

```
In [1]: import numpy as np
from scipy.integrate import odeint
from scipy.optimize import curve_fit
from scipy.optimize import differential_evolution
%matplotlib inline
import matplotlib.pyplot as plt
from matplotlib.backends.backend_pdf import PdfPages
import pandas as pd
```

```
In [2]: from endpoint_maker import sqres
from endpoint_maker import func
from endpoint_maker import t
from endpoint_maker import new
from endpoint_maker import lightdata
from endpoint_maker import rawdata
```

```
In [3]: if __name__ == '__main__':
def initparams():
    bounds = ([0.00001,10000],[0,4],[0.00001,1000],[0.00001,1000],[0.00001,1000]
    #bounds = ([0.00001,1000],[0.00001,1000],[0.00001,10000])
    result = differential_evolution(sqres,bounds,maxiter=100,popsize=20,polish=
    return result
```

```
In [4]: initialp = initparams()
print(initialp)
```

```
message: Maximum number of iterations has been exceeded.
success: False
  fun: 0.3217313162706648
   x: [ 7.971e+03  1.950e+00  6.760e+02  1.216e-01  1.548e+00]
  nit: 100
 nfev: 10100
```

```
In [5]: def tester(t,Kd,n,d2,k2,k3,i):
#def tester(t,d2,k2,k3,i):

    inivalues = [1,0,0,0,0,0,0]
    arrayvalues = np.asarray([])

    #for i in range(len(lightdata[:,0])):
    def I(t):
        tindex = t/5
        if tindex > 12241:
            tindex = 12240
        return lightdata[i][int(tindex)]

    def odes(z,t,Kd,n,d2,k2,k3):
    #def odes(z,t,d2,k2,k3):
        Pu,Pb,Pa,mRNA,mCherry1,mCherry2,mCherry3 = z
        d1 = 0.019905
        k1 = 0.08299
        #Kd = 90.41
        #n = 0.964487
        #d2= 486.67
```

```

#k2= 6.597
#k3= 0.0539

d3 = 0.000077
k4 = 1.25
d4 = 0.000031
k5 = 0.00283
k6 = 0.00283

Pu = z[0]
Pb = z[1]
Pa = z[2]
mRNA = z[3]
mCherry1 = z[4]
mCherry2 = z[5]
mCherry3 = z[6]

dPudt = d1*Pb - k1*Pu
dPbdt = k1*Pu - k2*I(t)**n/(Kd**n+I(t)**n)*Pb - d1*Pb + d2*Pa
dPadt = k2*I(t)**n/(Kd**n+I(t)**n)*Pb - d2*Pa
dmRNA dt = k3*Pa - d3*mRNA
dmCherry1dt = k4*mRNA-(d4 + k5)*mCherry1
dmCherry2dt = k5*mCherry1-(d4+k6)*mCherry2
dmCherry3dt = k6*mCherry2 - d4*mCherry3

return [dPudt,dPbdt,dPadt,dmRNA dt, dmCherry1dt, dmCherry2dt, dmCherry3dt]

solver = odeint(odes, inivalues, t, args = (Kd, n, d2, k2, k3), hmax=0.1)
#solver = odeint(odes, inivalues, t, args = (d2, k2, k3), hmax=0.1)

mCherryout = solver[:,6]
#mCherryout = mCherryout[0:24480:240]
return mCherryout

```

In [6]: `print(initialp.x)`

```
[7.97050586e+03 1.94960226e+00 6.76032123e+02 1.21622767e-01
1.54809198e+00]
```

In [7]: `popt, covt = curve_fit(func, t, new, initialp.x, maxfev=1000000)`

```

#popt, covt = curve_fit(func, t, newdata, initialp.x, maxfev=10000000, bounds=((0.0000
#popt, covt = curve_fit(func, t, newdata, initialp.x, maxfev=1000000)

Kd, n, d2, k2, k3 = pop
print('Kd=', Kd, 'n=', n, 'd2=', d2, 'k2=', k2, 'k3=', k3)

#d3, k4, d4, k5, k6 = pop
#print('d3=', d3, 'k4=', k4, 'd4=', d4, 'k5=', k5, 'k6=', k6)

#d2, k2, k3 = pop
#print('d2=', d2, 'k2=', k2, 'k3=', k3)

```

Kd= 7917.386171649975 n= 1.949605337619446 d2= 669.9230090801701 k2= 0.1224051496043
135 k3= 1.535828527168093

```
In [8]: import sys
import numpy
#params = [1,1,1,1,1,1,1]
params = [1,1,1,1,1]
numpy.set_printoptions(threshold=10)
model1 = np.asarray(func(t,Kd,n,d2,k2,k3))
#model1 = np.asarray(func(t,d2,k2,k3))
print(len(model1))
#print(model1)

#a,b,c,d,e,f,g = params
a,b,c,d,e = params

ydata = np.asarray(new)
print(len(ydata))

ssr = np.sum((ydata-model1)**2)
#ssr2 = np.sum((ydata-model2)**2)
sst = np.sum((ydata - np.mean(ydata))**2)
R2 = 1 - ssr/sst
#R2_2 = 1 - ssr2/sst

print('R2 is: ', R2)
#print(R2_2)
```

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R2 is: 0.7028470822202297

```
In [9]: pp = PdfPages('multipage.pdf')
ydata = np.asarray(new)

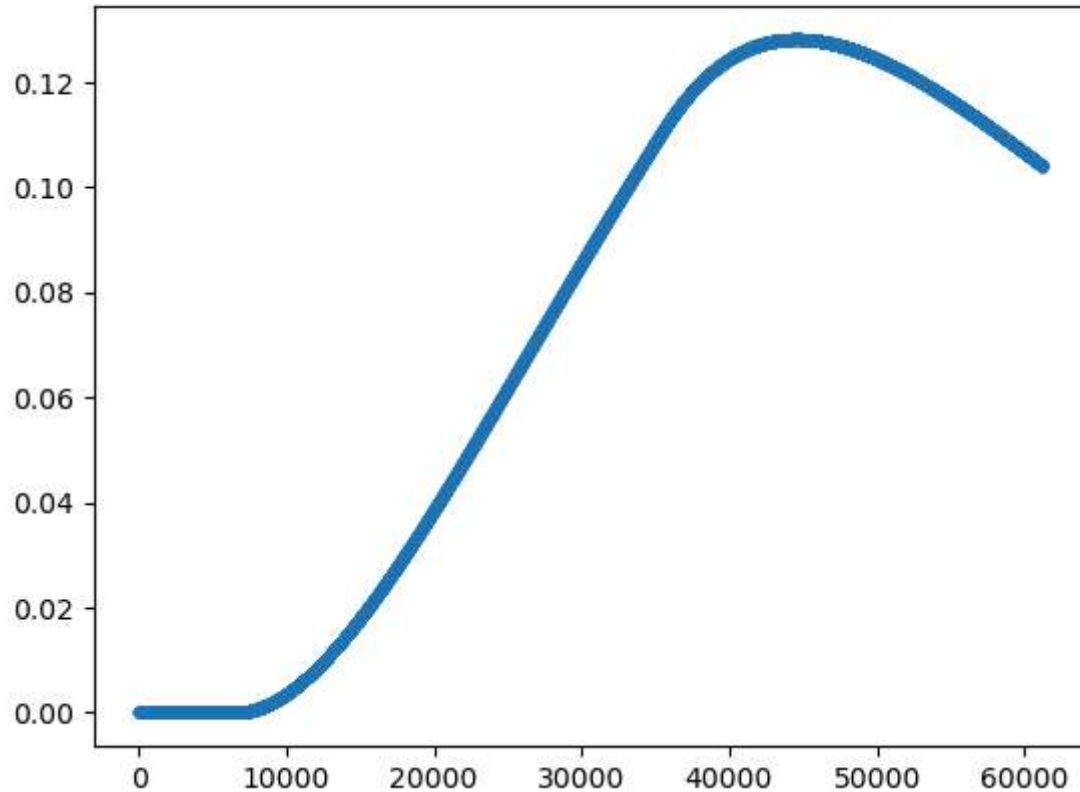
#condition = [1,2,3,4,5,6,7,8,9]
for i in range(2):
    model = tester(t,Kd,n,d2,k2,k3,i)
    #model = tester(t,d2,k2,k3,i)

    #print(model)
    #a,b,c,d,e,f,g= params
    a,b,c,d,e= params

    plt.plot(t,model,'.', label = 'model')
    #print(model)
    #t = np.linspace(0,34800, num=6961)
    #raw = rawdata[0:13920:240]
    plt.plot(t,raw[i],'.',label = 'data')
    #print(rawdata[i])
    plt.legend()
    pp.savefig()
    plt.show()

pp.close
```

```
-----  
NameError                                Traceback (most recent call last)  
Cell In[9], line 17  
    13 plt.plot(t,model,'.', label = 'model')  
    14 #print(model)  
    15 #t = np.linspace(0,34800, num=6961)  
    16 #raw = rawdata[0:13920:240]  
--> 17 plt.plot(t,raw[i],'.',label = 'data')  
    18 #print(rawdata[i])  
    19 plt.legend()  
  
NameError: name 'raw' is not defined
```



In []: