Poster

Collective Dynamics in an Ensemble of Excitable and Self-oscillatory Neurons: The Role of Higher-order Interactions

Soorya P. P.

Department of Physics, Amrita School of Physical Sciences, Amrita Vishwa Vidyapeetham, Coimbatore, Tamil Nadu, India

We examine the collective dynamics of a network comprising excitable and self-oscillatory Izhikevich neurons influenced by higher-order interactions. Specifically, we focus on a two-dimensional simplicial complex and analyze how the dynamics evolve as the fraction of inherently excitable units increases. Our study uncovers a range of emergent behaviors driven by the interplay of 1st-order and 2nd-order interaction strengths, the fraction of excitable neurons, and the nature of coupling functions. Three distinct collective dynamics are observed: inhomogeneous steady states, spiking, and bursting. During spiking and bursting phases, cluster synchronization occurs between excitable and self-oscillatory neurons. As the proportion of excitable neurons crosses a critical threshold, the network ceases all firing activity due to insufficient stimuli to generate spikes. This leads to a phase transition in the network, is referred to as the aging transition. We further investigate the bifurcation behavior of the reduced model to gain insights into the underlying mechanism of the aging transition.