Perspectives on networks dynamics

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From Biology to Socio-Technological networks and back
Epidemic spreading: From the Internet to Influenza

R. Pastor-Satorras and A. Vespignani PRL 2001

V. Colizza et al. PloS Medicine 2008
Evolution and the World-Wide-Web: the fitness model

Webpages have different fitness describing the different rates at which connectivity grows


$$k_{\eta}(t) = m \left( \frac{t}{t_i} \right)^{\eta_i / C}$$
Bose-Einstein condensations

World-Wide-Web: the winner-takes-all phenomena

Phase Fit-Get-Rich

Bose-Einstein condensate (ex. Google)

G. Bianconi et al. PRL 2001

Ecology: Dominance of invasive species

Below the Bose-Einstein condensation
A finite fraction of individuals belong to the dominating species

G. Bianconi et al. EPL 2009
Evolution of influenza and blog memes

Influenza viruses and memes in the blogosphere are bursty:

the fittest one spread in the population and then die out, to be substituted by a new one.

Koelle et al. Science 2006

J. Leskovec et al 2009
The spatio-temporal dimension of complex networks
The spatial model of networks

In the maximal entropy model for a spatial networks the link probability is given by

\[ p_{ij} = \frac{\theta_i \theta_j J(\vec{r}_i, \vec{r}_j)}{1 + \theta_i \theta_j J(\vec{r}_i, \vec{r}_j)} \]

G. Bianconi PRE 2009

Airport Network
Bianconi et al. PNAS 2009
Ising model in the annealed spatial network

Given a spectrum of the adjacency matrix given by

\[ \rho(\lambda) \propto (\lambda_c - \lambda)^{\delta_S} \]
\[ \Delta = \Lambda - \lambda_c \]

\( \Delta \) is the spectral gap and \( \lambda_c \) the spectral edge.

Mean-field fails if the gap vanish in the thermodynamic limit, and \( \delta_S < 1 \)

S. Bradde, F. Caccioli, L. Dall’Asta and G. Bianconi PRL 2010
Face-to-face interactions: Duration of contacts for groups

The model well capture the distribution of lifetime of different group sizes of small social gatherings
(Sociopatterns, data from Berlin conference)
Many open problems are related to the complex interplay between biological and evolutionary concepts and socio-technological networks and dynamical processes on networks and their spatio-temporal dimension.