Modeling human dynamics of face-to-face interactions

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Michele Starnini

Departament de Física
i Enginyeria Nuclear
UNIVERSITAT POLITÈCNICA DE CATALUNYA

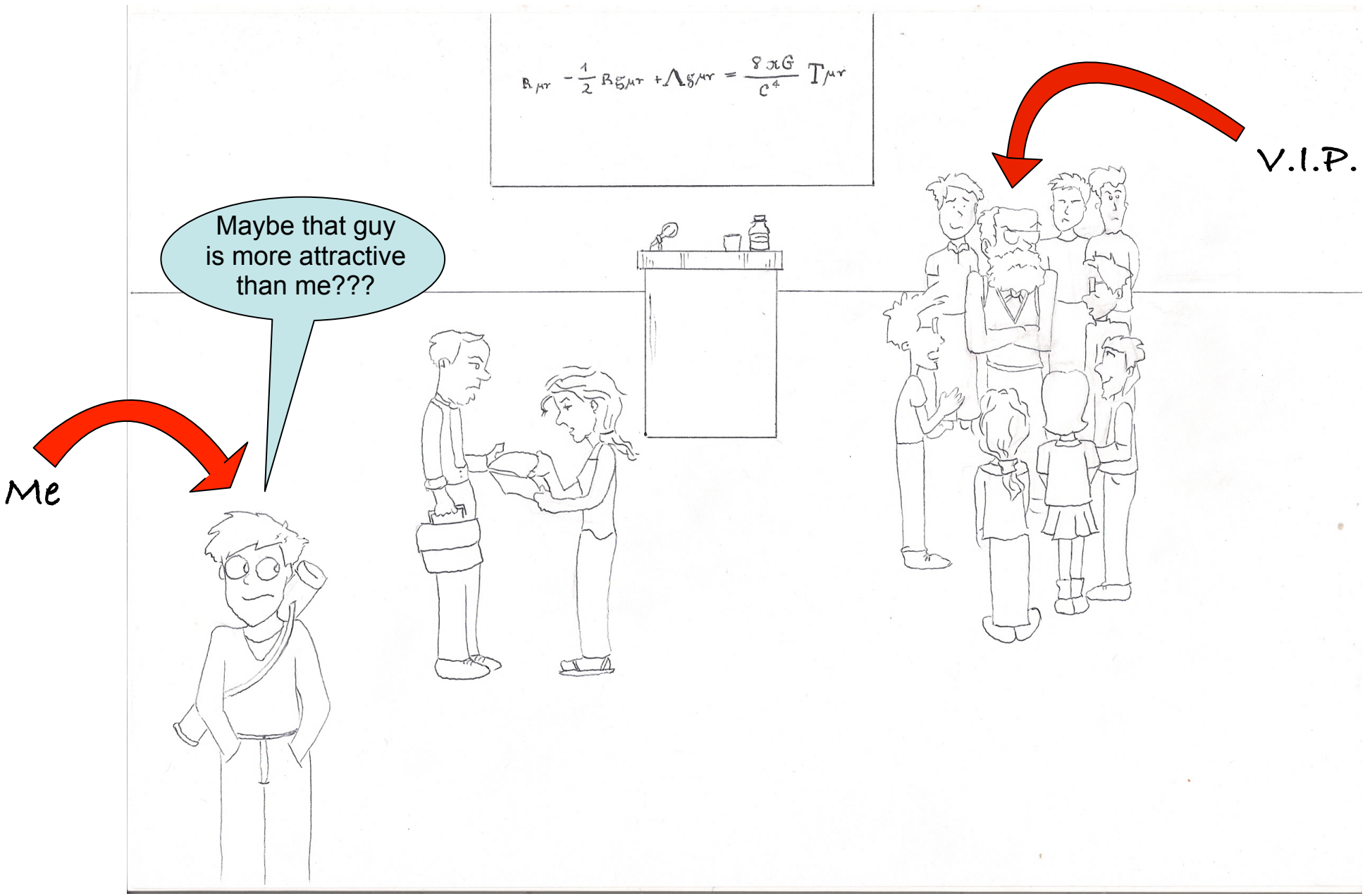
in collaboration with:
Andrea Baronchelli - Northeastern University, Boston
Romualdo Pastor Satorras - UPC, Barcelona

ECCS WARM-UP
SCHOOL ON COMPLEX NETWORKS

Barcelona, 14/09/2013

ECCS WARM-UP
SCHOOL ON COMPLEX NETWORKS

How's your first conference?

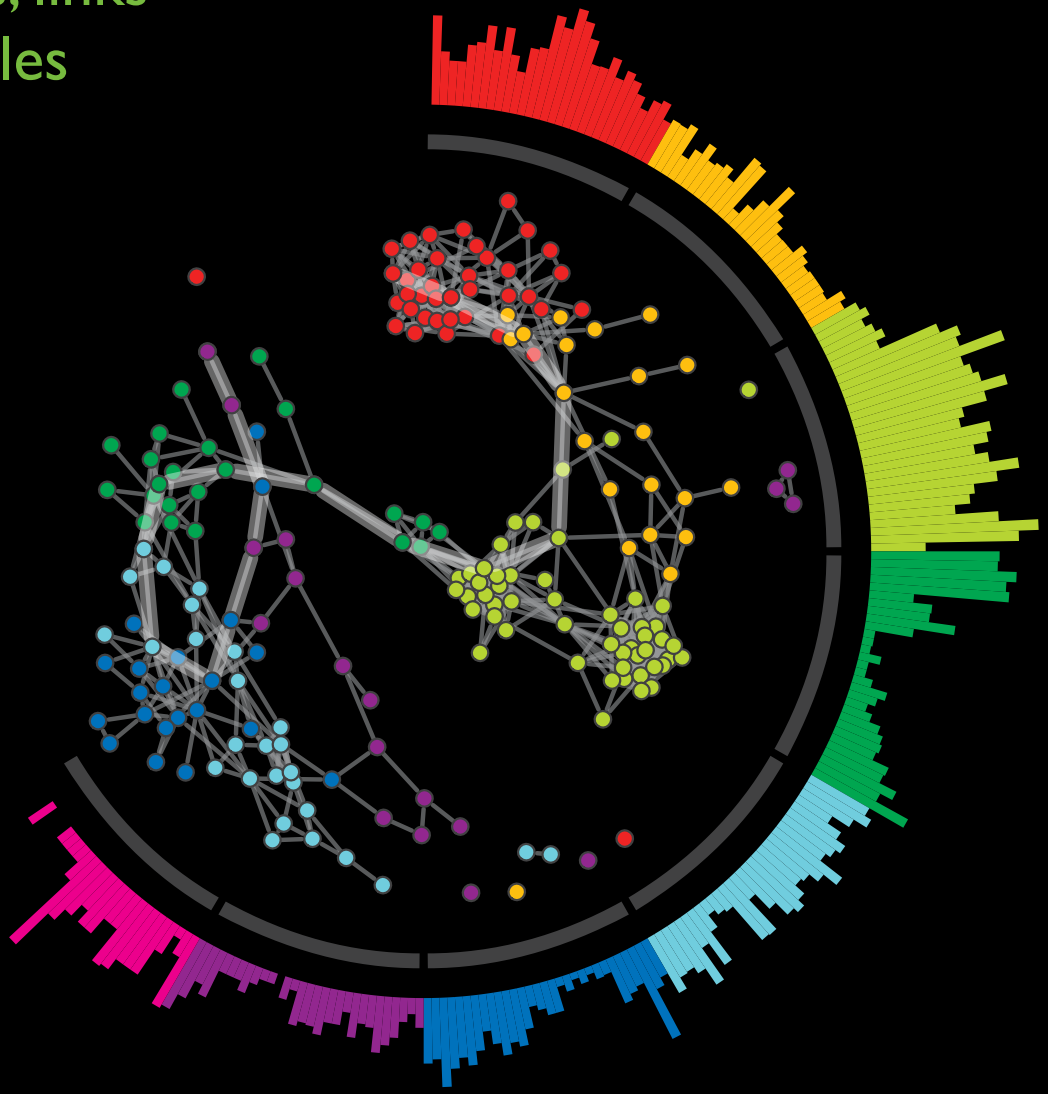


Temporal Networks

Real networks are dynamic entities, links are rewired on various time scales

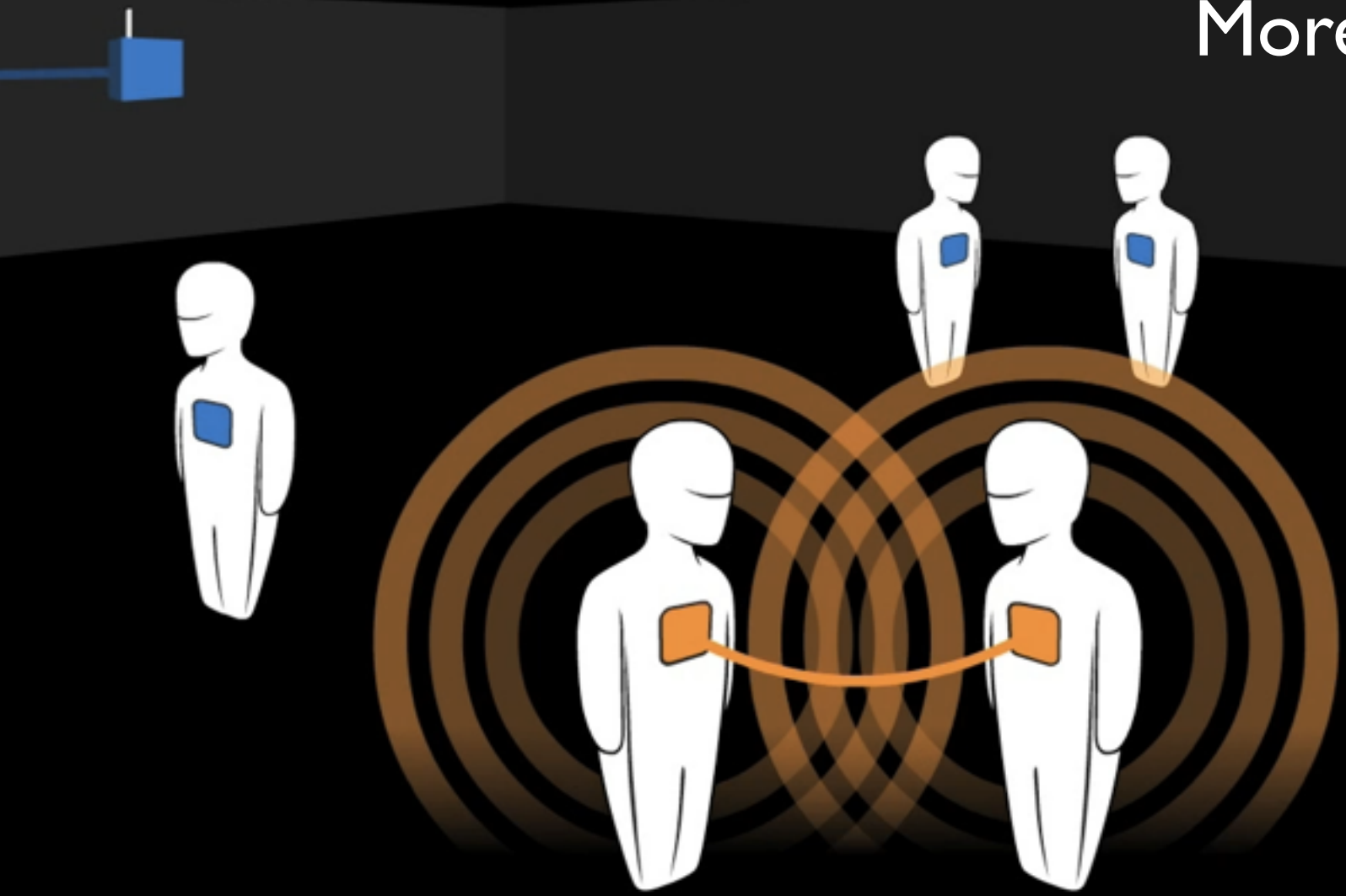
The temporal dimension impacts the dynamical processes developing on networks

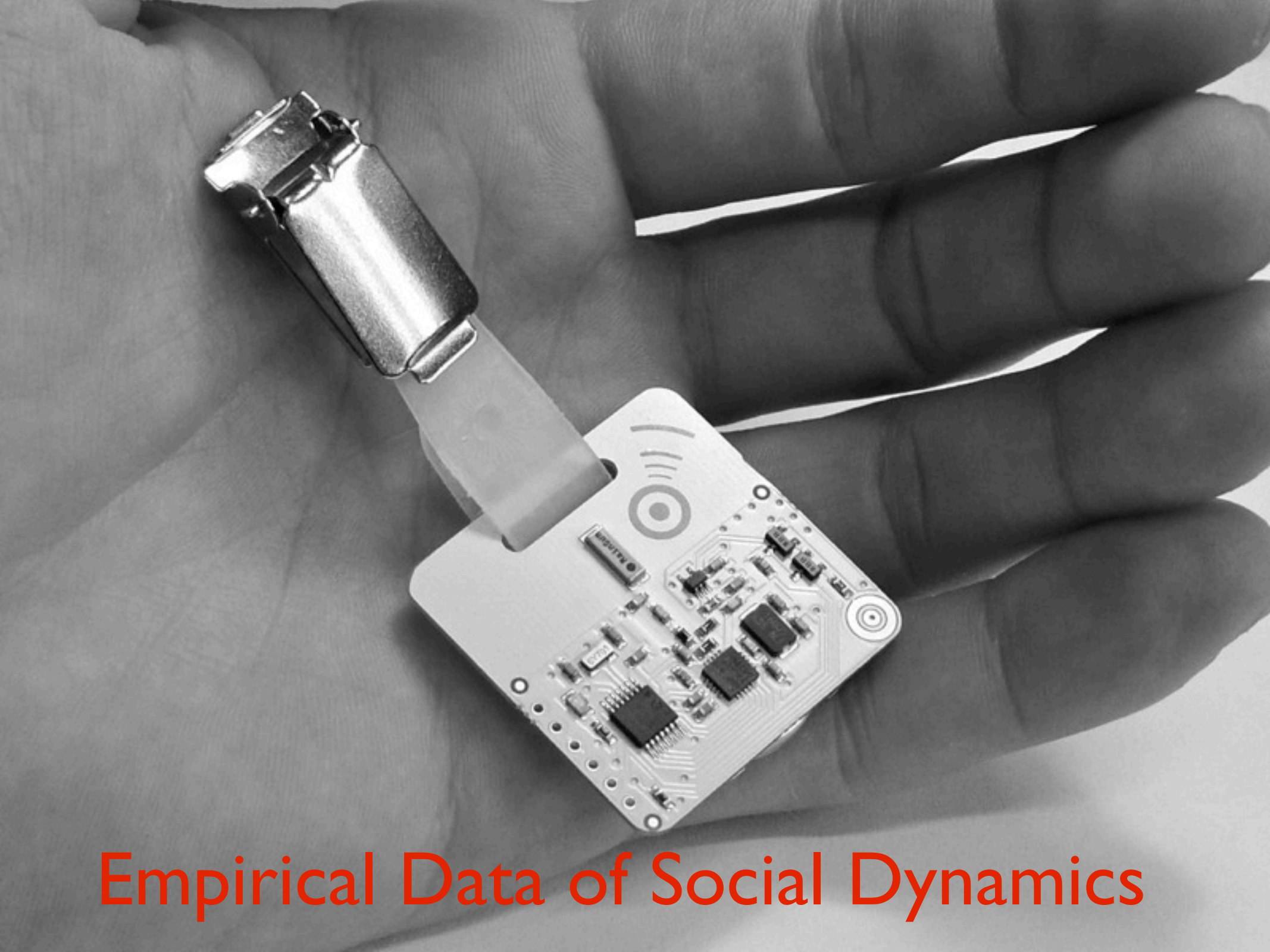
Social networks are intrinsically dynamic, interactions begin and end constantly



SocioPatterns

Conferences
Schools
Hospitals
Museum
More to come...

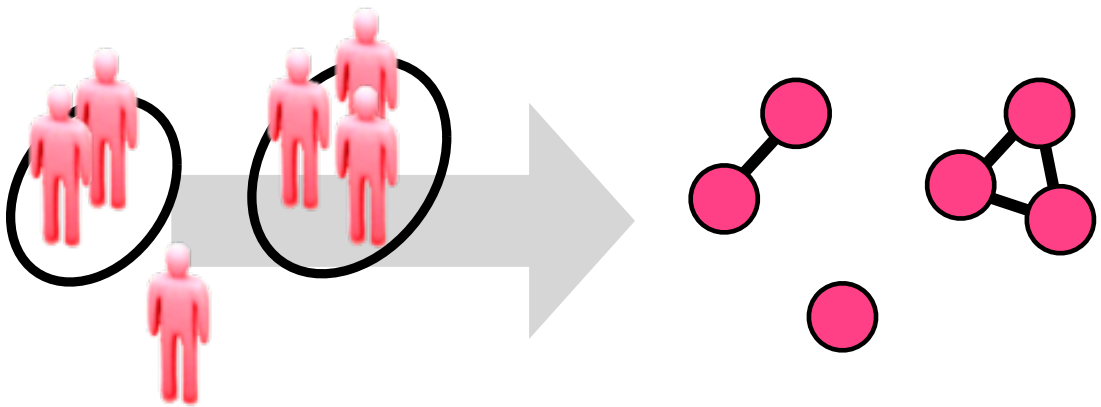




Empirical Data of Social Dynamics

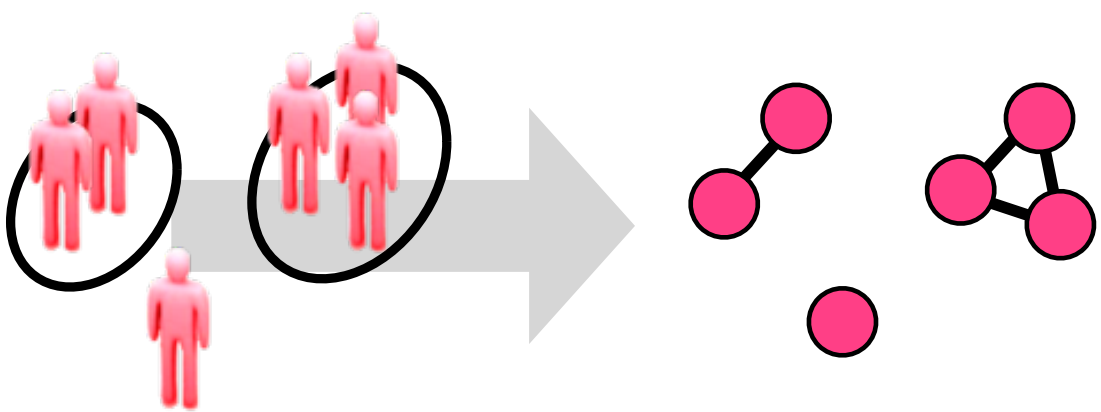
From face-to-face interactions to dynamical networks

Empirical data with
fine-grained spatial and
temporal resolution

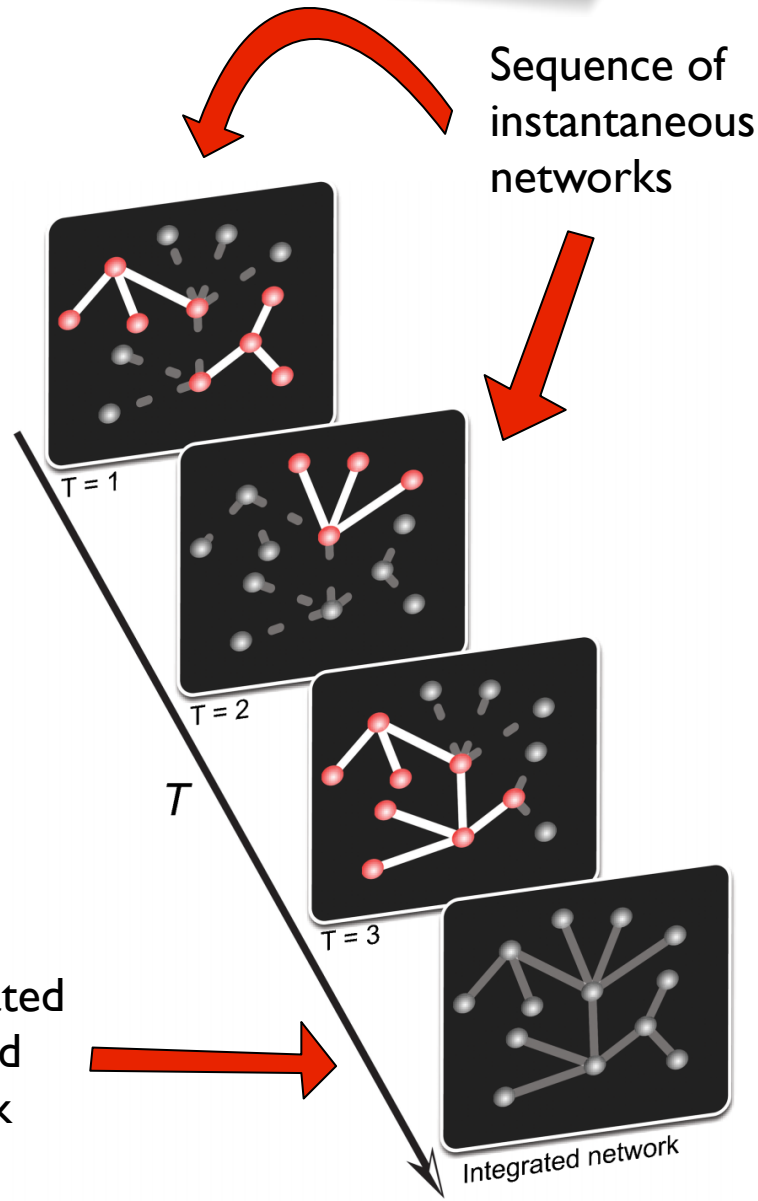


From face-to-face interactions to dynamical networks

Empirical data with fine-grained spatial and temporal resolution



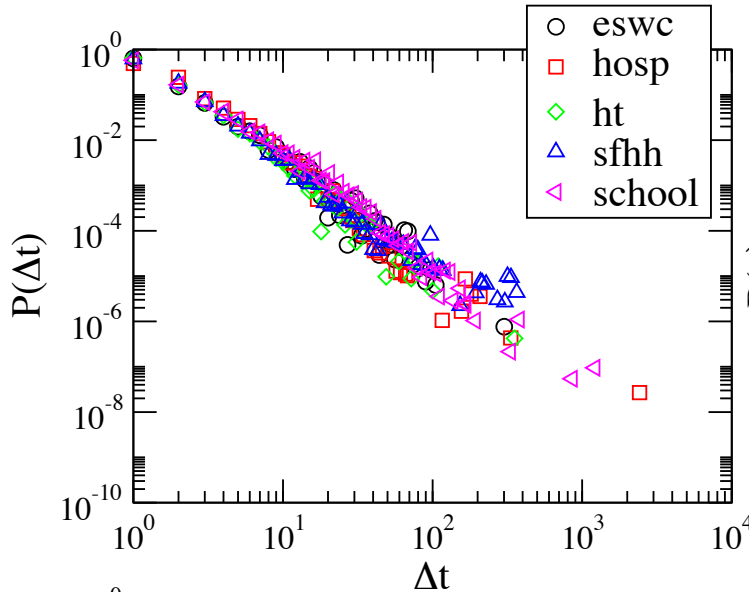
Sequence of instantaneous networks



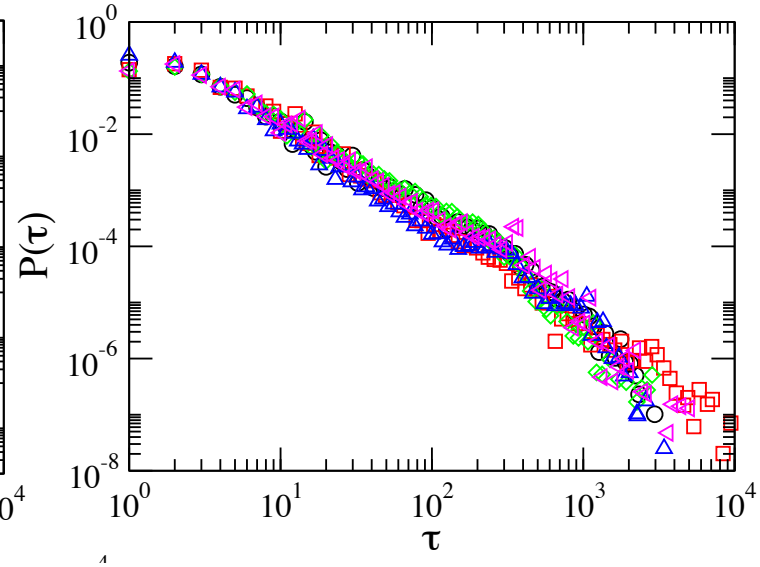
Aggregated weighted network

Heterogeneity and Burstiness

Duration of conversations



Inter-contacts gap times



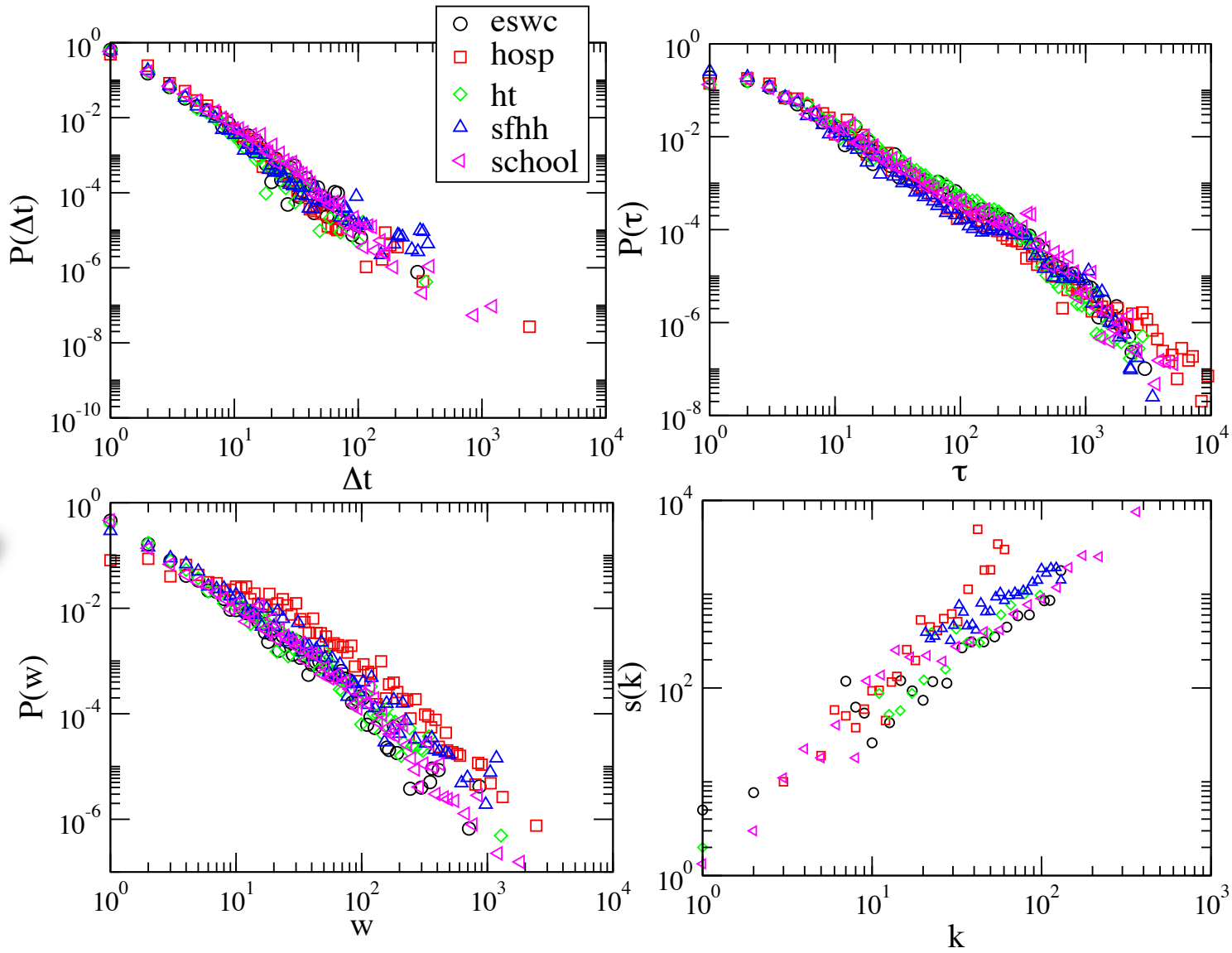
(1 time step = 20 seconds)

Heterogeneity and Burstiness

Duration of conversations

Inter-contacts gap times

Integrating Information



Total contact time between pairs

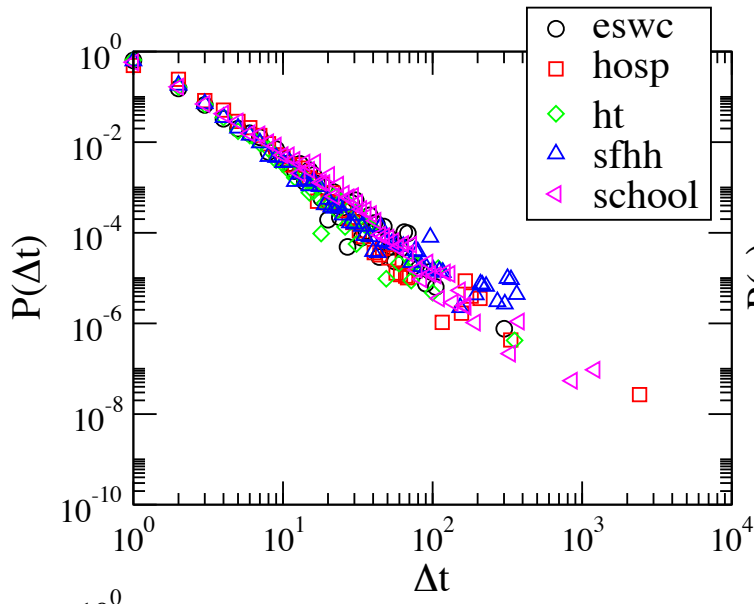
Strength vs Degree

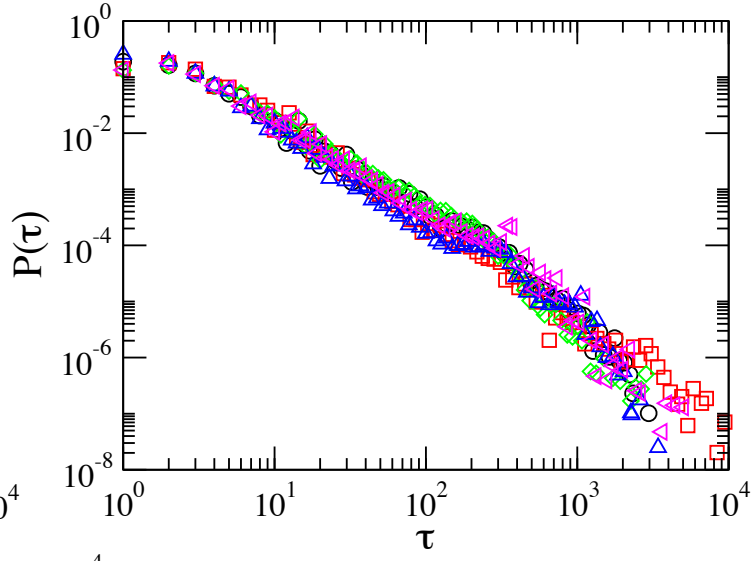
Heterogeneity and Burstiness

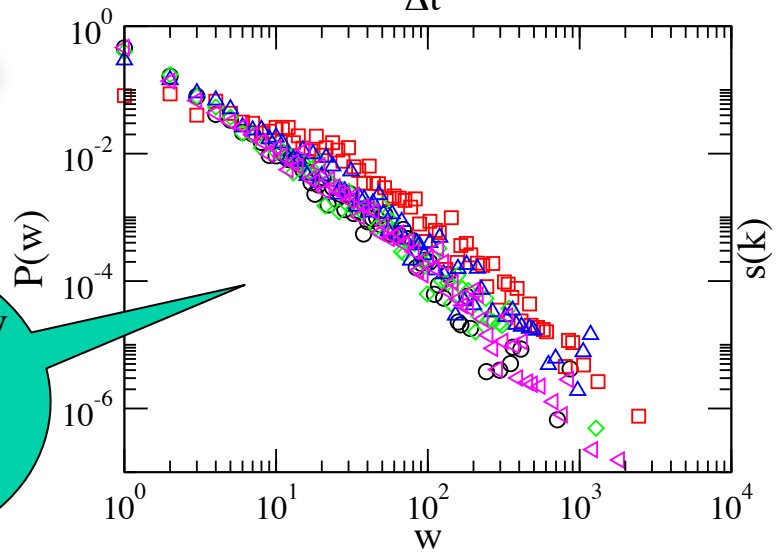
Duration of conversations

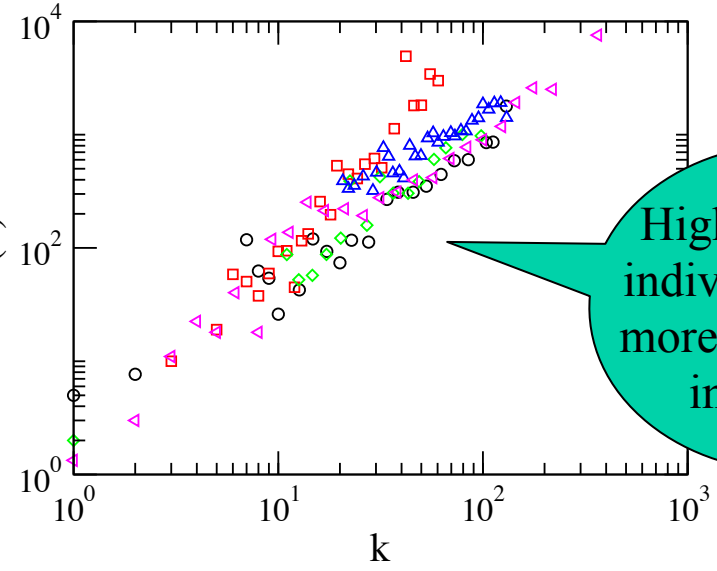
Inter-contacts gap times

Integrating Information









Heterogeneity persists over longer time intervals

High connected individuals spend more time in each interaction

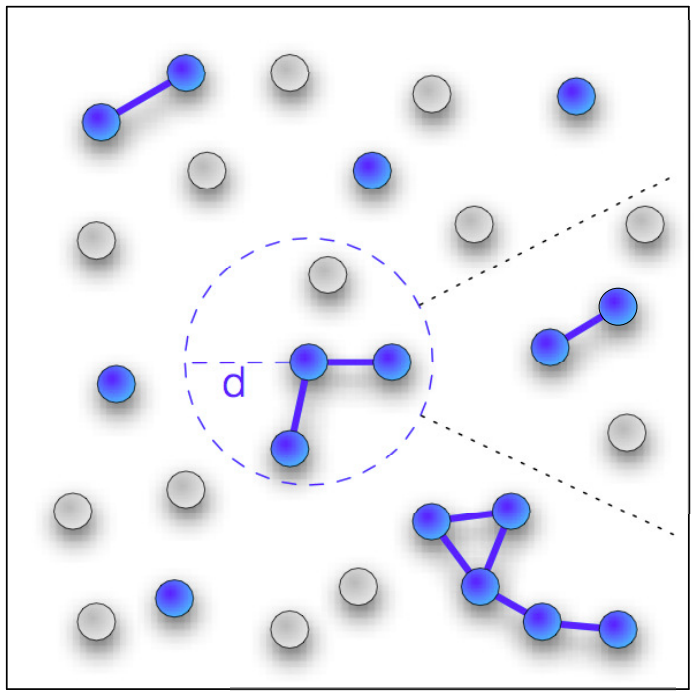
Total contact time between pairs

Strength vs Degree

Move
Interact
Get bored
Keep moving
Leave

A Model of Social Interactions

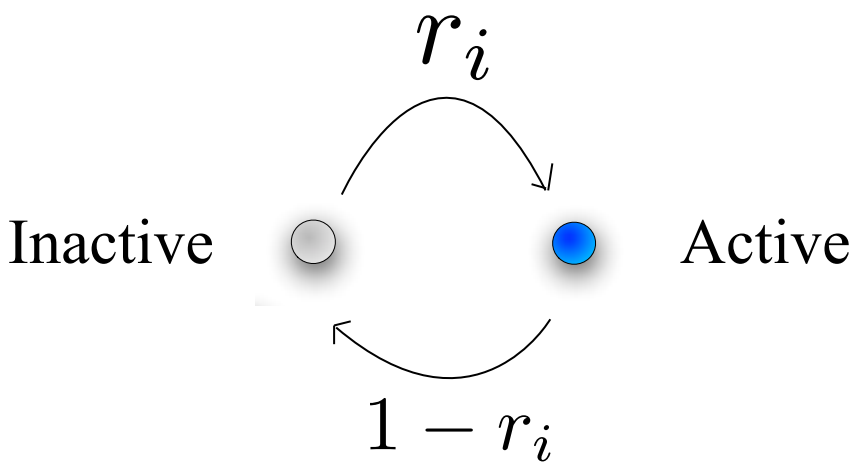
- N agents performs a biased random walk in a 2D space
- Whenever 2 agents intercept within a distance *d*, they start to interact



A Model of Social Interactions

- Agents can be in a active (move and interact) or inactive (not moving neither interacting) state

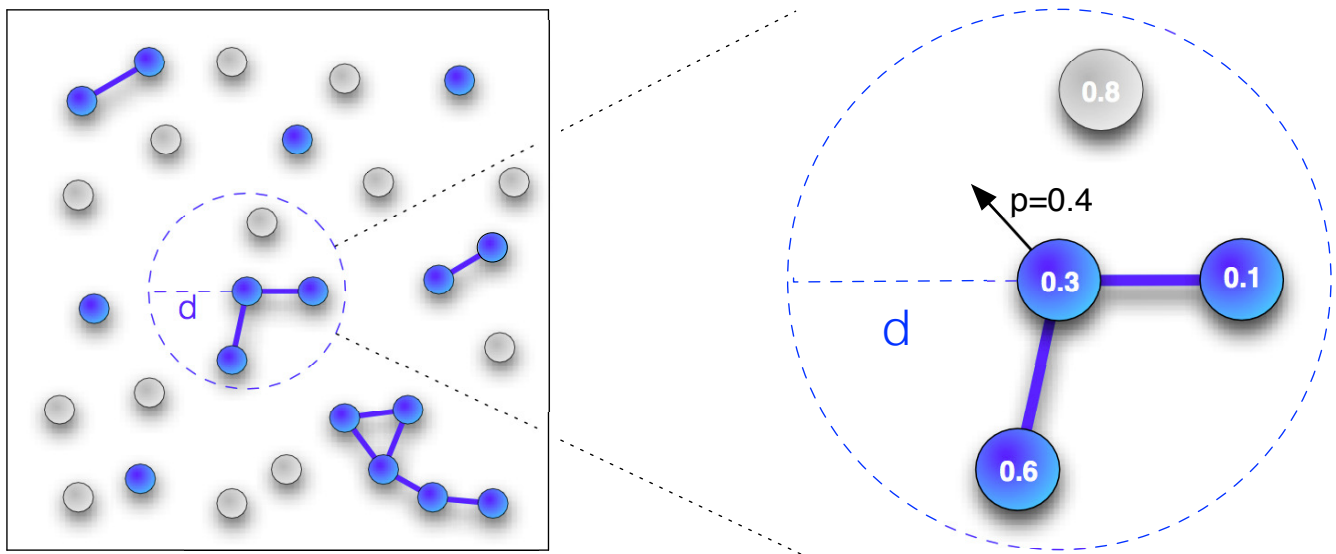
- From time to time, agents jump from active to inactive state with probability $r_i \in [0, 1]$ and viceversa



A Model of Social Interactions

- Each agent *i* is characterized by his attractiveness $a_i \in [0, 1[$
- At each time step *t* each *i* agent moves with prob. $p_i(t) = 1 - \max_{j \in \mathcal{N}_i(t)} a_j$

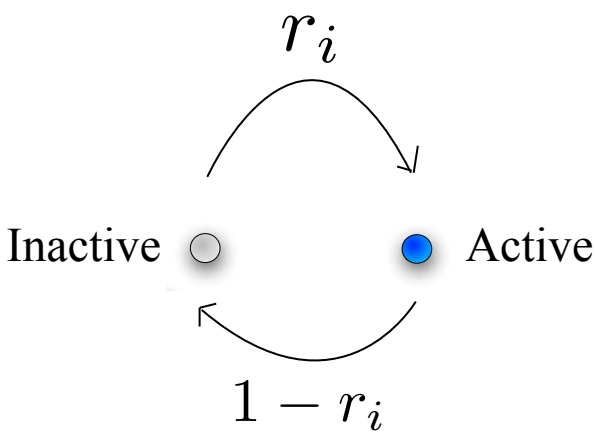
You decide if keep interacting depending on the attractiveness of your most interesting peer

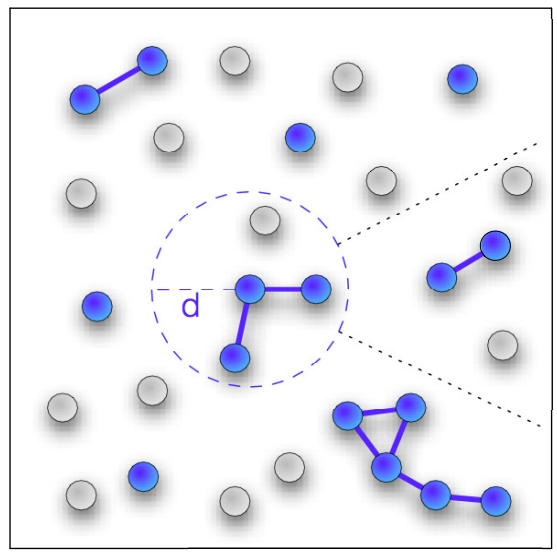


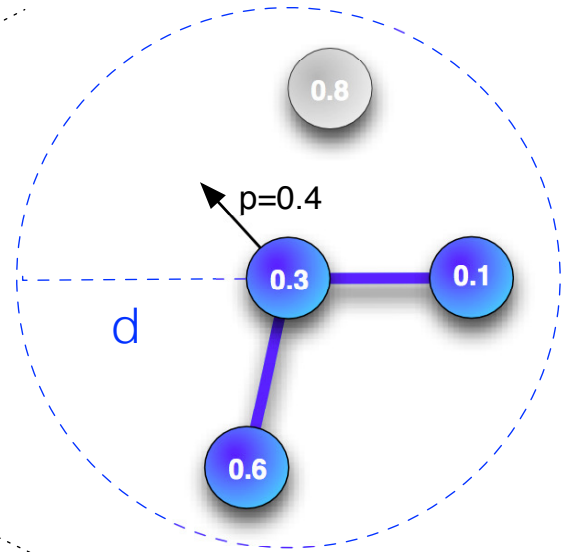
A Model of Social Interactions

- N agents performs a biased random walk in a 2D space
- Agents can be in a active or inactive state
- Interactions are ruled by the attractiveness of the agents

Simple but very realistic assumptions, reproducing experimental setting

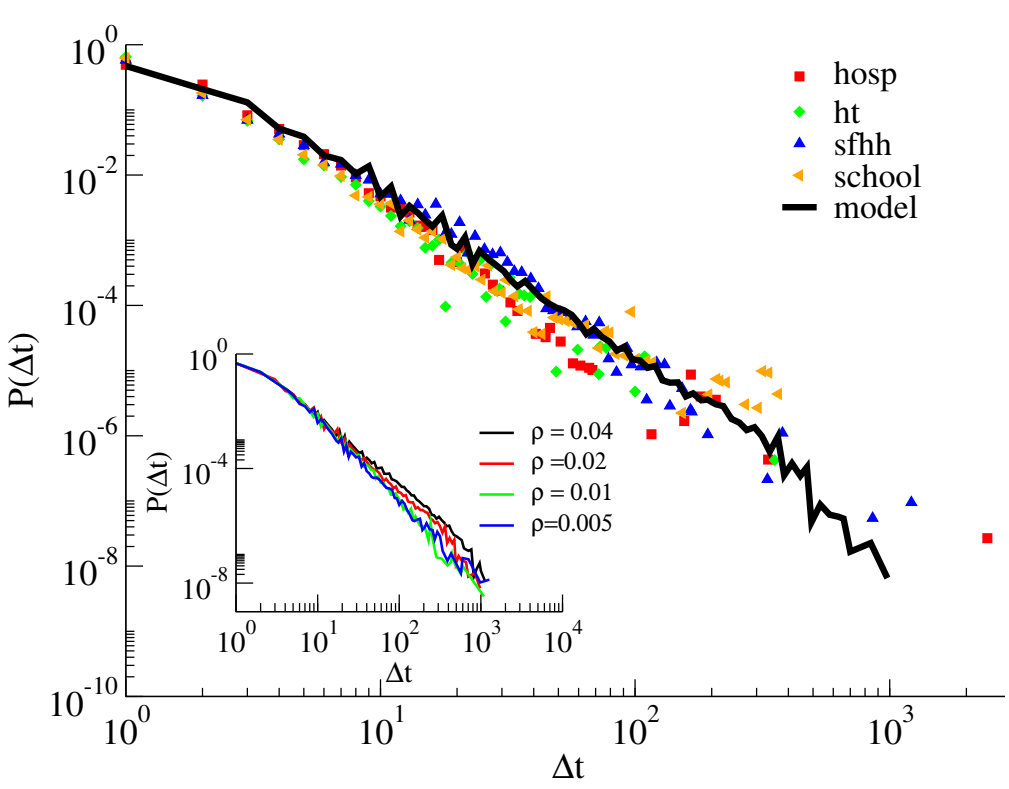




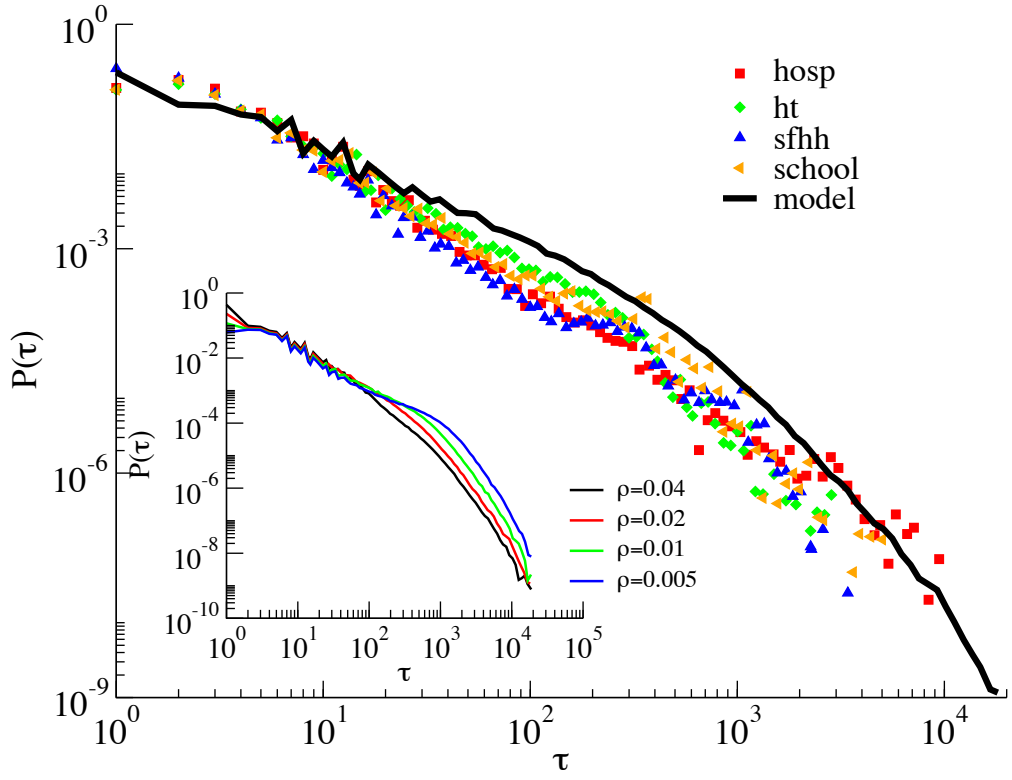


Statistical properties of social interactions

Distribution of the contact duration

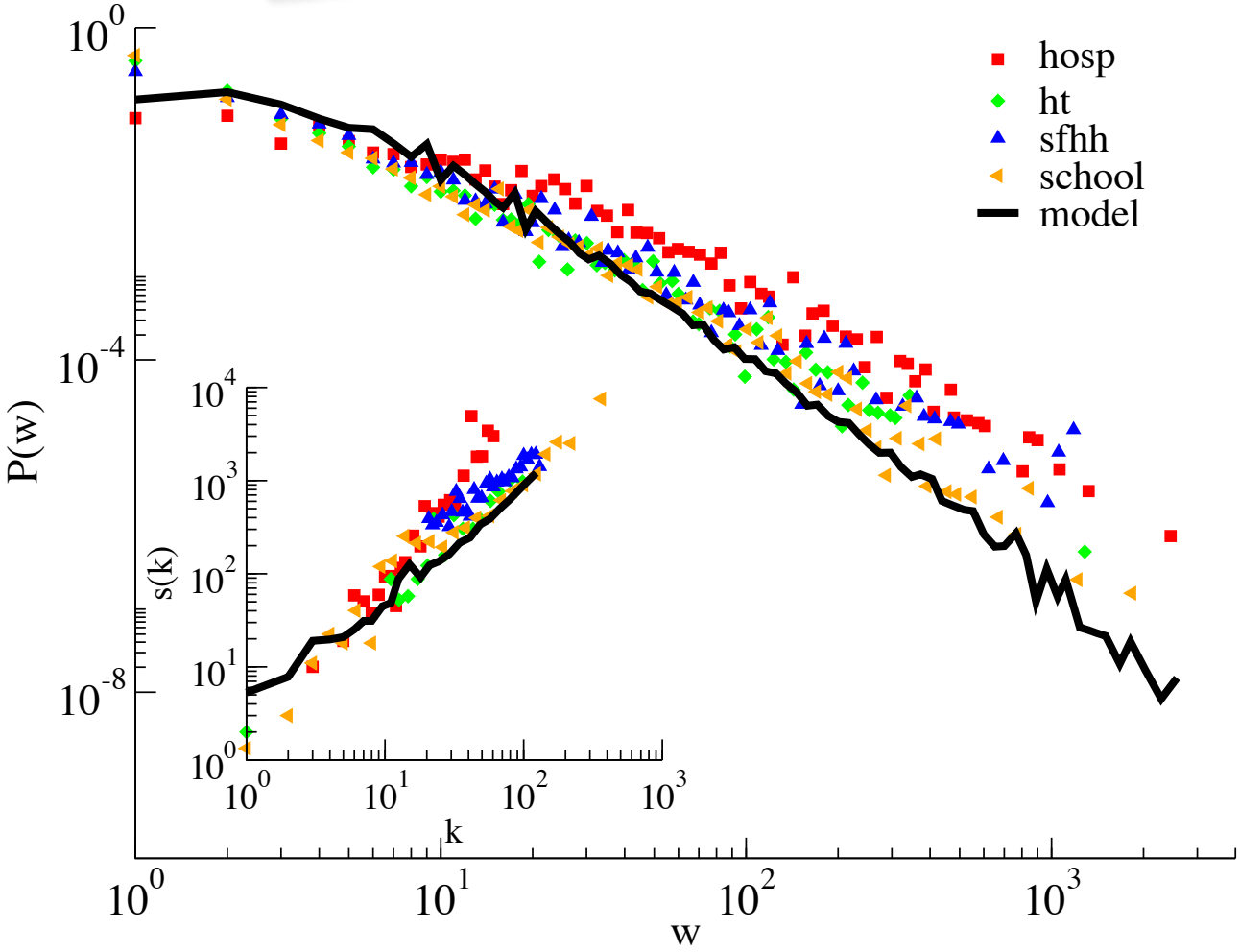


Distribution of the gap times between consecutive conversations



- Results are robust with respect to variations of the density ρ

Aggregated Network

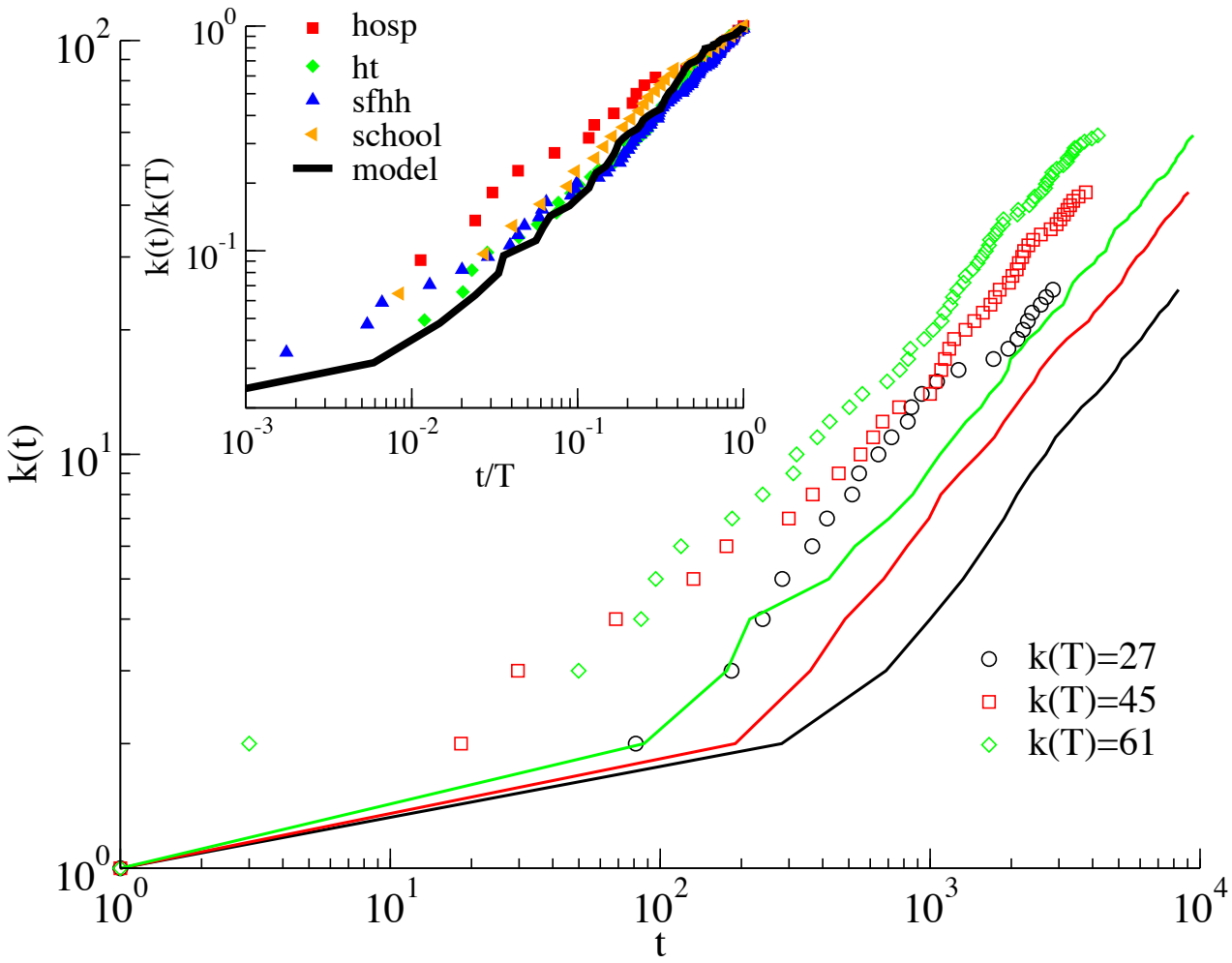


Weight distribution P(w)

Strength - Degree correlation s(k)

- The model output for the integrated weighted network is OK

Growing Network



Aggregated degree vs time, k(t)

- Tendency of an agent to interact with new peers decreases in time, $k(t) \sim t^{\mu}, \quad \mu \simeq 0.6$

Final Remarks

- Sociopatterns data of face-to-face interactions are dynamical social networks showing burstiness and heterogeneity in interactions

- We consider a simple model of mobile agents performing a RW in a 2D space, without any cognitive assumption or data-driven mechanism

- The model is able to reproduce empirical data from both points of view of human dynamics and social networks, without parameters tuning

- The intrinsic attractiveness plays a key role in ruling interactions: more interesting partners, larger tendency to keep talking (very realistic)

Thank you!
(and be cool at conferences)

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