Set up:

param\_struct = ...

    {'beta\_h', 0.24;

     'beta\_v', 0.24;

     'gamma\_h', 1/6;

     'mu\_h', 1/(70\*365);

     'nu\_h', 1/3;

     'psi\_v', 0.3;

     'mu\_v', 1/17;

     'nu\_v', 1/11;

     'sigma\_h1', 10; %low risk contacts

     'sigma\_h2', 30; %high risk contacts

     'sigma\_v', 0.5;

     'H0', 100;

     'theta1', 1-param(1); %proportion of population in group 1 - low risk

     'theta2', param(1);% proportion of population in group 2 - high risk

     'theta0', .8; % no risk group

     'init\_cumulative\_infected', param(4);

     'K\_v' , param(5);

     'pi1', param(2); %proportion that continues to be bitten in infected group 1

     'pi2', param(3); %proportion that continues to be bitten in infected group 2

    }';

params = struct(param\_struct{:});

init =  ...

    [param.H0 \*param.theta1 - param.init\_cumulative\_infected\*param.theta1,

     param.H0\* param.theta2 - param.init\_cumulative\_infected\*param.theta2,

     param.init\_cumulative\_infected \* param.theta1,

     param.init\_cumulative\_infected \* param.theta2,

     0,

     0,

     param.init\_cumulative\_infected \* param.theta1,

     param.init\_cumulative\_infected \* param.theta2,

     param.K\_v\*0.75,

     0,

     0];

str.psol=[0.7,0.8,.4,4 1100]'; % initial guess at the solution for the parameters

str.ub = [1,1, 0.6,10, 1400]';

str.lb = [0.5,0.5,0,1, 900]';

str.noise\_sd=0.05;

str.p0 = [0.75,0.75,0.3,5.5,1150]’;

The pfit solution values are

pfit =

7.1032e-01

9.5043e-01

4.4885e-01

4.0070e+00

9.0006e+02

BEGIN RESIDUAL ANALYSIS TESTS

Gaussian process models about the data fit should satisfy the conditions

residual mean = -0.069387 approx 0.14535 = residual median

residual STD = 3.4309 approx 2.7083 = residual MAD

Randomness test that the ratio of positive to negative res1d = 0.53465 is close to 0.5

No residual trend indicated if the trend threshold = 95 > 0 = autocorrelation

BEGIN BOOTSTRAP ANALYSIS

mean pfit 95% CI delta

6.7995e-01 2.2229e-02

8.7310e-01 8.0969e-02

4.5254e-01 6.6145e-03

4.2527e+00 2.4762e-01

9.3681e+02 3.3892e+01

Correlation coefficients

1.0000e+00 -3.0394e-01 -3.5861e-01 -7.8213e-01 -4.8571e-01

-3.0394e-01 1.0000e+00 1.7479e-01 5.2235e-01 -5.3116e-01

-3.5861e-01 1.7479e-01 1.0000e+00 7.7638e-02 -2.2541e-01

-7.8213e-01 5.2235e-01 7.7638e-02 1.0000e+00 1.1872e-01

-4.8571e-01 -5.3116e-01 -2.2541e-01 1.1872e-01 1.0000e+00

BEGIN LOCAL IDENTIFIABILITY HESSIAN ANALYSIS

Hessian

8.3924e+05 9.9119e+04 1.5198e+06 1.7589e+04 6.0722e+02

9.9119e+04 1.2683e+04 1.8101e+05 1.7118e+03 7.7949e+01

1.5198e+06 1.8101e+05 2.7755e+06 3.0482e+04 1.0989e+03

1.7589e+04 1.7118e+03 3.0482e+04 1.4992e+03 8.6846e+00

6.0722e+02 7.7949e+01 1.0989e+03 8.6846e+00 4.3128e-01

Fisher information matrix

8.4367e+05 1.0017e+05 1.5303e+06 1.7912e+04 6.0503e+02

1.0017e+05 1.2266e+04 1.8437e+05 1.9127e+03 7.3124e+01

1.5303e+06 1.8437e+05 2.7951e+06 3.0945e+04 1.1067e+03

1.7912e+04 1.9127e+03 3.0945e+04 5.6736e+02 1.2091e+01

6.0503e+02 7.3124e+01 1.1067e+03 1.2091e+01 4.3835e-01

The norm of the gradient = 51.0521 should be small at the minimium

The condition number of the Hessian = 62819114.8202

should be < 20724.3029 for all variables to be structually identifiable

The parameters

'\theta\_2' '\pi\_1' '\pi\_2' 'init' 'K\_v'

are structually identifiable

The parameters

'\theta\_2' '\pi\_1' '\pi\_2' 'init' 'K\_v'

are practically identifiable

The vectors 1 2 3 4 5 are structually identifiable

The vectors 1 2 3 4 5 are practically identifiable

Singular values

3.6215e+06 5.5371e+03 1.2252e+03 6.7034e+02 5.7649e-02

The vectors spanning the stuctural identifiable space are

-4.8020e-01 8.6291e-01 1.3308e-01 8.4177e-02 1.0626e-03

-5.7094e-02 -4.6595e-02 5.9994e-01 -7.9662e-01 6.4606e-03

-8.7524e-01 -4.7233e-01 -1.0346e-01 1.2436e-02 -5.8321e-04

-9.7303e-03 1.7358e-01 -7.8207e-01 -5.9845e-01 -2.1934e-03

-3.4734e-04 5.1066e-04 5.7932e-03 -3.7519e-03 -9.9998e-01

BEGIN EXTENDED IDENTIFIABILITY PROFILE ANALYSIS

res\_profile

Columns 1 through 6

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

1.1776e+03 1.1777e+03 1.1778e+03 1.1779e+03 1.1781e+03 1.1781e+03

Columns 7 through 12

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

1.1782e+03 1.1783e+03 1.1784e+03 1.1785e+03 1.1785e+03 1.1786e+03

Columns 13 through 18

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05 2.5343e+05

1.1787e+03 1.1787e+03 1.1788e+03 1.1788e+03 1.1789e+03 1.1789e+03

Columns 19 through 20

2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05

2.5343e+05 2.5343e+05

1.1789e+03 1.1790e+03

BEGIN GLOBAL IDENTIFIABILITY ANALYSIS

variance of variables 0.0030191717 0.0034547556 0.001453689 4.5420086e-05 1775.0719

the nonidentifiable variables are = 1 2 3 4 5