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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');
COVID_STLcity = COVID_MO(COVID_MO.name == "St. Louis",:);
covidstlcity_full = double(table2array(COVID_STLcity(301:594,[3:4])));

coviddata = covidstlcity_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(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

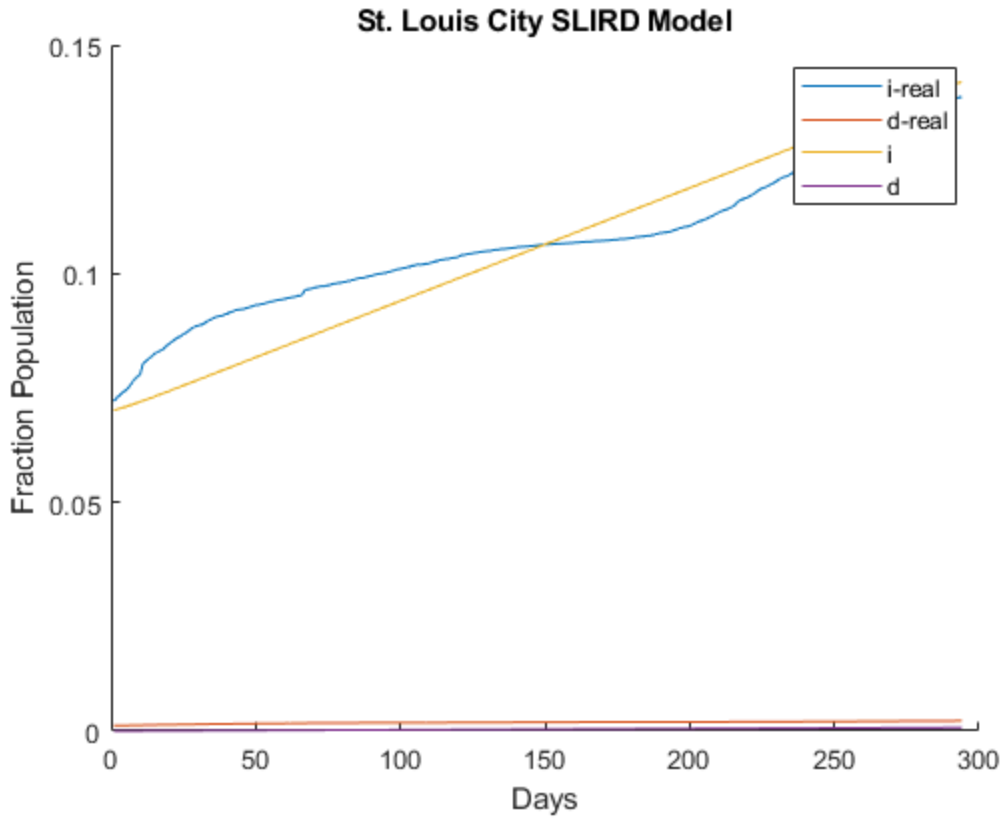
Set upper and lower bounds on the parameters lb < x < ub here, the inequality is imposed element-wise If you don't want such a constraint, keep these matrices empty.

```
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 = sliroutput_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./2805473);
split = ((cumlsumFinal./2805473)*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("St. Louis City 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
   x1      0.385         0.4           0           0           0
   x2        0.3         0.6         0.5           0           0
   x3      0.015           0   2.246e-06           0           0
   x4        0.3           0        0.49           1           0
   x5          0           0        0.01           0           1

  B =
       u1
```

```
  x1   0
  x2   0
  x3   0
  x4   0
  x5   0

C =
       x1  x2  x3  x4  x5
  y1    1   0   0   0   0
  y2    0   1   0   0   0
  y3    0   0   1   0   0
  y4    0   0   0   1   0
  y5    0   0   0   0   1

D =
       u1
  y1    0
  y2    0
  y3    0
  y4    0
  y5    0

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



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