Robustness of self-sustained oscillations in complex networks

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Complex networks of excitable nodes represent a thriving field of research with many applications, among which we can find neural networks. Under certain conditions, i.e., small world connections, the network can exhibit a self-sustained network oscillatory behavior, without external stimulus. It is known[1] that in order for this oscillations to occur, the excitation must travel through a loop, whose length must be compatible with the refractory period of the excitable cells. We study a directed graph with nearest neighbor connections and a fraction q of the edges being small world. The excitation mechanism of each cell consists of a cellular automaton with variable excitation time scales. In particular, we want to understand how a net with a stationary oscillating pattern reacts to the removal of nodes, and the robustness of these oscillations.

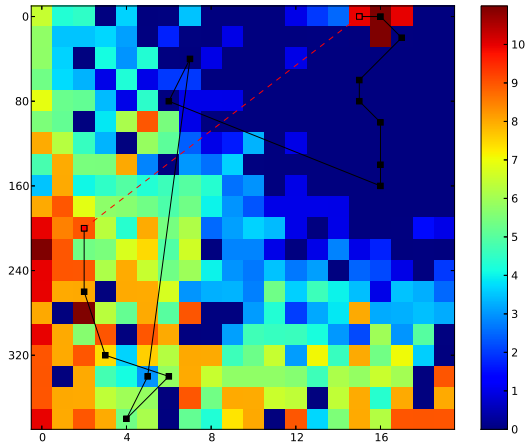

FIG. 1. Example of oscillation in a 20×20 network. States above 6 are excited, below are refractory and 0 is the resting state. The small squares joined by lines display the nodes of the loop that causes the oscillation. There is a long range connection (red dashed line) that sends the excitation back to the unexcited area in the top right corner, triggering thus a new target wave.

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[1] Xuhong Liao, Qinzhi Xia, Yu Qian, Lisheng Zhang, Gang Hu, and Yuanyuan Mi *Pattern formation in oscillatory complex networks consisting of excitable nodes* Physical review E 83, 056204 (2011)