The Role of Hubs and Authorities Nodes on the Onset of Synchronization in a Neural Network

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Complex networks have modeled neuronal systems in different description levels. Due to central embedding in the network, high-degree hub regions and their connections facilitate intermodular neural communication and global information integration by means of synchronization [1]. Here, we examined the role of hubs and authorities nodes in a network's brain dynamics, considering the connectivity matrix based on the cat cerebral cortex [2,3]. The cerebral cortex of the cat is separated into 53 cortical, interconnected by 826 directed edges, representing the fibers of the axons. The cortical areas are organized into four cognitive regions: visual, auditory, somatosensory-motor, and frontolimbic. The Kuramoto model was used to simulate the interaction of cortical brain areas through coupled phase oscillators—with anatomical connections between regions. We classify the most influential hubs and authorities nodes by analyzing the Hypertext Induced Topic Search (HITS) algorithm, and we compare the results to the classical Shannon Entropy. Regarding the dynamics and measures of global, mesoscopic, and microscopic synchrony, results were obtained for a scenario comparing the original network and others scenarios, in which it was considered a reduction in the intensity of connections of a group containing random nodes and the group with nodes chosen by the HITS algorithm. The reduction in the connections of a group of nodes chosen by the HITS algorithm considerably delayed the network's global, microscopic, and mesoscopic synchronization levels. Our results help us understand how synchronization flows through the network nodes.

References

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