ANDREA LIU, University of Pennsylvania
Tuning functional networks

Nature is rife with networks that are functionally optimized to propagate inputs in order to perform specific tasks. Whether via genetic evolution or dynamic adaptation, many networks create functionality by locally tuning interactions between nodes. Here we explore this behavior in two contexts: strain propagation in mechanical networks and pressure redistribution in flow networks. By adding and removing links, we are able to optimize both types of networks to perform specific functions. We define a single function as a tuned response of a single "target" link when another, predetermined part of the network is activated. Using network structures generated via such optimization, we investigate how many simultaneous functions such networks can be programmed to fulfill. We find that both flow and mechanical networks display qualitatively similar phase transitions in the number of targets that can be tuned, along with the same robust finite size scaling behavior. We discuss how these properties can be understood in the context of a new class of constraint-satisfaction problems. We also show how persistent homology reveals topological changes that enable functionality.