

Seminario Conjunto Núcleo MESCD/ Modelamiento Escolástico

Primera sesión:

15:30-16:30 hrs

Expositor:

Rodrigo Cofré (CIMFAV Universidad de Valparaíso)

Título:

Collective behavior of spiking neuronal networks and other biological systems inferred from the Maximum Entropy Principle.

Abstract:

Our sensations, thoughts, and memories emerge from interactions among many neurons. Physicists have long hoped that the emergent collective activity of populations of neurons could be described using the ideas and methods of statistical mechanics. Among the many ideas rooted in statistical physics that have been suggested to characterize the collective activity in the brain, perhaps the most intriguing is the idea of self-organized criticality [1]. While it is still unclear which biological mechanisms are behind the collective behavior, the idea that biological systems poise themselves at or near a critical point remains tantalizing. In the past few years, new experimental techniques have made it possible to build statistical mechanics models of biological systems directly from experimental recordings, allowing researchers to determine whether these ideas work in their models. In this talk, I will review the surprising successes of the maximum entropy approach in the field of spike train statistics [2,3,4] and some progress we have made to generalize and better characterize results obtained from this approach. In particular, I will discuss the surprising fact that the statistical models that emerge from the experimental spike train statistics seem to be poised at a critical point in their parameter space [5], which suggests that there may be some deeper theoretical principle behind this collective behavior [1].

- [1] T. Mora and W. Bialek, Are biological systems poised at criticality?, J. Stat. Phys, 144(2), 2011.
- [2] E. Schneidman, M.J. Berry II, and R. Segev and W. Bialek, Weak pairwise correlations imply strong correlated network states in a neural population, Nature, 440, 2006.
- [3] R. Cofré and C. Maldonado, Information Entropy Production of Maximum Entropy Markov Chains from Spike Trains, Entropy 20(34), 2018.
- [4] R. Cofré and C. Maldonado, F. Rosas, Large Deviations Properties of Maximum Entropy Markov Chains from Spike Trains, Entropy 20(8), 573, 2018.
- [5] I. Mastromatteo and M. Marsili, On the criticality of inferred models, Journal of Statistical Mechanics: Theory and Experiment, 2011.

Segunda sesión
16:30-17:30

Expositor:

Hector Olivero (CIMFAV Universidad de Valparaiso)

Título:

Synchronization of stochastic mean field networks of Hodgkin-Huxley neurons with noisy channels.

Abstract:

In this work we are interested in a mathematical model for the collective behavior of a fully connected network of finitely many neurons when their number or when time go to infinity. We assume that every neuron follows a stochastic version of the Hodgkin-Huxley model, and that pairs of neurons interact through both electrical and chemical synapses, the global connectivity being of mean field type. When the leak conductance is strictly positive, we prove that if the initial voltages are uniformly bounded and if the electrical interaction between neurons is strong enough, then, uniformly in the number of neurons, the whole system synchronizes exponentially fast as time goes to infinity, up to some error controlled by (and vanishing with) the channels noise level. Moreover, we prove that if the random initial condition is exchangeable, on every bounded time interval the propagation of chaos property for this system holds (regardless of the interaction intensities). Combining these results, we deduce that the nonlinear McKean-Vlasov equation describing an infinite network of such neurons concentrates, as times goes to infinity, around the dynamics of a single Hodgkin-Huxley neuron with neurotransmitter channels. Our results are illustrated and complemented with numerical simulations. Joint work with Mireille Bossy and Joaquín Fontbona.

Martes 27 de Noviembre a contar de las 15:30 hrs, en la sala de Seminarios John Von Neumann CMM, Beauchef 851, Torre Norte, Piso 7.