Evolving Networks

Topics

- Introduction
- The Bianconi - Barabási Model
- Measuring Fitness
- Bose-Einstein Condensation
- Evolving Networks
- Limitations

Evolving Networks

Preferential treatment of Barabási-Albert model suggests that older nodes will get the most links (per $k(t) \sim t^{1/2}$) – and follow First Mover Advantage.

However, in reality that is not always the case!

Evolving Networks

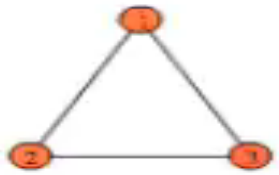
First Mover Advantage?

Late 1990: Alta Vista and Inktomi, two search engines with an early start, dominated the search market.

2000: A newcomer, Google soon not only became the leading search engine, but acquired links at such an incredible rate that it soon became the biggest hub of the Web as well.

2011: But it didn't last, and in 2011 Facebook, a yet another new entrant, took over as the Web's biggest node.

The Bianconi – Barabási Model



The Bianconi – Barabási Model

The video on the previous slide shows a growing network in which each new node acquires a randomly chosen fitness parameter at birth, indicated by the color of the node.

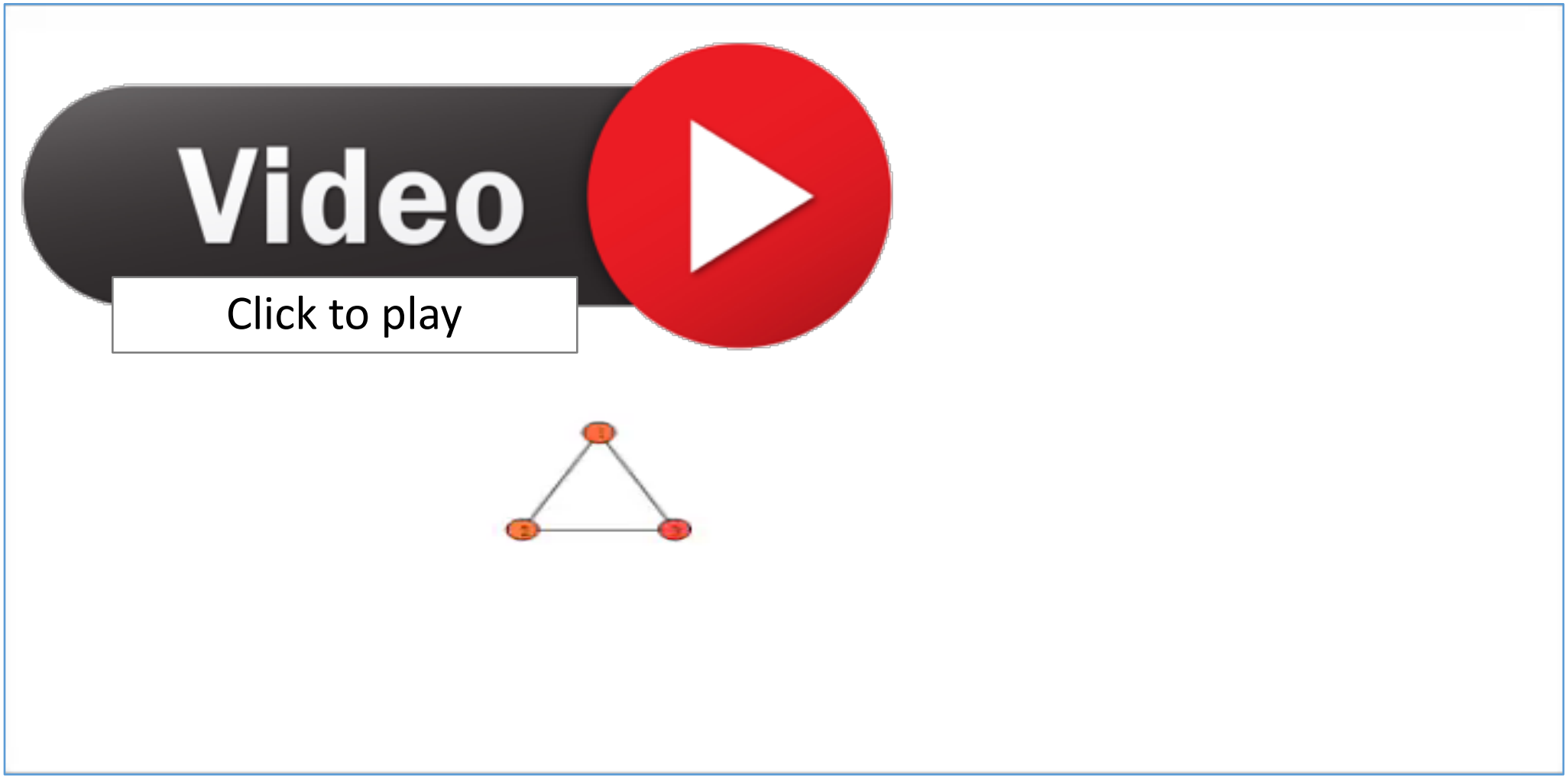
Each new node chooses the nodes it links to following generalized preferential attachment (6.1), making a node's growth rate proportional to its fitness.

The node size is proportional to its degree, illustrating that with time the nodes with the highest fitness turn into the largest hubs.

In the Barabási-Albert model we assumed that a node's growth rate is determined solely by its degree.

To incorporate the role of fitness we assume that preferential attachment is driven by the product of a node's fitness, η, and its degree k.

Bose-Einstein Condensation in Networks



Bose-Einstein Condensation and Networks

Energy levels: Fitness levels.

Subatomic particles: Links.

Low energy level ~ high fitness level.

Low energy levels attracts the subatomic particles.

Similarly, high fitness level attracts more links.

If high fitness level attracts all the links, then it would be winner-takes-all situation.

If high fitness level attracts many (but not all) links, then it would be fit-gets-richer situation.

Scale-Free (Barabási – Albert)

- Node grows with square root of time.
- $k(t) \sim t^{1/2}$
- Oldest node has the most links.

Fitness Model (Bianconi - Barabási)

- Comparing between two nodes of equal age, one which is fit gets more links.
- Comparing between two nodes of equal fitness, one which is older gets more links.

$$\Pi_i = \frac{\eta k_t}{\sum_j \eta_j k_j}$$

Examples

Fit-get-richer

- Google!

Winner takes all

- Star-hub typology
- Monopoly situation

Limitations

Models to compute fitness levels are currently being developed.

The model assumes that fitness level remains same throughout.

References

- Albert - László Barabási, *Linked*, Basic Books, 2014.
- Albert - László Barabási, *Network Science*, Cambridge University Press, 2016.
- http://www.barabasilab.com/

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