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Synchronized chaos in networks of simple units

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We study synchronization of non-diffusively coupled map networks with arbitrary network topologies, where the connections between different units are, in general, not symmetric and can carry both positive and negative weights. We show that, in contrast to diffusively coupled networks, the synchronous behavior of a non-diffusively coupled network can be dramatically different from the behavior of its constituent units. In particular, we show that chaos can emerge as synchronized behavior although the dynamics of individual units are very simple. Conversely, individually chaotic units can display simple behavior when the network synchronizes. We give a synchronization criterion that depends on the spectrum of the generalized graph Laplacian, as well as the dynamical properties of the individual units and the interaction function. This general result will be applied to coupled systems of tent and logistic maps and to two models of neuronal dynamics. Our approach yields an analytical understanding of how simple model neurons can produce complex collective behavior through the coordination of their actions.

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