Team 3: Prisoner's Dilemma On A Network

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Short description

Studying the emergence of cooperation through simulation of the iterated prisoner's dilemma on networks with varying architectures (e.g., grid, Erdős–Rényi, small-world, DC-SBM). We will vary initial conditions, agent strategies (e.g., Tit-for-Tat, imitation/mimesis), and payoff parameters, and measure how these choices affect the formation, size, and persistence of cooperative clusters. If time allows, we will also look into endogenous rewiring (cooperative nodes preferentially attaching to each-other) and its implications (such as potential SOC).

Research questions and hypotheses

Can sustained cooperative behaviour emerge endogenously from networked interactions?

- What are the requirements for such emergence?
- Which network architectures are more or less suited for emerging cooperation?
- How does the cluster size of cooperating clusters change?
- Are there critical points or phase transitions?
- Does percolation appear for certain parameter levels? If so, which?
- How do network structure and parameters affect the correlation/covariance between an agent's cooperation and the cooperation of its neighbors

Method and concept

Modules:

- NetworkX for network generation
- Mesa for agent-based simulation
- Axelrod for agent strategies

Key outputs:

- Fraction of cooperative actions over time
- Cooperative cluster size distribution
- Size of largest cooperative component
- Covariance between agent action and neighbor action

Hypotheses

- Clustering helps: Networks with higher clustering support higher long-run cooperation than random networks, holding average degree constant.
- Cooperation increases when cooperators connected to cooperators, measured by positive covariance between an agent's action and neighbor actions.
- There exists a parameter region where cooperative clusters transition from many small components to a giant connected cooperative component.

References

https://arxiv.org/pdf/2211.16329
https://arxiv.org/pdf/2004.06817
https://www.nature.com/articles/srep00325
https://www.nature.com/articles/s41599-021-00718-9
https://link.springer.com/chapter/10.1007/978-3-642-78860-4_12
https://journals.aps.org/pre/abstract/10.1103/PhysRevE.72.056118

Time planning

Monday 19 January
- Make & discuss Project Plan (everyone)

Tuesday 20 January
- Work on first version of the Network based Agent-based prisoner's dilemma with a simple strategy

Wednesday 21 January
- First modular network based agent-based simulator completed.

Thursday 22 January
- Everyone explores features of one of the different networks.

Friday 23 January
- First plots comparing different network

Monday 26 January
- Depends on how week 1 goes
- Decide presentation outline

Tuesday 27 January
- Depends on how week 1 goes

Wednesday 28 January
- First presentation draft

Thursday 29 January
- 13:00-17:00 Finalize and practice presentation

Friday 30 January
- Presentations