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Impact of topology on directed network dynamics

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Abstract: Many social, technological, and biological systems with asymmetric interactions display a variety of collective phenomena, such as opinion formation and synchronization. This has motivated much research on the dynamical impact of local and mesoscopic structure in directed networks. However, the constraints imposed by the global organization of directed networks remain largely undiscussed. Here, we control the global organization of directed Erd˝os–Rényi networks, and study its impact on the emergence of synchronization and ferromagnetic ordering, using Kuramoto and Ising dynamics. In doing so, we demonstrate that source nodes – peripheral nodes without incoming links – can disrupt or entirely suppress the emergence of collective states in directed networks. This effect is imposed by the bow-tie organization of directed networks, where a large connected core does not uniquely ensure the emergence of collective states, as it does for undirected networks

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