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Synchronization and amplification in long-range interacting neuromorphic networks

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Neuromorphic networks are the basic ingredients to let intelligent abilities emerge from an artificial hardware composed by connected spiking neurons. These systems can be described in terms of coarse-grained interacting units, and still some interesting behaviors spontaneously arise. It has been recently found that a directed linear chain of connected patch of neurons amplifies an input signal, also tuning its characteristic frequency. Here we study a generalization of such a simple model, introducing heterogeneity and variability in the parameter space and long-range interactions, breaking, in turn, the preferential direction of information transmission of a directed chain. On one hand, enlarging the region of parameters leads to more complicated conditions to let the amplification settled in; moreover, it becomes possible to have a given frequency distribution tuning the non-local interactions of each node. On the other hand, adding long-range interactions can cause the onset of novel phenomena, as coherent and synchronous oscillations among all the interacting units, which can also coexist with the amplification of the signal. The interplay between these two cooperative features lay the foundations for the understanding of the core ingredients needed to have a robust and coherent transmission of an input signal. In the light of the observations in biological neural networks on the role of amplification, synchronization and phase-locking, reproducing similar behaviors on neuromorphic systems could help in engineering hardwares which perform more complex computational tasks.

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