1 Abstract

Axelrod prominently showed how tendencies toward local convergence in cultural influence can help to preserve cultural diversity if influence is combined with *homophily*, the principle that "like attract." In the Axelrod's model of cultural dissemination, we consider mobility of cultural agents through the introduction of a density of empty sites and the possibility that agents in a dissimilar neighborhood can move to them if their mean cultural similarity with the neighborhood is below some threshold. While for low values of the dynamics can lead to the coexistence of disconnected domains of different cultures. Further increase of diversity leads to fragmentation of the dominant culture int domains, forever changing in shape and number, as an effect of the never ending eroding activity of cultural minorities.

2 Introduction

Cultural diversity is both persistent and precarious. People in different regions of the world are increasingly exposed to global influence from mass media, internet communication, interregional migration and mass tourism. Obviously, diversity is guaranteed in a world where everyone is free to move to a small island that is isolated from outside influences, where they could live only with those identical to themselves.
The model predict that cultural homogeneity is the inevitable long term outcome of processes by which individuals influence one another in response to the influences they receive. The model proposed an elegant extension of social influence models that incorporates *homophily*, or the "law of attraction" posited by Byrne(1969). This is the principle that "Like attract". Axelrod's assumed agents are connected in spatial network.However, Axelrod assumed the strength of a ties between two neighbors could vary over time, depending on their similarity. Homphily generates a self-reinforcing dynamic in which similarity strengthen influence and influence leads to greater similarity. Axelrod's computational studies showed how this process can preserve global diversity. Once the members of two cultural regions can no longer influence one another, their culture's evolve along divergent paths. This model thus accounts for both tendencies that are evident in cultural evolution, on the one hand, the relentless swallowing up the cultural minorities, and at the same time, the inability for this process to end in monoculture.
They Axelrod's assumption that cultural traits are entirely determined by influence from neighbors and allowed instead a small probability of random "perturbation" of cultural traits. Local convergence can trap a small population in an equilibrium in which influence is no longer possible because all neighbors are either identical or totally different. However, random culture perturbations can disturb the equilibrium by generating cultural overlap between otherwise perfectly dissimilar neighbors, allowing social influence across cultural boundaries. This influence allows formerly dissimilar neighbors to become increasingly similar until no differences remain and a new cultural boundary forms around a larger region. Eventually this boundary too will be bridged by a perturbation that creates a common trait between otherwise dissimilar neighbors, and so on, until no differences remain.

3 Model

In the Axelrod model of cultural dissemination, a culture modeled as a vector of F integer variables σ_f $(f = 1, ..., F)$, called cultural $features$, that can assume q values, $\sigma_f = 0, 1, ..., q-1$, the possible *traits* allowed per feature.
At each elementary dynamical step, the culture $\sigma_f(i)$ of individual i randomly chosen is allowed to change by imitation of an uncommon feature's trait of a randomly chosen neighbor j, with a probability proportional to the cultural overlap ω_{ij} between both agents, defined as the proportion of shared cultural features,

$$\omega_{ij} = \frac{1}{F} \sum_{f=1}^{F} \delta_{\sigma_f(i), \sigma_f(j)}$$

Where $\delta_{x,y}$ stands for the Kronecker's delta which is 1 if $x = y$ and 0 otherwise. Note that in the Axelrod dynamics the mean culture overlap $\overline{\omega_i}$ of an agent i with its k_i neighbors, defined as

$$\overline{\omega_i} = \frac{1}{k_i} \sum_{j=1}^{k_i} \omega_{ij}$$

not always increases after an interaction takes place with a neighboring agent: indeed, it will decrease if the feature whose trait has been changed was previously shared with at least two other neighbors.
To incorporate the mobility of cultural agents into the Axelrod model, two new parameters are introduced, say the density of empty sites h and a threshold $T(0 \leq T \leq 1)$, that can be called *intolerance*. After each elementary step of Axelrod dynamics, we perform the following action: If imitation has not occurred and $\omega_{ij} \neq 1$, we compute the mean overlap and if $\overline{\omega_i} < T$, the the agent i moves to an empty site that is randomly chosen. Finally, in the event that the agent i randomly chosen is isolated (only empty sites in its neighborhood), then it moves directly to an empty site.
We define the mobility m_i of an agent i as the probability that it moves in one elementary dynamical step:

$$m_i = (1 - \overline{\omega_i})\theta(T - \overline{\omega_i})$$

where $\theta(x)$ is the Heaviside step function, that takes the value 1 if $x > 0$, and 0 if $x \leq 0$. For an isolated agent, that moves with certainty, one may convene that its mean cultural overlap is zero, so that expression applies as well. The average mobility m of a configuration is the average of the mobility of the agents:

$$m = \frac{1}{N} \sum_{i=1}^{N} m_i$$

, where N is the total number of cultural agents. We will consider below tow-dimensional square lattices of linear size L, so that $N = (1-h)L^2$, periodic

boundary conditions, and von Neumann neighborhood, so that the number k_i of neighbors of an agent i is $0 \leq k_i \leq 4$. We vary parameters F,q,h,T, as well as the linear size L of the lattice.
For the initial conditions for the cultural dynamics, N cultural agents are randomly distributed in the $L \times L$ sites of the square lattice, and randomly assigned a culture.
In our case the simulation is stopped when $m < 0.2$. Because of existence of isolated agents we collect them at the end of each iteration and distribute them randomly throughout the empty sites in lattice the will be always some mobility probability that will remain during simulation.

4 Observations

By examining the simulation by providing required parameters and different variations of them, we will be observing the outcomes and will illustrated them in form of plots in following sections.

4.1 Cultures(q) as Variable

$T \backslash q$	$q = 5$	$q = 10$	$q = 20$	$q = 50$	$q = 100$	$q = 200$	$q = 400$
$T = 0.3$	191	453	584	664	714	704	712
$T = 0.5$	1334	1921	2394	2356	2333	2245	2142
$T = 0.7$	5434	7818	7135	7591	7523	7450	7556

Table 1: Time (i.e. no. of Iteration) taken with respect to constant T and variable q. (For other parameters : $L = 30$, $F = 10$ and $h = 0.5$).

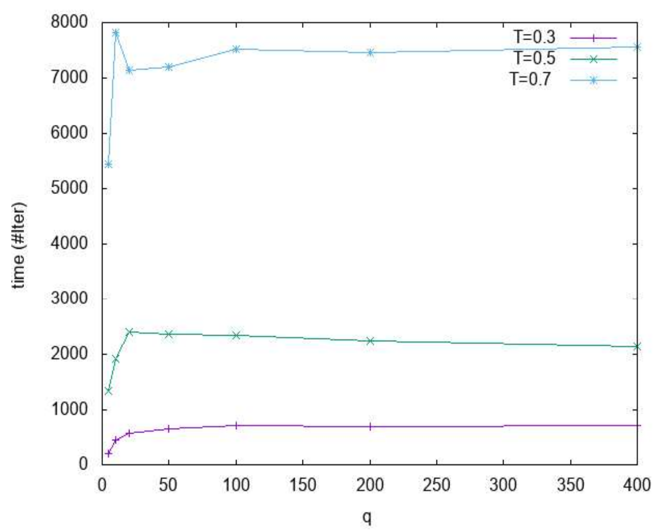

Figure 1: Cultures as Variable

4.2 Threshold(T) as Variable

$L \setminus T$	$T = 0.1$	$T = 0.2$	$T = 0.3$	$T = 0.4$	$T = 0.5$	$T = 0.6$	$T = 0.7$
$L = 20$	24	143	321	530	672	1081	2388
$L = 30$	31	285	640	984	1505	2411	5005
$L = 40$	44	480	992	1816	2637	4548	13344e

Table 2: Time (i.e. no. of Iterations) taken with respect to constant L and variable T. (For other parameters : $q = 200$, $F = 10$, and $h = 0.5$).

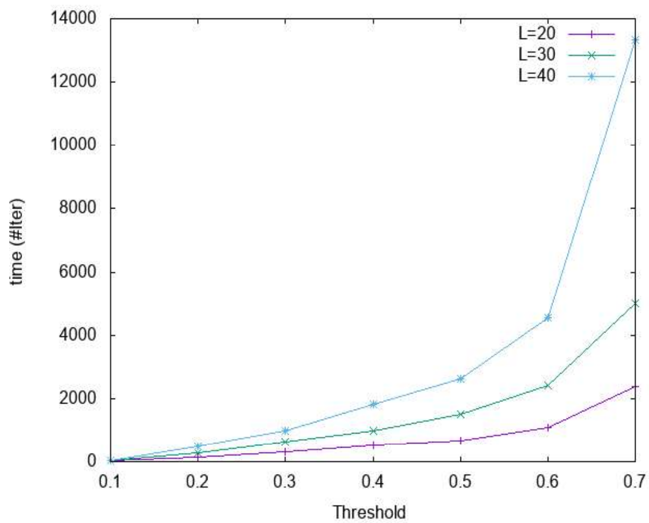

Figure 2: Threshold as Variable