

Branch: master ▼

Find file

Copy path

[610_Optimization](#) / [HW2](#) / [hw2.py](#) / <> Jump to ▼

JimVargas5 finished part b of hw2

bd3ca39 17 minutes ago

[1 contributor](#)

Raw

Blame

History



141 lines (113 sloc) 3.56 KB

```
1  # Jim Vargas
2  # MTH 610
3  # HW 2
4
5
6  import numpy as np
7  from tabulate import tabulate
8  from matplotlib import pyplot as plt
9  from matplotlib.backends.backend_pdf import PdfPages
10 pdf=PdfPages('JimVargas_610_hw2_graphs.pdf')
11
12
13 Beta=0.4
14 Gamma=0.04
15 N=1000
16
17 X_0=np.array( [997, 3, 0] )
18 X=np.array(X_0) # [S I R]^T
19 X_storage=np.zeros((1001,3))
20 X_storage[0]=np.array([X])
21
22 dXdu_0=np.zeros((3,2))
23 dXdu=np.array(dXdu_0)
24 dXdu_storage=np.zeros((1001,3,2))
25 dXdu_storage[0]=np.array([dXdu])
26
27 K=10000
28 h=0.01
29 t=np.linspace(0, 100, K+1)
30
31
32 # model equations
33 def dXdt(S, I, R): # 3x1
```

```

34     dSdt=-Beta*S*I/N
35     dIdt=Beta*S*I/N - Gamma*I
36     dRdt=Gamma*I
37     return np.array([ dSdt, dIdt, dRdt ])
38 def dfdu(S, I, R): # 3x2
39     return np.array([
40         [-S*I/N, 0],
41         [S*I/N, -I],
42         [0, I]
43     ])
44 def dfdX(S, I, R): # 3x3
45     return np.array([
46         [-Beta*I/N, -Beta*S/N, 0],
47         [Beta*I/N, Beta*S/N - Gamma, 0],
48         [0, Gamma, 0]
49     ])
50
51
52 # main loop Part A #####
53 for k in range(1, K+1):
54     X_next=X + h*dXdX(X[0], X[1], X[2])
55     X_storage[k]=np.array([X_next])
56
57     dXdu=dXdu +h*(
58         np.matmul(dfdX(X[0], X[1], X[2]), dXdu)
59         + dfdu(X[0], X[1], X[2])
60     )
61     dXdu_storage[k]=np.array([dXdu])
62
63     X=X_next
64
65
66 # plots
67 fig_state=plt.figure()
68 plt.plot(t, X_storage[:,0], label='S(t_k)')
69 plt.plot(t, X_storage[:,1], label='I(t_k)')
70 plt.plot(t, X_storage[:,2], label='R(t_k)')
71 plt.title("X=X[S,I,R], K="+str(K)+"\n"+"Beta="+str(Beta)+", Gamma="+str(Gamma))
72 plt.xlabel("t_k=1:K, step size="+str(h))
73 plt.ylabel("Portion of population N="+str(N))
74 plt.legend(loc='best')
75 plt.close()
76 pdf.savefig(fig_state)
77
78 fig_params, ax=plt.subplots(3,2, sharex=True)
79 fig_params.suptitle(
80     "Sate X Sensitivites to"+'\n'
81     "Parameters Beta="+str(Beta)+", Gamma="+str(Gamma))

```

```

82 )
83 fig_params.text(0.07,0.01,
84     "All graphs share the same horizontal axis as in Fig 1.\n"+
85     "Legend: [[dS/dBeta, dS/dGamma], [dI/dBeta, dI/dGamma], [dR/dBeta, dR/dGamma]]")
86 )
87 ax[0, 0].plot(t, dXdu_storage[:, 0, 0]) # dS/dBeta
88 ax[0, 1].plot(t, dXdu_storage[:, 0, 1]) # dS/dGamma
89 ax[1, 0].plot(t, dXdu_storage[:, 1, 0]) # dI/dBeta
90 ax[1, 1].plot(t, dXdu_storage[:, 1, 1]) # ...
91 ax[2, 0].plot(t, dXdu_storage[:, 2, 0])
92 ax[2, 1].plot(t, dXdu_storage[:, 2, 1])
93 plt.close()
94 pdf.savefig(fig_params)
95
96
97
98 # Part B #####
99 dBeta=0.1*Beta
100 dGamma=0.1*Gamma
101
102 dI_Beta=dBeta*dXdu_storage[:,1,0]
103 dI_Gamma=dGamma*dXdu_storage[:,1,0]
104
105 J=(h/100)*np.sum(X_storage[:,1])
106
107 tempSum=(h/100)*np.sum(dXdu_storage[:,1,0])
108 dJ_Beta=dBeta*tempSum
109 dJ_Gamma=dGamma*tempSum
110
111
112 # plots and table
113 fig_apriori_dI_Beta=plt.figure()
114 plt.title("A priori estimated Impact of +/- dBeta on I\n"+
115     "Beta="+str(Beta)+", dBeta="+str(dBeta))
116 plt.plot(t, X_storage[:,1], label="I(t_k)")
117 plt.plot(t, X_storage[:,1] + dI_Beta[:,], label="I+dI")
118 plt.plot(t, X_storage[:,1] - dI_Beta[:,], label="I-dI")
119 plt.legend(loc='best')
120 plt.close()
121 pdf.savefig(fig_apriori_dI_Beta)
122
123 fig_apriori_dI_Gamma=plt.figure()
124 plt.title("A priori estimated Impact of +/- dGamma on I\n"+
125     "Gamma="+str(Gamma)+", dGamma="+str(dGamma))
126 plt.plot(t, X_storage[:,1], label="I(t_k)")
127 plt.plot(t, X_storage[:,1] + dI_Gamma[:,], label="I+dI")
128 plt.plot(t, X_storage[:,1] - dI_Gamma[:,], label="I-dI")
129 plt.legend(loc='best')

```

```
130 plt.close()
131 pdf.savefig(fig_apriori_dI_Gamma)
132
133
134 pdf.close()
135
136 Table=[
137     ["Beta",Beta],["Gamma",Gamma],["+/- dBeta",dBeta],["+/- dGamma",dGamma],
138     ["J",J],["+/- dJ, from dBeta",dJ_Beta],["+/- dJ, from dGamma",dJ_Gamma]
139 ]
140 with open("JimVargas_610_hw2.txt", 'w') as output:
141     print(tabulate(Table), file=output)
```