Commentaries on Albert-László Barabási's books

Networks101Link9.1 Achilles' Heel ©frederick david abraham, 12 May 2013

As free-scale networks grow, and clusters start to form, at some point links, even a single link, between large clusters, cause a sudden bifurcation to a giant component which incorporates a significant portion of all the nodes [See Barabàsi, end note for p. 112 on p. 260 on percolation theory.] This chapter is more concerned with the reverse of this bifurcation sequence. What happens when nodes are removed either endogenous, spontaneous deletion or errors, or exogenously as by a malicious attack? Normally, not much (Albert, Jeong, & Barabàsi, 2000). The internet, ecosystems, genetic-biochemical systems all exhibit ***topological robustness*** which can, in part, depend on the redundancy of a dense network. This is true of random as well as scale-free networks. It may take a smaller fraction of nodes being knocked out for the scale-free compared to the random networks. But why the robustness for the scale-free situation? If nodes are deleted randomly, since there are few large hubs compared to the total number of nodes, mostly smaller, less influential nodes will be hit. Thus attacks on a net usually create fairly local damage. But if the attacks are directed at the largest hubs, the network can collapse (implosive bifurcation). Thus scale-free networks display a "coexistence of robustness and vulnerability . . .ecosystems can easily survive random species deletions" but not deletions of key hubs of high degree. (p. 118; Solé & Montoya, 2000)

There is an interesting end note (for p. 111 on p. 260) on redundancy in natural versus human made systems providing for alternative (redundant) pathways in a biodiverse ecology which relates to a discussion on evolutionary paleontology and complexity at Google Group Chaopsych, (see Abraham, Hoppe, & Koehler, https://groups.google.com/forum/#!topic/chaopsych/tMeS69roIDc.

Albert, R, Jeong, H, & Barabàsi, A-L (2000). Attack and error tolerance of complex networks. *Nature*, *406*, 378.

Solé, R, & Montoya, JM (2000). Compexity and fragility in ecological networks. Cornell University Library, http://xxx.lanl.gov/abs/cond-mat/0011196 Abstract:

A detailed analysis of three species-rich ecosystem food webs has shown that they display scale-free distributions of connections. Such graphs of interaction are in fact shared by a number of biological and technological networks, which have been shown to display a very high homeostasis against random removals of nodes. Here we analyse the response of these ecological graphs to both random and selective perturbations (directed to most connected species). Our results suggest that ecological networks are extremely robust against random removal but very fragile when selective attacks are used. These observations can have important consequences for biodiversity dynamics and conservation issues, current estimations of extinction rates and the relevance and definition of keystone species.