Dynamics of Social Networks

Hamed Haddadi
Hamed.haddadi@cl.cam.ac.uk

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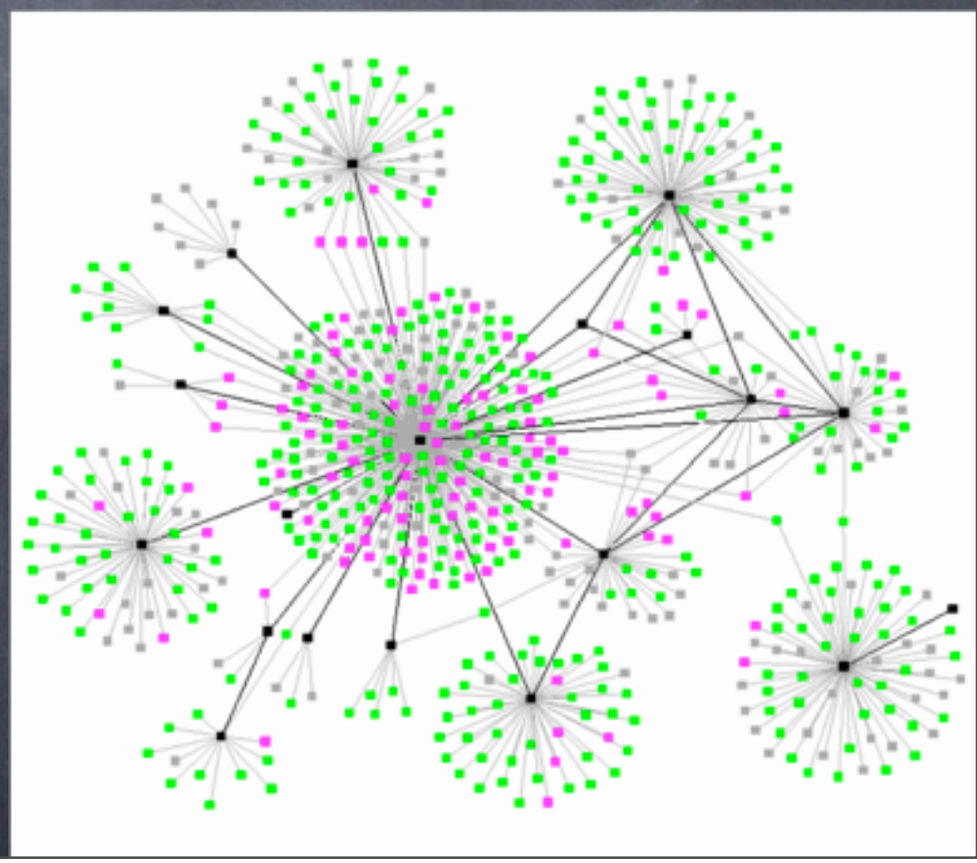
Mphil ACS Network Architecture

Social Networks

- Association != friendship
- Proximity != association
- Kinship=friendship
- friendship != friendship
- WHAT?!?!?!?!?!??!?
- Need to go beyond the surface

.....Let's start with OSNs



Online Social Networks

- Average usage 5.5 hours a day (Source: http://news.cnet.com/8301-1023_3-10457480-93.html)
- Some of the largest content providers (youTube, Facebook, myspace, flickr)
- Everyone is "there, somewhere" (passive or active)

- Easy to find users by finding their friends/community

Country	Unique Audience (000)	Time per Person (hh:mm:ss)
United States	142,052	6:09:13
Japan	46,558	2:50:21
Brazil	31,345	4:33:10
United Kingdom	29,129	6:07:54
Germany	28,057	4:11:45
France	26,786	4:04:39
Spain	19,456	5:30:55
Italy	18,256	6:00:07
Australia	9,895	6:52:28
Switzerland	2,451	3:54:34

Source: The Nielsen Company

Blogosphere

two months worth
of web feeds from 15 popular blog hosting sites
on the Internet.

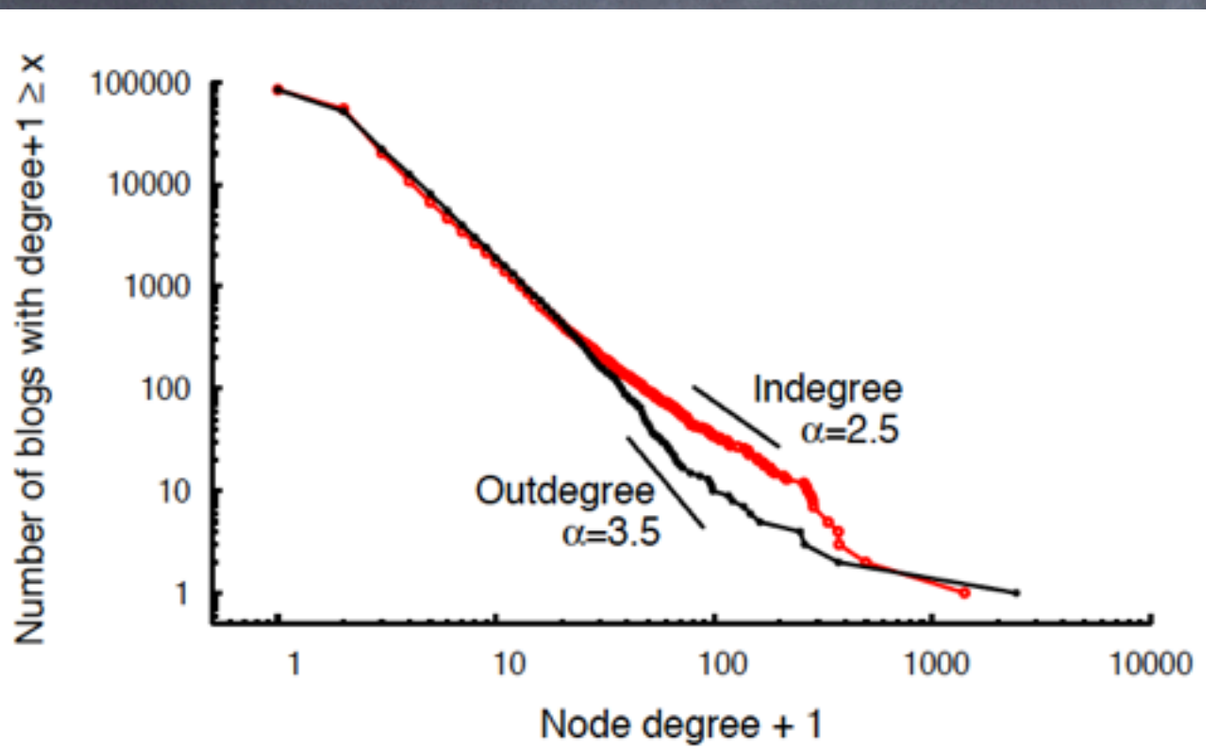
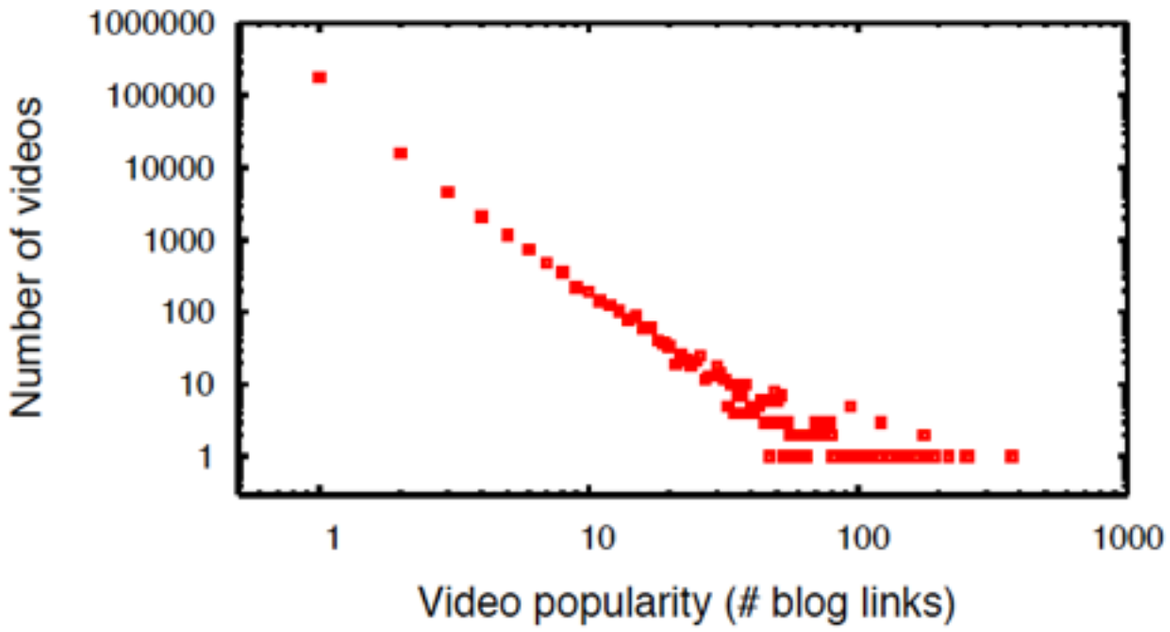


Figure 2: Degree distribution of the blog graph



Cha, Perez, Haddadi, "Flash Floods and Ripples:
The Spread of Media Content through the Blogosphere", ICWSM 2009

Diffusion of content

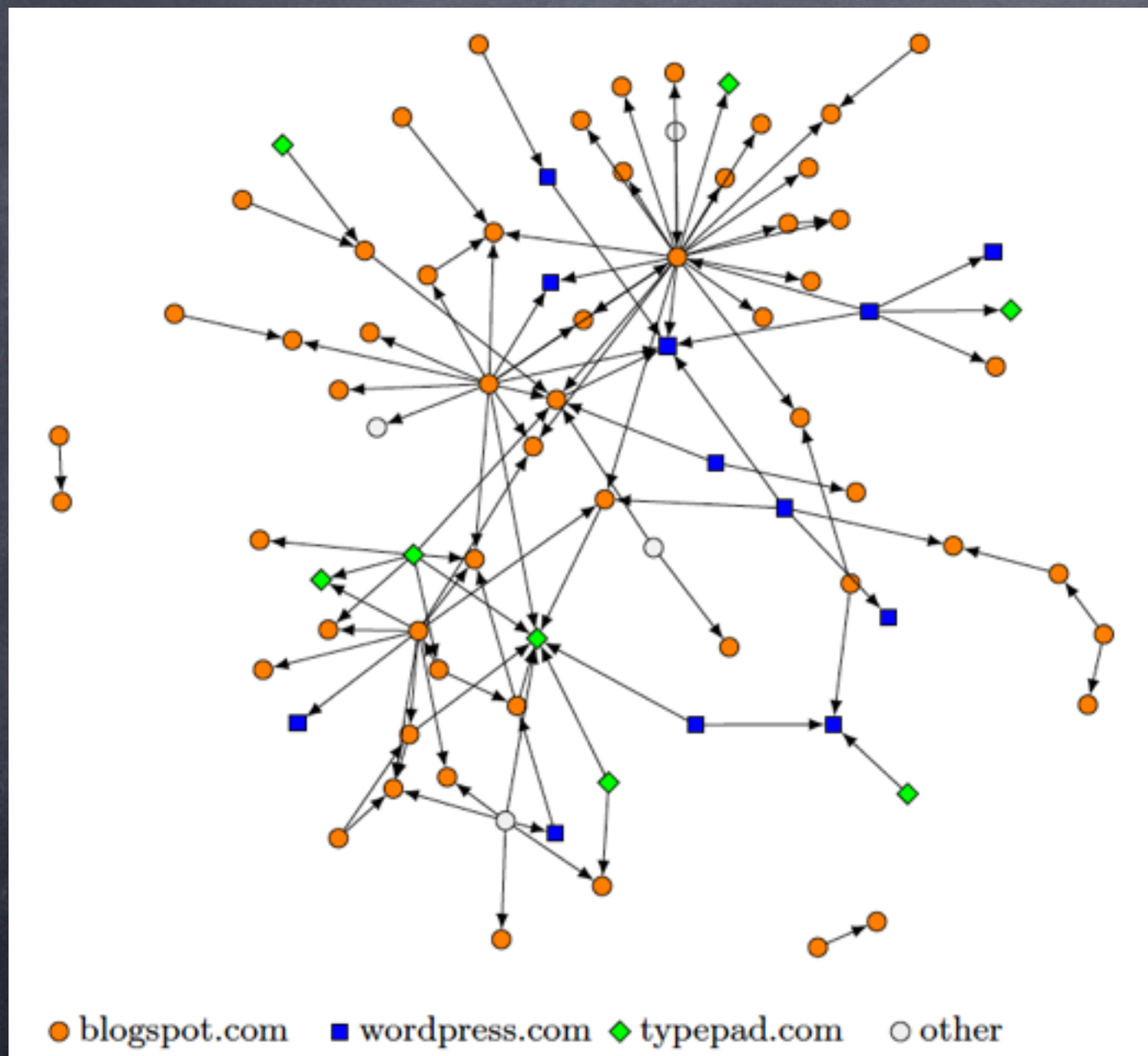


Figure 7: Diffusion of a political YouTube video in the blog graph. Node styles denote different blog domains.

Table 2: Top 10 linked websites

Rank	Web link domain	# posts
1	*youtube.com*	206,803
2	*photobucket.com*	140,194
3	*flickr.com*	135,327
4	*imageshack.us*	41,997
5	*amazon.com*	36,379
6	*nytimes.com*	33,801
7	*twitter.com*	30,572
8	*technorati.com*	27,583
9	*tinypic.com*	23,899
10	*bbc.co.uk*	20,893

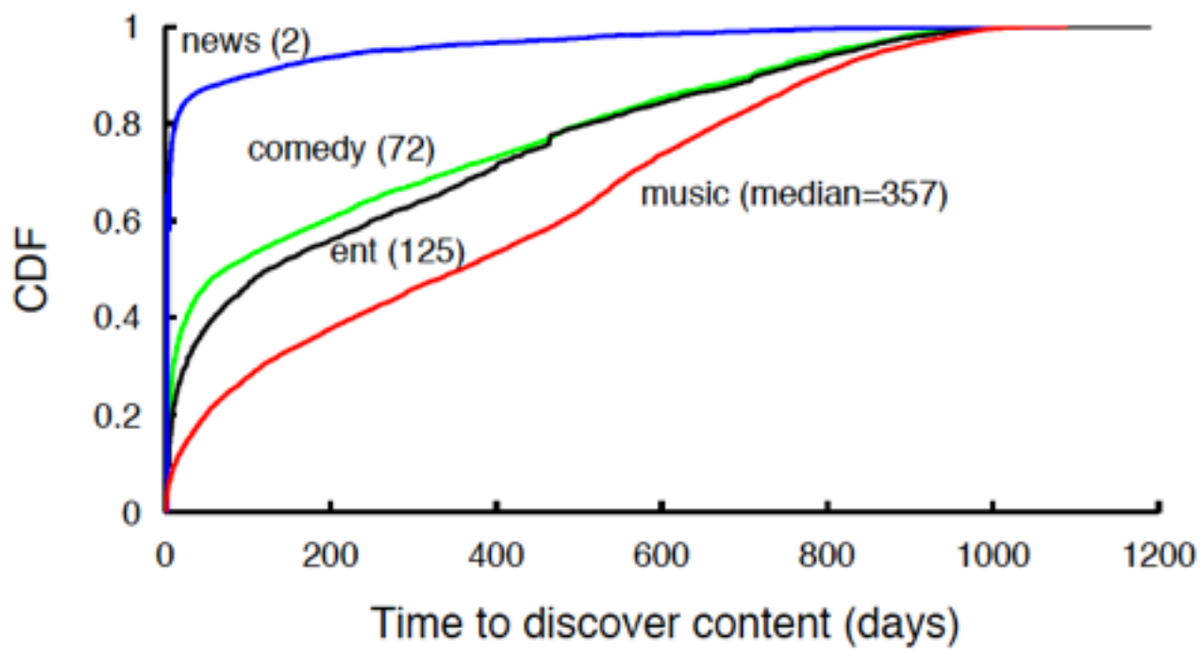
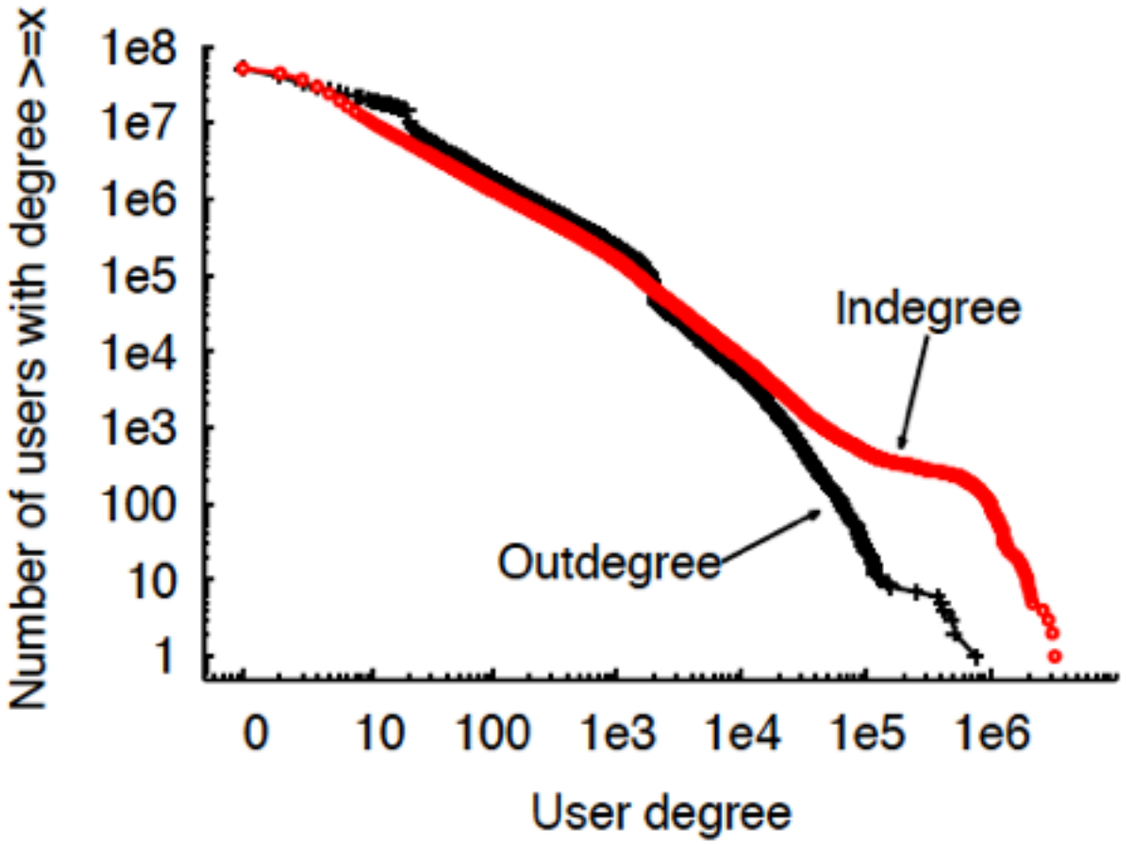
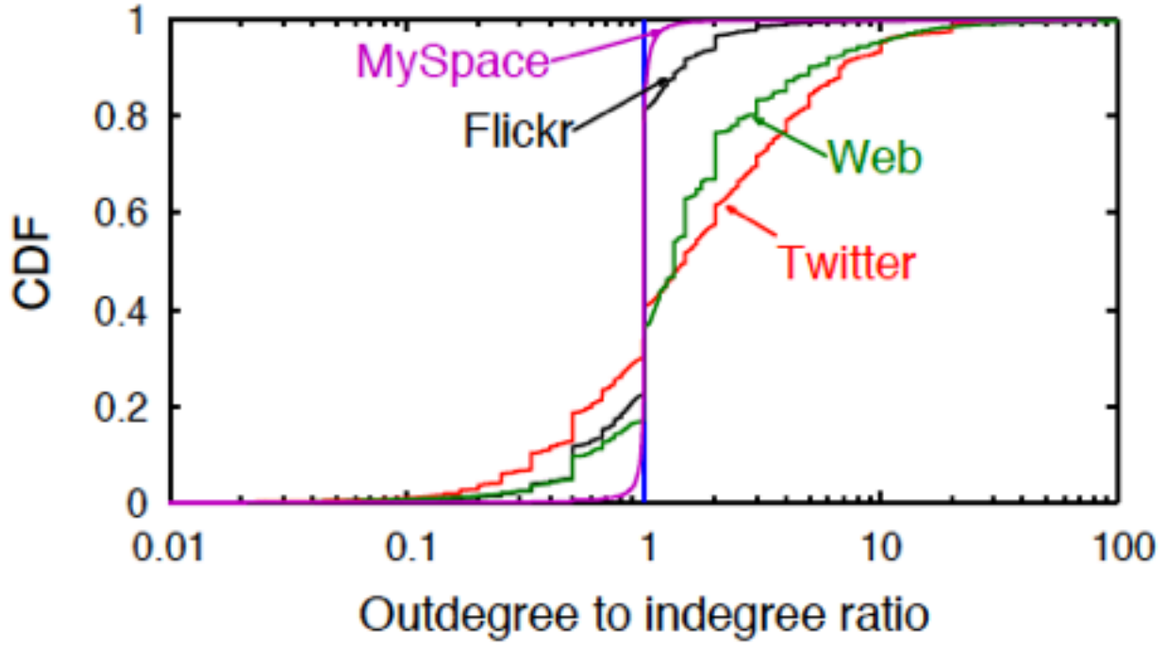


Figure 5: Age distribution of videos in the blogosphere

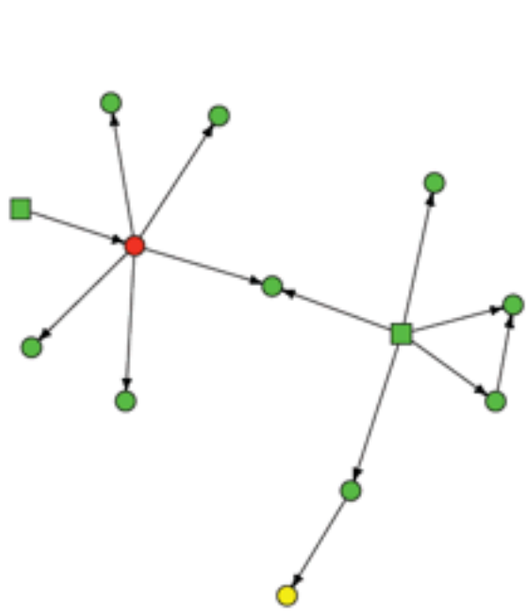
Twitter links



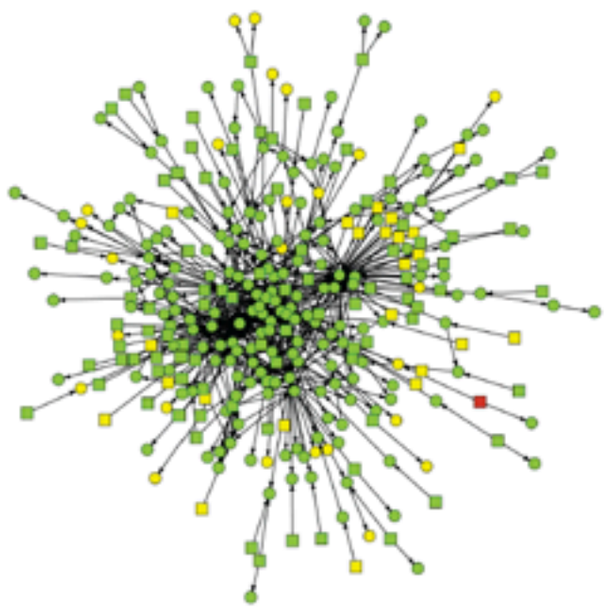
(a) Degree distribution



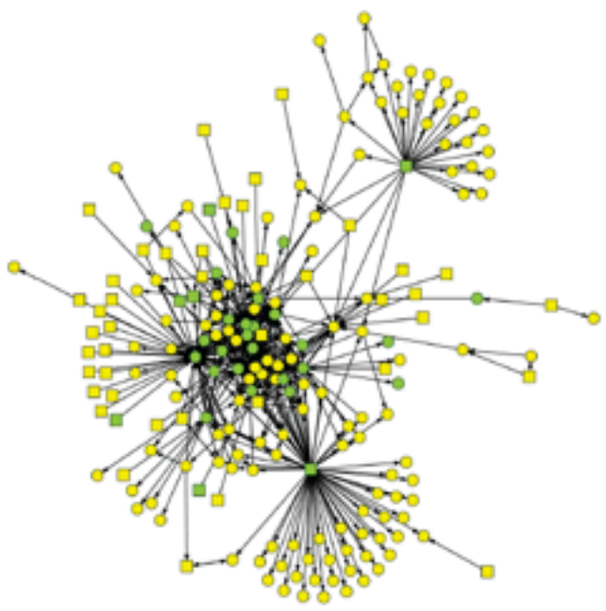
(b) Outdegree to indegree ratio



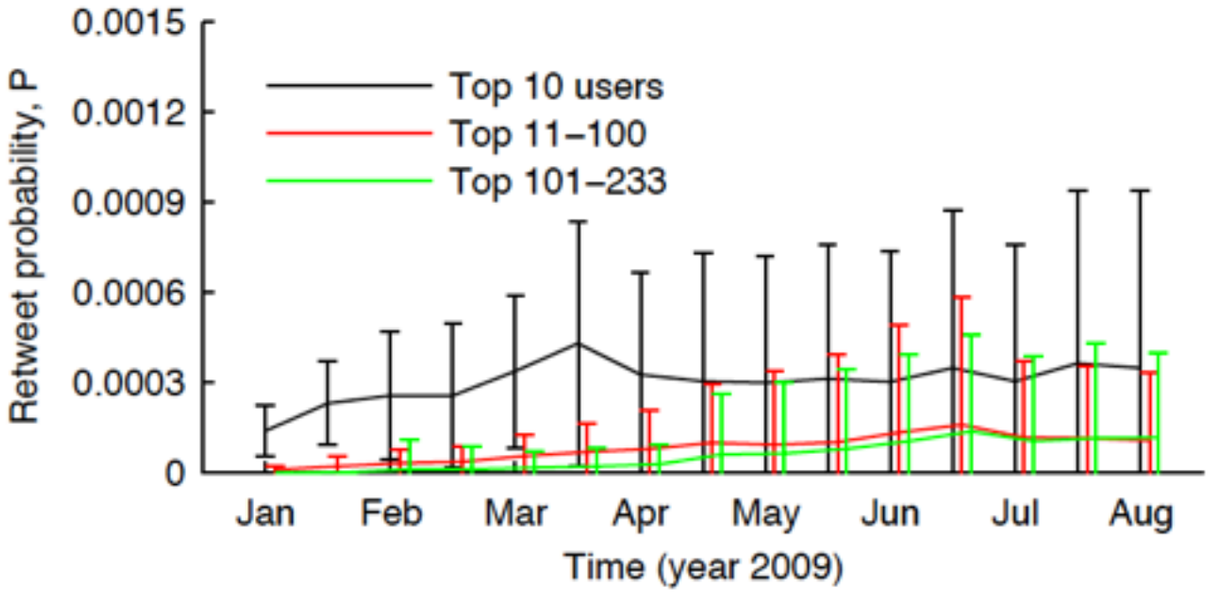
(a) Moldova



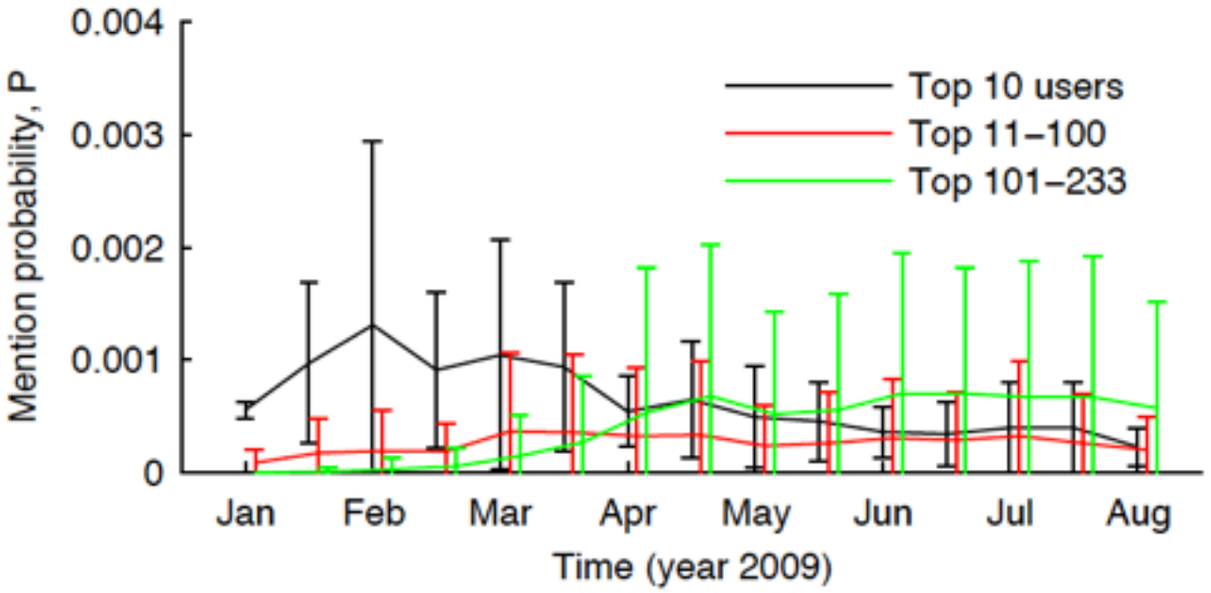
(b) Boyle



(c) Jackson

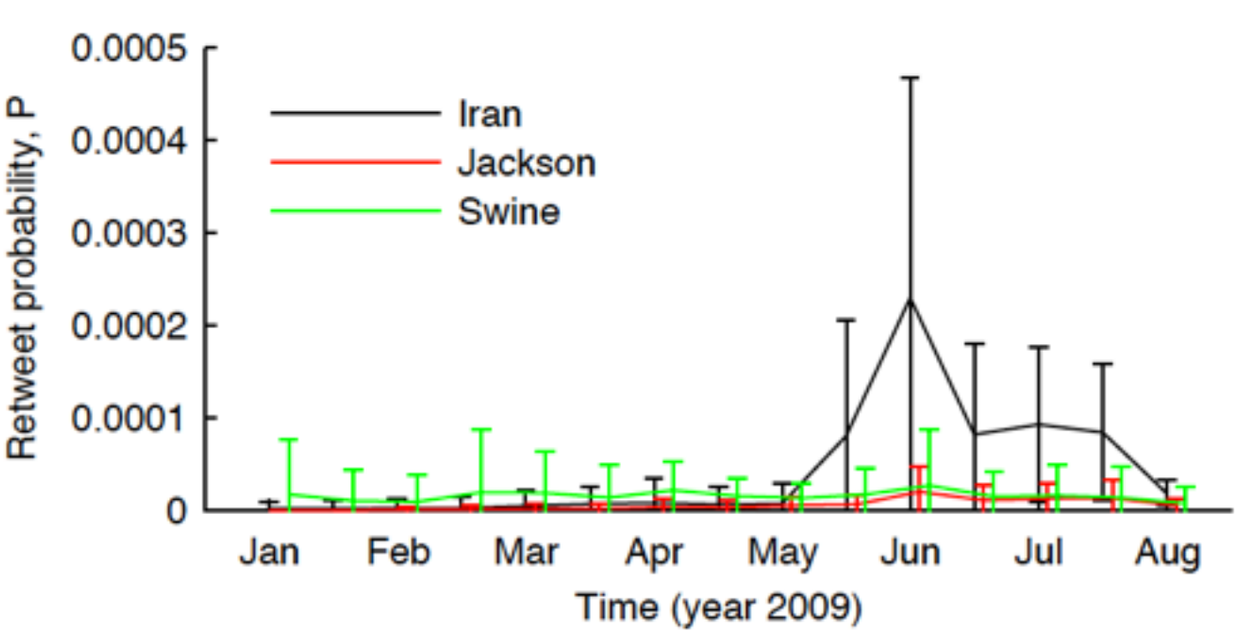


(a) Retweet influence

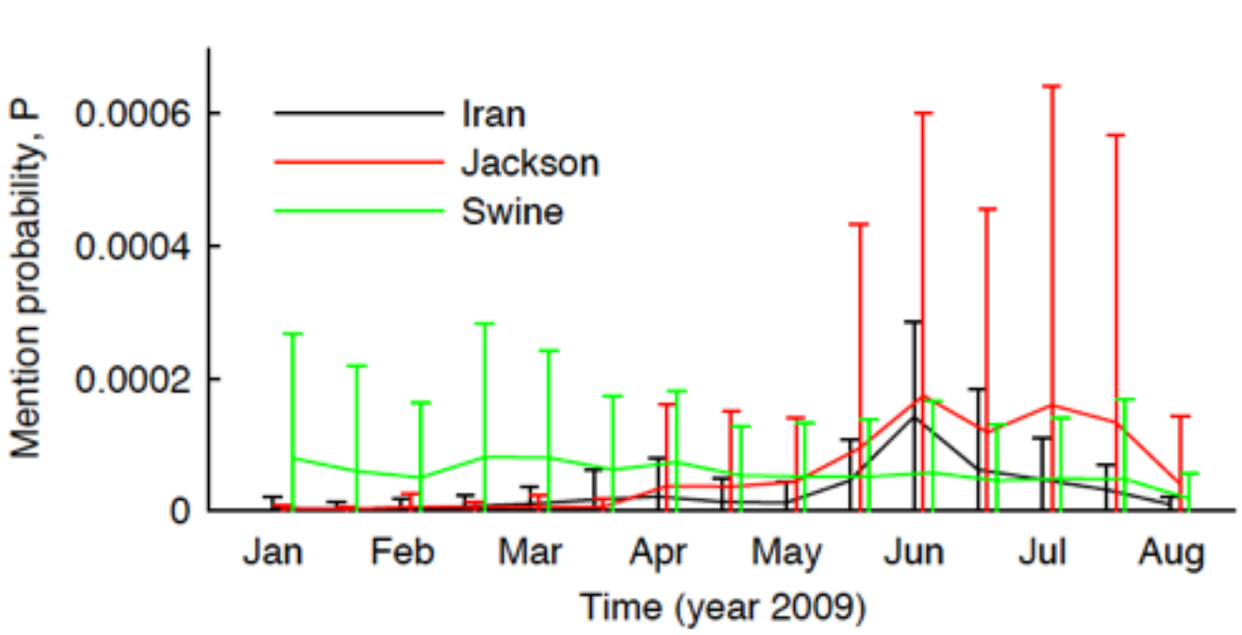


(b) Mention influence

Figure 4: The temporal evolution of retweets and mentions for the all-time influential users. For each data point, the error bars are centered on the average retweet (or mention) probability, and they extend up and down by two standard deviations.



(a) Retweet influence



(b) Mention influence

Figure 5: The temporal evolution of retweets and mentions for the topical influential users

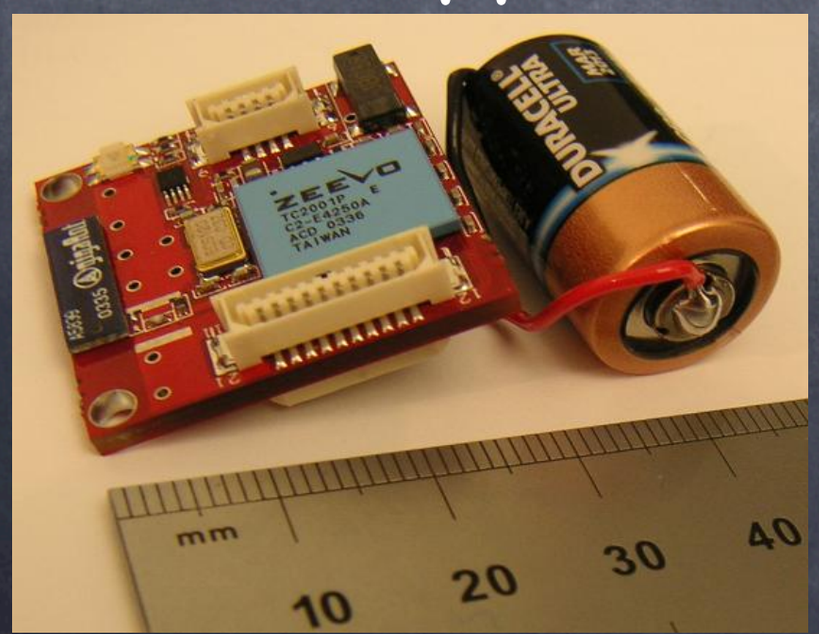
Cha, Haddadi, Benevenuto, Gummadi, "Measuring User Influence in Twitter: The Million Follower Fallacy", ICWSM 2010

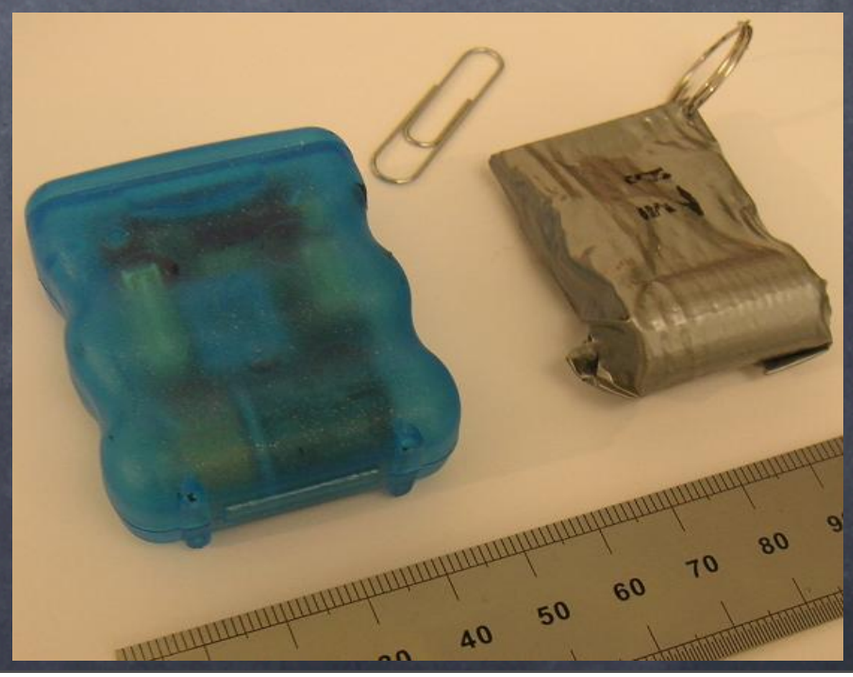
Why measure human mobility?

- Mobility increases capacity of dense mobile network [tse/grossglauser]

- Also create dis-connectivities

- Human mobility patterns determine communication opportunities





Haggle 2005 experiment

- 54 iMotes distributed for 3 days
- 41 yielded useful data
- 11 with battery or packaging problems, 2 not returned
- 182 external devices
- 22459 contacts between iMotes
- 5791 contacts between iMote/external device
- External devices are non-iMote devices in the environment, e.g. BT mobile phone, Laptop.

Chaintreau, Hui, Crowcroft, Diot, Gass, James Scott Impact of Human Mobility on Opportunistic Forwarding Algorithms, IEEE TMC 2007

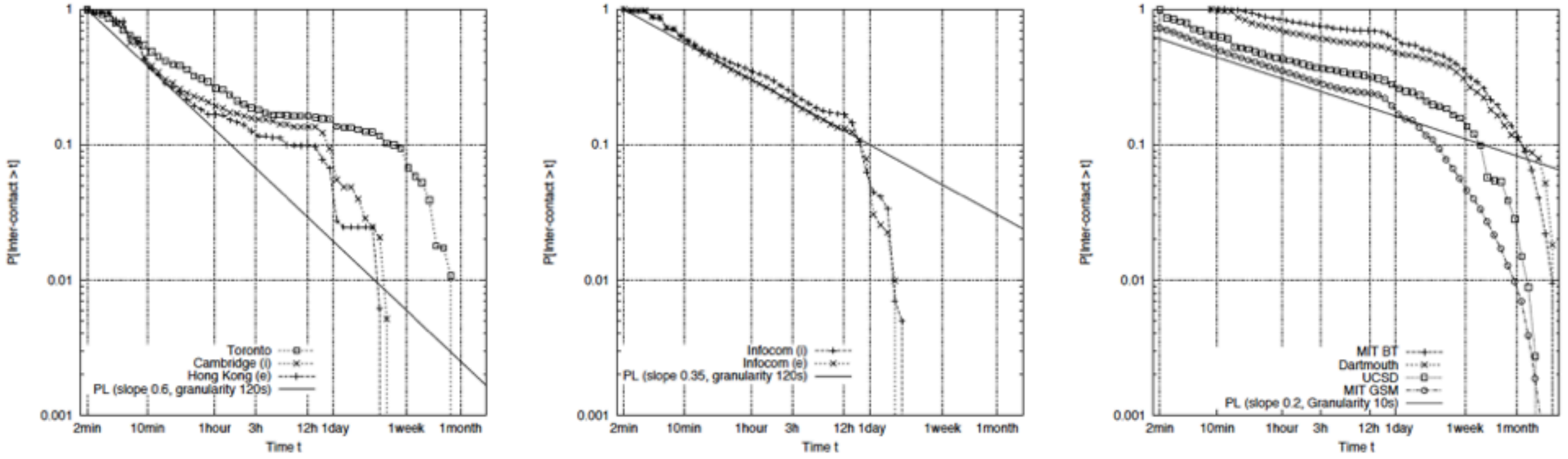


Fig. 1. Aggregated distribution of the inter-contact time in eight data sets experiments: iMote-based experiments at Cambridge and Hong Kong, and Toronto experiment (left), iMote-based experiment at INFOCOM (middle), data collected at UCSD, Dartmouth and MIT (right).

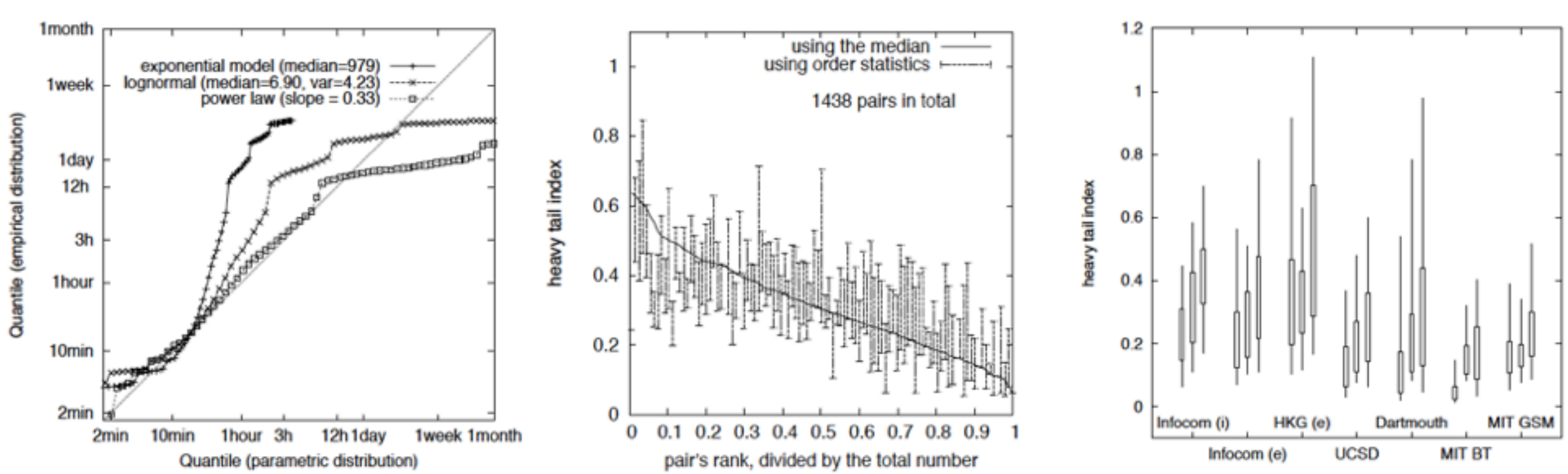
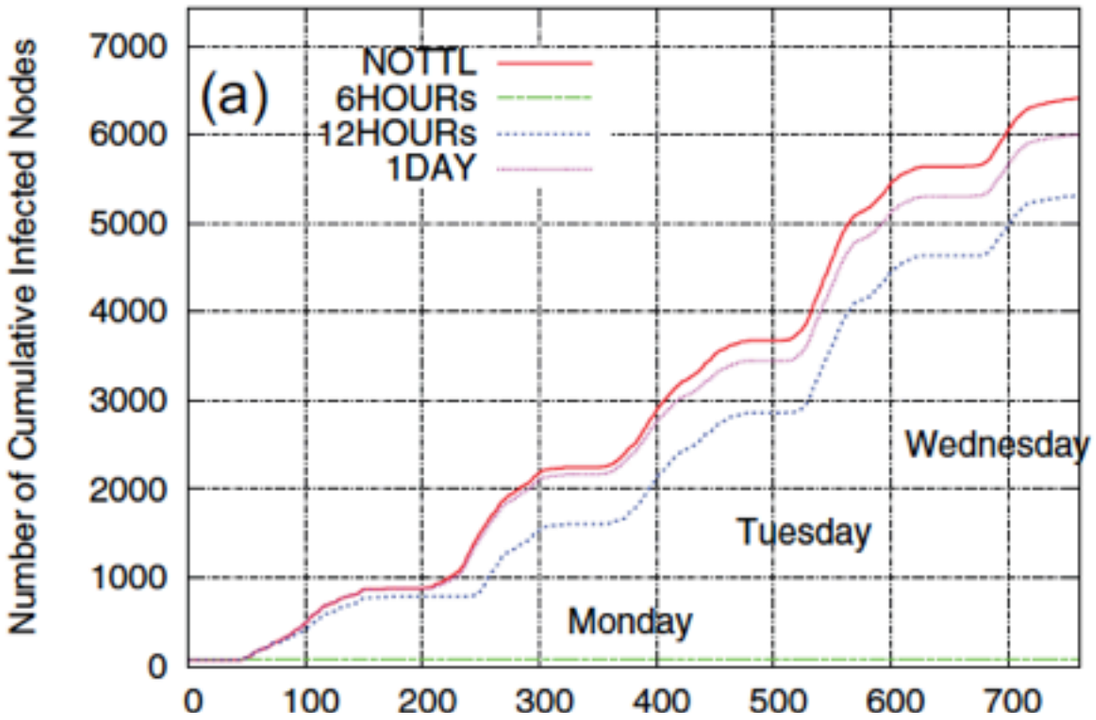
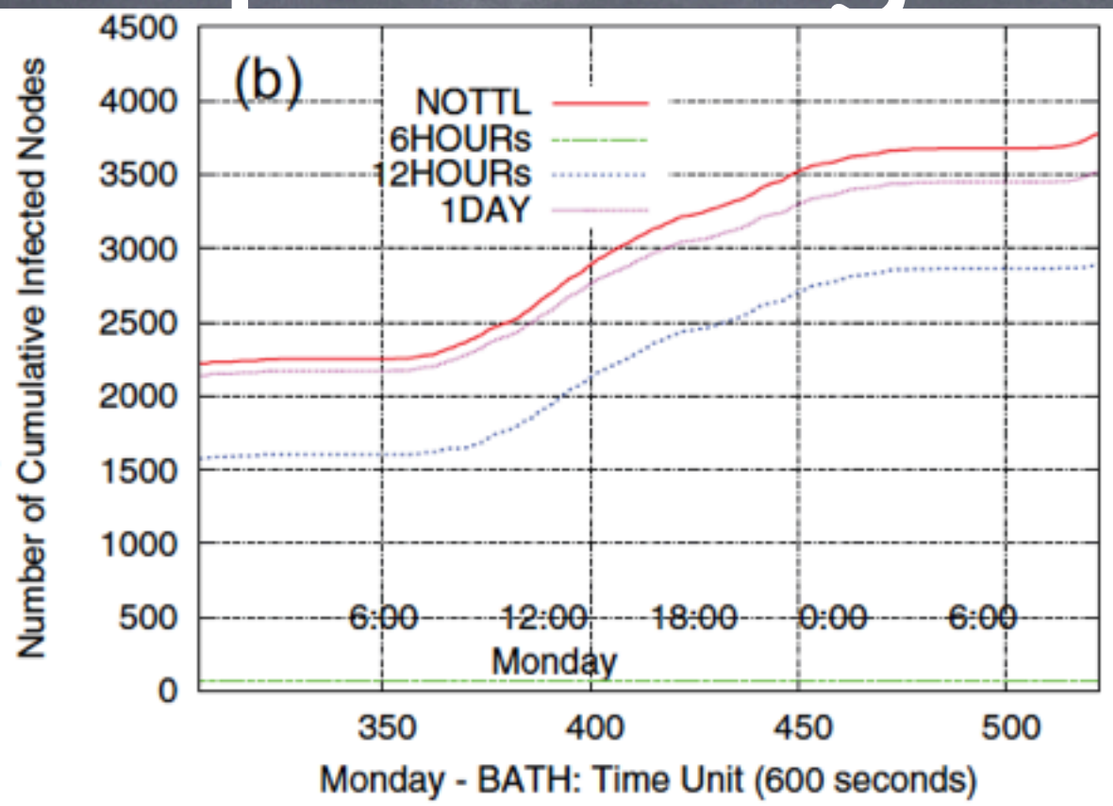


Fig. 2. iMote-based experiment at Infocom: Quantile-quantile plot of comparison between the aggregated distribution of the inter-contact time and three parametric models (left), estimation of the heavy tail index of the power law applied separately for each pair (middle), summary of results obtained in all data sets (right).

Epidemic spreading





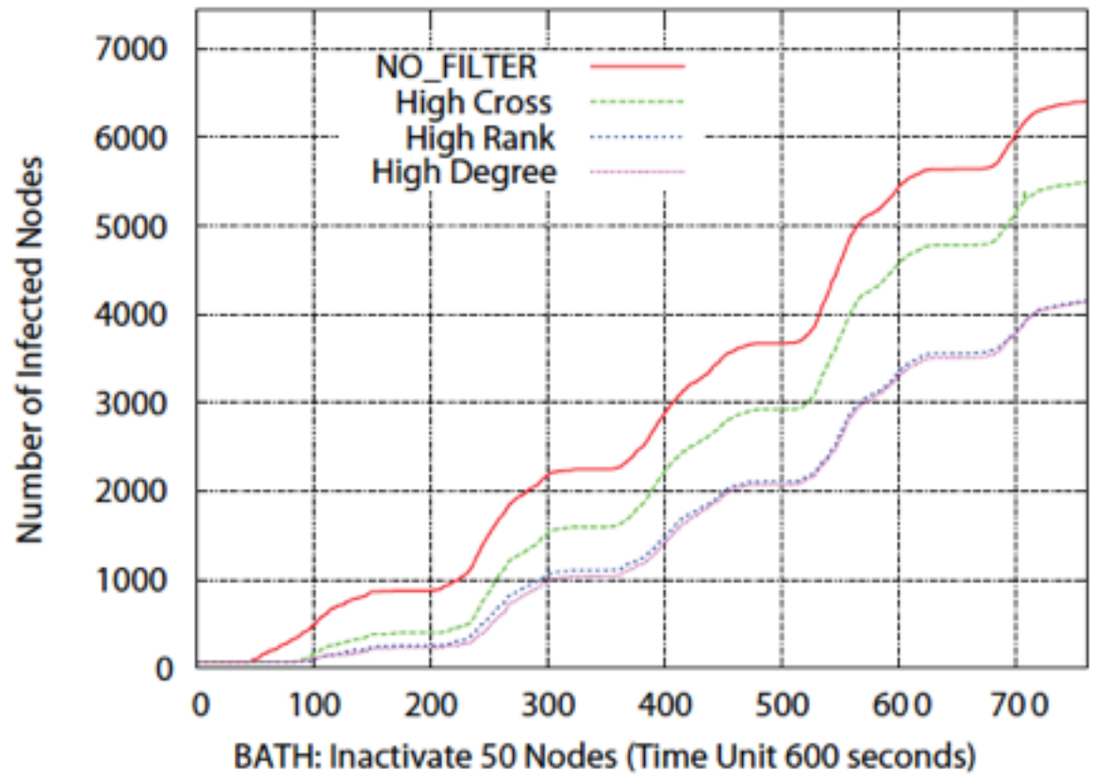


Fig. 13: Inactivation of Hub Nodes

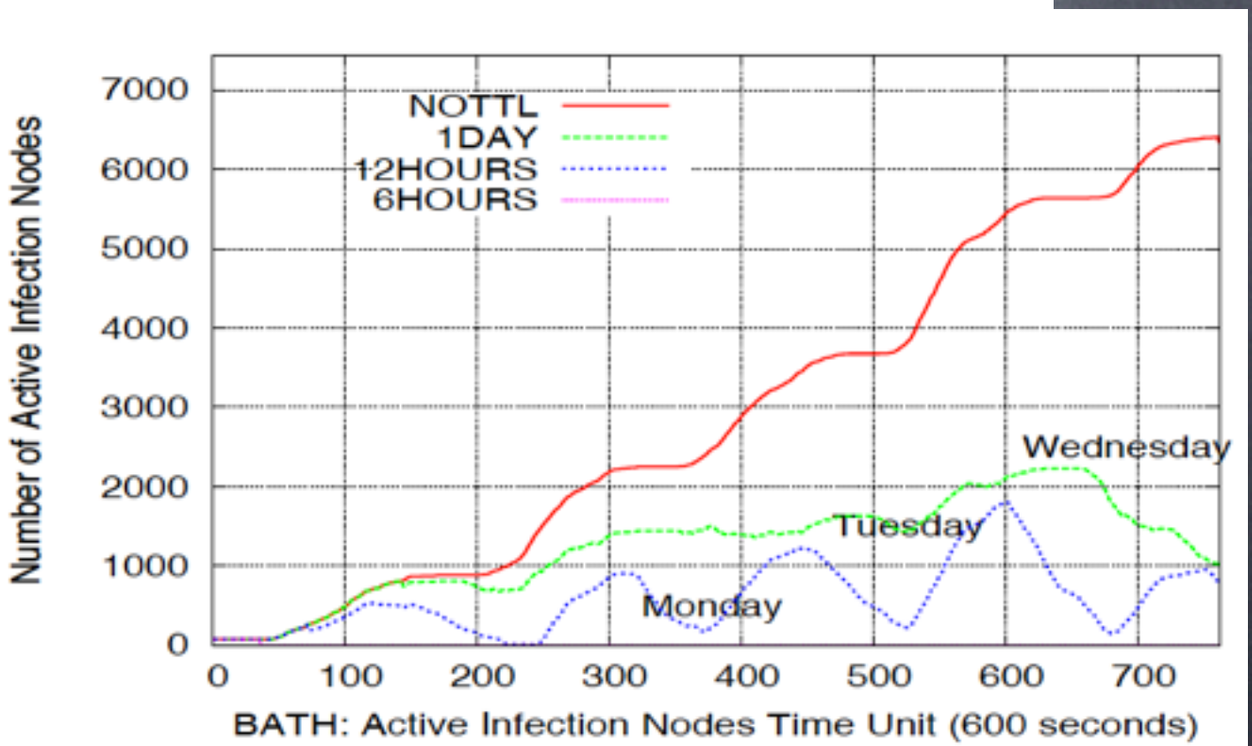
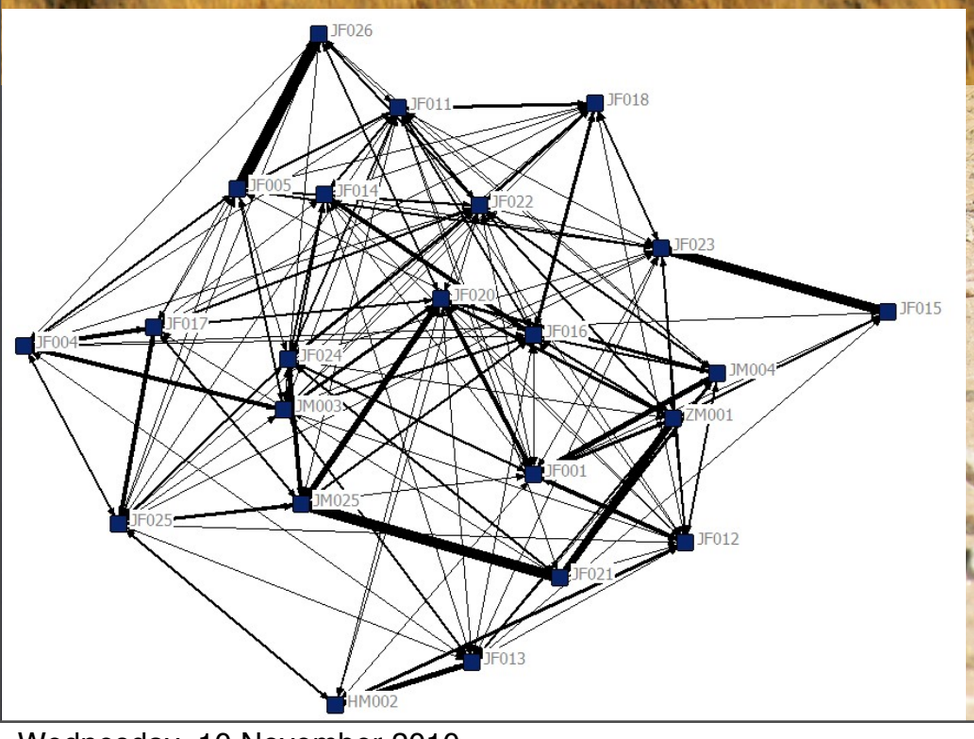


Fig. 8: BATH: Active Infected Nodes

Yoneki, Hui, Crowcroft, Epidemic Spread in Dynamic Human Networks, LNCS 5151, 2008

Animal Association Networks

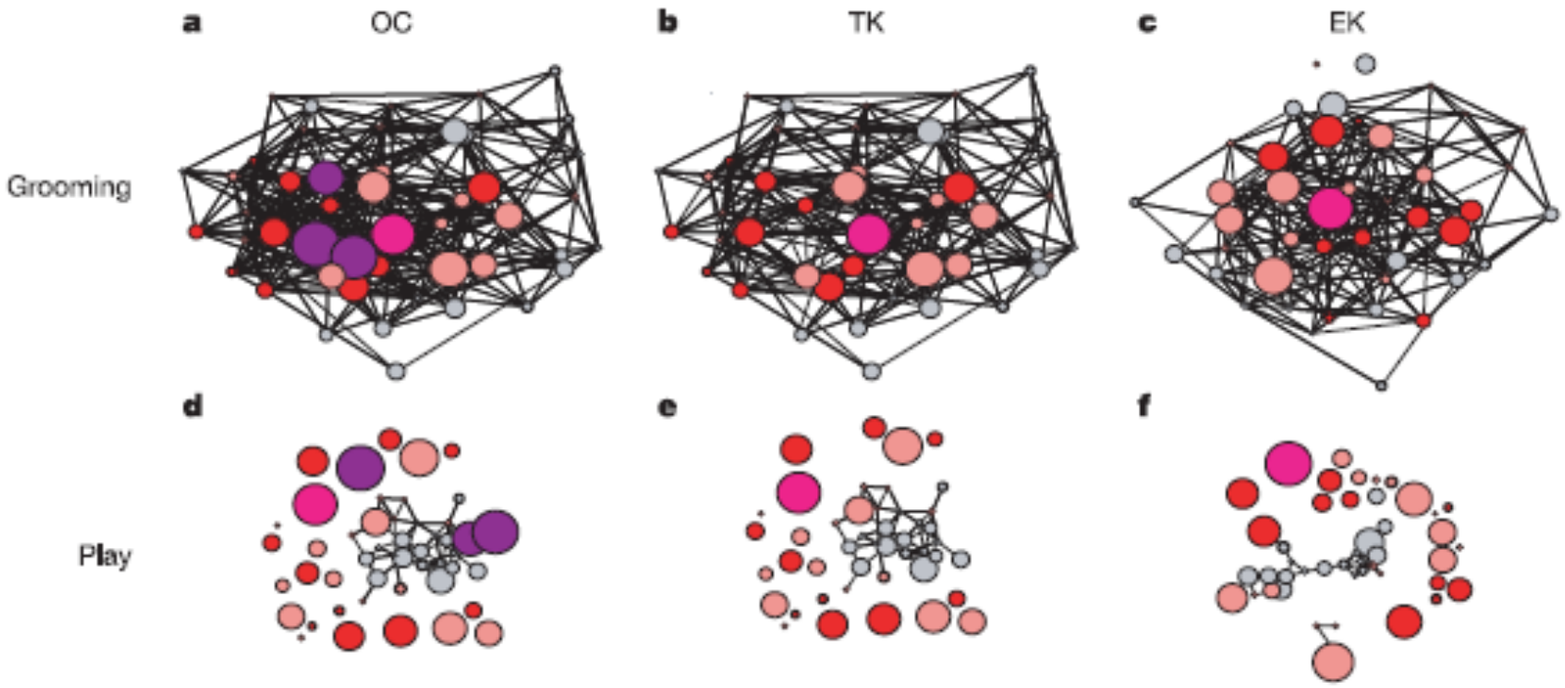


Animals Socialise to survive

nature Vol 439|26 January 2006|doi:10.1038/nature04326

Policing stabilizes construction of social niches in primates

Jessica C. Flack[1,2,3], Michelle Girvan[1], Frans B. M. de Waal[2,3] & David C. Krakauer[1]

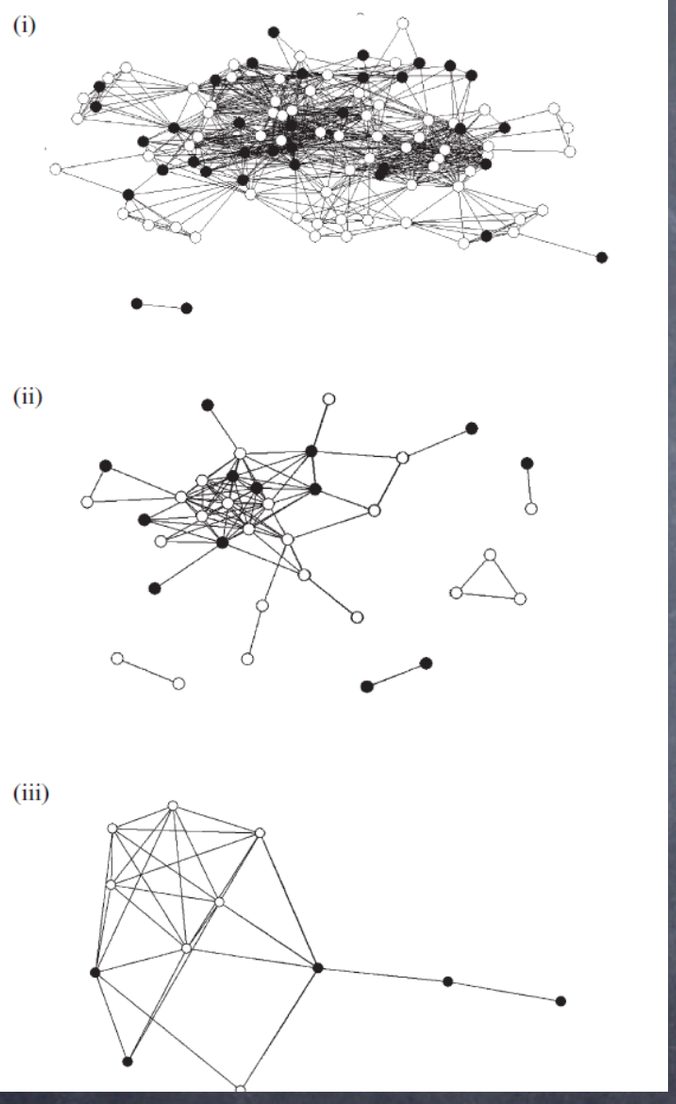


Using 'knockout' experiments on a large, captive group of pigtailed macaques (*Macaca nemestrina*), we show that a policing function, performed infrequently by a small subset of individuals[3], significantly contributes to maintaining stable resource networks in the face of chronic perturbations that arise through conflict. When policing is absent, social niches destabilize, with group members building smaller, less diverse, and less integrated grooming, play, proximity and contact-sitting networks. Instability is quantified in terms of reduced mean degree, increased clustering, reduced reach, and increased assortativity. Policing not only controls conflict[3–5], we find it significantly influences the structure of networks that constitute essential social resources in gregarious primate societies. The structure of such networks plays a critical role in infant survivorship[6], emergence and spread of cooperative behaviour[7], social learning and cultural traditions[8].

THE ROYAL SOCIETY biology letters

Social networks in the guppy (*Poecilia reticulata*)

Darren P. Croft[1*], Jens Krause[1] and Richard James[2]

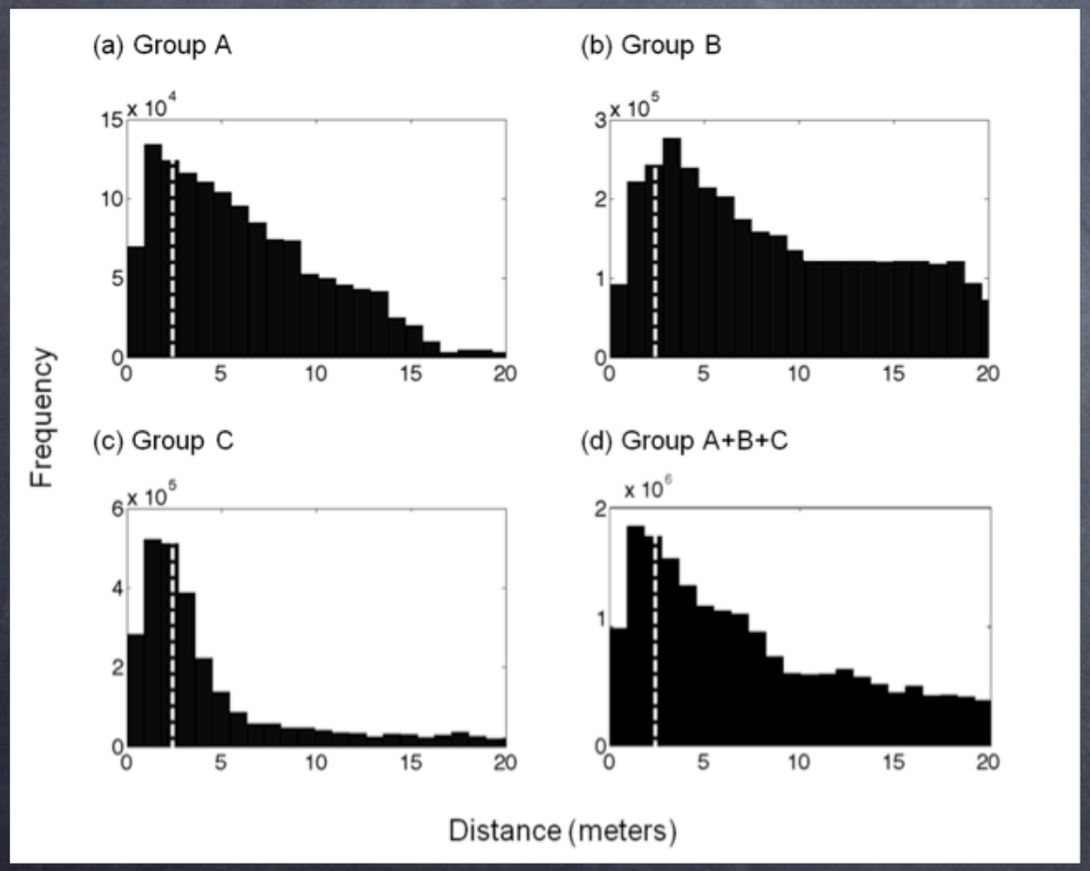


SNA used in conjunction with lagged association rates or other autoregressive methods to address temporal patterning.

Figure 1. (a)(i) The social network after 7 days of re-sampling (males, filled circles; females, open circles) drawn using the UCINET program (Borgatti et al. 2002), using spring embedding based on distance. Sub-networks are shown for different association strengths in which connections are displayed between two fish only if they were caught in the same shoal: (ii) at least twice; and (iii) at least three times.

Wanna get sheepish?

Performance of K-means in detecting familiar individuals once mixed together into one larger flock, at 30 different spatial-temporal scales. Warmer colours in the plot represent higher accuracy.

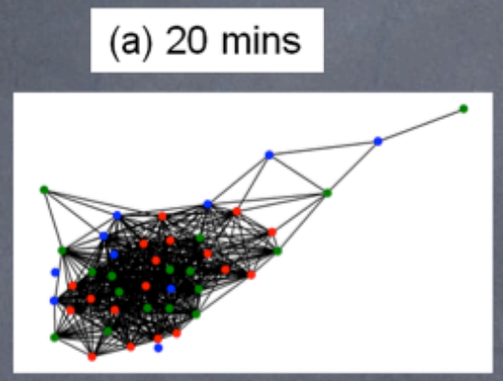


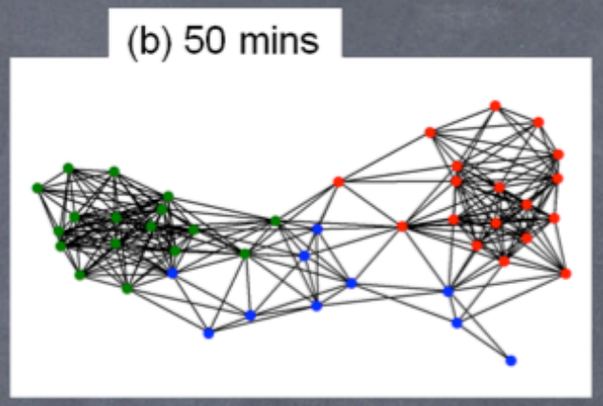
Time (minutes) \ Distance (meters)	1	1.5	2	2.5	3	3.5
1	0.56	0.58	0.60	0.59	0.85	0.79
2	0.49	0.57	0.46	0.58	0.64	0.72
3	0.37	0.55	0.60	0.85	0.69	0.70
4	0.52	0.58	0.81	0.80	0.70	0.70
5	0.51	0.56	0.57	0.81	0.80	0.75

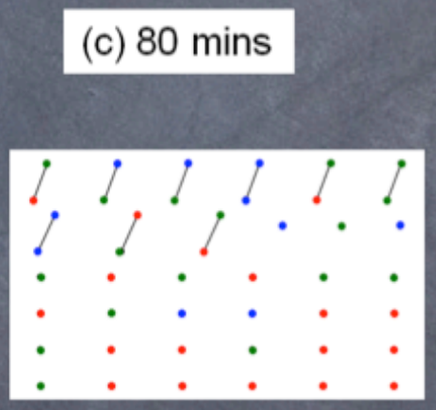
Haddadi et al., 2010, under review

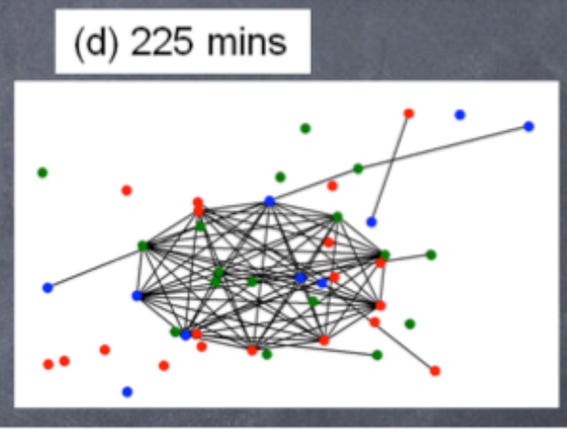
Temporal-spatial associations

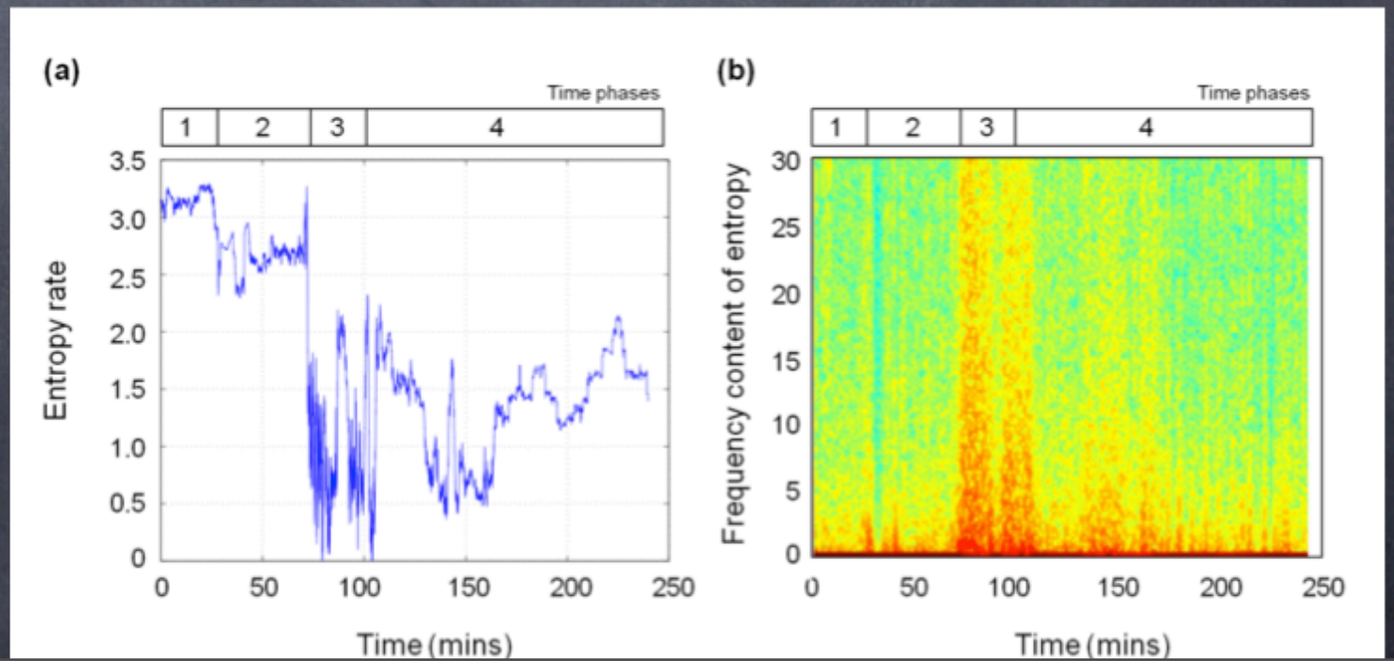
. Sociograms depicting spatial associations of the mixed group taken at four different single second 'snapshots' for a newly formed sheep flock. Nodes represent individual sheep and lines (edges) indicate an association between dyads at 2.5m. Each network's corresponding entropy rate can be seen in Figure











Reading and references

- Human Mobility Models and Opportunistic Communication System Design, Pan Hui and Jon Crowcroft, Royal Society Philosophical Transactions B, 2008.

- Alan Mislove, Massilmiliano Marcon, Krishna P. Gummadi, Peter Druschel, Bobby Bhattacharjee. Measurement and Analysis of Online Social Networks. (IMC'07).

- Croft, D.P., James, R., Krause, J. (2008). Exploring Animal Social Networks. Princetown, NJ, Princetown University Press.

- Studying Online Social Networks: http://jcmc.indiana.edu/vol3/issue1/garton.html

hamed.haddadi@cl.cam.ac.uk