

Agent based modelling

Civil Violence

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Civil violence: a broad issue

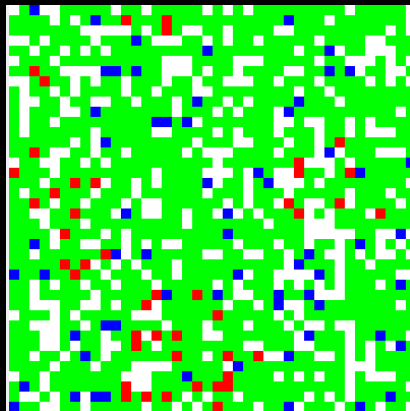


- Many forms
- Complex dynamics
- Multitude of actors
- Studied here: rebels vs. central authority

Model by Epstein: Generalised rebellion against central authority

Set-up

The model is situated on a square lattice. Agents and cops move around on the lattice and only have information about the lattice points in their proximity.



Model by Epstein: Generalised rebellion against central authority

Agents

- Hardship $H_i \in U(0, 1)$
- Risk aversion $R_i \in U(0, 1)$
- Arrest probability P_i

Global

- Legitimacy $L \in [0, 1]$
- Vision v
- Threshold T

Agent Rule

We define a personal **grievance** G_i and a **net-risk** N_i , and calculate P_i :

$$\begin{aligned}G_i &= H_i(1 - L) \\N_i &= R_i \cdot P_i \\P_i &= 1 - e^{-k\left(\frac{C}{A}\right)_v}\end{aligned}$$

If $G_i - N_i > T$, be active. Otherwise, be quiet.

Model by Epstein: Generalised rebellion against central authority

Cops

- Vision v^*

Cop Rule C

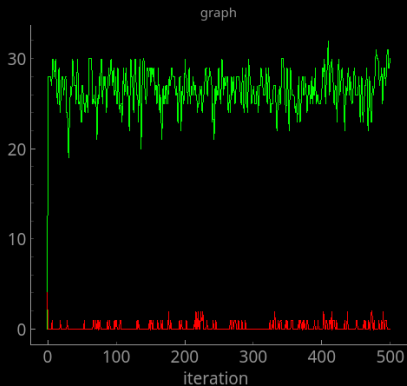
Inspect all sites within v^* and arrest a random active agent.

Model by Epstein

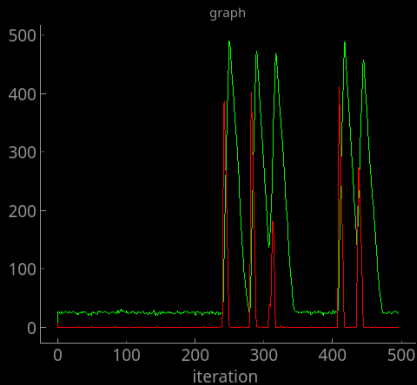
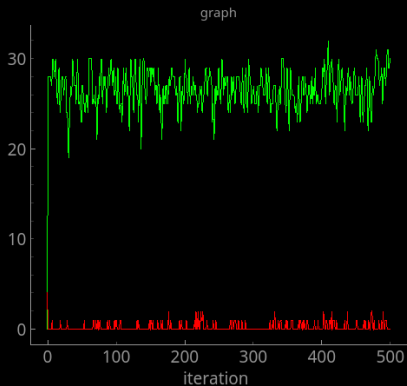
Movement rule

Move to a random site within your vision

Expected behaviour



Expected behaviour



Issue with the model

Why?

floor() function

Issue with the model

Why?

floor() function

Where?

$$P = 1 - \exp\left(-k \cdot \frac{C}{A}\right)$$

Issue with the model

Why?

floor() function

Where?

$$P = 1 - \exp(-k \cdot \frac{C}{A})$$

How?

- Situation: strike

Issue with the model

Why?

floor() function

Where?

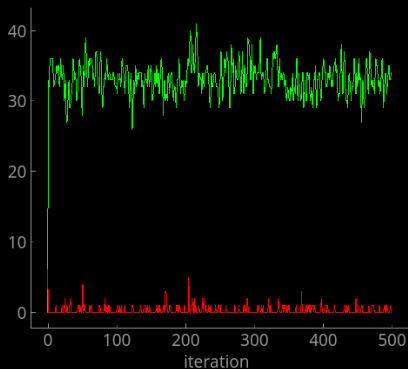
$$P = 1 - \exp\left(-k \cdot \frac{C}{A}\right)$$

How?

- Situation: strike
- Model: legitimacy (L) fluctuations

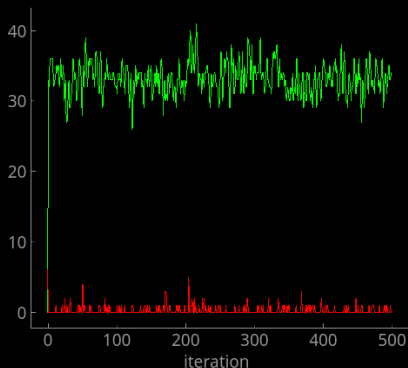
Corrections

High frequency fluctuations:

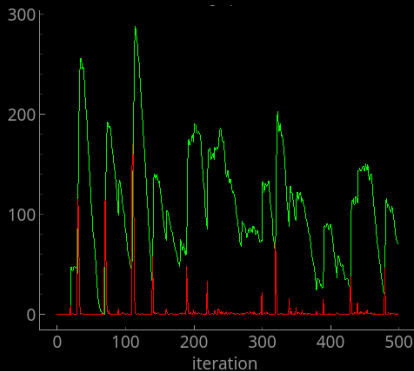


Corrections

High frequency fluctuations:



Periodic fluctuations:



Extension : Cop Motion Improvement

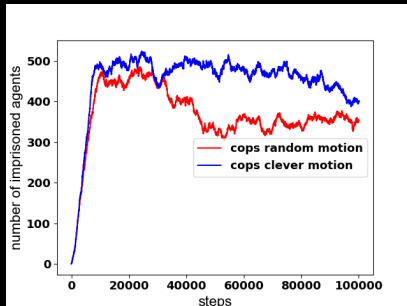
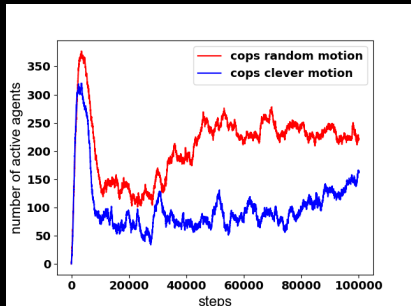
Previous movement
rule

Move to a random site
within your vision

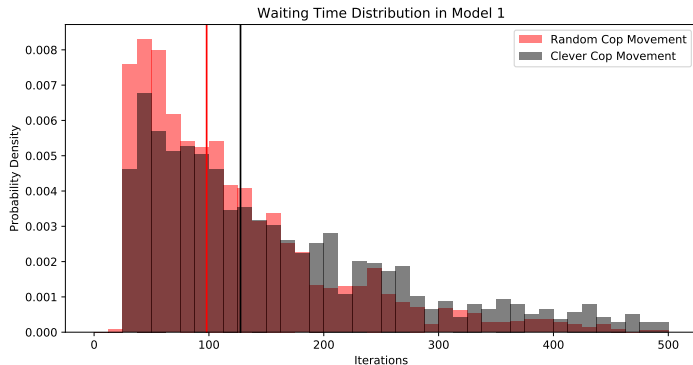
New cop movement
rule

Move towards the sub-box
that contains the greatest
number of active agents

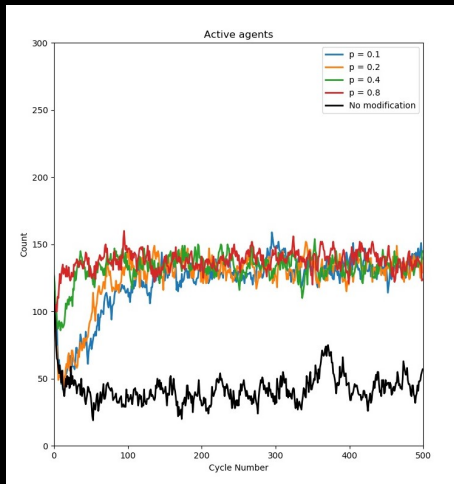
Extension : Cop Motion Improvement



Extension : Cop Motion Improvement



Extension: Agent Reactions



- ◇ Jailing of agent raises grievance and renders active a nearby neighbor with probability p
- ◇ p -independent saturation
- ◇ initial growth correlates with p

Conclusion

- ◇ Main results replicated (peaked active agent distribution, effect of perceived legitimacy drop)
- ◇ 3 extensions (global information access, intelligent cop movement, agents' reactions)
- ◇ Potential flaw identified and resolved (cop/agent ratio implementation)



Epstein, J. M. (2002). Modeling civil violence: An agent-based computational approach. *Proceedings of the National Academy of Sciences*, 99(suppl 3), 7243-7250.