Graduate School of Neural Information Processing, Tübingen
Philipp Berens, Alexander Ecker, Matthias Bethge

Task 5: Visualize response to stimulus

Due date: Monday, May 23, 11:59 AM

Prerequisites

Download the two files `NDA_stimulus` and `NDA_task3_results` from ILIAS. The first contains the necessary data about the stimulus. The second contains the spike sorting results.

Task

This week we start to analyze functional properties of the neurons. We start with orientation tuning. As discussed in the lecture, the stimulus is a drifting grating (speed 3.4 cycles/sec, diameter 2 deg, spatial frequency 3 cycles/deg). In each trial, it is drifting in one of 16 uniformly spaced directions. There are 176 trials in total.

1. **Plot spike rasters.** In a raster plot, each spike is shown by a small tick at the time it occurs relative to stimulus onset. Implement a function `plotRaster()`.

   Figure 1: For each cell, plot the spikes one trial per row and sorted by conditions (similar to what you saw in the lecture). Why are there no spikes in some conditions and many in others?

2. **Plot PSTH/SDF.** Compute an estimate of the spike rate against time relative to stimulus onset. There are two options:
   a. Discretize time: Decide on a bin size, count the spikes in each bin and average across trials.
   b. Directly estimate the probability of spiking using a density estimator with specified kernel width.

   Implement one of them in the function `plotPsth()`.

   Figure 2: For each cell, plot the PSTH sorted by condition. Make sure you normalize properly so the unit on the y-axis is spikes per second.

3. **Optimal bin/kernel width.** Implement the method of Shimazaki & Shinomoto (2007, 2010) for choosing the optimal bin/kernel width for the condition with the most spikes.

   Figure 3: For each cell, plot the cost function as a function of bin width/kernel width.

   Figure 4: For each cell, plot the PSTH/SDF in this condition with the optimal width and compare to suboptimal choices.

4. **Linearity index.** Implement the function `linearityIndex()` to characterize the cells as either simple or complex cells. The stimulus frequency is 3.4 cyc/sec. To find the linearity index, you need to compute the power of the PSTH/SDF at this frequency (project on a complex exponential with frequency of 3.4 Hz). Use the condition with the most spikes.

   Figure 5: For each cell, plot the PSTH in the condition with the most spikes overlaying the best fitting sinusoid at the modulation frequency of the stimulus. Print the linearity index on the figure as well. Which cells are likely simple cells?