UNIVERSITY of HOUSTON | ENGINEERING

Department of Biomedical Engineering

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Date	Friday August 30, 2024
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Latent Variable Modeling for Decoding Cognitive States from Behavioral and Physiological Data

Abstract: In this talk, I will present two distinct modeling frameworks built upon the latent variable model to infer underlying mental or cognitive states from high-dimensional neural recordings, behavioral data (including reaction time and decision-making), and physiological data (such as skin conductance and heartbeat). The first model characterizes the connection between neural and behavioral data through latent dynamical variables representing the underlying cognitive states. I will then showcase an application of this framework by inferring the underlying cognitive flexibility during a multi-source inference task and demonstrate how this inference can guide the control policy of deep brain stimulation. The second model integrates Gaussian Processes (GPs) with latent variables to generate a low-dimensional manifold capturing essential neural features. This model simultaneously encodes neural data, categorical stimulus, and physiological data into a shared latent space. This shared latent variable can then decode any of these information types from the neural data. I will show an application of this framework by predicting stimulus categories in a Verbal Memory task, where its prediction accuracy outperforms state-of-the-art decoder models. The promising performance of both models underscores the significance of well-crafted machine learning techniques in decoding brain function, which has wide-ranging applications in both clinical and basic neuroscience.

Ali Yousefi is an Associate Professor at the UH Biomedical Engineering department. Previously, he was an Assistant Professor at WPI. He earned his M.S. in Electrical Engineering from Sharif University of Technology in 2000 and a Ph.D. in Electrical and Computer Engineering from USC in 2014. He completed postdoctoral training in computational and statistical neuroscience at Mayo Clinic, Harvard Medical School, and Boston University. His research develops statistical methods to analyze neuroscience data, linking neural activity with biological and behavioral signals. He focuses on creating frameworks for statistical estimation, signal processing, Bayesian analysis, and stochastic control to model and understand neural systems.