Optim-Mauritius-2023-CS7

January 13, 2023

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
```

0.0.1 Parameters initialization

In [2]:
```
H0 = 0.003
I0 = 0.03
S0 = 0.967
R0 = 0
g1 = 1/12
g2 = 1/10
a = 1/10
c = 0.6
l = 1/10
T = 92
dt = 1/100
```

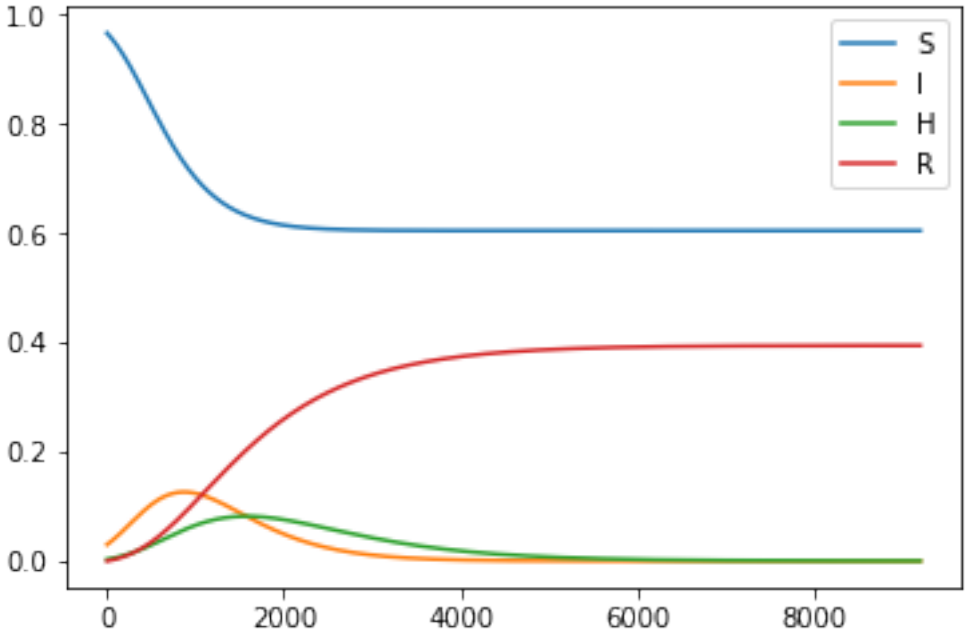
0.0.2 Solving the differential equation

In [3]:
```
def integrate(S0, I0, H0, R0, T, dt, c, l, g1, g2, a):
    S = [S0]
    I = [I0]
    H = [H0]
    R = [R0]
    n = int(1/dt)
    for i in range (T*n-1):
        S.append(S[i] - (c*np.exp(-l*i*dt)*I[i]*S[i])*dt)
        I.append(I[i] + (c*np.exp(-l*i*dt)*I[i]*S[i]-a*I[i]-g1*I[i])*dt)
        H.append(H[i] + (a*I[i] - g2*H[i])*dt)
        R.append(R[i] + (g1*I[i] + g2*H[i])*dt)
    return (S, I, H, R)
```

In [4]:
```
S, I, H, R = integrate(S0, I0, H0, R0, T, dt, c, l, g1, g2, a)
```

In [5]:
```
plt.plot(S, label = 'S')
plt.plot(I, label = 'I')
plt.plot(H, label = 'H')
plt.plot(R, label = 'R')
plt.legend()
```

Out[5]: <matplotlib.legend.Legend at 0x7f00d404a9e8>



0.0.3 Importation of the data

In [6]:
```
import pandas as pd
```

In [7]:
```
train1 = np.array([ 172., 408. , 463.,  581.,  679.,  853.,  981., 1230., 1422., 1638.
 2333., 2487., 2635., 2706., 2838., 2874., 2983., 3030., 2959., 2908., 2962., 2950.,
 2985., 3025., 3055., 3044., 3004., 2970., 2965., 2942., 2983., 2936., 2872., 2816.,
 2760., 2713., 2682., 2694., 2663., 2603., 2537., 2489., 2470., 2474., 2482., 2439.,
 2399., 2299., 2206.,2128., 2122., 2116.,2089., 2026., 1920., 1878., 1833., 1769.,
 1782.,1740., 1671., 1580., 1542., 1532., 1514., 1525., 1465., 1404., 1334., 1240.,
 1159., 1156., 1161., 1163., 1128., 1070.,  998.,  945.,  924.,  923.,  907., 865.,
  834.,  811.,  766.,  757.,  755.,  709.,  699.,  660.,  642.,  638.,  616.,  602.,
  595.,  581.,  571.,  553.,  543.,  525.,  525.,  505.,  503.])

train2=np.array([2841,3473,4552,4933,6329,7637,7728,12037,11341,13083,16020,14900,
                 19117,17393,22058,24346,21639,23481,22030,27282,25253,24206,26185,261
                 24062,28435,26635,20533,27145,25520,25878,24185,23323,21666,23197,224
                 19754,22607,24734,21932,21589,19171,21604,18962,21191,19081,19360,174
                 17652,18519,19186,14460,16119,18105,14155,14219,16033,13551,16279,138
                 14041,12092,12900,12557,12246,12143,11429,11355,11572,11067,10260,932
                 10042,9594,8867,9095,9014,9070,9286,8679,8978,9044]                  )

N1=8000000. # total population train1
N2=60000000. # total population train2
```

```
train=train1
N=N1
```

0.0.4 Formating the data

```
In [8]: def subdiv (data, dt):
            n = int(1/dt)
            T = data.__len__()
            Hd = np.zeros(T*n)
            for i in range(T*n):
                index = int(i*dt)
                Hd[i] = data[index]
            return Hd

In [9]: def extract (Hm, T, dt):
            He = np.zeros(T)
            n = int(1/dt)
            for i in range (T):
                He[i] = Hm[n*i]
            return He
```

0.0.5 Cost function

```
In [10]: def J(data, N, dt, c, l, g1, g2, a):
             n = int(1/dt)
             H0 = data[0]/N
             I0 = 10*H0
             S0 = 1-I0-H0
             R0 = 0
             T = data.__len__()
             H = integrate(S0, I0, H0, R0, T, dt, c, l, g1, g2, a)
             Hm = np.array(H)[2]
             He = extract(Hm, T, dt)
             Hd = np.zeros(T)
             for i in range(T):
                 Hd[i] = data[i]/N
             diff = np.zeros(T)
             for i in range (T):
                 diff[i] = He[i] - Hd[i]
             return (np.linalg.norm(diff)**2, Hm, He, Hd)

In [11]: Jd, H, He, Hd = J(train, N, dt, c, l, g1, g2, a)
         print(Jd)

         plt.plot(He)
         plt.plot(Hd)
```

```
8.73729453682e-06
```

Out[11]: [<matplotlib.lines.Line2D at 0x7f00cd444438>]