



Seminar/Talk

Theoretical and computational approaches to neuroscience with complex models in high dimensions across multiple timescales: from perception to motor control and learning

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Host: Andrew Saxe

Remarkable advances in experimental neuroscience now enable us to simultaneously observe the activity of many neurons, thereby providing an opportunity to understand how the moment by moment collective dynamics of the brain instantiates learning and cognition. However, efficiently extracting such a conceptual understanding from large, high dimensional neural datasets requires concomitant advances in theoretically driven experimental design, data analysis, and neural circuit modeling. We will discuss how the modern frameworks of high dimensional statistics and deep learning can aid us in this process. In particular we will discuss: (1) how unsupervised tensor component analysis and time warping can extract unbiased and interpretable descriptions of how rapid single trial circuit dynamics change slowly over many trials to mediate learning; (2) how to tradeoff very different experimental resources, like numbers of recorded neurons and trials to accurately discover the structure of collective dynamics and information in the brain, even without spike sorting; (3) deep learning models that accurately capture the retina's response to natural scenes as well as its internal structure and function; (4) algorithmic approaches for simplifying deep network models of perception; (5) optimality approaches to explain cell-type diversity in the first steps of vision in the retina. Papers: A.H. Williams, T.H. Kim, F. Wang, S. Vyas, S.I. Ryu, K.V. Shenoy, M.J. Schnitzer, T.G. Kolda, and S. Ganguli, Unsupervised discovery of demixed, low-dimensional neural dynamics across multiple timescales through tensor components analysis, *Neuron* 2018. J. Kadmon and S. Ganguli, Statistical mechanics of low-rank tensor decomposition, *Neural Information Processing Systems (NeurIPS) 2018*. A. Williams, B. Poole, N. Maheswaranathan, A. Dhawale, T. Fisher, C. Wilson, D. Brann, E. Trautmann, S. Ryu, R. Shusterman, D. Rinberg, B. Iveczky, K. Shenoy, S. Ganguli, Discovering precise temporal patterns in large-scale neural recordings through robust and interpretable time warping, *Neuron*, 2019. O.I. Rummyantsev, J.A. Lecoq, J.C. Savall, H. Zeng, S. Ganguli, M.J. Schnitzer, Fundamental limits of information encoding by sensory cortical neural ensembles, *Nature* 2020. E.M. Trautmann, S. Lahiri, S.D. Stavisky, K.C. Ames, M.T. Kaufman, S.I. Ryu, S. Ganguli, and K.V. Shenoy, Accurate estimation of neural population dynamics without spike sorting, *Neuron*, 2019. L.

McIntosh, N. Maheswaranathan, S. Ganguli, S. Baccus, Deep learning models of the retinal response to natural scenes, Neural Information Processing Systems (NIPS) 2016. L. McIntosh, N. Maheswaranathan, S. Ganguli, S. Baccus, Deep learning models reveal internal structure and diverse computations in the retina under natural scenes, www.biorxiv.org/content/early/2018/06/08/340943. H. Tanaka, A. Nayebi, N. Maheswaranathan, L.M. McIntosh, S. Baccus, S. Ganguli, From deep learning to mechanistic understanding in neuroscience: the structure of retinal prediction, NeurIPS 2019. S. Deny, J. Lindsey, S. Ganguli, S. Ocko, The emergence of multiple retinal cell types through efficient coding of natural movies, Neural Information Processing Systems (NeurIPS) 2018.

Friday, October 16, 2020 03:00pm - 04:00pm

Online Talk crowdcast



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