Network Science

Class 5: BA model

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With

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Section 1

Hubs represent the most striking difference between a random and a scale-free network. Their emergence in many real systems raises several fundamental questions:

•Why does the random network model of Erdős and Rényi fail to reproduce the hubs and the power laws observed in many real networks?

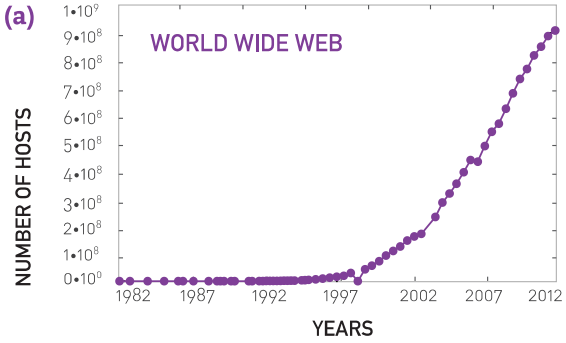
• Why do so different systems as the WWW or the cell converge to a similar scale-free architecture?

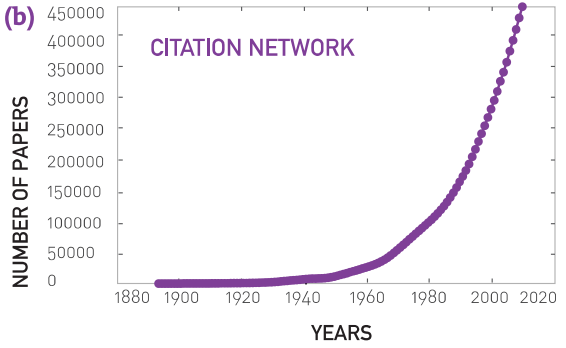
Growth and preferential attachment

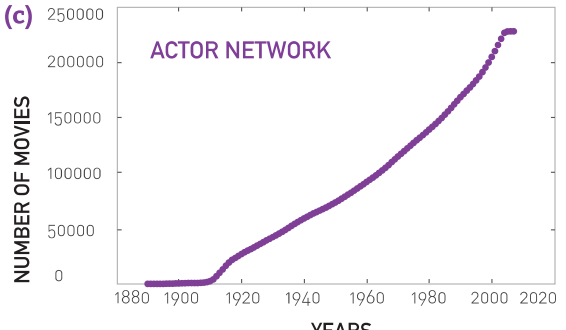
BA MODEL: Growth

ER model:
the number of nodes, N, is fixed (static models)

networks expand through the addition of new nodes







Barabási & Albert, *Science* **286,** 509 (1999)

BA MODEL: Preferential attachment

ER model: links are added randomly to the network

New nodes prefer to connect to the more connected nodes

Rich-gets-richer phenomenon

Barabási & Albert, *Science* **286,** 509 (1999)

Section 2: Growth and Preferential Sttachment

The random network model differs from real networks in two important characteristics:

Growth: While the random network model assumes that the number of nodes is fixed (time invariant), real networks are the result of a growth process that continuously increases.

Preferential Attachment: While nodes in random networks randomly choose their interaction partner, in real networks new nodes prefer to link to the more connected nodes.

Barabási & Albert, *Science* **286,** 509 (1999)

The Barabási-Albert model

Origin of SF networks: Growth and preferential attachment

(1) Networks continuously expand by the addition of new nodes

WWW : addition of new documents

(2) New nodes prefer to link to highly connected nodes.

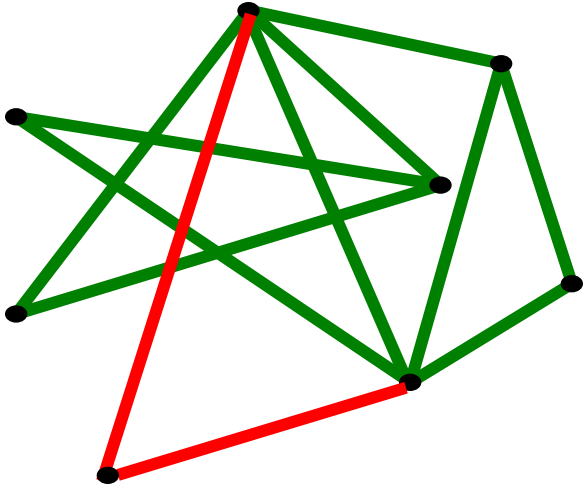
WWW : linking to well known sites

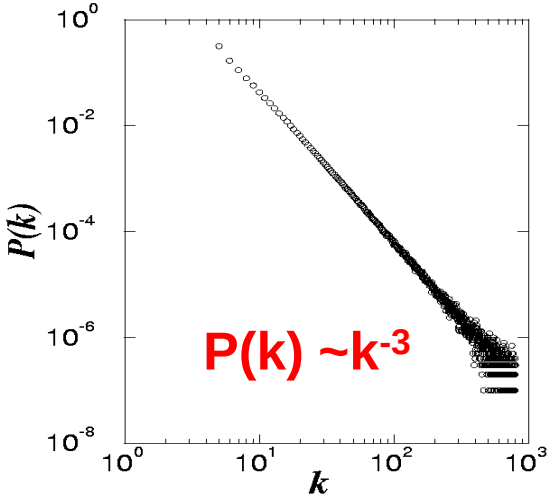
GROWTH:

add a new node with m links

PREFERENTIAL ATTACHMENT:

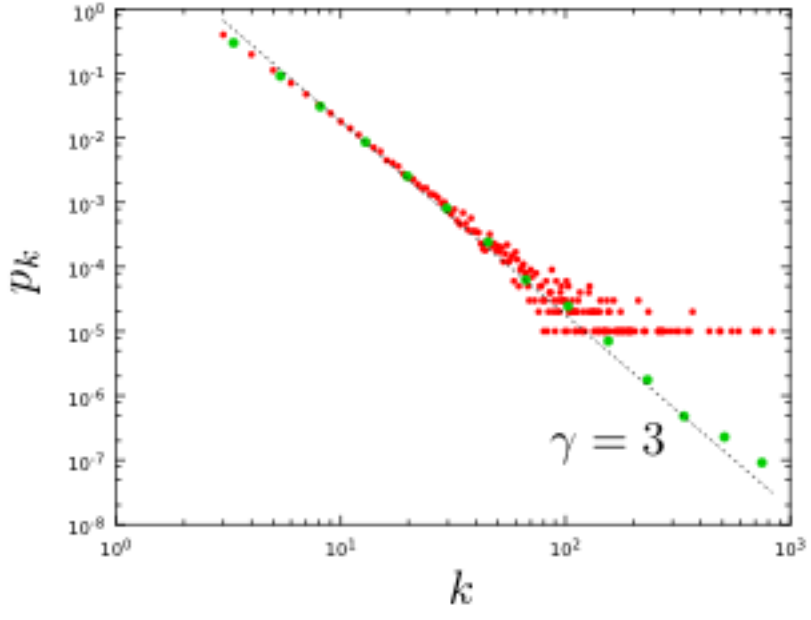
the probability that a node connects to a node with *k* links is proportional to *k*.





Barabási & Albert, *Science* **286,** 509 (1999)

Section 4



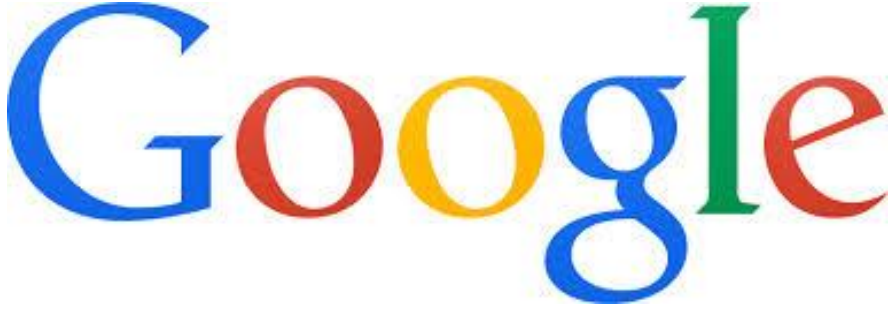
Do we need both growth and preferential attachment?

YEP.

See

http://barabasi.com/networkscience book/resources/chapter5.html

The BA model is only a minimal model.



Founded six years after birth of the World Wide Web, Google was a latecomer to search. By the late 1990s Alta Vista and Inktomi, two search engines with an early start, have been dominating the search market. Yet Google, the third mover, soon not only became the leading search engine, but acquired links at such an incredible rate that by 2000 became the most connected node of the Web as well [1]. But its status didn't last: in 2011 Facebook, with an even later start, took over as the Web's biggest hub.