Three-state opinion q-voter model with bounded confidence

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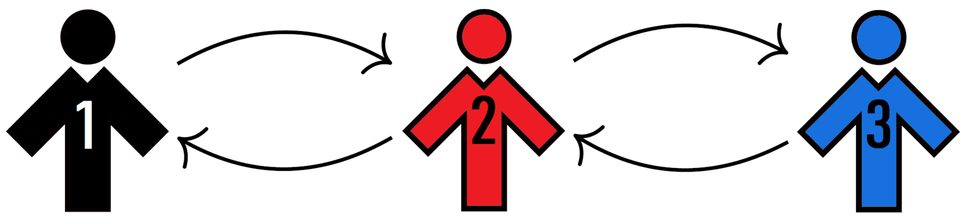
Motivation

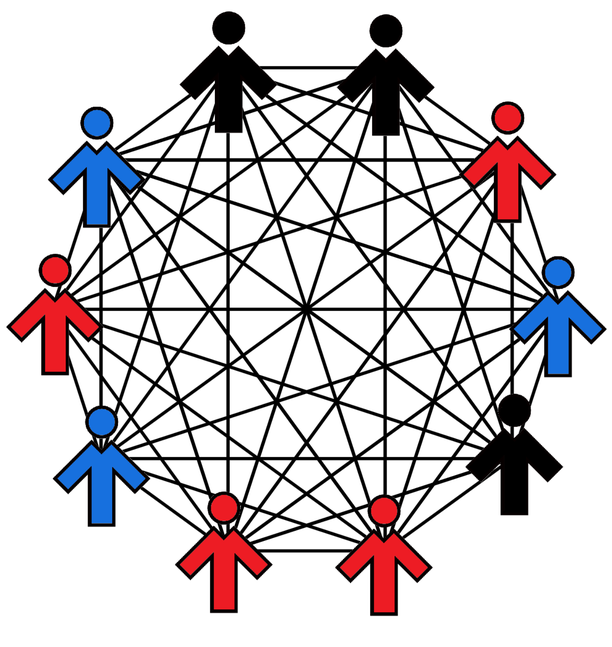
- Q-voter model is widely used in the area of opinion dynamics.
- Opinions – equivalent binary variables: (0 - *NO*, 1 - *YES*).
- Recently q-voter model with multi-state opinions was introduced.
- Stauffer introduced non-equivalent opinions into Sznajd model: agents can exchange opinion only in defined range (**bounded confidence**).

Our model

- Q-voter model with three-state opinion.
- Non-equivalence – bounded confidence.



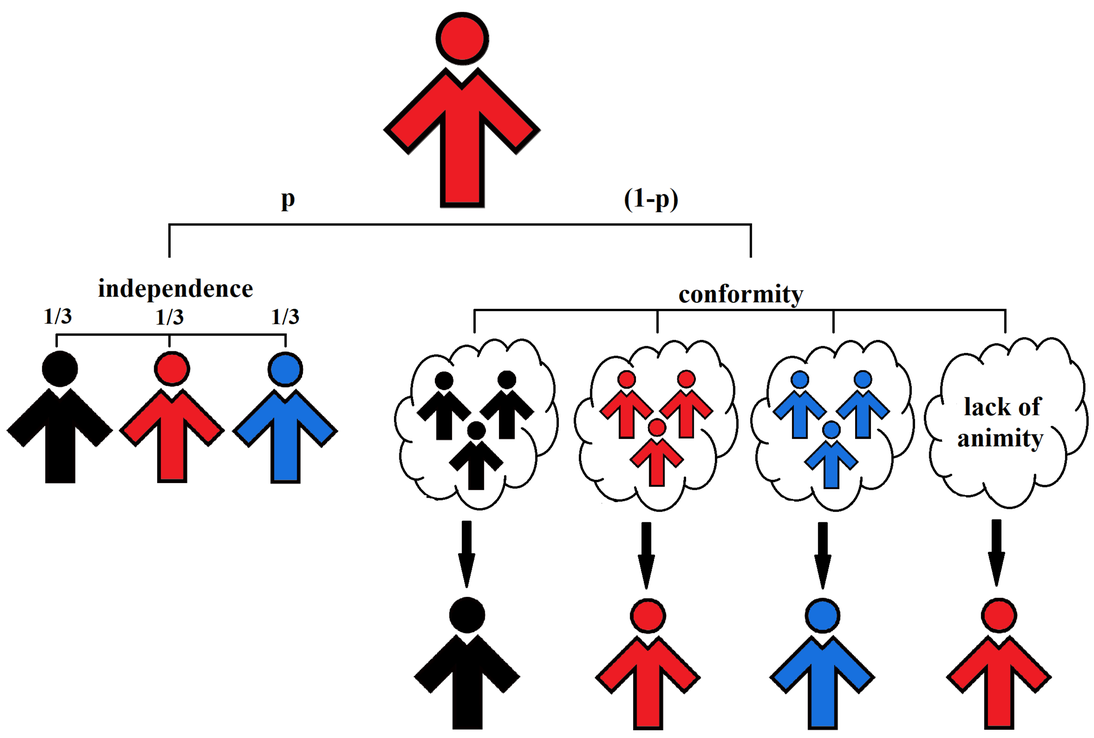
- Complete graph.



Agents interactions

Two types of behaviour:

- Independence with prob. p.
- Conformism with prob. $1-p$.



Paramaters of the model

- N – number of agents
- $p \in [0, 0.5]$
- Size of group of influence: $q \in \{2, 3, 4, 5\}$
- Opinion $k \in \{1, 2, 3\}$
- Concentration of opinion k: $c_k = N_k/N$
- t – Monte Carlo time

Acknowledgments

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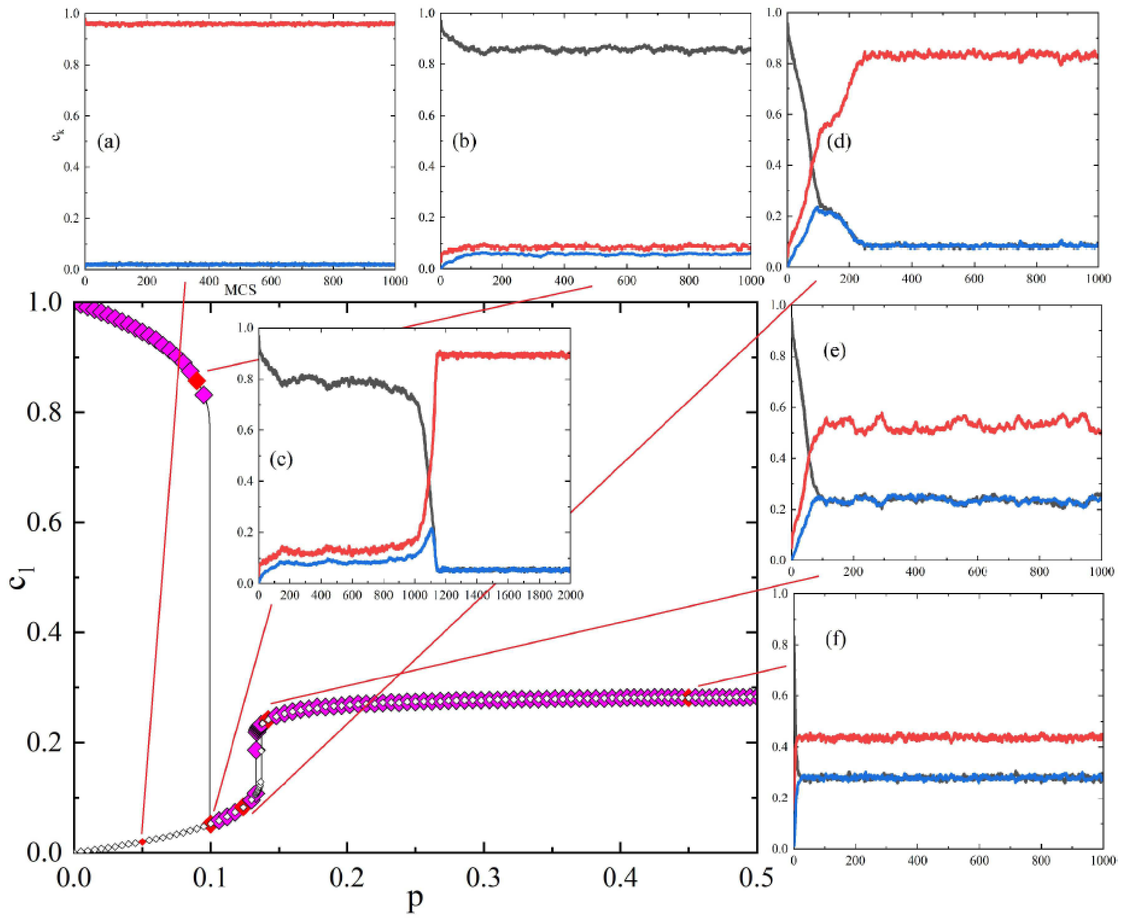
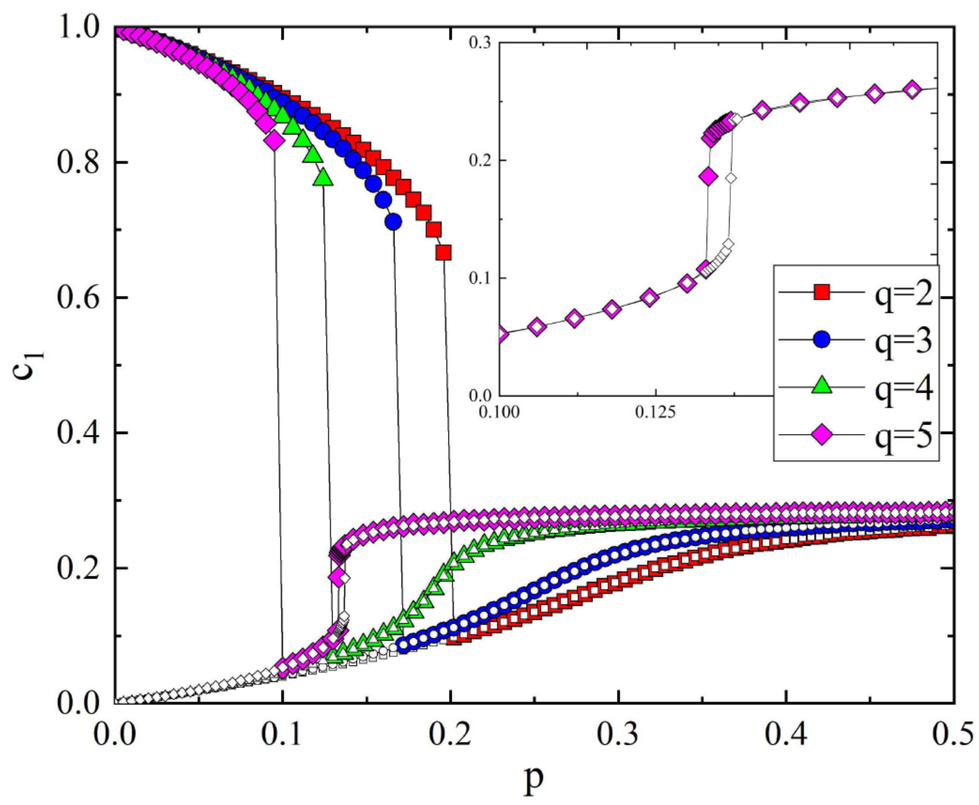
Time trajectories



Centre graph – stationary value of c_1 against p, $q = 5$.
Plots $(a) - (f)$: Trajectories of $c_k(t)$ against MC time for $q = 5$ and $p = 0.09, 0.1, 0.125, 0.142, 0.45, 0.05$, respectively.
Black line – c_1, **red** – c_2, **blue** – c_3.

Concentration vs independence



Stationary value of c_1 against p for various q. Symbols – MC simulations; solid lines – numerical solutions. Colored/empty symbols stand for different initial conditions.

Analytical solution

Using mean field approach we derive time evolution of concentrations:

$$\frac{dc_1}{dt} = c_2\left((1-p)\left(c_1^q\right) + \frac{p}{3}\right) - c_1\left((1-p)\left(c_2^q\right) + \frac{p}{2}\right),$$

$$\frac{dc_2}{dt} = (c_1 + c_3)\left((1-p)\left(c_2^q\right) + \frac{p}{2}\right) - c_2\left((1-p)\left(c_1^q + c_3^q\right) + \frac{2p}{3}\right),$$

$$\frac{dc_3}{dt} = c_2\left((1-p)\left(c_3^q\right) + \frac{p}{3}\right) - c_3\left((1-p)\left(c_2^q\right) + \frac{p}{2}\right).$$

Conclusions

- Two transitions in the system:
  order $\rightarrow$ *different order* and *order* $\rightarrow$ *disorder*.
- The first transition is discontinuous in all analyzed cases.
- The second transition is discontinuous only for $q = 5$.
- Bounded confidence changes qualitatively the dynamics of the system.