Phase diagram in the one-dimensional civil violence model

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Abstract

The civil violence model is agent-based simulates a social protest process where the police force restores public order. The interactions of cops and citizens produce dynamics that do not yet have any analysis from the sociophysics approach. We present numerical simulations to characterize the properties of the one-dimensional civil violence model on stationary-state. To do this, we consider short- and long-range interactions on a Moore neighborhood and a random neighborhood, a Potts-like energy function, and construct the phase diagram. We find order-disorder phases like those observed in the opinion models. These results are a first approach to studying this model in other dimensions and topologies and considering other complexities of social protest dynamics.

The Epstein Model

The agents dynamics is governed to

$$H(1-L) - R(1-\exp[-k(C/A)_v]) > T$$

Arrest probability → P

Grievance → G ; $N = RP$ → Net risk

G − N > T: Passive → Active

where each parameter is

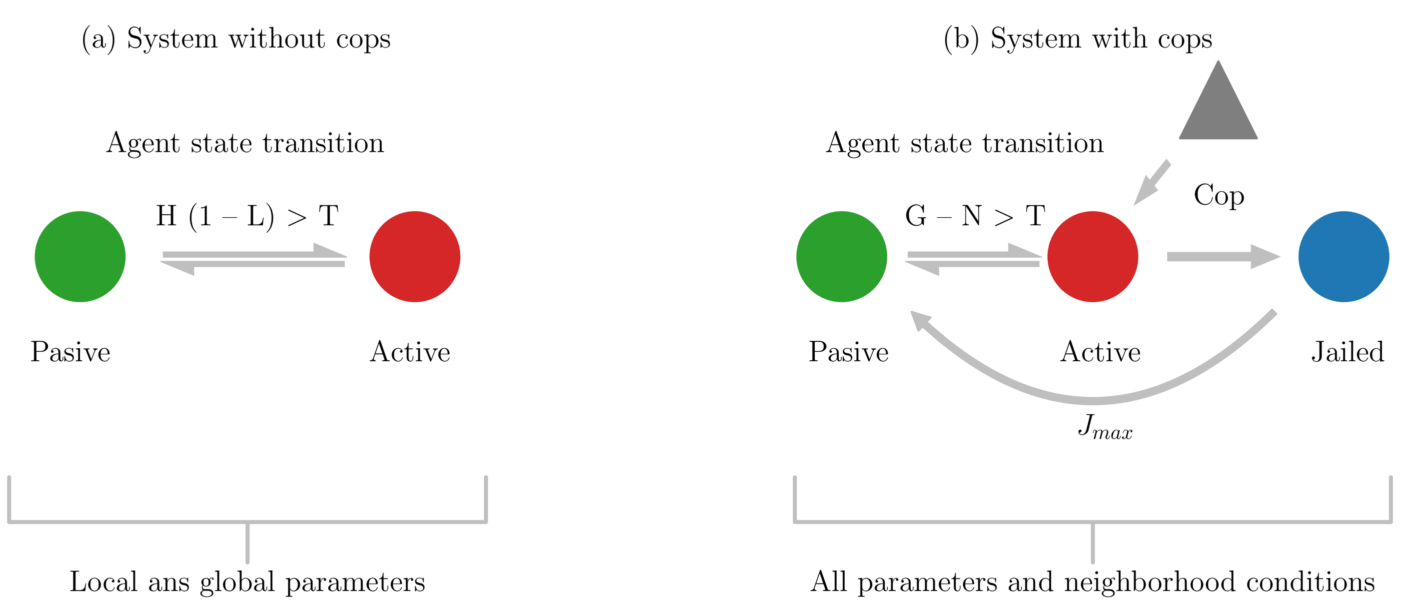
Global Parameters:
- L → Legitimacy
- T → Threshold
- J_{max} → Max jail term
- v → Agent vision

Local Parameters:
- H → Hardship
- R → Risk aversion

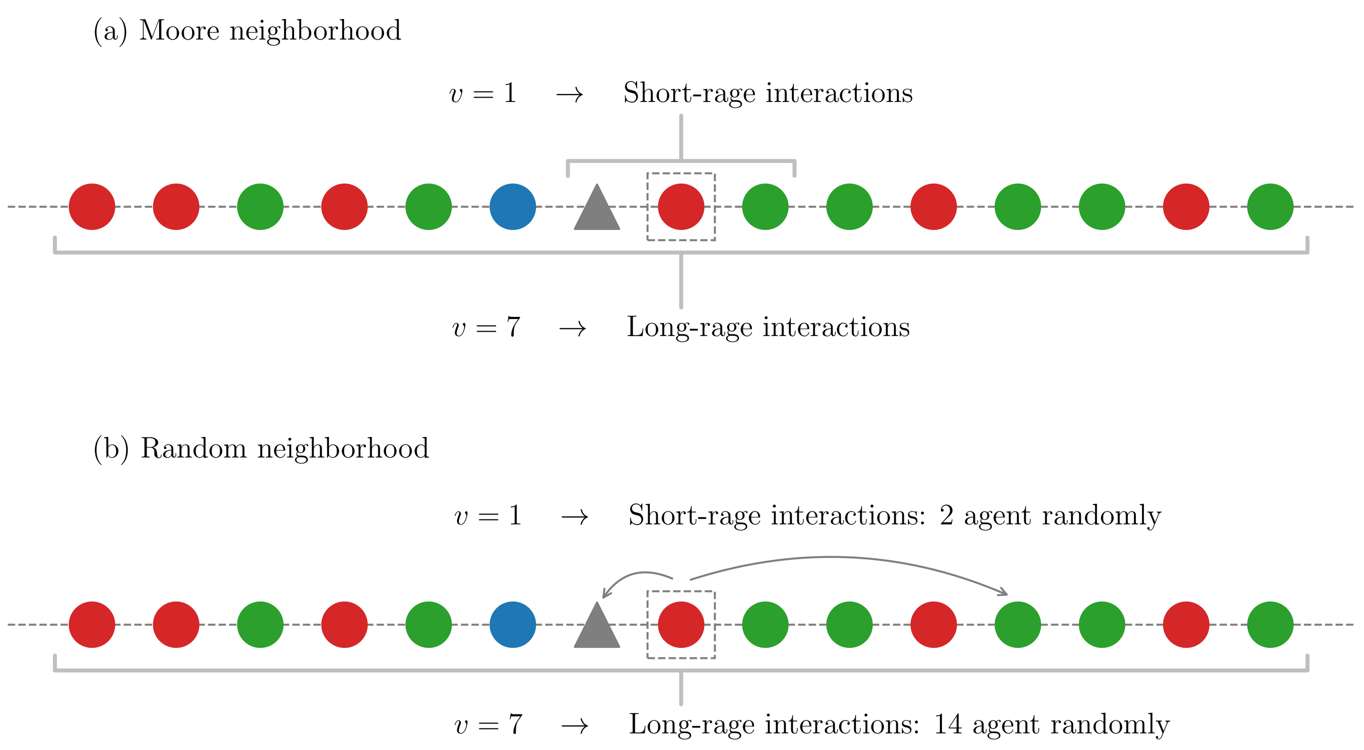
To observe the dynamics, we define

Energy: $E[s] = -\sum_{\langle i,j\rangle} J_{ij}\delta(s_i, s_j)$ Concentration: $C_\alpha = \frac{N_\alpha}{N}$

Agents state changes



Neighborhoods and agents vision



As usually used in opinion dynamics models we distinguish the following phases:

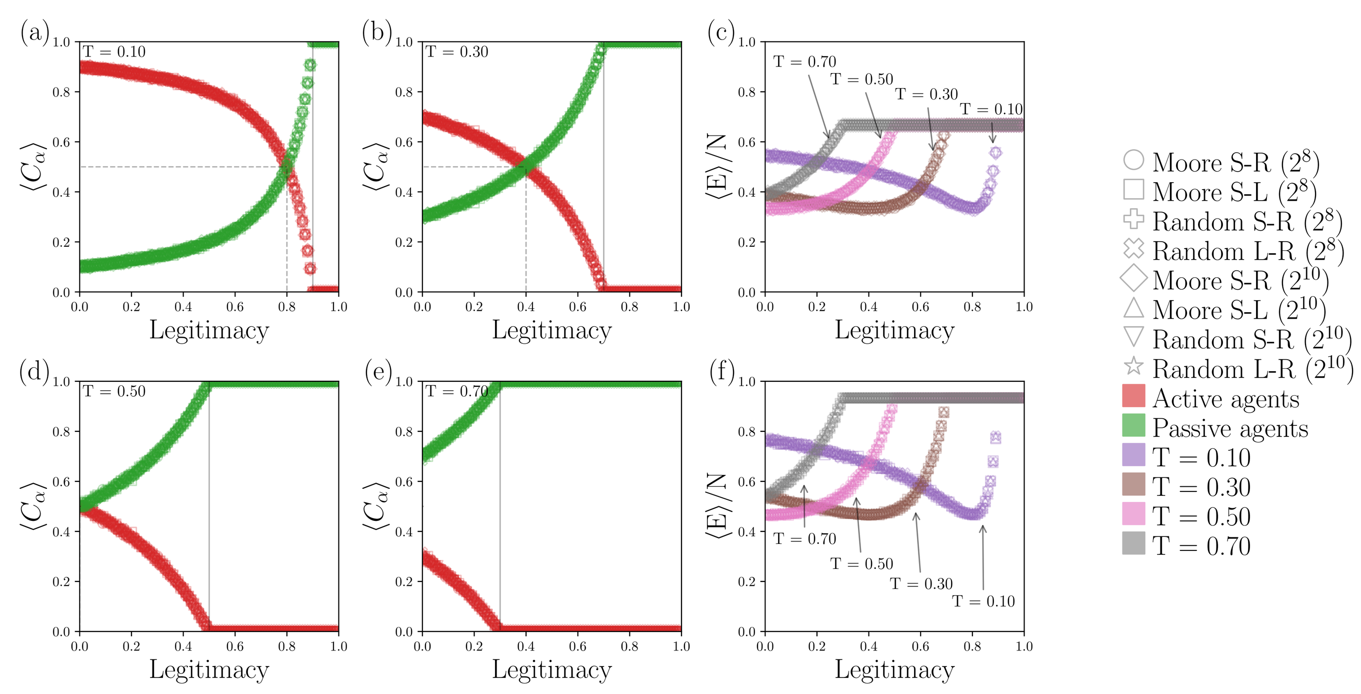
(i) The disordered phase, when all agent states are of a similar concentration in the system.

(ii) The ordered phase, when one agent state is majority over the others. A particular case is when all agents have the same state, so the system reaches a consensus state.

Results

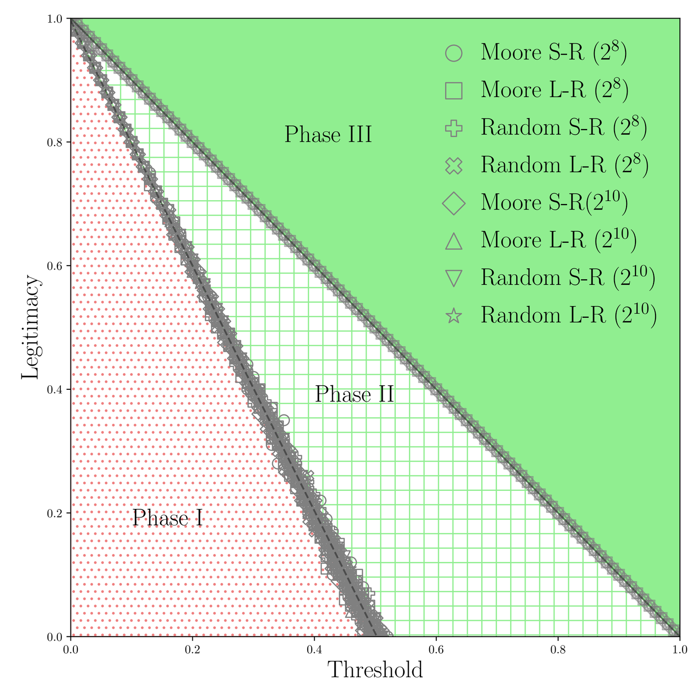
We performed simulations with systems of size $N = 2^8$ and 2^{10} to study a system without cops and with cops. We consider Moore and random neighborhoods for the agents' interactions, with short-range interactions when $v = 1$ and long-range interactions when $v = 7$. For all cases, we performed 20 realizations with 5500 iterations each. We discarded the first 500 iterations to obtain a steady-state and calculate all quantities to characterize the model.

Dynamic without cops

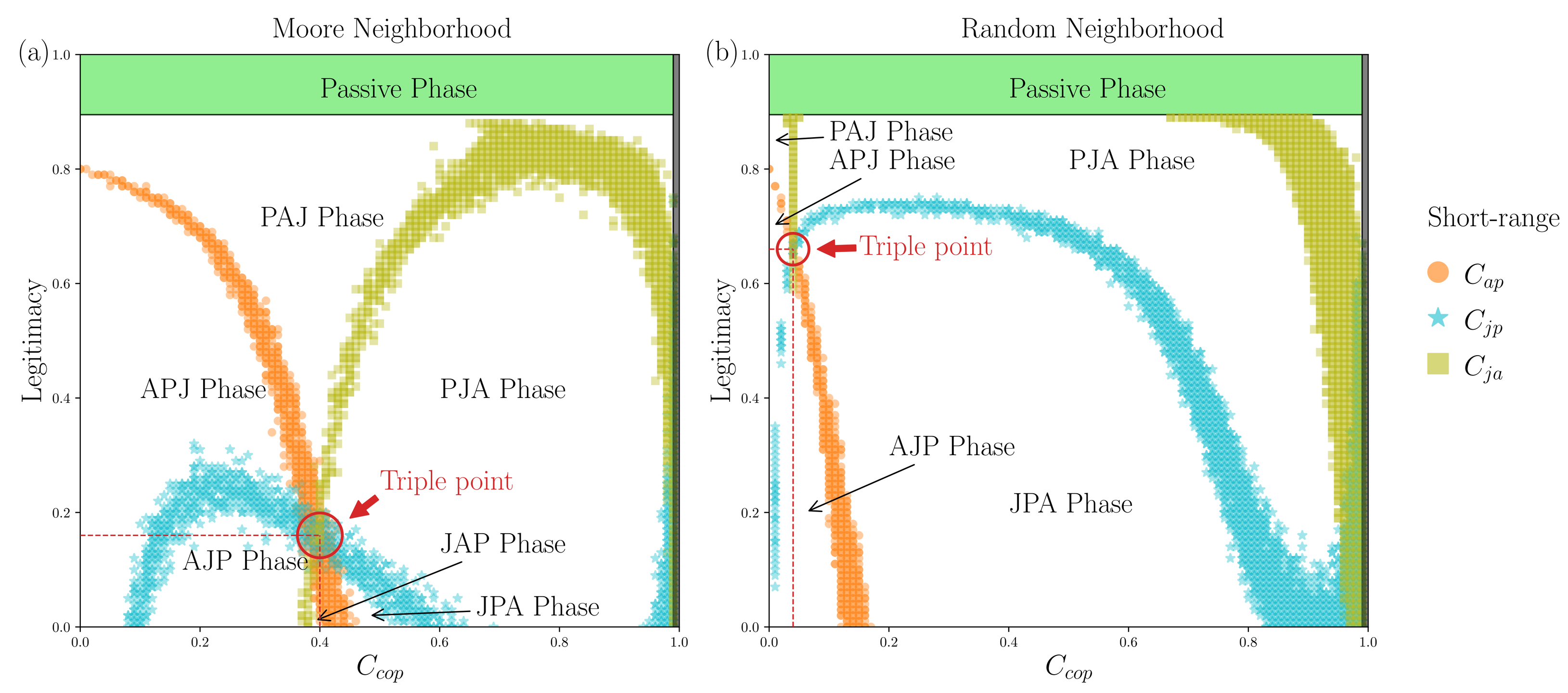


Phase diagrams

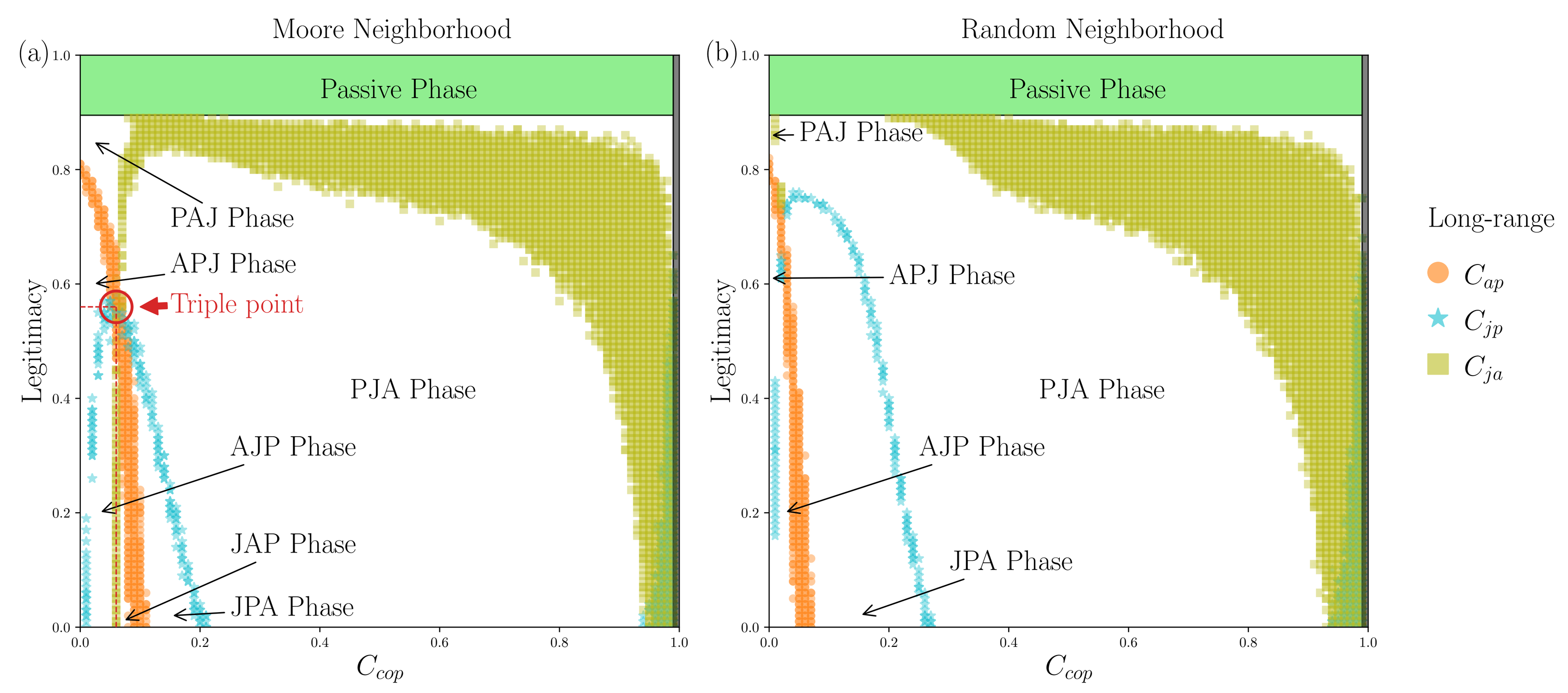
I) System without cops



II) System with cops and short-range interactions



III) System with cops and long-range interactions



Concluding Remarks

- In the system without cops, the phase diagram shows us order-disorder transitions like observed in opinion models. We denote Phase I and II as order phases with a majority state, active a passive, respectively. Crossing between these phases, find a disordered phase when the agent concentrations are similar. Phase III is a particular ordered phase when all agents are passive. we confirm the independence of the initial conditions of the system dynamics because, for all types of interactions, neighborhoods, and chain dimensions, the results collapse on the same lines.
- In the system with cops, the dynamics depend on the interactions. When the system has short-range interactions, the phase diagram shows order-disorder transitions observed without cops. Now the system has three agent states. As a result, we observed six ordered phases with a majority state and a disordered phase at a particular point when there are similar concentrations for the three states. The system reaches a consensus in the passive phase when all agents are passives. The position of the disorder point and the size regions of the phases change with the neighborhood. When the interactions are with long-range interactions, the cops' activity increases, producing a change of the system dynamics. While we can still observe order-disorder transitions in the Moore neighborhood, we do not observe these transitions in the random neighborhood.
- These results allow us to determine the relevance of the cops' actions in different scenarios. For short-range interactions, the capture of active agents is the most relevant cop's action to dissuading a protest. However, with long-range interactions, the relevant cops' action prevents citizen agents from becoming active and prevents the emergence of a protest.

References

[1] I. Ormazábal, Felipe Urbina, F. A. Borotto and H. F. Astudillo: Phase diagram in the one-dimensional civil violence model, arXiv:2110.00835(2021).

Acknowledgements

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