CoSMo 2013

Bayesian decoding of movement from neural firing rates

The goal of this assignment is to gain experience using Bayesian statistical methods, such as used for multi-sensory integration, optimal feedback control, Kalman filtering, etc. As an example, we will use neural spike rates from different neurons and apply a Bayesian decoder to infer movement direction.

Basic statistics

- Please download the data set and familiarize yourself with it. It contains firing rate data of 35 neurons over 205 trials (curtesy of Lee Miller and Jim Rebesco).
- Identify the firing rate distributions for each neuron (suppose they're Gaussian).
- Compute and plot the likelihoods for each neuron N: p(N|Left) and p(N|Right)
- Do the same for the posterior probabilities. How well do likelihood and posteriors code for movement direction? Hint: for the marginal, remember you have to sum over all options.

Population decoding: iterative Bayesian (=Kalman)

- Now combine the individual neurons posteriors. Here, previous decoding performance will act as a prior to the next iteration. Note, this is only correct if all observations are statistically independent, which we will assume here.
- How does the decoding performance depend on the number of neurons used for the decoder?
- How does the introduction of a prior change the decoding performance? How does the mean and SD of this prior change the interpretation of the neural code? How could this prior relate to real-life situations?