Title:	Multiple-node basin stability in complex dynamical networks
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Abstract:	Dynamical entities interacting with each other on complex networks often exhibit multistability. The stability of a desired steady regime (e.g., a synchronized state) to large perturbations is critical in the operation of many real-world networked dynamical systems such as ecosystems, power grids, the human brain, etc. This necessitates the development of appropriate quantifiers of stability of multiple stable states of such systems. Motivated by the concept of basin stability (BS) [P. J. Menck et al., Nat. Phys. 9, 89 (2013)], we propose here the general framework of multiple-node basin stability for gauging the global stability and robustness of networked dynamical systems in response to nonlocal perturbations simultaneously affecting multiple nodes of a system. The framework of multiple-node BS provides an estimate of the critical number of nodes that, when simultaneously perturbed, significantly reduce the capacity of the system to return to the desired stable state. Further, this methodology can be applied to estimate the minimum number of nodes of the network to be controlled or safeguarded from external perturbations to ensure proper operation of the system. Multiple-node BS can also be utilized for probing the influence of spatially localized perturbations or targeted attacks to specific parts of a network. We demonstrate the potential of multiple-node BS in assessing the stability of the synchronized state in a deterministic scale-free network of Rössler oscillators and a conceptual model of the power grid of the United Kingdom with second-order Kuramoto-type nodal dynamics.
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