The Three Dimensions of Social Prominence

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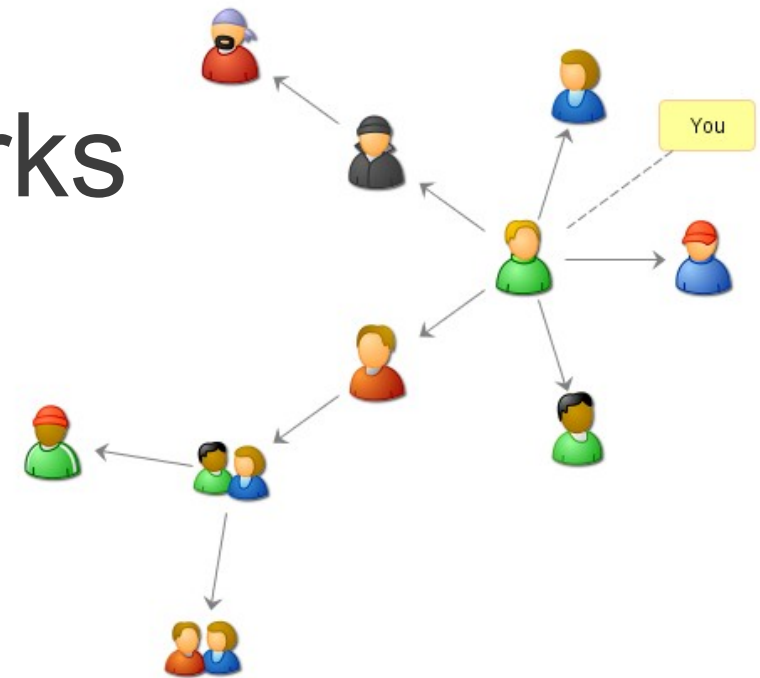
Social Prominence

It has been observed that a small set of users in a social network is able to anticipate (or influence) the behavior of the entire network.

Related Works

- Threshold models
  - Kempe et al. 2003
- Influence as heat diffusion
  - Ma et al. 2008
- Controllability of complex system
  - Liu et al. 2011
- Leader detection to maximize influence spread
 - Goyal et al. 2008

However

- The stress is always on maximizing the influence
    - Or minimizing the seed set of the influencer
- A fundamentally monodimensional view of the problem
- There are different possible scenarios
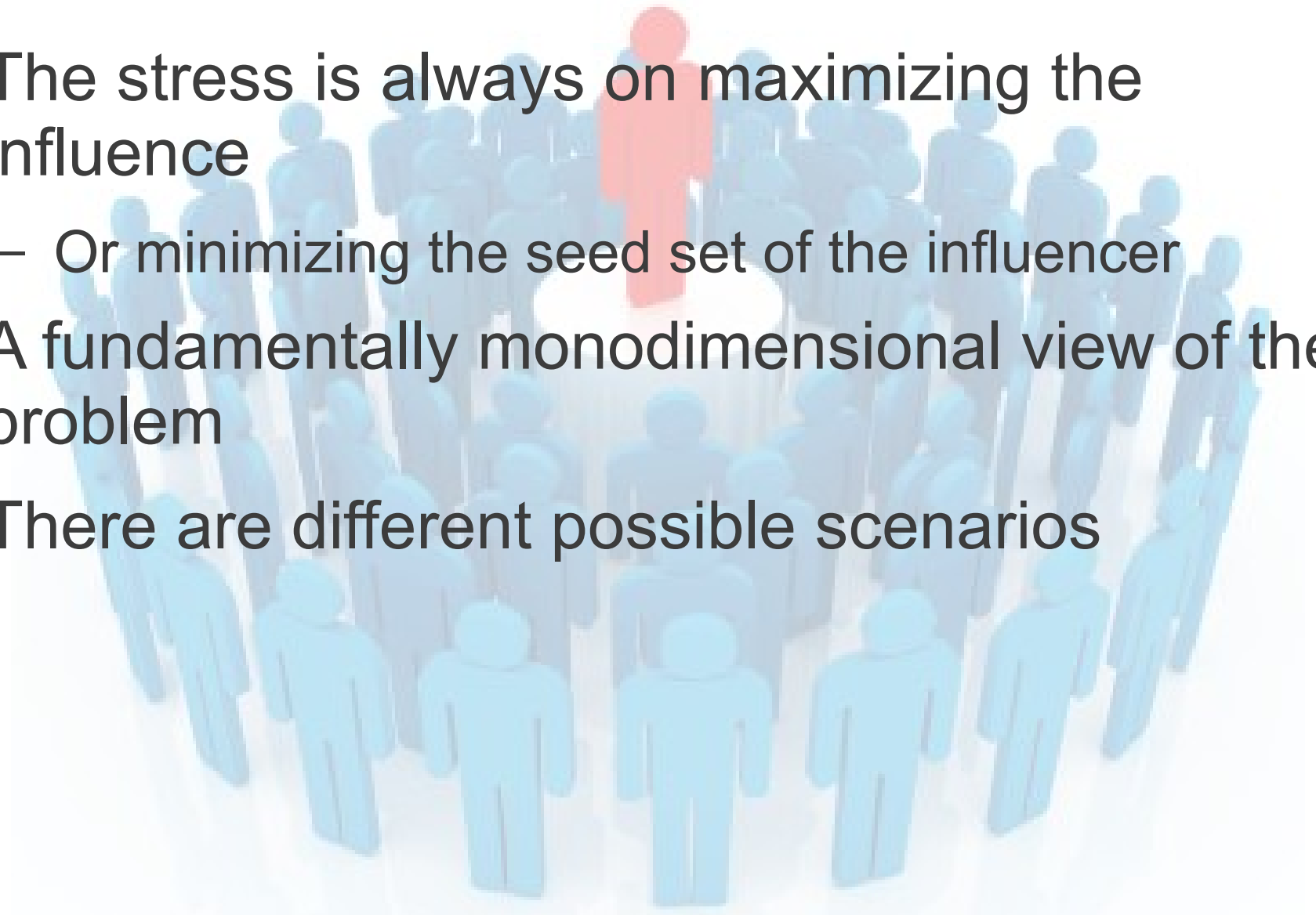
Scenario #1

- An analyst needs information from the personal acquaintances of a subject

- The important aspect is that many subject's direct connections respond

- People two steps away or more are not important
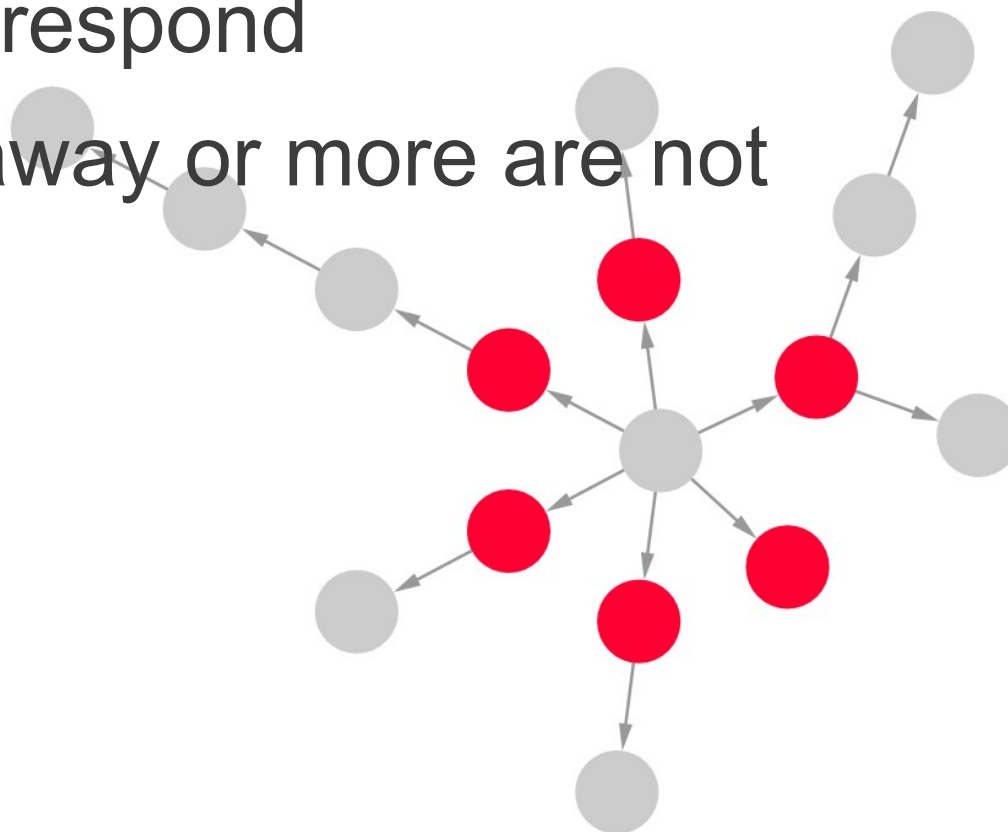
Scenario #2

- A person wants to find another person with a given object

- The important aspect is that some people are able to pass her message through a chain pointing to the target

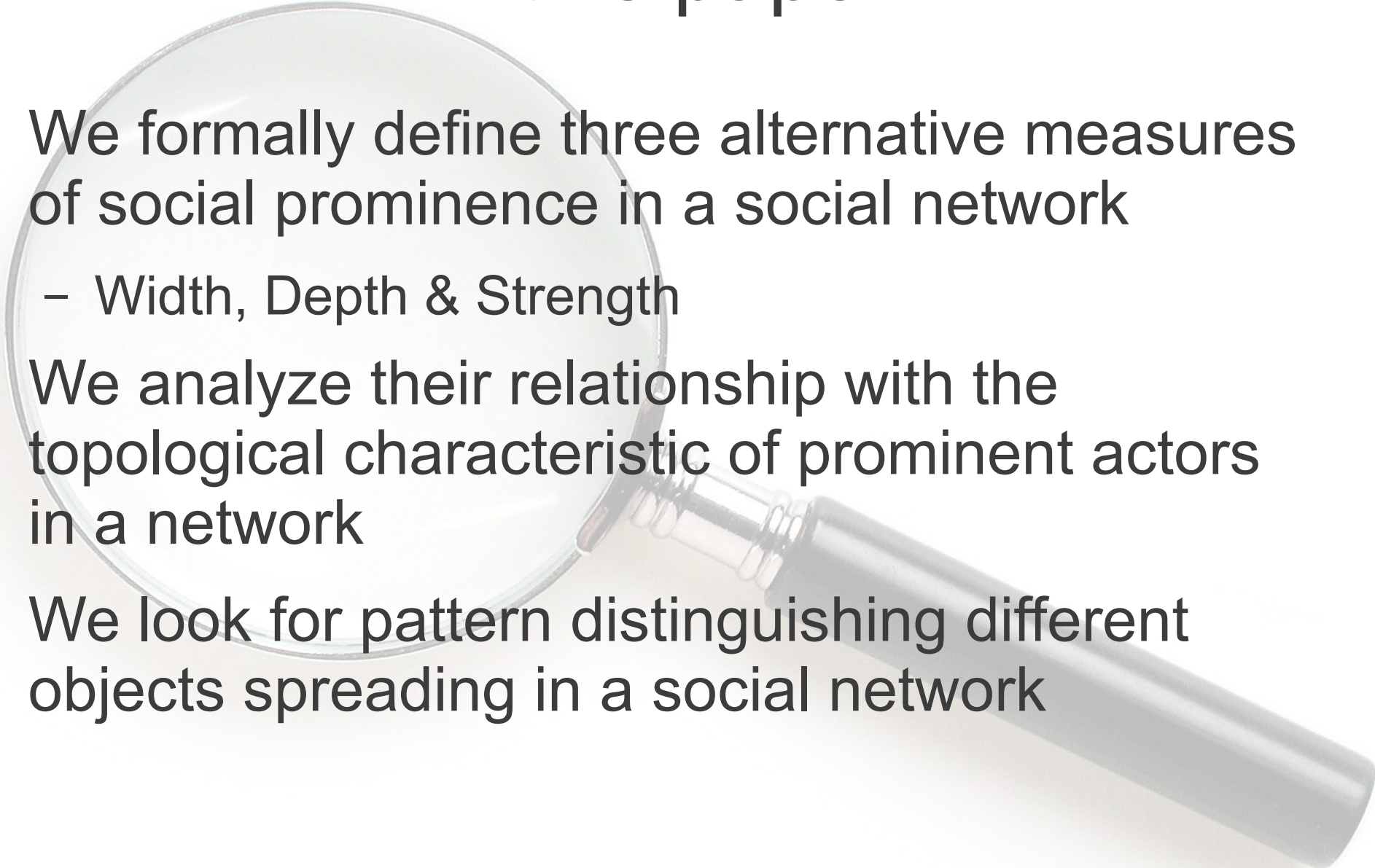- Actually, the **least** people involved, the better!

Scenario #3

- An artist wants to influence people in a social network to her art

- The important aspect is that some people are strongly influenced

- Influenced above the threshold that will make them aware of the art
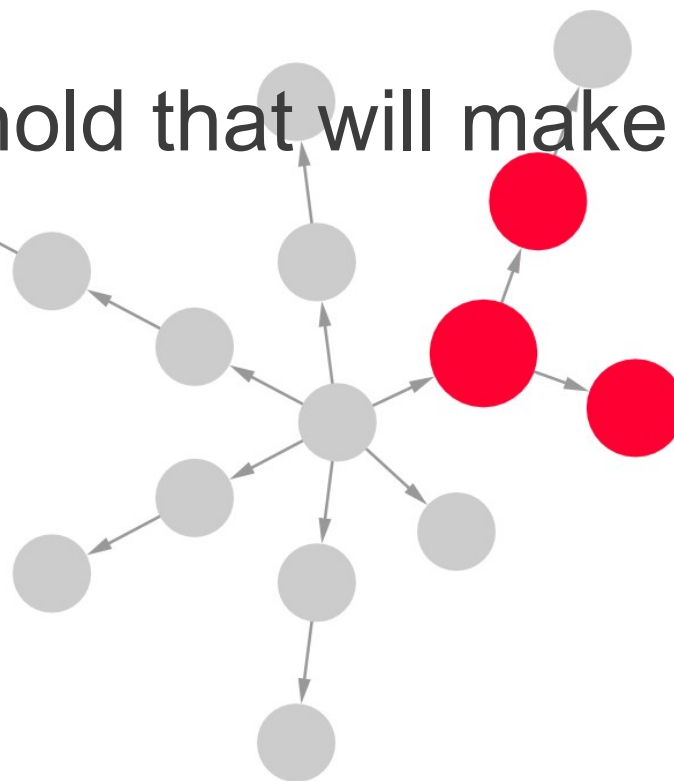
In this paper

- We formally define three alternative measures of social prominence in a social network
    - Width, Depth & Strength

- We analyze their relationship with the topological characteristic of prominent actors in a network

- We look for pattern distinguishing different objects spreading in a social network
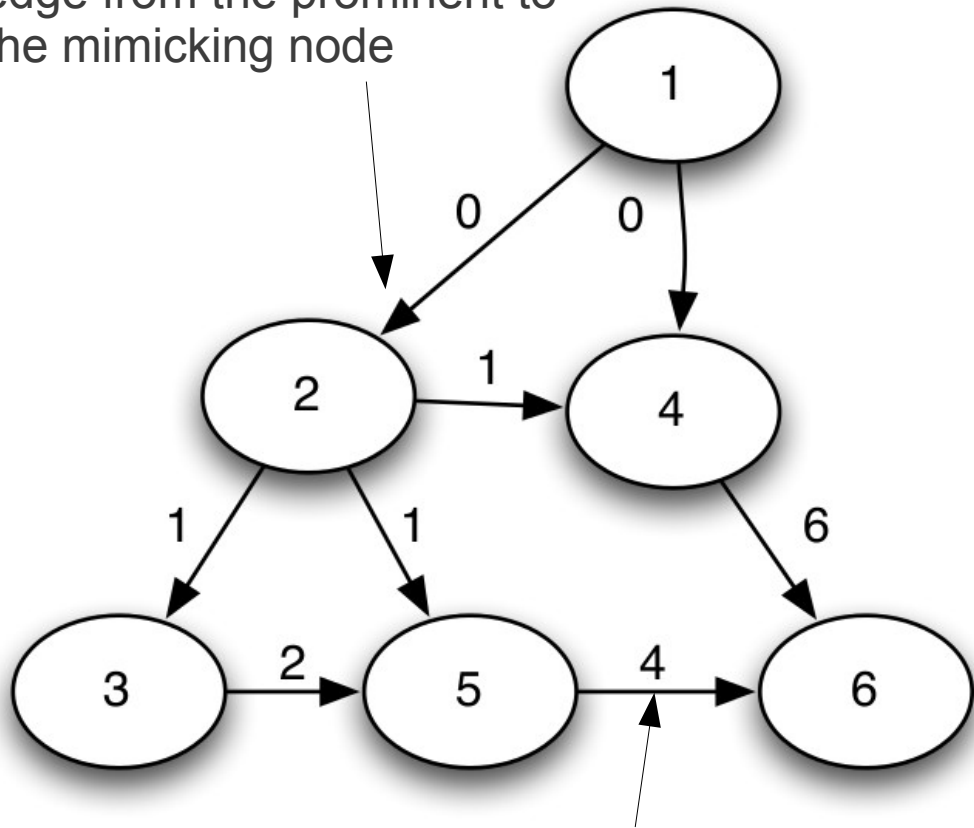
Social Graphs & Actions

$a_{1,x} = (1,0)$ $a_{4,y} = (2,1)$
$a_{2,x} = (2,1)$ $a_{7,y} = (4,3)$
$a_{3,x} = (1,2)$ $a_{8,y} = (5,2)$
$a_{4,x} = (4,6)$ $a_{6,y} = (6,2)$
$a_{5,x} = (1,4)$ $a_{1,y} = (2,3)$
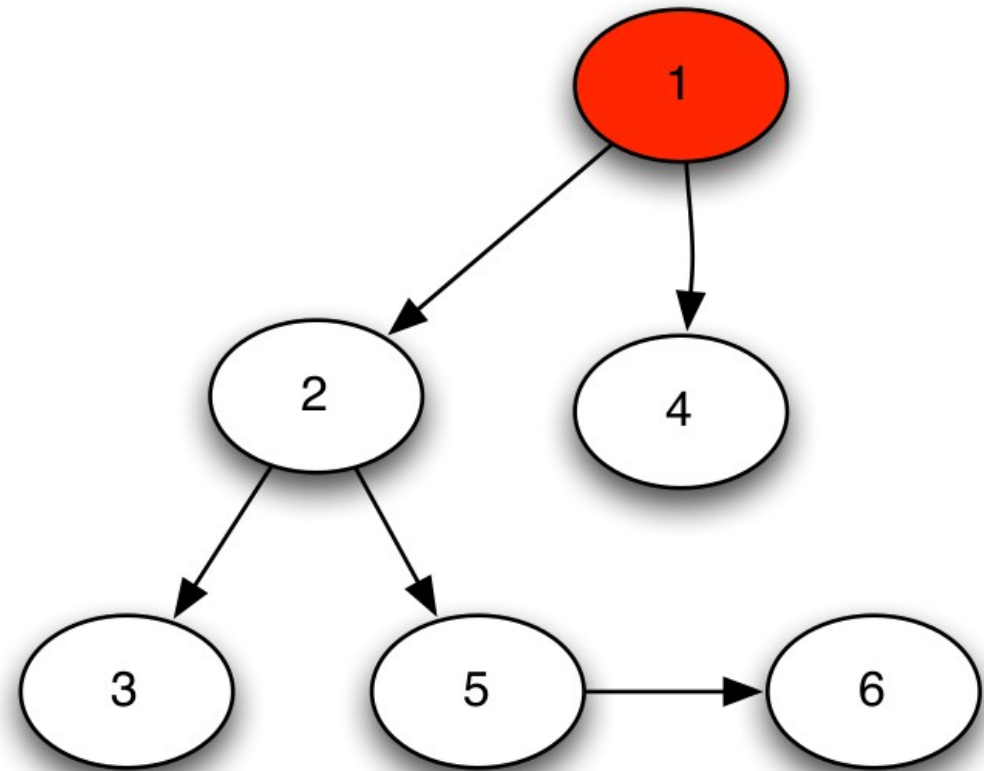$a_{6,x} = (6,7)$ $a_{2,y} = (1,5)$
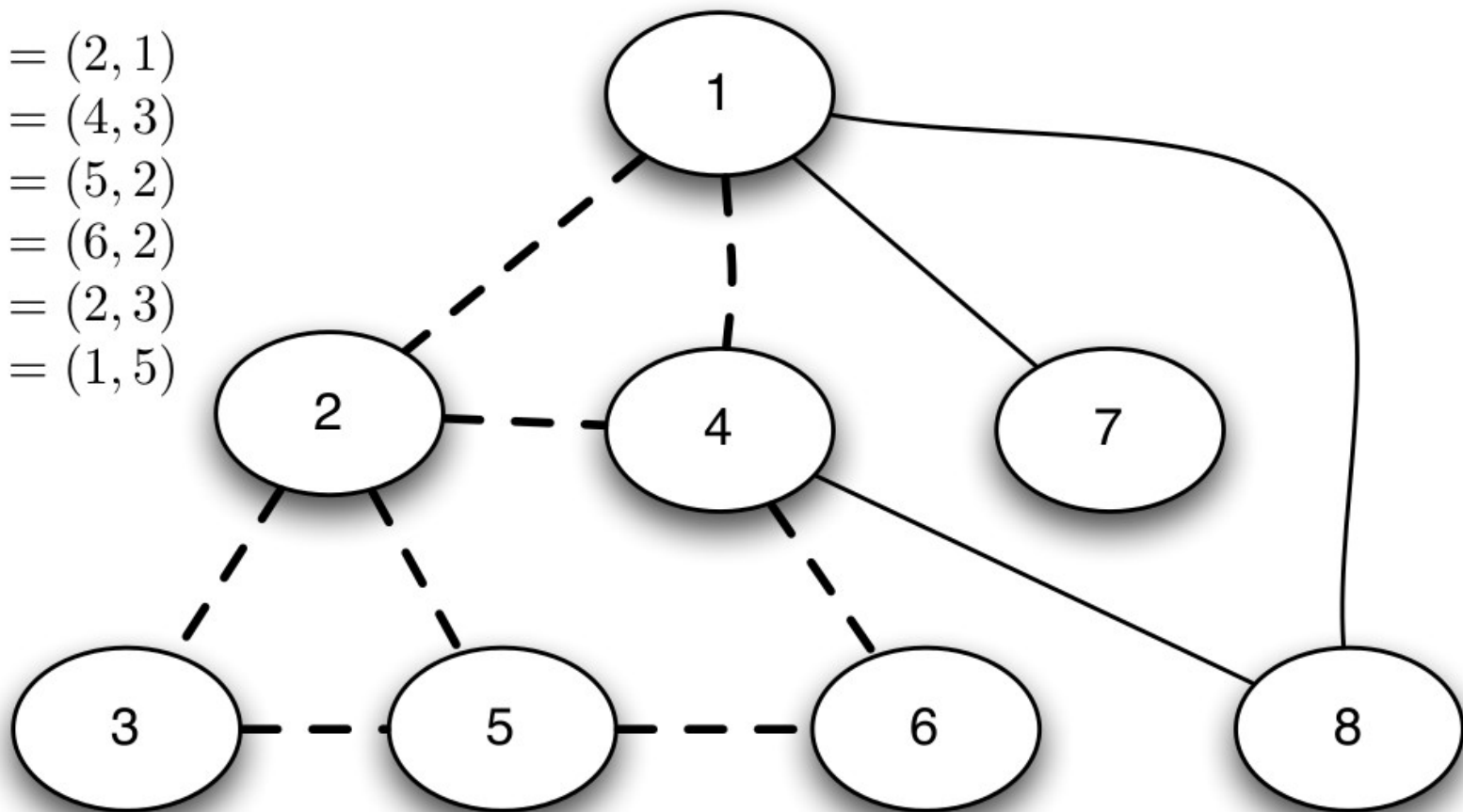
Actions in Action

Each social connection is transformed in a directed edge from the prominent to the mimicking node

The label on the edge represents the timestep in which the prominent node performed the action

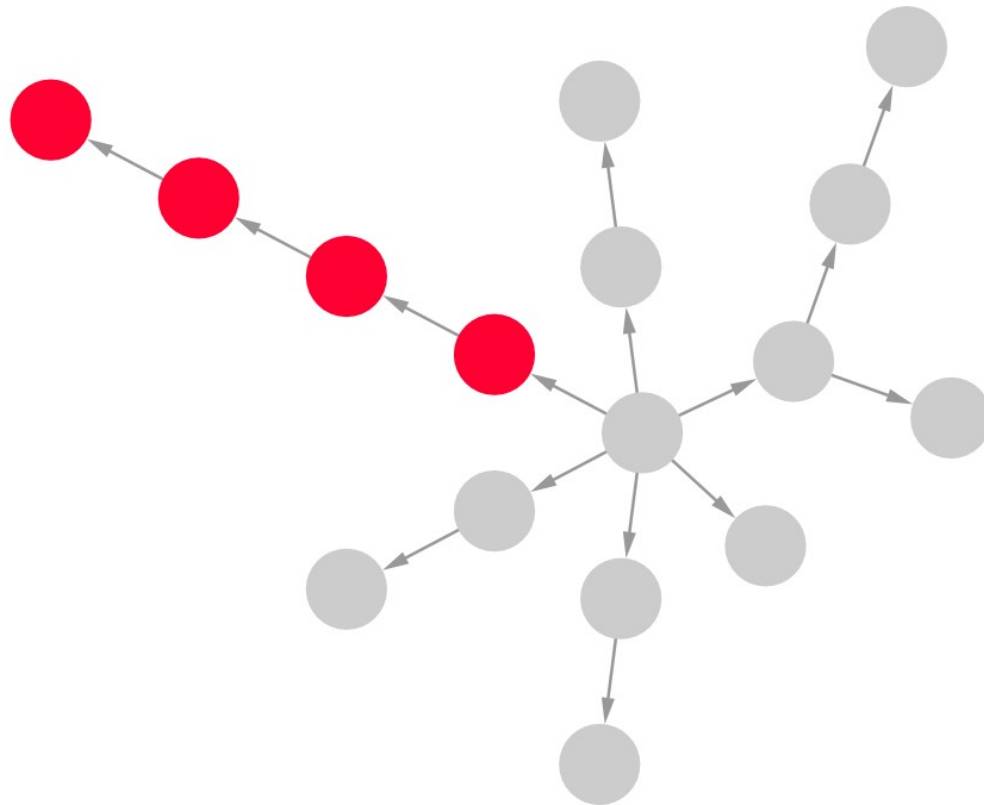The Minimum Diffusion Tree (MDT) is then the minimum spanning tree

Width

"The fraction of your directed connection that performed the action after you"
Neighbors in the MDT / Tot # Neighbors
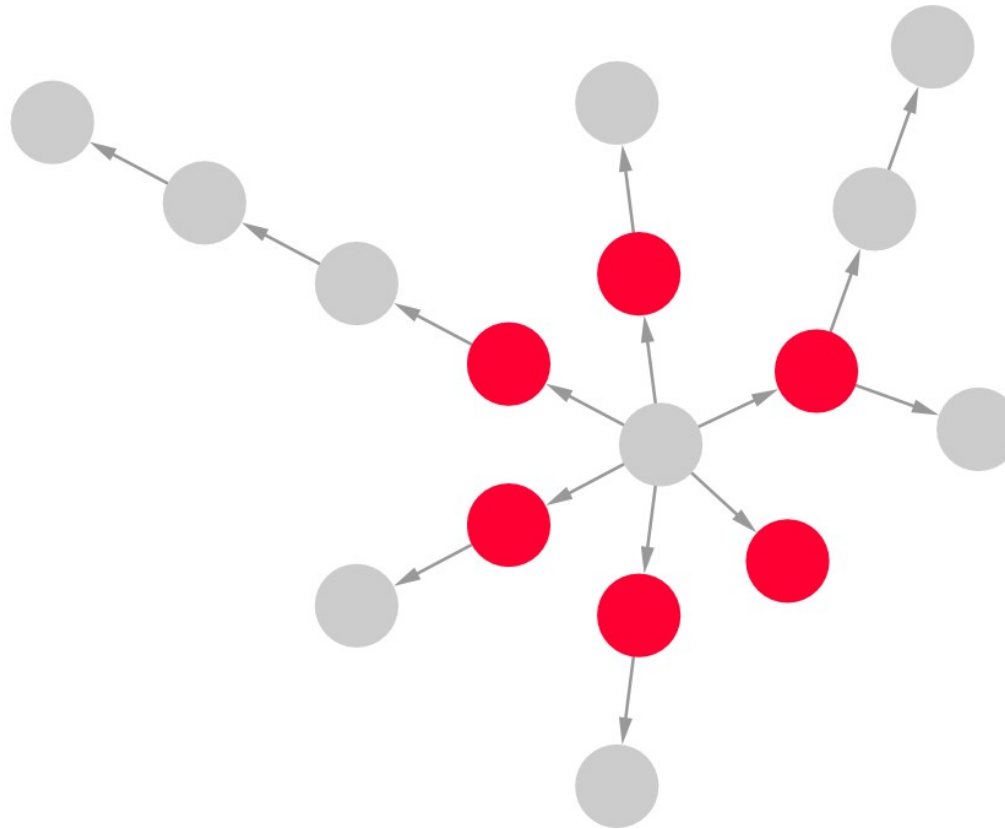
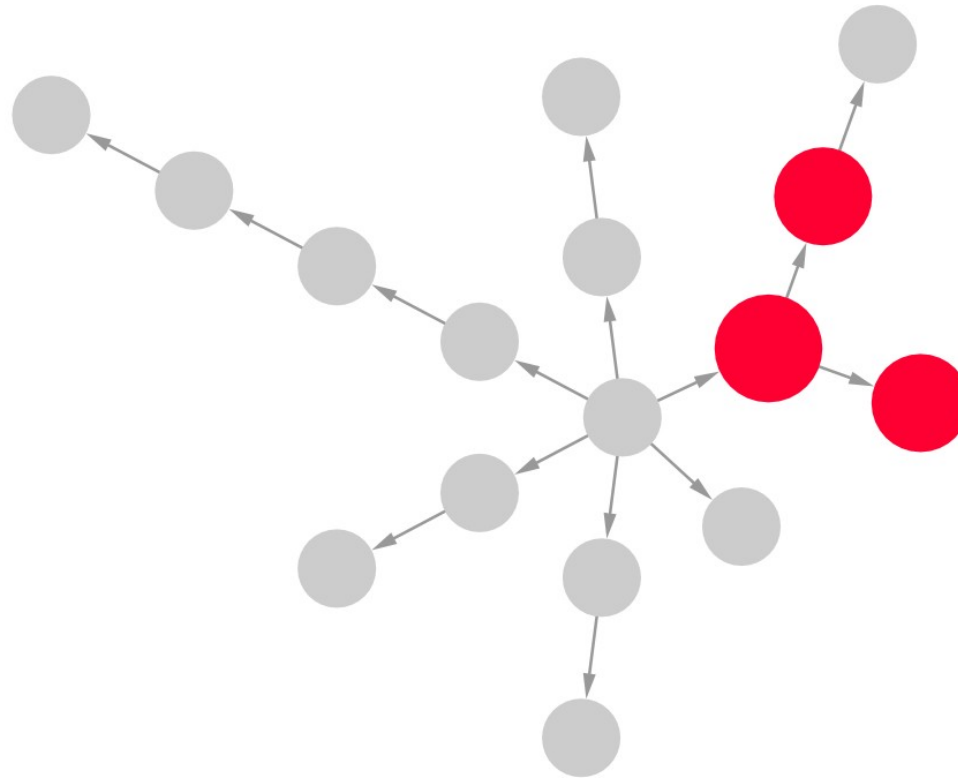$$width(l, \psi) = \frac{|\{u | u \in \Gamma(l) \wedge \exists a_{u,\psi} \in \mathcal{A}\}|}{|\Gamma(l)|}$$

Depth

"How far is the last node mimicking the action you performed first"
Diameter of the MDT

Strength

How committed are the nodes to the action they are mimicking from you
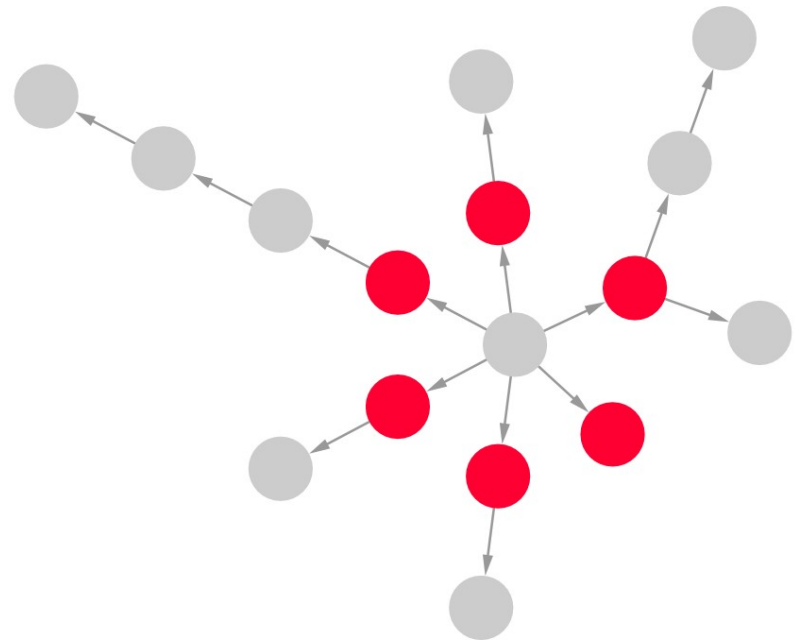Distance adjusted count of the number of times the action is performed

$$strength(T_{l,\psi}, \beta) = \sum_{i \in [0, depth(l)]} \beta^i L(T_{l,\psi}, i) \qquad L(T_{l,\psi}, i) = \sum_{\{u | u \in T_{l,\psi} \wedge distance(l,u) = i\}} \frac{w_{u,\psi}}{w_u}$$
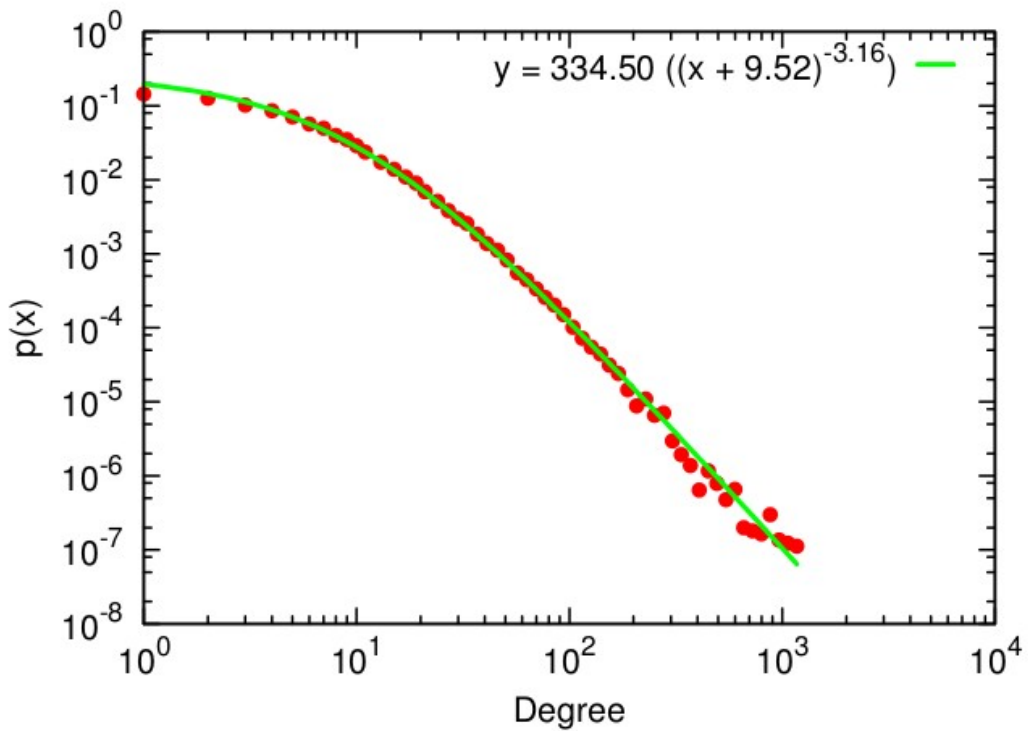
Data

Select random seeds from UK Last.fm
Crawled the friendship graph using BFS
Reached the fifth degree of separation
Collected all "scrobbles" from Jan 2010 to Dec 2011
Scrobbles are grouped in weekly snapshots

Data

Degree distribution per node

$$y = 334.50 \, ((x + 9.52)^{-3.16})$$

Listener distribution per artist

$$y = (x + 2.27)^{-1.58} e^{-x/15203}$$
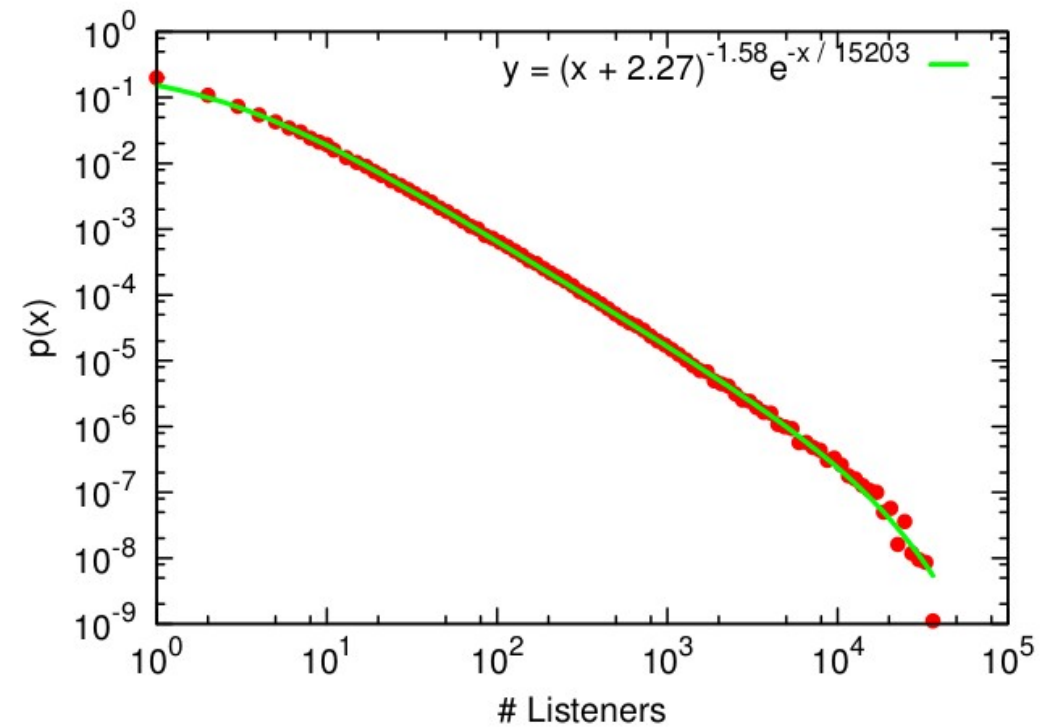
Detecting artists' genre

Metal

Metal, Rock

Metal, Punk

Metal, Rock

Metal

Metal = 5 / 8 = .625
Rock = 2 / 8 = .25
Punk = 1 / 8 = .125

Metal!
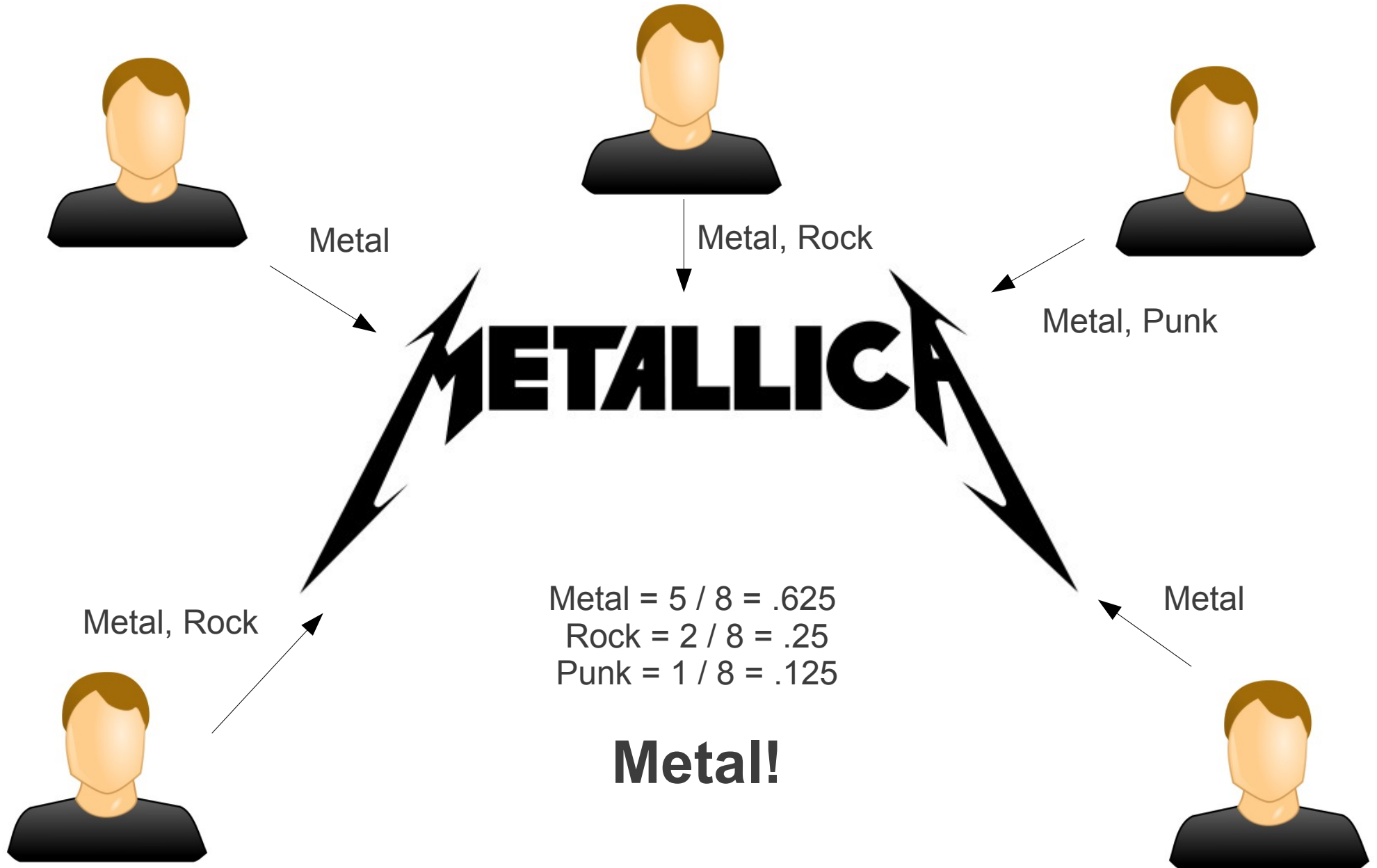
Result #1

|	Width	Strength	Degree	Clustering	Neigh Deg	Bet Centr	Clo Centr
AVG Depth	-0.03	**-0.23**	-0.08	0.05	-0.08	-0.02	**-0.13**
Width	-	0.01	**-0.31**	**0.13**	0.05	-0.07	**-0.59**
Strength	-	-	0.02	-0.02	0.03	0.00	0.04
Degree	-	-	-	**-0.16**	-0.02	**0.77**	**0.56**
Clustering	-	-	-	-	-0.05	-0.06	**-0.32**
Neigh Deg	-	-	-	-	-	-0.00	**0.39**
Bet Centr	-	-	-	-	-	-	**0.22**

Central nodes are characterized by low Depth & Width
High Width are usually reached only by nodes in tightly knit communities
There is a trade-off between Depth and Strength
(Not between Depth and Width nor Strength and Width)

Clusters of Measures

| Cluster	size	dance	ele	folk	jazz	met	pop	punk	rap	rock
0	1822	1.25	1.13	**1.54**	1.37	1.50	0.76	1.31	1.13	1.10
1	136	1.28	1.55	1.28	**2.35**	0.78	0.73	0.64	1.35	0.70
2	664	0.59	0.87	0.98	0.48	0.95	0.97	**1.50**	1.20	1.19
3	482	1.26	1.16	1.09	1.12	0.91	0.80	**2.48**	1.24	0.89
4	973	1.14	1.20	1.15	**1.41**	0.80	0.91	0.66	0.97	0.97
5	512	**1.29**	0.96	0.95	1.09	1.10	0.97	0.33	1.06	1.01
6	682	0.89	0.79	0.61	0.64	**1.13**	1.08	1.07	1.08	1.01
7	124	0.75	**1.45**	0.35	0.64	0	1.09	0	1.02	0.62
8	524	0.93	1.01	1.12	0.91	**1.15**	1.07	0.43	0.95	0.87
9	937	0.40	0.46	0.19	0.23	0.45	**1.56**	0.13	0.37	1.06
10	232	0.72	0.57	0.27	0.99	0.38	**1.44**	0.38	0.46	1.00
11	612	0.74	0.94	0.71	0.40	0.70	**1.27**	0.07	0.68	0.83
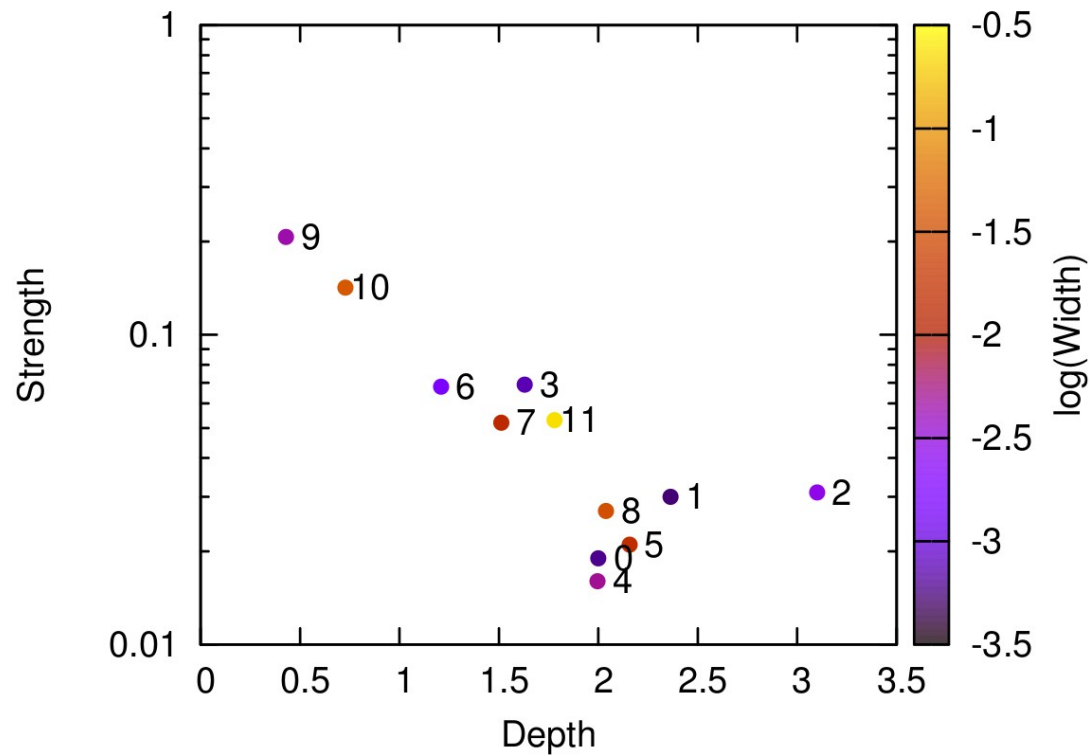
- **Jazz**: 1 (lowest Width) and 4 (lowest Strength): not easy to be prominent
- **Pop**: 9, 10, 11 (lowest Depth, highest Strength): leaders for pop artists are embedded in groups of users very engaged with the new artist, but not prominent among their friends
- **Punk**: 2 (high Depth): long cascades, exactly the opposite of the pop genre
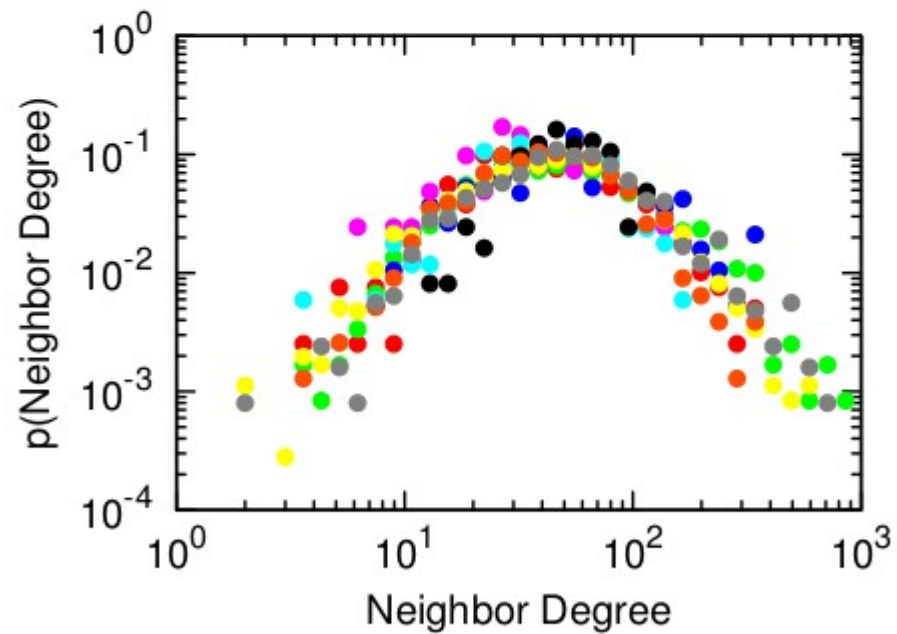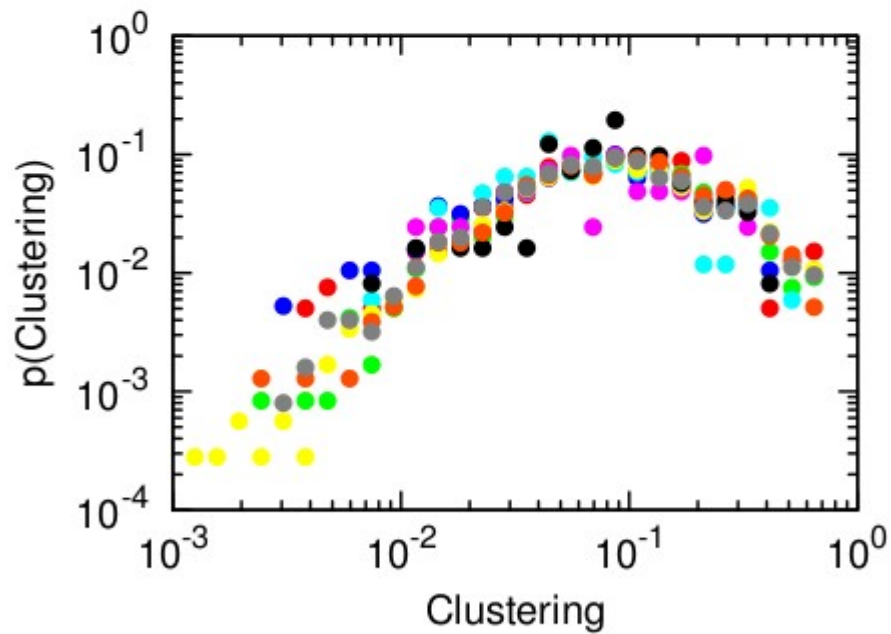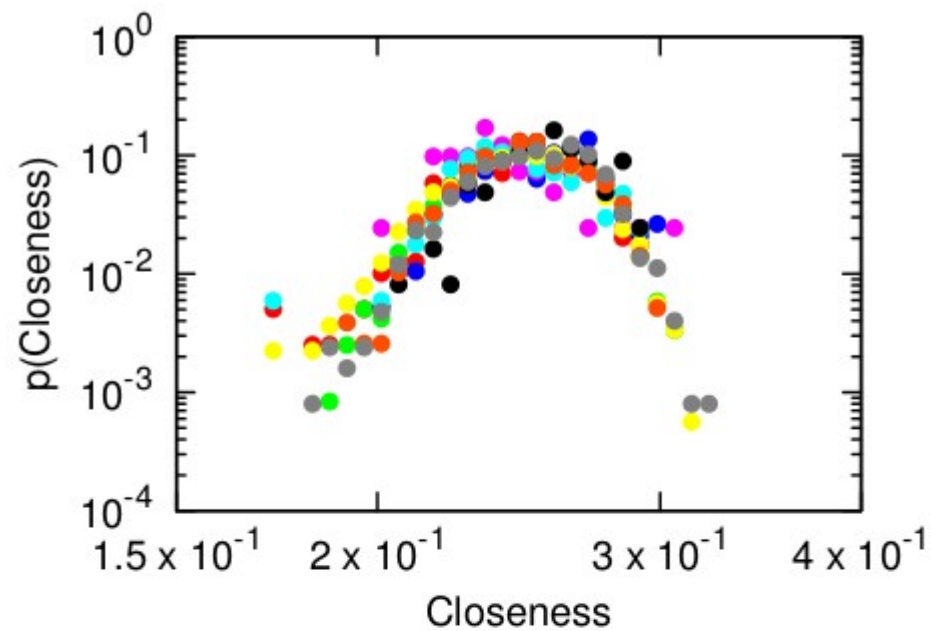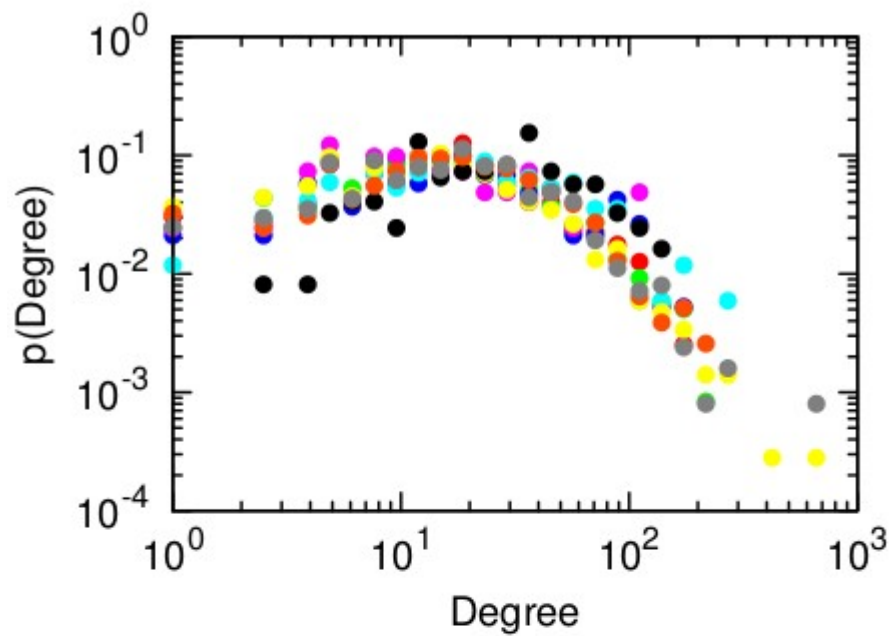
Dance 🔴 Folk 🔵 Metal 🔵 Punk 🔵 Rock ⚫

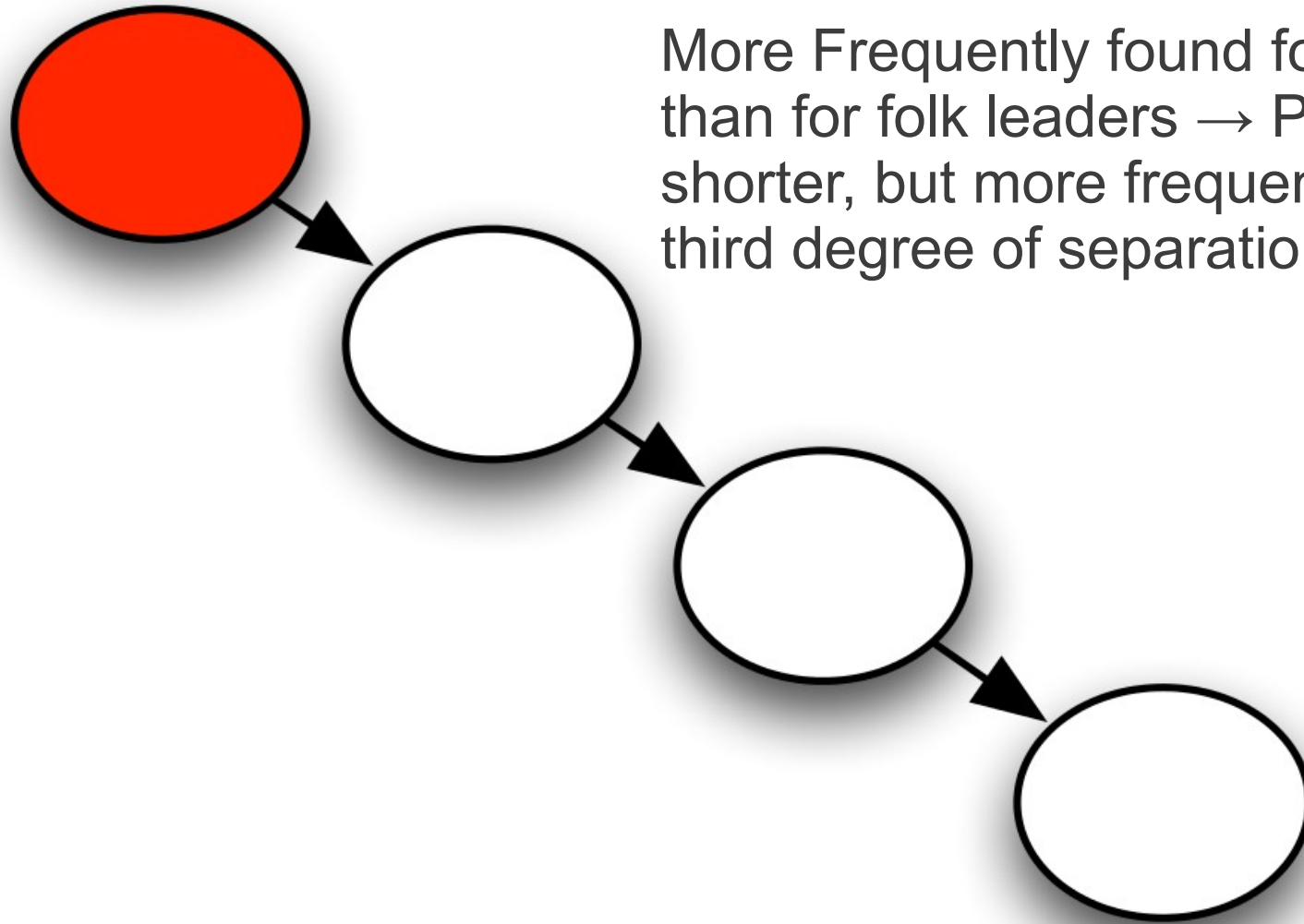Electronic 🟢 Jazz 🟣 Pop Rap 🟡 🟠
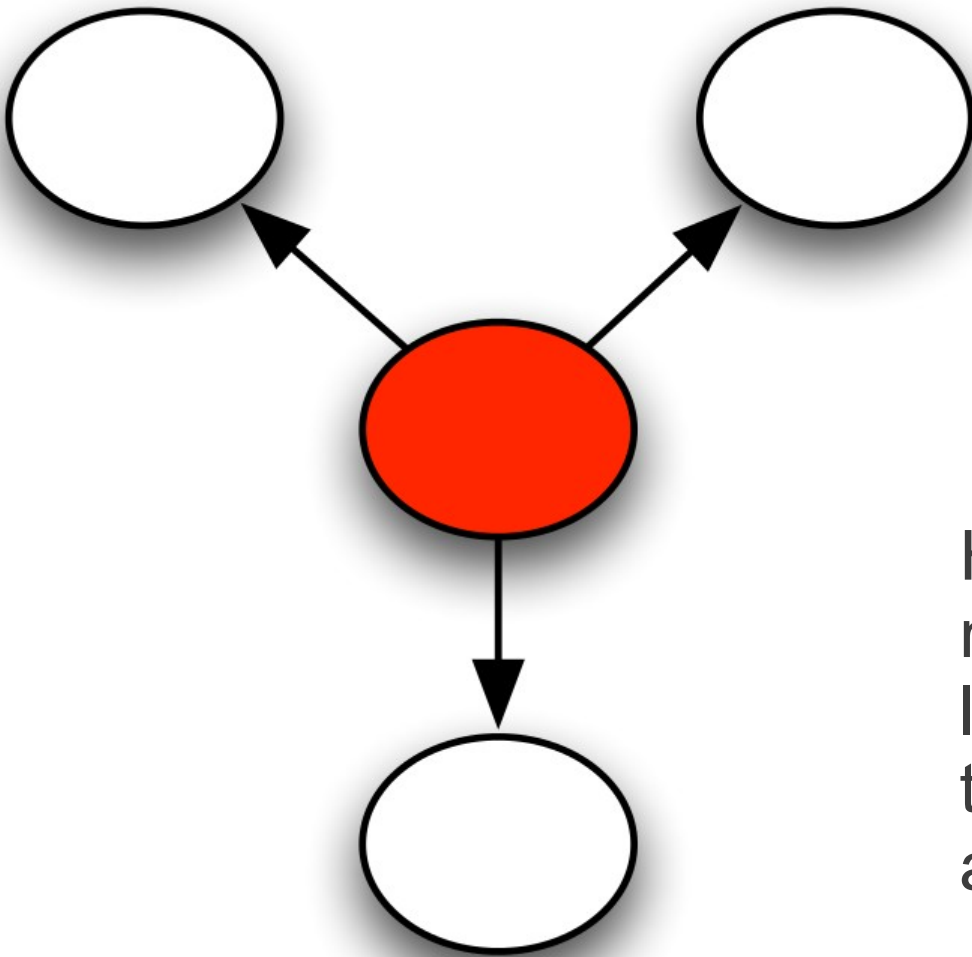
Diffusion Motif #1

High in the Jazz prominent nodes (62.5%) → While with low Width, in Jazz at least three friends will mimic the action
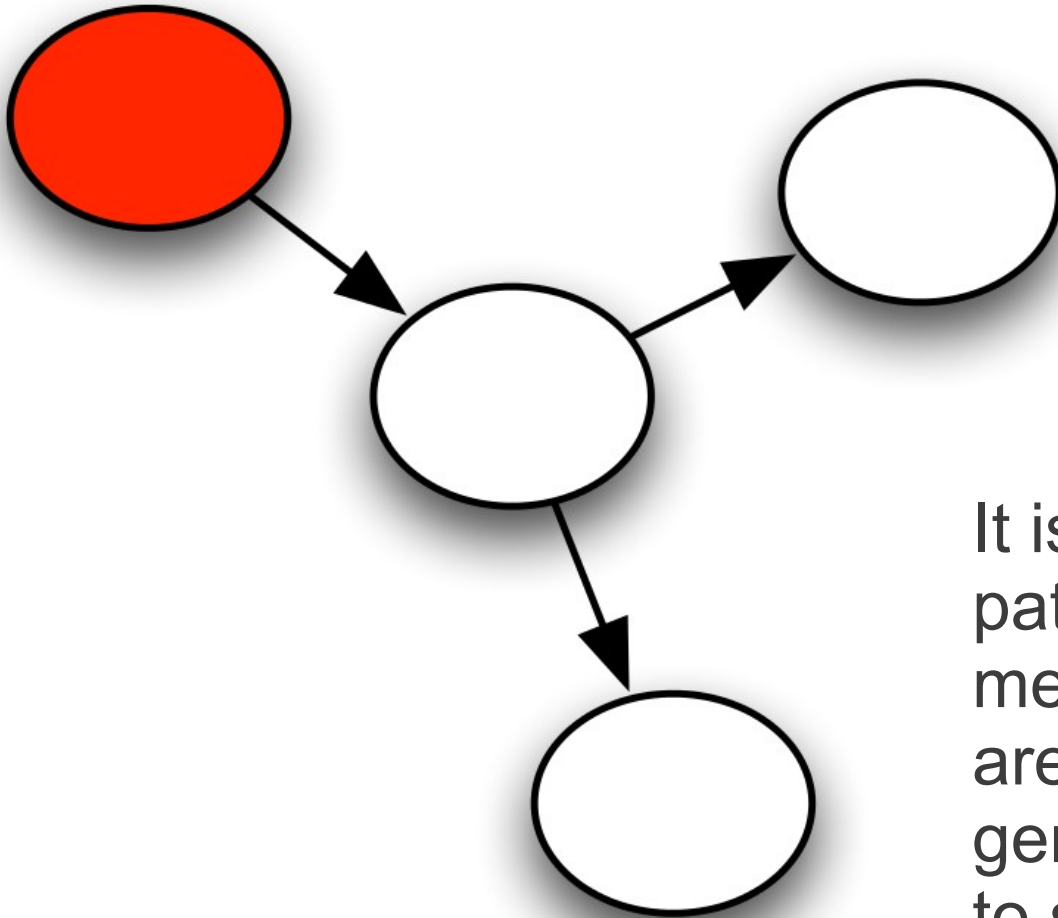
Diffusion Motif #2

More Frequently found for pop leaders than for folk leaders → Pop chains are shorter, but more frequently get to the third degree of separation
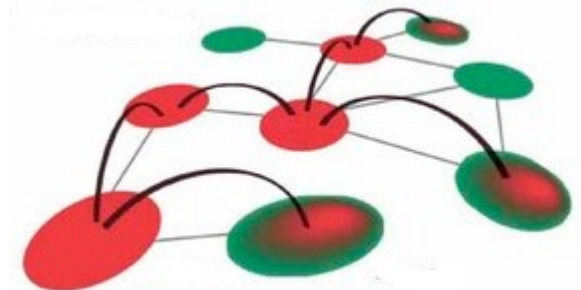
Diffusion Motif #3

It is the most common pattern for the leaders in metal genre → Metal users are very devoted to their genre and that brings them to strongly committed friends too

Conclusion

- We described three alternative dimensions of prominence spread

- We found that:

  - Hubs have questionable importance in this task

  - A trade off between reach and commitment

  - Better Width in tightly knit communities

- We can characterize how different music genres spread fro user to user

Thank you!

Questions?