

# MS Hands-on

## SIR using Differential Equations and RK4

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### Simple SIR Model:

$$\frac{\partial S}{\partial t} = -\beta SI$$

$$\frac{\partial I}{\partial t} = \beta SI - \gamma I$$

$$\frac{\partial R}{\partial t} = \gamma I$$

Susceptible declines, Recovered increases and Infected increases and then decreases having peak at some location.

With initial values; we gets following plot:

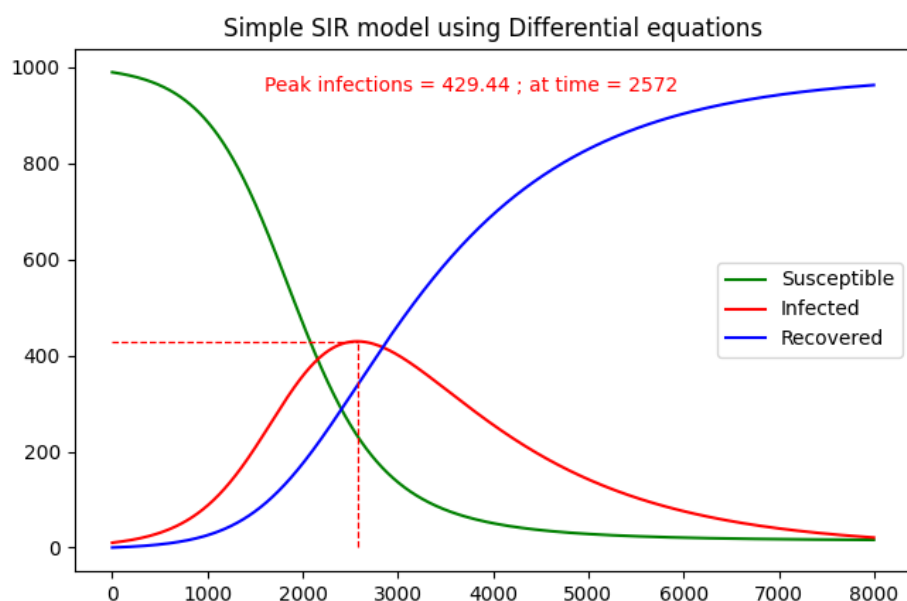
Susceptible = 990

Infected = 10

Recovered = 0

Beta = 0.0015

Gamma = 0.35



**SIR Model with Births and Deaths:**

$$\frac{\partial S}{\partial t} = -\beta SI + \Delta$$

$$\frac{\partial I}{\partial t} = \beta SI - \delta\gamma I - (1 - \delta)\gamma I$$

$$\frac{\partial R}{\partial t} = \delta\gamma I$$

Susceptible declines, Recovered/Deaths increases and Infected increases and then decreases having peak at some location, there are constant births.

With initial values; we gets following plot:

Susceptible = 990

Infected = 10

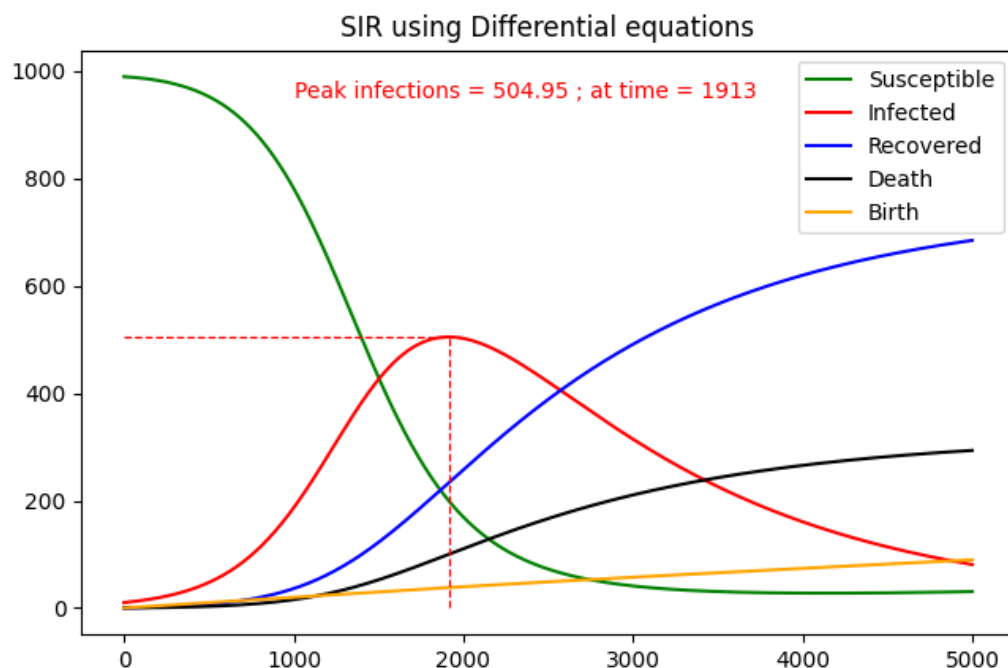
Recovered = 0

Beta = 0.0015

Gamma = 0.35

Birth Rate = 0.01 \* Current Population

Delta = 0.7



**SIR Model with Births, Deaths and Lockdown:**

$$\frac{\partial S}{\partial t} = -\beta\lambda SI + \Delta$$

$$\frac{\partial I}{\partial t} = \beta\lambda SI - \delta\gamma I - (1 - \delta)\gamma I$$

$$\frac{\partial R}{\partial t} = \delta\gamma I$$

With lockdown imposed; infected peoples are affected. Decreasing rate of infection.

Susceptible declines, Recovered/Deaths increases and Infected increases and then decreases having peak at some location, there are constant births.

Peak moves 30% late in time period than the system without lockdown.

With initial values; we gets following plot:

Susceptible = 990

Infected = 10

Recovered = 0

Beta = 0.0015

Gamma = 0.35

Birth Rate = 0.01 \* Current Population

Delta = 0.7

Lambda = 1 or 0.5 interchanging every time period

