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Controllability of Complex Networks YANG LIU, Northeastern University, JEAN-JACQUES SLOTINE, Massachusetts Institute of Technology, ALBERT-LASZLO BARABASI, Northeastern University — The ultimate proof of our understanding of natural or technological systems is reflected in our ability to control them. While control theory offers mathematical tools to steer engineered systems towards a desired state, we lack a general framework to control complex self-organized systems, like the regulatory network of a cell or the Internet. Here we develop analytical tools to study the controllability of an arbitrary complex directed network, identifying the set of driver nodes whose time-dependent control can guide the system's dynamics. We apply these tools to real and model networks, finding that sparse inhomogeneous networks, which emerge in many real complex systems, are the most difficult to control. In contrast, dense and homogeneous networks can be controlled via a few driver nodes. Counterintuitively, we find that in both model and real systems the driver nodes tend to avoid the hubs. We show that the robustness of control to link failure is determined by a core percolation problem, helping us understand why many complex systems are relatively insensitive to link deletion. The developed approach offers a framework to address the controllability of an arbitrary network, representing a key step towards the eventual control of complex systems.

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