Preliminary results from an agent-based adaptation of friendship games

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Outline

Lamberson (2011)

- Based on Galeotti et al. (2010) *Network Games*: agent payoff depends on own actions and the actions of neighbors in a social network.
- **Strategic complement** - network externality (widely adopted software)
- **Strategic substitute** - privately provided public good (streetlight, security, power tools)

Strategic complements

Suppose there are two strategies, x and y. If an agent has k friends, then, at any given instance, there are k_x of them playing strategy x, and k_y of them playing strategy y. For the strategic complements models, the payoff for playing strategy x is

$$\pi_x(k_x) = f(k_x) - c_x$$

and the payoff for playing strategy y is

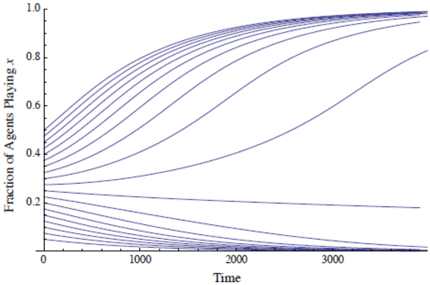
$$\pi_y(k_x) = f(1 - k_x) - c_y$$

where f is a non-decreasing function andc_x and c_y are the costs of play x and y, respectively.

Lamberson strategic complements

Play strategy x if four or more neighbors (in a random network of mean degree 10) are playing x.

$$\pi_x^{complement} = \begin{cases} 1 & k_x \geq 4 \\ 0 & \text{otherwise} \end{cases}$$



Strategic substitutes

For the strategic substitutes models, the payoff for playing strategy x is

$$\pi_x(k_x) = 1 - c_x$$

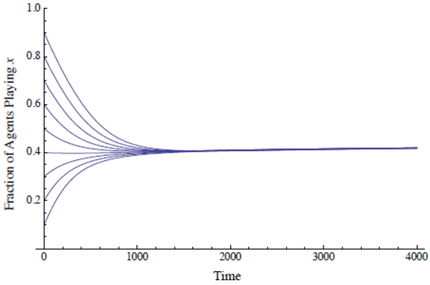
where $0 < c_x < 1$ and the payoff for playing strategy y is

$$\pi_y(k_x) = \begin{cases} 1 & k_x \geq 1 \\ 0 & \text{otherwise} \end{cases}$$

Lamberson strategic substitutes

Play strategy x if four or fewer neighbors (in a random network of mean degree 10) are playing x.

$$\pi_x^{substitute} = \begin{cases} 1 & k_x \leq 4 \\ 0 & \text{otherwise} \end{cases}$$



Generating a Random Network

- NetLogo doesn't have a random graph capability per se
- NetLogo doesn't allow loops over loops of turtles
- Completely random selection of all possible pairs is time consuming
- For a Gilbert random graph $G(n,p)$, each edge in the graph has probability p

Random Network (first attempt)

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- Approach: for each turtle, try to create links to pn other random turtles

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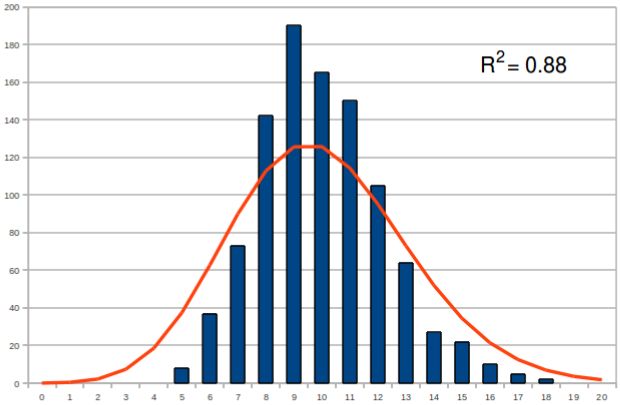
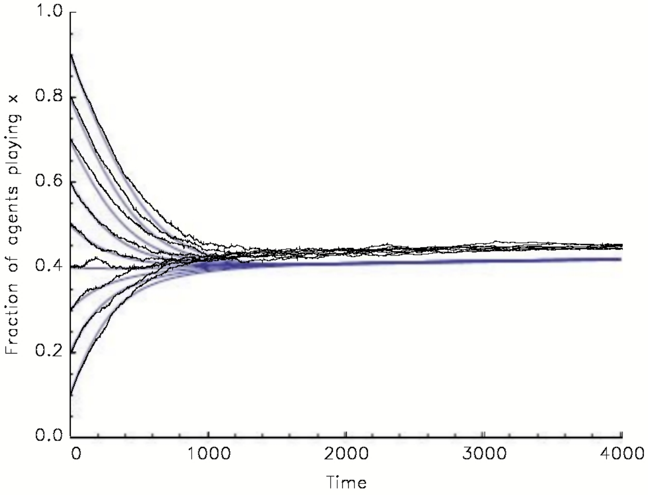
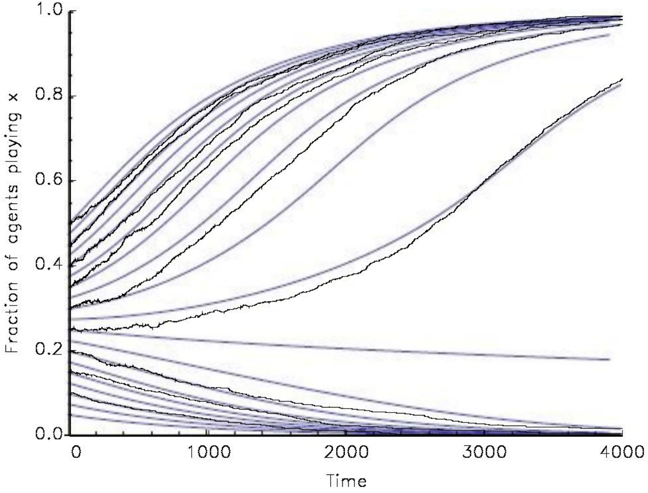


Friendship ABM - substitutes



Friendship ABM - complements



Random Network (second attempt)

- A random graph with n nodes has $\frac{n^2}{2}$ unique (undirected) edges, and for edge probability p, the total number of edges (links) is $n_l = \frac{pn^2}{2}$
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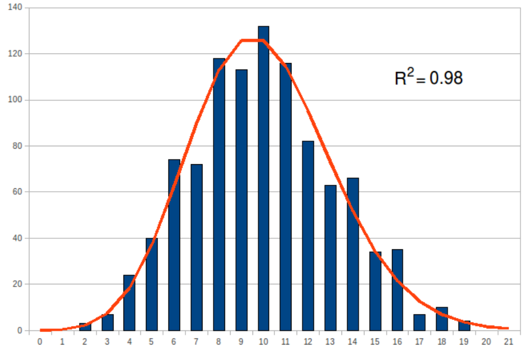
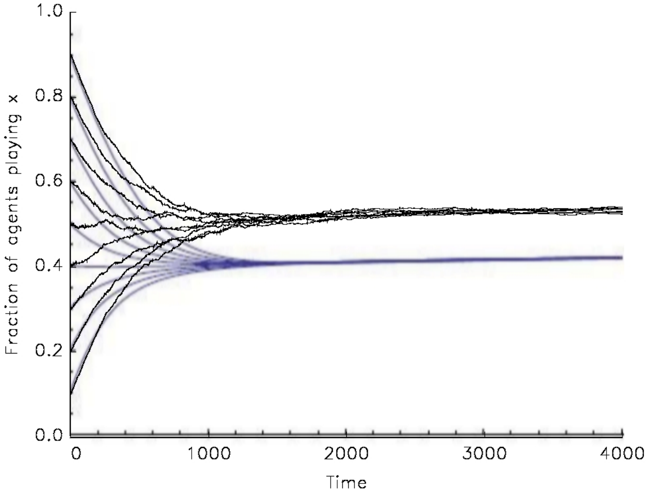
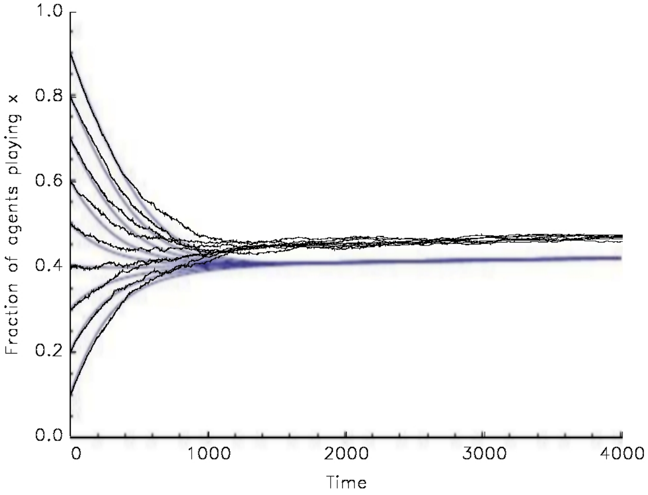


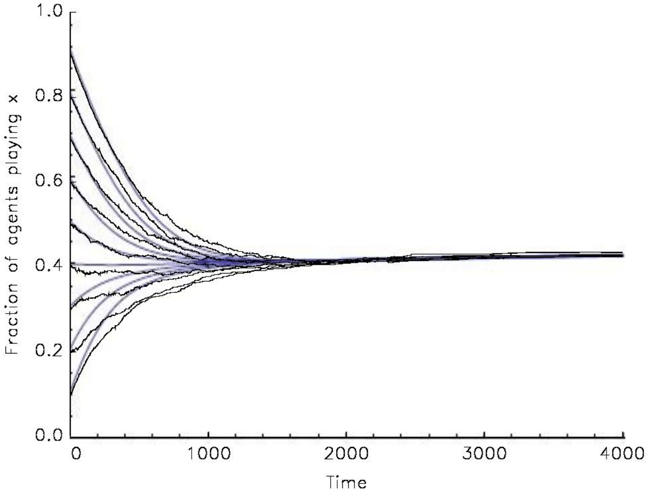
Friendship ABM (2) - substitutes



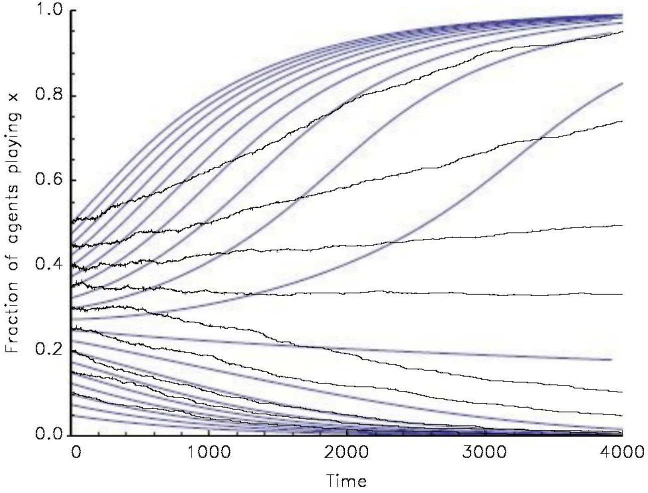
Endpoint error?



2-Regular Network - substitutes



2-Regular Network - complements



Summary

- ABM equivalent of a network game is sensitive to the network topology
- Gilbert random graph G(1000,0.01) is close but not as close as expected
- 2-regular graph is very close on substitutes, very far on complements

- Outlook
  - Results from 10-regular graph will be instructive
  - Once the network topology is worked out, shocks, preference switching, innovation, extensive-form games...