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=[0.7,0.6,.8,4,1100]'; % initial guess at the solution for the parameters

str.ub = [0.8,0.9, 1,10,1500]';

str.lb = [0.5,0.3, 0.6,1,700]';

str.noise\_sd=0.05;

str.p0 = [6.5000e-01, 6.0000e-01,8.0000e-01, 5.5000e+00, 1.1000e+03]

The pfit solution values are

pfit =

7.8588e-01

8.9999e-01

6.0008e-01

3.4161e+00

1.4116e+03

BEGIN RESIDUAL ANALYSIS TESTS

Gaussian process models about the data fit should satisfy the conditions

residual mean = 0.010068 approx 0.21323 = residual median

residual STD = 4.6034 approx 3.655 = residual MAD

Randomness test that the ratio of positive to negative res1d = 0.51485 is close to 0.5

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

BEGIN BOOTSTRAP ANALYSIS

mean pfit 95% CI delta

7.6830e-01 1.2172e-02

8.3090e-01 6.7010e-02

7.6285e-01 8.7027e-02

3.4842e+00 9.7897e-02

1.1598e+03 1.5268e+02

Correlation coefficients

Columns 1 through 4

1.0000e+00 -4.5628e-01 -1.5659e-01 -3.1363e-01

-4.5628e-01 1.0000e+00 -2.9502e-02 6.6150e-02

-1.5659e-01 -2.9502e-02 1.0000e+00 -2.8073e-01

-3.1363e-01 6.6150e-02 -2.8073e-01 1.0000e+00

2.6649e-02 7.2030e-02 -9.8580e-01 2.7125e-01

Column 5

2.6649e-02

7.2030e-02

-9.8580e-01

2.7125e-01

1.0000e+00

BEGIN LOCAL IDENTIFIABILITY HESSIAN ANALYSIS

Hessian

Columns 1 through 4

3.8519e+05 1.1798e+04 3.7924e+05 1.5376e+04

1.1798e+04 4.3647e+02 1.2407e+04 4.0881e+02

3.7924e+05 1.2407e+04 3.8179e+05 1.4533e+04

1.5376e+04 4.0881e+02 1.4533e+04 7.5212e+02

9.8991e+01 3.2815e+00 1.0011e+02 3.7485e+00

Column 5

9.8991e+01

3.2815e+00

1.0011e+02

3.7485e+00

2.6278e-02

Fisher information matrix

Columns 1 through 4

3.8337e+05 1.1880e+04 3.7788e+05 1.5337e+04

1.1880e+04 4.4626e+02 1.2541e+04 4.1306e+02

3.7788e+05 1.2541e+04 3.8137e+05 1.4511e+04

1.5337e+04 4.1306e+02 1.4511e+04 7.5304e+02

9.8810e+01 3.3255e+00 1.0020e+02 3.7449e+00

Column 5

9.8810e+01

3.3255e+00

1.0020e+02

3.7449e+00

2.6358e-02

The norm of the gradient = 2.6107 should be small at the minimium

The condition number of the Hessian = 227569306368.3289

should be < 41448.6057 for all variables to be structually identifiable

None of the variables are structually identifiable

The parameters

'K\_v'

are practically identifiable

The vectors 1 2 3 4 are structually identifiable

The vectors 1 2 3 4 are practically identifiable

Singular values

Columns 1 through 4

7.6370e+05 4.3690e+03 9.3215e+01 3.1855e-01

Column 5

3.3559e-06

The vectors spanning the stuctural identifiable space are

-7.0824e-01 6.9443e-01 1.1429e-01 -5.5684e-02

-2.2423e-02 -1.0911e-01 4.0236e-02 -9.9296e-01

-7.0507e-01 -6.9921e-01 -7.7187e-02 8.9628e-02

-2.7716e-02 1.3030e-01 -9.8963e-01 -5.3793e-02

-1.8446e-04 -2.5726e-04 1.0170e-04 9.6281e-04

The vectors spanning the stuctural non-identifiable space are

Nonidentiviable vectors

8.9995e-05

9.1973e-04

-3.8837e-04

1.8084e-04

1.0000e+00

BEGIN EXTENDED IDENTIFIABILITY PROFILE ANALYSIS

res\_profile

Columns 1 through 4

6.5328e+03 5.9596e+03 5.4588e+03 5.0449e+03

1.2465e+04 1.2531e+04 1.2596e+04 1.2662e+04

1.3672e+04 1.5613e+04 1.7576e+04 1.9528e+04

9.9111e+03 1.3174e+04 1.6272e+04 1.9119e+04

2.1400e+03 2.1270e+03 2.1236e+03 2.1230e+03

Columns 5 through 8

4.7293e+03 4.5206e+03 4.4239e+03 4.4439e+03

1.2729e+04 1.2795e+04 1.2862e+04 1.2930e+04

2.1389e+04 2.3391e+04 2.5314e+04 2.7206e+04

2.1734e+04 2.4148e+04 2.6385e+04 2.8473e+04

2.1225e+03 2.1220e+03 2.1216e+03 2.1213e+03

Columns 9 through 12

4.5809e+03 4.8370e+03 5.2096e+03 5.7001e+03

1.2998e+04 1.3066e+04 1.3135e+04 1.3204e+04

2.9068e+04 3.0929e+04 3.2661e+04 3.4330e+04

3.0430e+04 3.2271e+04 3.4019e+04 3.5677e+04

2.1210e+03 2.1207e+03 2.1204e+03 2.1202e+03

Columns 13 through 16

6.3042e+03 7.0244e+03 7.8559e+03 8.8029e+03

1.3273e+04 1.3343e+04 1.3413e+04 1.3483e+04

3.6124e+04 3.7726e+04 3.9316e+04 4.0921e+04

3.7258e+04 3.8768e+04 4.0220e+04 4.1613e+04

2.1200e+03 2.1198e+03 2.1196e+03 2.1194e+03

Columns 17 through 20

9.8641e+03 1.1041e+04 1.2343e+04 1.3768e+04

1.3554e+04 1.3625e+04 1.3697e+04 1.3768e+04

4.2379e+04 4.3859e+04 4.5284e+04 4.6704e+04

4.2954e+04 4.4247e+04 4.5496e+04 4.6704e+04

2.1193e+03 2.1191e+03 2.1195e+03 2.1199e+03

BEGIN GLOBAL IDENTIFIABILITY ANALYSIS

variance of variables 5.83864e-06 0.000388238 9.052e-06 0.000111987 78.7844

the nonidentifiable variables are = 1 2 3 4 5