WeekOneActivity

September 5, 2024

[3]:
```python
import numpy as np
import numpy.linalg as npl
import math
import matplotlib.pyplot as plt
from scipy.integrate import odeint
```

[ ]:
```python
t_data = list()
S_data = list()
I_data = list()
R_data = list()


tinitial = 0
tfinal = 30

numberofsteps = 60

t = tinitial
S = 15000# Susceptible
I = 2100 # Infected
R = 2500 # Recovered

a = .00002
b = (1/14)

deltat = (tfinal - tinitial)/numberofsteps
for k in range(0, numberofsteps+1, 1):
    Sprime = -a * S * I
    Iprime = (a * S * I) - (I * b)
    Rprime = (I * b)

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

    t_data.append(t)
    S_data.append(S)
```

```
    I_data.append(I)
    R_data.append(R)

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

Math Activity Write-up

I found the math activity to be very helpful in my understanding of equations. I found it interesting how changing the way I thought about a problem made a complicated looking equation much easier to solve. It all has to do with context. I had never considered adding my own context when none is given or changing the context to better my understanding. This ended up helping me during this first assignment. For example, problem 19 part (d) and (e) has us finding amin and amax for the given SIR problem. After analyzing what the question was really asking for, I realized that they were essentially asking for the same value. Both are looking for a value derived from the same condition with the same given values, prevent infection growth. Going forward I think it will be important for me to make sure that I am looking at the equation from all possible options. Breaking it down into a context that I can better understand may help me understand the equation at more complicated level and better my understanding of the model as a whole.

Exercises

Problems 1-6

#1 To determine peak infection, look at the graph of I. The peak is at approximately 14,000 people on day 12.

#2 The initial susceptible is around 42,000. That number is cut in half in roughly 15 days.

#3 The recovered population reaches 25,000 around day 35. I believe the number of people that eventually recover is around 45,000. I found this by looking at the graph of R and seeing where the line begins to level off.

#4 The number infected is increasing and decreasing most rapidly when the slope is steepest. Increasing looks to be around day 8 and decreasing around day 18.

#5 Using the S graph, take the total initial susceptible and subtract the number of susceptible on day 20. For each infected the number of susceptible decreases. 42,000 - 18,000 = 24,000. Therefore, 24,000 were infected in the first 20 days.

#6

Problem 7

a) S(0) = 20000 S' = -470 deltaS = S' * 10 days = -4700 S(10) = 20000 - 4700 = 15300
b) Find when S(t) = 0 0 = 20000 - 470t 470t = 20000 t = 20000/470 = 42.55 days
c) Sunday is 3 days before Wednesday and since we are going backwards its negative so deltaT = -3 deltaS = -470 * -3 = 1410 S(-3) = S(0) + deltaS = 20000 + 1410 = 21410
d) Looking for when S(t) = 30000 30000 = 20000 - 470t 10000 = -470t 10000/-470 = t = -21.28 days prior to Wednesday

Problem 19

a) Initial a = 0.00001 The quarantine cuts the transmission rate in half so the new a = 0.00001 * 0.5 = 0.000005
b) The threshold is found by setting I' to 0 so 0 = aSI - bI Solving for S I get S = b/a Using the new a = 0.000005 and b = 1/14, S = 1/14 / 0.000005 = 14285.7
c) For the quarantine to eliminate the epidemic then S must be less than b/a. If S = 45400 and b/a = 14285.7, the number of infected will initially continue to increase becuase the number of susceptible is greater than the new threshold.
d) To find the min a value use the same equation S < b/a S = 45400 b = 1/14 so 45400 = 1/14 / amin 45400 * amin = 1/14 amin = 1/14 / 45400 = 0.0000015733
e) amax is the same value as amin because the condition being tested is the same just a different context. amin is the smallest value that keeps the value from growing and amax is the largest value that still prevents growth. To determine the quarantine level use the reduction factor a/amax = 0.00001 / 0.0000015733 = 6.36. This value means that the chance that a susceptible person gets sick needs to be reduced by one-sixth.

Problem 20

a) The rate of recovery is R' = 0.08 * I. This means 0.08 recover per day. This means it takes 1 / 0.08 days to recover. 1 / 0.08 = 12.5 days.
b) For I to increase the rate of infection must be greater than the rate of recovery. So, 0.00002 * S * I > 0.08 * I 0.00002 * S > 0.08 S > 0.08 / 0.00002 = S > 4000 for the number of infected to increase
c) The recovery rate is 8% per day as shown in part a. If 100 people are infected that means that 8 people will recover in the next 24 hours.
d) If 30 new cases appear that means the susceptible population decreases by 30 so S' = -30.
e) From part c and d S' = 30 and I = 100 -30 = -0.00002 * S * 100 -30 = S * -0.002 S = 15000

Problem 21

a) b = 1/4 a = 0.003 * 1/6 = 0.0005 S' = -0.0005 * S * I I' = 0.0005 * S * I - 0.25 * I R' = 0.25 * I
b) For the illness to fade away a * S < b 0.0005 * S < 0.25 S < 500

Problem 22

a) The threshold level for S can be expressed by S < b / a
b) A lower threshold means that the infection can grow even with fewer susceptible people. A longer recovery time means a lower recovery rate and shorter recovery time means higher recovery rate. Since a is the same for both illnesses the threshold depends on b(the recovery rate). A higher recovery rate results in a higher threshold while a lower recovery rate results in a lower threshold. For example if b1 = 0.5 and b2 = 0.25 and a = 0.0005 Threshold1 = 0.5 / 0.0005 = 1000 Threshold2 = 0.25 / 0.0005 = 500

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