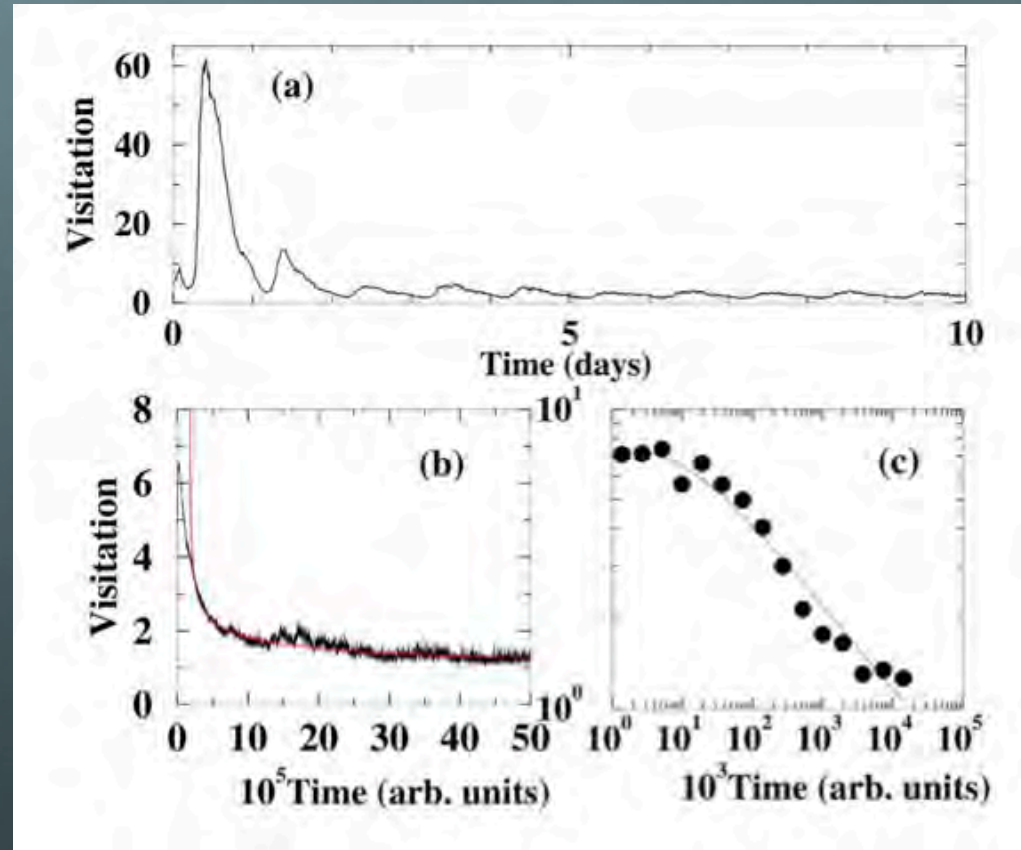


Characterizing and modeling the dynamics of online popularity

Santo Fortunato



Popularity dynamics



- News popularity is short-lived
- Access to news items decays after 36 hours

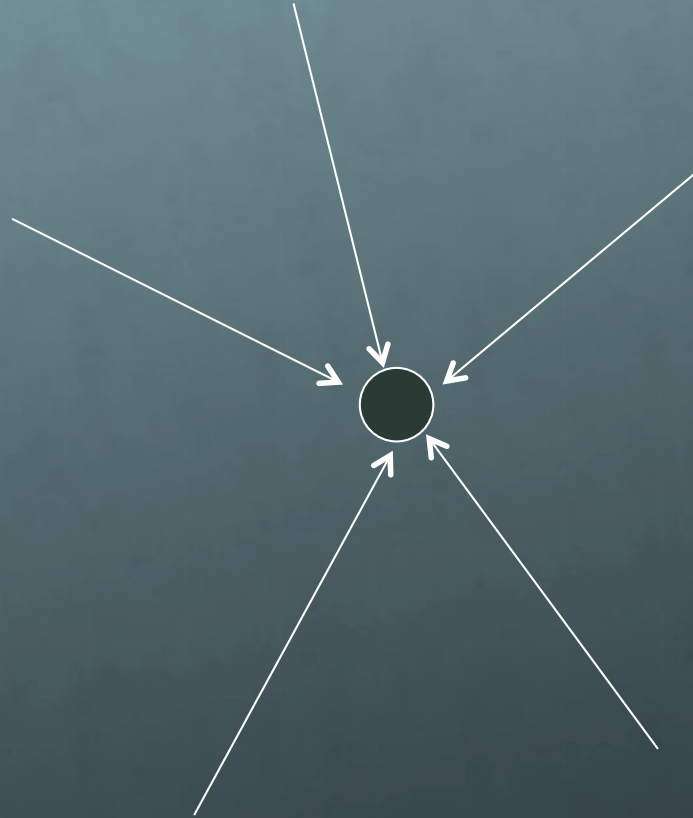
Popularity dynamics

Focus: online content!



- Wikipedia history from 2001 till March 2007
- Web traffic data from users of Indiana University
- Yearly sequence of crawls of the Chilean Web

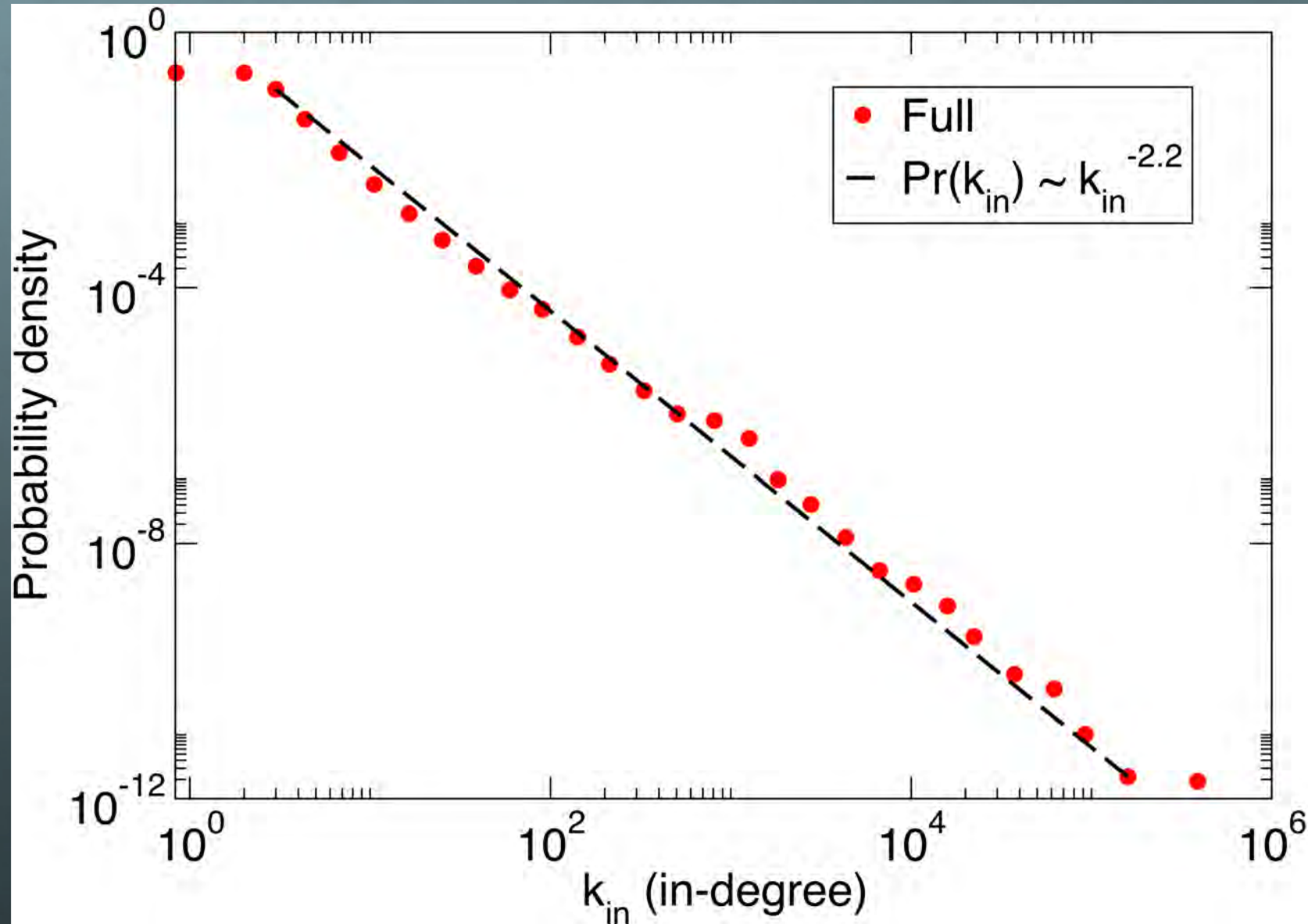
Link popularity on the Web



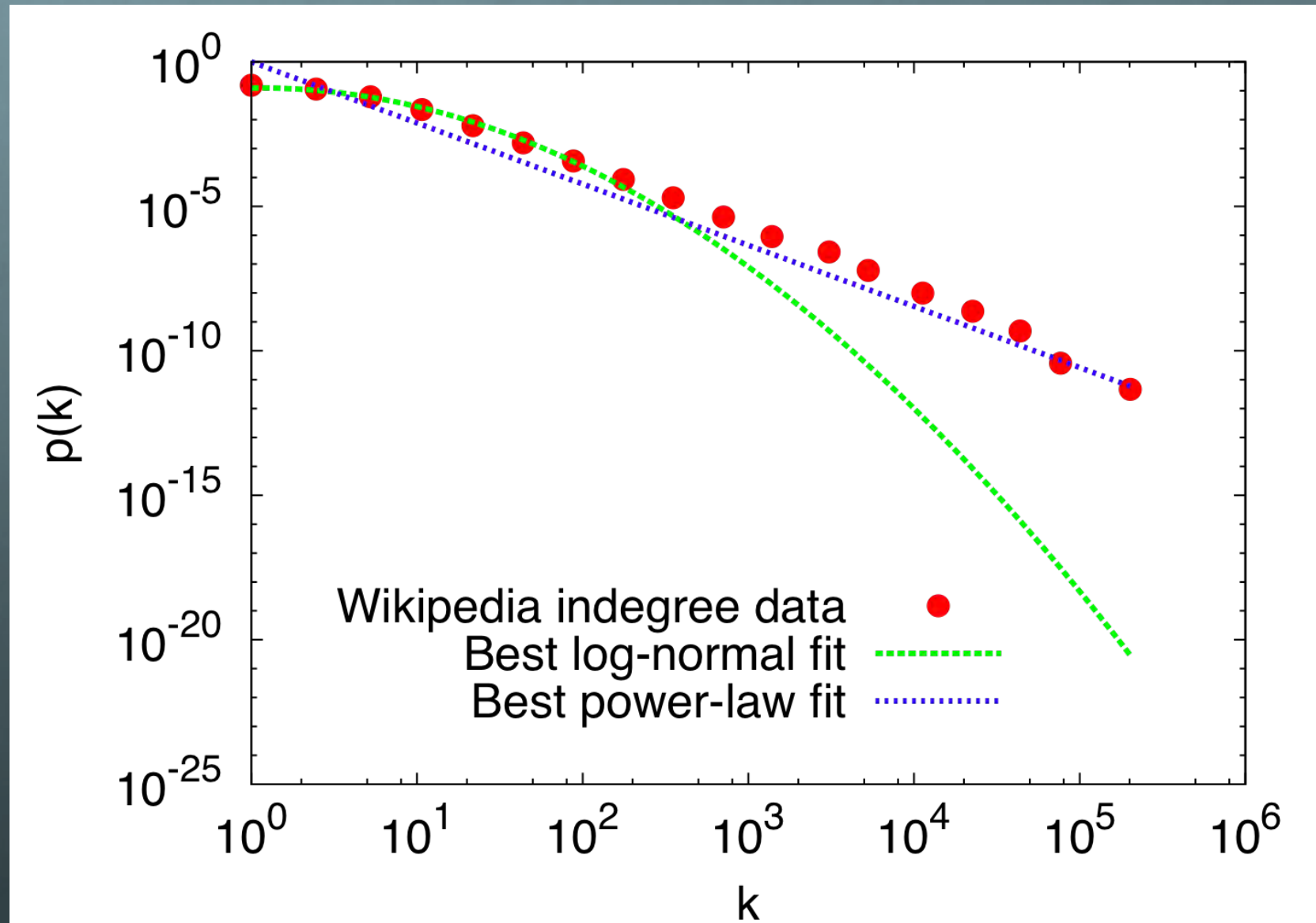
Indegree: number of incoming hyperlinks to a page

Natural popularity measure: the more in-links, the more popular the page

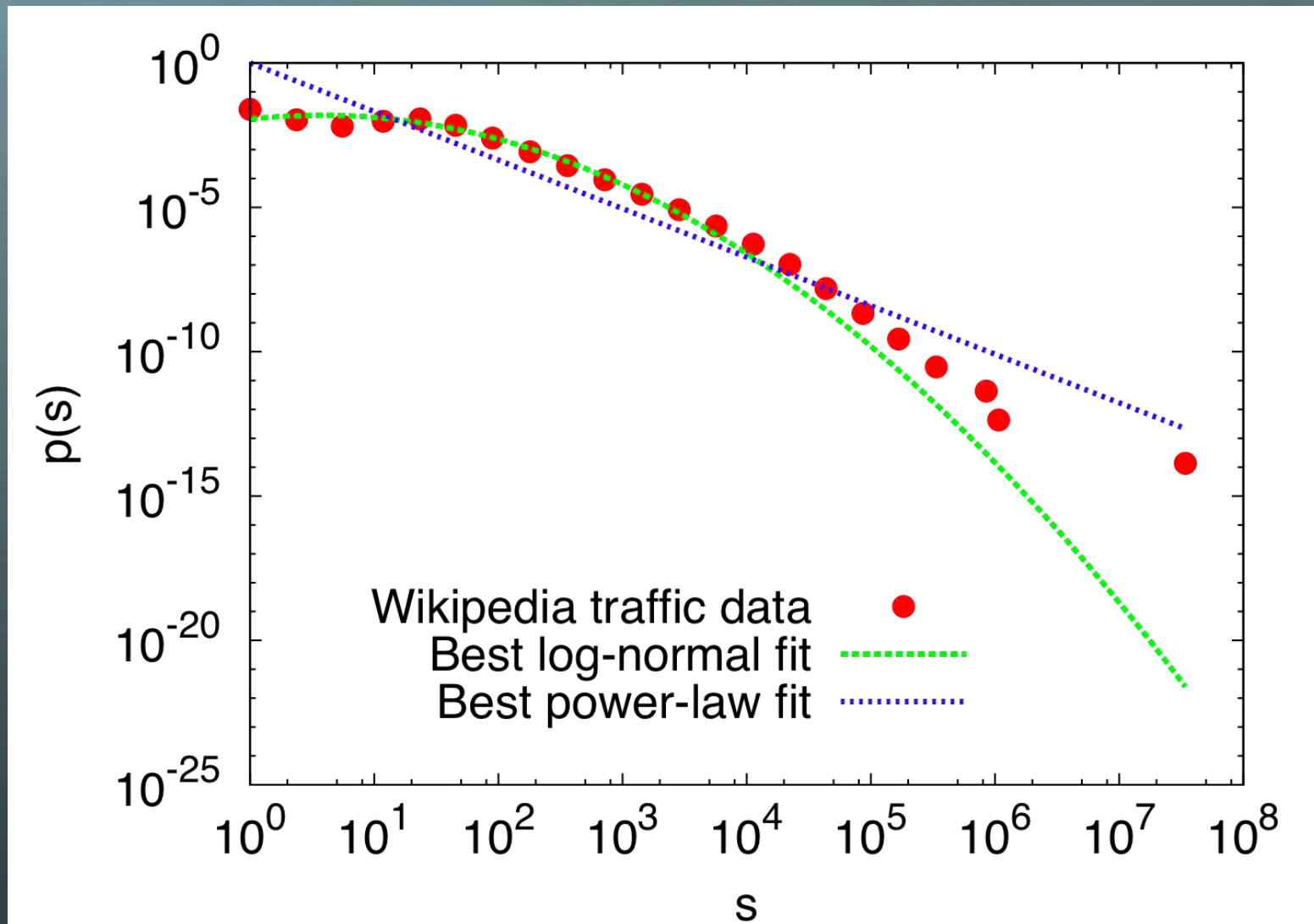
Link popularity on the Web



Link popularity on Wikipedia



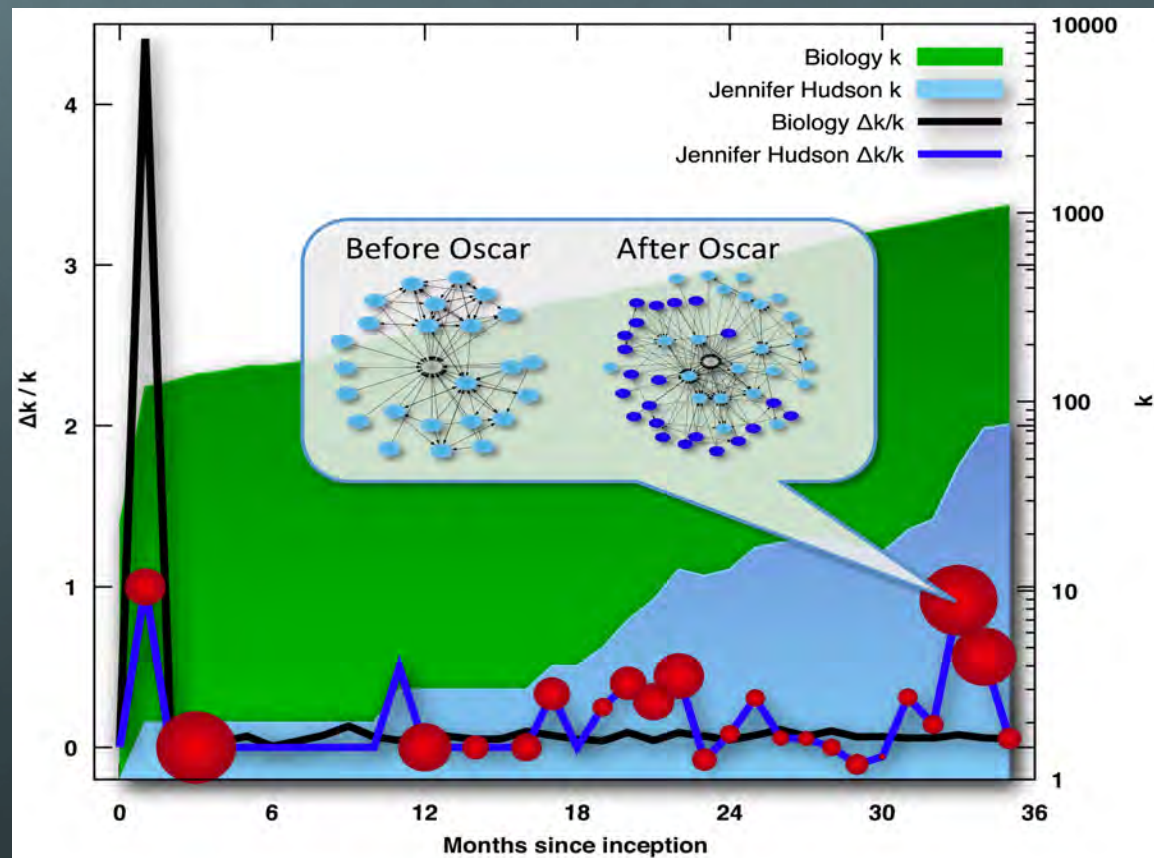
User traffic on Wikipedia



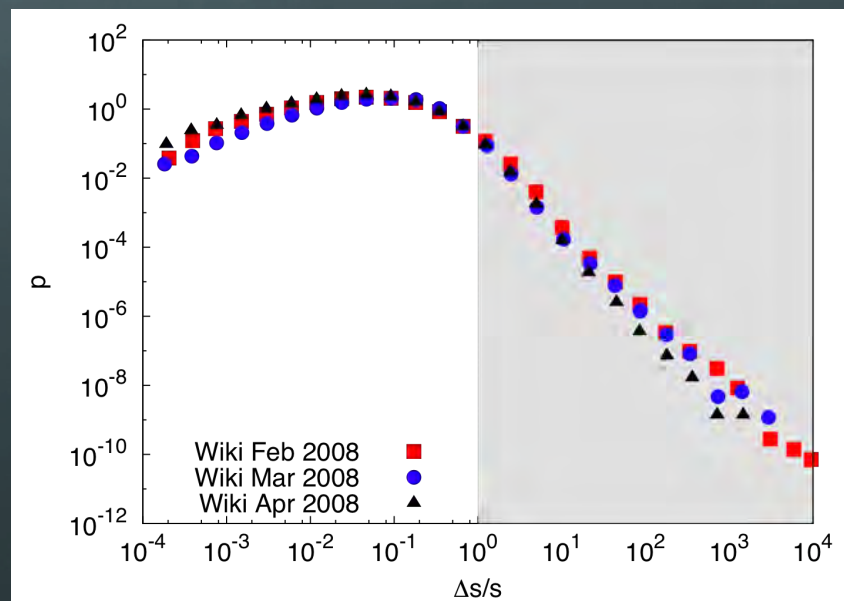
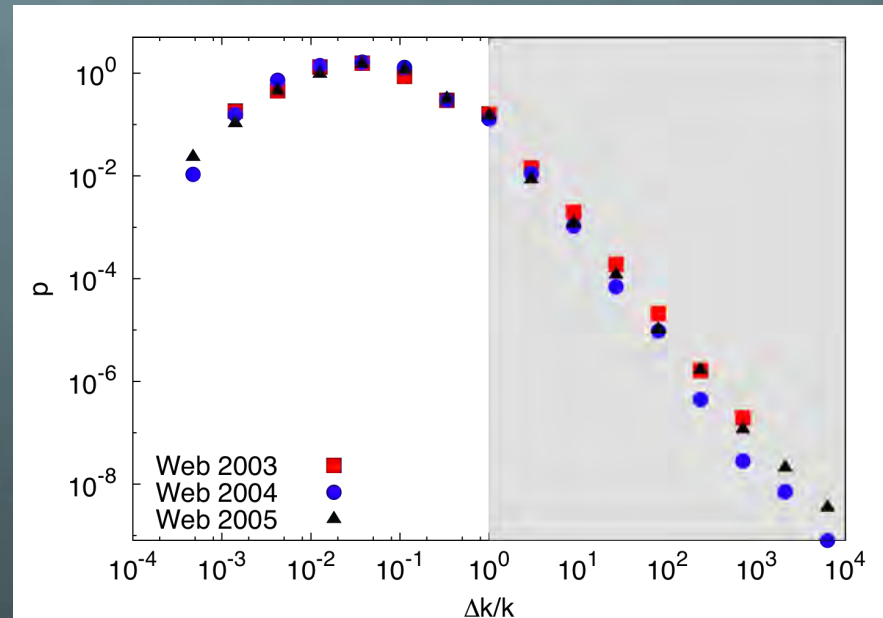
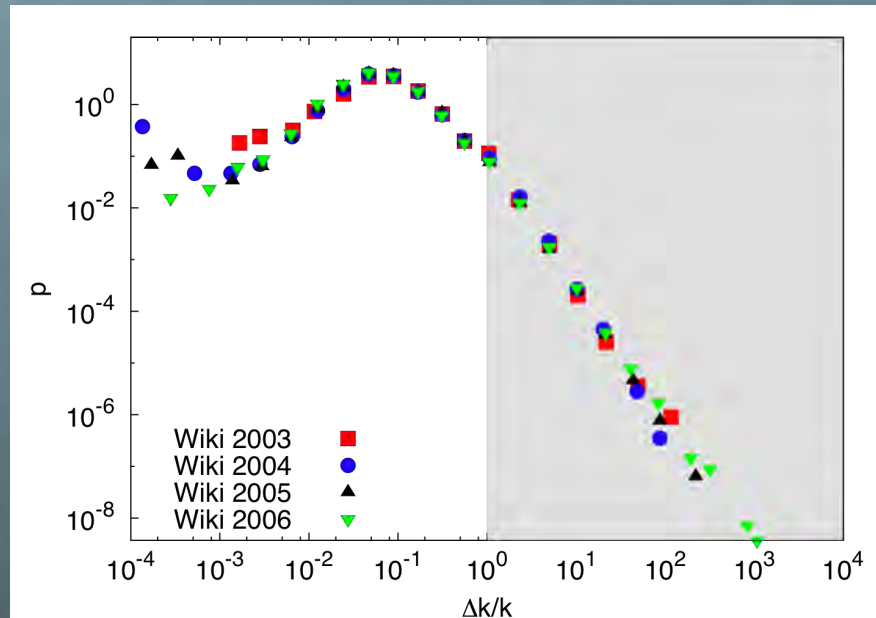
Popularity dynamics

J. Ratkiewicz, S. Fortunato, A. Flammini, F. Menczer, A. Vespignani, Physical Review Letters 105, 15870 (2010)

Relative increment $\Delta x/x$ of popularity x (in-degree, traffic)



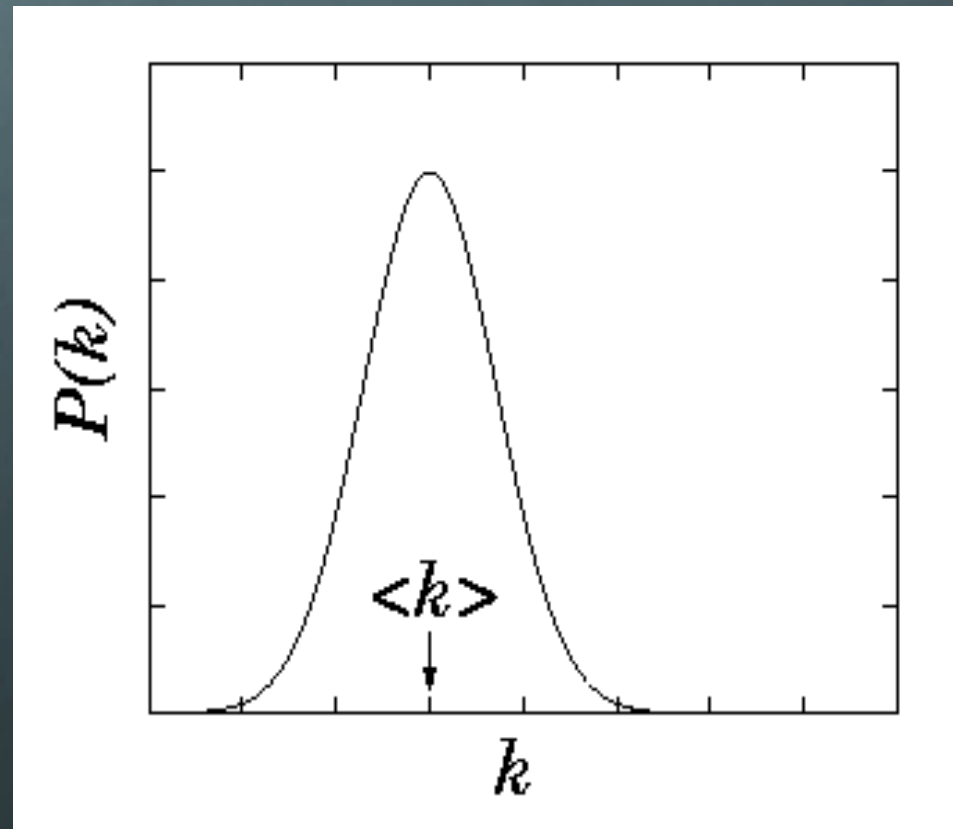
Distributions: fat tails!



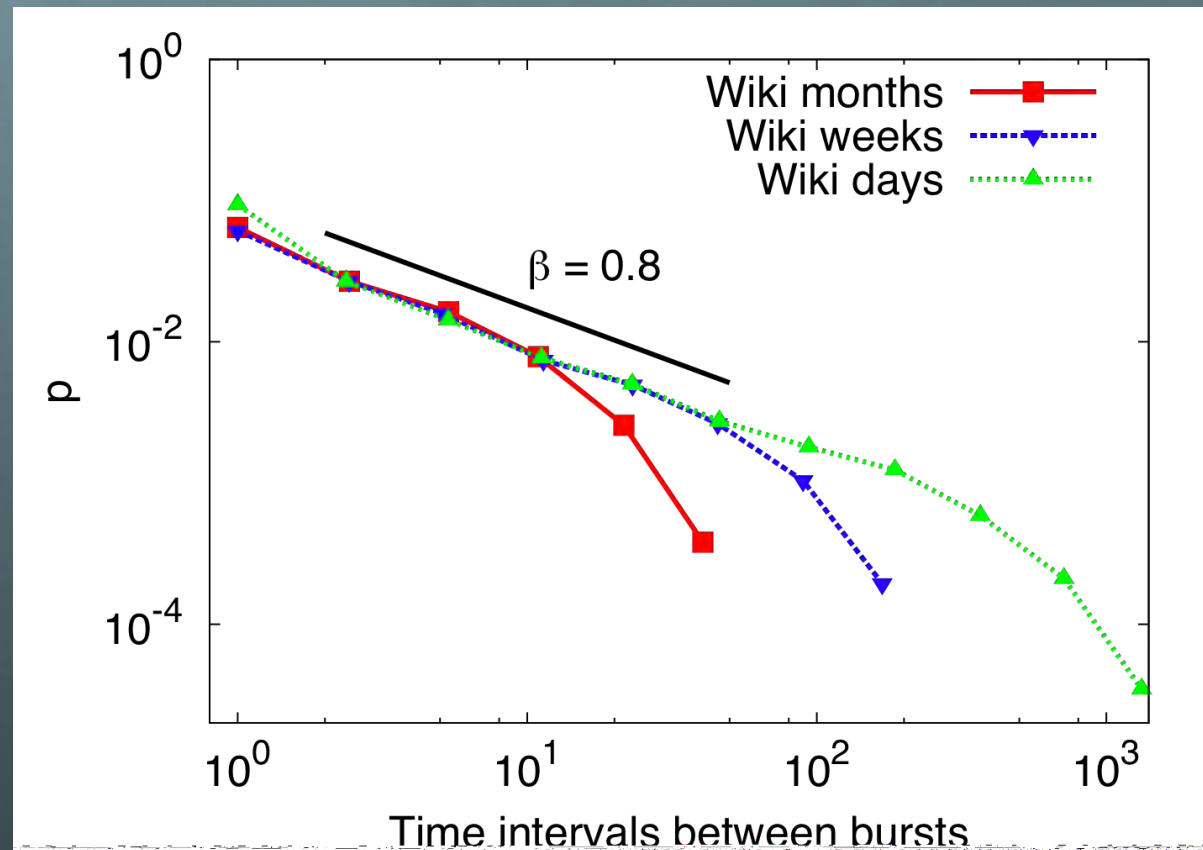
Inter-event time distributions

Independent events: events having the same probability to occur regardless of other events

Poissonian behavior!

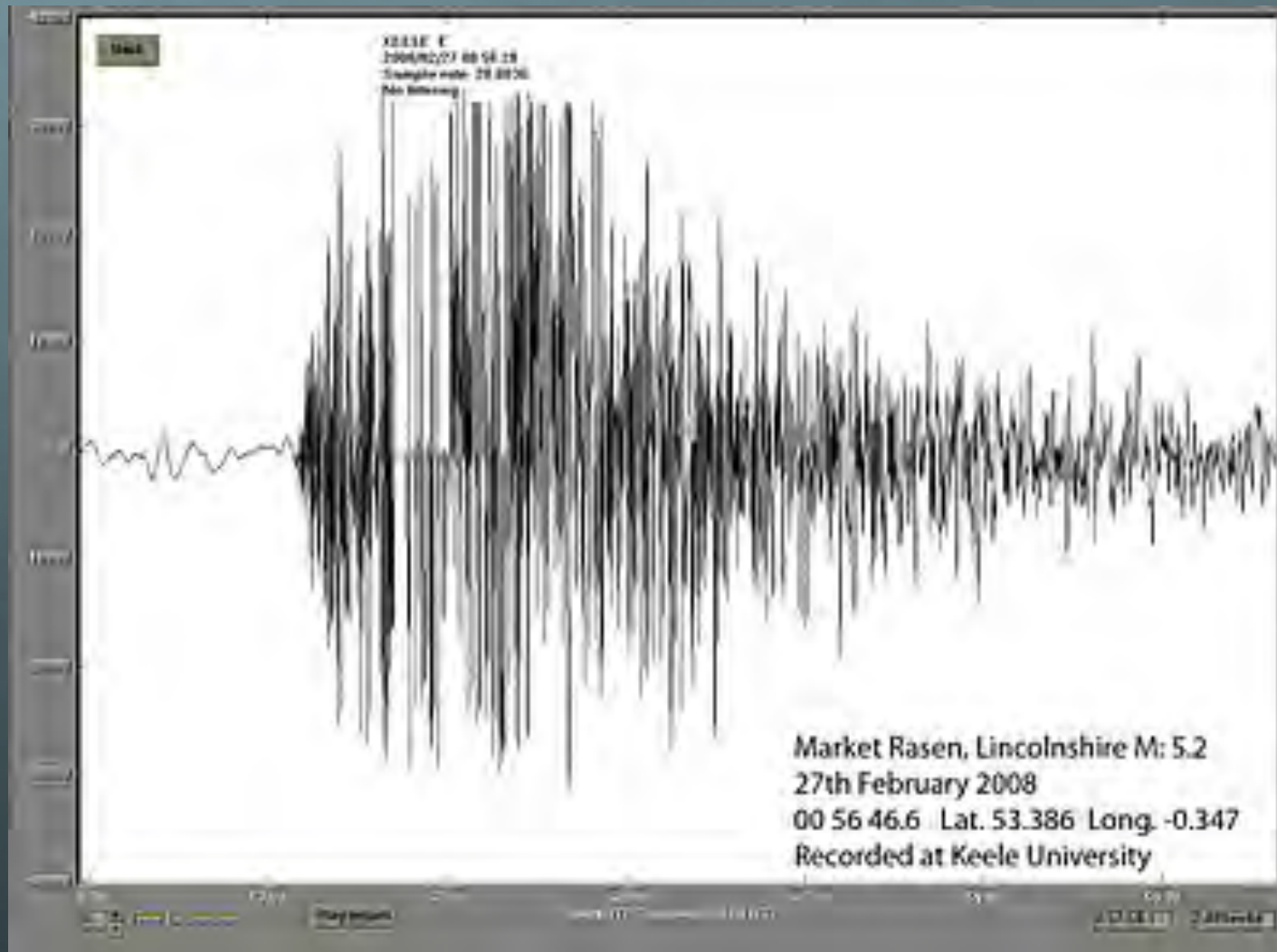


Inter-event time distributions

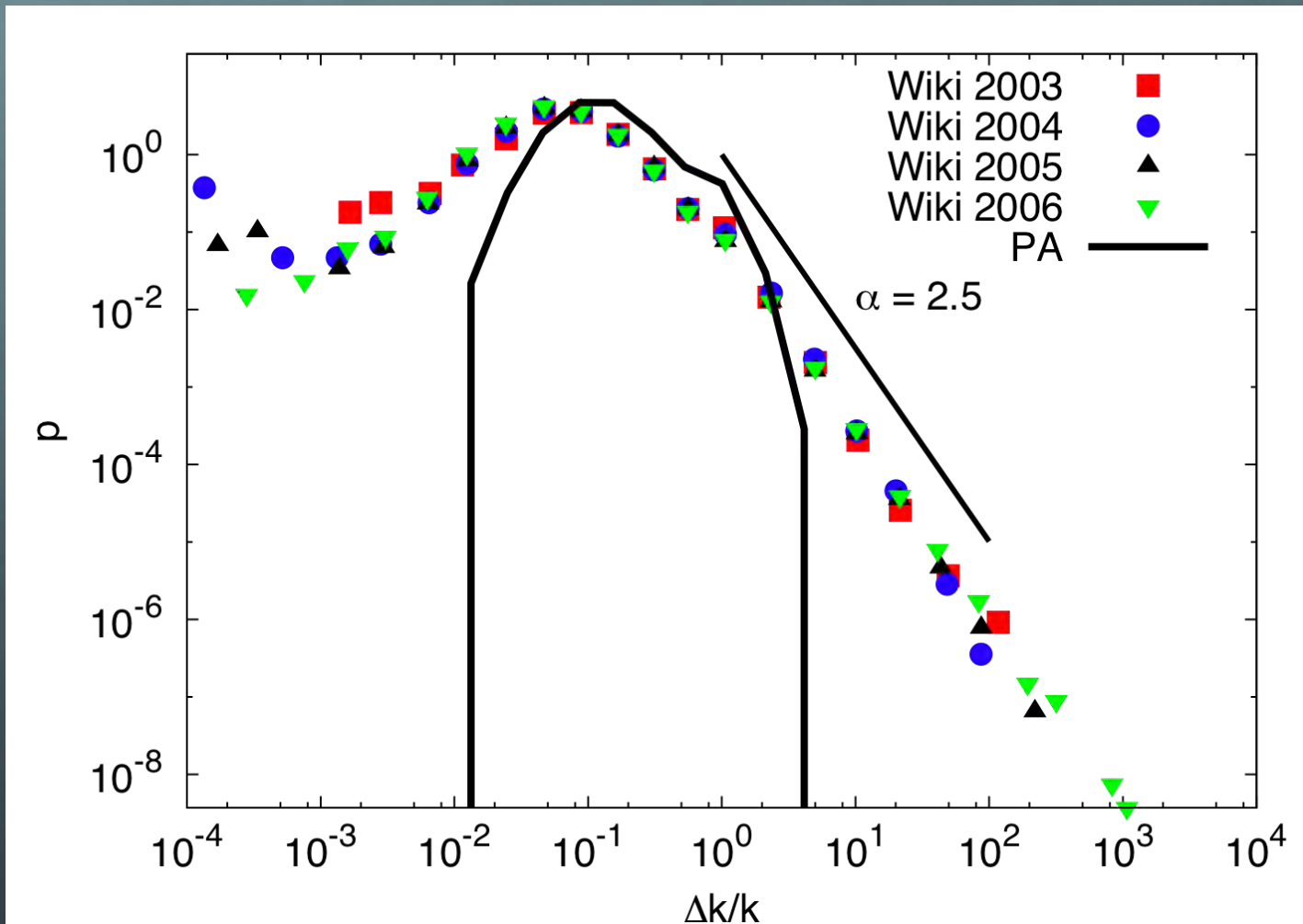


Non-Poissonian behavior (power law): events take place also after long times!

Popularity bursts like earthquakes



Preferential attachment unable to explain fat tail!



The ranking model



Absolute importance of items is often not perceived: ranking is easier!

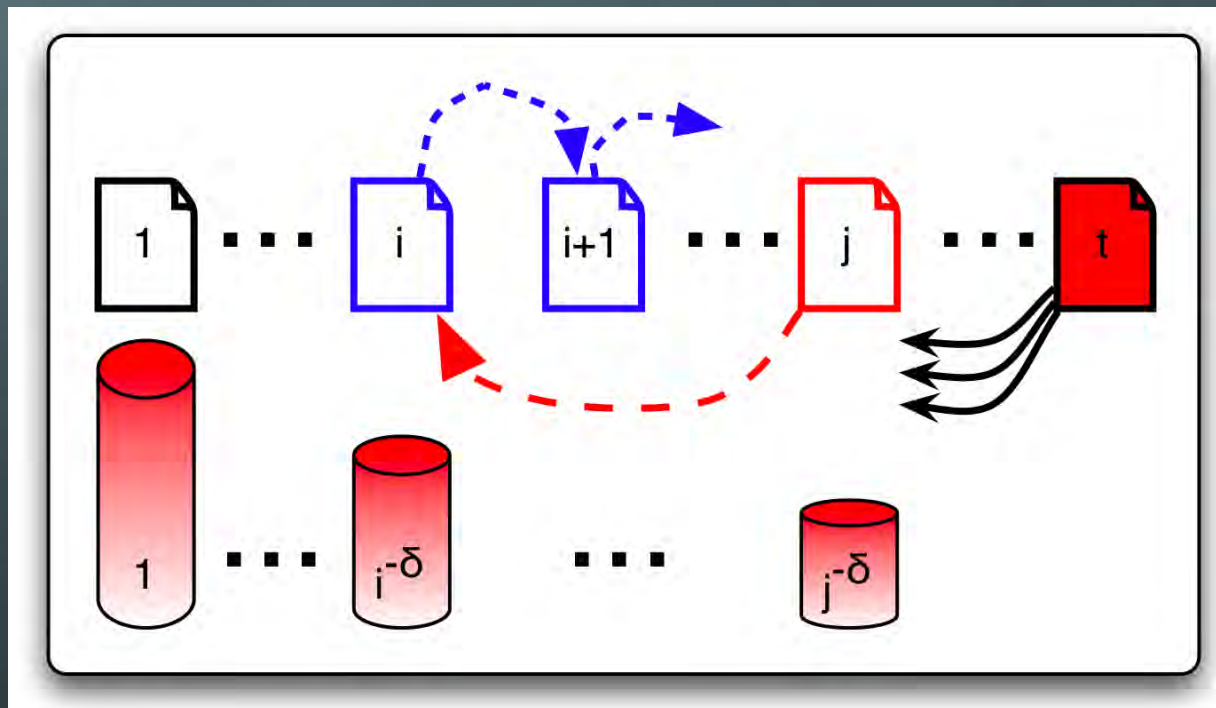
Probability that page j receives an inlink/click depends on rank of j :

$$p(i \rightarrow j) \sim R_j^{-\delta}$$

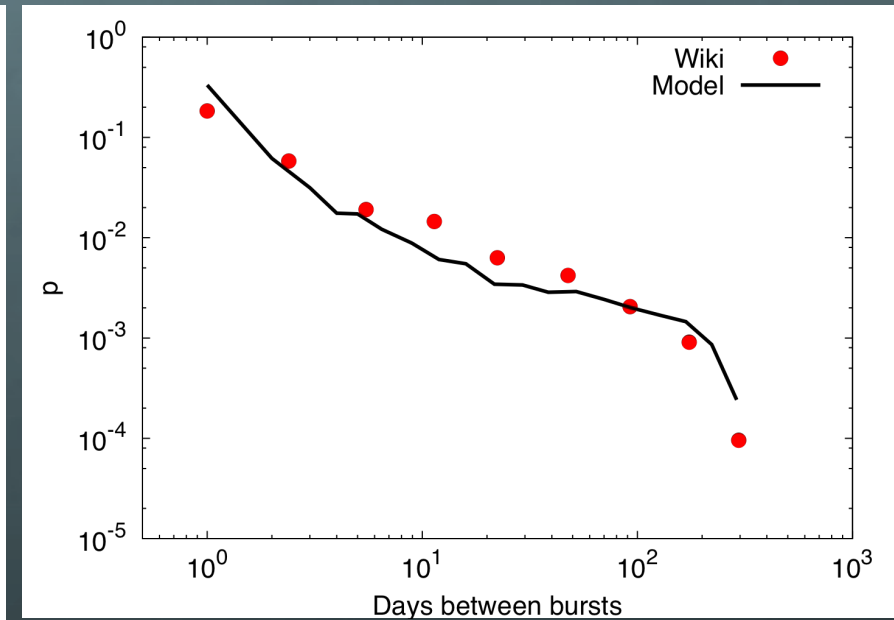
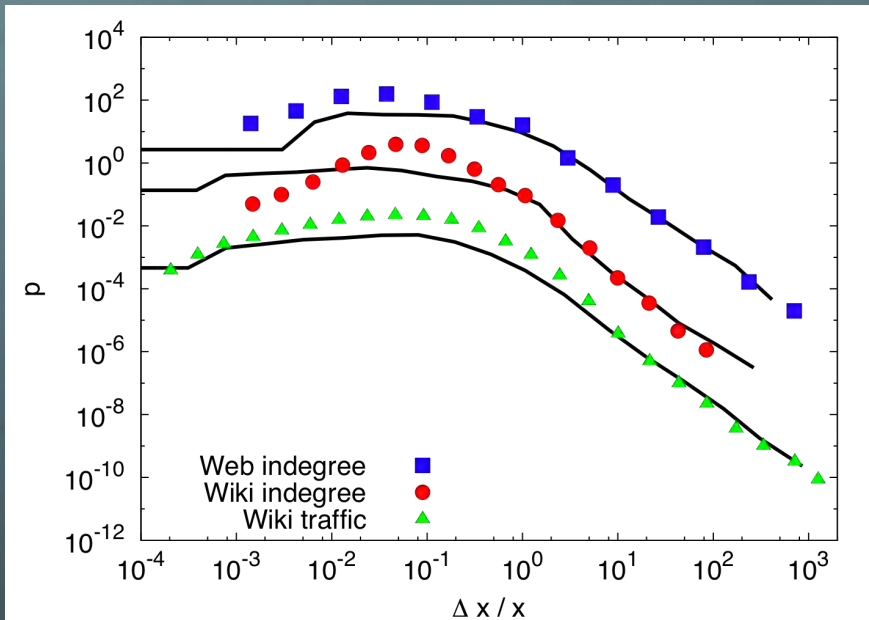
S. F., A. Flammini, F. Menczer,
Phys. Rev. Lett. 96, 218791 (2006)

Rank-shift model

- 1) Nodes are ranked based on some variable
- 2) Linking probability proportional to $r^{-\delta}$
- 3) Nodes are occasionally re-ranked: at any iteration a randomly chosen node receives a new rank, taken at random among all higher ranks



Rank-shift model describes well the data



Features

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Popularity contest



Characterizing and Modeling

Jacob Ratkiewicz, Santo Fortunato
Phys. Rev. Lett. 105, 15870

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A website's popularity proceeds like a snowball: The stream of hyperlinks and clicks its way.

Model describes Web page popularity

October 20, 2010 By Lisa Zyga

(PhysOrg.com) -- How do some Web pages become popular? In a recent study, researchers have analyzed Wikipedia articles and a collection of all the Web pages of Chile to better understand the dynamics of online popularity. They observed that online popularity is characterized not by a gradual accumulation process, but by "bursts" that display many of the same features of critical systems, such as stock market crashes and natural phenomena. They also developed a model that captures these critical features of online popularity.

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"We see that Internet popularity behaves in unpredictable ways, with big shifts in attention causing changes which have statistical signatures like those seen in earthquakes and avalanches," Jacob Ratkiewicz from Indiana University told *PhysOrg.com*.

Ratkiewicz and his coauthors from Indiana University and the Institute for Scientific Interchange in Torino, Italy, have published their study on online popularity in a recent issue of *Physical Review Letters*. As they explain,

Outlook

- ✓ Popularity dynamics of Websites and Wikipedia pages is “bursty”
- ✓ The size of the bursts is very heterogeneous and their frequency decreases as a power law, just like in earthquakes!
- ✓ Standard cumulative advantage cannot explain the data
- ✓ By modelling bursts as sudden endogeneous/exogeneous variations in the importance of a page we are able to reproduce the data

Statistical physics of social dynamics

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(Published 11 May 2009)

Statistical physics has proven to be a fruitful framework to describe phenomena outside the realm of traditional physics. Recent years have witnessed an attempt by physicists to study collective phenomena emerging from the interactions of individuals as elementary units in social structures. A wide list of topics are reviewed ranging from opinion and cultural and language dynamics to crowd behavior, hierarchy formation, human dynamics, and social spreading. The connections between these problems and other, more traditional, topics of statistical physics are highlighted. Comparison of model results with empirical data from social systems are also emphasized.

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C. Castellano, S. F., V. Loreto,
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