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NSCI 1230

January 13, 2022

**Homework 3: Fano Factor & CV**

**Group 1 with Diana Xu**

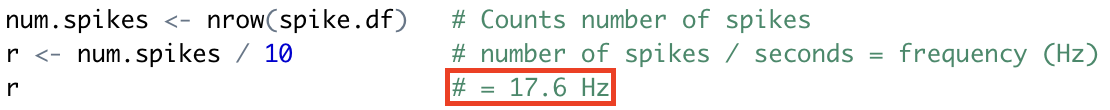
**Worksheet 2: Fano Factor**

**Question 2:** Plot spike times like the last assignment. What do you notice about the spike train?

This plot shows that the spike train fires continuously with a regular and high firing rate. However, with such a large time scale and how many spikes there are, it is hard to tell specific details about this firing neuron from the plot.



**Question 3:** Compute the average firing rate, r.



**Question 4 & 5:** Bin the spikes using cut(). Create a data frame that contains spike counts per bin. Add a column to the data frame that contains firing rate in Hz.

Text

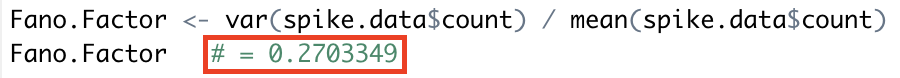
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**Question 6:** Use geom\_col to create a histogram of firing rates.



**Question 7:** Compute the Fano Factor for this spike train. What does it say about the variability in the spike count?

The Fano factor of this spike train is 0.2703349. This tells us that this spike train is more regular than a Poisson distribution, which means there is a similar firing rate throughout the spike train.

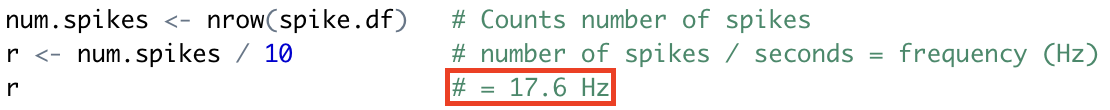


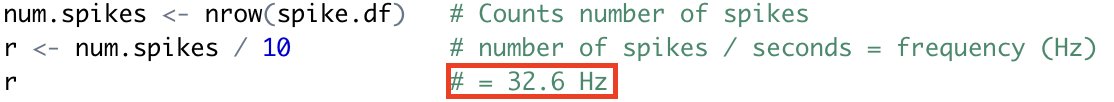
**Question 8:** Repeat 1-7 for “spikeTimes\_example5\_FR.csv” and compare. Explain similarities/differences between spike trains by the Fano Factor. Put them side to side for a better comparison.

**KEY:** spikeTime\_sim5.csv and spikeTimes\_example5\_FR.csv

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It can be seen in this graph that the sim5 spike train has a lower firing rate than the example5 graph, because the example5 is much denser, meaning it fires more frequently than the sim5 neuron.



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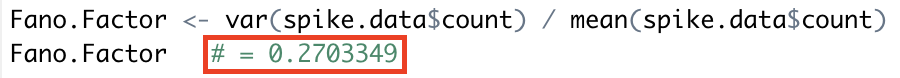
The example5 neuron fires at almost x2 the average frequency than the sim5. This supports the observation above and is why the example5 has a denser look to it.

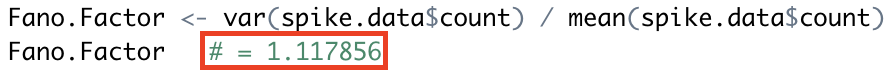
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By changing the bin size of the example5 data so it can have a similar Y-axis / count in each bin to the sim5 data, it is evident that the sim5 data is more regular in firing rate distribution than the example5 data. This supports the calculations of the Fano Factors below because the sim5 data has a lower Fano Factor which means it is more regular in its firing rate distribution than the example5 data. This also supports the observation above that the example5 data has a higher average firing rate, because to make the firing rate the same in terms of the y-axis, we had to split the data up into smaller bins. So, with more spikes across the time, the average firing rate of the example5 must be greater (which supports the calculations above)

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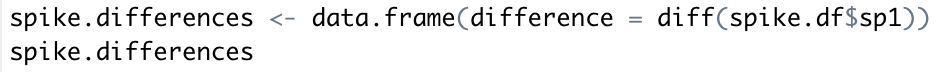


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The Fano Factor’s support the observation above that the sim5 data has a more regular firing rate throughout the whole spike train. We can see that the example5 data is less regular than a Poisson because it’s Fano Factor is > 1.

**Worksheet 3: ISI & CV**

**Question 2:** Create a new data frame that holds successive spike time differences for the spike train (use the function diff() )



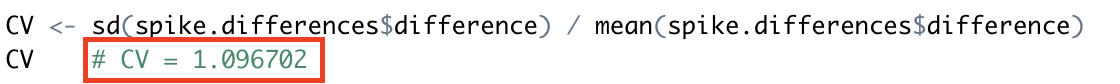
**Question 3:** Create an ISI plot. What does this plot tell us about the spike train? What kinds of conclusions can we draw?

This plot tells us about the regularity of Interspike intervals. We can see that the most common time between spikes was around 10 – 20 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 0 ms to 220 ms, but has a large right skew towards lower intervals



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**Question 4:** Compute the coefficient of variation (CV). Discuss what this means about your spike train.

This CV means that this ISI graph is more regular than a Poisson distribution. This shows that there is a regular distribution of Interspike intervals, and most spike time differences lie within a few bins (as explained above). The graph above also looks similar to a Poisson distribution of ISI because it has a lot of short intervals and not a lot of long ones.

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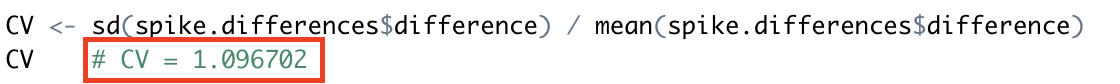
**Question 5:** Repeat 1-4 for the data “spikeTime\_sim5\_FR.csv” and compare. Explain similarities/differences between these two spike trains as illustrated by the ISI and CV.

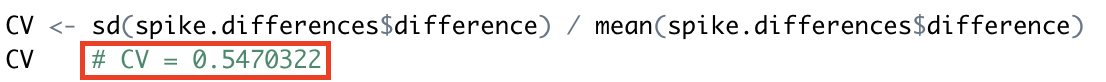
**KEY:** spikeTime\_sim5.csv and spikeTimes\_example5\_FR.csv

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These graphs look similar in their shape because they are both right skewed, however there are a few key differences. First, the example5 data needed to be cut into smaller bin sizes to have the same y-scale (count) of the sim5 data. This shows that the example5 data is more regular because it had more neurons firing in the same time intervals than the sim5 data. Another, is that the most common firing time for the sim5 was around 40 - 50 ms while the example5 was around 10 – 20 ms, which means also shows that the example5 had a higher average firing rate and that it is similar to a Poisson distribution because it has a lot of spikes with small intervals and not a lot with large intervals. Both graphs show a lack of Interspike intervals in the higher ranges (100 – 200 ms), but both graphs had a few that were very high (example5 ~215 ms, sim5 ~200)





As explained above, the example5 CV is more regular than Poisson which means it is regular in its distribution of Interspike intervals. However, since the CV of the sim5 data is greater than 1, it is less regular than Poisson and less regular in its Interspike intervals. This shows in the two graphs above because the example5 graph follows a Poisson distribution in the fact that there are a lot of small intervals and not a lot of long intervals, and there are a few bins that hold many of the spike differences. The sim5 also follows this distribution, but not as clearly. It is also important to note that the Interspike intervals are more spread out because it has less spike counts in the smaller time difference bins

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