Topology of evolving networks: the role of growth signals

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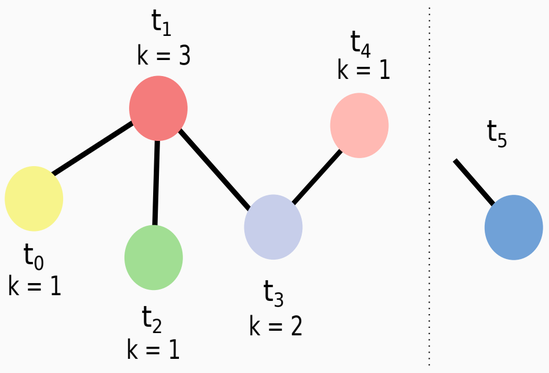
AGING MODEL



In each time step we add one new node and link it to the older i-th node according to probability [1]:

$$\Pi_i(t) \sim \tau_i^{\alpha} k_i(t)^{\beta}$$

- $\tau_i = t - t_i$ – age difference between nodes
- $k_i(t)$ – degree of node i at time t
- α and β – model parameters

$\alpha = 0$ and $\beta = 0$ – random network

$\alpha = 0$ and $\beta = 1$ – Barabasi-Albert model

$\alpha < -0.5$ and $\beta > 0$ – reinstate scale-free properties

Model modifications: we allow addition of multiple **number of nodes (M)** and **link them to L old nodes** which are selected according to probability $\Pi_i(t)$.

D-MEASURE

Differences between two networks, G and G' are given by D-measure [2]:

$$D = \frac{1}{2}\left|\sqrt{NND(G)} - \sqrt{NND(G')}\right| + \frac{1}{2}\sqrt{\frac{J(\mu_G,\mu_{G'})}{log2}}$$

Through **Jensen-Shannon divergence** J we calculate dissimilarities between:

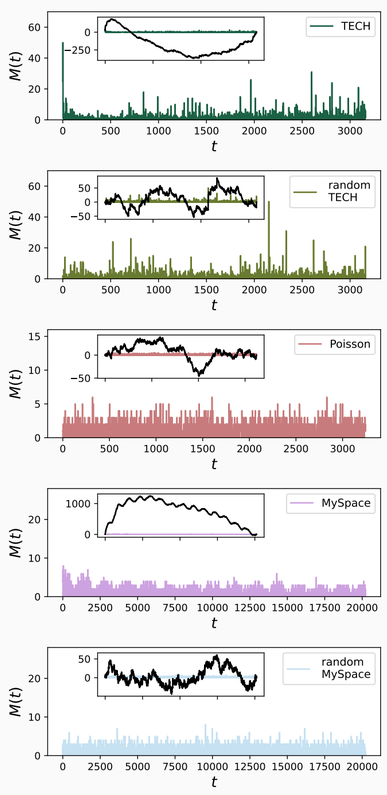
- nodes distance distributions P_i

$$NND(G) = \frac{J(P_1(G),..P_N(G))}{log(d_G)}$$

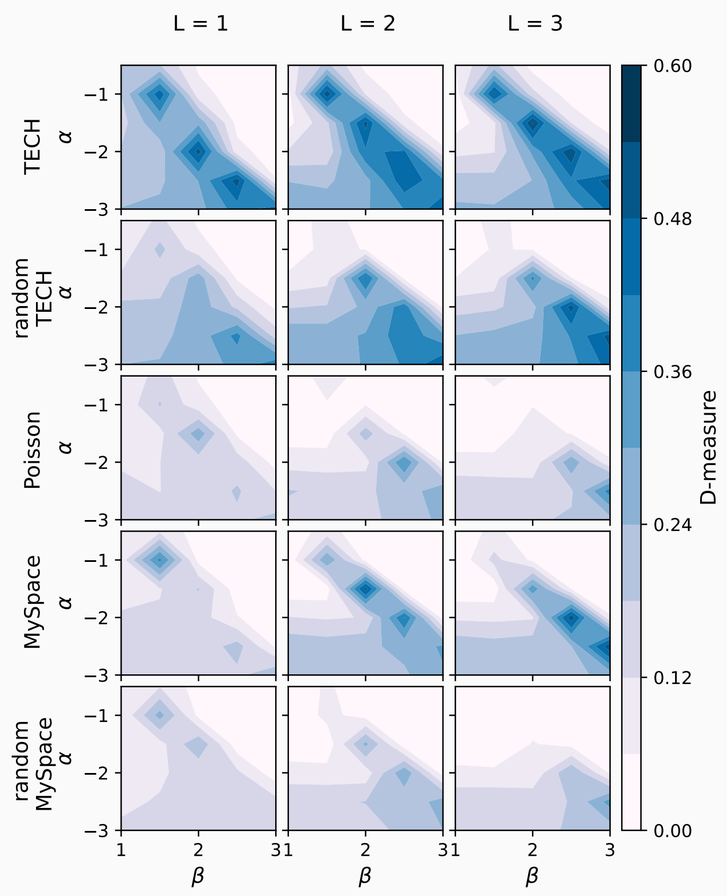
- averaged nodes distance distributions $\mu(G)$, $\mu(G')$.

RESULTS

We use growth signals from real social networks. Signals represent the number of new members at each time step: 1) **TECH social group**, from the Meetup website [3]; 2) **My Space**
Real signals are long-range correlated and have multifractal properties. To remove correlations, the original signals are **randomised**, keeping the average value and standard deviation.
Poisson signal: uncorrelated random signal



Growth signals



Comparison between networks grown with growth signals $M(t)$ and constant signal $M = 1$.

- Generate networks for different parameters of the aging model, α and β and the number of links L=1, L=2 and L=3, while the number of nodes follows growth signals $M(t)$ [4]
- Generate the networks with the same number of nodes and values of model parameters whose growth was constant, $M = 1$
- Compare the structure of evolving networks for $M(t)$ and $M = 1$ using D-measure

Growth signal is an important parameter for the evolution of complex networks. Stronger influence on the structure of scale-free networks.

Signals with trends, cycles and long-range correlations can change the topological properties of the networks.

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