In The Name of God

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Advanced Neuroscience HW3

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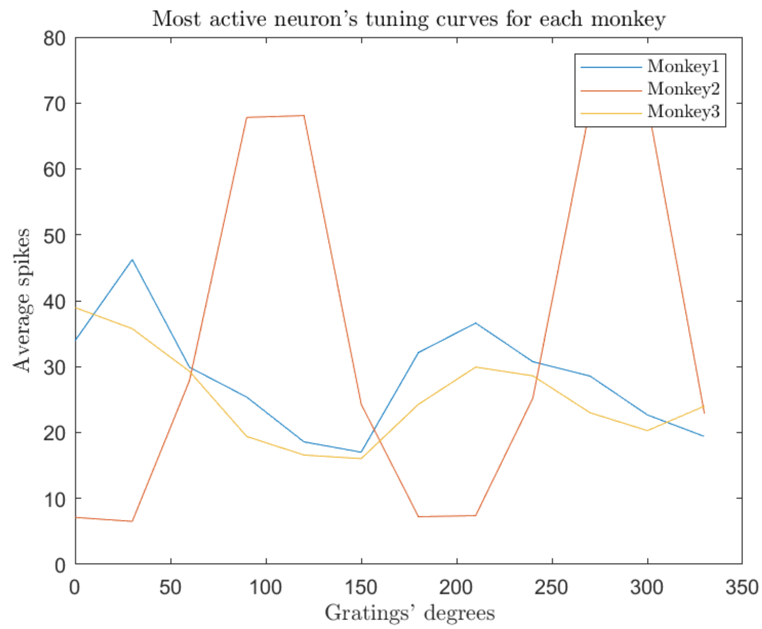
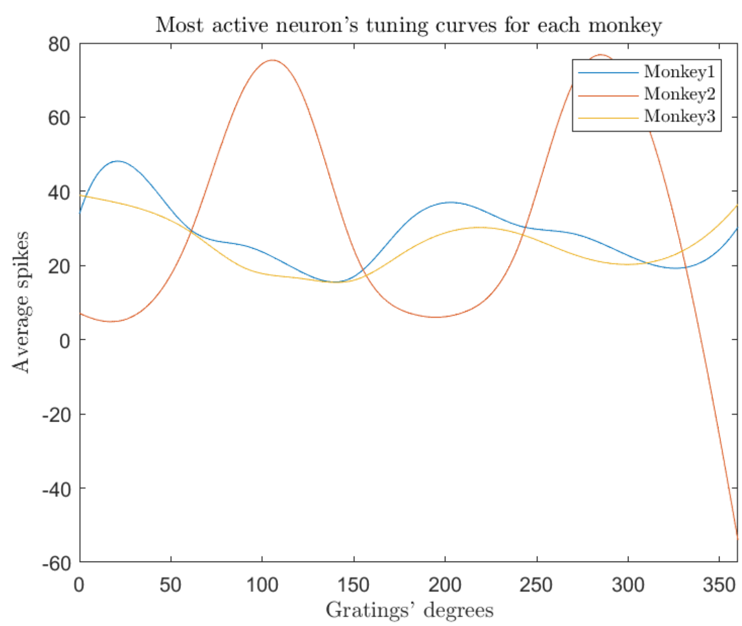
Part 1)

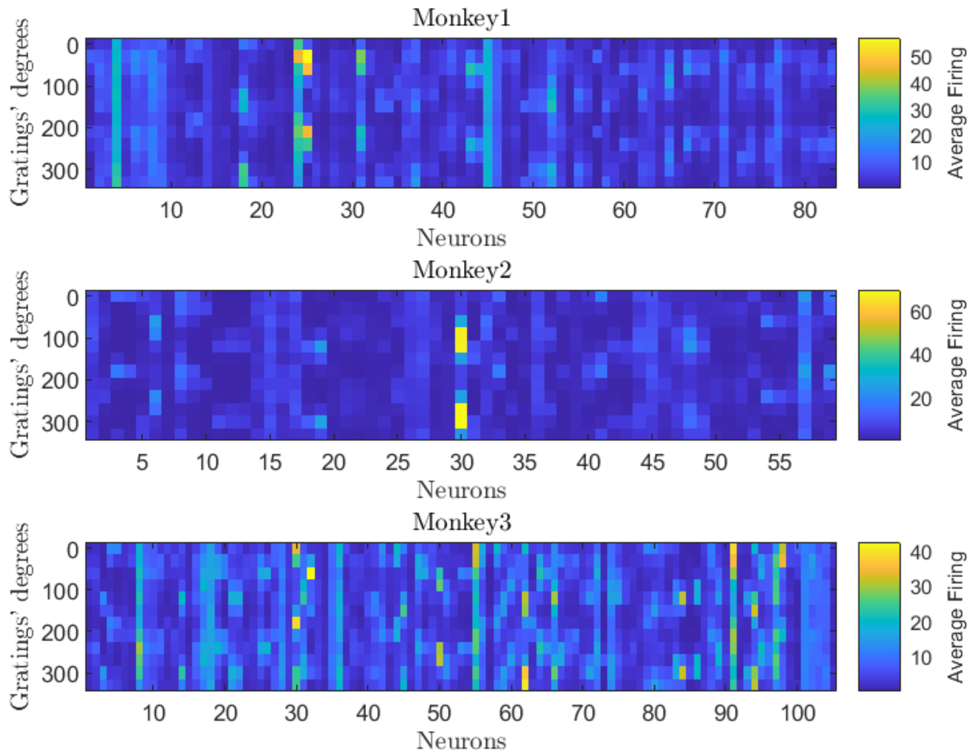
In the first step, we use a pre-processing method to improve the raw data. The given script is used for this aim. Then, the most active neurons were found in each array. The figure below shows the tuning curve for these three neurons:



As we can see the plot is somehow far from a real tuning curve shape, because the number of the points used for plotting are few. In fact, we need to have the data for a lot more conditions to see a better tuning curve. Thus, we can rather use interpolation to retrieve lack of information. Here is the result for the three tuning curves after interpolation:



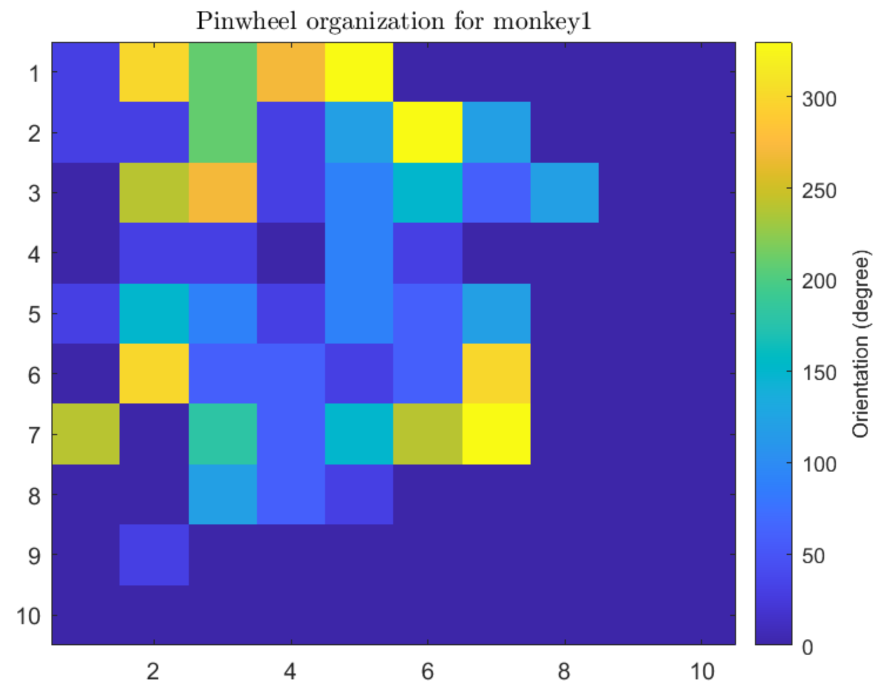
In order to have a better perception for the orientation detection of all neurons, a colorful plot is shown here, which represents each neuron's tuning curve. The warmer colors are used for the conditions which has activated a neuron the most.

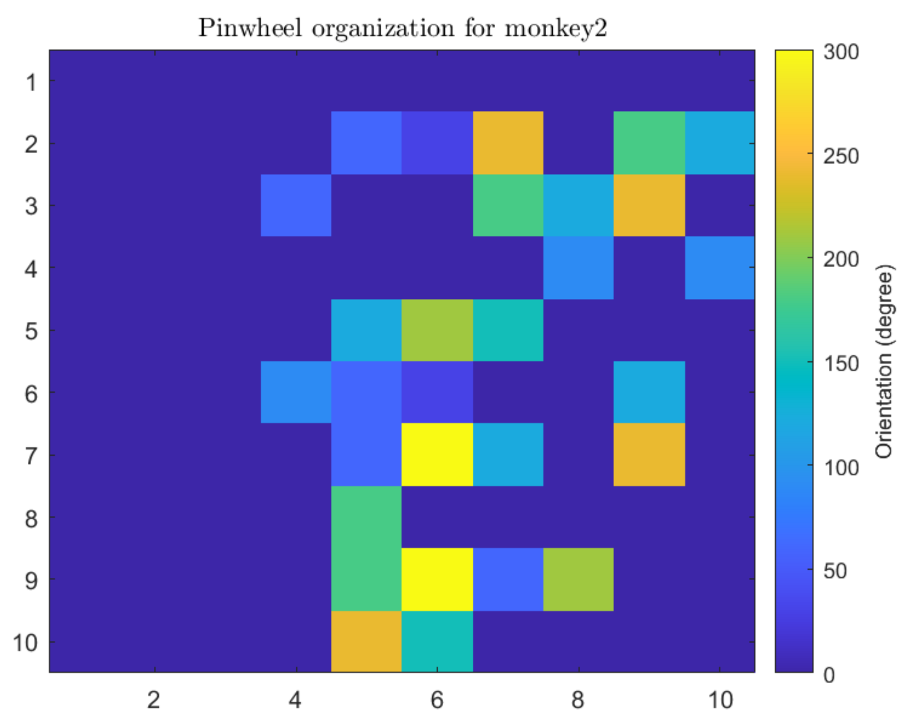


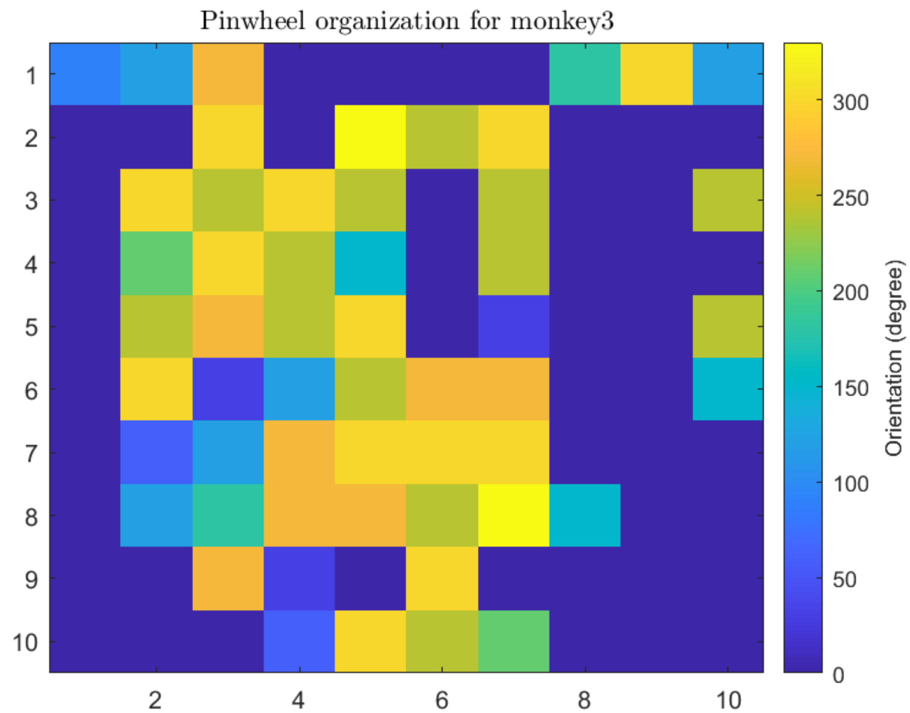
Note that the neuron's preferred orientation has a 180-degree period like shape, it was expected because these neurons are expected to detect angle, not movement direction and a T + 180 and T degree line are same for this task, some other differences are due to the noise effects.

Part 2)

To plot pinwheel, we use the most activating gratings for each neuron of the map and plot the response. The total activity is used for each neuron and each condition, and the same conditions are plotted with the same color. Here are the plotted pinwheels for each array.



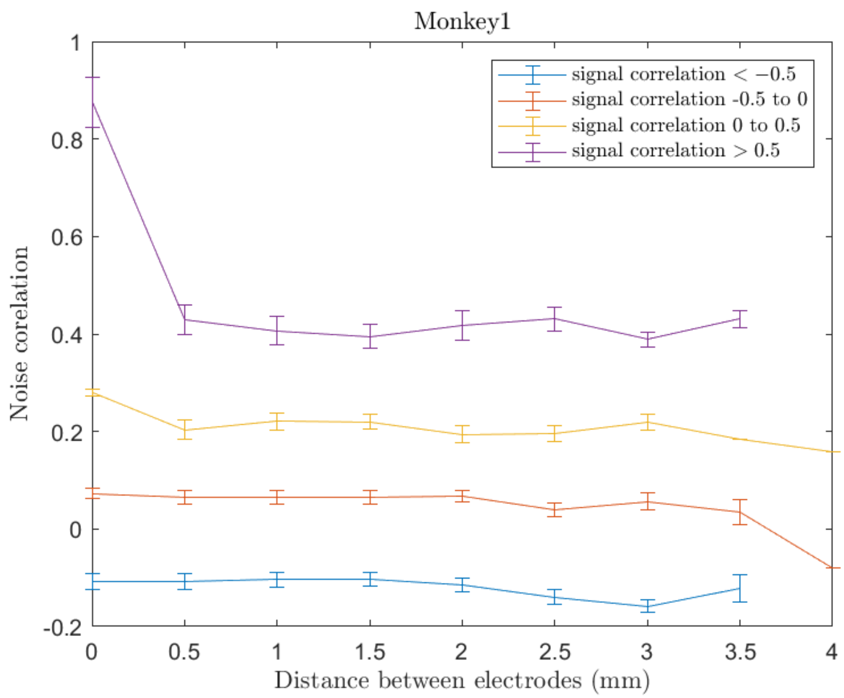


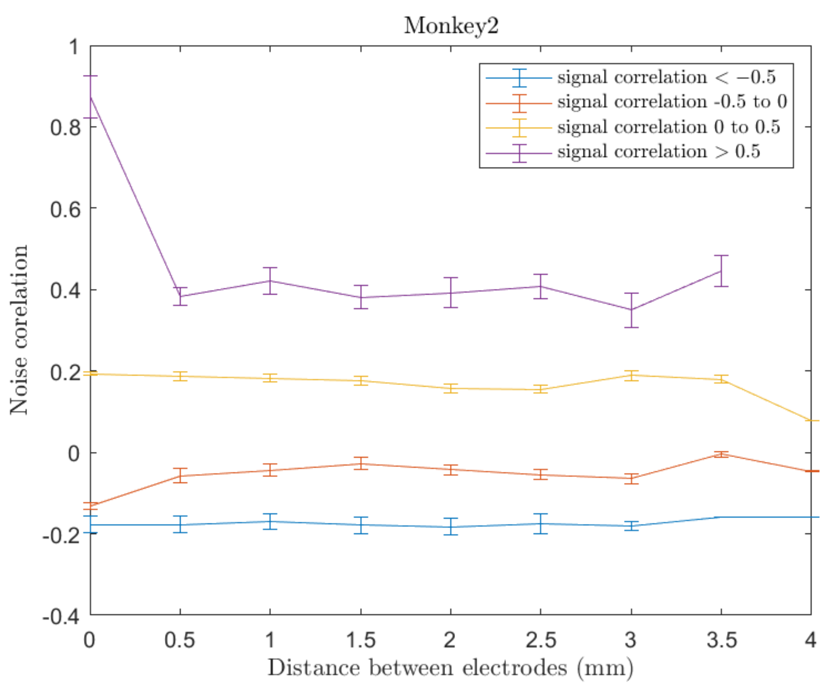


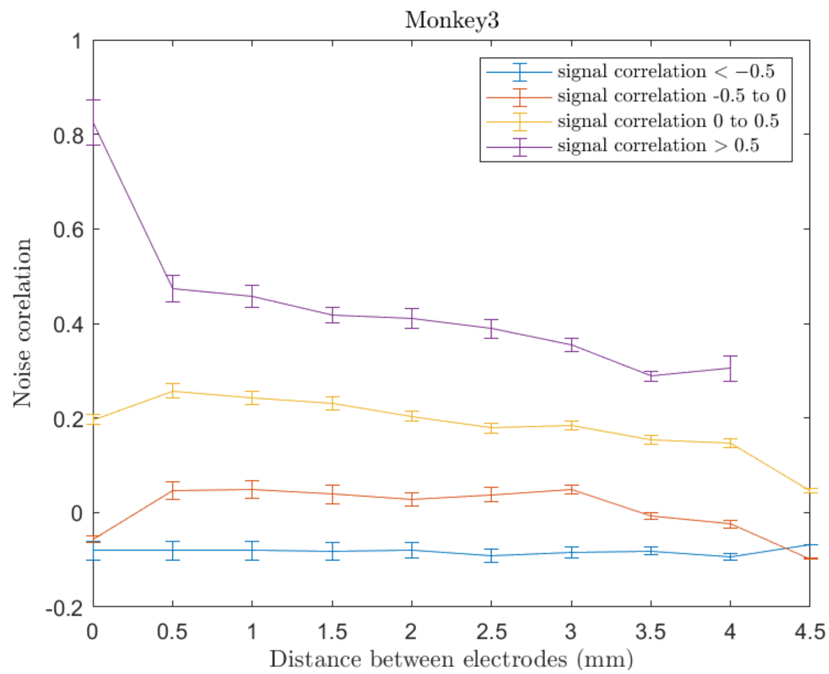
The significant property of pinwheels is that they have local similarity while they can have fast changes when getting far from a specific region. As we can see in the figures, our pinwheels are somewhat the same, except that the local similarity and soft changing can hardly be seen in our plot. This is because our spatial resolution is very low considering to a neuron's size.

Part 3)

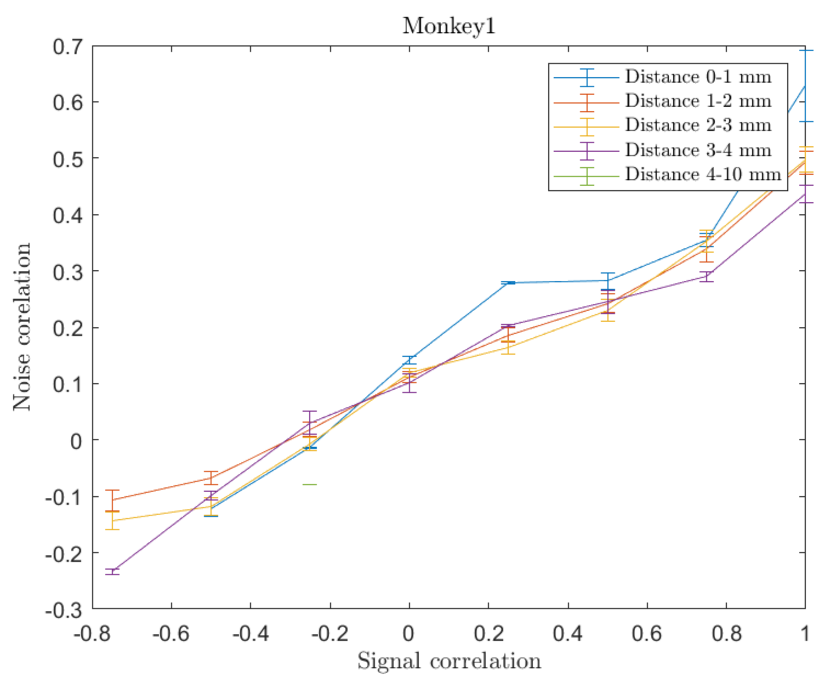
In this part we first compute the signal correlation (via taking an average on trials), noise correlation and electrode distances as a simulation for the real distances between the neurons. Then try to show the relation between these three. The three plots below show the relation between the noise correlation and neurons distances in each array. As it can be seen the noise correlation decreases for the further neurons.

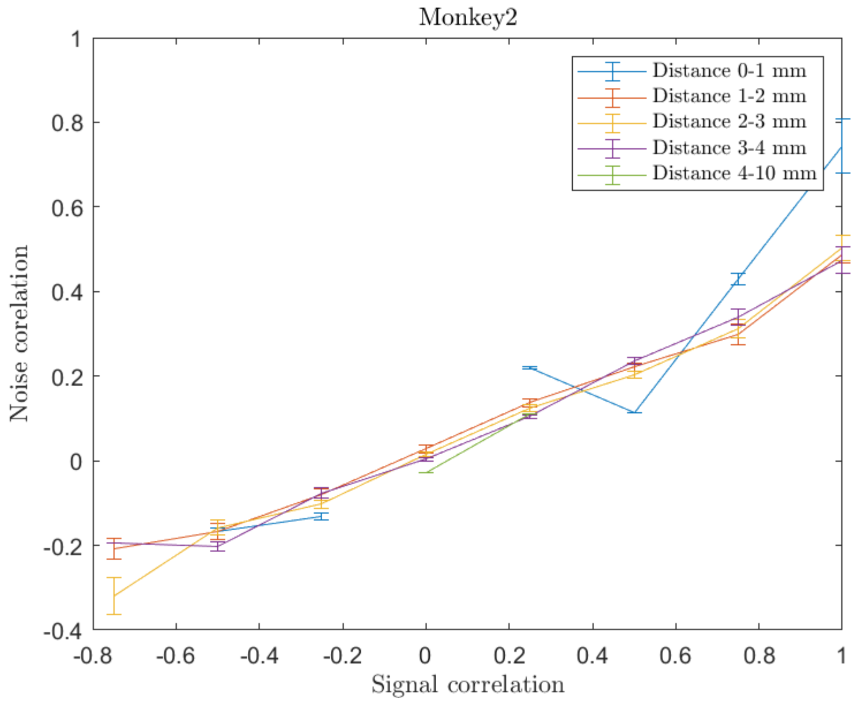


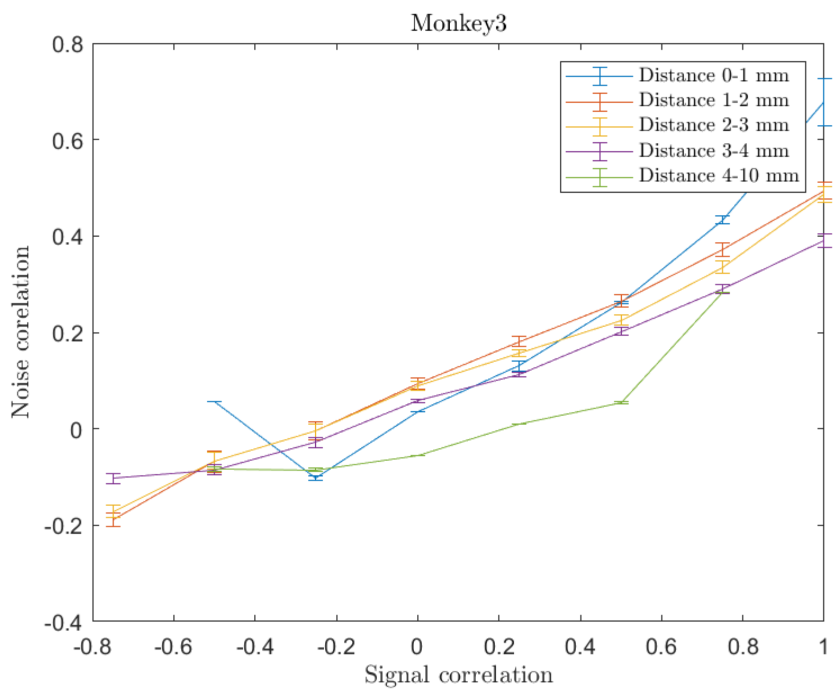




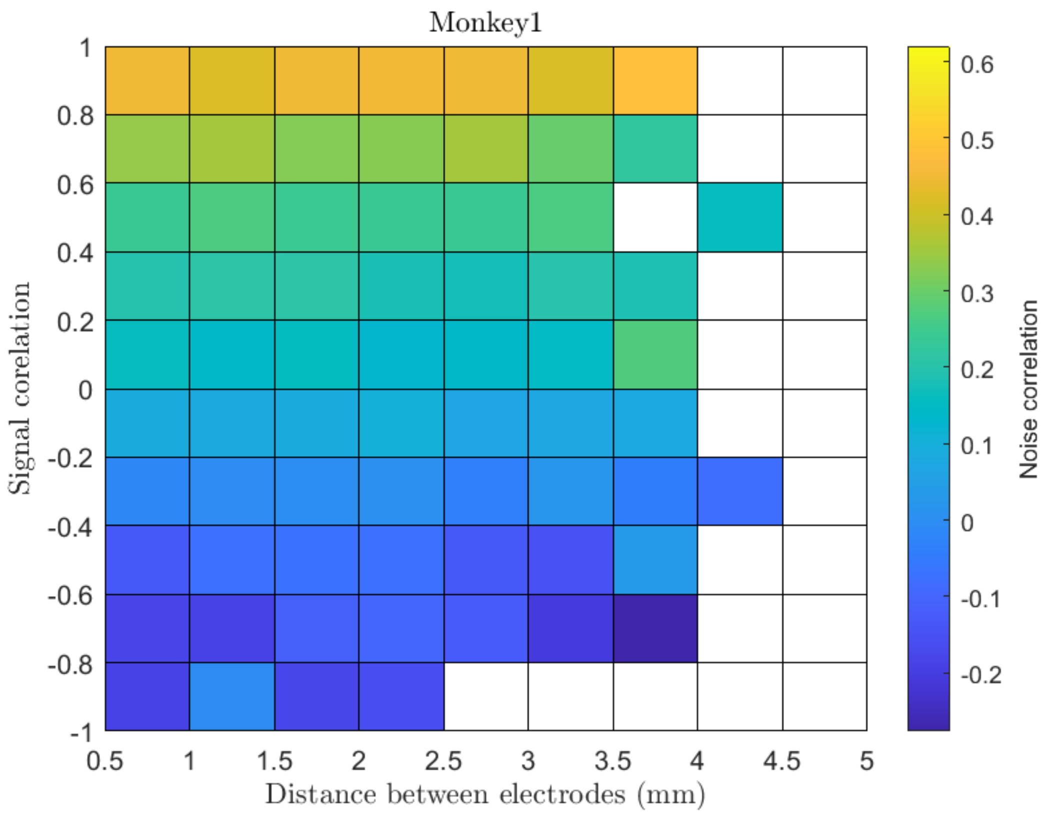
The three plots below show the relation between the noise correlation and signal correlation in each array. As it can be seen the noise correlation and signal correlation have a direct relation.

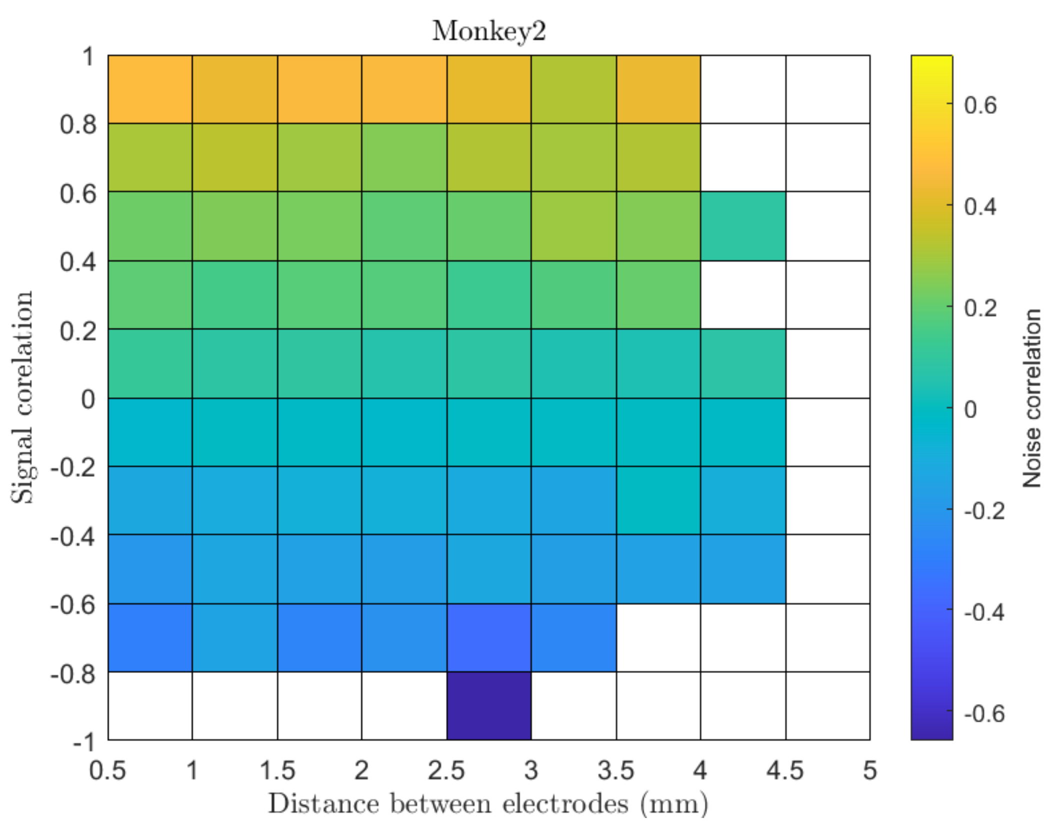


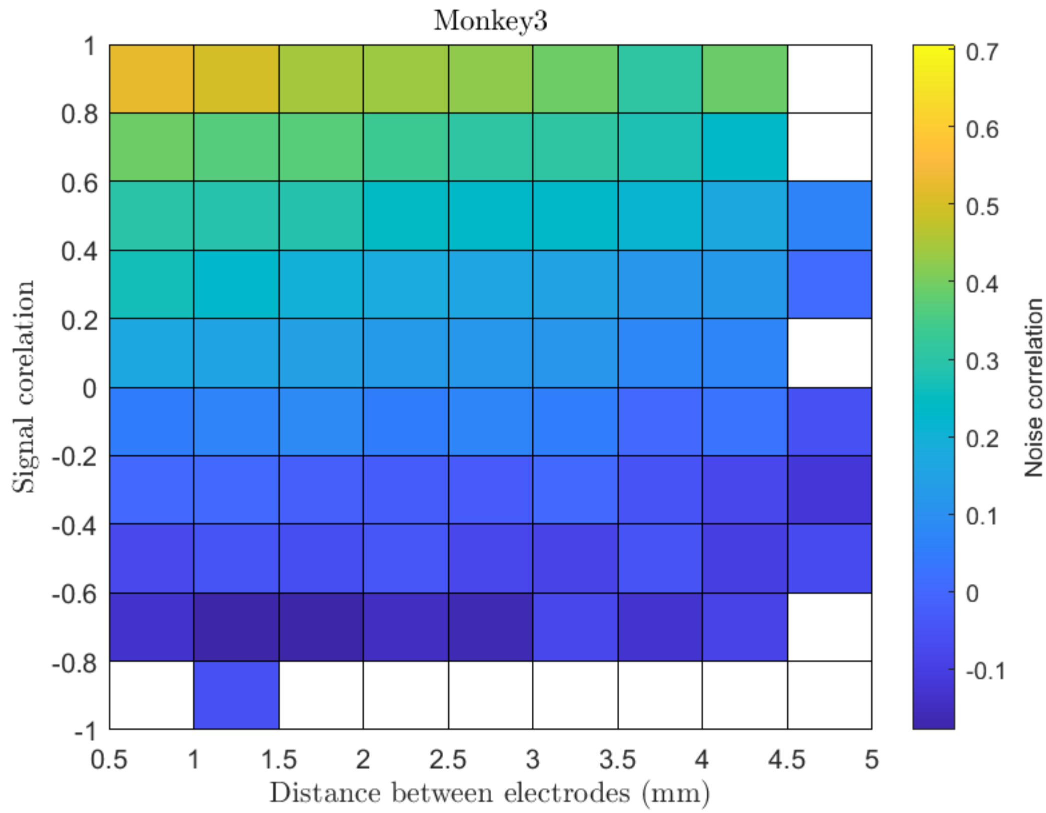




The next three plots below show the relation between the noise correlation, neurons distances and signal correlation in a colorful map in each array. As it can be seen the noise correlation is maximum when in closer neurons and the neurons with higher amount of signal correlation the signa correlation.


Monkey1
Signal corelation
Distance between electrodes (mm)
Noise correlation
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2


Monkey2
Signal corelation
Distance between electrodes (mm)
Noise correlation
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
0.6
0.4
0.2
0
-0.2
-0.4
-0.6



Part 4)

When spontaneous activity is recorded, there is no preferred grating and neural activity is almost random. Thus, neurons do not process the spontaneous signal and they are not forced to produce a specific output. As we know, the closer neurons have more noise correlation and that means they somehow have influence on each other, when there is no significant input so they are not forced to make their specific pattern due to their preferred grating, so they will be forced to act less random, and this changes the noise and domain of their output in their preferred gratings.

In other words, when there are no stimuli, they are bellow threshold and their activity has no causation, so they will have more diversity even with noises, and close units have more effect on them also, but when there are stimuli, they will be in their active state and will work with causation, so they are not as random as previous.