Opinion Dynamics in Case of Different Communication Channels and Incomplete Awareness

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DeGroot Model

N – the number of agents

μ_i – the agent's i resistance for external influence

$\Lambda = ||\lambda_{ij}||$ – relative interaction matrix

$p_i(t)$ – the agent's i opinion at the moment t

Opinion change for one iteration:

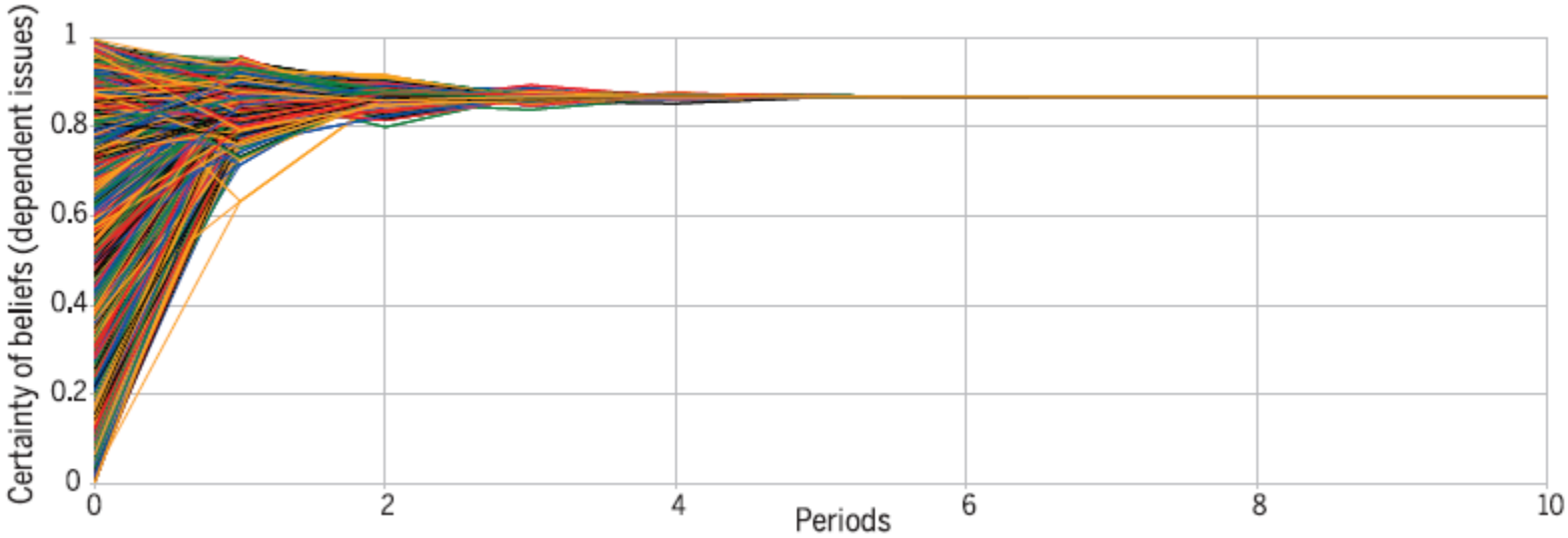
$$p_i(t+1) = \mu_i p_i(t) + (1-\mu_i) \sum_{j \in I} \lambda_{ij} p_j(t)$$

Concensus

Based on the asymptotic convergence of the opinion dynamics system, the behavior can be classified as:

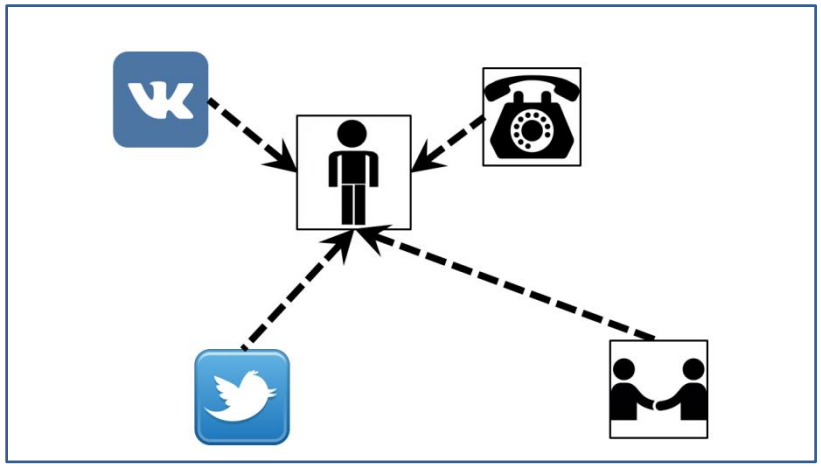
- Concensus
- Polarization
- Fragmentation

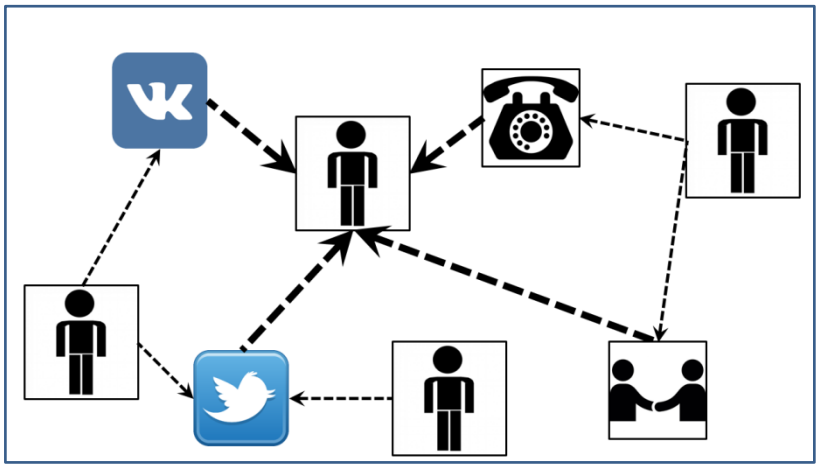
For the standard DeGroot model there exists a criteria of concensus.
(DeGroot, M. H. (1974). Reaching a consensus.)



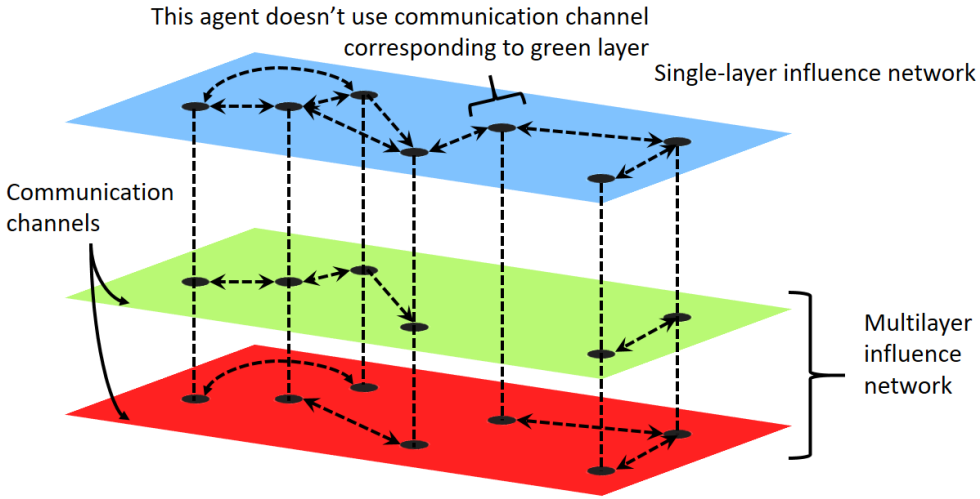
Example of dynamics leading to concensus
(taken from "Network science on belief system dynamics under logic constraints", Noah E. Friedkin (2016)

Our contribution





Different communication channels are considered through multi-layered network



Our contribution

Q – the set of communication channels

ρ_{iq} – relative importance of the channel q for the agent i

λ_{ij}^{q} – the openness of the agent i to the opinion of agent j in the communication channel q

Assumption: for each i, j, q

(Dunbar R. The structure of online social networks mirrors those in the offline world. 2015)

$$\frac{\lambda_{ij}}{\lambda_{ik}} = \frac{\lambda_{ij}^{q_l}}{\lambda_{ik}^{q_l}}.$$

Then the new iteration process:

$$p_i(t+1) = \mu_i p_i(t) + (1-\mu_i)\left\{\rho_{iq_1}\sum_{j\in I}\lambda_{ij}^{q_1}p_{ij}(t) + \rho_{iq_2}\sum_{j\in I}\lambda_{ij}^{q_2}p_{ij}(t) + \ldots + \rho_{iq_m}\sum_{j\in I}\lambda_{ij}^{q_m}p_{ij}(t)\right\}$$

Our contribution

•Cohen R., Ruths D. (2015)
"Classifying political orientation on Twitter: It's not easy!"
• Preoţiuc-Pietro D. (2017)
"Beyond binary labels: political ideology prediction of Twitter users".

Less than 5% of social media users openly show their interest, making invisible their position

•Daniel Romero, Wojciech Galuba. (2010)
"Influence and Passivity in Social Media".

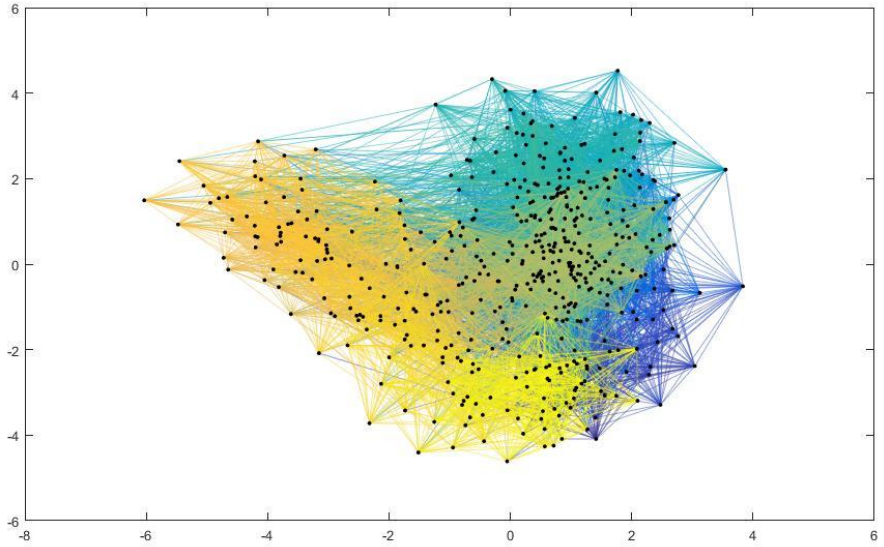
In order for individuals to become influential they must not only obtain attention and thus be popular, but also overcome user passivity.

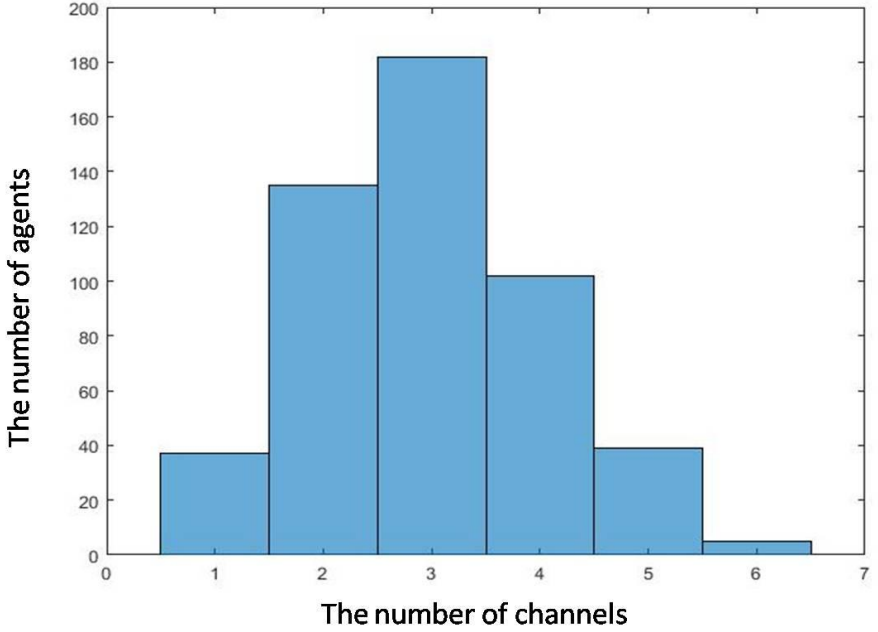
Activity: each agent shows his opinion in the communication channel with probability p

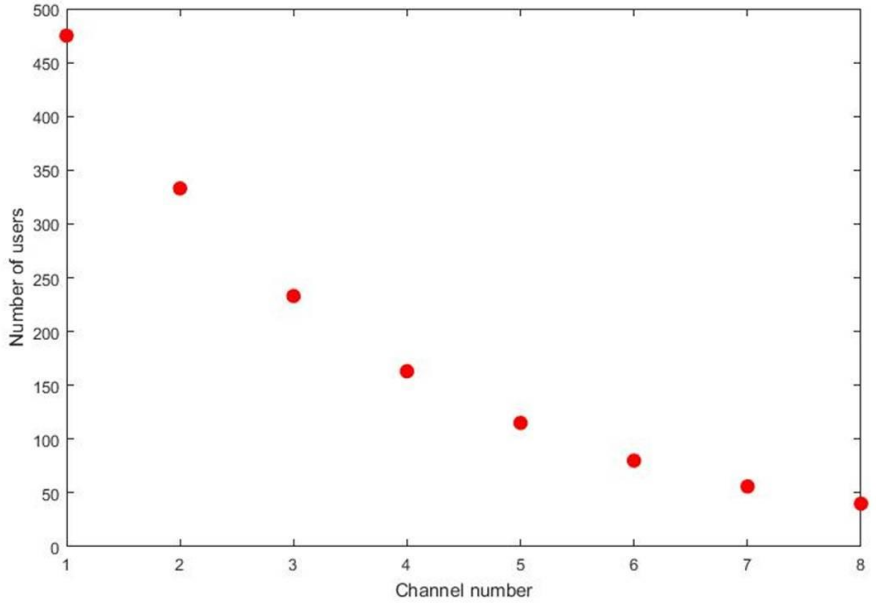
Computational experiment

Watts – Strogatz model,
N = 500, K = 30, β = 0.3

8 communication channels
with geometric distribution
of the number of users

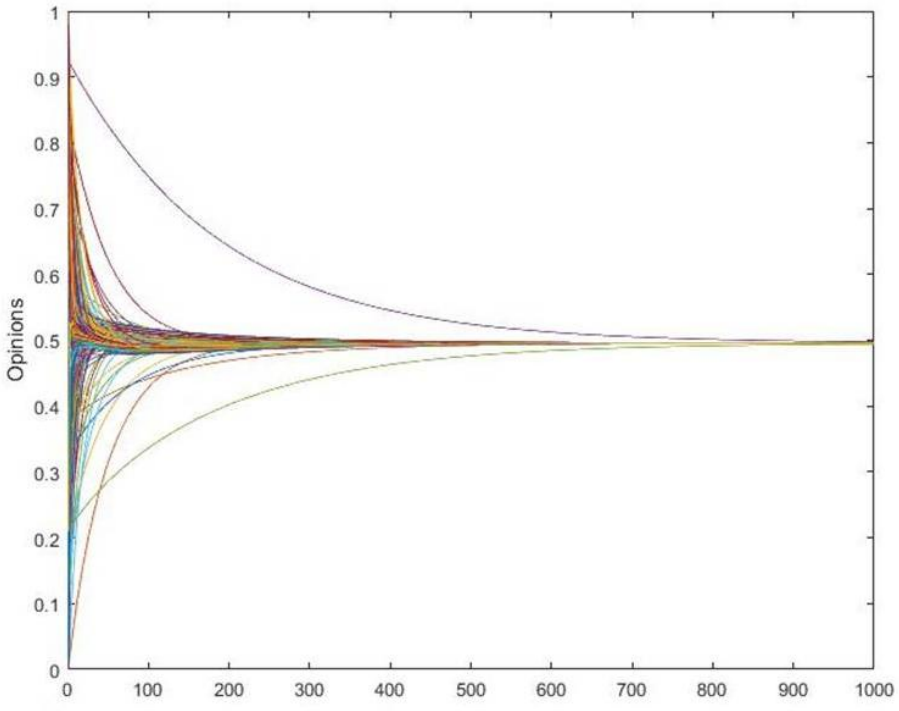




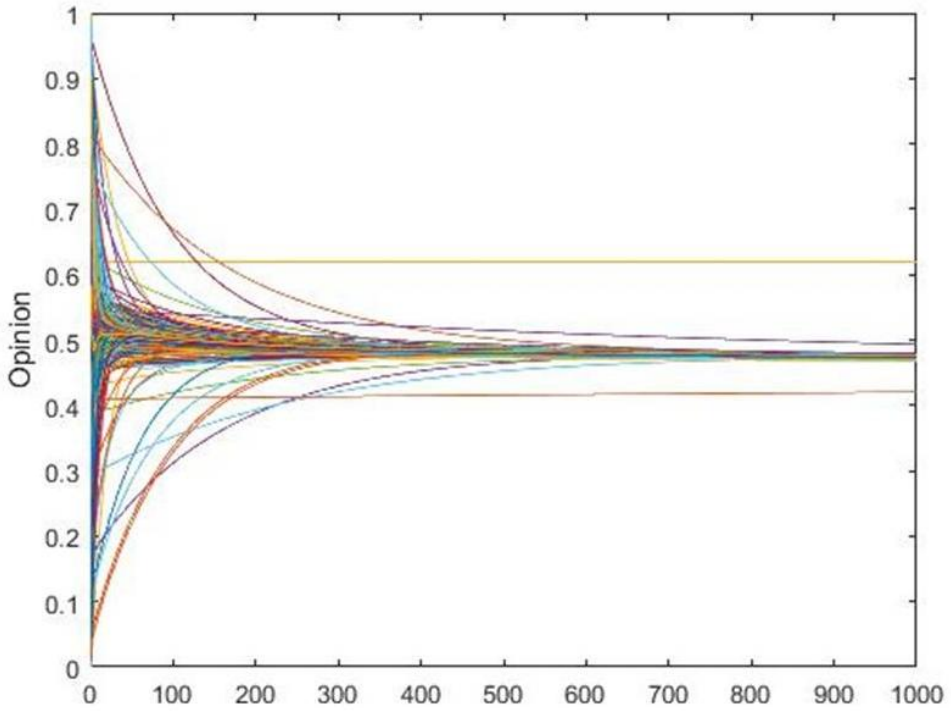


A series of computational experiments was carried out for model testing

Simulation with no channels or activity rate
(simple DeGroot model)

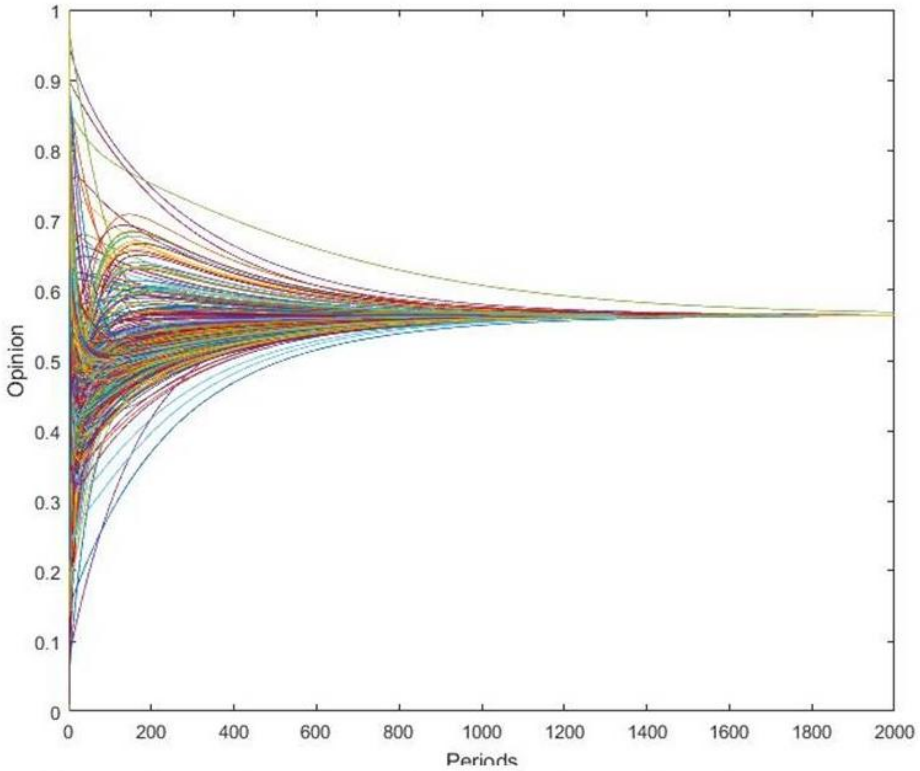


Simulation with communication 8 communication channels

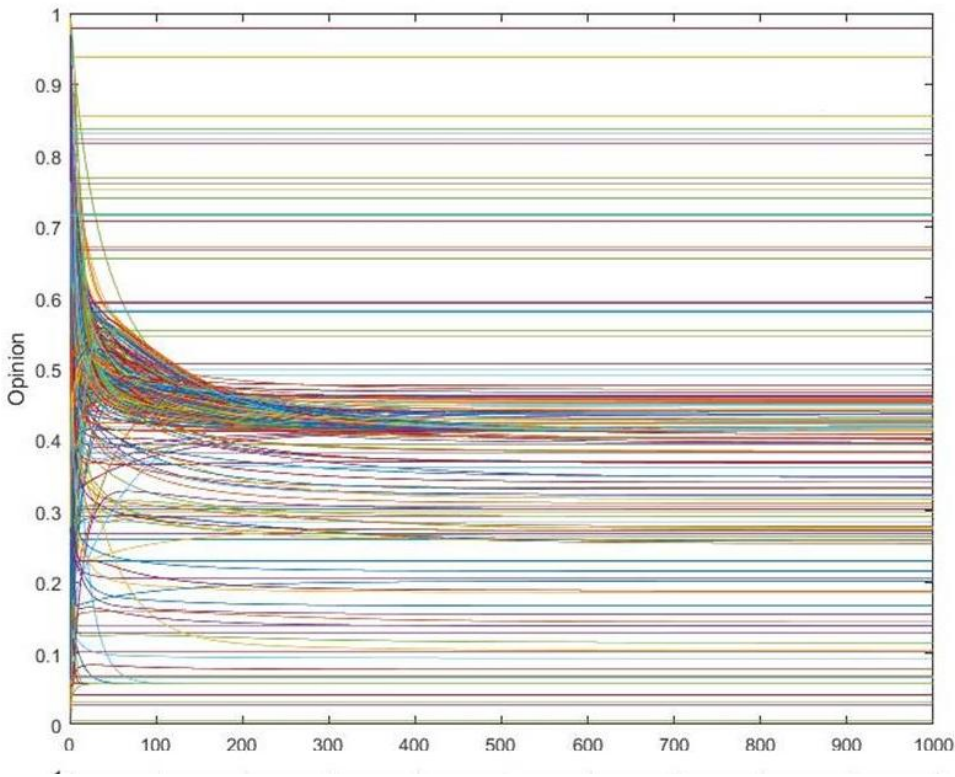


A series of computational experiments was carried out for model testing

Simulation without channels at the mean activity rate p = 15%

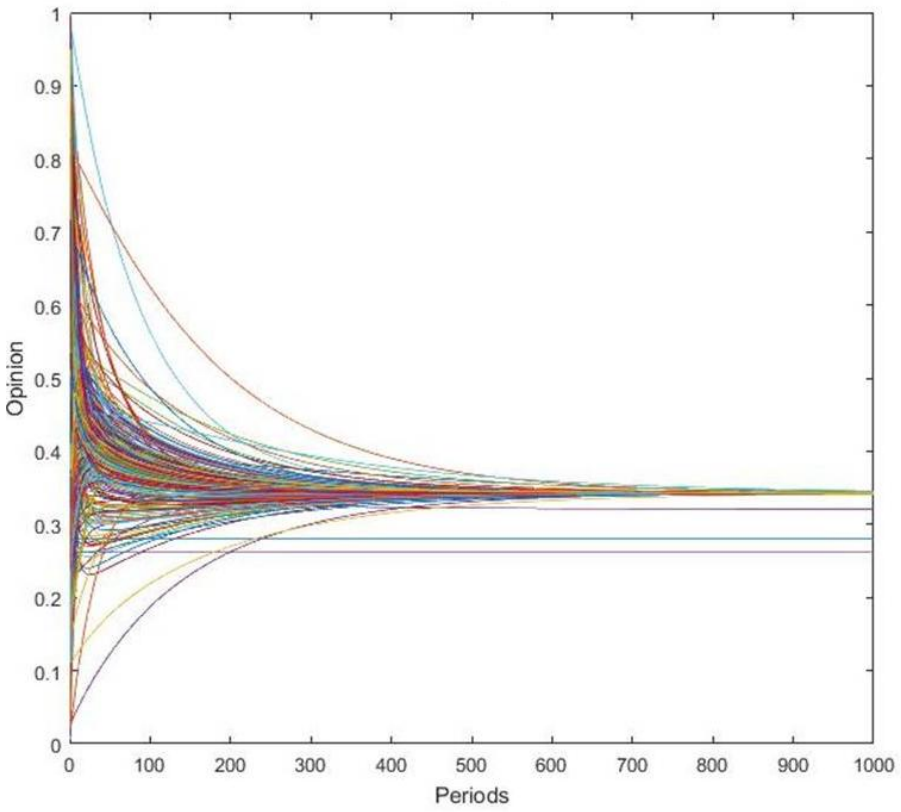


Simulation without channels at the mean activity rate p = 13%

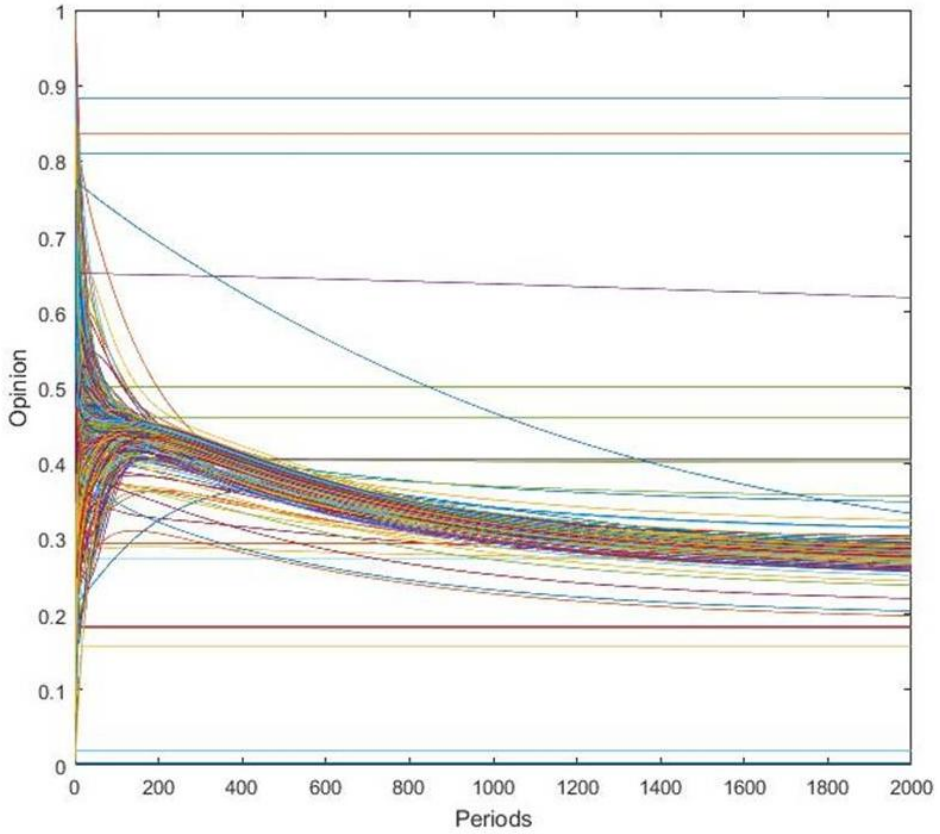


A series of computational experiments was carried out for model testing

Simulation with communication channels at the mean activity rate p = 18%



Simulation with communication channels at the mean activity rate p = 15%



Summary of the results

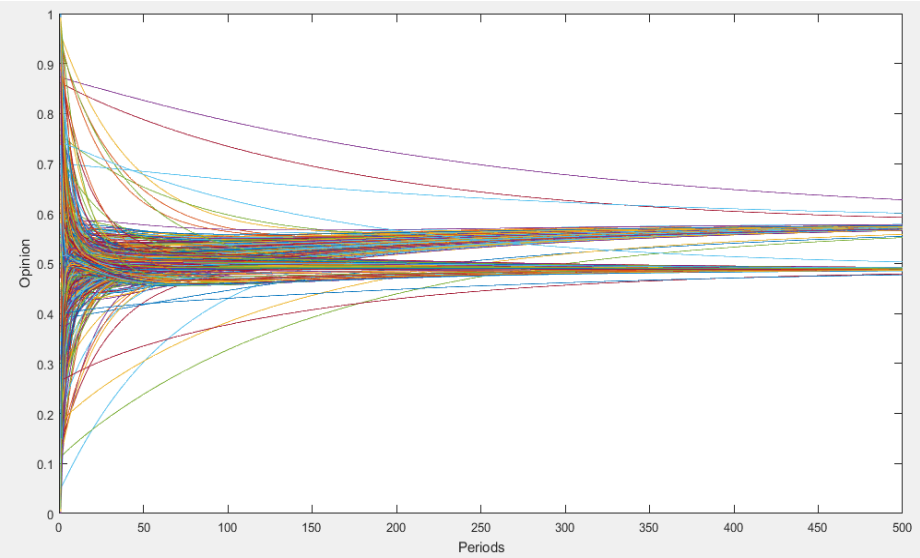
The observed behaviour of the opinion dynamics is the following:

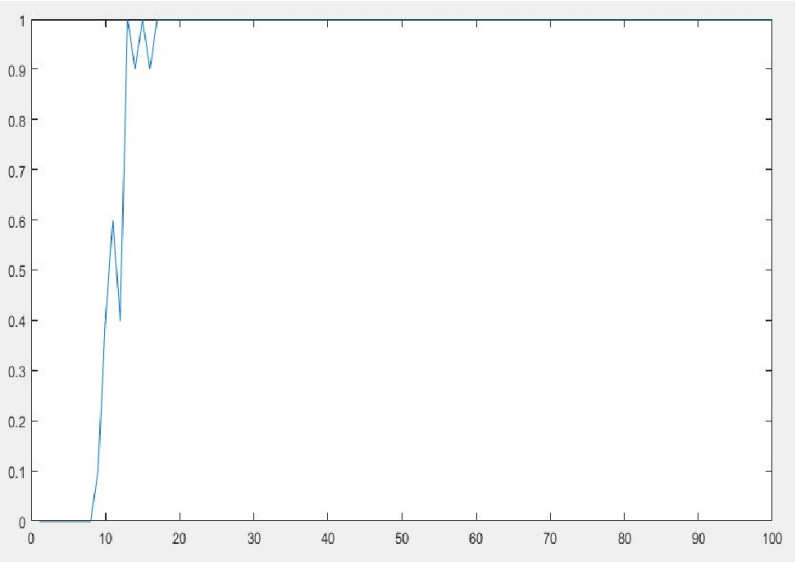
$p > \alpha_0$ => concensus

$p < \alpha_1$ => fragmentation

$\alpha_0 < p < \alpha_1$ => phase transition

Adding of the communication channels increases α_0, α_1





Generalization and discussion

Concensus is realized if and only if in the influence network there is only one component of strong connectivity without outgoing edges.

For each vertex all the ingoing edges are removed with the probability p. How will it affect the asymptotic behaviour of the opinion dynamics?