Control of a network refers to the possibility of designing localized interventions to enforce a chosen configuration and to promote a desirable global behavior. Most real-world networks in social, biological and technological domains exhibit complex topological features and dynamics, and it remains an outstanding problem to characterize to what extent these networks can be reprogrammed by few control nodes, and what topological features are most relevant for controllability

The control problem of complex networks consists of the selection of a set of control nodes, and the design of a control law to steer the network to a target state. For this problem (i) we propose a metric to quantify the difficulty of the control problem as a function of the required control energy, (ii) we derive bounds based on the system dynamics (network topology and weights) to characterize the tradeoff between the control energy and the number of control nodes, and (iii) we propose an open-loop control strategy with performance guarantees. In our strategy we select control nodes by relying on network partitioning, and we design the control input by leveraging optimal and distributed control techniques. Our findings show several control limitations and properties. For instance, for Schur stable and symmetric networks: (i) if the number of control nodes is constant, then the control energy increases exponentially with the number of network nodes, (ii) if the number of control nodes is a fixed fraction of the network nodes, then certain networks can be controlled with constant energy independently of the network dimension, and (iii) clustered networks may be easier to control because, for sufficiently many control nodes, the control energy depends only on the controllability properties of the clusters and on their coupling strength.