ABSTRACT: Controllability of complex network systems is an active area of research at the intersection of network science, control theory, and multi-agent coordination, with multiple applications ranging from brain dynamics to the smart grid and cyber-physical systems. The basic question is to understand to what extent the dynamic behavior of the entire network can be shaped by changing the states of some of its subsystems, and decipher the role that network structure plays in achieving this. This talk examines this question in two specific instances: characterizing network controllability when control nodes can be scheduled over a time horizon and hierarchical selective recruitment in brain networks. Regarding controllability, we show how time-varying control schedules can significantly enhance network controllability over fixed ones, especially when applied to large networks. Through the analysis of a novel scale-dependent notion of nodal centrality, we show that optimal time-varying scheduling involves the actuation of the most central nodes at appropriate spatial scales. Regarding hierarchical selective recruitment, we examine network mechanisms for selective inhibition and top-down recruitment of subnetworks under linear-threshold dynamics. Motivated by the study of goal-driven selective attention in neuroscience, we build on the characterization of key network dynamical properties to enable, through either feedforward or feedback control, the targeted inhibition of task-irrelevant subnetworks and the top-down recruitment of task-relevant ones. Our results allow us to draw interesting interpretations on the role played by timescale separation, the structure of intra- and inter-connections among network layers, and the selective activity of task-irrelevant and task-relevant subnetworks in the brain.

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