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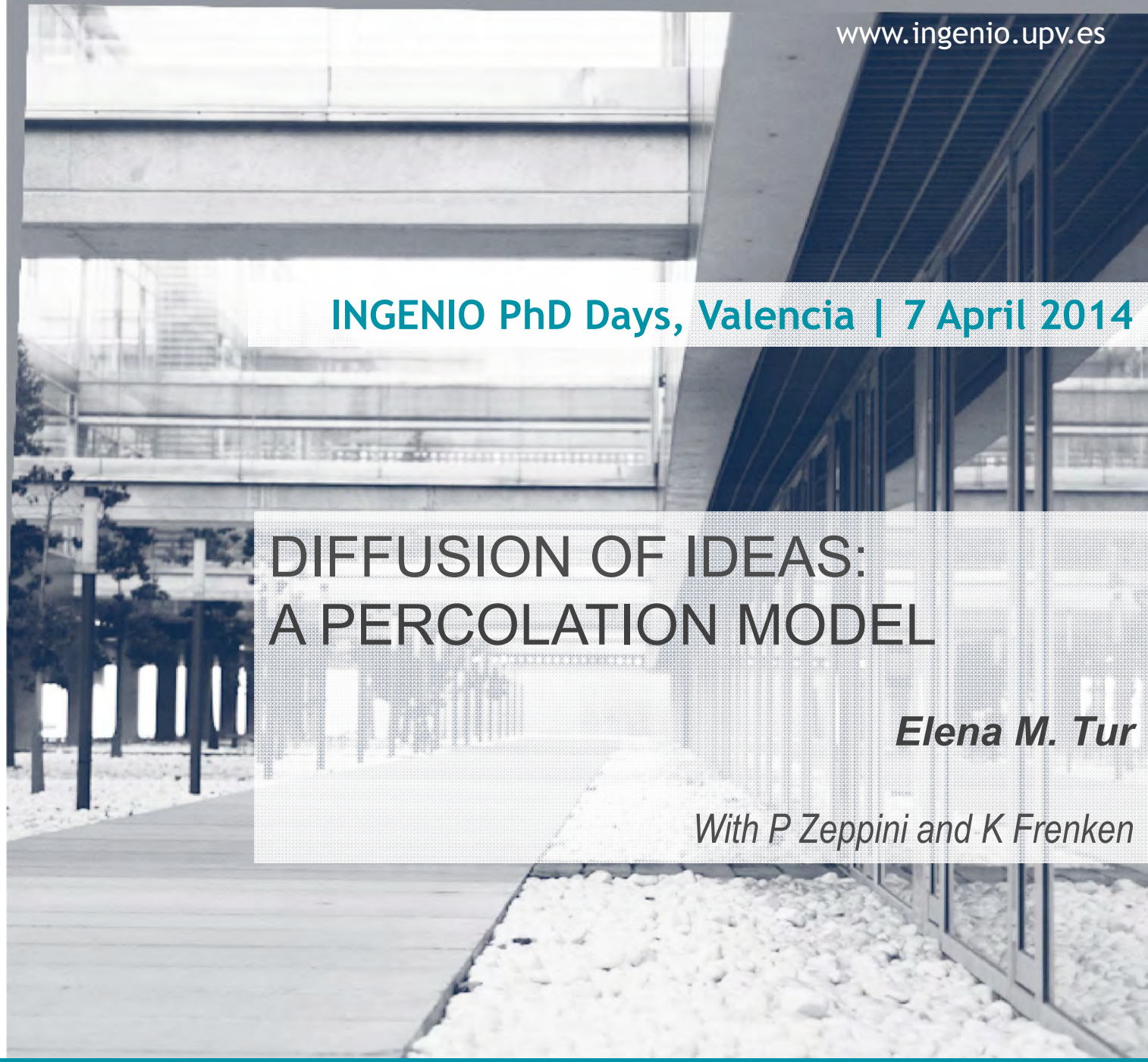

INGENIO PhD Days, Valencia | 7 April 2014

DIFFUSION OF IDEAS: A PERCOLATION MODEL

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What is percolation?

- Diffusion process in a network
  - Spread of rumors (Zanette, 2002)
  - Online spreading of behavior (Centola, 2010)
  - Opinion dynamics (Shao et al., 2009)
  - Paradigm shift in science (Brock and Durlauf, 1999)

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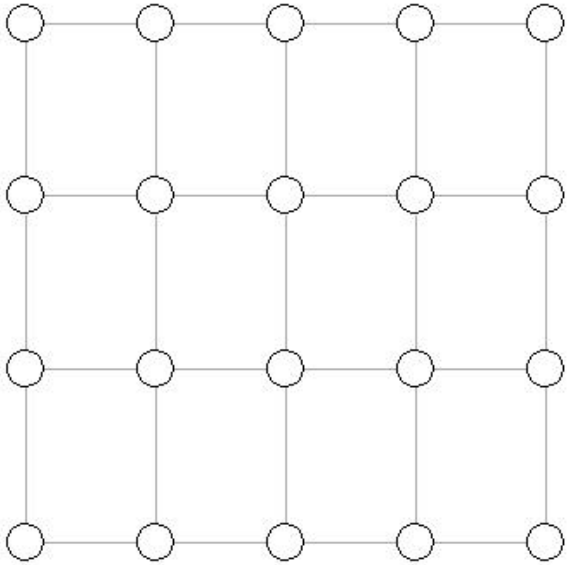
Percolation in a social network



Percolation in a social network

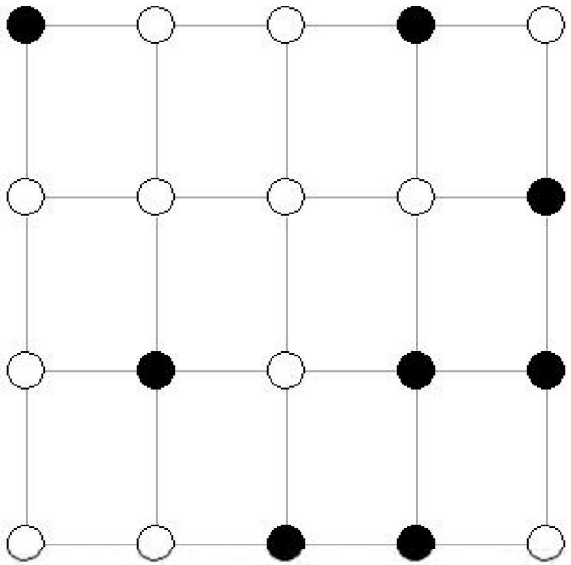
- $v_0 \in [0,1]$: value of the idea
- q^i: minimum quality requirement of agent i

Agent i adopts the idea at time t if:

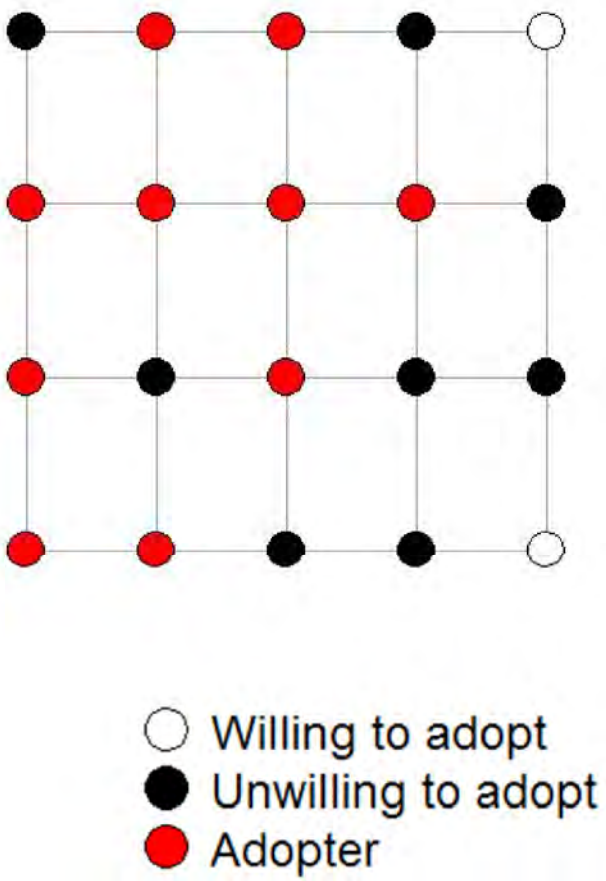
- i has not adopted before t
- i is informed: a neighbor has adopted at time $t-1$
- i is willing to adopt: $q^i \leq v_0$

Percolation in a social network

$$q^i \sim U[0,1] \;\rightarrow\; q^i \leq v_0\,?$$

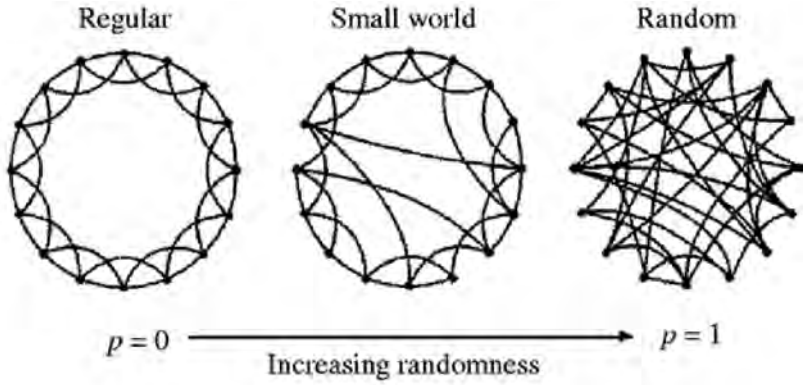


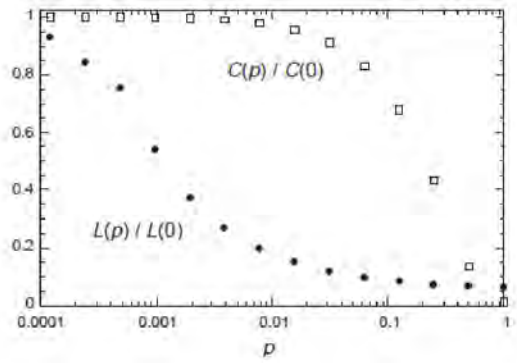
Percolation in a social network



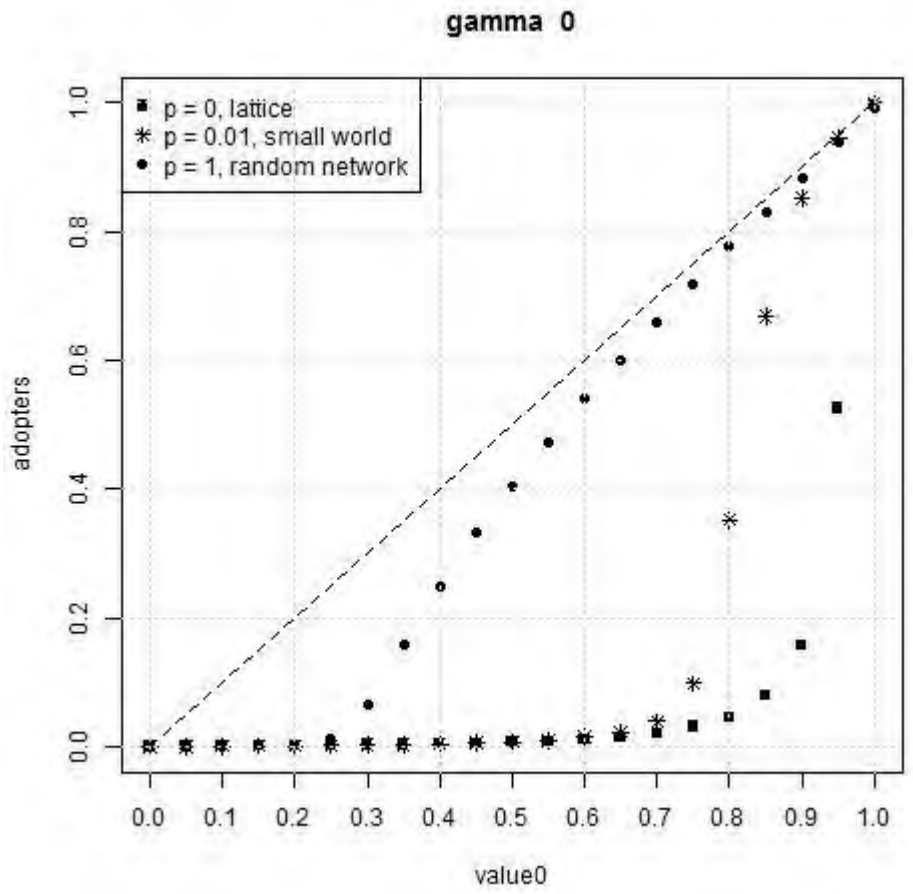
Social network

- Small world (Watts and Strogatz, 1998)
  Starting with a regular lattice, with n nodes and k edges per node, rewire each edge at random with probability p
- High clustering coefficient, low average path length





Percolation without social pressure



- Upper bound to diffusion: 45º line (well-mixed population)
- Diffusion increases with p
- Phase changes: from a non-diffusion to a diffusion regime
- Percolation thresholds decrease with p

SOCIAL PRESSURE

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Why social pressure?

- The unwilling to adopt can be persuaded
- Network externalities: shared language, shared experiences, shared beliefs…
- Increasing amount of evidence
- Conformity (Asch,1958)
- Weariness

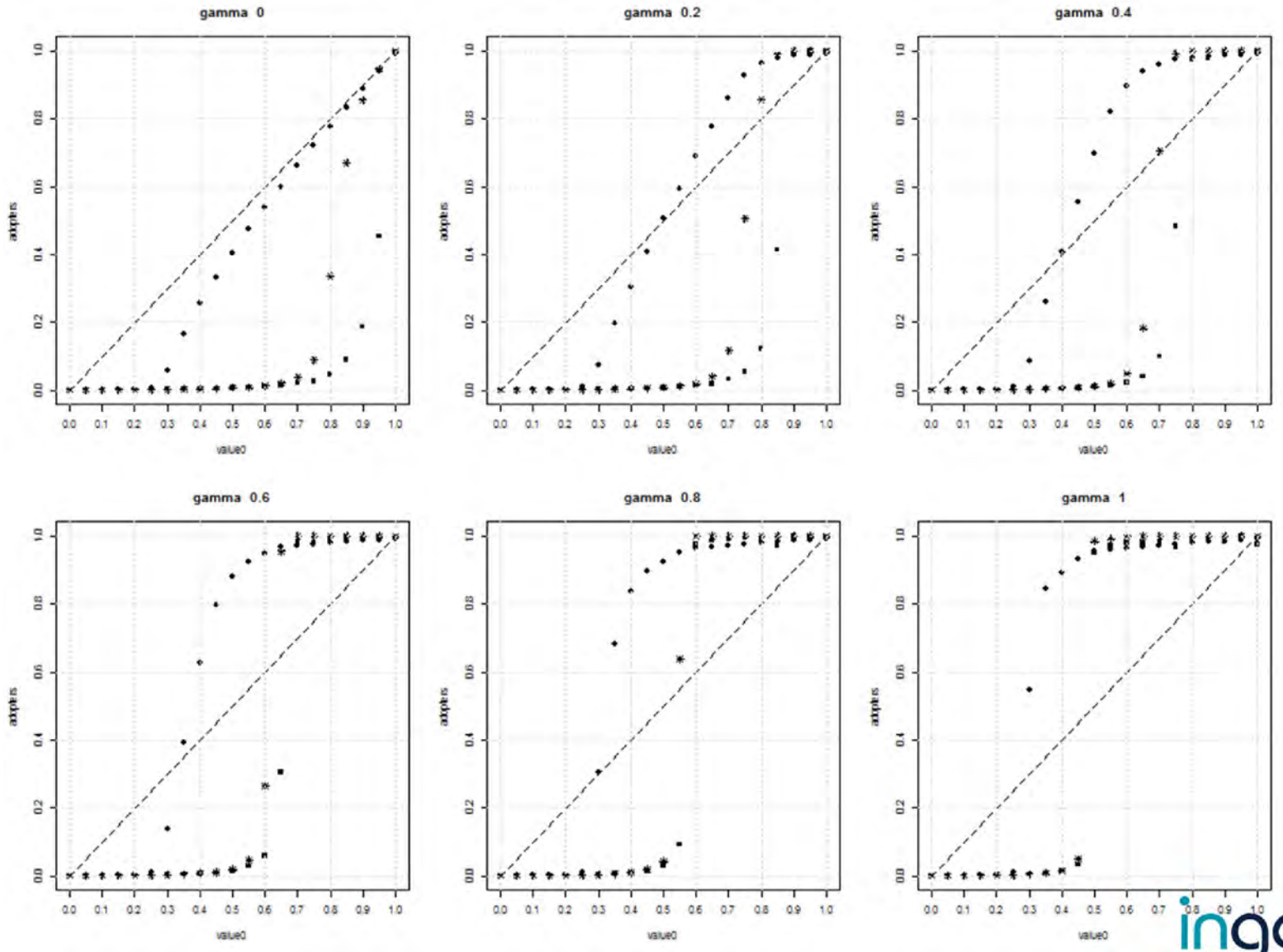
Modelling social Pressure

- a_t^i: # neighbors of agent i that have adopted at time t
- γ: social pressure intensity

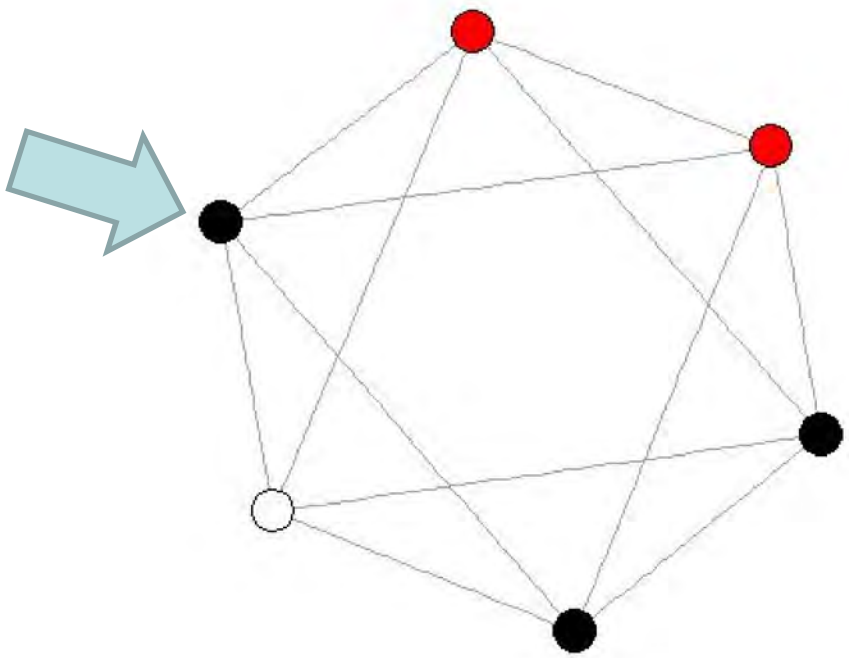
$$q_t^i = q_0^i \cdot \left(\frac{1}{a_t^i}\right)^{\gamma}$$

- q_t^i is decreasing in the number of adopting neighbors
- q_t^i is decreasing in the social pressure intensity
- $q_t^i = q_0^i$ if $\gamma = 0$
- $q_t^i = q_0^i$ if $a_t^i = 1$

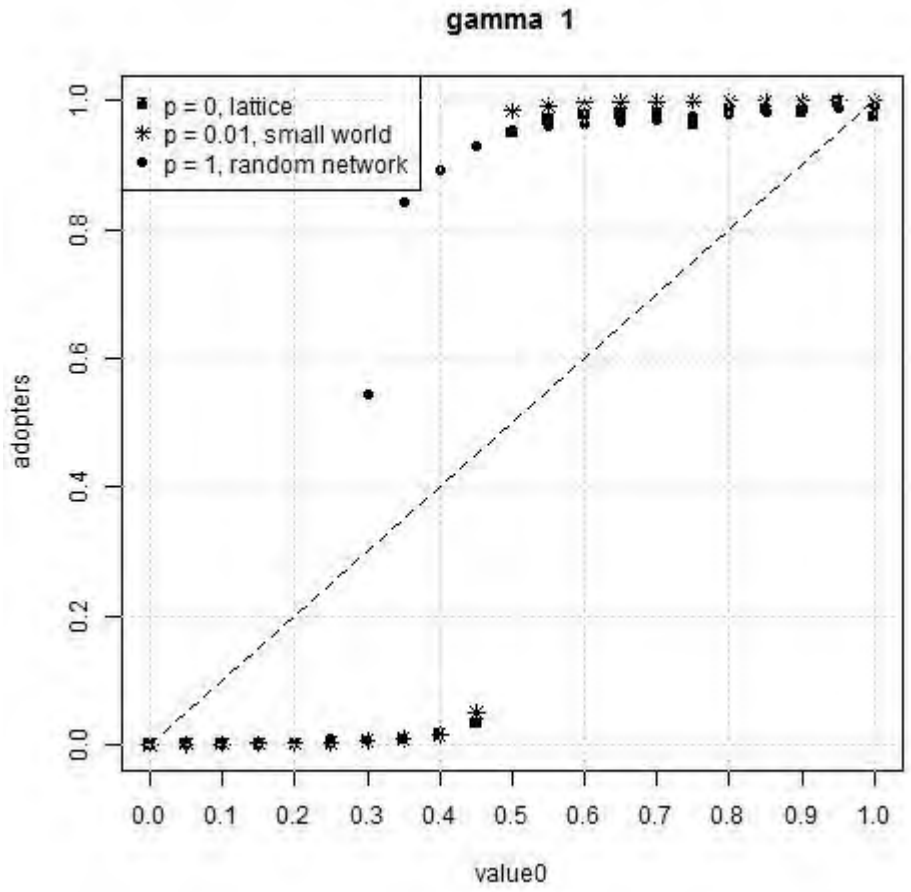
Percolation with social pressure



Clustering with social pressure



Percolation with social pressure



- The 45º line is no longer an upper bound to diffusion
- Diffusion increases
- Percolation thresholds decrease
- Differences between networks are reduced

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ASSORTATIVITY

People tend to be friends with similar people

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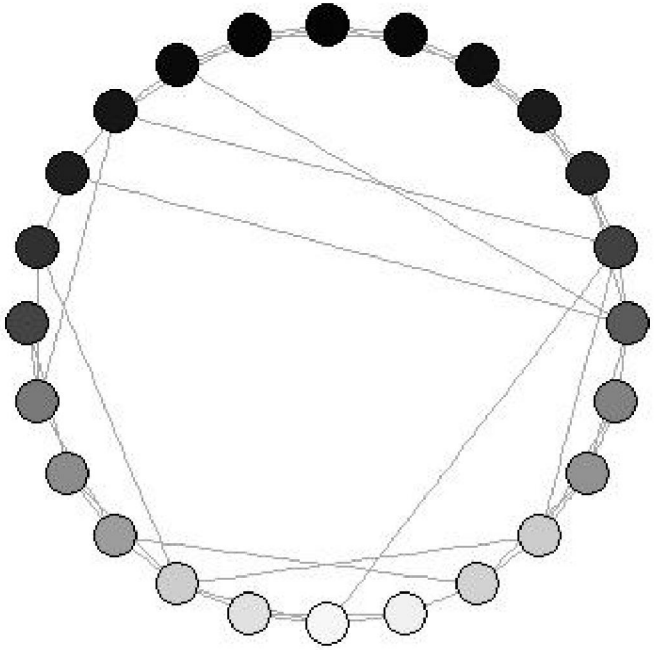
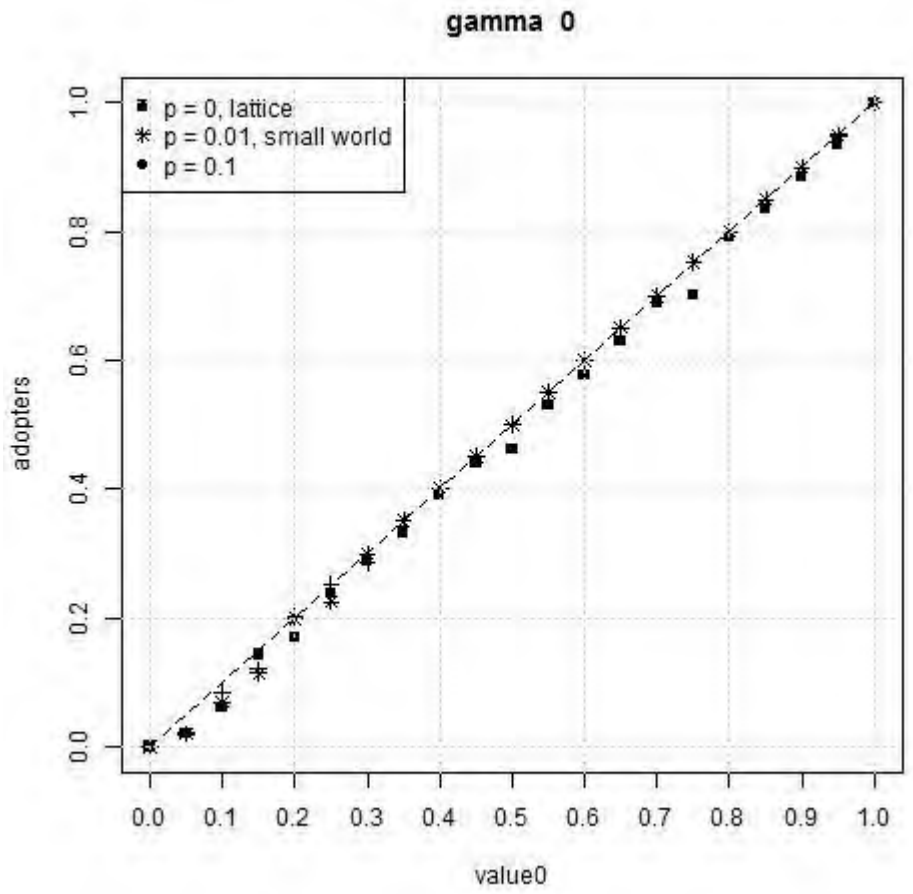
Modelling assortativity



Most willing to adopt

Most unwilling to adopt

Percolation with assortativity



- No critical transition from non-diffusion to diffusion
- Diffusion size scales linearly with idea value
- No effect of the network structure (well-mixed population)

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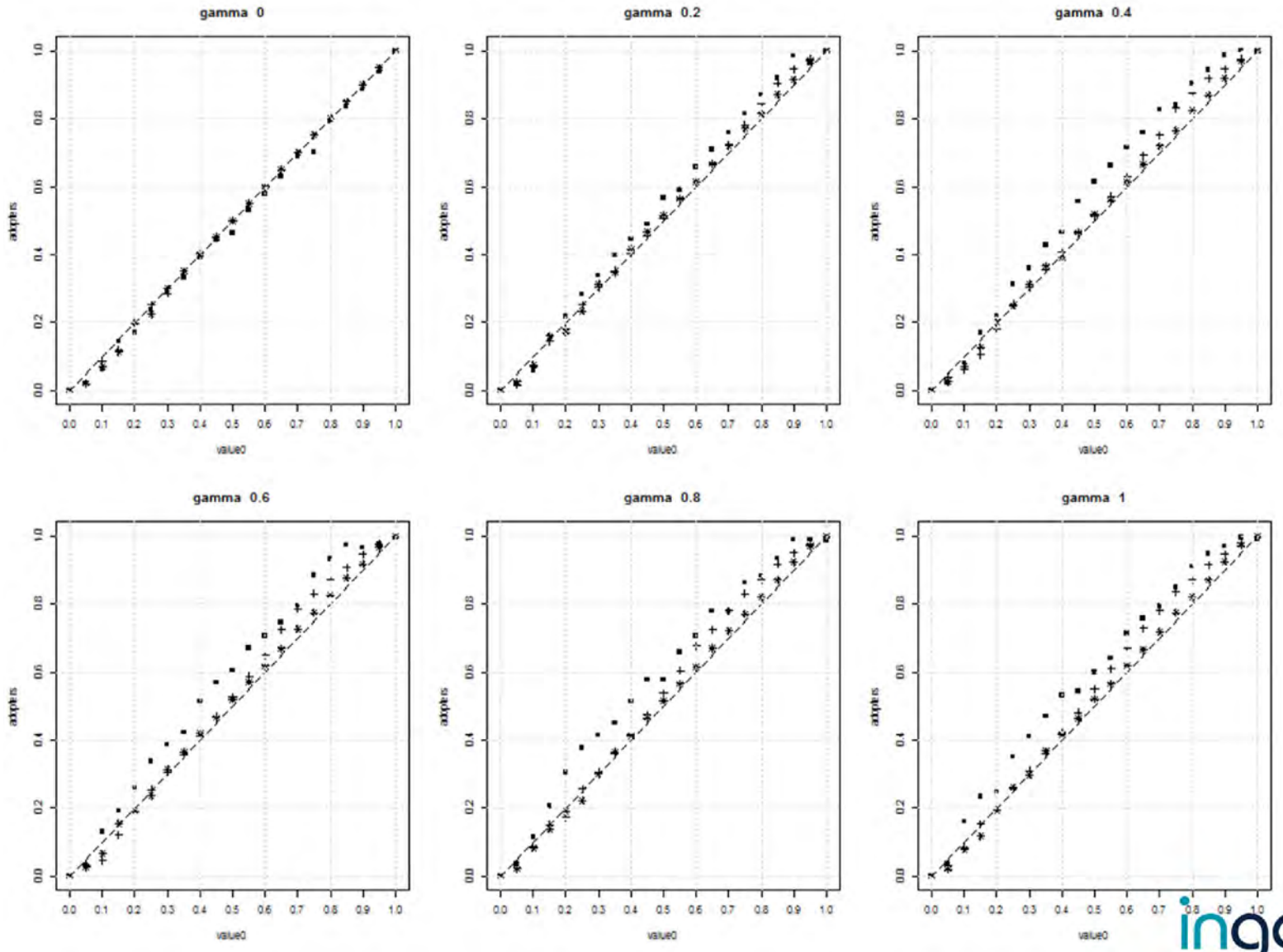
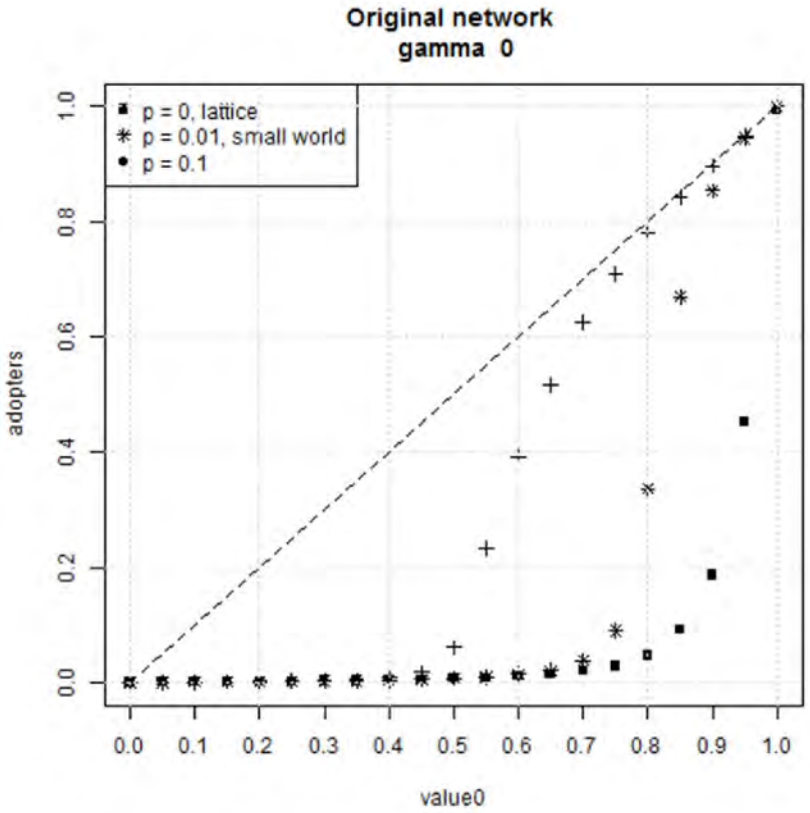
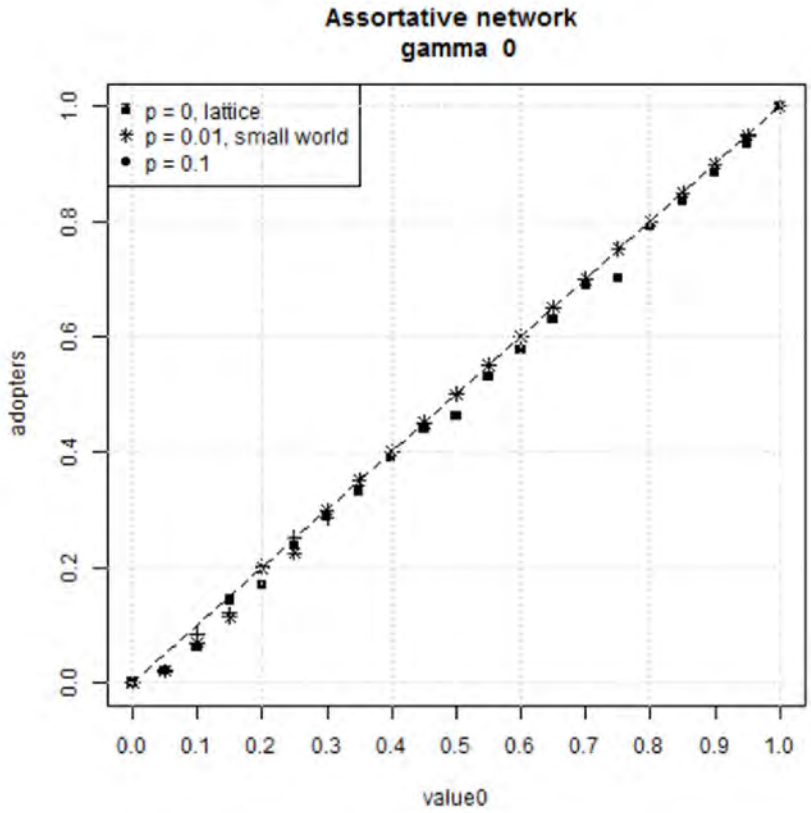
Percolation with social pressure and assortativity



Does assortativity help diffusion?





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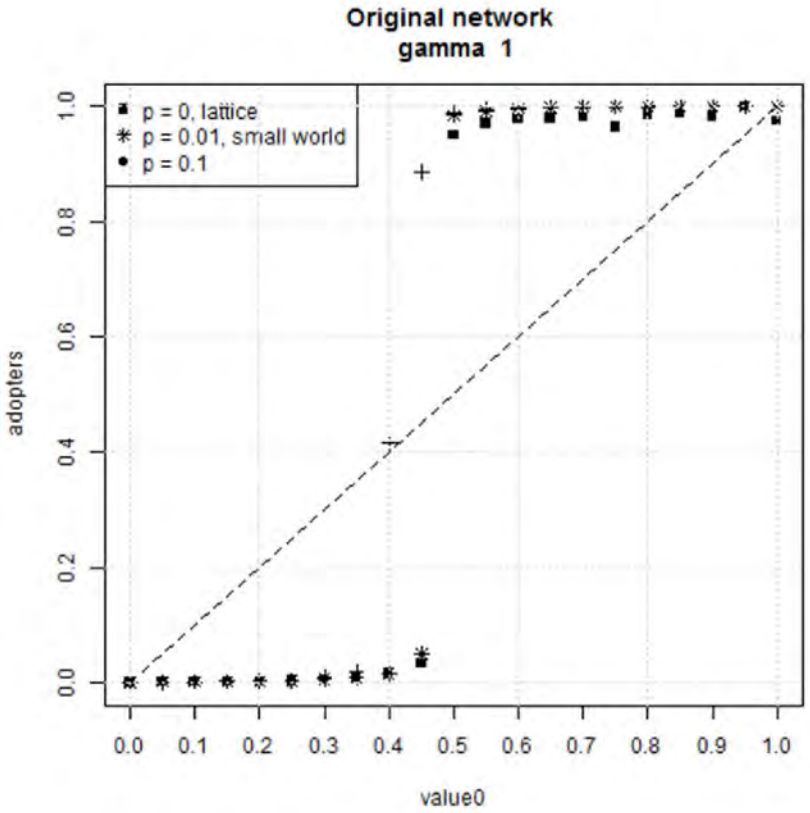
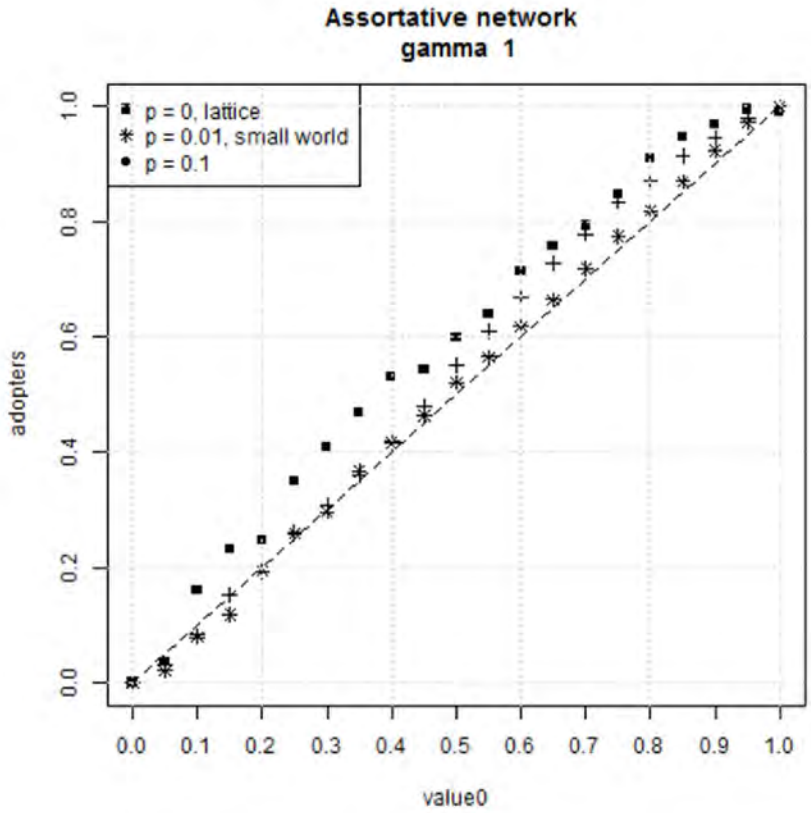
Does assortativity help diffusion? (2)





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CONCLUSIONS

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Conclusions

- Social pressure changes the behavior of the percolation process: higher diffusion size, lower percolation thresholds
- The effect of social pressure is different for different network structures: critical transition in small worlds and lattices
- With social pressure, clustering becomes beneficial for diffusion: reduced differences between networks
- Assortativity removes the effect of the network structure: all behave as a well-mixed population
- Assortativity can help or hamper diffusion depending on the setting

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Future work and limitations

- Other social network structures: scale-free networks (Barábasi and Albert, 1999)
- Evolving endogenous social network
- Re-think the social pressure implementation
- Different minimum quality requirement distributions, $Beta(\alpha, \beta)$

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