Endogenization of topology formation in metamimetic games

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Introduction

- Based on the work of Chavalarias, 2007 (Cooperation as the outcome of a social differentiation process in metamimetic games)
- Presents a model of cultural dynamics based on the mimesis of behaviours seen as advantageous
- Simplifies social interaction as a Prisoner's Dilemma
- Agent-based model

The Basic Model

- Agents play a simultaneous Prisoner's Dilemma with their immediate neighbours
- Outcome of these games compose a total payoff for each agent
- Agents have access to strategies, rules and payoff from their neighbours

Player A	Player B	
	C	D
C	$(1-p, 1-p)$	$(0, 1)$
D	$(1, 0)$	(p, p)

Figure: Parametrized Prisoner's Dilemma used in this work

Rules and Behaviours

- An agent can cooperate of defect, the two possible behaviours in a Prisoner's Dilemma
- In addition to that, each agent has a rule to judge his outcome in comparison to that of his neighbours
  - Maximizer/minimizer: wants to have the maximum/minimum payoff from the neighbourhood
  - Conformist/anti-conformist: wants to have the same/opposite behaviour from the majority of the neighbourhood

The Metamimetic Dynamics

- After playing the Prisoner's Dilemma with his neighbours, an agent evaluates his fitness (and that of his neighbours) according to his rule.
- If he is not fitter than his neighbours (or as fit as them), he will look around for the fittest agent in his neighbours (according to him)
- If his best neighbour has a different rule or behaviour, the agent will mimic that

The Metamimetic Dynamics

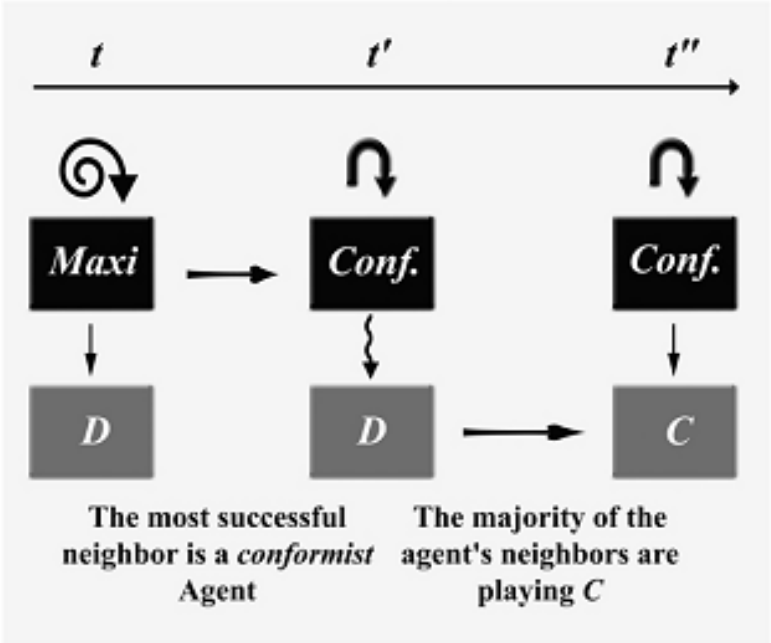

Figure: Example of metamimetic dynamics

Previous work

- Chavalarias, 2007: cooperation as the outcome of a spontaneous differentiation process in the case of spatial Prisoner's Dilemma
- Chavalarias, 2006: conterfactually stable states, irreductibility of metamimetic dynamics to standard replicator dynamics
- Batta, 2012: endogenization of preferences

Motivation and question

- All the work being done is in a simple 2D grid - concept of "neighbourhood" is limited
- Milgram, Watts/Strogatz argue that real-life social networks are very similar to small-world networks
- Question: can a small-world topology emerge from metamimetic dynamics?

Small-world networks

- Lattices have high clustering, high average distance. Random networks have low clustering, low average distance
- Watts/Strogatz show that, by random rewiring of a lattice, we get high clustering, low average distance
- Various kinds of social networks have been found to have this configuration

Additions to the model

- The basic model was implemented in a 2D grid, where neighbouring relations were only relative to a position in space.
- Introduction of links between agents and change of paradigm: neighbouring relations are link-related, not being connected to the position in space anymore
- Changing a neighbourhood is equivalent to rewiring links
- Probability to rewire introduced as a parameter for the agents

Additions to the model

- Transcription error, as a summary of the noise in perception and implementation of rules and strategies
- Weighting of history, smoothing the payoff perception of the agents
- Preferential rewiring, making it possible to set connections to "near" agents more probable than to "far" agents
- Selective pressure, increasing probabilities to "die" for agents under a certain payoff threshold

A screenshot

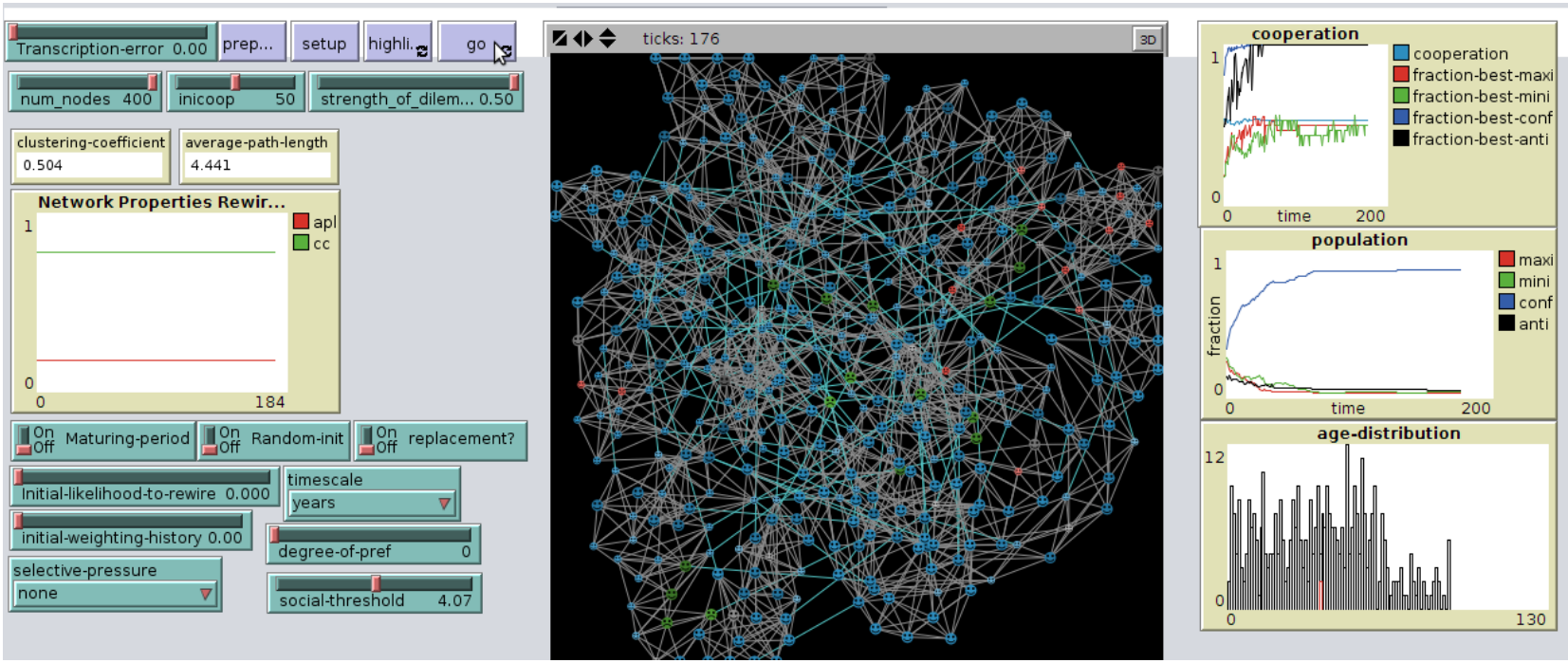

Figure: here, the basic dynamics (no rewiring, etc) implemented on agents distributed in a small-world network

Some results

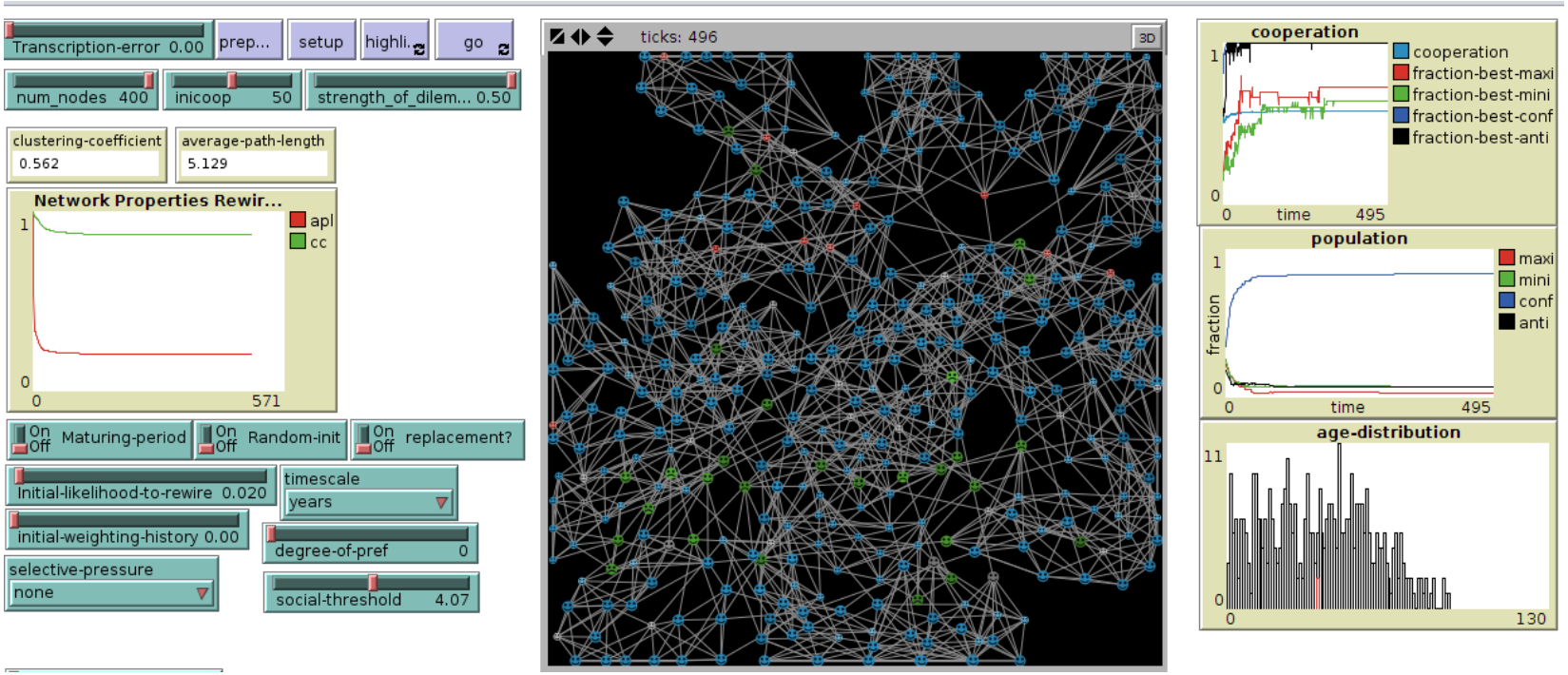

Figure: a small-world network is the attractor if the system start from a lattice with a small probability to rewire

Some results

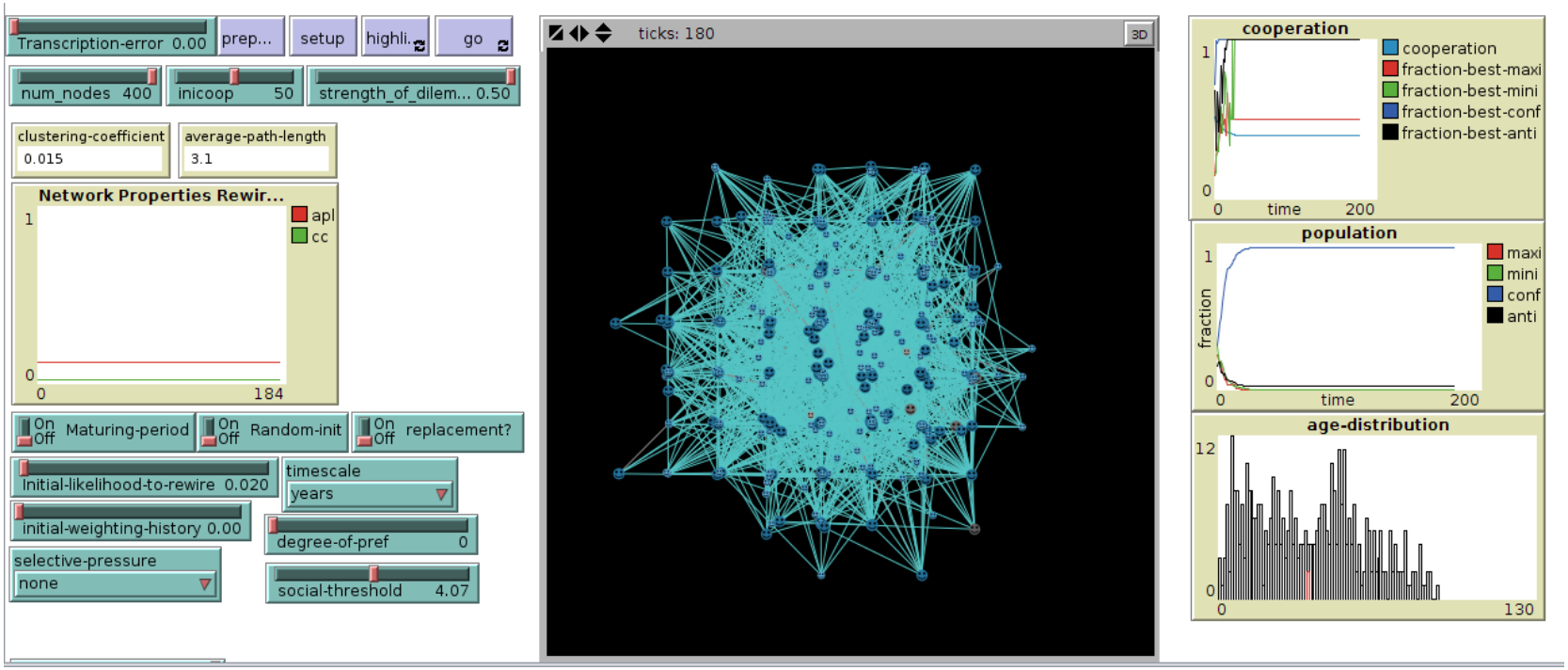

Figure: however, starting from a random network does not yield any interesting changes

Some results

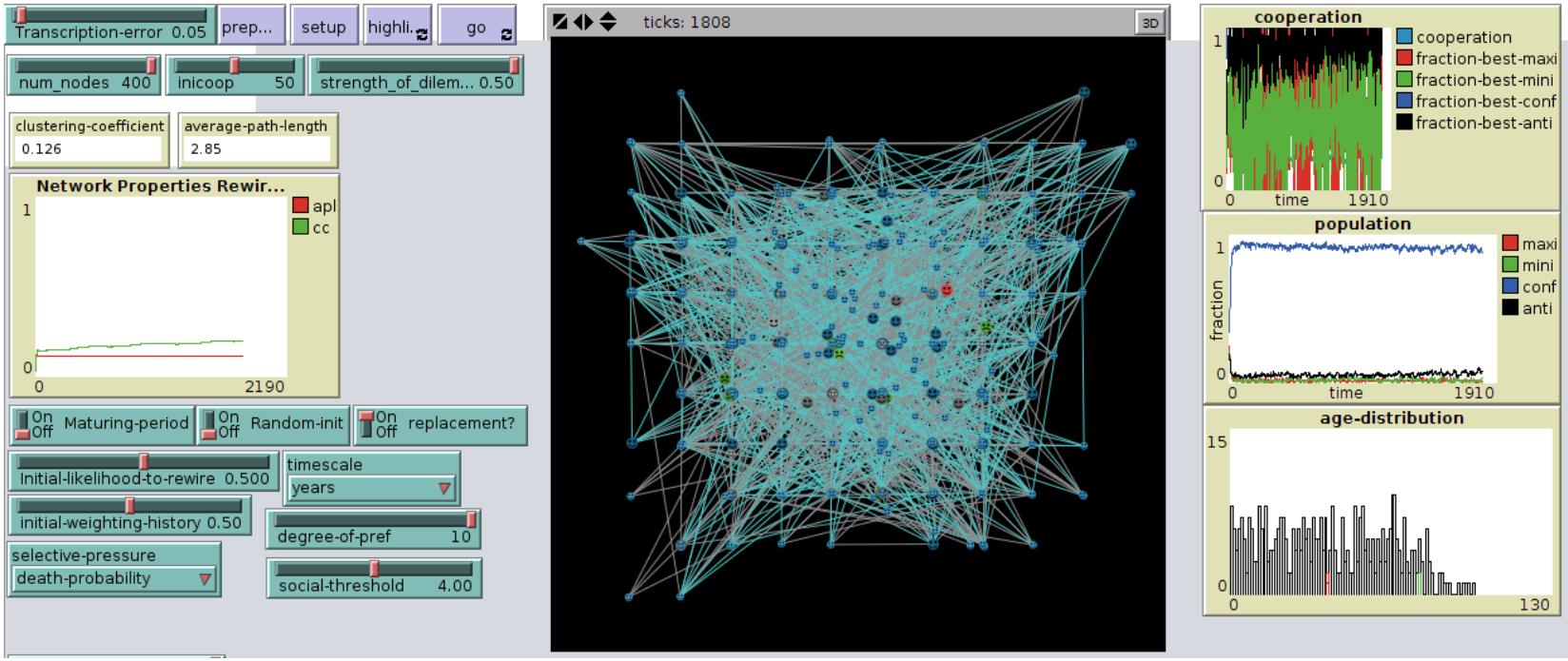

Figure: only in very extreme settings we see considerable clustering happening

Some results

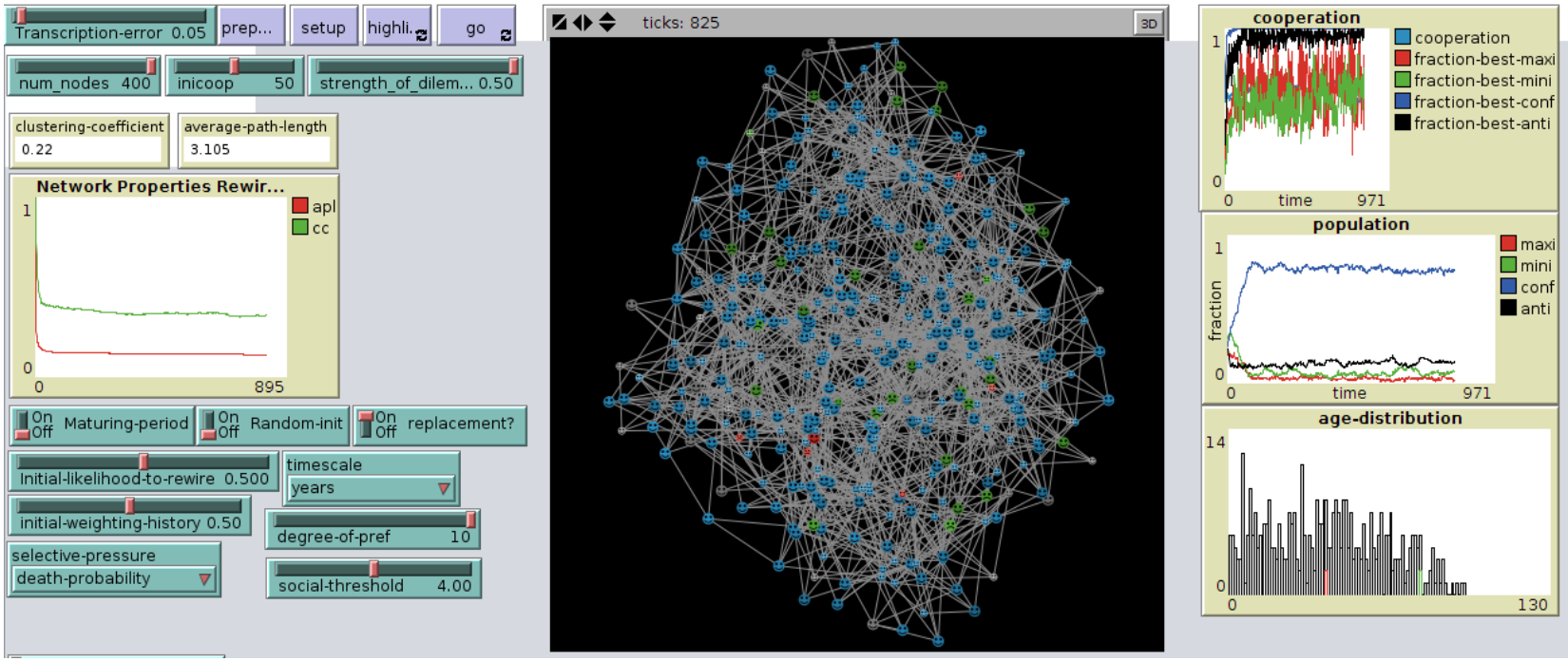

Figure: from a lattice, we go towards a low-clustering small-world network

Future work

- In the month of work ahead of us, the main goal is to run large-scale simulations of the system
- Investigate the behaviour on different ranges of parameters
- Confirm or dismiss the impressions from the small-scale experiments

Thank you!