Simulating social norms in gene-culture coevolution multi-agent model.

Peter Gonda

Faculty of Mathematics, Physics and Computer Sciences, Comenius University, Bratislava
Social norms

Definition

“Norms are rules that prescribe or proscribe a behavior or set of behaviors. Norms are enforced by external sanctions. Norms are consensual, group-level phenomena. Group members recognize the existence of norms and feel entitled to enforce them.”
Master's thesis

Structure
1. Theoretical part – survey of relevant research (evolutionary anthropology, social science, social neuroscience, economics / game theory, AI)
2. Model / Simulation – agent model building up on surveyed theory, simulation of the model in MAS.

Motivation
Emergence of social norms within a group of interacting individuals
Using gene-culture coevolution theories
Social dimensions

Social / Vygotskian intelligence hypothesis
Tomasello *et al*: significant differences between human infants and higher apes social cognition. Species equal in terms of physical/practical cognition. Proposed some evolutionary trait making humans much more social.

Evolutionary models
- Group selection theories
- Gene-culture coevolution theories

“At some point during the evolution of the human species a type of social learning leading to cumulative cultural evolution was evolutionary advantageous.”

Computer models
Classical PD/IPD modelling – cooperation
Norms – some research involving IPD, some incorporating emotion models
General parameters

Tech stuff

- Aglobe – Czech multi-agent framework
- Agents move in a 2D grid
- Agents have energy levels,
- Agents get energy from eating food
- Food appears on random positions in the grid
- Energy above 10 = ALL OK
- Energy below 10 = agent unable to move
- Energy equals 0 = agent removed (death)
Agent model

Genetic traits
- *genSight* (how far an agent sees)
- *genSocialLearner* (how good an agent can learn)
- *genCooperator* (if agent of selfish or non-selfish type)
  Binary encoded numbers
  Passed to children after crossover & mutation (GA)

Social traits
- *socGiving* (how much food the agent donates)
- *socRaising* (how fast can the agent procreate and “shut up” the parents)
  Numbers between zero and one
  Initialized randomly, but subject to social learning
Social learning in the simulation

1. Reproduction.
   - Agent sends requests to reproduce
   - Agent that received a request decides according to similarities of social traits
   - Until child reaches age given by socRaising it learns from parents.

2. Food donations.
   - Agent having a critically low energy level sends requests for help.
   - Agent that received such a request decides according to similarities of social traits
   - When receiving food the agent learns the social traits of the donor.
Social learning in the simulation

Learning rule

\[ a[i]_{t+1} = a[i]_t + (b[i]_t - a[i]_t) \cdot \text{sgm}(\alpha) \]

a[i]_{t+1} – new value of social trait
a[i]_t – old value of social trait
b[i]_t – the donor value of social trait
alpha – speed of learning, given by genSocialLearner
Multi-agent modelling of social norms

Simulation setup
- 6 variants (a, b, c, d, e, f) have been run
- Each variant run 5 times, each 150 000 cycles
- Two populations compete for resources (selfish / non-selfish)

Variants
- a – no learning, no donations
- b – no learning, donations
- c – learning, donations
- d – no learning, donations to all
- e – learning, donations to all
- f – learning, donations, all initial agents are non-selfish
Multi-agent modelling of social norms

Results

- Effects of altruistic behaviour: 300% increase in life-span longer
- Effects of social learning: 700% increase in life-span
- But there's less of them
Multi-agent modelling of social norms

socGiving average variants by type: non-selfish

Norm strength vs. Cycles
Multi-agent modelling of social norms

socRaising average variants by type: non-selfish
Multi-agent modelling of social norms

genSight average variants by type: non-selfish

![Graph showing genotype value over cycles for different variants](image)
Multi-agent modelling of social norms

Wrap up

- Altruism promotes longevity
- Altruism + social learning even more
- socGiving and SocRaising have converged similarly across variants
- Genetic adaptation for non-selfish agents was observed (genSight increase)
Thanks for attention

gnd@itchybit.org