Abstract

Statistical learning and probabilistic inference techniques are used to infer the hand position of a subject from multi-electrode recordings of neural activity in motor cortex. First, an array of electrodes provides training data of neural firing conditioned on hand kinematics. We learn a non-parametric representation of this firing activity using a Bayesian model and rigorously compare it with previous models using cross-validation. Second, we infer a posterior probability distribution over hand motion conditioned on a sequence of neural test data using Bayesian inference. The learned firing models of multiple cells are used to define a non-Gaussian likelihood term which is combined with a prior probability for the kinematics. A particle filtering method is used to represent, update, and propagate the posterior distribution over time. The approach is compared with traditional linear filtering methods; the results suggest that it may be appropriate for neural prosthetic applications.

1 Introduction

This paper explores the use of statistical learning methods and probabilistic inference techniques for modeling the relationship between the motion of a monkey’s arm and neural activity in motor cortex. Our goals are threefold: (i) to investigate the nature of encoding in motor cortex, (ii) to characterize the probabilistic relationship between arm kinematics (hand position or velocity) and activity of a simultaneously recorded neural population, and (iii) to optimally reconstruct (decode) hand trajectory from population activity to smoothly control a prosthetic robot arm (cf [14]).

A multi-electrode array (Figure 1) is used to simultaneously record the activity of 24 neurons in the arm area of primary motor cortex (MI) in awake, behaving, macaque monkeys. This activity is recorded while the monkeys manually track a smoothly and randomly mov-