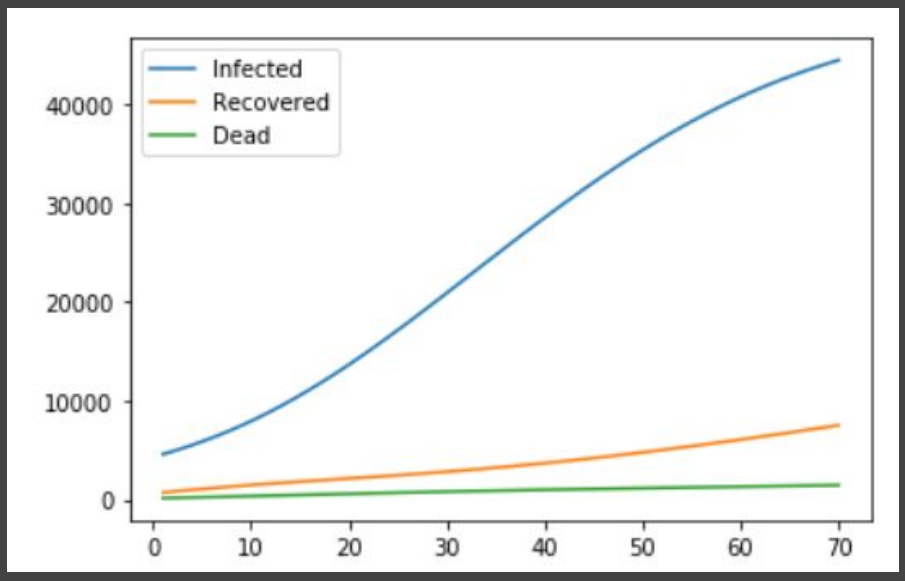

**The values observed by simulation (SIRD) is -**




$\beta = 0.0482799$ $=0.00279097$

$\gamma = 0.00704444$ $R_o = 4.90878367$

## The values observed by simulation (MODIFIED SIRD) is -

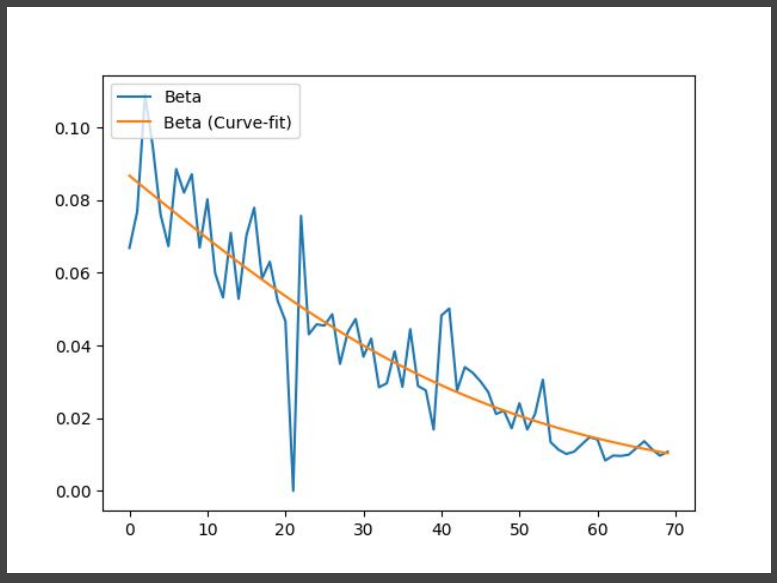



$\beta(t) = 0 + 0.17702274/(1 + e^{0.03969398t})$

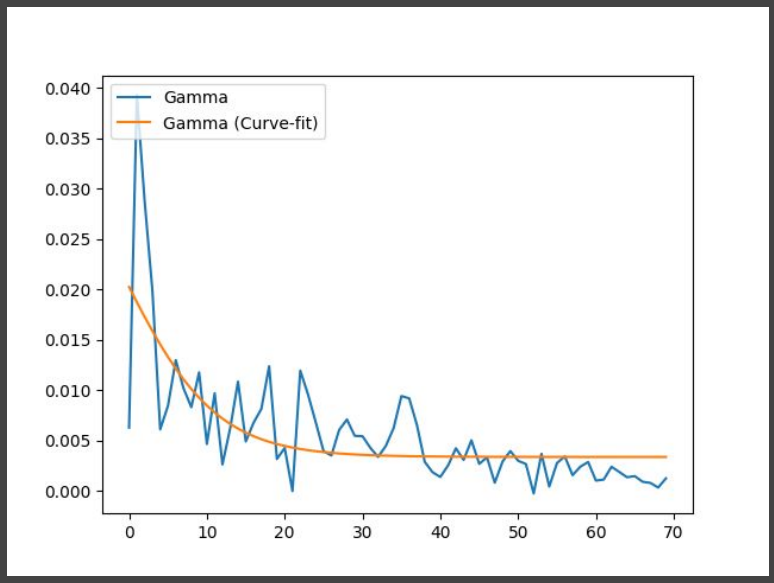
$\gamma(t) = 0.00338116 + 0.03678575/(1 + e^{0.16606175t})$

$(t) = 0.00031368 + 0.00875426/(1 + e^{0.08402617t})$

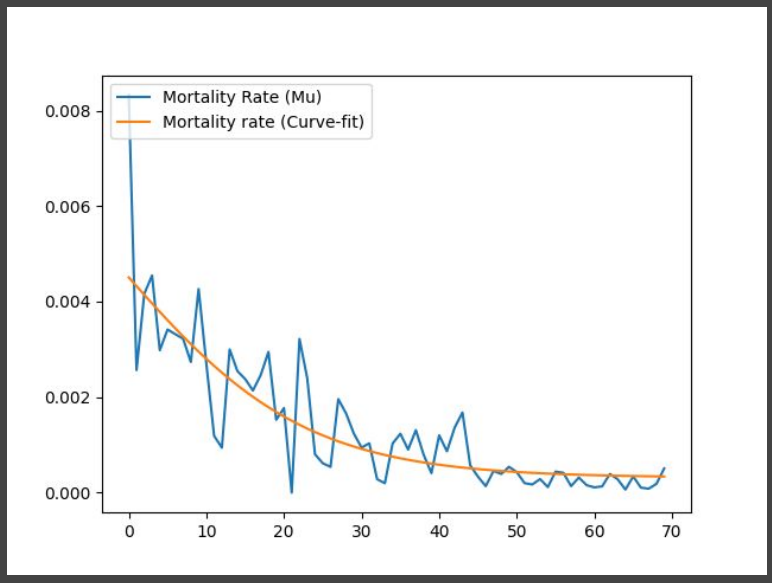
## Graph of $\beta(t)$:-



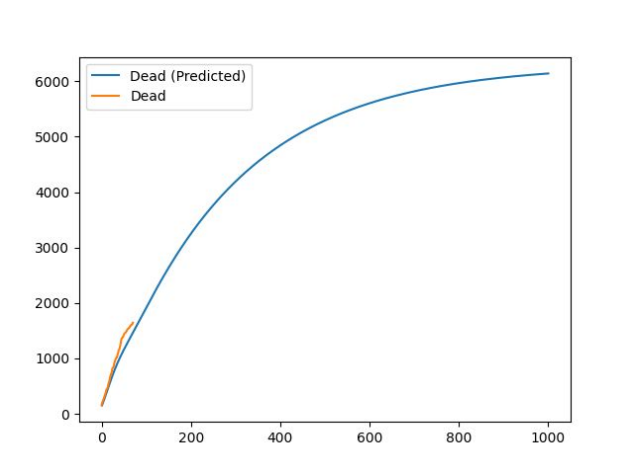
## Graph of γ(t):-

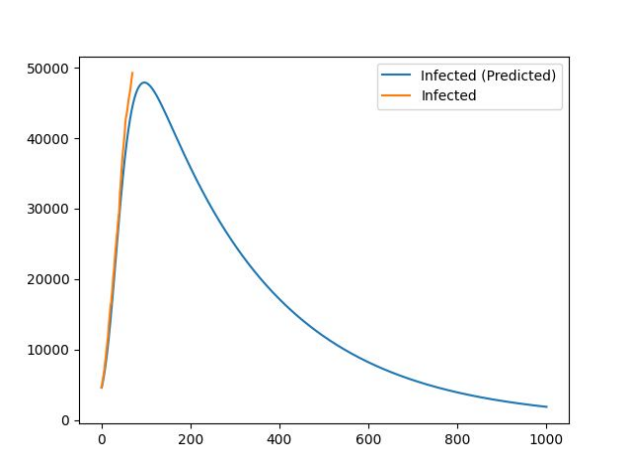


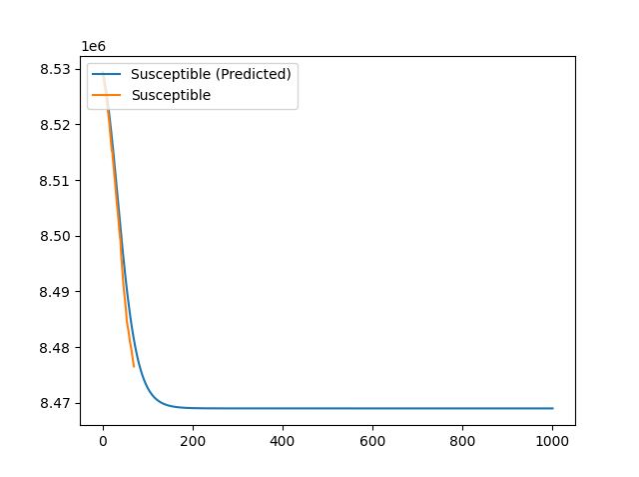

## Graph of $(t)$:-

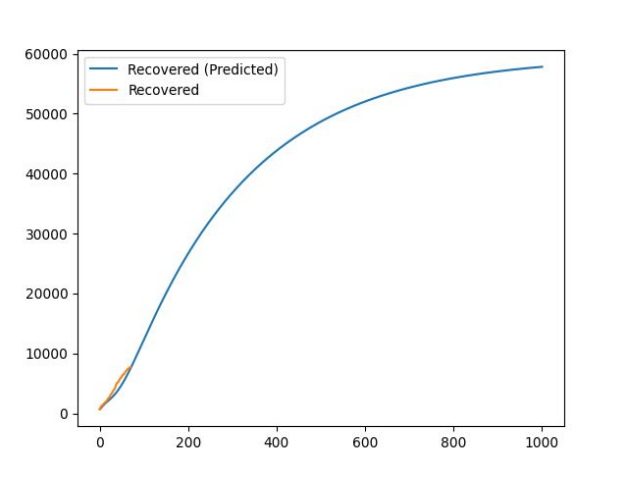


## Graphs of prediction Vs Actual Data:-




- The day at which maximum infection occurs on **20th July 2020** that is **97** days after the pandemic has started and the number of infected individuals is **47892**.
- The duration of the pandemic is most probably **1170 ,**ending around **20 march 2023.**
- The death toll due to the pandemic will be at **6300** (approx)**.**
- The data collection was started on **14 april 2020.**

## DISCUSSION:-

- ➢ The data collected was not accurate.
- ➢ The recovery was available for only after 14th April,and that too had some anomalies.
- ➢ The value of β is reducing overtime which indicates that the containment strategies had some effect.
- ★ We could use a stochastic or a network model to attain more accurate results.

**Limitations-**

- This is one of the simplified models for epidemiological analysis.
- Asymptomatic infected people are not taken into account and are treated as susceptible to infection.
- The diversity in the age and gender of people are not accounted for.
- The testing rate is low and the cases which were not tested cannot be taken into account.
- The model does not take into account containment strategies like lockdown and social isolation.