THE EVOLUTION OF ALTRUISTIC BEHAVIOR

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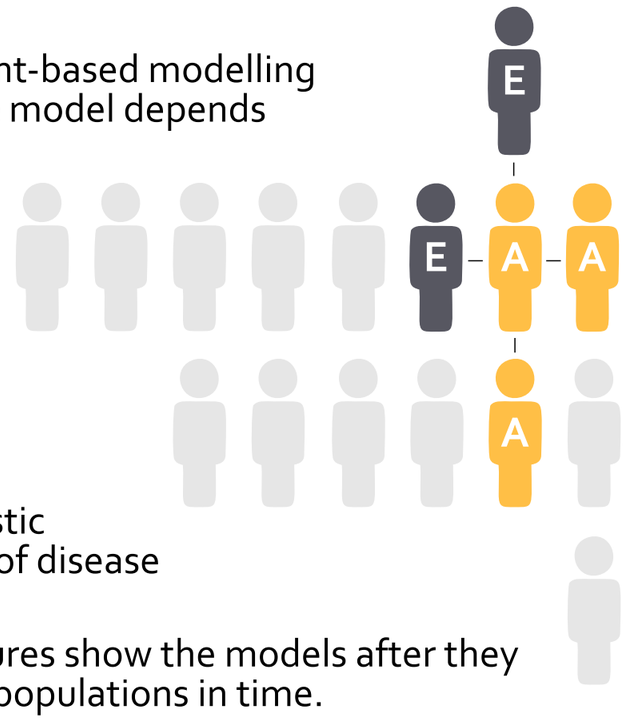
Evolution can be seen as a competition among same-species individuals for reproductive success.

INTUITION: survival of the fittest

It can be observed that altruistic behaviors are at odds with this evolutionary success of an entity. Agent-based modelling allows us to simulate the evolutionary process and check the group's properties in a specyfic time. The model depends on a few constant parameters:

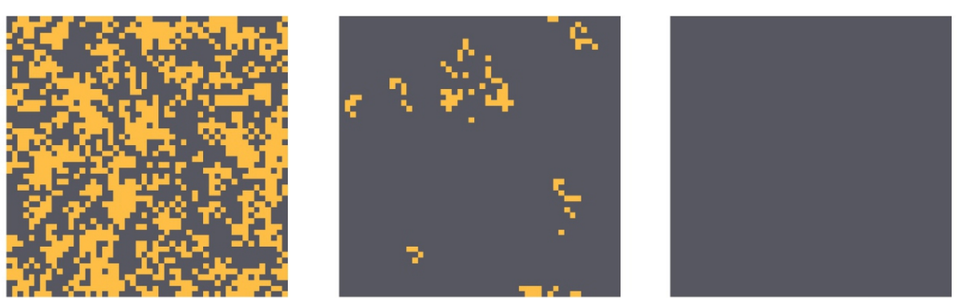
- probability that an agent is altruistic (0-0.5)
- probability that an agent is selfish (0-0.5)
- cost of being an altruist (0-0.9)
- benefit from altruistic neighbors (0-0.9)
- harshness – probability that an empty cell will remain empty each turn (0-1)
- disease – probability that an agent will fail to reproduce (0-1)

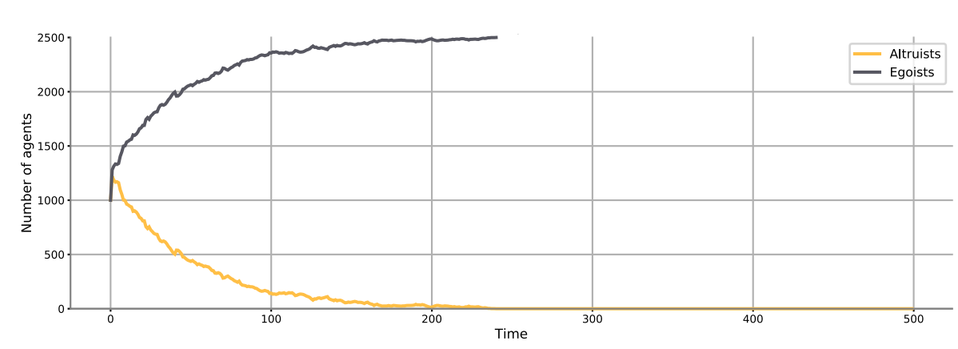


One evolutionary step consists of two operations:

1. Calculating **fitness assesment** of an individual basing on their own and their neighbors' characteristic
2. **Reproductive lottery** taking into account one's altruistic fitness, selfish fitness and the probability of disease

Below we present the results of the simulation with fixed benefit from altruism and its cost. Upper figures show the models after they have run for 5, 150 and 240 generations. The bottom figure shows frequencies of altruists and egoists populations in time.

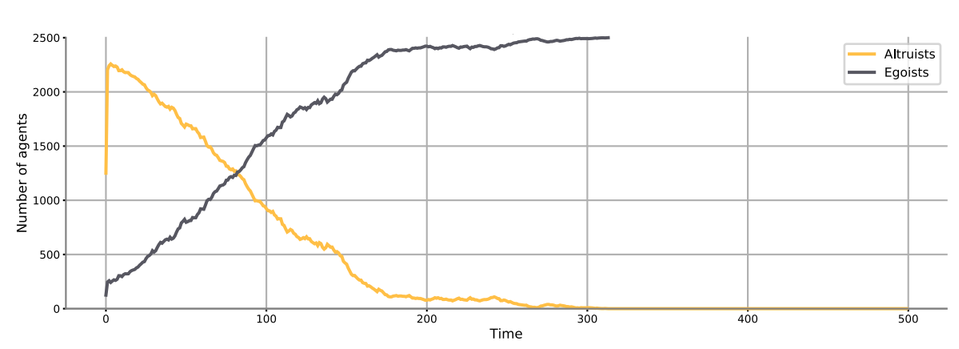




Parameters values:
equal densities of altruists and egoists, harshness – 0%, disease – 0%

Egoists win

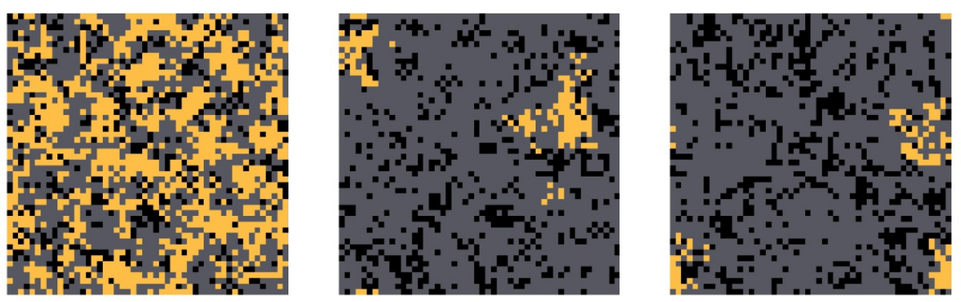
Reason: The fitness of the selfish agents is higher than the fitness of the altruistic agents. Thus after some time all of the altruistic agents are extinct.

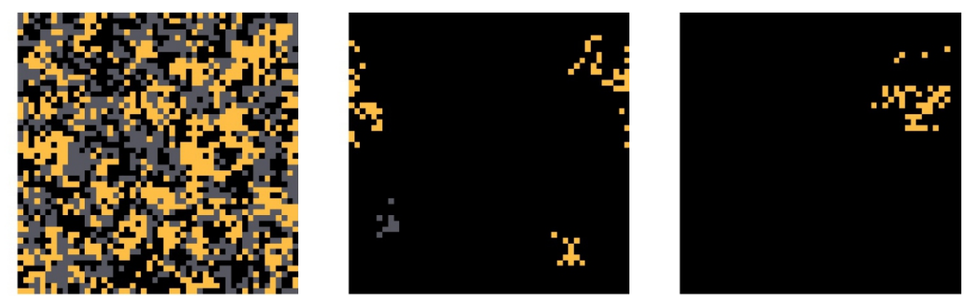


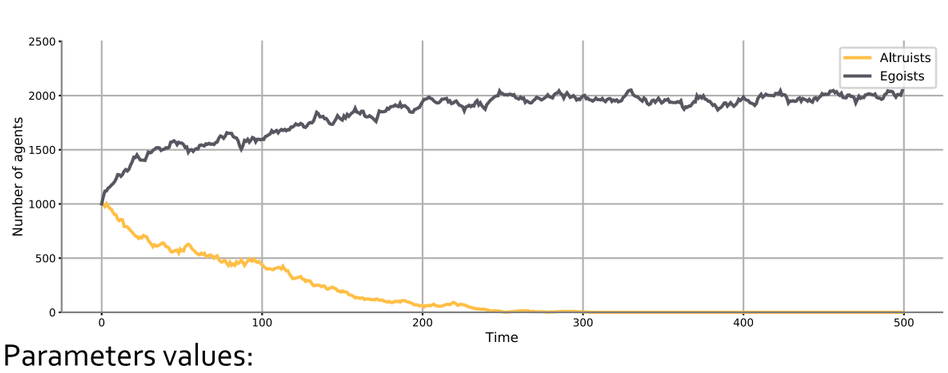
Parameters values:
density of altruists – 50%, egoists – 5%, harshness – 0%, disease – 0%

Egoists win

Reason: Even though we start with almost no selfish agents, still their high fitness values finally cause extinction of the altruistic agents.



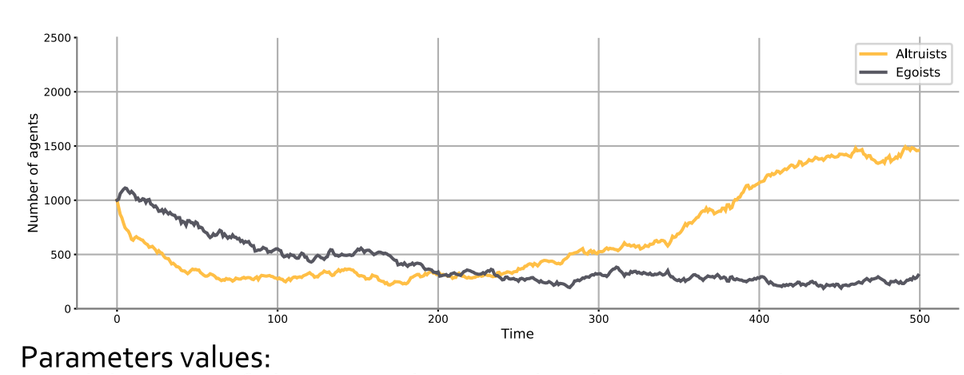




Parameters values:
equal densities of altruists and egoists, harshness – 75%, disease – 20%

Egoists win

Reason:Altruists are not separated from egoists, giving them the benefit.



Parameters values:
equal densities of altruists and egoists, harshness – 95%, disease – 20%

Altruists win

Reason: Altruists are separated from egoists, giving the benefit to each other without the egoists leaching any of their benefits, which means they can do better against harsh conditions and disease.

Conclusions:

- Group membership effects on an individual's evolutionary fitness in the altruism model.
- In natural conditions, due to the higher fitness of the selfish agents, every situation leads to the extinction of altruists.
- When the conditions are harsh enough, selfish agents cannot survive against nature because they have less resistance.
- The altruists can survive without the egoists leaching any of their benefit, when harshness parameter is high.

References:

- *A Hands-on Modeling Approach to Evolution: Learning about the Evolution of Cooperation and Altruism Through Multi-Agent Modeling - The EACH Project;* Damon Centola, Uri Wilensky, Eamon Mckenzie; Center for Connected Learning & Computer-Based Modeling, Northwestern University, Evanston
- *Population Viscosity and the Evolution of Altruism;* Mitteldorf, J. & Wilson, D.S. (in press); Journal of Theoretical Biology