Caroline Cutter

NSCI 1230

January 19, 2022

**Homework 4: Neural Networks**

**PART 1:** Create some raster plots. Write a couple of sentences explaining your process. Why did you choose the one you did? What other plots did you try? Why didn’t you like them?

**Final Raster Plot:**

I used geom\_tile for this raster plot. I liked this raster plot the best because it was simple, easy to differentiate the cells and nicely compares the spike times of the cell next to each other. I also think the white background with the black boarder and colors is aesthetically pleasing to the viewer without being too overwhelming. If there were more cells, I probably would not color code them, but with only 5 cells I think it worked out nicely.

Chart, bar chart

Description automatically generated

**Code:**

**Text

Description automatically generated**

**Other Raster Plots:**

At first, I tried to make the raster plots with geom\_point, but since there were so few cells, they were very spread out and it made it difficult to compare the firing times (the top two graphs below). I even tried changing the colors and the shapes of the dots, but I felt it was still too difficult to understand the graphs. So, I moved to geom\_tile which I think did a much better job showing the comparisons between cells. So, then I tried a few different themes (bottom two graphs below) and decided which one I thought looked the best and clearly showed the data (graph above).

Chart, bar chart

Description automatically generatedChart, line chart

Description automatically generated

**Chart, bar chart

Description automatically generated**

Chart, line chart

Description automatically generated

**PART 2:** Create firing rate histogram and ISI graph and calculate FF and CV.

**Firing Rate Histogram:**

This firing rate plot shows that the average firing rate per neuron is fairly consistent over 10,000 ms because there is low variability in the bar heights. The firing rate could look more variable with smaller bin sizes but with the 500 ms bin size it is regular. According to this graph, the highest average firing rate is about 22 Hz while the lowest average firing rate is about 15 Hz for the network of neurons. The rest of the bins lie somewhere in between these 15 and 20 Hz, but more skewed towards 15 Hz.

**Chart, histogram

Description automatically generated**

**Table

Description automatically generatedFano Factor:**

A screenshot of a computer

Description automatically generated with low confidence

The Fano factor must be calculated separately for each cell because it tells the variability of firing rates, and if we calculated them all together, it could average them out to make them look more or less regular than they really are. All the Fano factors are less than 1, which means they are more regular than a Poisson distribution. This supports the graph above because there is a regular average firing rate throughout the whole recording. I created firing rates graphs for each neuron and the ones with slightly higher Fano Factors (Neurons 3 & 5) have more variability in their firing rate bars.

**ISI Plot:**

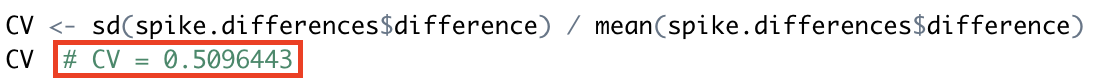
This plot tells us about the regularity of Interspike intervals for the network of neurons. We can see that the most common time between spikes was around 30 - 40 ms long, because this is where the highest number of Interspike intervals was recorded. We can also see that the Interspike intervals ranged from about 10 ms to 260 ms, but has a large right skew towards lower intervals. This is consistent with most Interspike interval graphs because according to a normal or Poisson distribution, there should be more spikes with shorter intervals than longer. However, there are not a lot of very short intervals due to the refractory period of a neuron.

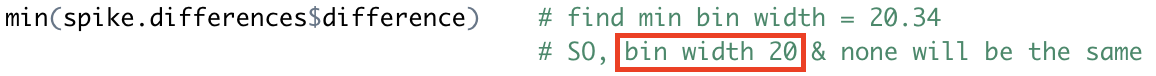
**Chart, histogram

Description automatically generated**

**CV:**

Since the CV is 0.51, which is less than 1, this means that this network of neurons is more regular in terms of variability of Interspike intervals than a Poisson distribution. This is supported from the graph above because many of the spike time differences lie within the 30 – 40 ms range, which means the time between spikes was fairly consistent / regular through the whole graph.



**PART 3:** Synchrony.

**Probability of Firing:**

This graph shows us the synchrony of the neural network firing though a probability distribution over time. By splitting up the bins where only 1 spike could happen for each neuron, we showed how likely it was for the network to fire. Since we have 5 neurons, 1 means that all 5 neurons fired and 0 means that none of the neurons fired. We can see synchrony of the neural network when all 5 of the neurons fired together. Since we have quite a few peaks at the 1 mark, I would say that this network is fairly synchronous.

Chart, bar chart, histogram

Description automatically generated

**Firing Rate Curve:**

The firing rate curve is another way to see how synchronous this neural network is. We can see this because when the firing rate is high, then we know that the network is synchronous because there is more firing within that time interval. The more consistent the neurons fire together, the more synchronous the network is. So, with this graph we can see that there are a lot of times where all 5 of the neurons fired together, so it is a fairly synchronous graph.

Chart, bar chart, histogram

Description automatically generated