Project 2: Data Analysis

LGBIO2072

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1 Data structures

In this project you will work on actual data that was collected in three different labs to explore kinematic and electrophysiological signals including neural activity in monkey and surface recordings of muscles activity in human. The three tasks were planar reaching movements. You have access to the data in the `dataP2.zip` folder uploaded on moodle. This folder contains a script that you can run to extract three dictionaries organised as follows:

- `dictNeurons`: this dictionary contains 8 dictionaries with kinematic and neural data from reaching movements to eight different targets. For each target, there were 6 trials, and for each trial, the recorded data was shoulder and elbow angle, hand position, and cell activity. Data was sampled at 200Hz, and `'cells'` entry is a binary vector with ones when the neuron emitted a spike. To access this data, you can extract subdictionaries as follows:
  `di = dictNeurons['targeti'],    i = 1:8`.
  Then each `di` contains keys named `trial1` to `trial6`. These dictionaries correspond to the six movements performed towards the target number `i`. Thus if you follow the notation above and type:
  `dictNeurons['target1']['trial3']['shoang']`
  you will see the recorded shoulder angles for the third movement towards the first target.

- `dictMuscles`: this structure contains position, velocity, forces, and muscles activity. There were different types of trials, which are indexed in the matrix `extracted`. Each row of this matrix contains information about the trial with the same row from the other matrices. The type of trial is the third column of the matrix `extracted`. All trials with indices 1 correspond to normal trials. All trials with indices 2 and

3 correspond to trials during which the robot applied a lateral force proportional to forward hand velocity: $F_x = \pm 13\dot{y}$. The forces in this structure are the forces applied by participants' hand to the robotic handle, thus if the perturbation applied was positive ($F_x = 13\dot{y}$), the measured force was negative. In the matrix `extracted[:,0]`, you will see that all trials are separated in six series of 60 trials. It corresponds to what participants did. Within each series, the trial types 1, 2, and 3 were randomly interleaved. The sequence within each series of 60 can be retrieved using the second column. The muscle data for the two muscles (pectoralis and deltoid) were processed already and you can directly work with them.

- `dictAdaptation`: this structure contains x and y positions for 5 different participants and a `sequence` variable representing the order in which the trials were performed. For all these trials, the robot applied a lateral force proportional to forward hand velocity: $F_x = 13\dot{y}$. For each participant, you will see that you have 180 consecutive trials during which the participants were exposed to the force field. The applied force was therefore predictable.

2 Instructions

- For the neural data structure, you must calculate the firing rate and explore the relationship between the firing rate and the movement kinematics. Does the cell exhibit directional tuning? Is there a difference between hand coordinate and joint angles with respect to the cell's directional tuning?
- For the muscle data structure you must describe the relationship between EMG activity the other parameters (force and hand kinematics). For instance when a perturbation is applied (trial types 2 or 3), there is clear change in force and related EMG signals. What do you observe? How would you describe the time course of these signals?
- For the adaptation data, you must look at the behaviour of participants across trials. What do you observe? Do you see any sign of adaptation to the force field? How to represent this?
- Present your results in a report of maximum 6 pages, you can find the deadline on Moodle.