The Center for Control, Dynamical Systems, and Computation
University of California at Santa Barbara
Spring 2009 Seminar Series
Presents

Dynamics of Correlation and Coding in Simple Neural Circuits

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Abstract:

Correlations among neural spike times are ubiquitous, and questions of how these correlations develop, and of the impact they have on the neural code, are central in neuroscience. Their analysis also poses rich applied mathematics problems. We address two of the most basic ones here. First, we ask: How do correlations among different neurons depend on the cells' operating range -- their rate and regularity of spiking? We use both linear response calculations and in vitro experiments to show that correlations between pairs of neurons vary sharply with their firing rates, almost universally. We illustrate the consequences via Fisher information, which quantifies the accuracy of encoding. Next, we ask: How do correlations among different trials depend on architecture of neural circuits? (Here, the same stimulus is received by the circuit on each 'trial.') We take a first step toward the answer by identifying a surprising role for some, but not all, feedback connections in creating unreliable (and hence decorrelated) responses, a phenomenon which we quantify via Lyapunov exponents. This is joint work with Jaime de la Rocha, Brent Doiron, Kreso Josic, Kevin Lin, Alex Reyes, and Lai-Sang Young.

About the Speaker:

Eric Shea-Brown, Assistant Professor of Applied Mathematics, University of Washington. My interests span a wide set of topics in computational neuroscience and biological dynamics. Current and recent projects focus on optimal signal processing and decision making in simple neural networks, the dynamics of neural populations in interval timing tasks, correlations and reliability in simple neural circuits, and properties of oscillator networks with generalized symmetries. This work is supported by the Burroughs-Wellcome Fund (BWF) Scientific Interfaces Program and the NSF.

Before coming to UW, I was a postdoctoral fellow in mathematical neuroscience at NYU's Courant Institute and Center for Neural Science with John Rinzel as my mentor. In 2004, I completed my Ph.D in Princeton's Program in Applied and Computational Mathematics, working with Phil Holmes and Jonathan Cohen.