Influence of the topology of cultural networks on the equilibrium of an exchange-based economy

Ignacio Morer, Simon Carrignon, and Xavier Rubio-Campillo
simon.carrignon@bsc.es

ECONOMIC & POLITICAL NETWORK

Introduction

Cultural change comprises processes that modify spread of information by social interaction within a population [1] and numerous social scientists are using an evolutionary framework to model this [2].
Here we use this framework to study economics, a social activity that depends on particular cultural traits: the value attributed to goods used to trade during the economic activity. Multiple cultural processes could influence the way those values evolve through space and time leading to different trade dynamics.
We focus on the way those values are transmitted and vary from individual to individual, and on the bias that affect this transmission. We propose a framework that allow us to implement and test hypotheses and claims made about the nature of such transmission processes and bias and study how those claims and hypotheses affects a given economy.

Framework

To explore the co-evolution between trade and cultural change we developed a framework where the different agents produce and trade goods. The model is composed of a population Pop of m agents. Each agent i is defined by 2 vectors Q^i and V^i of size n. Q^i stores the quantity of each good owned by i and V^i represents the price estimated by i for each of the n good.

Algorithm 1 Model

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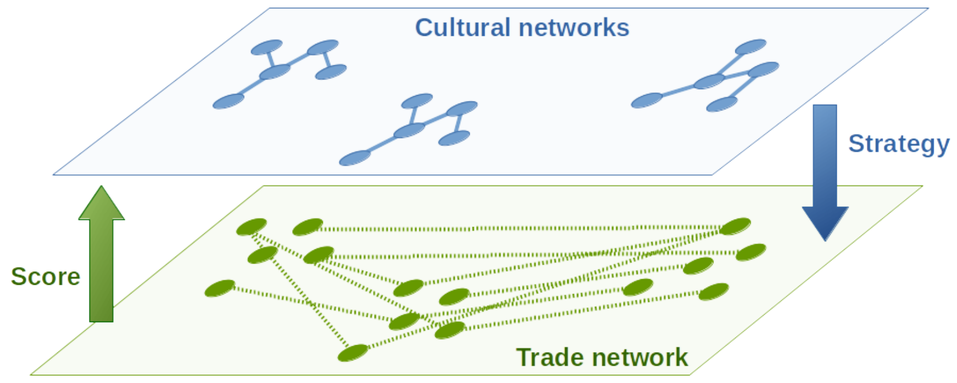
1:  INITIALIZATION:
2:  for i ∈ #Pop do                          ▷ Initialize the agent with no goods and a random value vector
3:      Q^i = (0, ··· , 0)
4:      V^i = (v_0^i, ··· , v_n^i)           ▷ The values of v_j^i are selected randomly
5:  end for
6:  SIMULATION:
7:  loop step ∈ TimeSteps
8:      for i ∈ Pop do
9:          Production(Q^i)
10:     end for
11:     for i ∈ Pop do
12:         for j ∈ Pop do
13:             TradeProcess(V^i, Q^i, V^j, Q^j)
14:         end for
15:     end for
16:     for i ∈ Pop do
17:         ConsumeGoods(Q^i)                ▷ All goods are consumed
18:         if (step mod CulturalStep) = 0 then
19:             CulturalTransmission(V)
20:             Innovation(V^i)
21:         end if
22:     end for
23: end loop
```

Given the prices attributed by the agents for each good (V^i), an exchange is made or not (l.13). Given the quantities (Q^i) gathered, a score reflecting the "economic success" of each agent is attributed (l.17). Finally the value attributed to each good V^i is modified (l.19-20).



Experiments & Resuluts

Experimental Setup 1

We carry out simulations in which cultural networks are complete. Every agent knows the strategy of the producers of its own good.

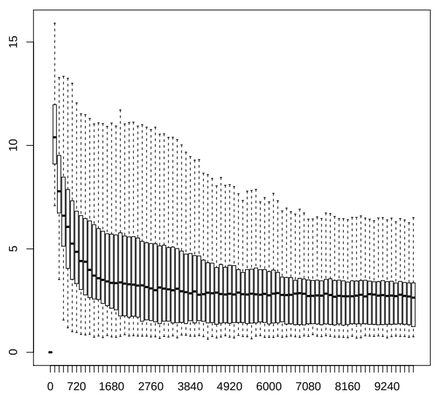


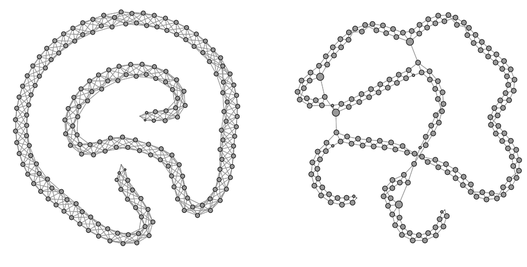
Figure 1: Evolution of the score within the two different models for two typical run with 500 agents and 3 goods evolving during 10000 timesteps.

Experimental Setup 2

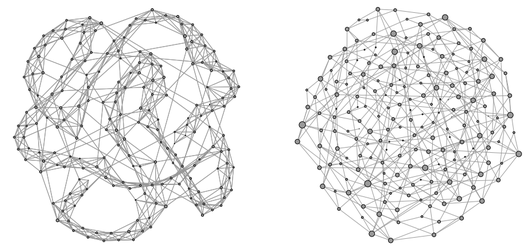
A first attempt to test the influence of the topology of cultural networks is made. We use several networks with the same average distance L and different average degree $\langle k \rangle$. We create ring lattices of v neighbours and then we rewire other ring lattices with $v' < v$ until the former network's L is achieved.

	$\langle k \rangle_1$	...	$\langle k \rangle_n$
L_1	G_{11}		G_{1n}
...		...	
L_m	G_{m1}		G_{mn}

$D = 0.02$ $D = 0.04$



$A \approx 17$



$A \approx 4$

Results

The average distance L have been proven to be the key property for the simulations not only to reach the equilibrium faster, but also to show better performances for the agents. For equal values of L.

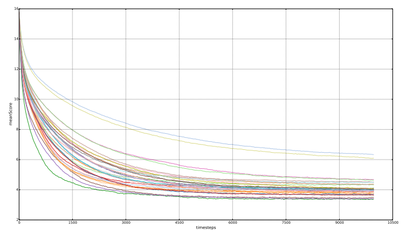


Figure 2: Behaviour of the simulations with different topologies.