Analysis of Hippocampal Data

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The aim of this coursework is to analyze data from four hippocampal neurons of six rats running in a maze. The experiment is described in [1].

1. *Generate plots showing positions in which each neuron fired*

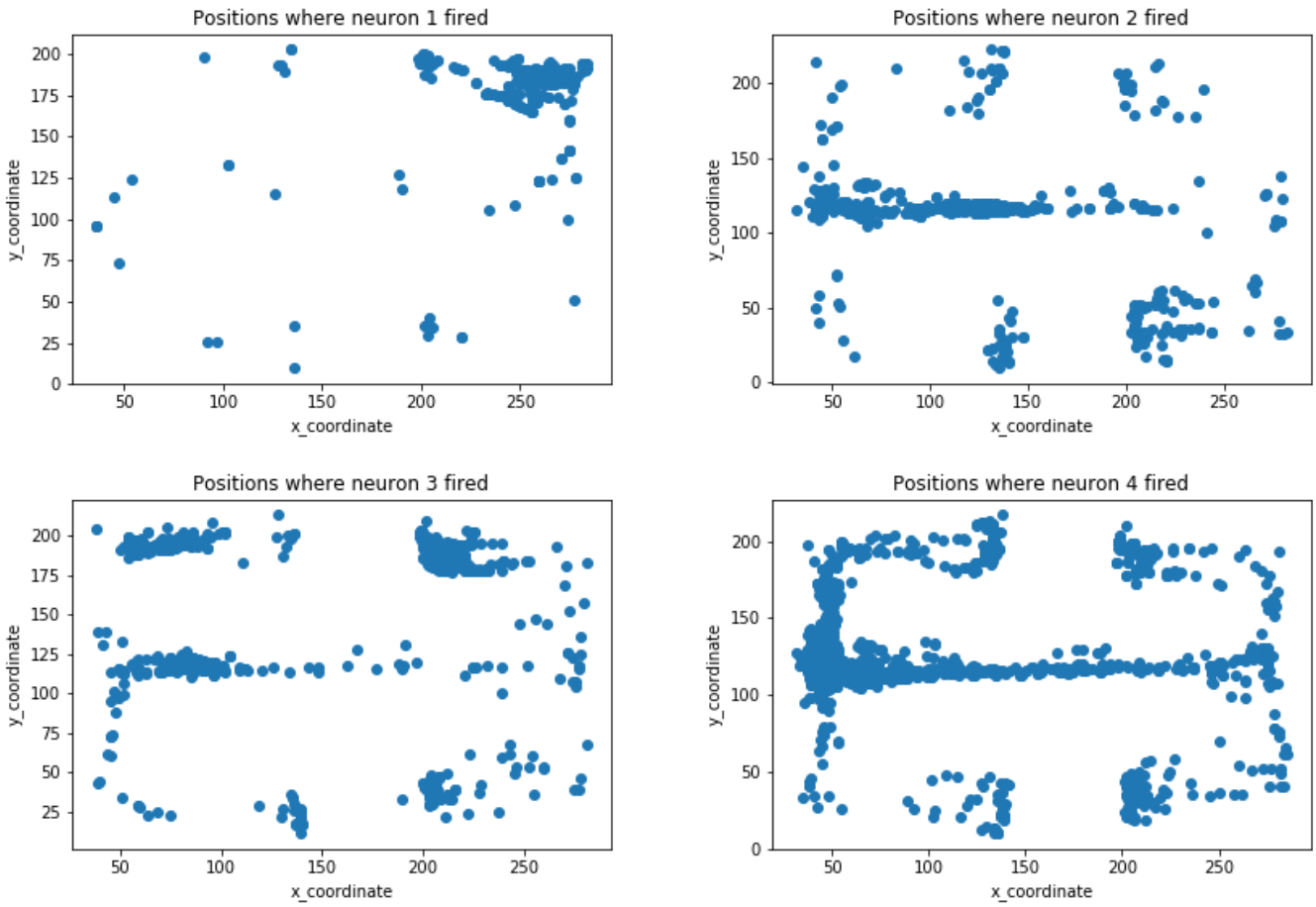

Figure 1: Positions where each neuron fired

2. *Calculate firing rates of each neuron, and plot histograms of the firing rates*

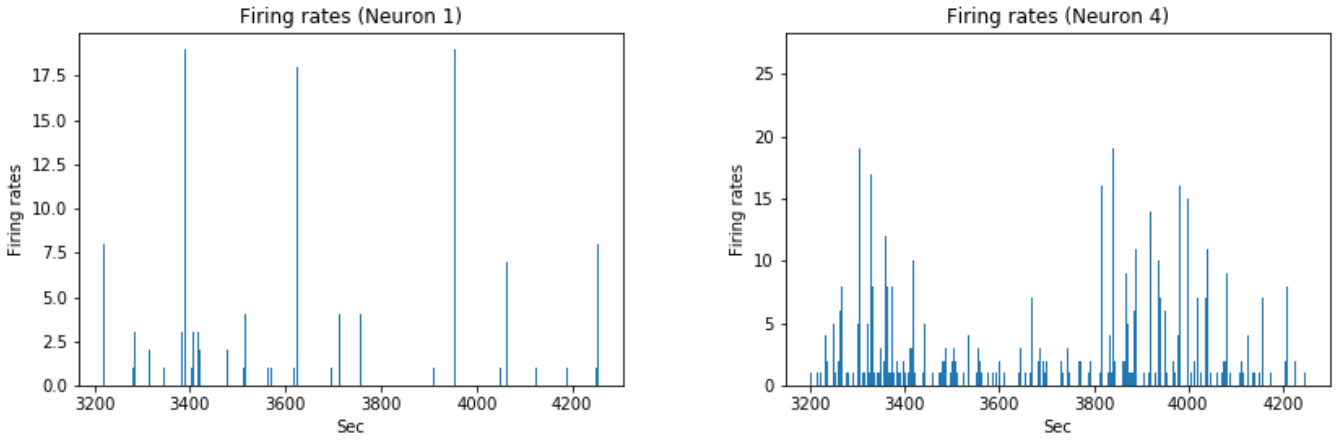

Figure 2: Firing rates of neuron 1 and 4 (in each 1 second interval)

I plot the position (x, y) in which each neuron fired. As shown in Figure 1 and 2, Neuron 4 is the most excited one because it fired the most. Obviously, Neuron 2 and 4 have a similar position distribution, and they fired most when those rats were moving on stage 2 when they were required to choose a left turn or a right turn[1]. Stage 1 and 2 invoked rats' spatial working-memory processes, so I guess Neuron 2 and 4 are responsible for memorizing initial turn forced by a movable barrier. Neuron 3 shows high firing rates at the rewarding areas – top right and bottom right area of this maze, and Neuron 1 also fired more at the top right area. These spikes may be regarded as a reinforce learning process, and that means rats can gain a reward (chocolate) when they make a right decision and learn the relation between choice in the left and right junction.

3. *Plot auto-correlograms of neurons*

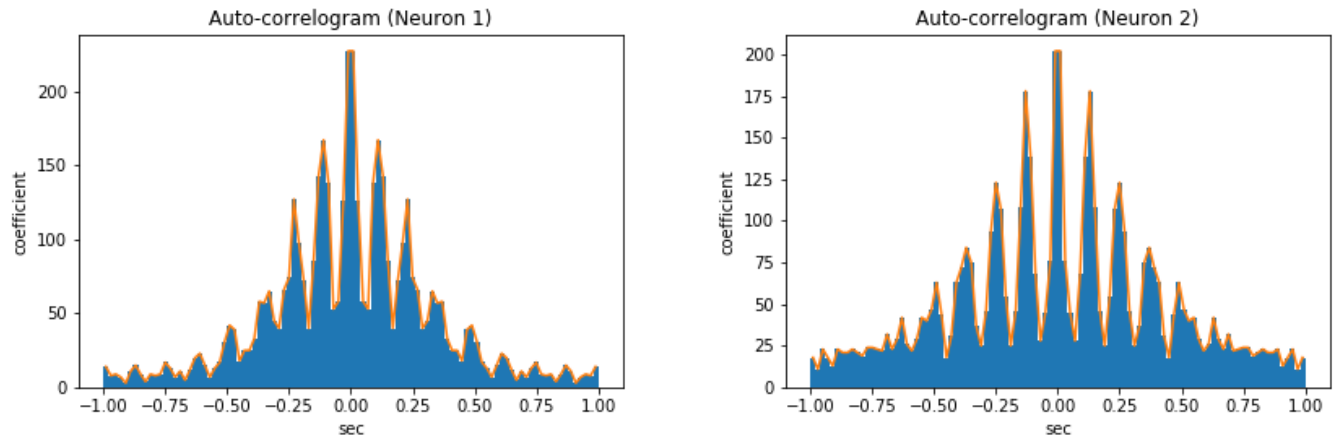

Figure 3: Autocorrelation histogram for neurons

In order to measure reoccurrence of patterns in a spike train (periodicity), we can calculate the auto correlation of it. Autocorrelation histograms for Neuron 1 and 2 recorded in the Figure 3. From these two figures, we can see that Neuron 1 has a shorter period than Neuron 2, since the 'hill' in left figure is tighter than the right one.

4. *Plot cross-correlograms of pairs of neurons*

In order to compare two neurons with each other, we could plot the cross correlation histogram. The cross correlation of two perfectly spike trains is one single peat at time zero. From Figure 4, the upper one shows the cross correlation histogram between Neuron 1 and 4. Although there are several peaks in this cross-correlogram, the highest one is at the center (time zero). However, the highest peak in the lower figure is at around -0.2s. This means time difference between Neuron 3 and 4 spikes is around -0.2s.

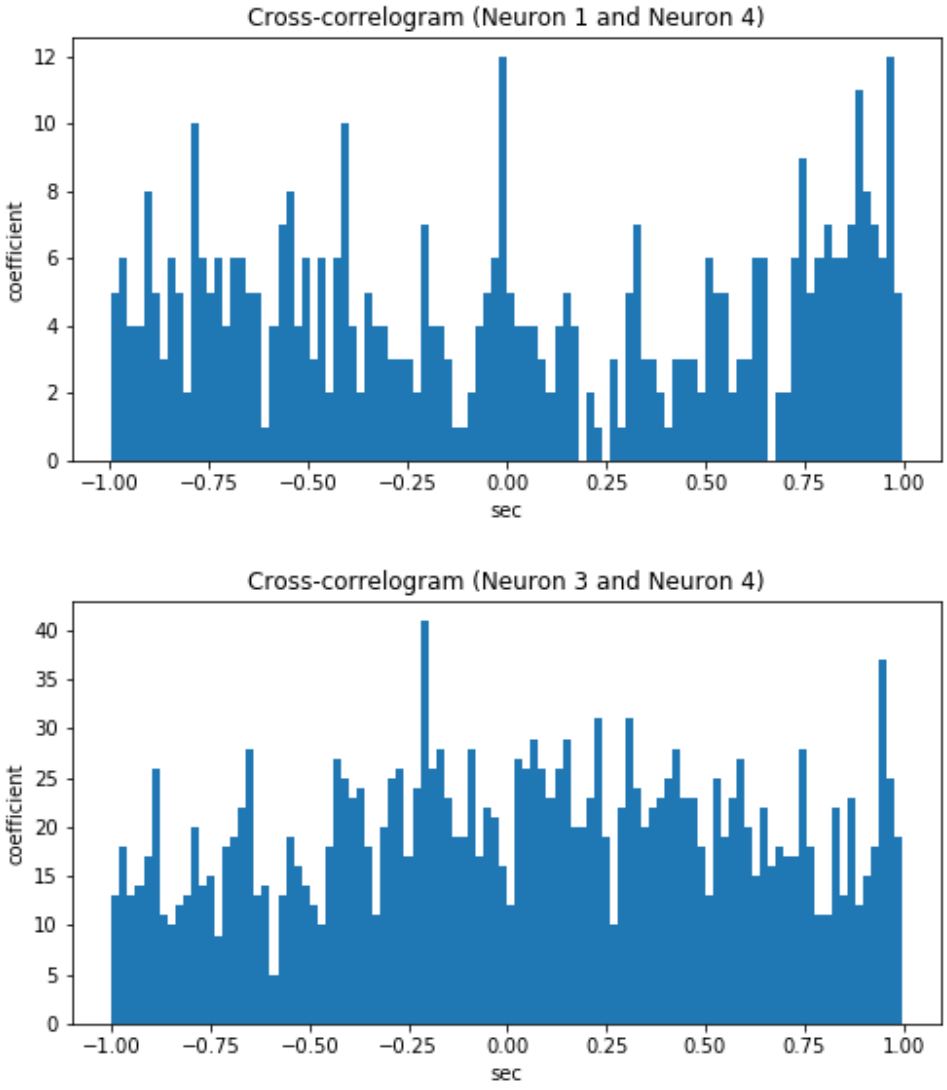

Figure 4: Crosscorrelation histogram for neurons

References

[1] Matthew W Jones and Matthew A Wilson. Theta rhythms coordinate hippocampal–prefrontal interactions in a spatial memory task. *PLoS biol*, 3(12):e402, 2005.