Topology Reconstruction of Integrate-and-Fire Neuronal Networks

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Current experimental techniques usually cannot probe the global interconnection pattern of a network. Thus, reconstructing or reverse-engineering the network topology based upon observed data has become a very active research area. Most existing reconstruction methods are based on networks of oscillators with generally smooth dynamics. However, for nonlinear and non-smooth stochastic dynamical systems, such as widely used conductance-based integrate-and-fire (I&F) neuronal networks, the reconstruction of the full topology remains a theoretical challenge. In this talk, I will first give a brief review of I&F network dynamics and illustrations of our mathematical approaches to the study of such systems, then I will present our mathematical framework to establish a direct connection between Granger causal connectivity and structural connectivity of neuronal networks. Finally, I will discuss important mathematical issues in applications of Granger causality analysis.