

Bio 450 Computational Neuroscience
Homework Due April 10, 2025

Total - 100 points

Part 1 - NMF

During the class, we explored how nonnegative matrix factorization can be used to identify regions of interest (neurons) in simulated data. Now let's try this on some real data. Use the script NMF_Murugan_realdata.m located in the below section on Canvas for the analysis.

Assignments>Calcium imaging + Place cells>Scripts. This field of view has ~30 neurons.

1. Run through the program as is. How well does the code do in pulling out individual neurons ? Why does the code perform better on simulated data versus real data ? **(10 points)**
2. Now instead of 100 repetitions, what would happen to the output if you were to do a 1000 repetitions. Explain ? **(10 points)**

Part 2 - Place cells

1. Observing the animal trajectory plot, are there places along the track where the animal spends more time? Where ? **(10 points)**
2. What is the overall shape of these sample place fields? Roughly how wide is a typical place field, in meters? Is the maximum firing rate the same for all 12 place fields? **(10 points)**
3. When you decode using the winner take all method, the red asterisks indicate the position derived from the model at each moment and the solid blue curve shows the actual trajectory of the rat. There are clearly some errors in the computed trajectory - why might these errors occur? **(10 points)**
4. Now decode trajectory using the MLE method. Repeat this analysis using time windows of 0.025 and 1.0 seconds. What are the advantages and disadvantages of choosing short and long time windows? Which of the three time windows works best for decoding? **(20 points)**
5. For each trial, during which periods of time does the recovery of the spatial trajectory based on the maximum likelihood estimate work best? **(10 points)**
6. Compare times when the animal is moving at low and high velocities, and when there are changes in the movement direction (this information can be extracted graphically from the trajectory plots). **(20 points)**