The observability radius of network systems

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Abstract: We will introduce the observability radius of network systems, which measures the robustness of a network to perturbations of the edges. We consider linear networks, where the dynamics are described by a weighted adjacency matrix, and dedicated sensors are positioned at a subset of nodes. We allow for perturbations of certain edge weights, with the objective of preventing observability of some modes of the network dynamics. Our work considers perturbations with a desired sparsity structure, thus extending the classic literature on the controllability and observability radius of linear systems. The paper proposes two sets of results. First, we propose an optimization framework to determine a perturbation with smallest Frobenius norm that renders a desired mode unobservable from the existing sensor nodes. Second, we study the expected observability radius of random networks with given structure. In this context, we provide fundamental robustness bounds dependent on the connectivity properties of the network, and we analytically characterize optimal perturbations of line and star networks, showing that line networks are inherently more robust than star networks. To conclude (if time permits), we illustrate the use of our results to study a novel class of topology attacks against power networks. Joint work with G. Bianchin, A. Gasparri, F. Pasqualetti.