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```
% Here is an example that reads in infection and fatalities from STL City
% and loads them into a new matrix covidstlcity_full
% In addition to this, you have other matrices for the other two regions in
 question
```

```
load('COVIDdata.mat');
%get the same amount of covid data from each of the three regions
COVID_jeffcity = COVID_MO(COVID_MO.name == "Jefferson City",:);
covidjeffcity_full = double(table2array(COVID_jeffcity(301:584,[3:4])));
COVID_STLcity = COVID_MO(COVID_MO.name == "St. Louis",:);
covidstlcity_full = double(table2array(COVID_STLcity(301:584,[3:4])));
COVID_springfield = COVID_MO(COVID_MO.name == "Springfield",:);
covidspringfield_full = double(table2array(COVID_springfield(301:584,[3:4])));
%combine the three regions covid data for the model
coviddata = covidstlcity_full+ covidspringfield_full +covidjeffcity_full;
t = length(coviddata);
```

The following line creates an 'anonymous' function that will return the cost (i.e., the model fitting error) given a set of parameters. There are some technical reasons for setting this up in this way. Feel free to peruse the MATLAB help at https://www.mathworks.com/help/optim/ug/fmincon.html and see the sectiono on 'passing extra arguments' Basically, 'sirafun' is being set as the function siroutput (which you will be designing) but with t and coviddata specified.

```
sirafun2= @(x)sliroutput_big(x,t,coviddata);
```

set up rate and initial condition constraints

Set A and b to impose a parameter inequality constraint of the form A*x < b Note that this is imposed element-wise If you don't want such a constraint, keep these matrices empty.

```
A = [1 1 1 1 0 0 0 0 0;
     0 1 1 0 0 0 0 0 0];
b = [1, 0.5];
```

set up some fixed constraints

Set Af and bf to impose a parameter constraint of the form Af*x = bf Hint: For example, the sum of the initial conditions should be constrained If you don't want such a constraint, keep these matrices empty.

```
Af = [0 0 0 0 1 1 1 1 1];
bf = [1];
```

set up upper and lower bound constraints

Set upper and lower bounds on the parameters lb < x < ub here, the inequality is imposed element-wise If you don't want such a constraint, keep these matrices empty.

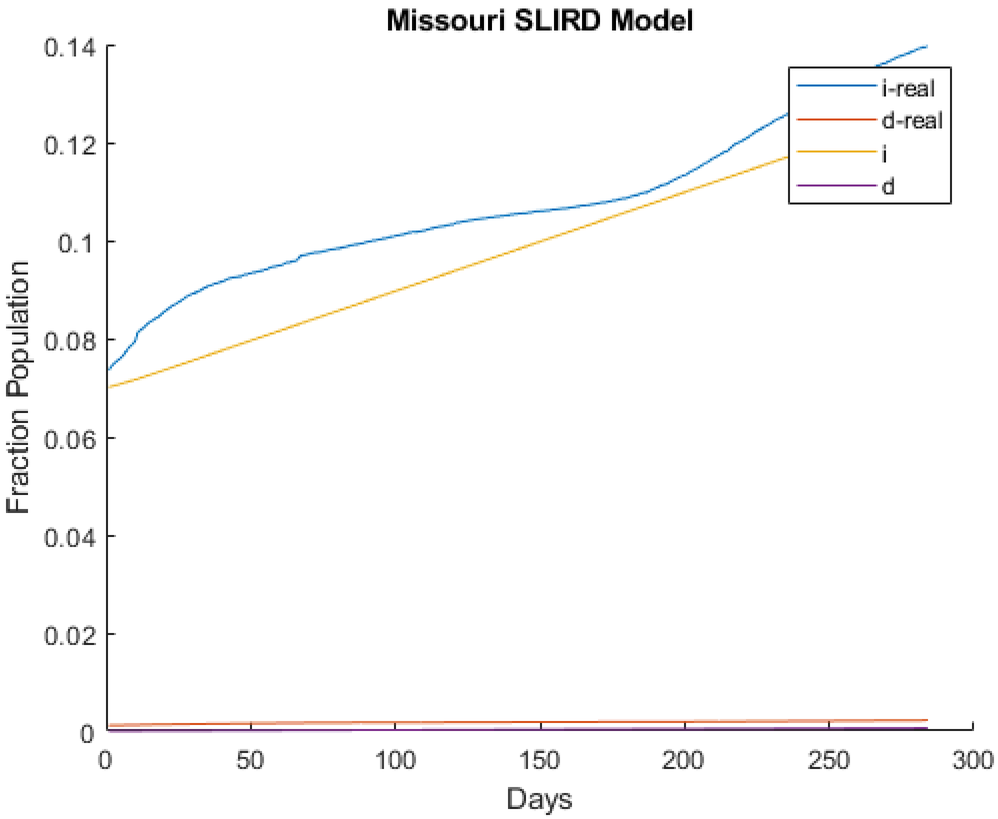
```
ub = [1 1 1 1 1 1 .7  .7  .3];
lb = [.015 0.01 .3 .3 .3 .1 .01 .01 .01];

% Specify some initial parameters for the optimizer to start from
x0 = [.3 .03 .4 .27 .5 .5 0 0 0];
% This is the key line that tries to opimize your model parameters in order to
% fit the data
% note tath you
x = fmincon(sirafun2,x0,A,b,Af,bf,lb,ub);

Y_fit = slircutput_big_full(x,t);



% Make some plots that illustrate your findings.
temp = Y_fit;
cumlsum = cumsum(temp);

figure();
cumlsumFinal = cumlsum(: , [4,5]).*7;
hold on;
plot(coviddata./3430891);
split = ((cumlsumFinal./3430891)*100); % splitting the data to apply a manual
 fit to the data.
plot(1:t, (split(:,1) + .07));
plot(1:t, split(:,2));
%Plot labling:
legend("i-real", "d-real","i","d");
xlabel("Days");
ylabel("Fraction Population");
title("Missouri SLIRD Model");
hold off
```

```
Local minimum found that satisfies the constraints.

Optimization completed because the objective function is non-decreasing in
feasible directions, to within the value of the optimality tolerance,
and constraints are satisfied to within the value of the constraint tolerance.


sys_sir_base =

  A =
              x1         x2         x3         x4         x5         x6         x7
   x1      0.385        0.4          0          0          0          0          0
   x2        0.3        0.6        0.5          0          0          0          0
   x3      0.015          0   1.23e-05          0          0          0          0
   x4        0.3          0       0.49          1          0          0          0
   x5          0          0       0.01          0          1          0          0
   x6          0          0          0          0          0      0.385        0.4
   x7          0          0          0          0          0        0.3        0.6
   x8          0          0          0          0          0      0.015          0
   x9          0          0          0          0          0        0.3          0
```

```
 x10         0         0         0         0         0         0         0
 x11         0         0         0         0         0         0         0
 x12         0         0         0         0         0         0         0
 x13         0         0         0         0         0         0         0
 x14         0         0         0         0         0         0         0
 x15         0         0         0         0         0         0         0

            x8        x9       x10       x11       x12       x13       x14
 x1          0         0         0         0         0         0         0
 x2          0         0         0         0         0         0         0
 x3          0         0         0         0         0         0         0
 x4          0         0         0         0         0         0         0
 x5          0         0         0         0         0         0         0
 x6          0         0         0         0         0         0         0
 x7        0.5         0         0         0         0         0         0
 x8   1.23e-05         0         0         0         0         0         0
 x9       0.49         1         0         0         0         0         0
 x10      0.01         0         1         0         0         0         0
 x11         0         0         0     0.385       0.4         0         0
 x12         0         0         0       0.3       0.6       0.5         0
 x13         0         0         0     0.015         0  1.23e-05         0
 x14         0         0         0       0.3         0      0.49         1
 x15         0         0         0         0         0      0.01         0

           x15
 x1          0
 x2          0
 x3          0
 x4          0
 x5          0
 x6          0
 x7          0
 x8          0
 x9          0
 x10         0
 x11         0
 x12         0
 x13         0
 x14         0
 x15         1

B =
      u1
 x1    0
 x2    0
 x3    0
 x4    0
 x5    0
 x6    0
 x7    0
 x8    0
 x9    0
 x10   0
 x11   0
```

```
  x12   0
  x13   0
  x14   0
  x15   0

C =
        x1    x2    x3    x4    x5    x6    x7    x8    x9   x10   x11   x12   x13
  y1     1     0     0     0     0     0     0     0     0     0     0     0     0
  y2     0     1     0     0     0     0     0     0     0     0     0     0     0
  y3     0     0     1     0     0     0     0     0     0     0     0     0     0
  y4     0     0     0     1     0     0     0     0     0     0     0     0     0
  y5     0     0     0     0     1     0     0     0     0     0     0     0     0
  y6     0     0     0     0     0     1     0     0     0     0     0     0     0
  y7     0     0     0     0     0     0     1     0     0     0     0     0     0
  y8     0     0     0     0     0     0     0     1     0     0     0     0     0
  y9     0     0     0     0     0     0     0     0     1     0     0     0     0
  y10    0     0     0     0     0     0     0     0     0     1     0     0     0
  y11    0     0     0     0     0     0     0     0     0     0     1     0     0
  y12    0     0     0     0     0     0     0     0     0     0     0     1     0
  y13    0     0     0     0     0     0     0     0     0     0     0     0     1
  y14    0     0     0     0     0     0     0     0     0     0     0     0     0
  y15    0     0     0     0     0     0     0     0     0     0     0     0     0

       x14   x15
  y1     0     0
  y2     0     0
  y3     0     0
  y4     0     0
  y5     0     0
  y6     0     0
  y7     0     0
  y8     0     0
  y9     0     0
  y10    0     0
  y11    0     0
  y12    0     0
  y13    0     0
  y14    1     0
  y15    0     1

D =
       u1
  y1    0
  y2    0
  y3    0
  y4    0
  y5    0
  y6    0
  y7    0
  y8    0
  y9    0
  y10   0
  y11   0
  y12   0
```

```
   y13   0
   y14   0
   y15   0

Sample time: 1 seconds
Discrete-time state-space model.
```



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