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Long Term Evolution of Email Communication Network

2nd Workshop on Graph-based Technologies and Applications
Barcelona

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Techno-social system: the combination between technology and social interactions

- University email network 2007
- British telephone records
- Air transportation network
Techno-social system: the combination between technology and social interactions

University email network 2007

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British telephone records
Current Methods focus on Short Term Dynamics

Homophily leads to new connections

Information flow

Kossinets, Gueorgi and Kleinberg, Jon and Watts, Duncan. KDD ’08 (2008)
Current Methods focus on Short Term Dynamics

→ Information flow

→ Homofily leads to new connections

What about long term Evolution (on a yearly basis)?
Definition of the network which lead to the Evolution
The Growth of Email Communication has High Variability

To study the Evolution of the network we calculate which is called the **annual logarithmic growth rate (LGR)** of each link.

\[ g_{ij}^\omega = \log \left( \frac{\omega_{ij}(t+1)}{\omega_{ij}(t)} \right) \]
The Growth of Email Communication has High Variability

To study the Evolution of the network we calculate which is called the annual logarithmic growth rate (LGR) of each link.

$$g_{ij}^\omega = \log \left( \frac{\omega_{ij}(t+1)}{\omega_{ij}(t)} \right)$$

The Fit is a convolution of a not centered Exponential distributions and a gaussian distribution.

$$\sigma_{\text{exp}} \approx 0.4 \quad \sigma_{\text{gauss}} \approx 0.1 \quad x_0 \approx 0.08$$
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\[ g_{ij}^\omega = \log \left( \frac{\omega_{ij}(t+1)}{\omega_{ij}(t)} \right) \]

\[ s_i(t) = \sum_{j, j \neq i} (\omega_{ij}(t)) \]

\[ g_{ij}^s = \log \left( \frac{s_i(t+1)}{s_i(t)} \right) \]

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\[ \sigma_{\text{exp}} \approx 0.5 \quad \sigma_{\text{gauss}} \approx 0.009 \quad x_0 \approx 0.2 \]
Individuals have Stable Patterns on Long Term

**Gini Coefficient** is a measure of how equally is distributed the information (email) over each user's contacts.

- **G=0** Equally distributed
- **G=1** Unequally distributed
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\[
G_i(t) \rightarrow G_i(t + \Delta t)
\]

\[
d_{self_i}
\]

\[
G_j(t), j \neq i
\]

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\[ G_{ij}(t) = d_{self_i} \]

\[ G_{ij}(t+\Delta t) \]

\[ G_{ij}(t), j \neq i \]

\[ G = 0 \text{ Equally distributed} \]

\[ G = 1 \text{ Unequally distributed} \]
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\[ d_{self_i} \]

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**Persistence of Social Signatures at the Individual Level**

- **G=0 Equally distributed**
- **G=1 Unequally distributed**

- **Self** $\Delta t=1\text{year}$
- **Self** $\Delta t=3\text{years}$
- **Others** $\Delta t=0\text{year}$

![Graph showing the distribution of Gini values over time](image)
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More:
- http://seeslab.info
- http://twitter.com/sees_lab