Convergence of contracting networks towards an asymptotic maximum-entropy structure

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Complex networks encountered in biology, ecology, sociology and technology often contract due to node failures, infections or attacks. The ultimate failure, taking place when the network fragments into disconnected components was studied extensively using percolation theory. We show that long before reaching fragmentation, contracting networks lose their distinctive features. In particular, we identify that a very large class of network structures, which experience a broad class of node deletion processes, exhibit a stable flow towards universal fixed points, representing a maximum-entropy ensemble, which in the pure contraction scenario is the Erdos-Renyi ensemble. Under more general combination of growth and deletion processes of such networks the resulting degree distribution is Poisson-like. This is in sharp contrast to network growth processes that often lead to scale-free networks. It also implies that contracting networks in the late stages of node failure cascades, attacks and epidemics reach a common structure, providing a unifying framework for their analysis.