Phase diagram in the one-dimensional civil violence model

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Abstract

The civil violence model is agent-based and 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 by

\[ \Delta P_i = \sum_{j \neq i} (H \cdot \Delta L) - R \cdot \exp(-A[C/A]) > T \]

where each parameter is

- \( H \) \rightarrow Legitimacy
- \( T \) \rightarrow Threshold
- \( A \) \rightarrow Min arrest
- \( v \) \rightarrow Agent vision

Agents state changes

- Passive \( \rightarrow \) Active
- Net risk \( G \)
- Passive \( \rightarrow \) Active

To observe these changes, we define

\[ E[i] = \sum_{j \neq i} H \cdot \Delta L \]

Concentration \( C_{\alpha} = \frac{\Delta}{\beta} \)

Neighborhoods and agents vision

- Moore Neighborhood
- Random Neighborhood

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 \( N = 2^5 \) and \( 2^8 \) 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 5000 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. Crossings between these phases, a disordered phase when the agent concentrations are similar. Phase III is a particular ordered phase when all agents are passive. We confirm the dependence 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, the 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 passive. 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


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