Information Spreading in Last.fm Online Social Network

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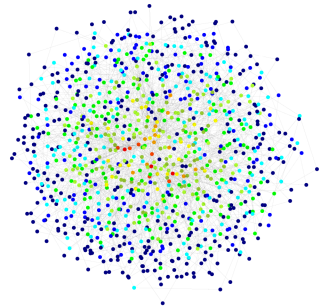

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Introduction

Last.fm

Densification in artist subgraphs

Temporal influences

Summary

Problem

- Characterize *information diffusion*, or *information spreading* by investigating online social networks

LAST.FM

- About Last.fm
  - Leading online service in music based social networking
  - "Scrobbling": collecting listening activity of users
  - Recommendation system for users
  - Social network
  - Public statistics
- Influences
  - People often share their musical taste
  - They recommend each other new artists, albums, tracks
  - Directed influences

Main goal

- User-user social network, with scrobble time series
- Justify the existence of influences, i.e. correlation between individuals and the listening behavior of their contacts

Large dataset

- Available for us under NDA for Last.fm
- Selection criteria
  - Location is stated as UK
  - Date of birth between 1/12/1961 and 1/12/1997
  - Profile displays scrobbles publically
  - $5 \cdot 10^{-5} 1/s \leq Act < 10^{-2} 1/s$, where

    $$Act = \frac{\text{\# scrobbles}}{\text{elapsed time from registration}}$$
  - Scrobbles between January 2010 and December 2011
- Size
  - 10^5 users, $3 \cdot 10^5$ edges, 10^9 scrobbles

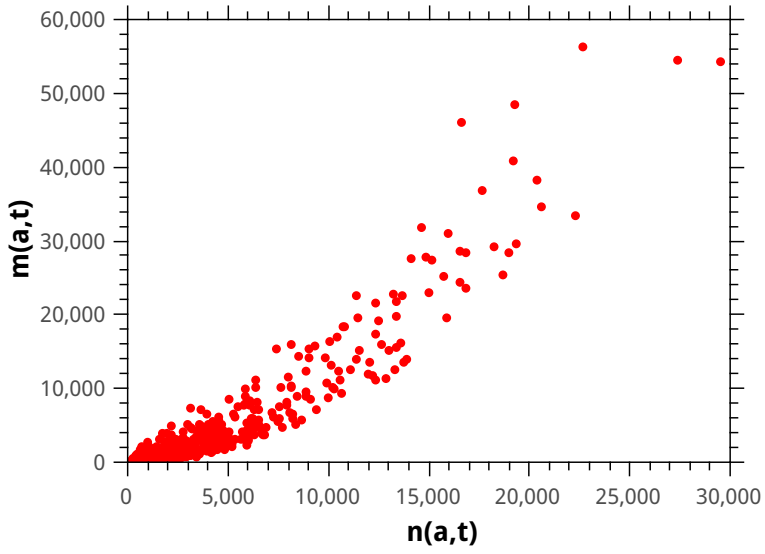
ARTIST SUBGRAPHS

- For artist a in time t

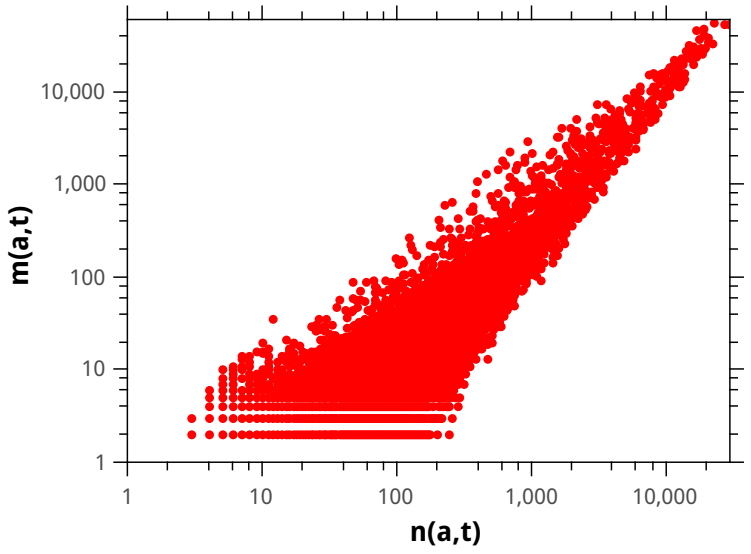
  $$G(a,t) = \{\text{subgraph of users who listened to } a \text{ before } t\}$$

- *Main result:*
  - Increased edge density in $G(a,t)$
  - The number of edges $m(a,t)$ is power-law function of the number of users $n(a,t)$ in the subgraph with exponent ≈ 1.535

MEASUREMENTS



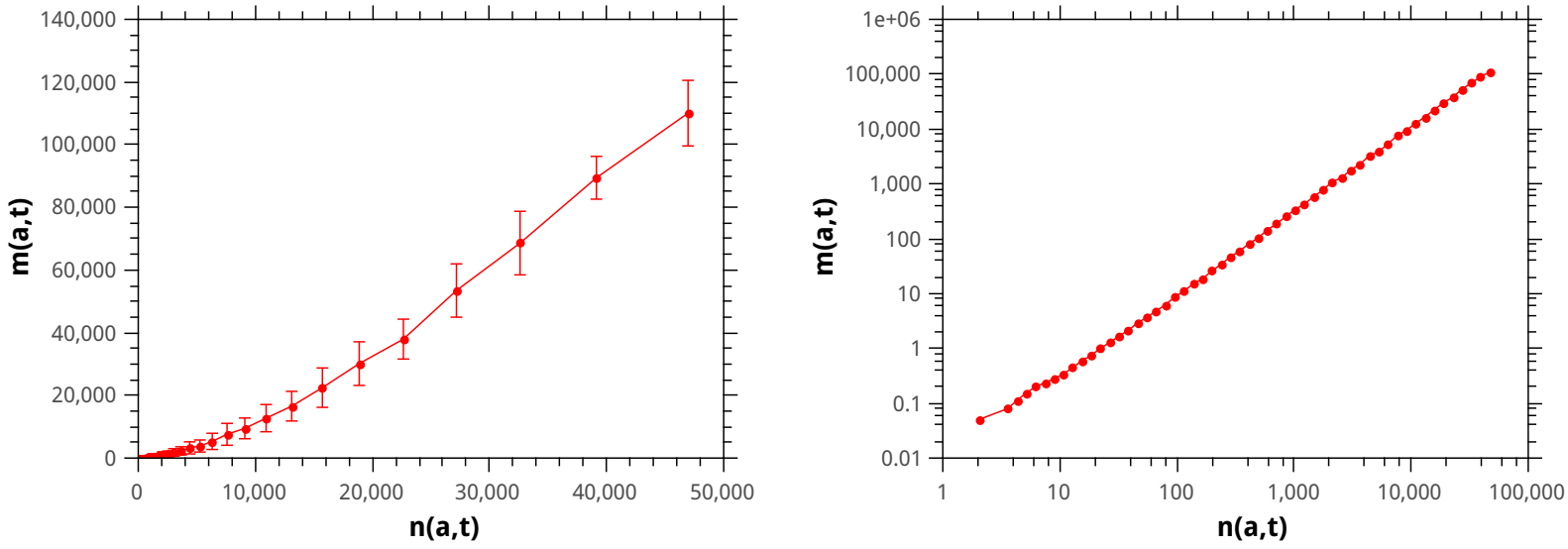
(a) linear scale



(b) log scale

Figure: # edges as the function of vertex number

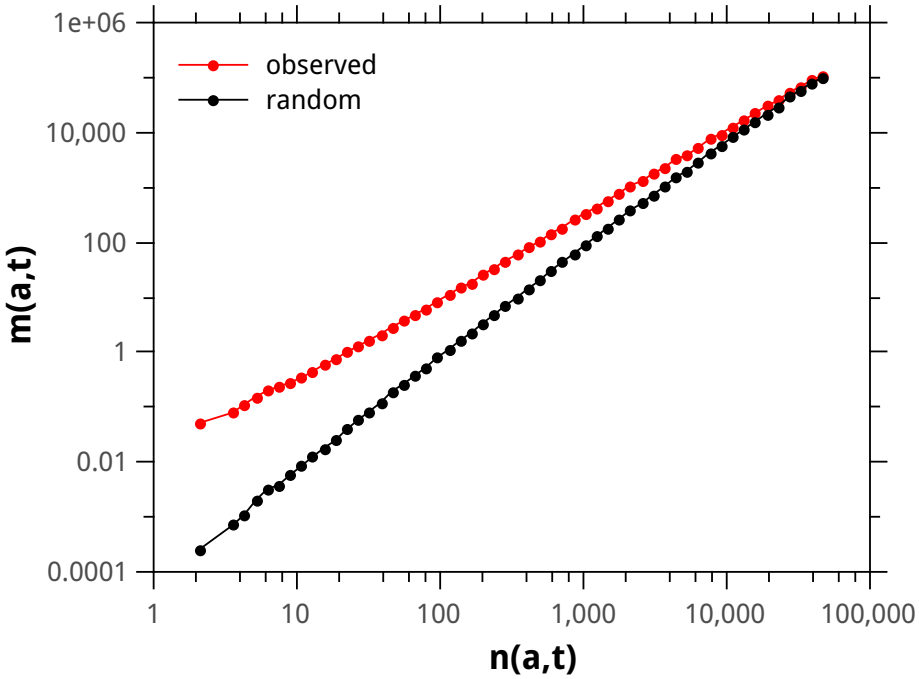
MEASUREMENTS



(a) linear scale (b) log scale

Figure: # edges as the function of vertex number

Difference from the uncorrelated case



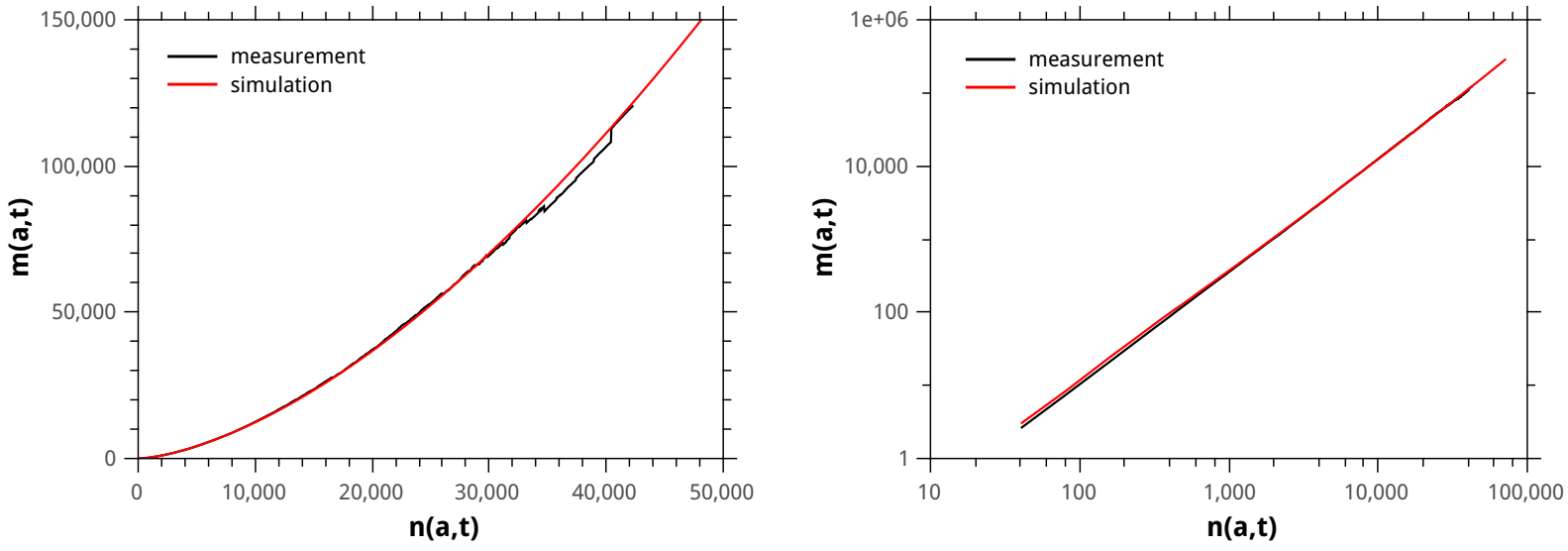
- Larger graphs are denser
- But small artist subgraphs are much denser than random subgraphs

Proposed model

- Fixed friendship network
- At each time, select a new fan of a
- Select randomly proportional to its weight $w(i)$
- Initial weight $w(i)$ is uniform
- User i gets weight at time t when first neighbor j listens to a

$$w(i) = 1 + \frac{C}{d(j)} \left(\frac{n(a,t)}{N} \right)^{-\alpha}$$

Simulation result



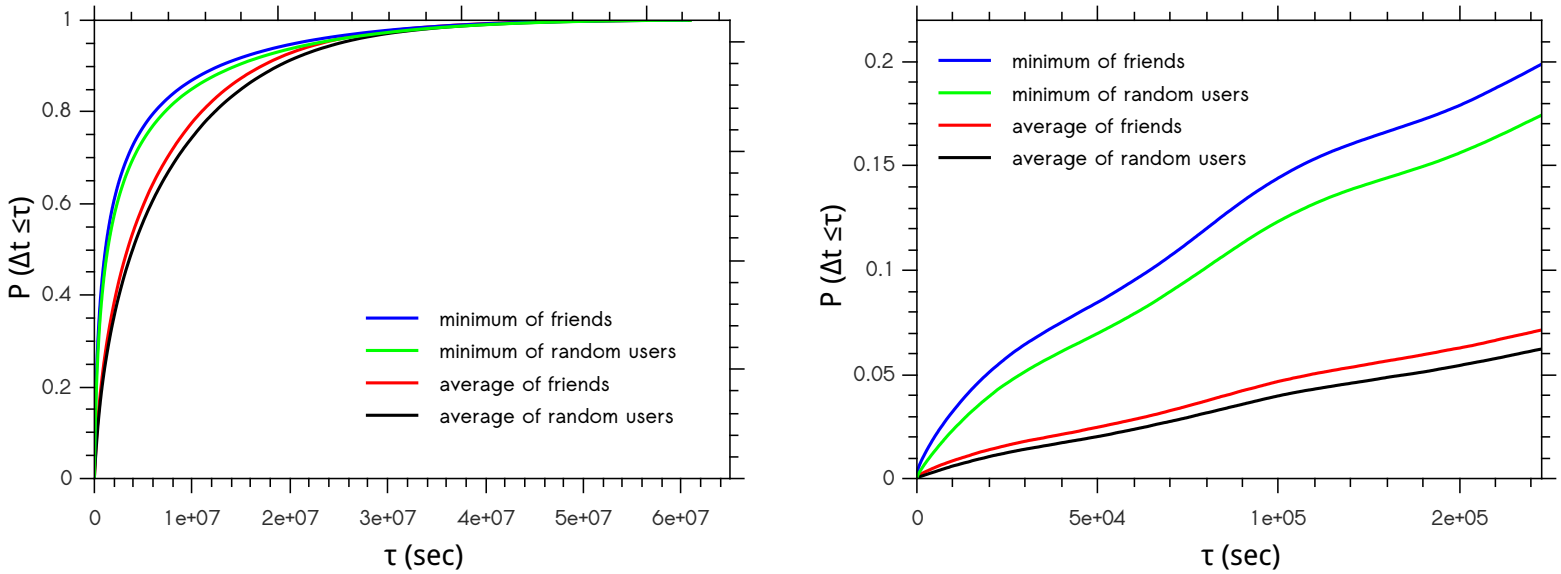
(a) (b)

Figure: Simulation result

Temporal influence

- User j is influenced by user i
- User j listens to a at the first time at t
- If i listens to a at time $t - \Delta t$
- We compute $\overline{\Delta t}$ and Δt_{min} in case of friends and random users.

CDF CURVES



(a) whole distribution (b) first 48 hour

Figure: CDF curves

STRENGTH OF INFLUENCES

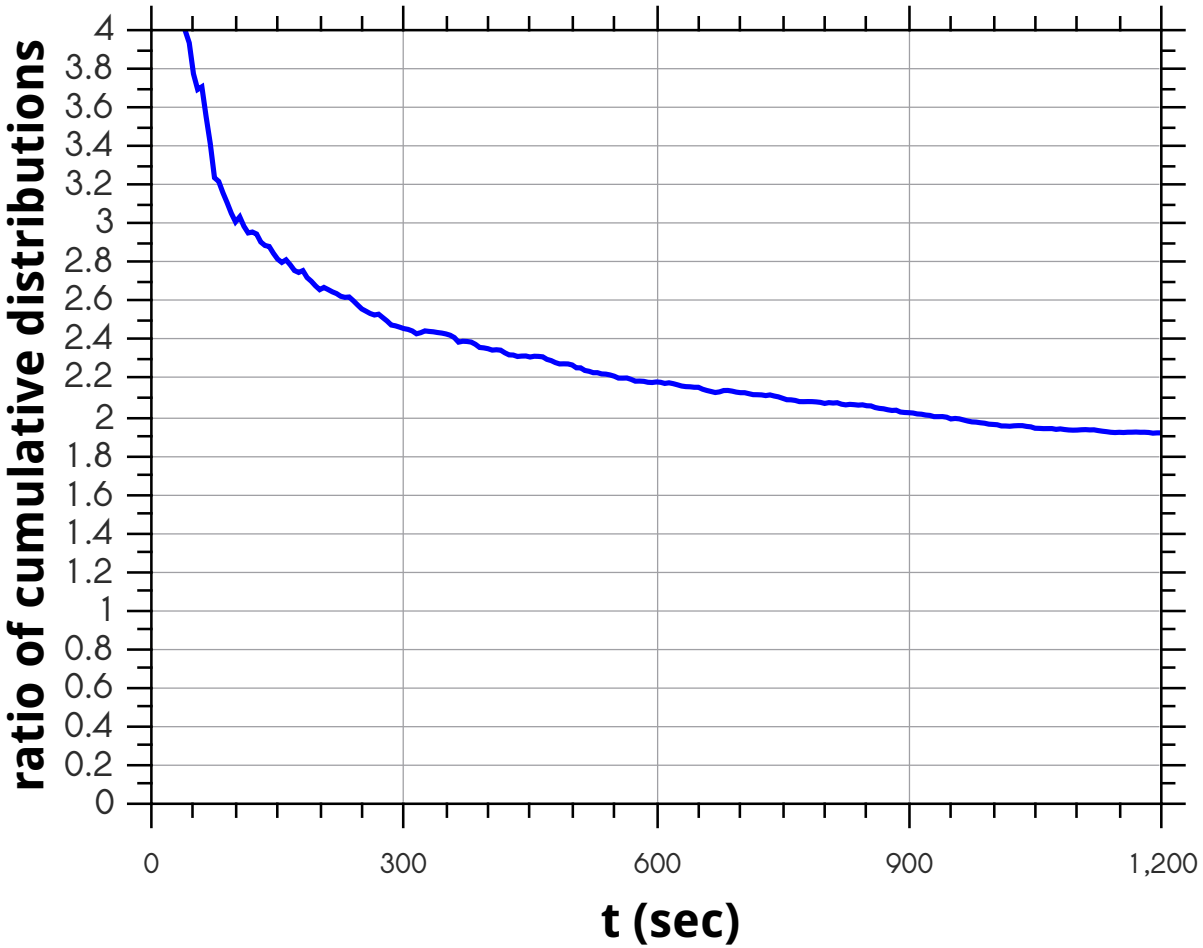
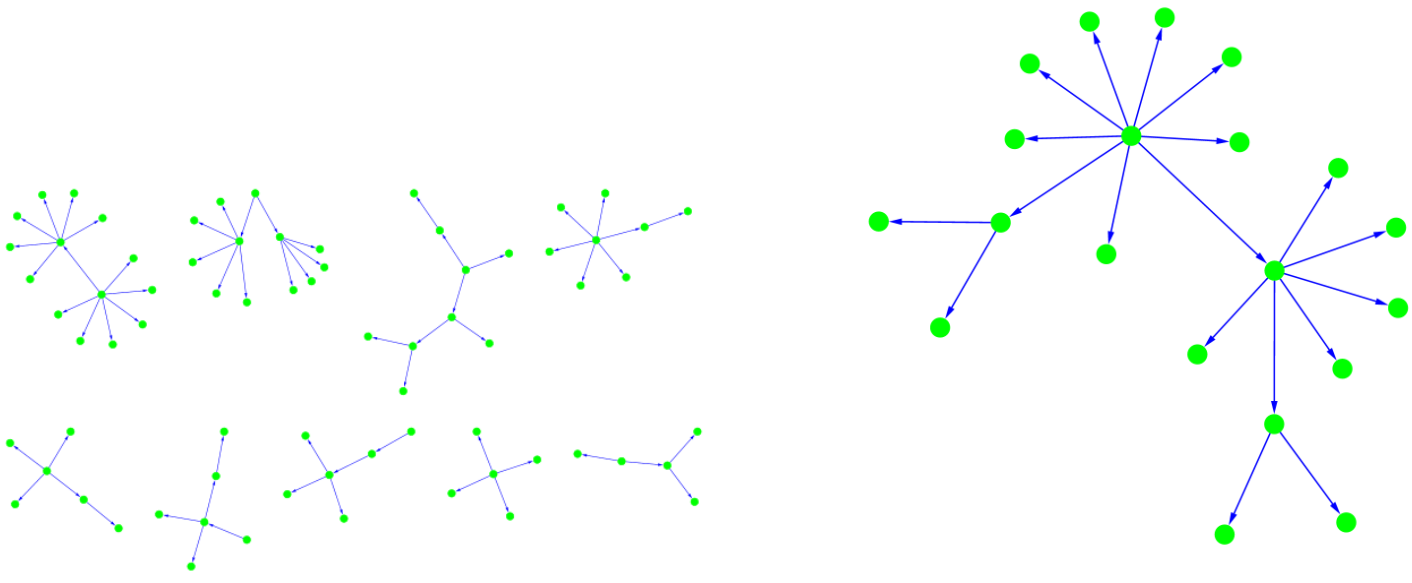


Figure: Ratio of cumulative distributions in the first 20 minutes

INFLUENCES



(a) (b)

Figure: Influences

Summary

- Work in progress over the Last.fm community
- Large dataset
- Increased edge density in artist subgraphs
- Proposed model for artist subgraphs
- Temporal influences
- Strength of influences