

Project #2: Neural Spike Decoding for Brain-Machine Interface

Overall Content

The data contains spike trains recorded from 98 neural units while the monkey reached 182 times along each of 8 different reaching angles, as well as the monkey's arm trajectory on each trial. On each trial, both the neural data and arm trajectory are taken from 300 ms before movement onset until 100 ms after movement end. There are 100 trials per reaching angle.

(1) .mat File

The .mat file has a single variable named `trial`, which is an array of dimensions 100(trials) x 8(reaching angles). The trial array contains 100*8 struct data structures which contain 3 fields: `trialId`, `spikes`, `handPos`. The first is the trial ID number and is therefore of little consequence. The latter two are arrays containing the neural data and the hand position traces respectively.

(2) Neural Data

The spike train data takes the form of a time-discretized sequence of zeros and ones with time steps of 1 ms. Each value in the array therefore takes the binary form 0/1 and represents the presence or absence of a spike in its neural unit in the 1 ms time window, or bin. A zero indicates that the unit did not spike in the 1 ms bin, whereas a one indicates that the unit spiked once in the 1 ms bin. Thus, a spike train of duration T ms is represented by a $1 \times T$ vector. The spike train recorded from the i^{th} unit on the n^{th} trial of the k^{th} reaching angle is accessed as: `trial(n,k).spikes(i,:)` where $i = 1, \dots, 98$, $n = 1, \dots, 100$, and $k = 1, \dots, 8$.

(3) Trajectory Data

In this task, the monkey reached to targets on a fronto-parallel screen. Most of the arm movement was in the plane of the screen along the horizontal directions: `handPos(1,:)` and `handPos(2,:)`. The movement perpendicular to the plane of the screen, `handPos(3,:)`, was relatively small. The three-dimensional arm trajectory recorded on the n^{th} trial of the k^{th} reaching angle is contained in `trial(n,k).handPos`, which is a $3 \times T$ matrix of the hand position (in mm) at each 1 ms time step. On each trial, the data in `spikes` and `handPos` are aligned in time. The indices $k = 1, \dots, 8$ correspond to the reaching angles ($30/180\pi$, $70/180\pi$, $110/180\pi$, $150/180\pi$, $190/180\pi$, $230/180\pi$, $310/180\pi$, $350/180\pi$) respectively. The reaching angles are not evenly spaced around the circle due to experimental constraints that are beyond the scope of this problem set.

Note: The neural data have been generously provided by the laboratory of Prof. Krishna Shenoy at Stanford University.