# Controllability and observability in complex dynamical networks

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Dynamical networks can be used to model almost any large-scale complex system where nodes represent functional units and their interconnections as links. The main indicator of the effectiveness of a model is our capacity to control their behavior to impose a desired behavior on the complex system. In control theory, controllability implies that for a given system there is a set of inputs that drive the system to a desired target behavior, while its dual concept, observability, refers to the existence of a set of outputs from which one can determine the current state of the system. In dynamical networks the controllability and observability depend on both aspects: the dynamics of the nodes and the structure of their interconnections. In the simplest case, where the nodes are identical linear systems with linear static connections, controllability can be determined using the well-known Kalman rank criterion. However, for more complex cases where the nodes are nonlinear or the connections change with time, for example, alternative approaches are needed. In a previous publication, we addressed the case of linearly coupled nonidentical linear nodes and showed that controllability is dominated by dynamical components, where even in the case of structurally uncontrollable networks of different nodes the network becomes controllable if the dynamics of its nodes are properly chosen. Conversely, a structurally controllable network becomes uncontrollable due to a given choice of the node's dynamics. In this research proposal, these ideas are extended to consider nonlinear nodes and the case of evolving connection structure.

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