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Extracting Dynamical Structure Embedded in Motor Preparatory Activity

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Spiking activity from neurophysiological experiments often exhibits dynamics beyond that driven by external stimulation, presumably reflecting the extensive recurrence of neural circuitry. Characterizing these dynamics may reveal important features of neural computation, particularly during internally-driven cognitive operations. For example, the activity of premotor cortex (PMd) neurons during an instructed delay period separating movement-target specification and a movement initiation cue is believed to be involved in motor planning. Current methods to characterize recurrent neural dynamics on a trial-by-trial basis are limited. Standard methods average activity from different trials or different cells, and so cannot express variable dynamics. Our goal is to test the hypothesis that the dynamics underlying this activity can be captured by a low dimensional non-linear dynamical systems model, with underlying recurrent structure and stochastic point-process output. Here, we present and validate initial latent variable modeling methods that simultaneously estimate system parameters, and extract trial-by-trial dynamical trajectories, from PMd data recorded from a chronically-implanted 96-electrode array while monkeys performed delayed-reach tasks. Moving forward, our goal is to use such single trial estimates of underlying dynamics to predict variation in details of reaching motor behavior.

Project (or PI) Website

<http://www.stanford.edu/~shenoy/Group.htm>

<http://www.gatsby.ucl.ac.uk/~maneesh/>

Publications

1. Yu, BM, Kemere C, Santhanam G, Afshar A, Ryu SI, Meng TH, Sahani M, Shenoy KV (2006, in submission). Mixture of trajectory models for neural decoding of goal-directed movements. *Journal of Neurophysiology*.
2. Yu BM, Shenoy KV, Sahani M (2006, in submission) Expectation Propagation for Inference in Non-linear Dynamical Models with Poisson Observations. *Nonlinear Statistical Signal Processing Workshop 2006*.

3. Yu BM, Afshar A, Santhanam G, Ryu SI, Shenoy KV, Sahani M. Extracting dynamical structure embedded in neural activity. In Y. Weiss, B. Schölkopf, and J. Platt, eds., *Advances in Neural Information Processing Systems 18*, Cambridge, MA, 2006. MIT Press.
4. Yu BM, Kemere C, Santhanam G, Afshar A, Ryu SI, Meng TH, Sahani M, Shenoy KV (2005) Mixture of trajectory models for neural decoding of goal-directed movements. Program No. 520.18. *2005 Abstract Viewer/Itinerary Planner*. Washington, DC: Society for Neuroscience.
5. Sahani M, Yu BM, Afshar G, Santhanam G, Ryu SI, Shenoy KV (2005) Extracting dynamical structure embedded in neural activity. Program No. 689.14. *2005 Abstract Viewer/Itinerary Planner*. Washington, DC: Society for Neuroscience.