Hippocampal Network Analysis Using a Multi-electrode Array (MEA)

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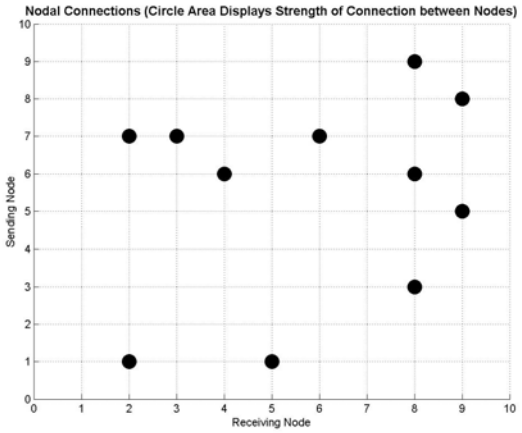
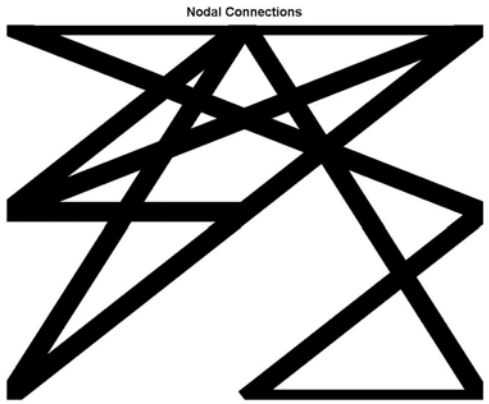
Outline

- Goal: To create a neuron level map of the dissociated hippocampal network
- Take correlations between stimulated neurons and all other neurons; Use result to assign unidirectional connection strength
- Will use spike sorting to connect electrode level to neuron level
- First lets see if this correlation makes sense by applying it to an artificial network
- Possible applications
  - Integrating man and machine
  - Understanding and repairing diseases/damages

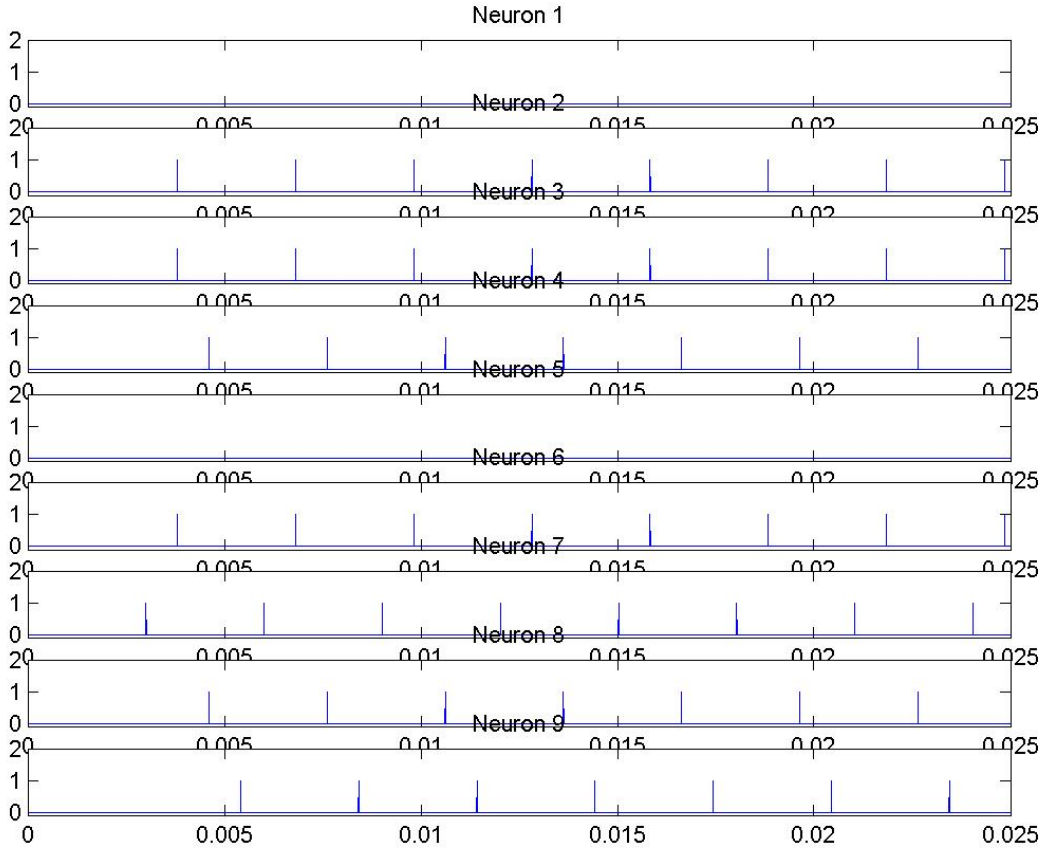
Toy Network – Step I

- 9 Neurons with first order connections, the magnitude of these connections is specified
  - Any pair of neurons can be connected
- Model includes parameters for
  - Synaptic delay
  - Refractory Period Length
- Benefit of model is infinite signal to noise ratio
- Program generates nine “data” sets, each one corresponding to the “stimulation” of one of the neurons

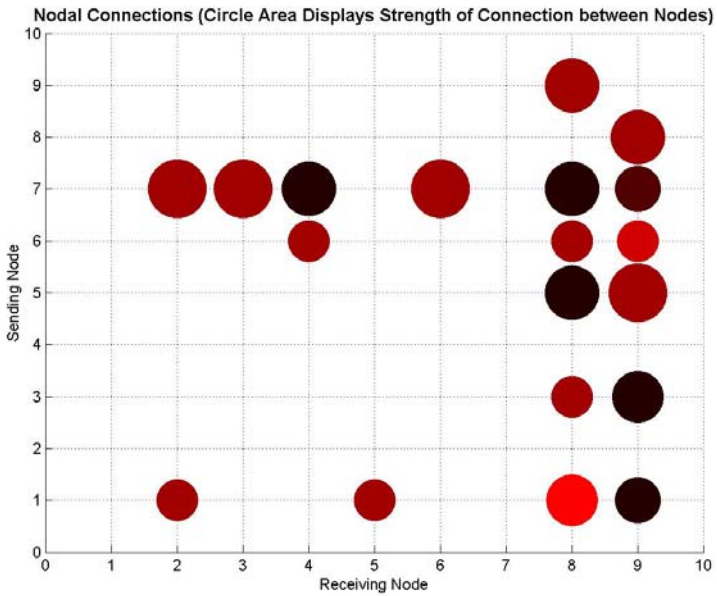


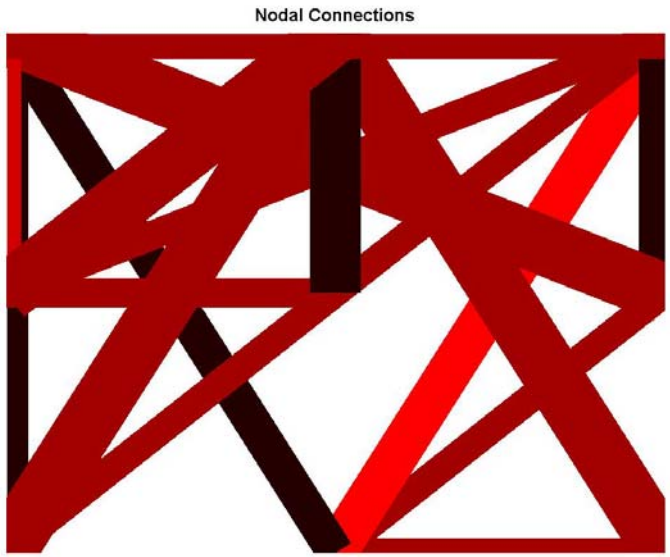


Toy Network – Step II

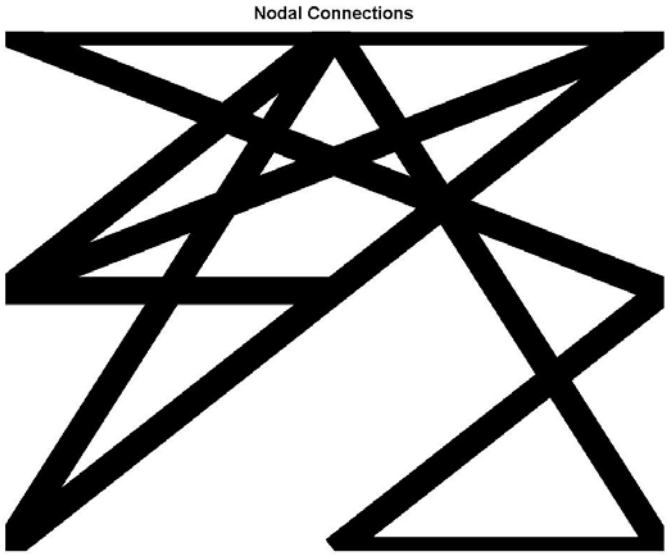


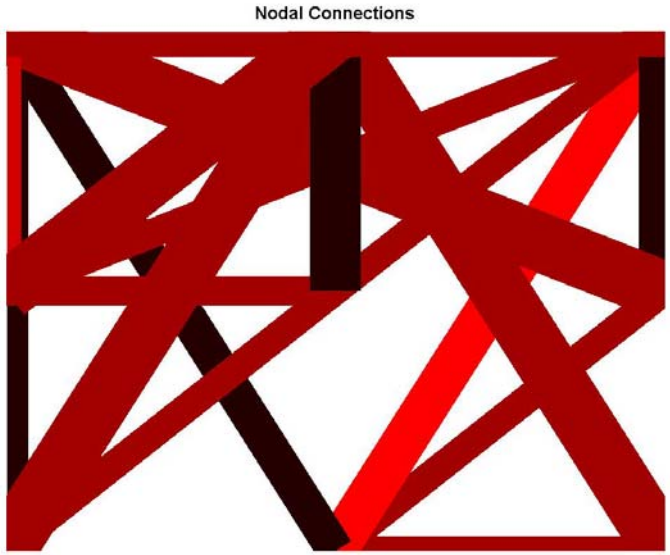
Toy Network – Step III



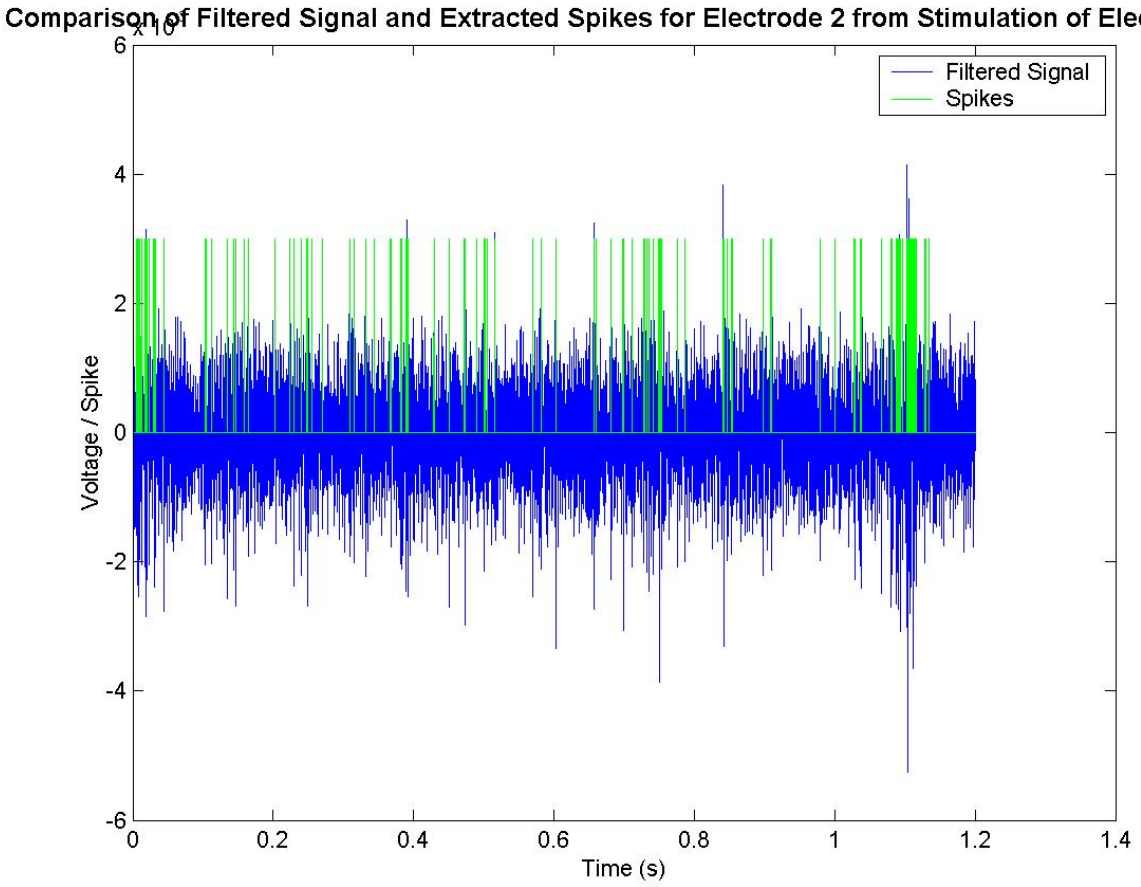


Toy Network

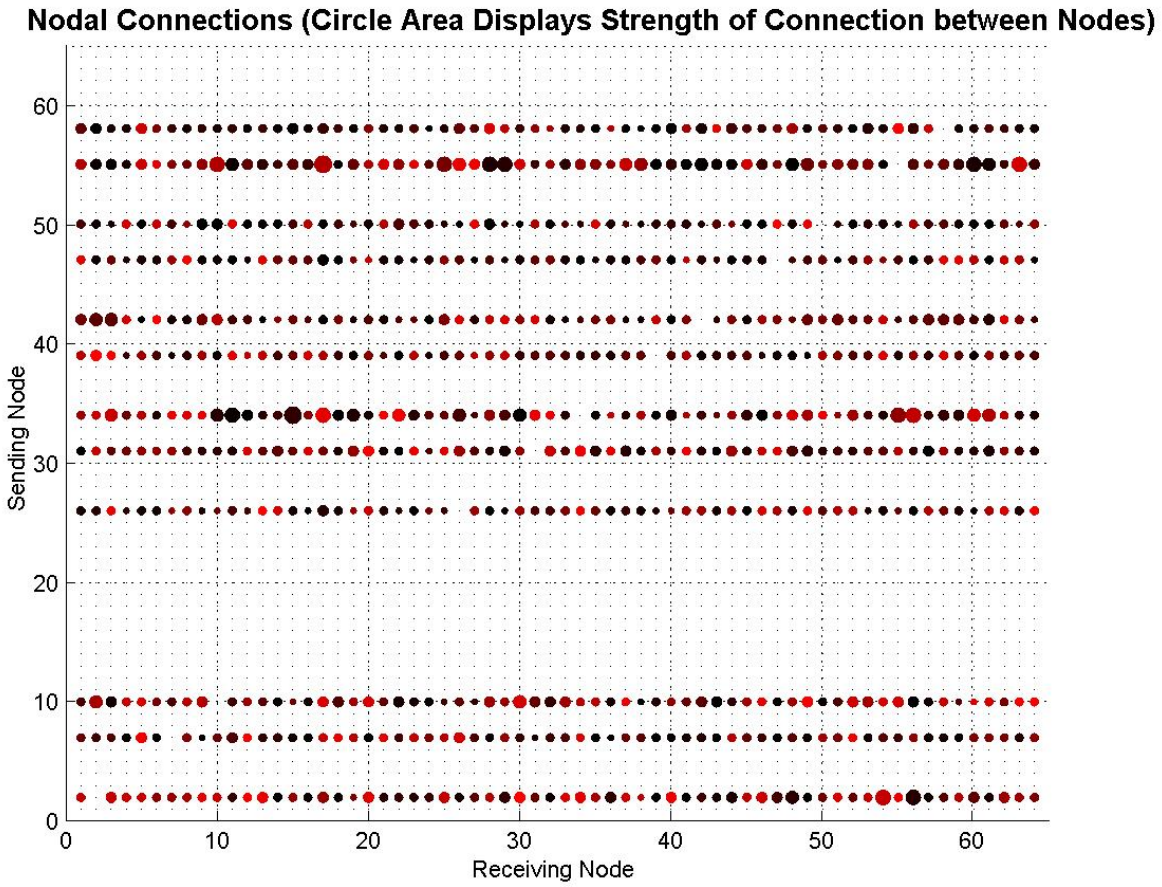




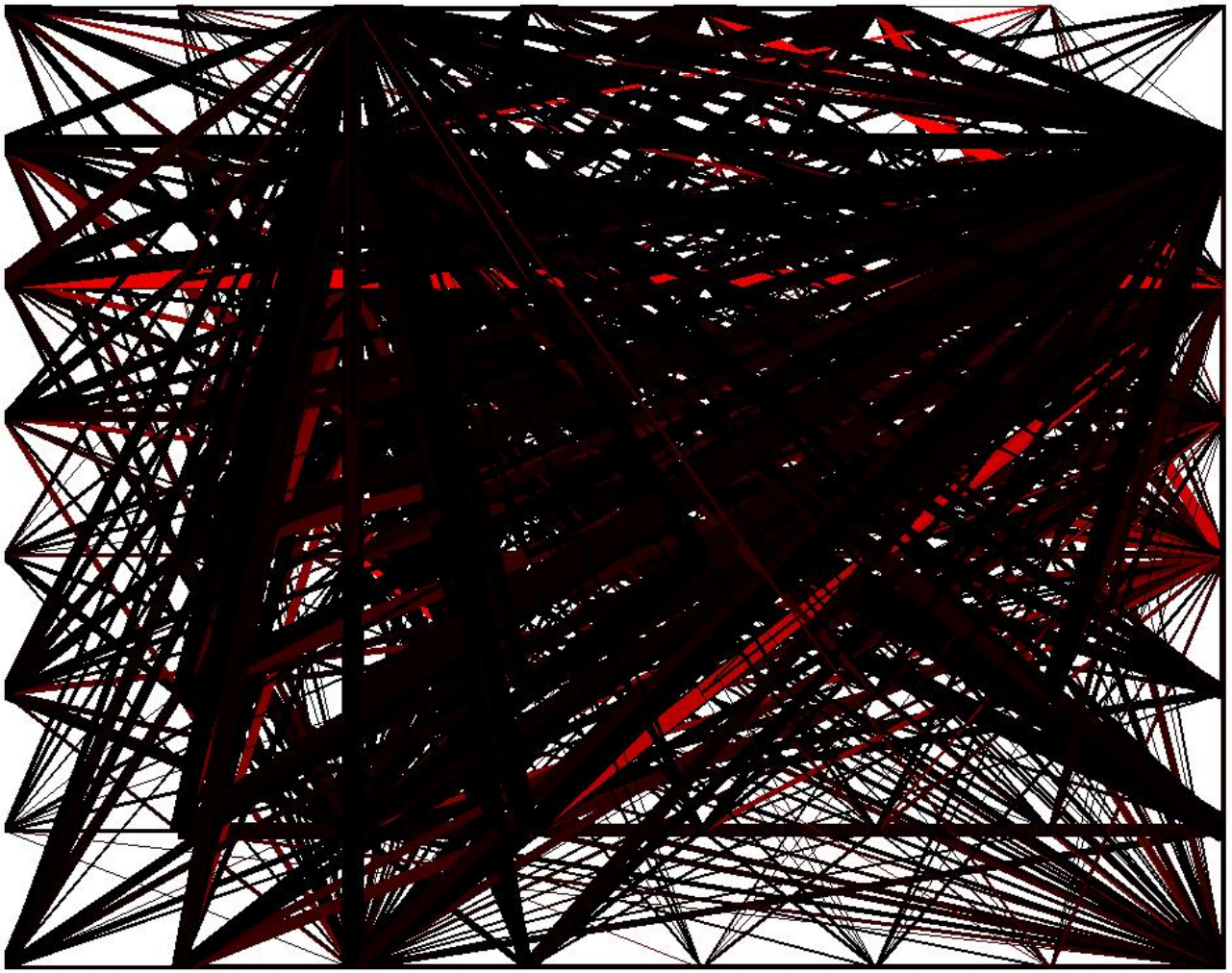
Hippocampal Network – Step II

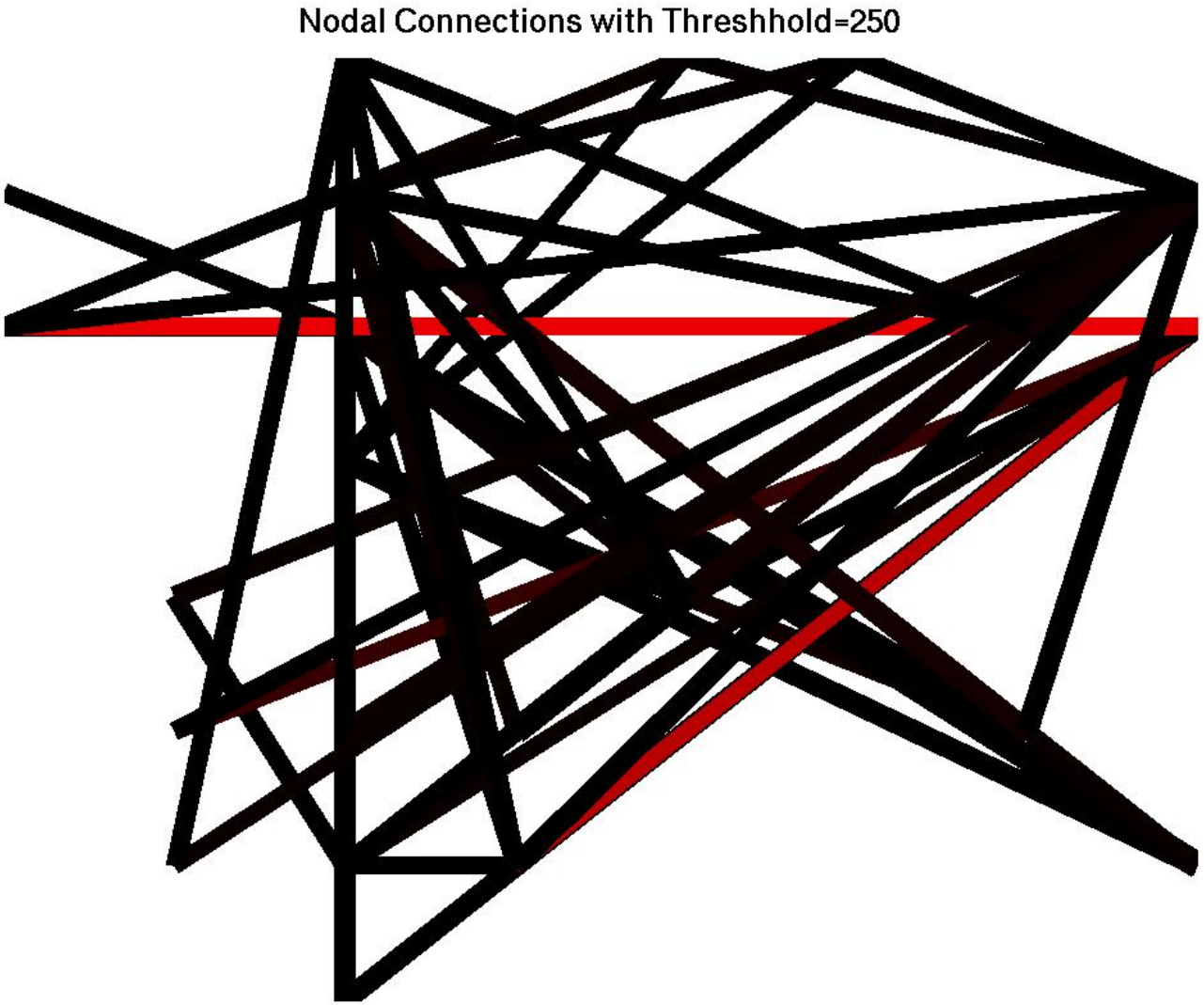


Hipppocampal Network – Step III



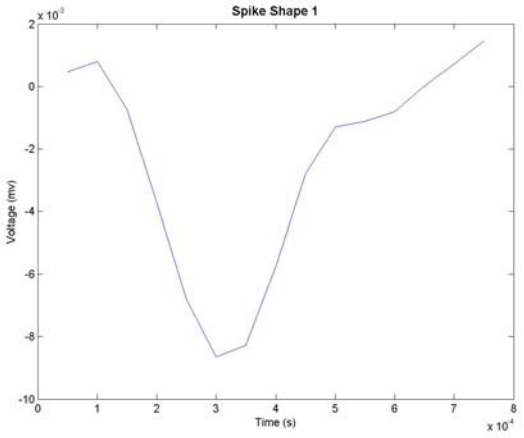
Nodal Connections with Threshhold=0

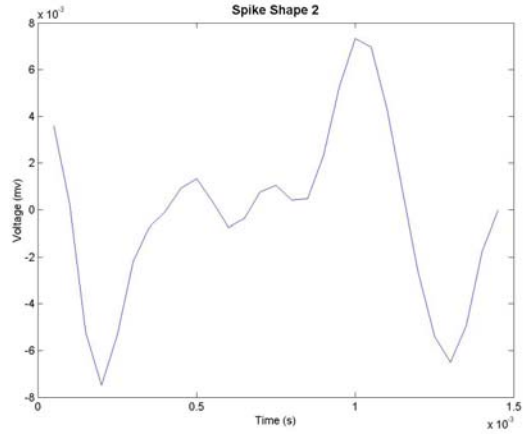


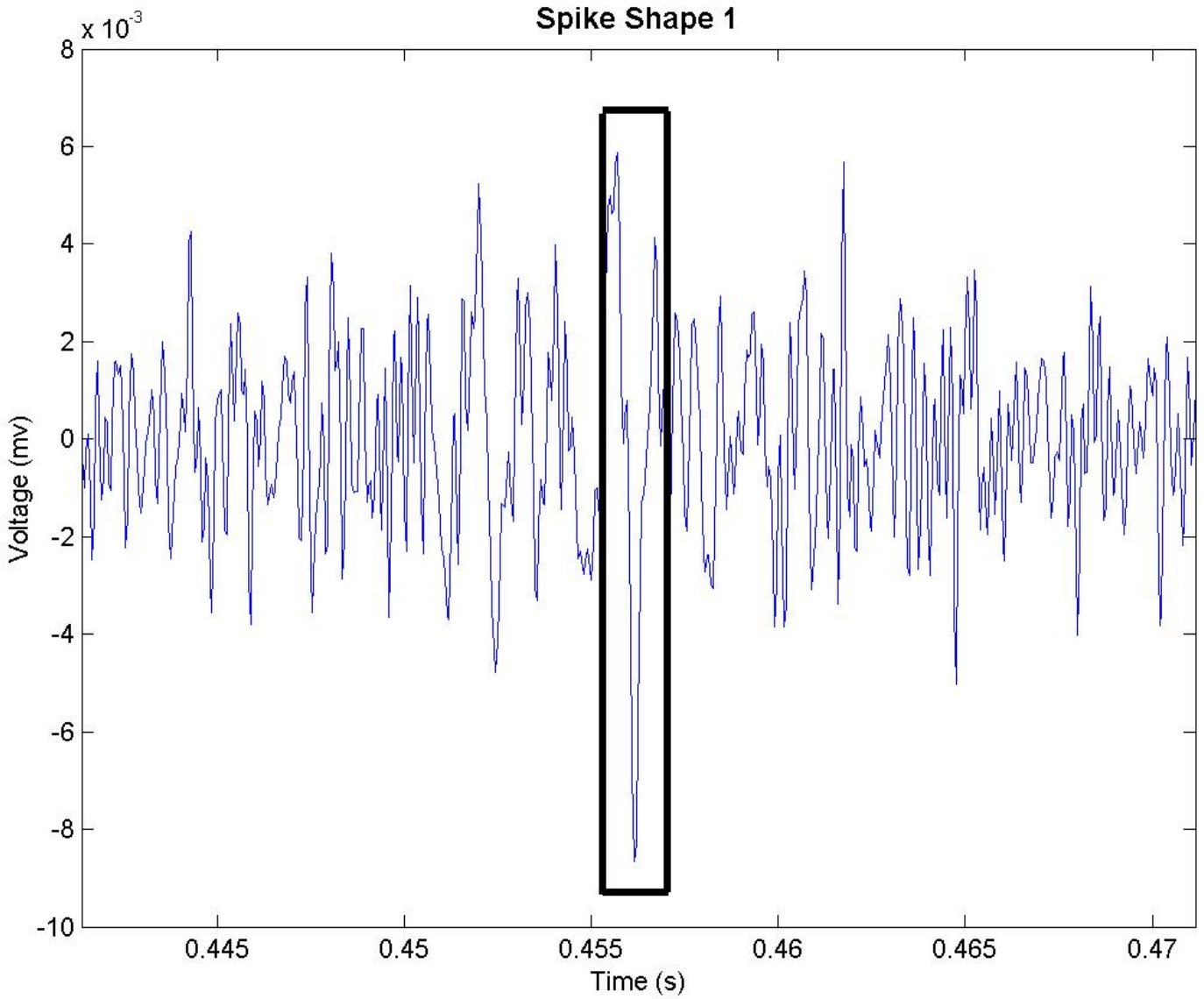

Nodal Connections with Threshhold=250

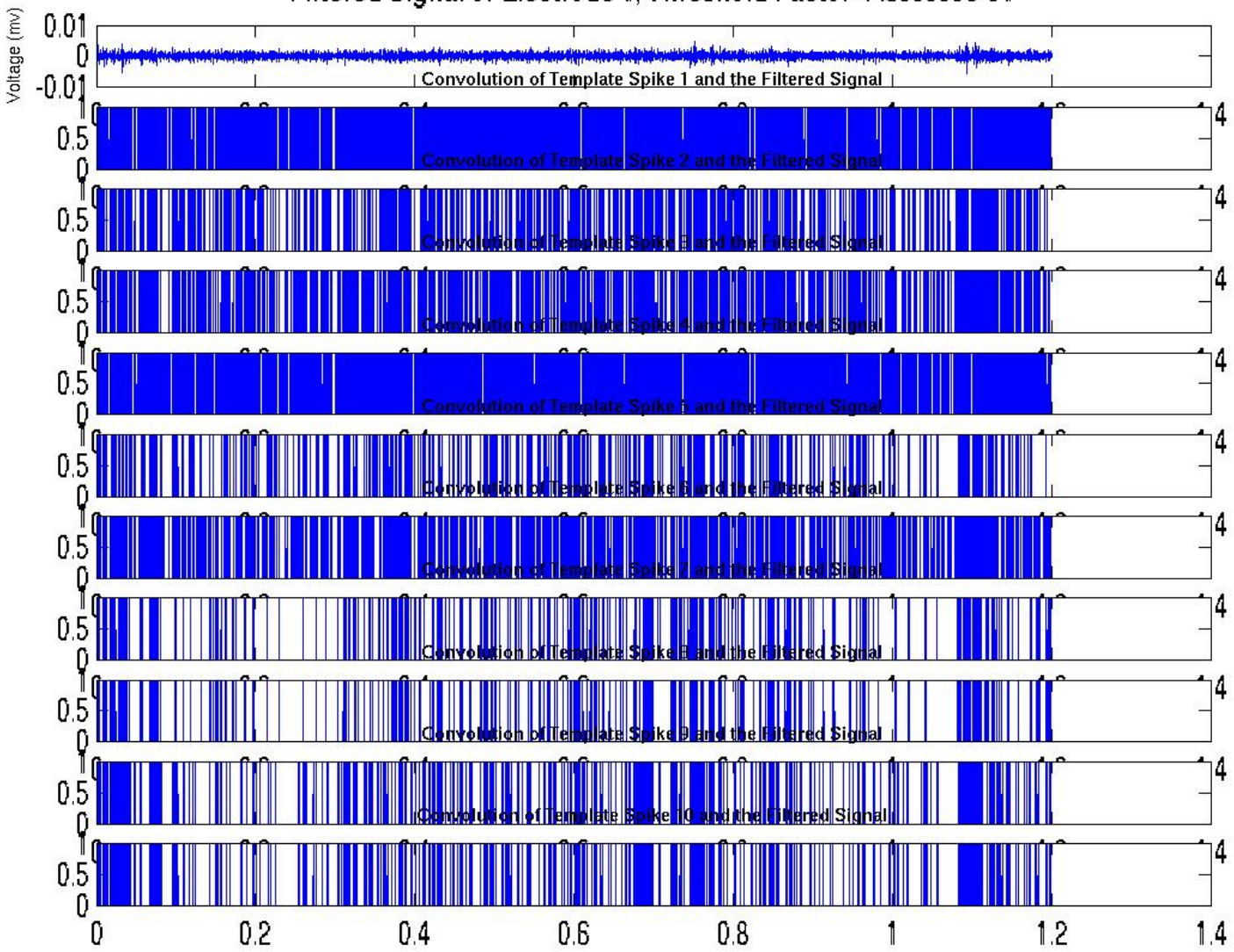
Spike Sorting

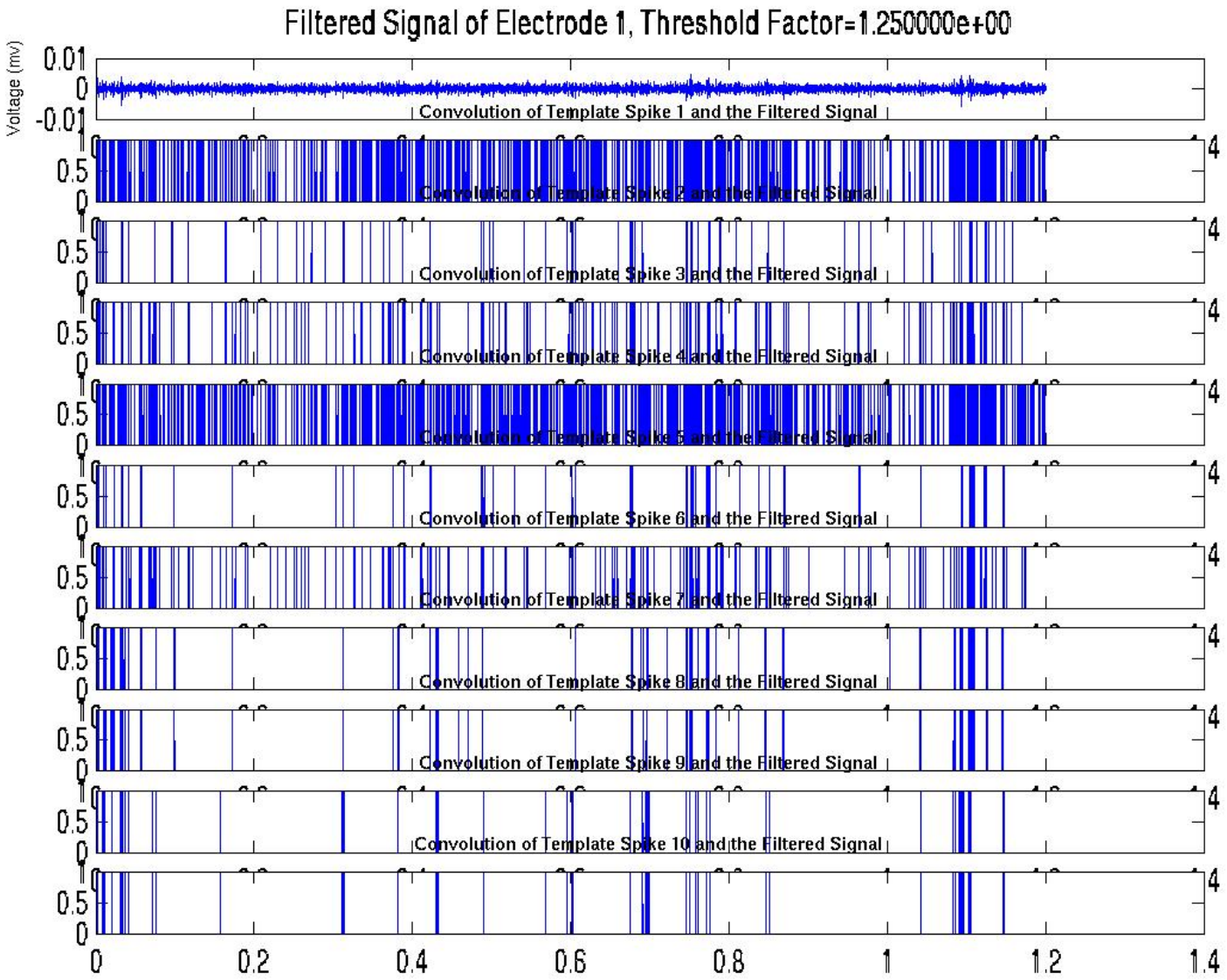
- Goal is to connect level of electrodes to the level of individual neurons
- Idea is to attribute spikes to individual neurons by performing convolutions and then look at the correlations between the spike trains of neurons
- Method requires the assumption no two neurons at one electrode spike with the same shape
- This requires a low neuron density as well as ten different spike shapes randomly distributed among in the culture.






Spike Shape 1
x 10^-3
8
6
4
2
0
-2
-4
-6
-8
-10
Voltage (mv)
0.445
0.45
0.455
0.46
0.465
0.47
Time (s)


Filtered Signal of Electrode 1, Threshold Factor=7.500000e-01
Voltage (mv)
0.01
0
-0.01
Convolution of Template Spike 1 and the Filtered Signal
Convolution of Template Spike 2 and the Filtered Signal
Convolution of Template Spike 3 and the Filtered Signal
Convolution of Template Spike 4 and the Filtered Signal
Convolution of Template Spike 5 and the Filtered Signal
Convolution of Template Spike 6 and the Filtered Signal
Convolution of Template Spike 7 and the Filtered Signal
Convolution of Template Spike 8 and the Filtered Signal
Convolution of Template Spike 9 and the Filtered Signal
Convolution of Template Spike 10 and the Filtered Signal
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4


Filtered Signal of Electrode 1, Threshold Factor=1.250000e+00
Voltage (mv)
0.01
0
-0.01
Convolution of Template Spike 1 and the Filtered Signal
Convolution of Template Spike 2 and the Filtered Signal
Convolution of Template Spike 3 and the Filtered Signal
Convolution of Template Spike 4 and the Filtered Signal
Convolution of Template Spike 5 and the Filtered Signal
Convolution of Template Spike 6 and the Filtered Signal
Convolution of Template Spike 7 and the Filtered Signal
Convolution of Template Spike 8 and the Filtered Signal
Convolution of Template Spike 9 and the Filtered Signal
Convolution of Template Spike 10 and the Filtered Signal
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4

Works Cited

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