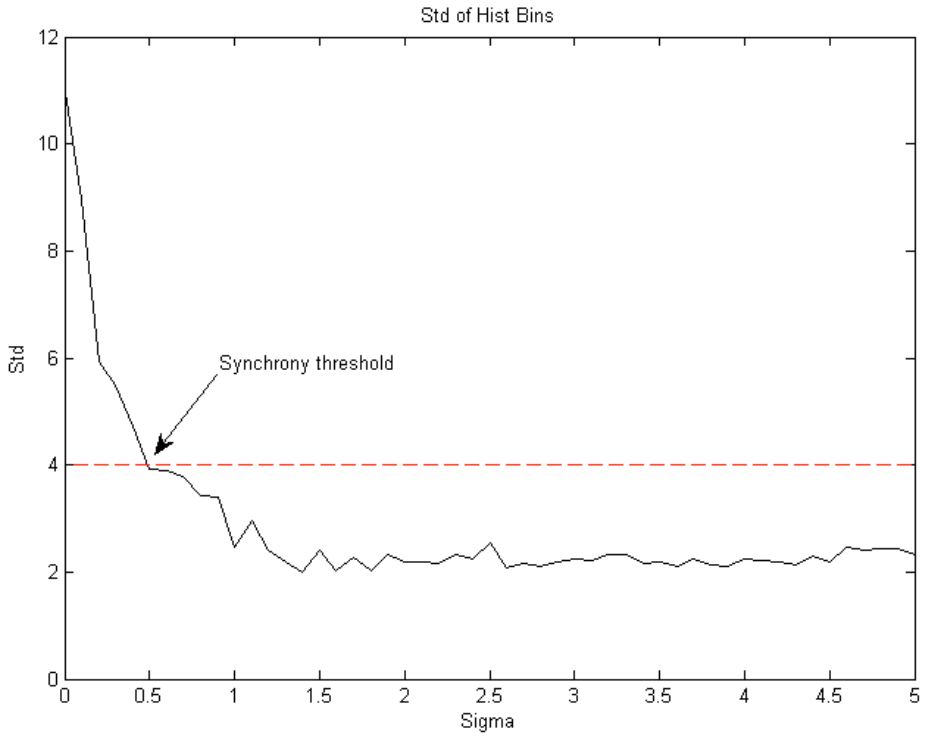
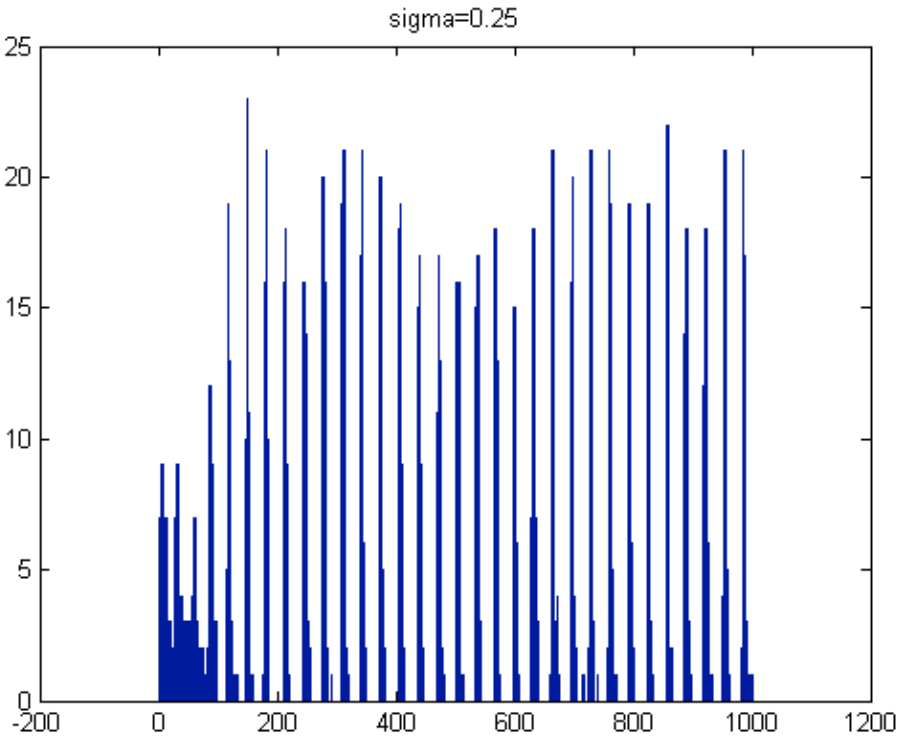
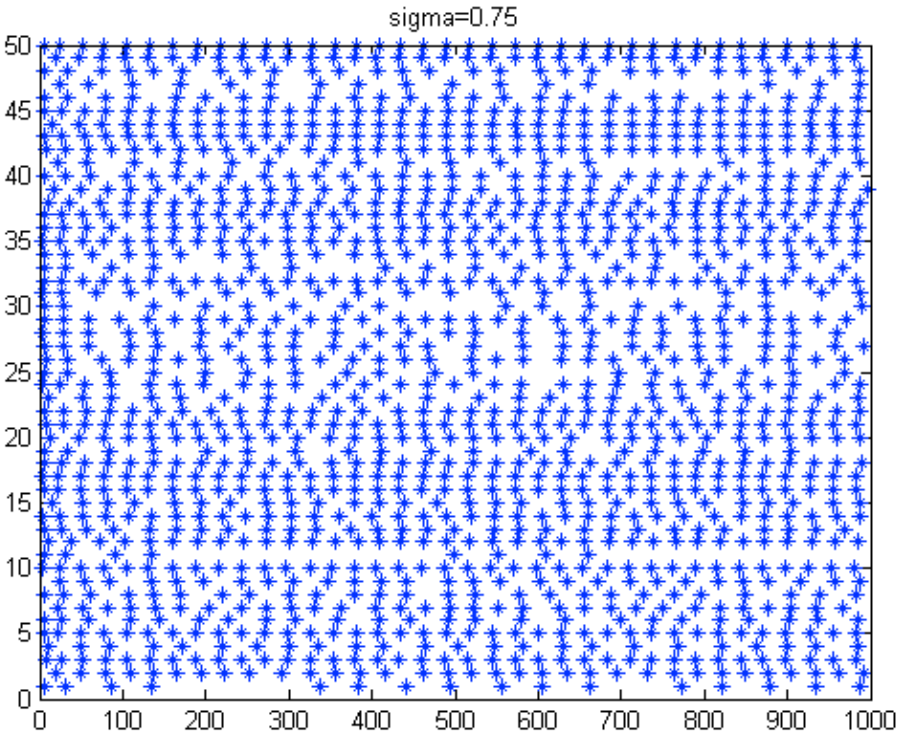
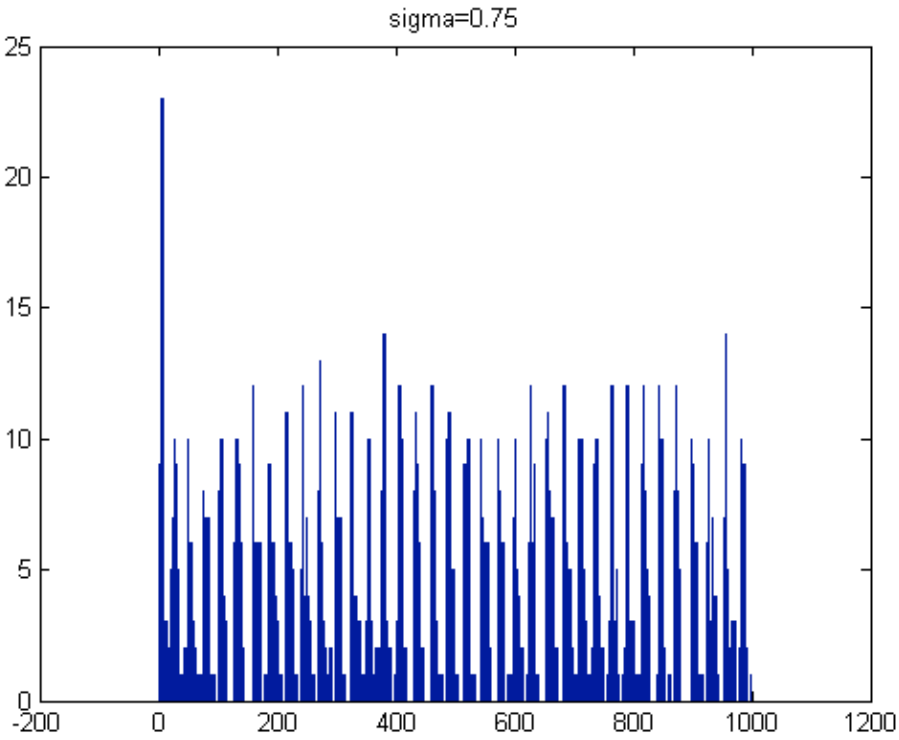
q1a. When spike synchrony is high the spike time histogram exhibits bins that have very many, or very few events. By using the “hist” function output in Matlab, I was able to run a standard deviation on all the bins, which was loosely a measure of across-cell synchrony. The figure below shows that low sigma values exhibit a higher standard deviation, representing disparate bin values, and thus, higher synchrony. I chose a subjective inflection point along this graph at STD=4 to represent a “synchronous system”, which corresponds to SIGMA=0.5.

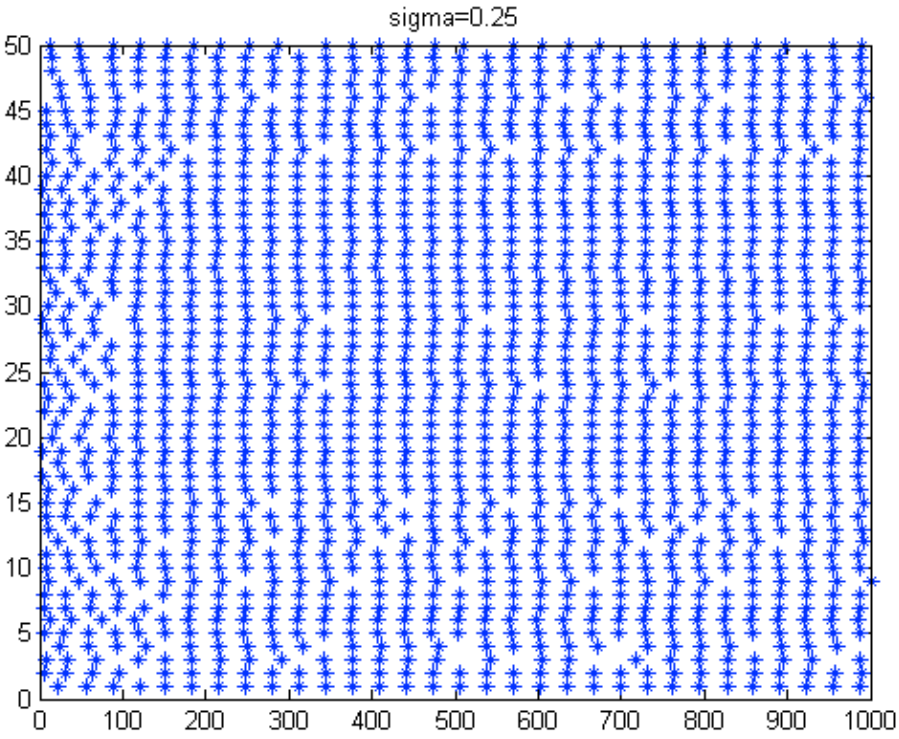



```
%  q1a
% Average cell frequency is     29.712
% Average network frequency is    108.165
% Sigma:0, Std of hist counts:10.8555
% Average cell frequency is     28.386
% Average network frequency is   1138.683
% Sigma:0.5, Std of hist counts:3.8169
% Average cell frequency is     33.260
% Average network frequency is   1309.355
% Sigma:1, Std of hist counts:3.2349
% Average cell frequency is     35.963
% Average network frequency is   1381.381
% Sigma:1.5, Std of hist counts:2.0013
% Average cell frequency is     37.370
% Average network frequency is   1384.492
% Sigma:2, Std of hist counts:2.2771
```


sigma=0.25
25
20
15
10
5
0
-200
0
200
400
600
800
1000
1200

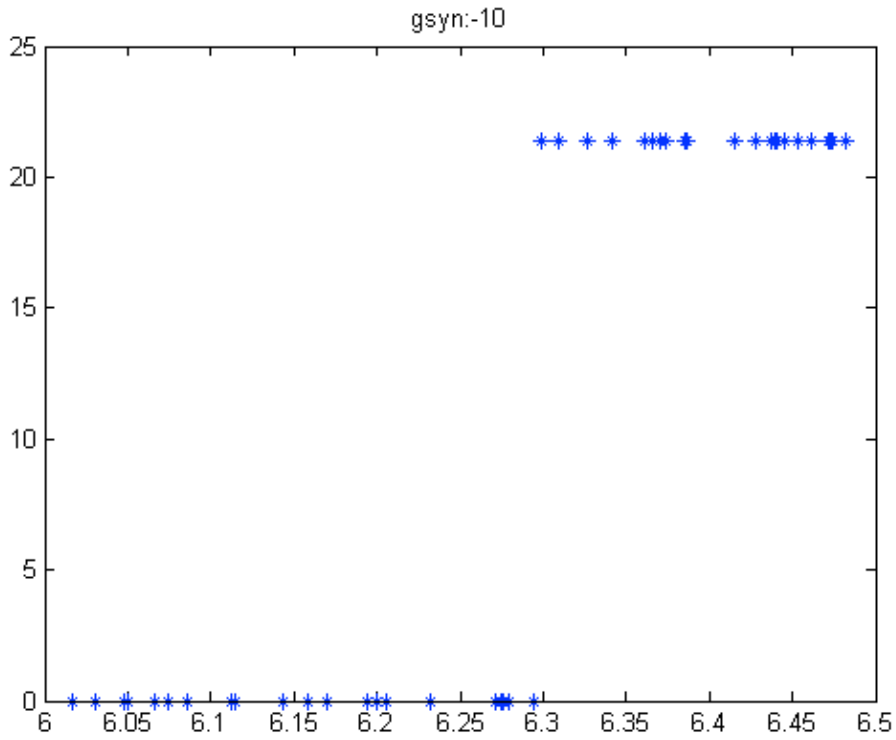

sigma=0.75
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000

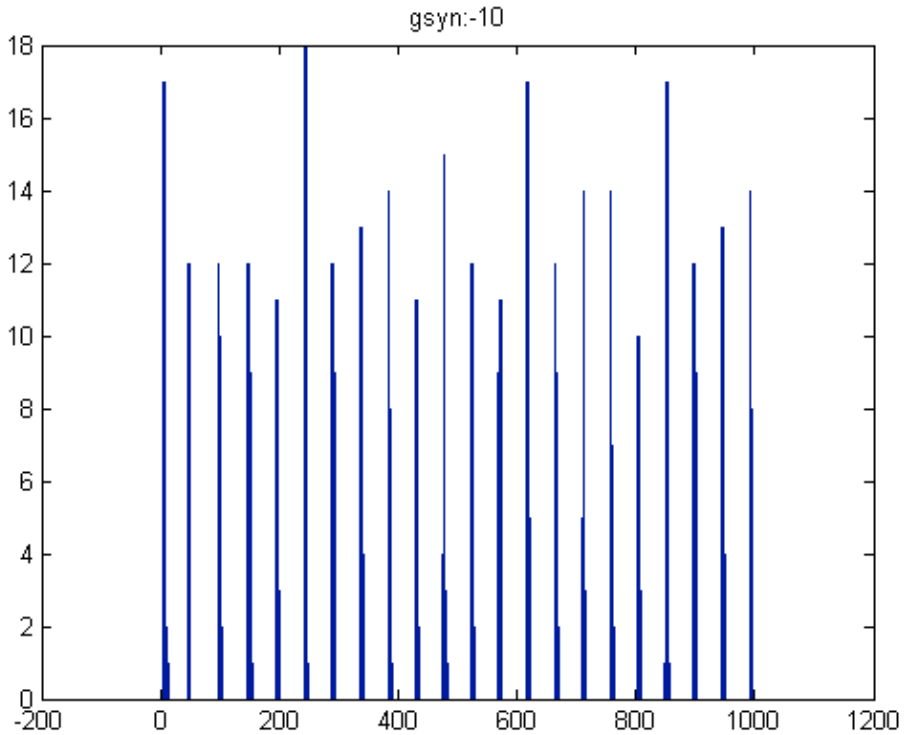

sigma=0.75
25
20
15
10
5
0
-200
0
200
400
600
800
1000
1200

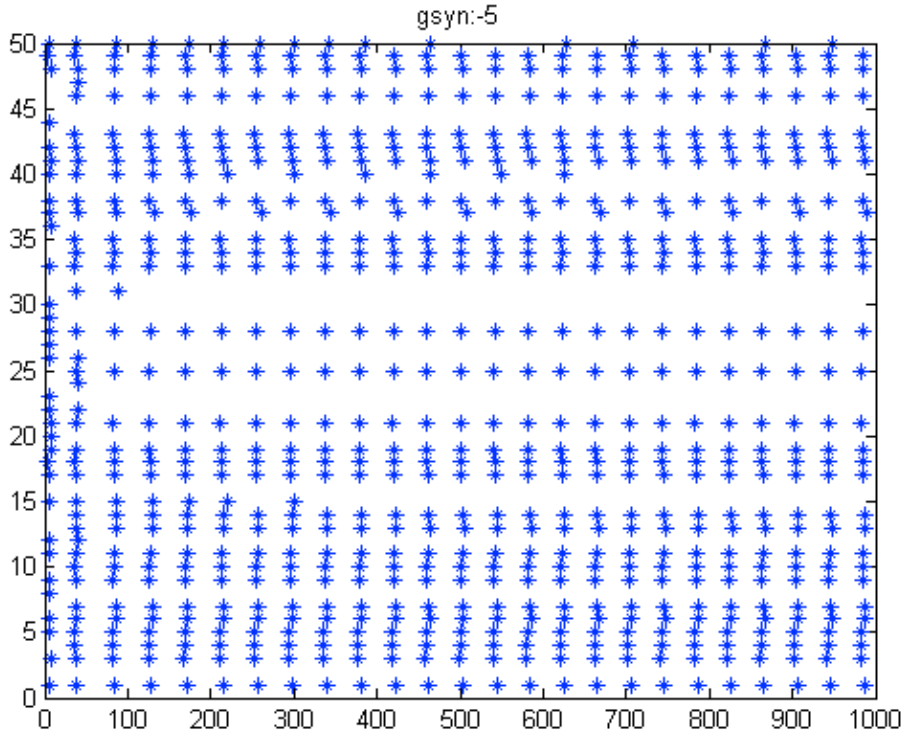

sigma=0.25
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000

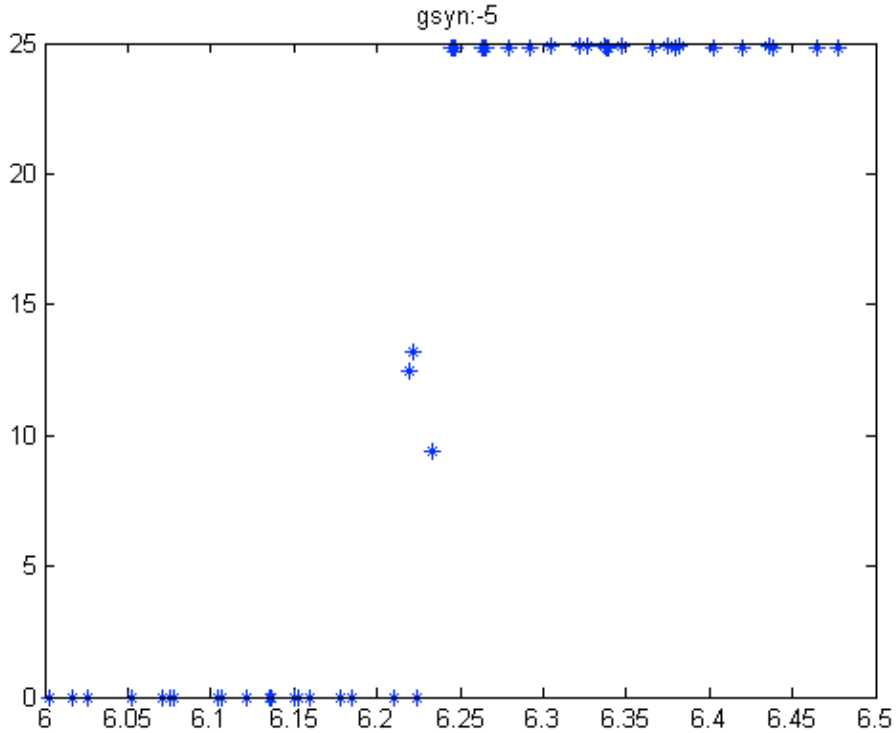
```
allStd=[];
for sigma=0:0.1:5
    % modified to accept sigma, return hist counts
    [spiketimes,freqs,nisis,Iapp,counts]=ILIFnetwork_syn(n,W,sigma);
    disp(['Sigma:',num2str(sigma),', Std of hist
counts:',num2str(std(counts))]);
    allStd = [allStd std(counts)];
end

figure;
plot(0:0.1:5,allStd);
title('Std of Hist Bins');
xlabel('Sigma')
ylabel('Std')
```

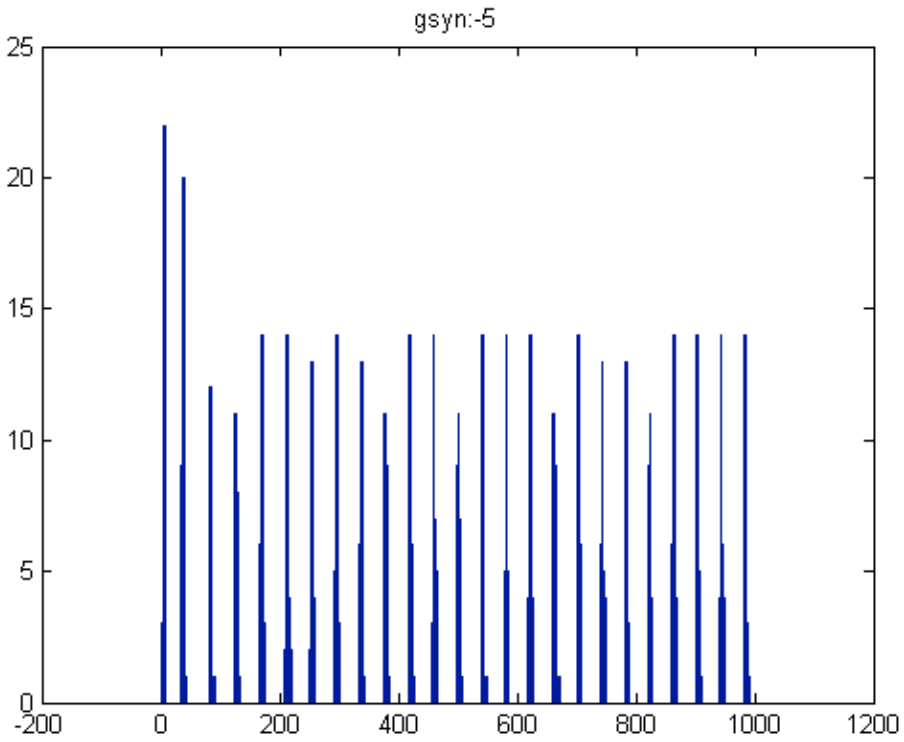
q1b. With SIGMA=0.5 (from q1a), increasing gsyn resulted in a cell network with higher synchrony. This conforms with intuition—that a network that is more connected gravitates towards synchrony more robustly.

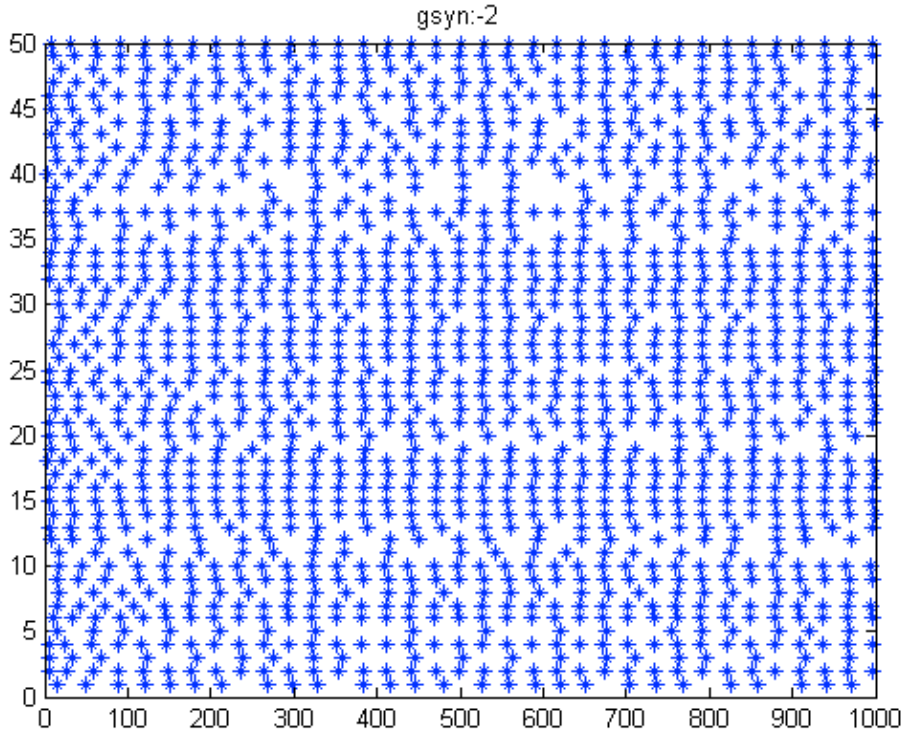

gsyn:-10
25
20
15
10
5
0
6
6.05
6.1
6.15
6.2
6.25
6.3
6.35
6.4
6.45
6.5

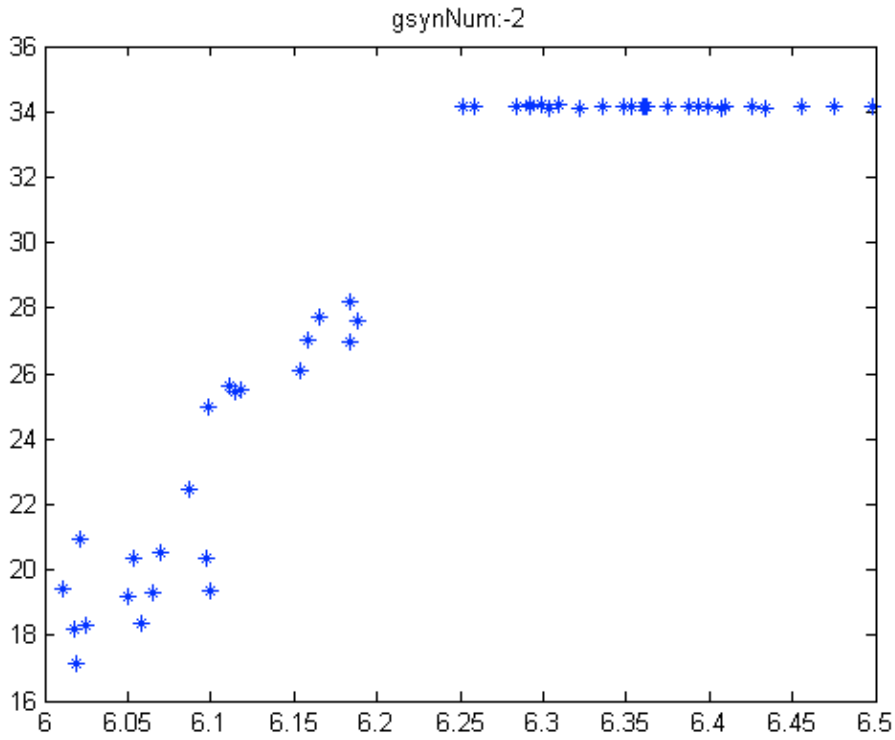

gsyn:-10
18
16
14
12
10
8
6
4
2
0
-200
0
200
400
600
800
1000
1200

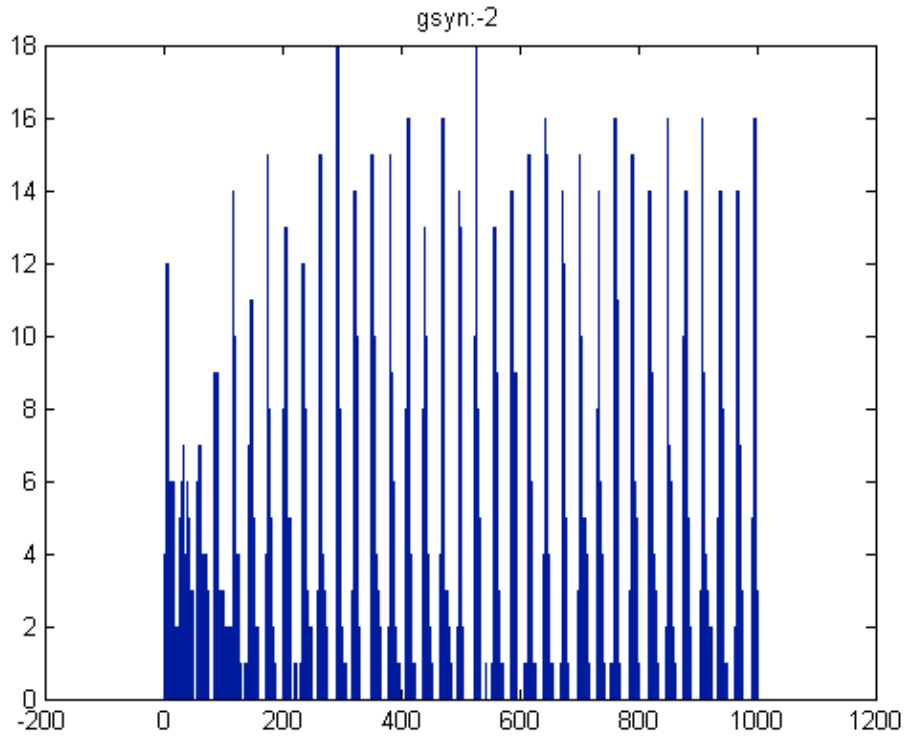

gsyn:-5
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000


gsyn:-5
25
20
15
10
5
0
6
6.05
6.1
6.15
6.2
6.25
6.3
6.35
6.4
6.45
6.5


gsyn:-5
25
20
15
10
5
0
-200
0
200
400
600
800
1000
1200


gsyn:-2
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000

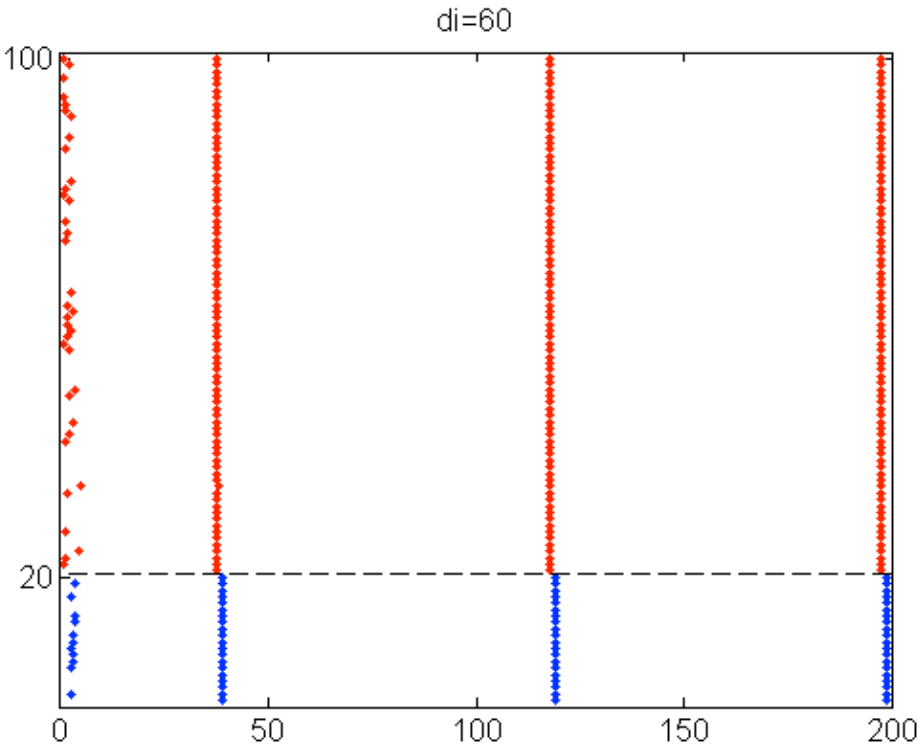

gsynNum:-2
36
34
32
30
28
26
24
22
20
18
16
6
6.05
6.1
6.15
6.2
6.25
6.3
6.35
6.4
6.45
6.5

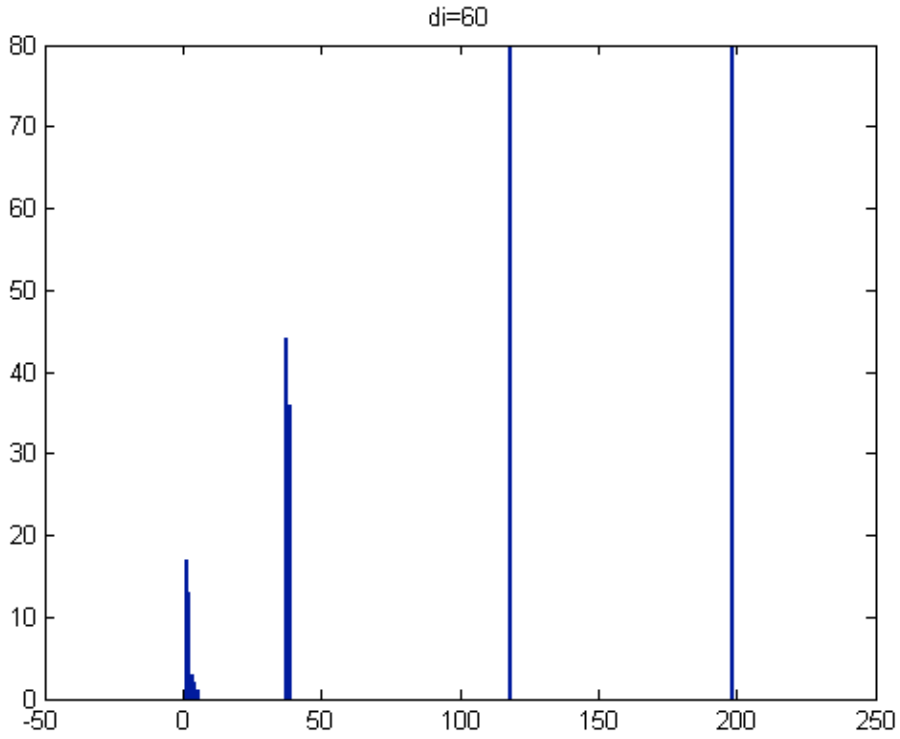

gsyn:-2
18
16
14
12
10
8
6
4
2
0
-200
0
200
400
600
800
1000
1200

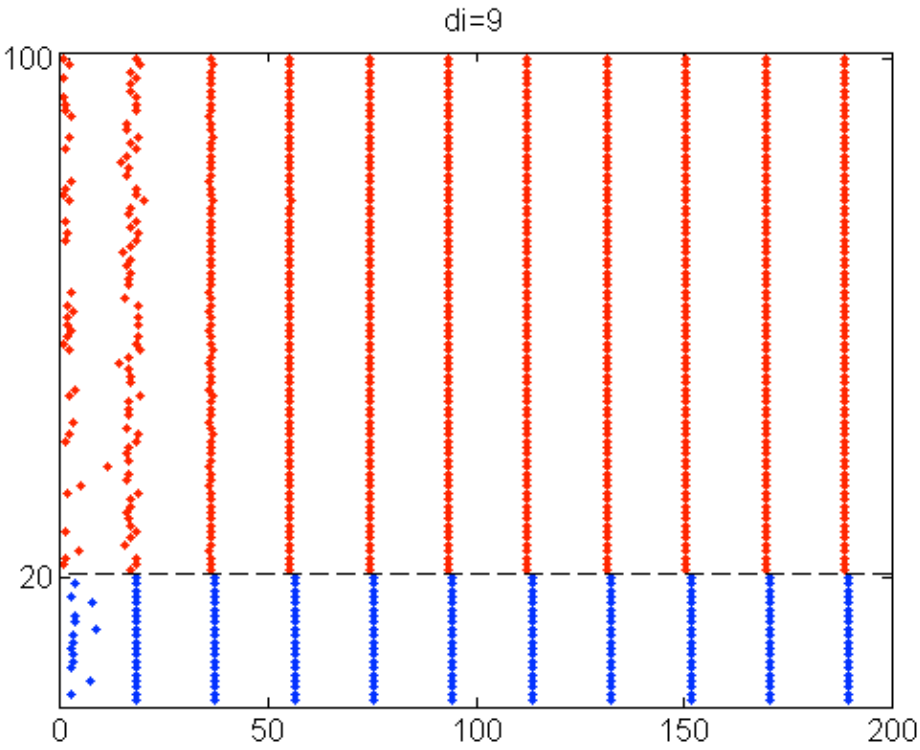
```
for gsynNum=-2:-1:-10
    [spiketimes,freqs,nisis,Iapp]=ILIFnetwork_syn(n,W,gsynNum);
    figure;
    plot(Iapp,freqs,'*');
    title(['gsynNum:',num2str(gsynNum)]);
    disp(num2str(gsynNum));
end
```

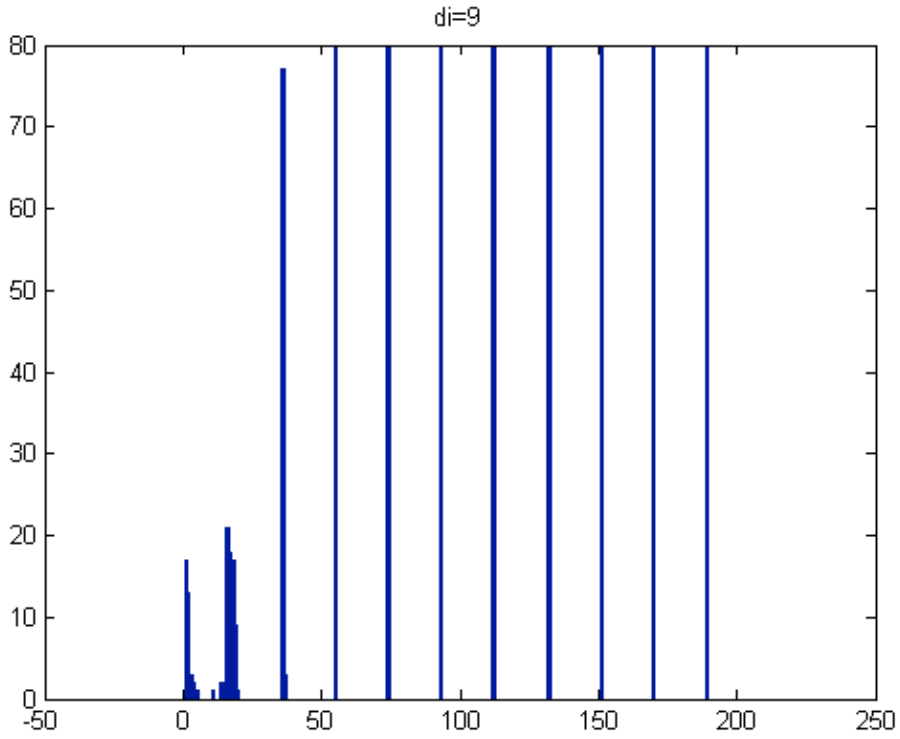
q1c. When sigma was increased, network synchrony increased. When gsyn increased, network synchrony increased.

q2. As tau_d_i increased, E cell frequency decreased, as show by the raster plots that exhibit longer time spans between synchronous firing.

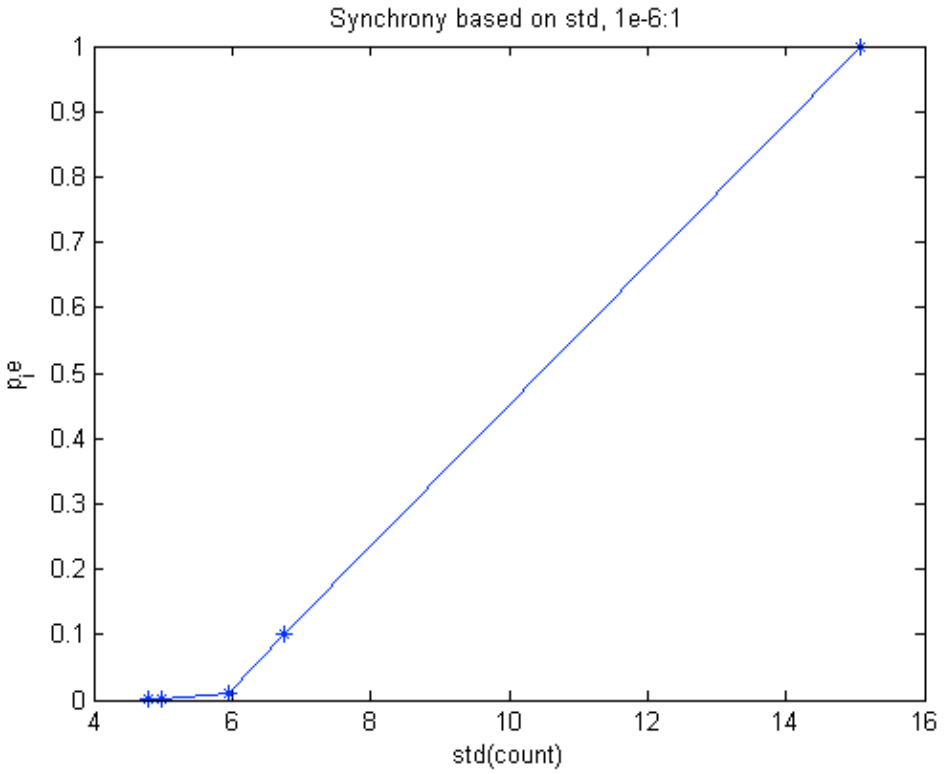

di=60
100
20
0
50
100
150
200

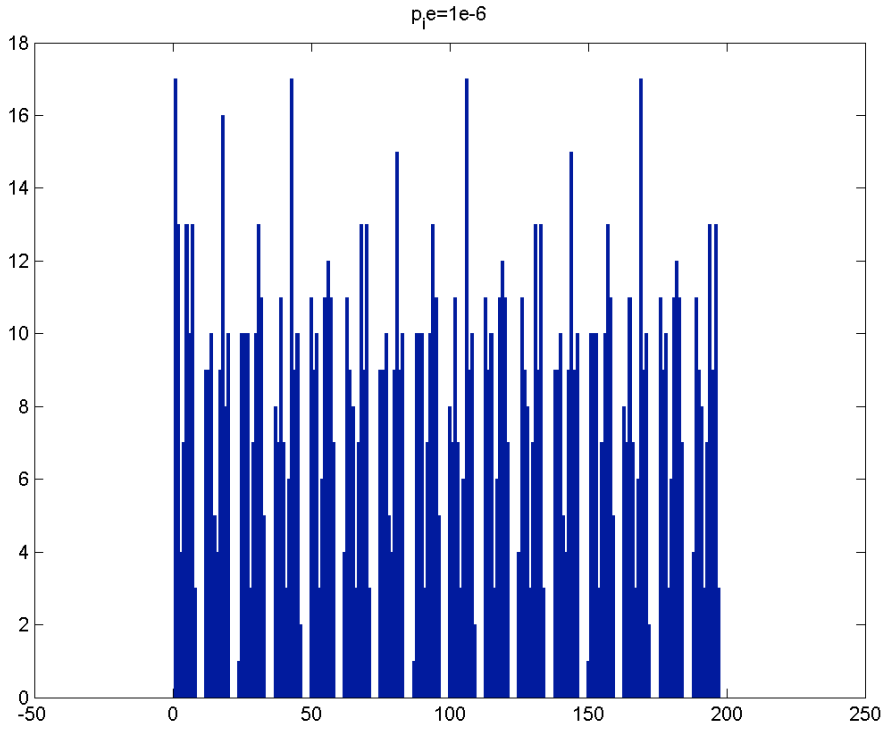

di=60
80
70
60
50
40
30
20
10
0
-50
0
50
100
150
200
250

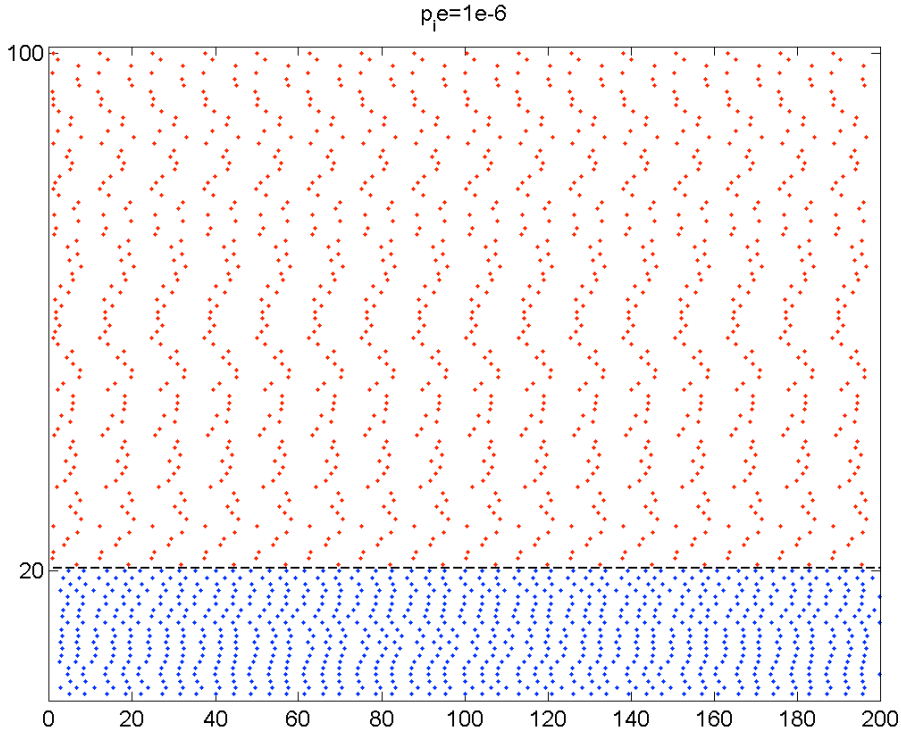

di=9
100
20
0
50
100
150
200

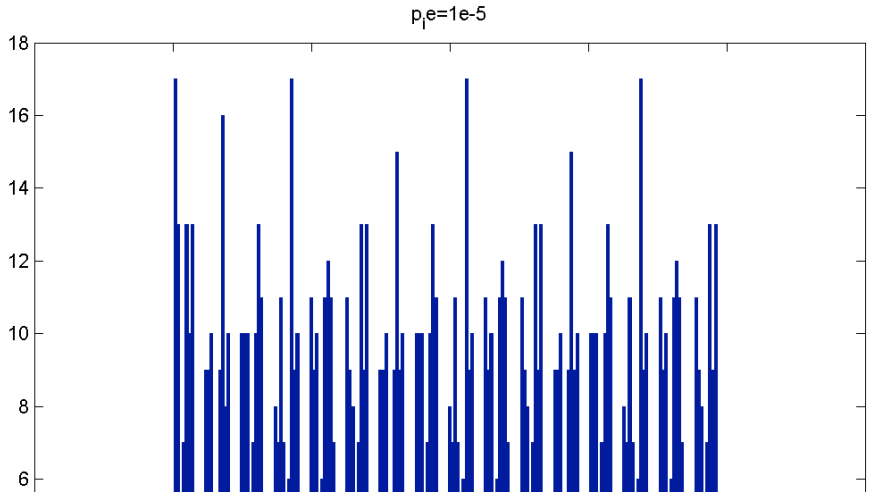

di=9
80
70
60
50
40
30
20
10
0
-50
0
50
100
150
200
250

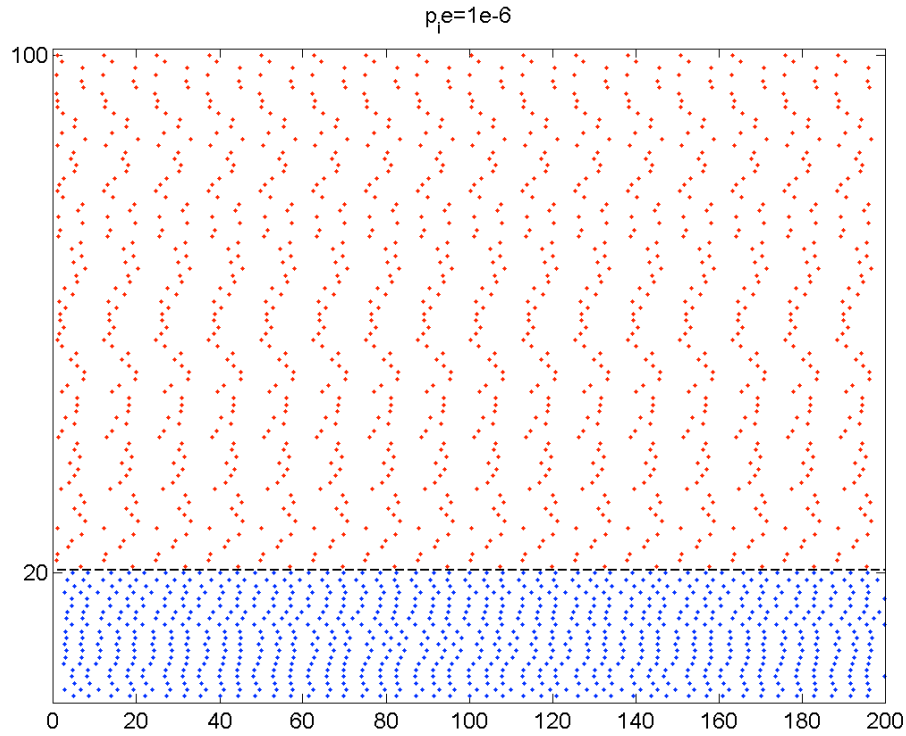
q3a. There was a definite inflection point based on my measure of spike synchrony, however I had to adjust my subjective estimate of what defines “synchrony,” as my previous assessment was too aggressive. It appears that values of p_ie > 1-4 exhibit much different patterns of synchrony than lower values.

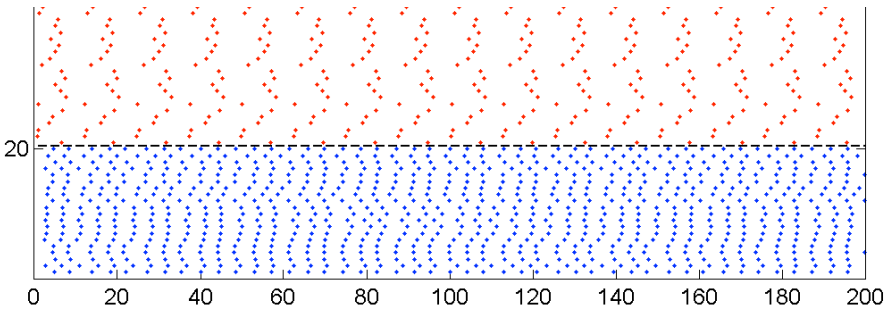


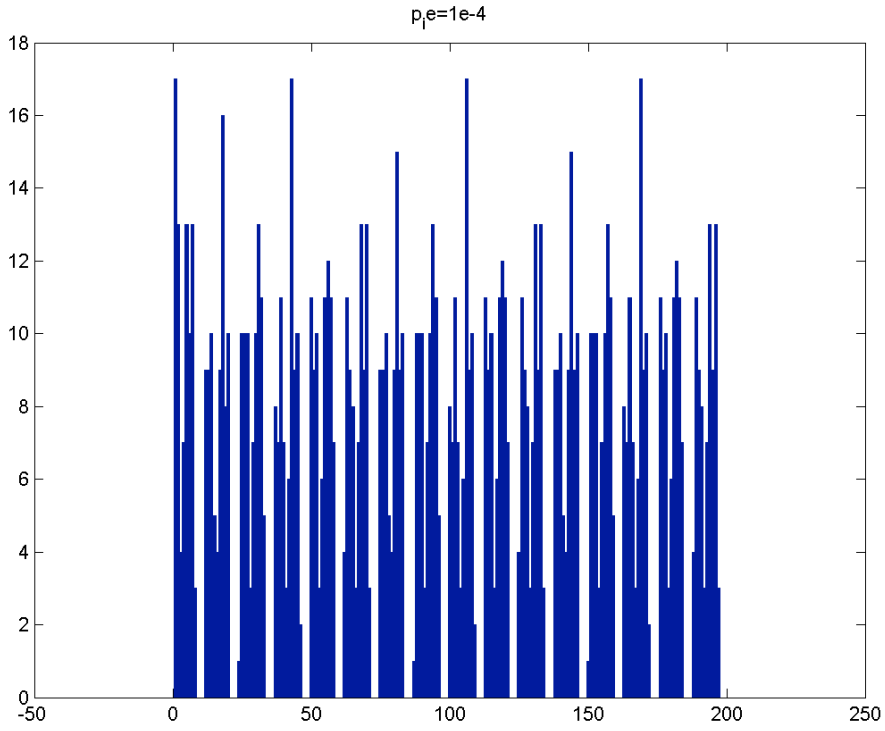

p_I e=1e-6
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250

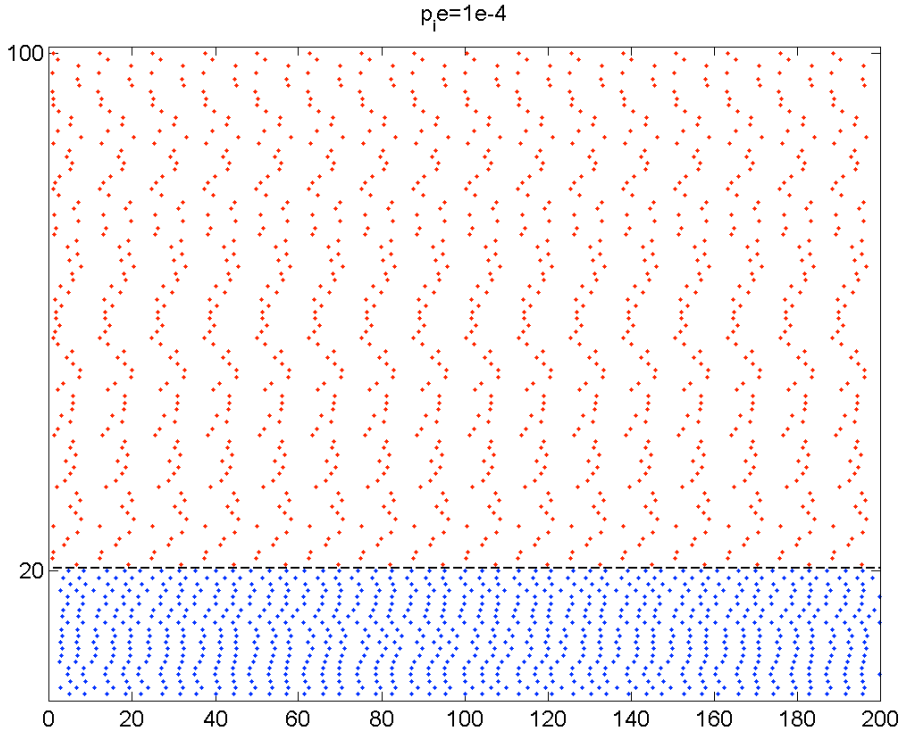

p_I e=1e-6
100
20
0
20
40
60
80
100
120
140
160
180
200

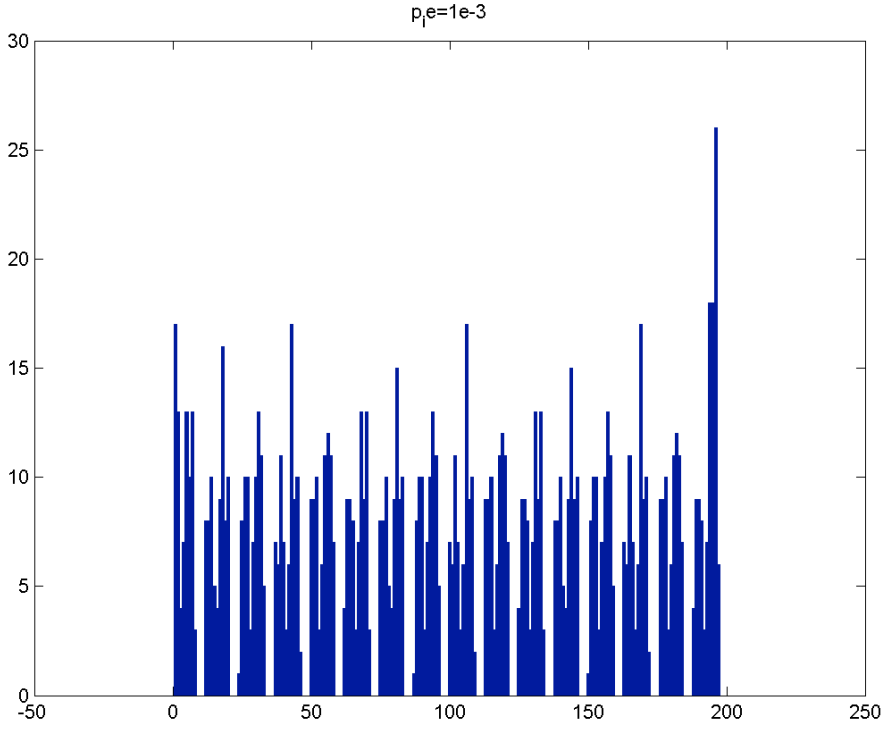

p_i e=1e-5
18
16
14
12
10
8
6

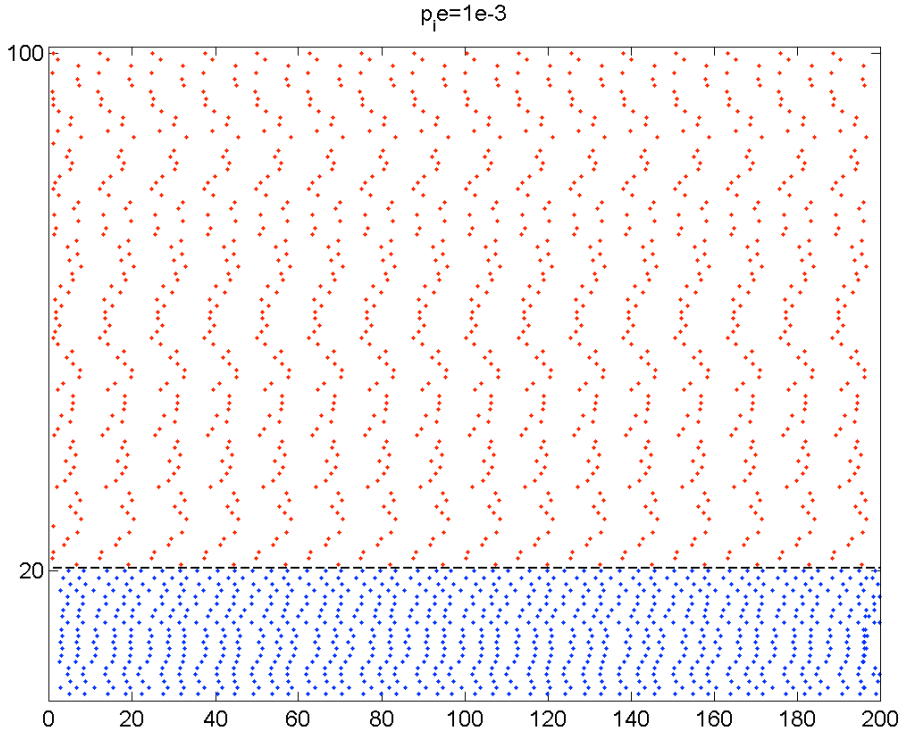

p_i e=1e-6
100
20
0
20
40
60
80
100
120
140
160
180
200

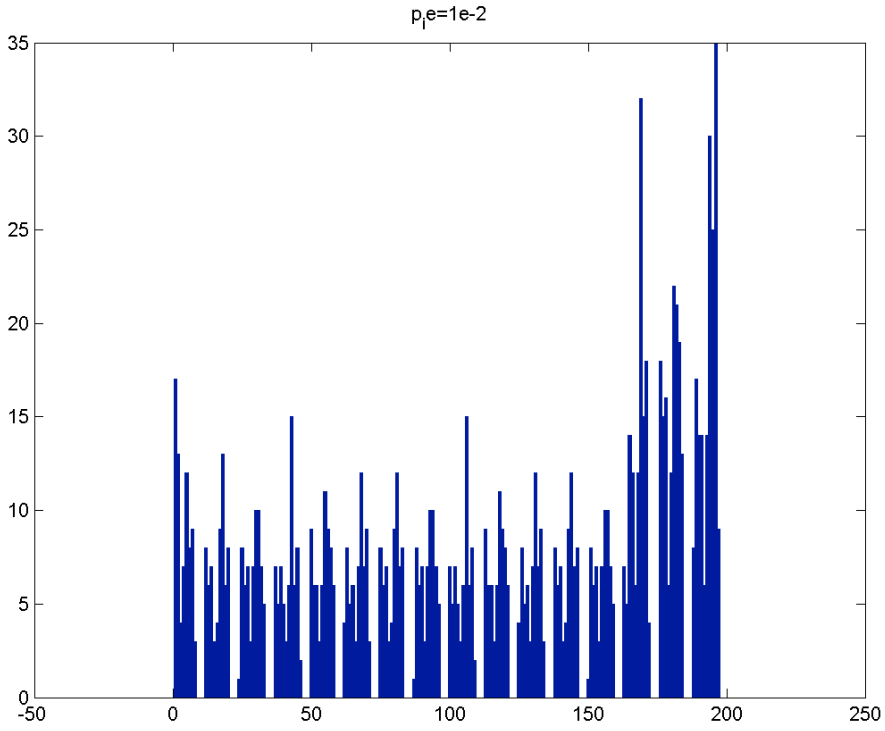

20
0
20
40
60
80
100
120
140
160
180
200

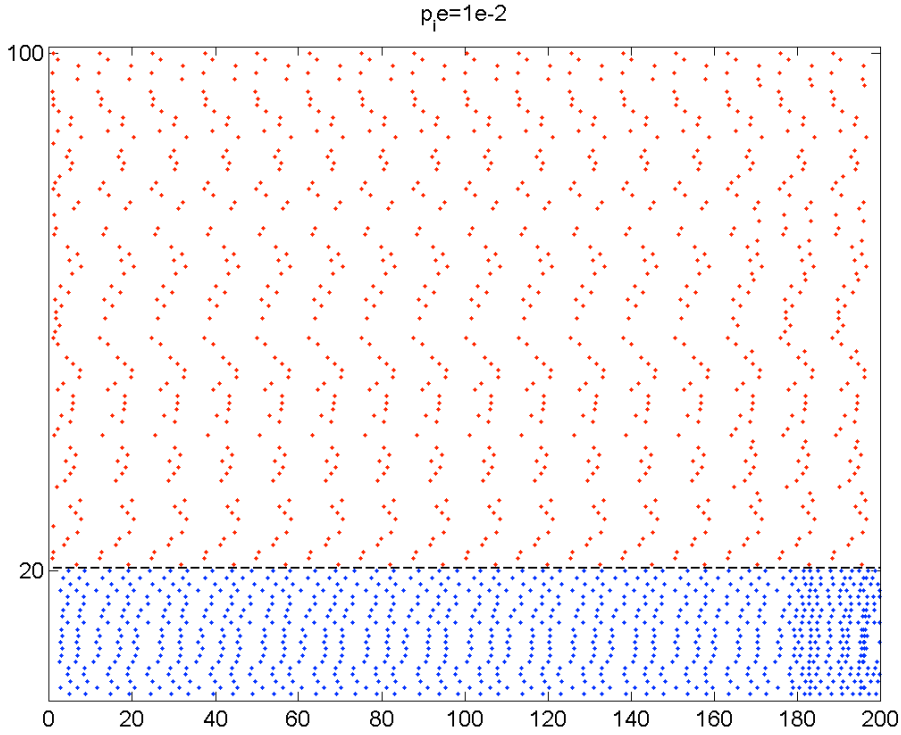

p_i e=1e-4
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250


p_i e=1e-4
100
20
0
20
40
60
80
100
120
140
160
180
200


p_I e=1e-3
30
25
20
15
10
5
0
-50
0
50
100
150
200
250

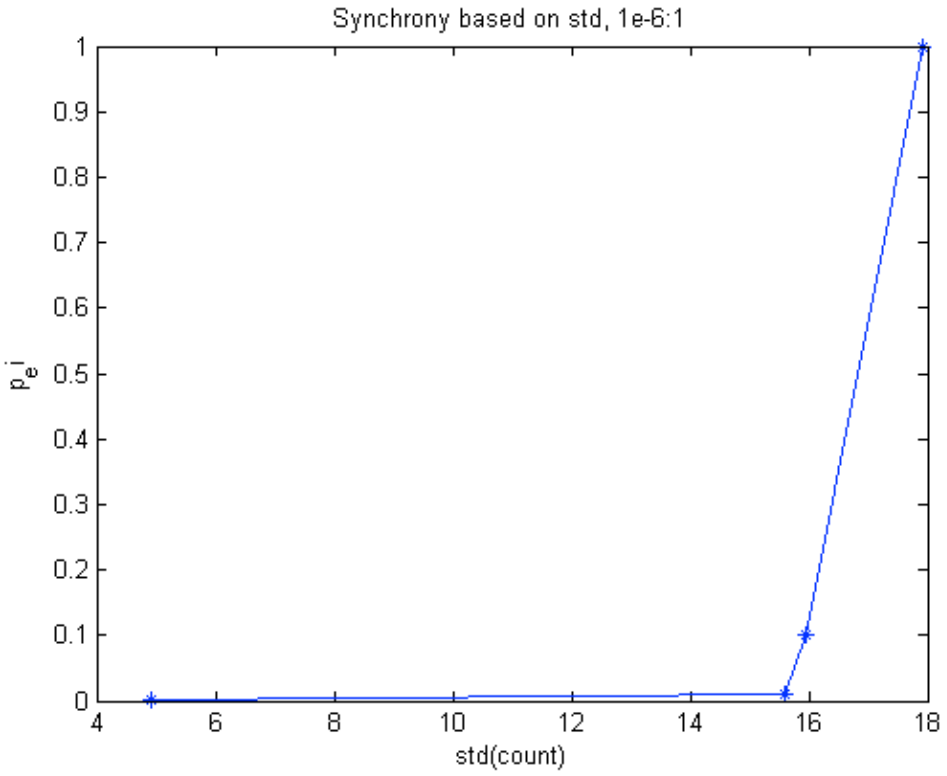

p_I e=1e-3
100
20
0
20
40
60
80
100
120
140
160
180
200

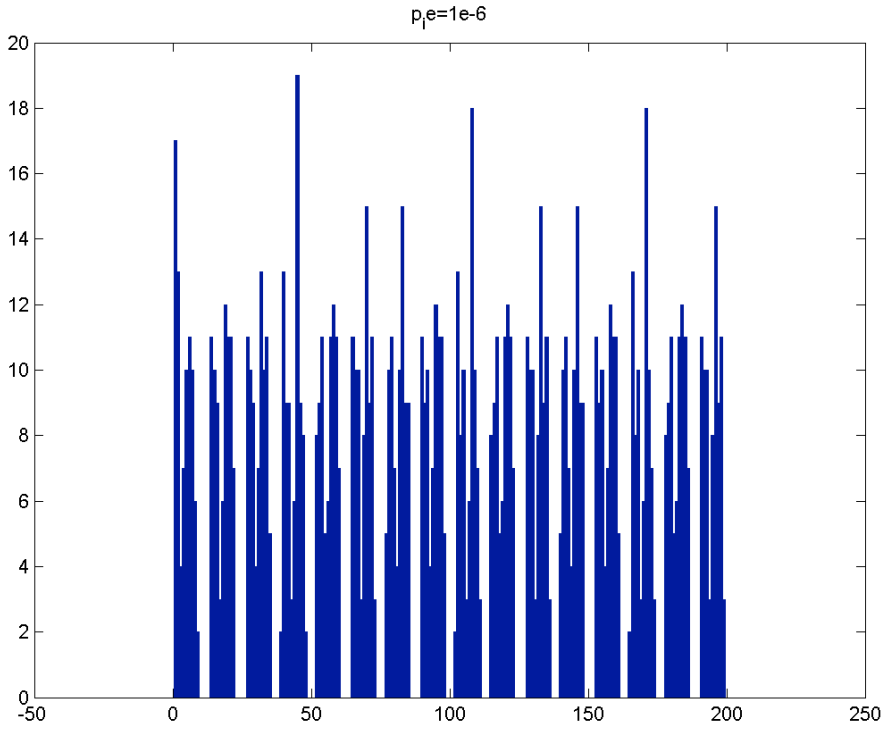

p_I e=1e-2
35
30
25
20
15
10
5
0
-50
0
50
100
150
200
250

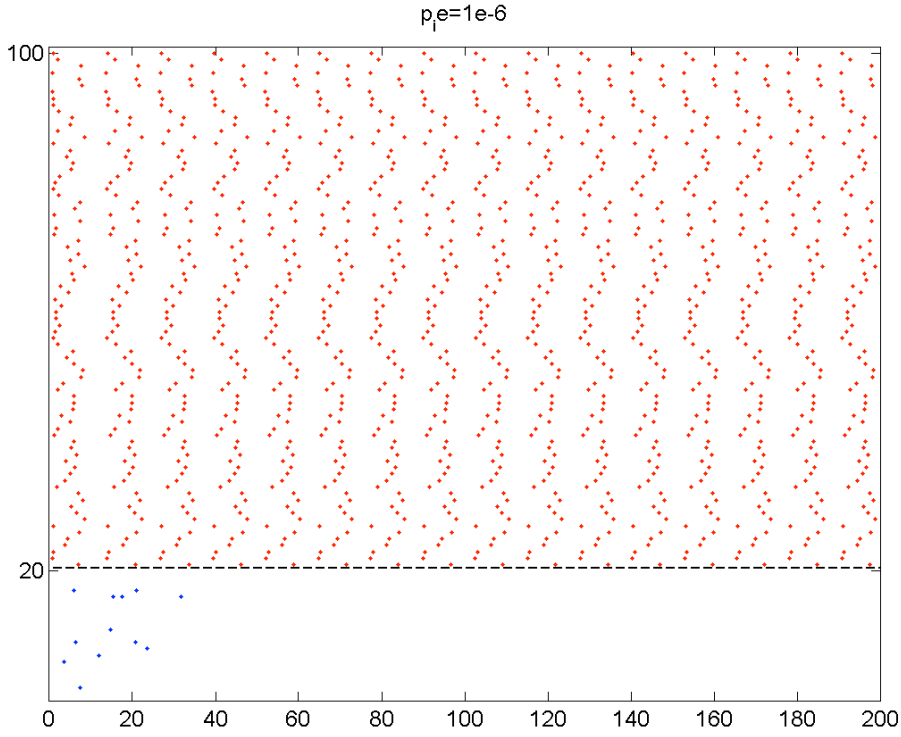

p_I e=1e-2
100
20
0
20
40
60
80
100
120
140
160
180
200

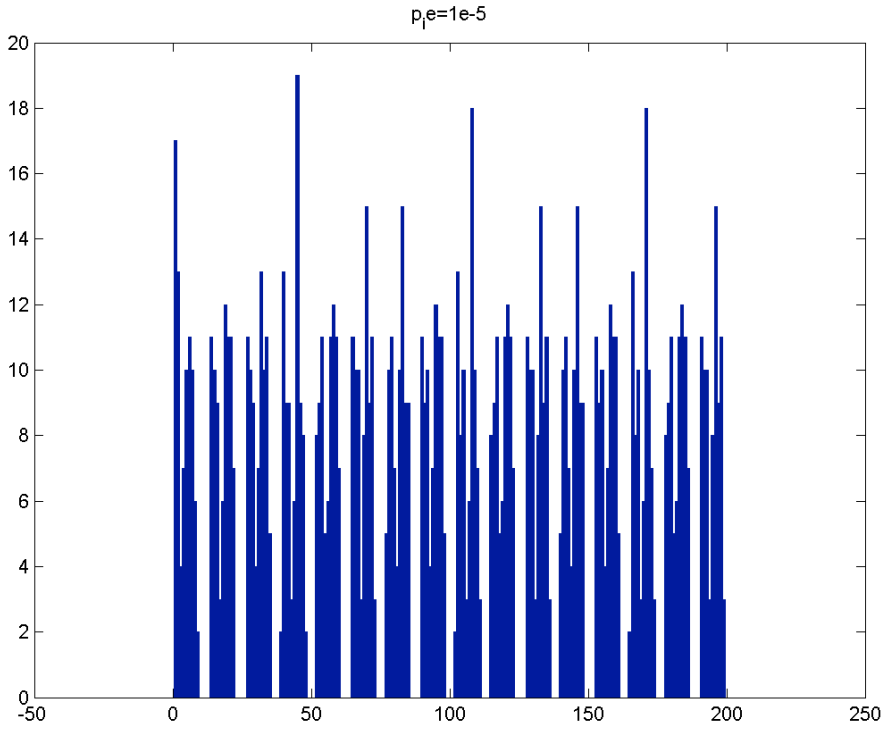
```
%clear variables
% allStd=[];
% allPie = [];

allStd = [allStd std(counts)];
allPie = [allPie p_ei];
for i=1:2
    figure(i);
    title('p_ie=1');
    saveas(i,['q3b_1_',num2str(i)],'png');
end
```

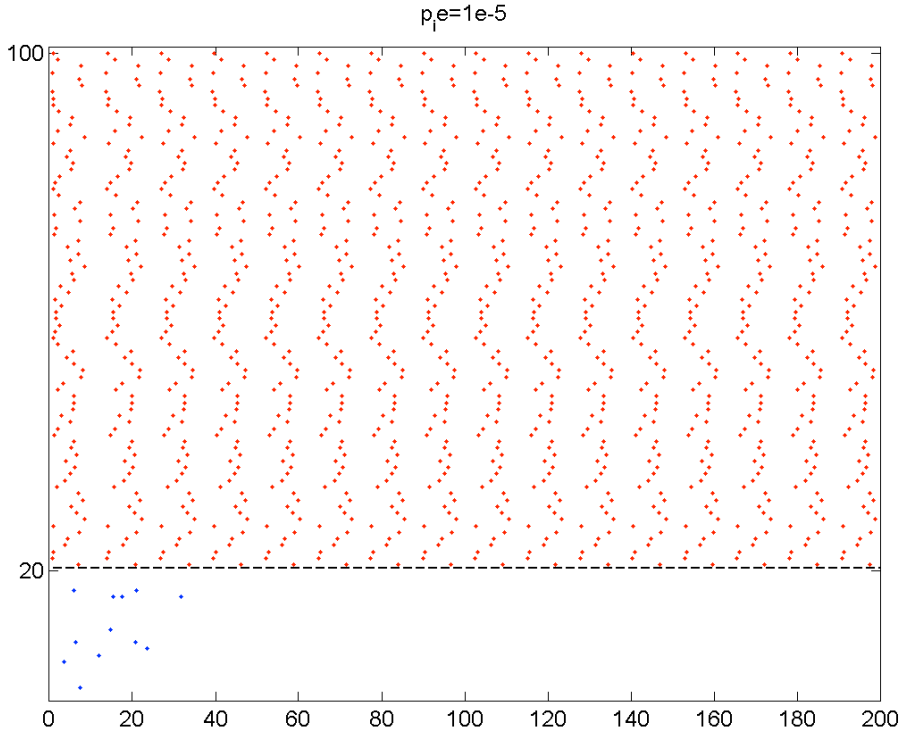
q3b. Much like q3a, there was a point at which synchrony in the network deflected, which was at p_ei > 1e-3.

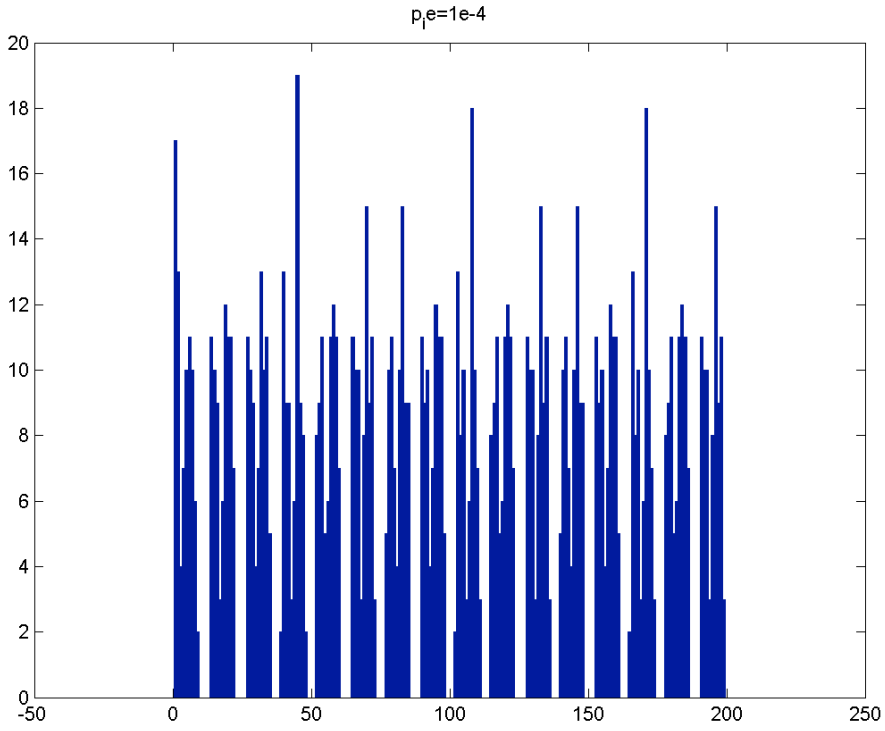


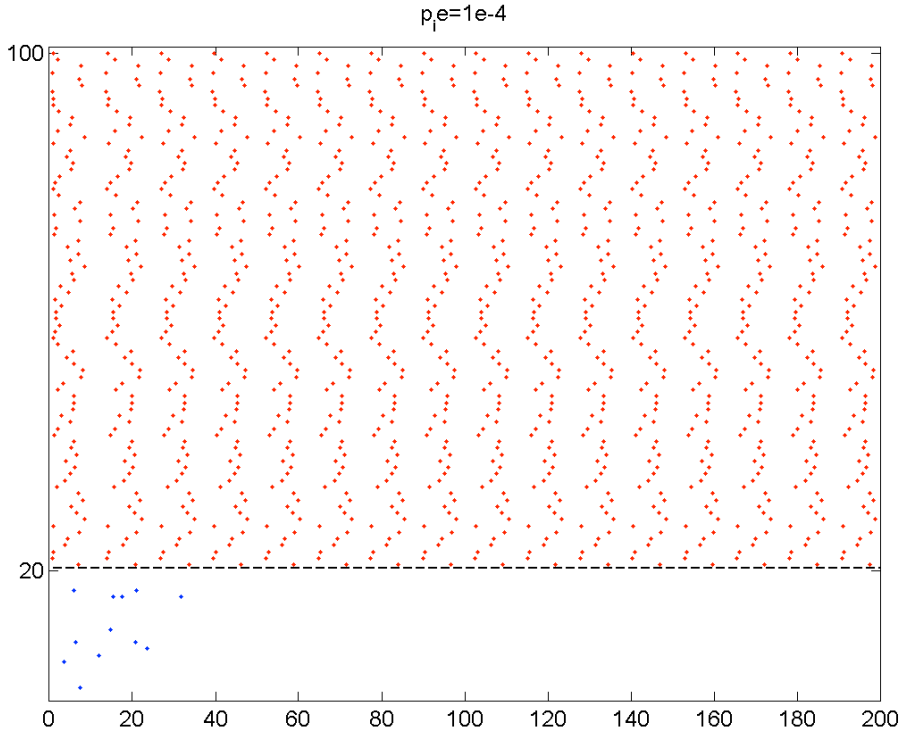

p_i e=1e-6
20
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250

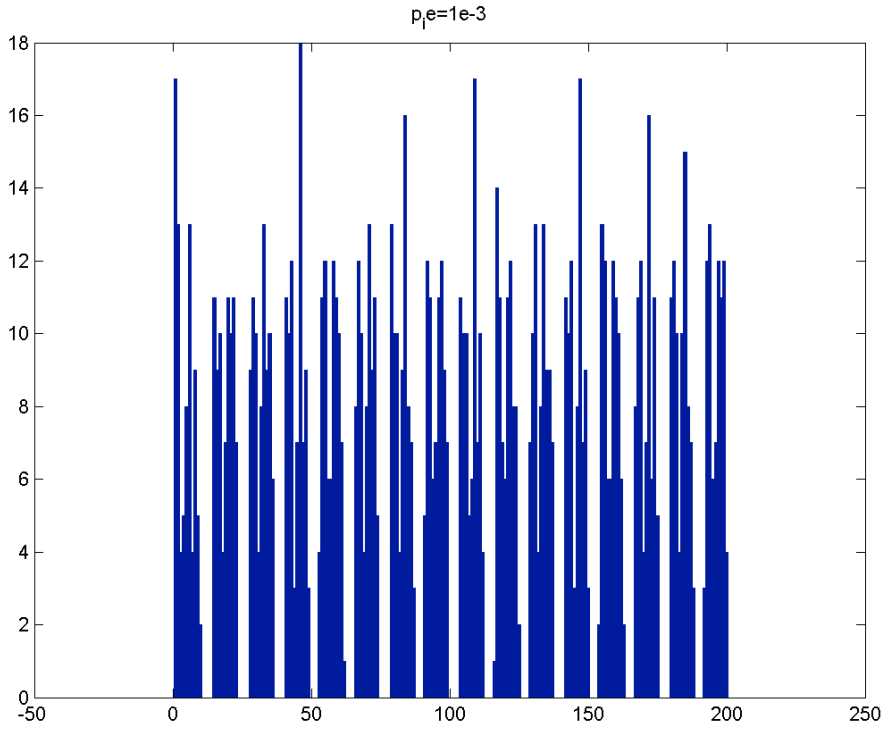

p_i e=1e-6
100
20
0
20
40
60
80
100
120
140
160
180
200

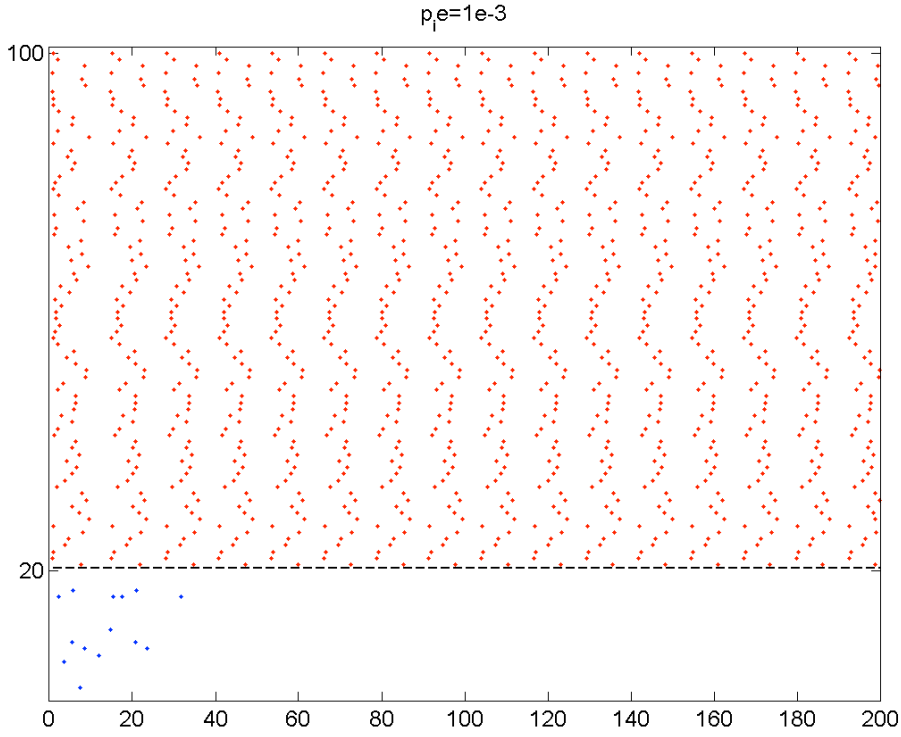

p_i e=1e-5
20
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250

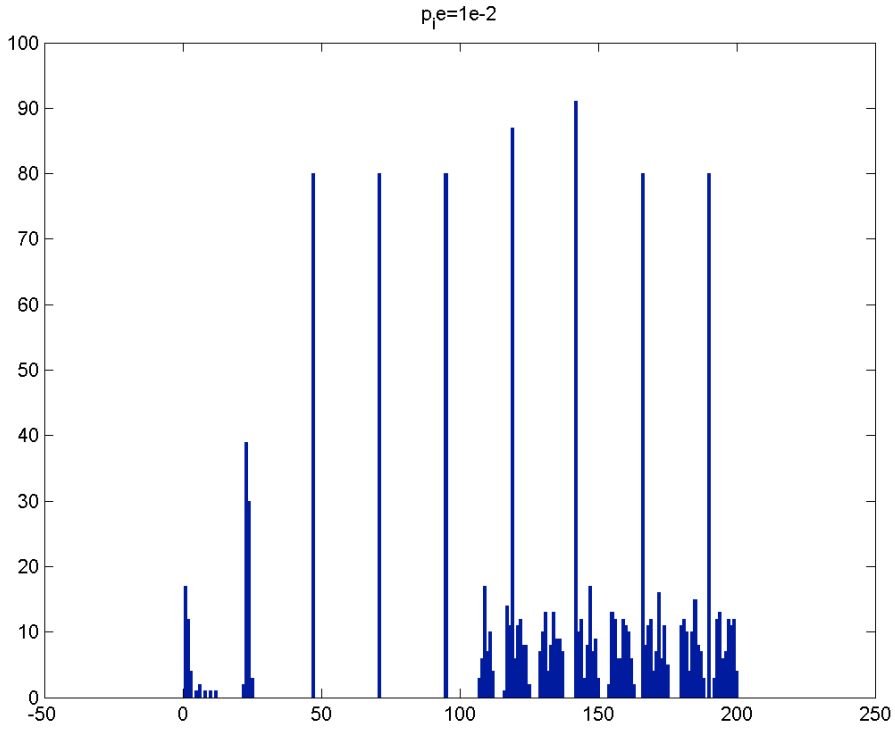

p_i e=1e-5
100
20
0
20
40
60
80
100
120
140
160
180
200

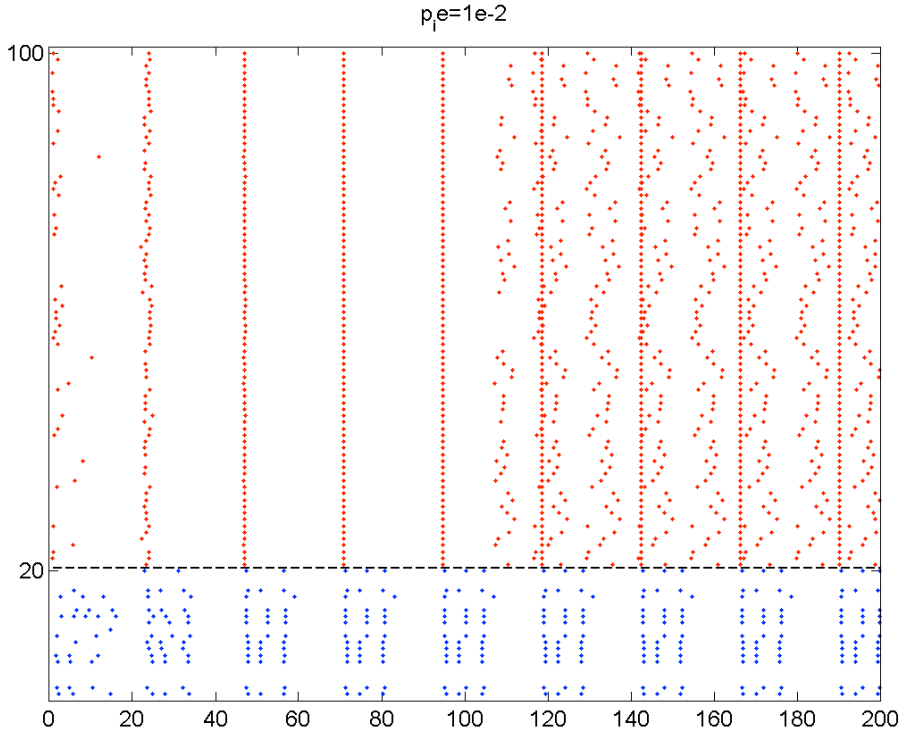

p_i e=1e-4
20
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250

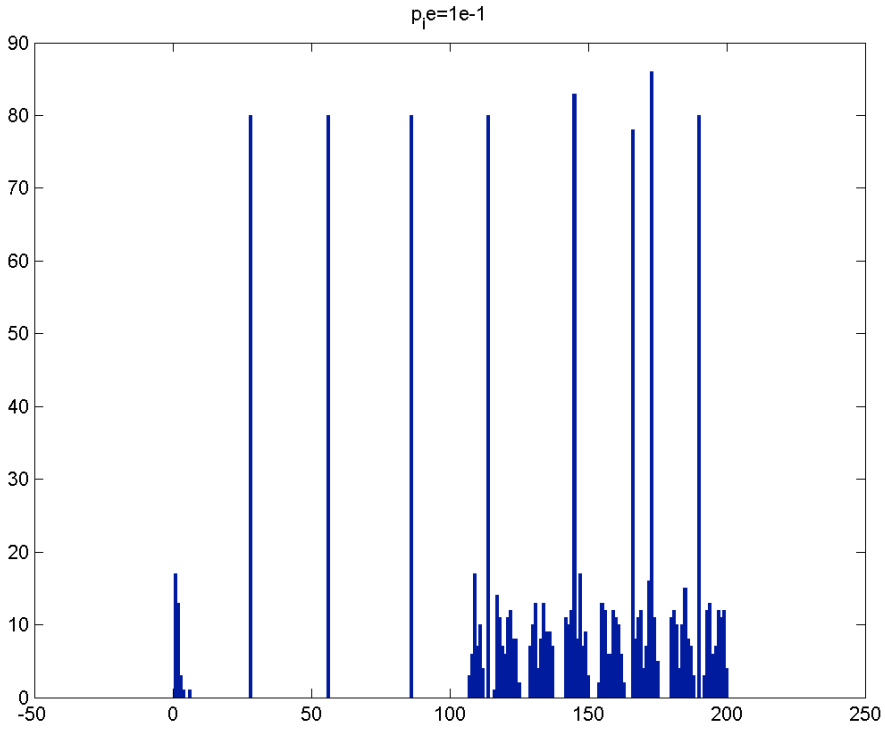

p_i e=1e-4
100
20
0
20
40
60
80
100
120
140
160
180
200

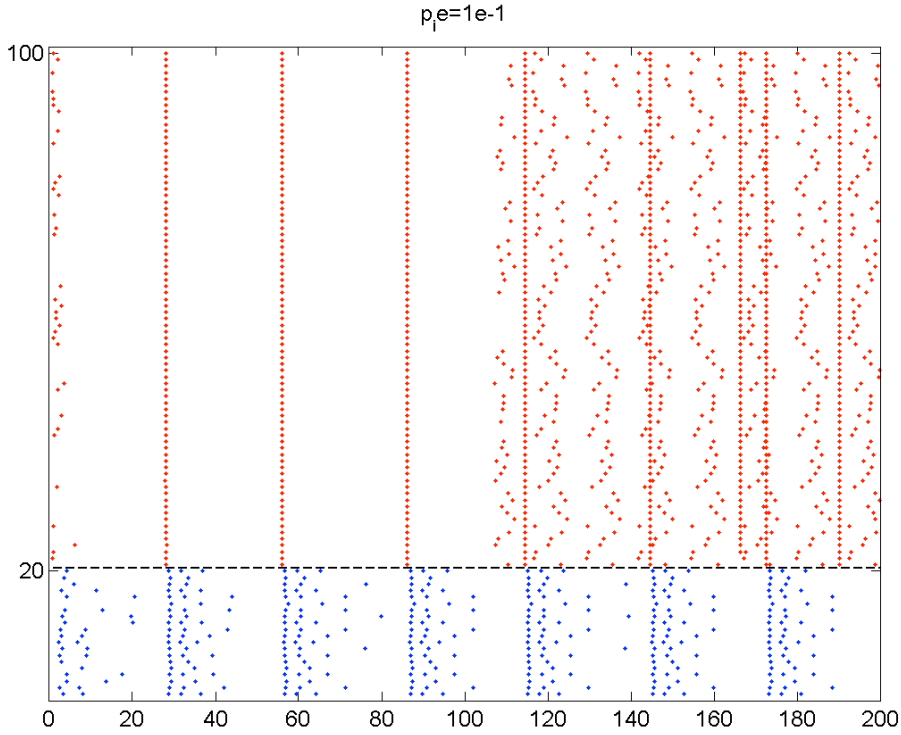

p_i e=1e-3
18
16
14
12
10
8
6
4
2
0
-50
0
50
100
150
200
250

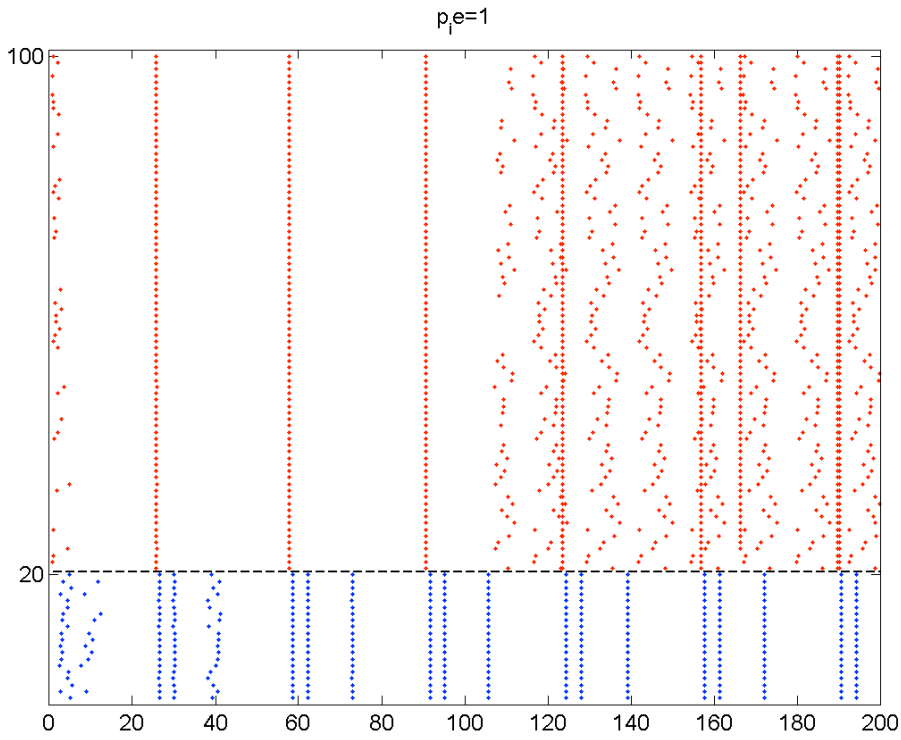

p_i e=1e-3
100
20
0
20
40
60
80
100
120
140
160
180
200

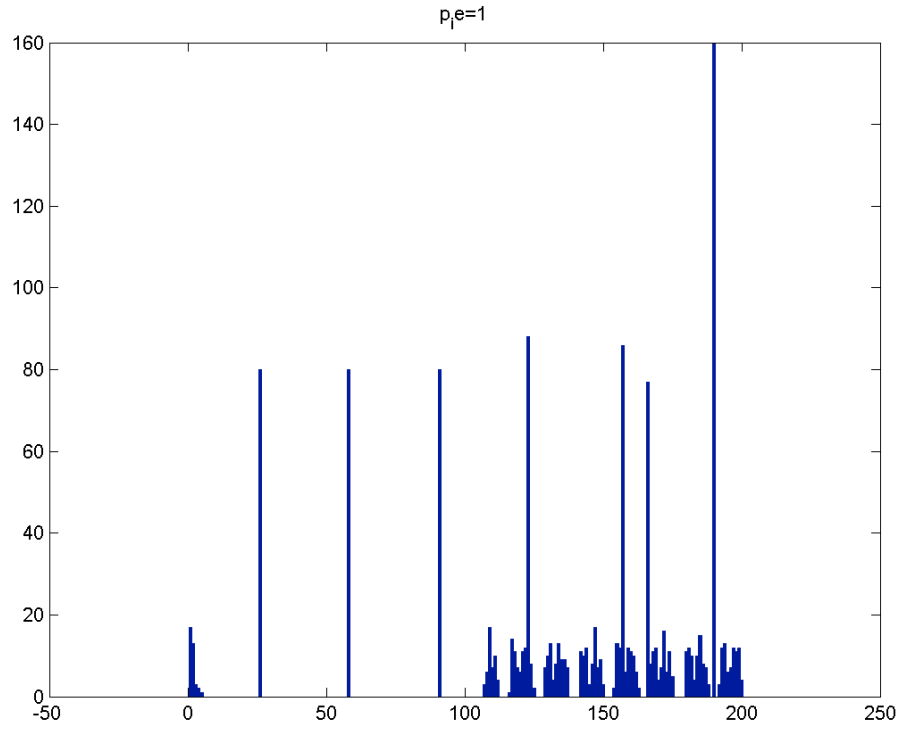

p_i e=1e-2
100
90
80
70
60
50
40
30
20
10
0
-50
0
50
100
150
200
250


p_i e=1e-2
100
20
0
20
40
60
80
100
120
140
160
180
200


p_I e=1e-1
90
80
70
60
50
40
30
20
10
0
-50
0
50
100
150
200
250


p_I e=1e-1
100
20
0
20
40
60
80
100
120
140
160
180
200


p_i e=1
100
20
0
20
40
60
80
100
120
140
160
180
200


p_i e=1
160
140
120
100
80
60
40
20
0
-50
0
50
100
150
200
250

```
%clear variables
% allStd=[];
% allPie = [];

allStd = [allStd std(counts)];
allPie = [allPie p_ei];
for i=1:2
    figure(i);
    title('p_ie=1');
    saveas(i,['q3b_1_',num2str(i)],'png');
end
```

q3c. There was a clear relationship between p_ei and p_ie with network synchrony. As these values increased, so did across-cell synchrony, as measured by my methods (std deviation across bins). This agrees with the prediction that networks with higher connectivity show increased synchrony.