Synchronization phenomena in networks of spiking neurons with a correlated scale-free topology

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The topology of neural networks has been found recently to be relevant in different computational and storage performance tasks, as well as in their robustness under the effect of noise [1]. We consider here some network scale-free topologies that could be characterized by the non trivial correlations between the degrees of a node and those of their neighbors, i.e the assortativity. This feature has been observed to be determinant in the dynamic of different empirical networks [2]. If the average nodes degree-degree correlation is positive the network is said to be assortative, while it is called disassortative if negatively correlated. We consider here a population of leaky Integrate and Fire (LIF) neurons and analyze theoretically and with numerical simulations the different synchronous and asynchronous phases that emerge. In our study we have observed that the heterogeneity of the topology induces the emergence of a completely asynchronous phase, with a distribution of typical frequencies, dependent on the degree of the neurons, as well as a "mixture" phase, where only a subpopulation of neurons, having a degree within certain range, fires synchronously. In addition, the level of assortativity influences the robustness of the different phases under variation of stimulation parameters. Global and partial synchronization are enhanced by networks with assortative configurations, in which a certain level of homogeneity is guaranteed, at least locally.

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