Print this Page

Neuroscience 2013

Presentation Abstract

Program#/Poster#: 750.07/XX9

Presentation Title: Dimensionality in the motor cortical substrate for reaching

Location: Halls B-H

Presentation time: Wednesday, Nov 13, 2013, 10:00 AM -11:00 AM

Authors: ***E. TRAUTMANN**[1], P. GAO[2], J. FAN[2], J. KAO[2], S. STAVISKY[2], P. NUYUJUKIAN[2], B. YU[3], G. SANTHANAM[2], S. RYU[2], S. GANGULI[2], K. SHENOY[2];
[1]Stanford Neurosciences, Palo Alto, CA; [2]Stanford Univ., Stanford, CA;
[3]Carnegie Mellon Univ., Pittsburg, PA

Abstract: Understanding how behavior emerges from populations of neurons constitutes a fundamental question in neuroscience. To gain insight into population dynamics, dimensionality reduction methods such as PCA and GPFA are often applied, yielding an effective dimensionality that is often smaller than the number of recorded neurons (Yu et al. 2009). This finding motivates a deeper investigation into what determines the dimensionality of neuronal activity, and whether experimentalists can be confident that they are recording enough neurons, for enough time, to capture the full behaviorally relevant richness of a system's dynamics. We recently proposed a theoretical upper bound on measured dimensionality (Gao et al. COSYNE 2013), which depends not only on the dynamics of the system, but also increases with complexity of the behavioral task and the measurement duration. We support this theory using two sets of experimental data from M1 and PMd of macaques performing reaching tasks: one consisting of short segmented reaches, and one of continuous reaching spanning several minutes.
We find for short trials, the measured dimensionality of this dataset nearly achieves the theoretical upper bound, suggesting that motor cortical activity is not necessarily low dimensional, but perhaps as high dimensional as possible given constraints imposed by the network and task. The first dataset consists of 109

simultaneously recorded neurons from monkey H, performing an eight direction delayed reach task. Our calculated bound is 30, far lower than the number of neurons. We further explored how the data achieves such high dimensionality: we find that most neurons in this dataset exhibit a sharp, monophasic activity peak during movement, whose timing, but not amplitude, is consistent across reach directions. This sparse wave of neural activity occupies different dimensions at different points in time, causing the total explored dimensionality to increase with time.

We next ask whether the measured dimensionality increases for longer and more complex behaviors. The second dataset consists of multi-unit activity from 192 channels in PMd and M1 in monkey J during a continuous reaching task with targets appearing sequentially at random locations. We use PCA to determine the number of dimensions required to explain 90% of variance for different length subsets of data, and find that dimensionality continues increasing up to ~100 seconds, exceeding the dimensionality for shorter tasks.

Overall, this work suggests new ways to think about the dimensionality of neural data, and provides guidance for the design of experiments whose goal is to probe the complexity of neuronal population dynamics.

Disclosures: **E. Trautmann:** None. **P. Gao:** None. **J. fan:** None. **J. Kao:** None. **S. Stavisky:** None. **P. Nuyujukian:** None. **B. Yu:** None. **G. Santhanam:** None. **S. Ryu:** None. **S. Ganguli:** None. **K. Shenoy:** None.

Keyword(s): MOTOR CORTEX

PREMOTOR

SIMULATION

Support: NIH Director's Pioneer Award

DARPA REPAIR

NIH TR01