Lecture 5: Degree distributions and power laws

Matthew J. Salganik

Sociology 204: Social Networks, Spring 2021
Princeton University

2/2: Scale-free networks: implications, empirical work, and additional modeling

Follow up work:

- Implications
- Empirical
- Modeling

Implication

Epidemic Spreading in Scale-Free Networks

Romualdo Pastor-Satorras[1] and Alessandro Vespignani[2]

[1]*Departament de Física i Enginyeria Nuclear, Universitat Politècnica de Catalunya, Campus Nord, Mòdul B4, 08034 Barcelona, Spain*

[2]*The Abdus Salam International Centre for Theoretical Physics (ICTP), P.O. Box 586, 34100 Trieste, Italy*

(Received 20 October 2000)

Implication

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- Diseases are harder to stop when spreading in scale-free networks

http://dx.doi.org/10.1103/PhysRevLett.86.3200

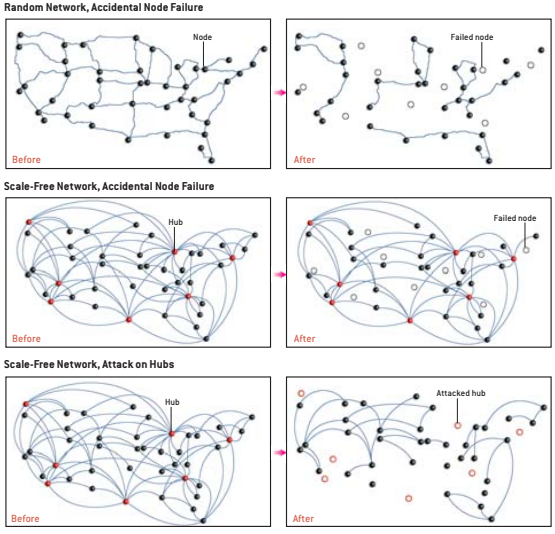
Error and attack tolerance of complex networks

Réka Albert, Hawoong Jeong & Albert-László Barabási

Department of Physics, 225 Nieuwland Science Hall, University of Notre Dame, Notre Dame, Indiana 46556, USA

http://dx.doi.org/10.1038/35019019

Implication

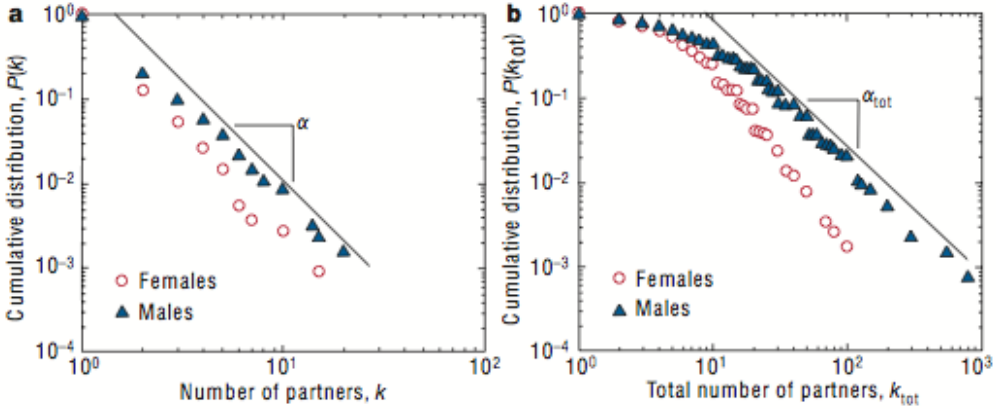


The web of human sexual contacts

Promiscuous individuals are the vulnerable nodes to target in safe-sex campaigns.

https://doi.org/10.1038/35082140

Emprical


a
b
Cumulative distribution, P(k)
Cumulative distribution, P(k_tot)
α
α_tot
Females
Males
Number of partners, k
Total number of partners, k_tot

Empirical

ARTICLE

https://doi.org/10.1038/s41467-019-08746-5 OPEN

Scale-free networks are rare

Anna D. Broido[1] & Aaron Clauset[2,3,4]

- Formal definitions of scale-free networks: Super-weak, weakest, weak, strong, strongest

Empirical

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Empirical

COMMENT

https://doi.org/10.1038/s41467-019-09038-8 OPEN

Rare and everywhere: Perspectives on scale-free networks

Petter Holme [1]

https://doi.org/10.1038/s41467-019-09038-8

Modeling

Organization of growing random networks

P. L. Krapivsky and S. Redner
Center for BioDynamics, Center for Polymer Studies, and Department of Physics, Boston University, Boston, Massachusetts 02215
(Received 7 November 2000; published 24 May 2001)

- Generalizes preferential attachment process

https://doi.org/10.1103/PhysRevE.63.066123

Modeling

Scale-Free Networks from Varying Vertex Intrinsic Fitness

G. Caldarelli,[1] A. Capocci,[2] P. De Los Rios,[3,4] and M. A. Muñoz[5]

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[2]*Département de Physique, Université de Fribourg-Pérolles, CH-1700 Fribourg, Switzerland*
[3]*Institut de Physique Théorique, Université de Lausanne, CH-1004 Lausanne, Switzerland*
[4]*INFM UdR Politecnico di Torino, Corso Duca degli Abruzzi 24, 10129 Torino, Italy*
[5]*Instituto de Física Teórica y Computacional Carlos I, Universidad de Granada, Facultad de Ciencias, 18071-Granada, Spain*
(Received 15 July 2002; published 3 December 2002)

- power laws can from from "good-get-richer" in addition to "rich-get-richer"

https://doi.org/10.1103/PhysRevLett.89.258702

Question from previous year:
"Is it possible for hubs to exist even where a network doesn't follow a power law distribution? Meaning, the fact that some nodes will be more connected than other nodes, but without the entire network being scale-free?"

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A note on terminology:

- power law
- scale-free
- hubs

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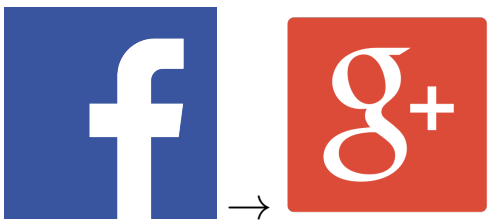
- networks with power law degree distribution are robust to random failure but fragile to targeted attack

- Gladwell, M. (1999). Six degrees of Lois Weisberg. *The New Yorker*.
- Watts, Chapter 4, 114-129.
- Feld, S.L. (1981) The focused organization of social ties. *American Journal of Sociology*.



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