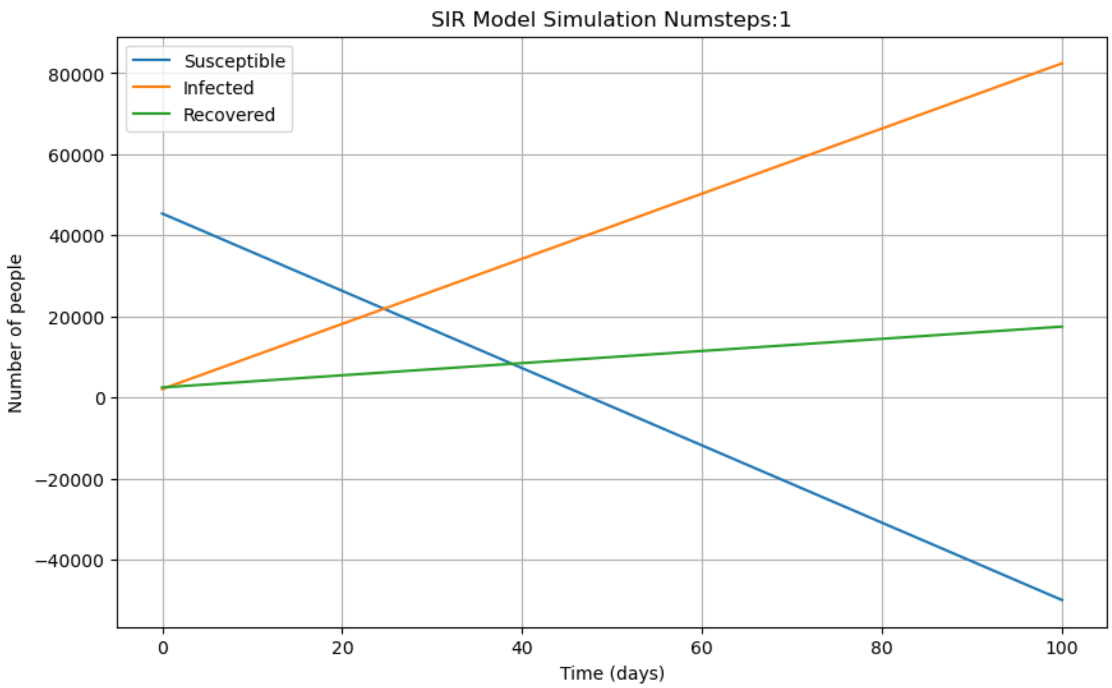
# Week 2 - SIR and Euler's Method

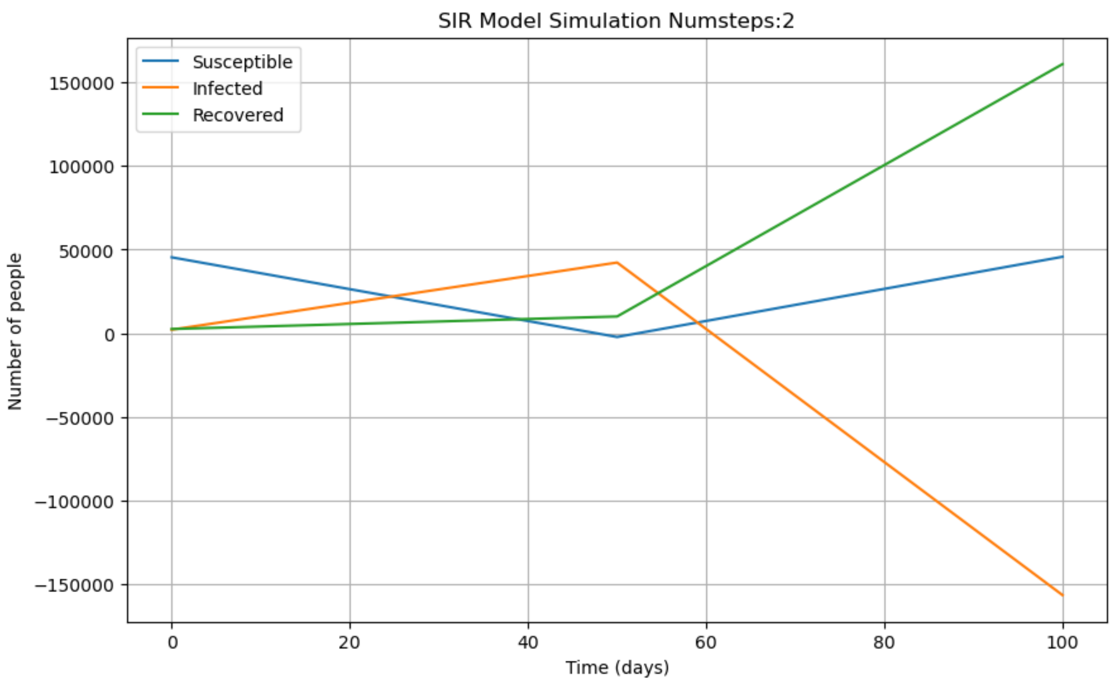
November 21, 2024

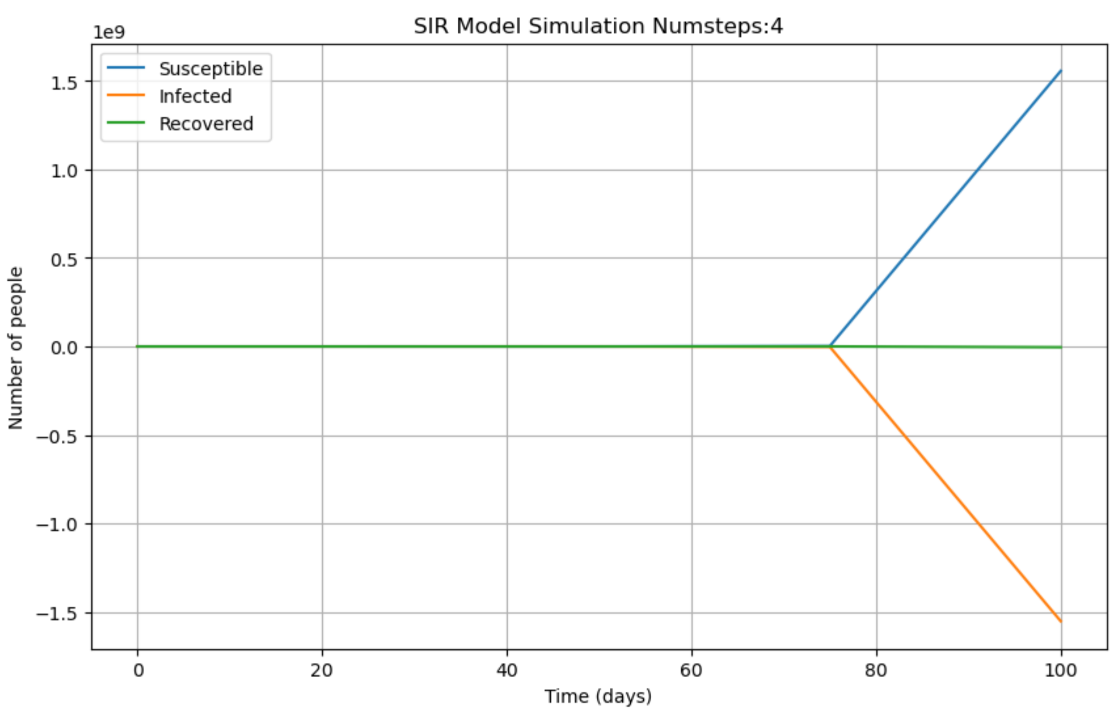
Blake Stoffel Week 2 Activities

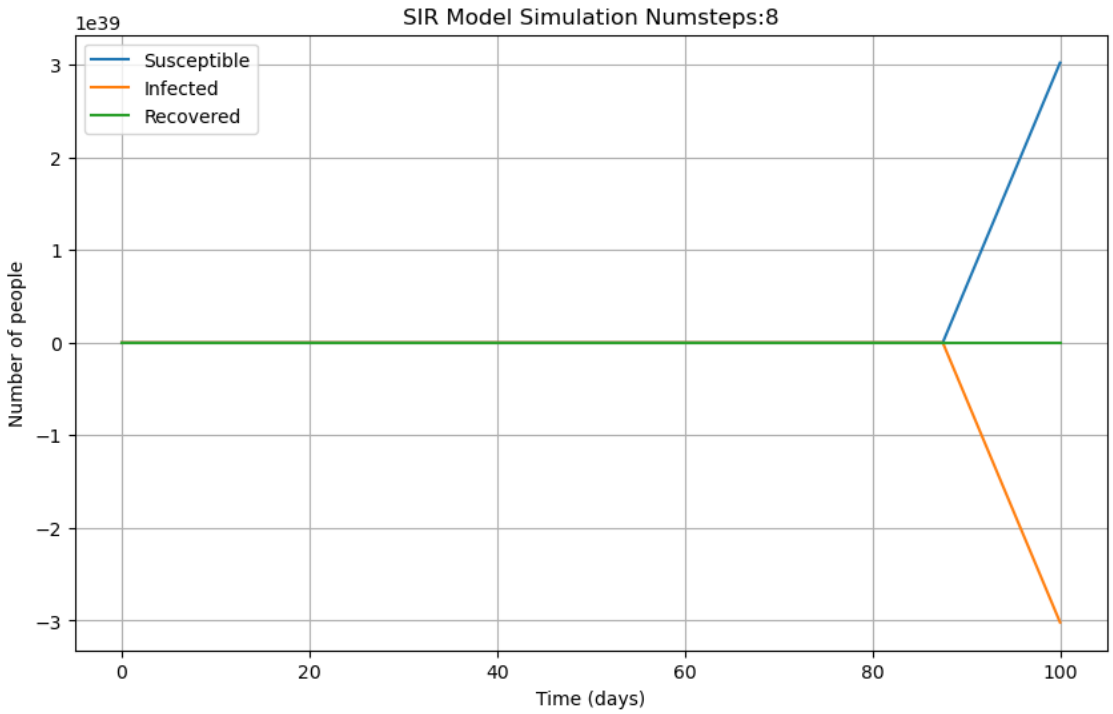
[1]:
```
#SIRPLOT
import matplotlib.pyplot as plt

for x in range(10):
    t_data, S_data, I_data, R_data = [], [], [], []
    tinitial = 0
    tfinal = 100
    t = tinitial
    S = 45400
    I = 2100
    R = 2500
    a = .00001
    b = 1/14
    numsteps = 2**x
    deltat = (tfinal - tinitial)/numsteps
    #print ("t = " + str(t), "S = " + str(S), "I = " + str(I), "R = " + str(R))
    for x in range(numsteps+1):

        #Append current values
        t_data.append(t)
        S_data.append(S)
        I_data.append(I)
        R_data.append(R)

        Sprime = -a * S * I
        Iprime = a * S * I - b * I
        Rprime = b * I

        deltaS = Sprime * deltat
        deltaI = Iprime * deltat
        deltaR = Rprime * deltat

        t = t + deltat
        S = S + deltaS
        I = I + deltaI
        R = R + deltaR
```

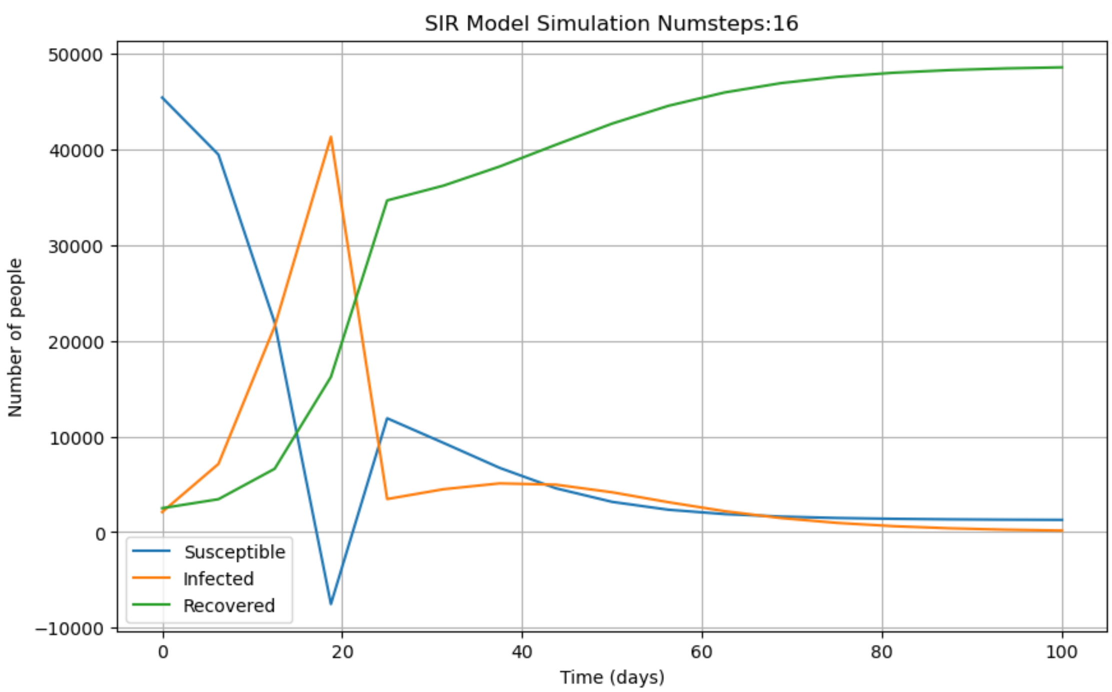
```
        #print ("t = " + str(t), "S = " + str(S), "I = " + str(I), "R = " +
 ↪str(R))

    plt.figure(figsize=(10, 6))
    plt.plot(t_data, S_data, label='Susceptible')
    plt.plot(t_data, I_data, label='Infected')
    plt.plot(t_data, R_data, label='Recovered')
    plt.xlabel('Time (days)')
    plt.ylabel('Number of people')
    plt.title('SIR Model Simulation Numsteps:' + str(numsteps))
    plt.legend()
    plt.grid(True)
plt.show()
```

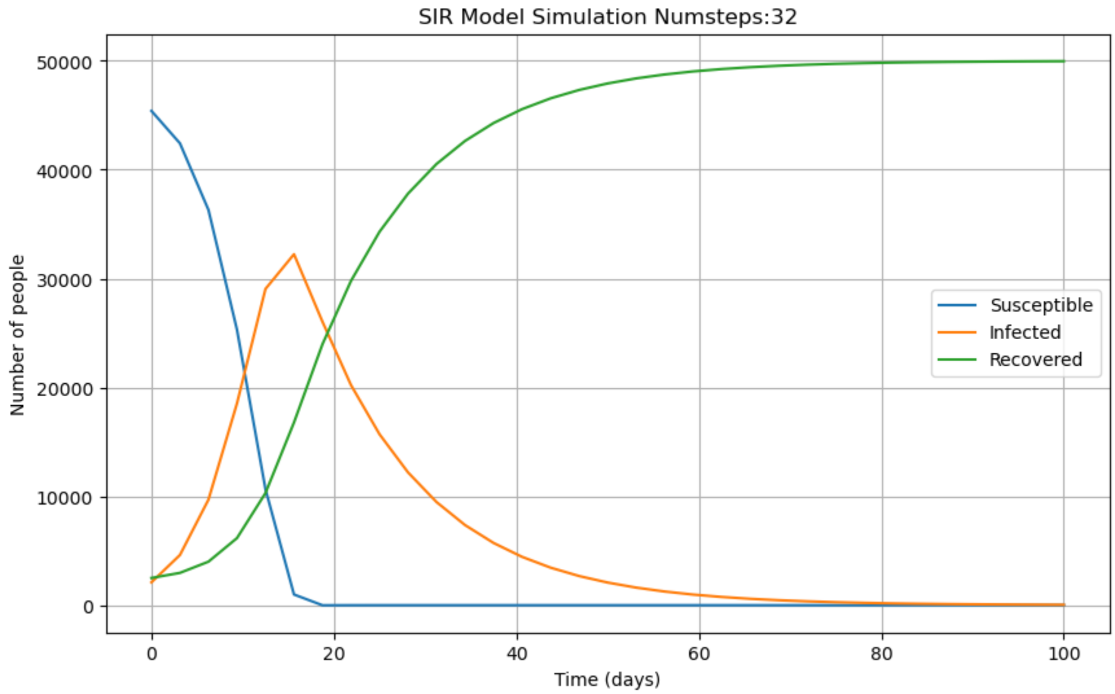


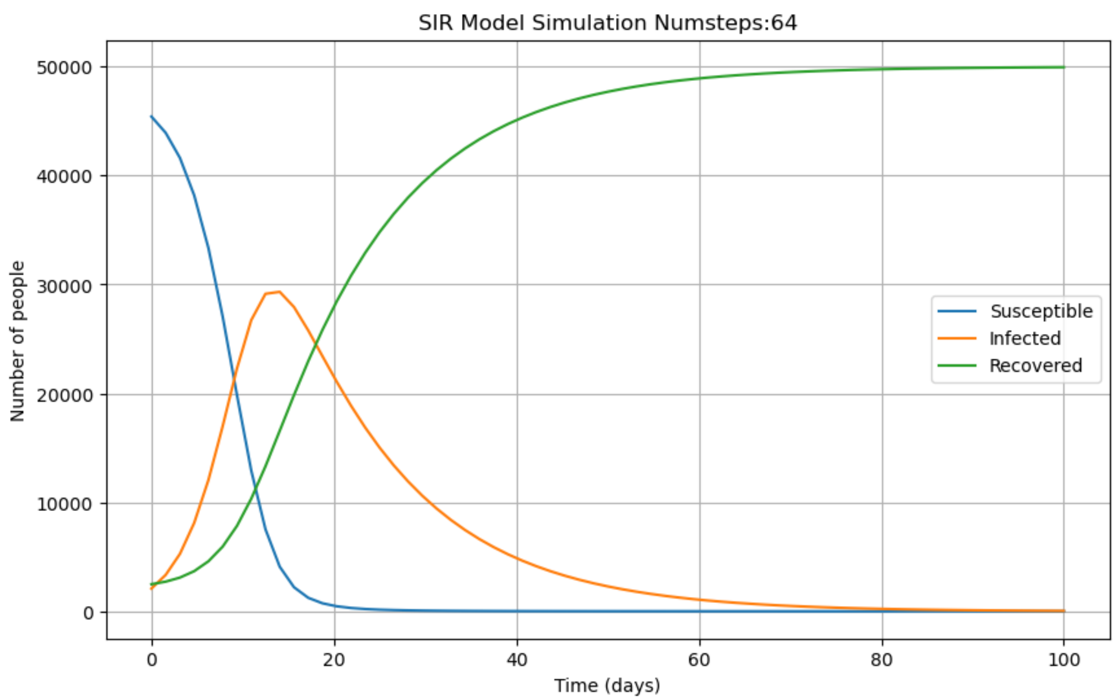

SIR Model Simulation Numsteps:2
Susceptible
Infected
Recovered
150000
100000
50000
0
−50000
−100000
−150000
Number of people
0
20
40
60
80
100
Time (days)

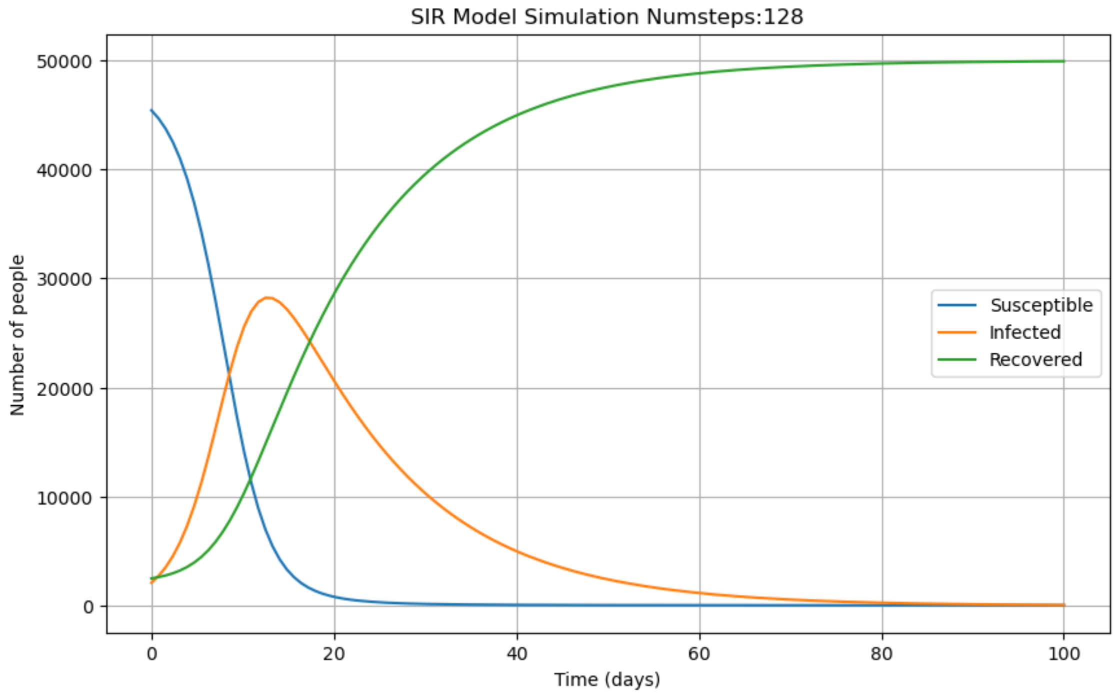

SIR Model Simulation Numsteps:4
1e9
Susceptible
Infected
Recovered
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
Number of people
0
20
40
60
80
100
Time (days)

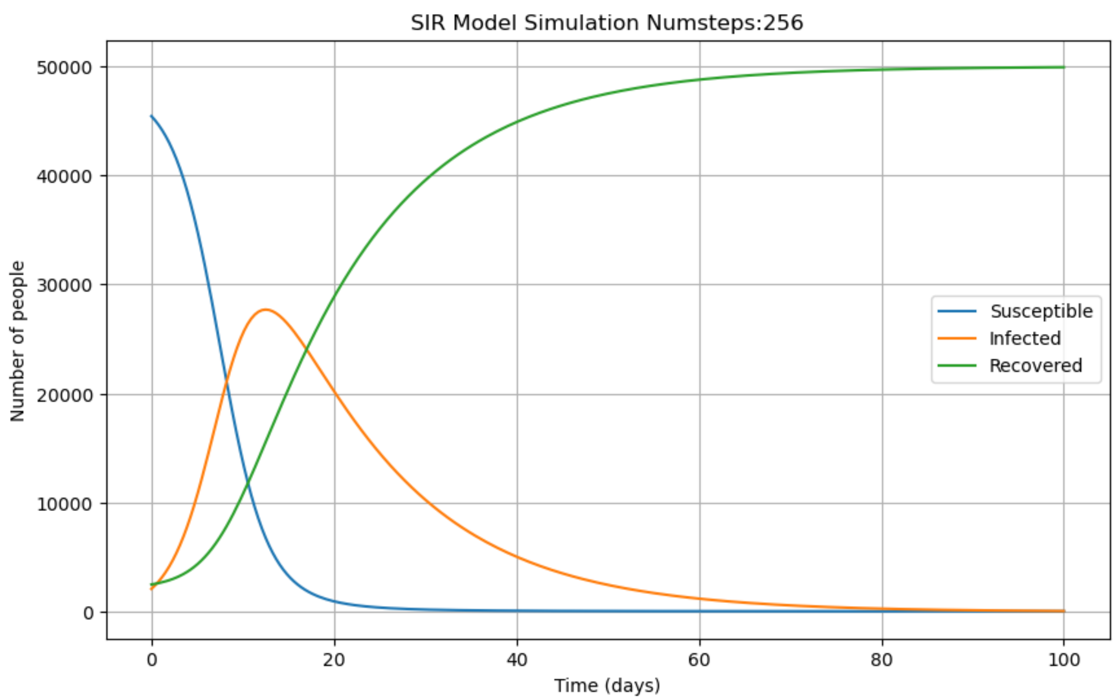

SIR Model Simulation Numsteps:8
1e39
Susceptible
Infected
Recovered
Number of people
Time (days)

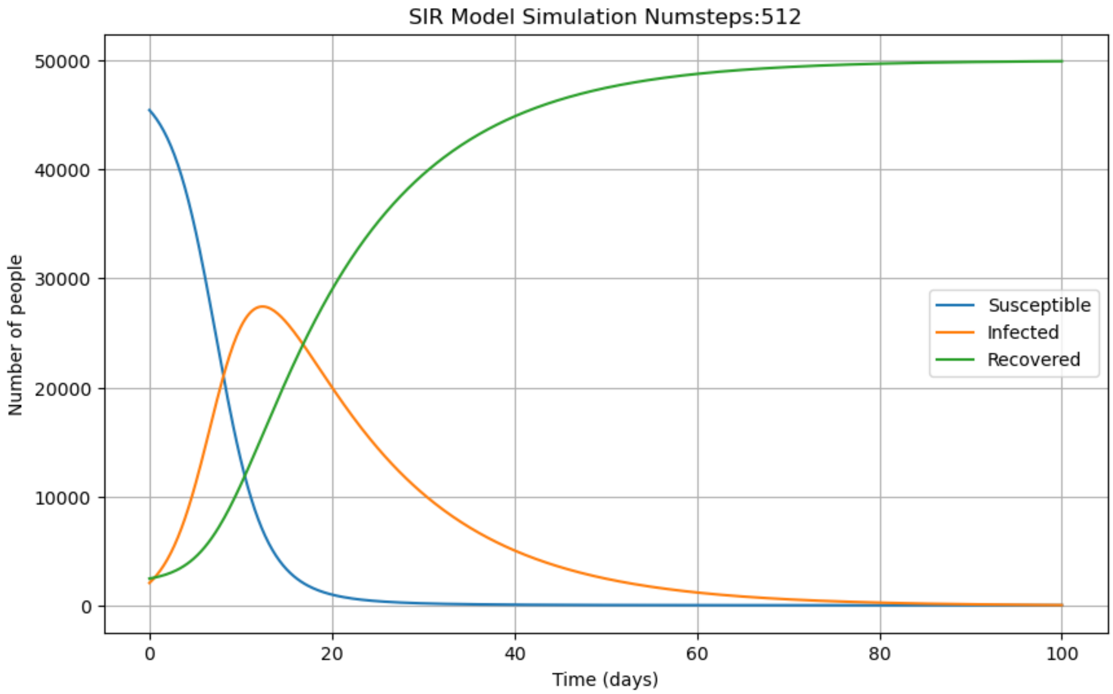


SIR Model Simulation Numsteps:16
Susceptible
Infected
Recovered
Number of people
Time (days)


SIR Model Simulation Numsteps:32
50000
40000
30000
20000
10000
0
Number of people
0
20
40
60
80
100
Time (days)
Susceptible
Infected
Recovered


SIR Model Simulation Numsteps:64
50000
40000
30000
20000
10000
0
Number of people
0
20
40
60
80
100
Time (days)
Susceptible
Infected
Recovered


SIR Model Simulation Numsteps:128
50000
40000
30000
20000
10000
0
Number of people
0
20
40
60
80
100
Time (days)
Susceptible
Infected
Recovered


SIR Model Simulation Numsteps:256
50000
40000
30000
20000
10000
0
Number of people
0
20
40
60
80
100
Time (days)
Susceptible
Infected
Recovered




1.2 - 24

Growth rate has units of persons per year. The per capita growth rate is the growth in ratio for each person, so that equals persons per year / person. If we then look at the net growth rate we multiply (persons per year / person) * person(i.e. population) and that gives us a net growth rate of persons per year.

1.2 - 25

a) Pprime(Poland) = .009 * P(Poland) Pprime(Afghanistan) = .0216 * P(Afghanistan)

b)

[2]:
```
afghanistan = .0216*15000000
poland = .009 * 37500000
print("Afghanistan growth: ", afghanistan)
print("Poland growth: ", poland)
```

```
Afghanistan growth:  324000.0
Poland growth:  337500.0
```

When comparing two countries the larger per capita will not necessarily have the larger net growth rate as demonstrated because net growth rate is dependent on current population.

c) The time it takes for the population to grow by one person is is found by solving the equation:

Net Growth Rate * Time = # of new People

therefore:

Time = # of new people / Net Growth Rate in this case it will be 1 person / Net Growth Rate

[3]:
```
print("Poland 1 person: ", 1/poland, " years")
print("Afghanistan 1 person: ", 1/afghanistan, " years")
```

```
Poland 1 person:  2.962962962962963e-06  years
Afghanistan 1 person:  3.0864197530864196e-06  years
```

[ ]:
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