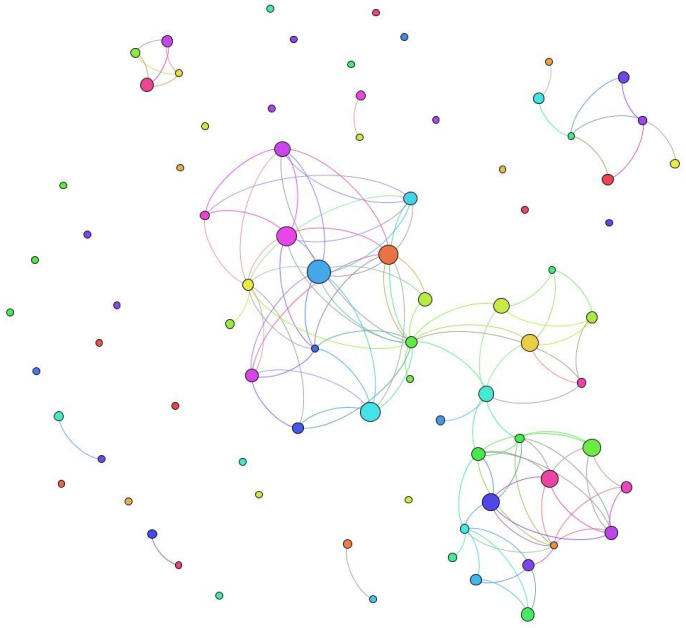
Commentaries on Albert-László Barabási's books

Networks101Link8.1 Einstein's Legacy ©frederick david abraham, 10 May 2013

The preferential attachment model has nodes linking to previous nodes proportionally to their degree, which made for branching structures of hierarchical hubs and scale-free, power law properties (see figures in my commentary Networks101Link5.1). But most networks are more complex, more modular, with some dense clusters. Here is my FaceBook page as an example whose statistics are presented in some of the previous commentaries.



In this chapter, Barabási describes a modification of preferential attachment that accounts for such complexities. Quite simple, node are each assigned a 'fitness' parameter, η, which is multiplied by that node's simple probability, yielding a 'fitness connectivity product'. This is similar to the value of Easley & Kleinberg that I presented in my Networks101Link5.1Hubs, and to the concept of weighted or biased links of many other authors, such as Sporns. This enables faster growth of some hubs, slower of others. In addition to the connectivity product, there can be nonlinear preferential attachment (Krapivsky, Redner, & Leyvraz, 2000).

Than he shows how the evolution of (a) is like a Bose-Einstein condensate, and idea developed by his graduate student, Ginestra Bianconi (2001a,b), and (b) usually continues to display scale-free properties, except in rare instances when the fittest wins all (almost all) links, when the

network goes ‘condensate’, such as with Microsoft. That is the behavior of the network is acting quantum-like, with “Adding a new node to the network is like adding a new energy level to the Bose gas; adding a new link to the network is the same as injecting a new Bose particle into the gas.” (p. 101.) “Every network has its fitness distribution. . . a network’s behavior and topology are determined by the shape of its fitness distribution.” (p. 102.) “In most networks, the scale-free toplogy survives.” And there is a hierarchy of hubs, “The winner’s lead is never significant.” (p. 103.) “When the winner takes all, “the scale-free topology vanishes.” (p. 107.)

Bianconi, G, & Barabási, A-L (2001a). Competition and multiscaling in evolving networks. *Europhysics Letters*, **54** (May).

Bianconi, G, & Barabási, A-L (2001b). Bose-Einstein condensation in complex networks. *Physical Review Letters*, **86**, 5632-5635. (June)

Krapivsky, PL, Redner, S, & Leyvraz, F (2000). Connectivity of growing random networks. *Physical Review Letters*, **85**, 4629-4642.