Dynamic Networks and the Evolution of Trust

Models and Simulations in Philosophy
May 14th, 2013

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  - Replicator Dynamics
    - Did cooperation emerge when agents played a one-shot PD?
    - Repeated?
  - Network Models
    - Lattice: What is a lattice model?
    - Small-Worlds: What characterizes a small worlds network?
    - Bounded degree
    - Dynamic: We'll discuss these today.

Outline

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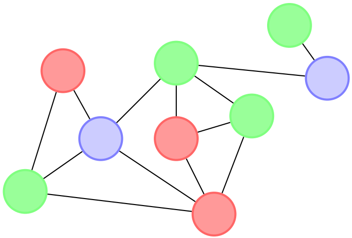
In the past, I've shown you networks like this:



Nodes = Agents
Edges = Indicate which agents "interact"
Colors = "Type" of Agent

But real networks change . . .

- Individuals find new friends and ditch old ones on Facebook.
- Computers in computer networks break and are sometimes replaced.
- Airports in airport networks are abandoned or shut down particular flights.
- Authors on the WWW add new pages, destroy old hyperlinks, etc.
- And so on.

Question: If we were just interested in "how possible" stories for the evolution of cooperation, then why consider dynamic networks at all?

We already have how possible stories using population models (e.g., the replicator dynamics) and static network models.

Further, dynamic network models will likely also be too simple and idealized to provide "how so" explanations.

Potential Answer: Robustness.
See Muldoon [2007] for a defense and Parker [2011] for criticism.

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- Dynamic network models need not even be "more realistic" than the static ones to accomplish this goal.
- Of course, adding more realism does provide additional confidence.

Two ways to change an undirected network:

1. Add and delete agents.
2. Add and delete edges.

Alexander [2007] considers only modifications of the second type.

There are several different ways of changing edges:

1. In the game-theoretic setting: form links with those with whom you earned higher payoffs in the past.
    - This is the model Alexander describes.
    - Perhaps unsurprisingly, cooperators stop interacting with defectors in PDs.
    - So cooperation can be sustained in a population, which self segregates according to strategy.

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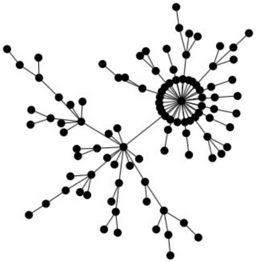
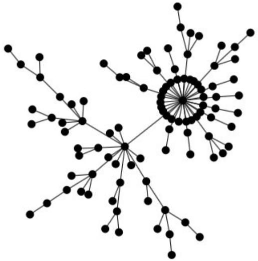
   - Perhaps unsurprisingly, cooperators stop interacting with defectors in PDs.
   - So cooperation can be sustained in a population, which self segregates according to strategy.
2. But there are lots of other methods for changing networks. See Bilgin and Yener [2006] for a survey.

Preferential Attachment



The most common model for dynamic networks is called preferential attachment: agents form new link to agents that have many existing neighbors.

Preferential Attachment



- One Motivation: edges represent status, and agents try to gain status by forming links with those who have it.
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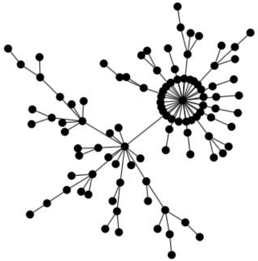

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- Preferential attachment models evolve to produce power law degree distributions, which lends them some measure of empirical support for certain social networks.

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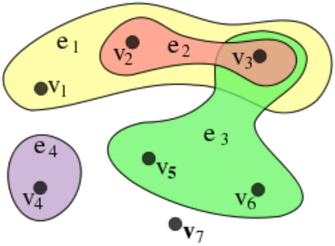
2. Adjacency matrices to represent frequency of interactions.
3. Hypernetworks to represent multi-actor interactions (This is not common!)



How does Alexander model the action of "trusting" another individual?

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By playing Stag in a Stag Hunt game. What is a Stag Hunt?

	Stag	Hare
Stag	2, 2	0, 1
Hare	1, 0	1, 1

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What are the Nash equilibria of this game?

Why might it be hard to explain the evolution of trust using the classical rational actor model?

When trust is identified with hunting stag in this way, which of the models from Chapter 2 (on the evolution of cooperation) can we use to try to model the evolution of trust?

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All of them!

So Alexander [2007]'s general strategy for modeling norms is as follows:

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1. Identify the norm with a particular action in a two-person game
2. Use replicator dynamics and network models to test whether the norm emerges in population and/or local interaction models
3. Try different boundedly rational learning rules in the local interaction models.

Group discussion questions: What are the virtues and drawbacks of modeling norms and their evolution in this way? In particular:

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2. When one identifies a norm, say trusting, with a particular action in a game, are there any features of the norm that are not captured in the model? If so, do the assumptions matter for explaining the evolution of the norm?
3. When one identifies interaction with playing a game, are there any features of human interactions that are not represented and which may matter for the evolution of norms?

Topics we'll discuss today:

- Three Types of Agents: Turtles, Patches, and Links
- Built-in Agent Variables
- Manipulating Agent Variables
- Creating Agentsets

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