A Generic Agent-Based Model of Historical Social Behaviors Change

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Abstract The primary theme of this chapter is trying to describe, discuss and understand how human societies change over time using agent-based modeling. Agents become a major paradigm of social simulation allow us to model the complex social phenomena under the bottom-up approach. Certainly one of the key points of the bottom-up approach is the emergence of macro level phenomena from micro level actions and interactions. The main objective of this work is to build a Virtual Social Laboratory, from Rafael Pla Lopez Social evolution model, in order to explore the social evolution of a set of artificial societies/agents that evolve within a grid of cells which are characterized by a level of natural resources (artificial environment). This laboratory can help to explore and understand the East–West duality, the North–South Divide, the Human migration process, the globalization-polarization and some possible human social evolution.

1 Introduction

The primary theme of this chapter is trying to describe, discuss and understand how human societies change over time using agent-based modeling. Agents become a major paradigm of social simulation allow us to model the complex social phenomena under the bottom-up approach. Certainly one of the key points of the bottom-up approach is the emergence of macro level phenomena from micro level actions and interactions. The main objective of this work is to build a Virtual Social Laboratory, from Rafael Pla Lopez Social evolution model, in order to explore the social evolution of a set of artificial societies/agents that evolve within a grid of cells which are characterized by a level of natural resources (artificial environment).

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M. Nemiche, M. Essaaidi (eds.), *Advances in Complex Societal, Environmental and Engineered Systems*, Nonlinear Systems and Complexity 18,
DOI 10.1007/978-3-319-46164-9_2

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Understanding the historical human social change is a hard task. Social change refers to an alteration of social structures, including consequences in cultural symbols, norms, social organization, and values. The social change can evolve from a number of different sources, including social conflict (Karl Max, Dahrendrof (Dahrendorf 1958; Giner s.f.; Marx and Fredrick Engels 1888)), conflict between the norms of group behaviors (Rafael Pla-Lopez), social learning (diffusion), changes in the ecosystem, technological progress (as agricultural and industrial revolutions) and population growth.

2 Conflict as an Engine for Social Change

Conflict is a natural phenomenon in any human society; it is a social reality consubstantial with social life. The social conflict is not unusual, in fact the conflict is neither good nor bad it is an engine for social change (Giner s.f.). Conflict arises when resources, status and power are unevenly distributed among groups of same society (micro-conflict) or between different societies (macro-conflict).

Karl Marx has conceived society as an integrated organization shared among different social classes that are in permanent conflicting interests. The history of all hitherto existing society is the history of class struggles: Freeman and slave; feudal lord and peasant; bourgeois and proletarians (Marx and Fredrick Engels 1888). In a footnote added to the 1888 edition of the Communist Manifesto, Engels notes that of course the sentence "The history of all hitherto existing society" is only referring to written history, and that by then it was well known that there were no social classes in pre-history (Marx and Fredrick Engels 1888). According to Karl Marx social conflict is the conflict between social classes.

Ralf Dahrendrof agreed that class struggles were the basis of social conflicts in eighteenth and nineteenth centuries societies. In the twentieth century the category of social class was too broad to be useful in social analysis. A significant number of conflicts have been presented in the same class; so that could not be explained by traditional Marx's conflict theory as a class against another. According to Dahrendorf, this is the unequal distribution of authority that is the basis of social conflicts in society. Each class has an opposite position vis-à-vis the authority, the ruling class will try to maintain its position, while the dominated class will act to change this situation. Social conflict is a struggle to maintain or change the distribution of authority and not a struggle for the possession of means of production in capitalist societies as claimed by Karl Marx (Dahrendorf 1958). For Dahrendorf conflict is manifested as a struggle between social groups and not just between social classes.

The bottom line is that economic conflicts underlying political conflicts, although Karl Marx himself admitted relative autonomy of the political superstructure.

Rafael Pla-Lopez considers society as a finite set of social behaviors with conflicting norms. The number of social behaviors available of a society increases with the increase of its dimension. So, studying human social evolution returns to the study of social behaviors evolution. In this work, we define social behavior as a set of values, beliefs, norms, customs, rules and codes that socially defines a group of people. In our model, social behaviors are characterized by a satisfaction capacity and a repressive capacity. In each society, each social behavior represses the norms of other social behaviors except a particular theoretical social behavior available for societies with dimension $\boldsymbol{m = 4}$ that Rafael Pla-Lopez called "Free Scientific Society". This theoretical social behavior is characterized by a full satisfaction capacity and without initial repressive capacity (Pla-López 1989).

3 Artificial Society: Agent-Based Social Simulation

In an artificial society, the model is a multi-agent system: a set of autonomous agents that operate in parallel and that communicate with each other. Agent-based social simulation as a computational approach has-been largely used to explore and understand social phenomena thanks to (i) the agent social nature (ability to interact, communicate and collaborate with other agents), and (ii) its ability to detect emergent complex phenomena (Nemiche et al. 2013).

Sugarscape model built by Epstein and Axtell is a good example of an agent-based model that simulates an artificial society in which agents move over a grid of cells. Each cell has a renewable amount of sugar. The agents must consume sugar according to their metabolisms (metabolic rate, units of sugar the agent burns per time-step) for surviving. The agents move to the unoccupied cells with the greatest amount of sugar in their vision (vision rate, which is the maximum number of cells the agent can see in each of the four principal lattice directions: north, south, east and west). The agents accumulated sugar wealth is increased by the sugar collected and deceased by the agent's metabolic rate. The agent dies when its sugar wealth is zero. Whenever an agent dies it is replaced by a new agent of age 0 placed on a randomly chosen unoccupied cell (Epstein and Axtell 1996; Izquierdo et al. 2009).

Epstein and Axtell present a series of elaborations of Sugarscape model to illustrate various social phenomena. These models illustrate that:

- Agents that start in the most fertile areas and with high vision are those who accumulate wealth quickly. Then, by accumulation effect, the rich get richer and the poor even poorer
- From an equal distribution of sugar, the simulation evolves into a very unequal distribution of wealth; in which a minority of agents (with high vision rate) accumulates a wealth more than the average while the majority just has enough to survive (or dies).

Another important agent-based model in the social science is Axelrod's model of dissemination of culture (Axelrod cultural model). This model was motivated by the question: "If people tend to become more alike in their beliefs, attitudes and behaviors when they interact, why do not all such differences eventually disappear"? Axelrod's model has been the subject of several studies on cultural evolution with implications for issues such as state formation and social inclusion (Axelrod 1997). In this model, each cell represents a stationary individual's culture characterized by a set of f features, or cultural dimensions. Each feature composed by a set of q traits, which are the alternative values the feature may have. All agents have the same value for features, and all features have the same value traits. The individual culture is represented by a vector of f variables, where each variable takes an integer value in the set $\{0,1,..,q-1\}$. The model starts with random individual cultures. The parameter q model the initial cultural variety in the system (Axelrod 1997).

In each time-step, Agents interact according to the following rules:

- One agent A (active) is selected at random.
- One of agent A's neighbors, denoted agent P (passive), is selected randomly.
- Agents A and P interact with probability equal to their cultural similarity n_{AP}/f, where n_{AP} denotes the number of cultural features for which agents A and P has the same trait. The interaction consists in that active agent k selects at random one of the $f - n_{AP}$ features on which the two agents differ, and copies the passive agent r's trait. In this way, agent A approaches agent P's cultural interests (Izquierdo et al. 2009).

The process outlined above continues until no cultural change can occur. This happens when every pair of neighboring agents have cultures that are either identical or completely different (Axelrod 1997; Izquierdo et al. 2009).

Axelrod's model illustrates how local convergence can generate global polarization in terms of stable regions of differing culture. Simulations show that the number of multicultural regions decreases with the number of features f in the culture, increases with the number of alternative traits q per feature and decreases with the range of interaction (Axelrod 1997; Izquierdo et al. 2009).

4 Model Description

In this section we present an extended and modified version of Rafael Pla-Lopez Social Evolution Model. We simulate social evolutions of N mobile artificial societies/Agents initially randomly distributed in a bi-dimensional grid of cells.

The Fig. 1 shows the basic structure of this model. Each society/Agent is composed of a set of social behaviors. The number of social behaviors available for a society depends on its dimension. Social behavior is modeled by a multidimensional vector $B = (B_m, \ldots B_2, B_1)$ of binary features $B_i \in \{0, 1\}$ where m represents the agent dimension. For example, if the dimension of an agent is 3 (three bits) then the social behaviors available for this agent are ***(0,0,0), (0,0,1), (0,1,0), (0,1,1), (1,0,0), (1,0,1), (1,1,0), and (1,1,1)***.

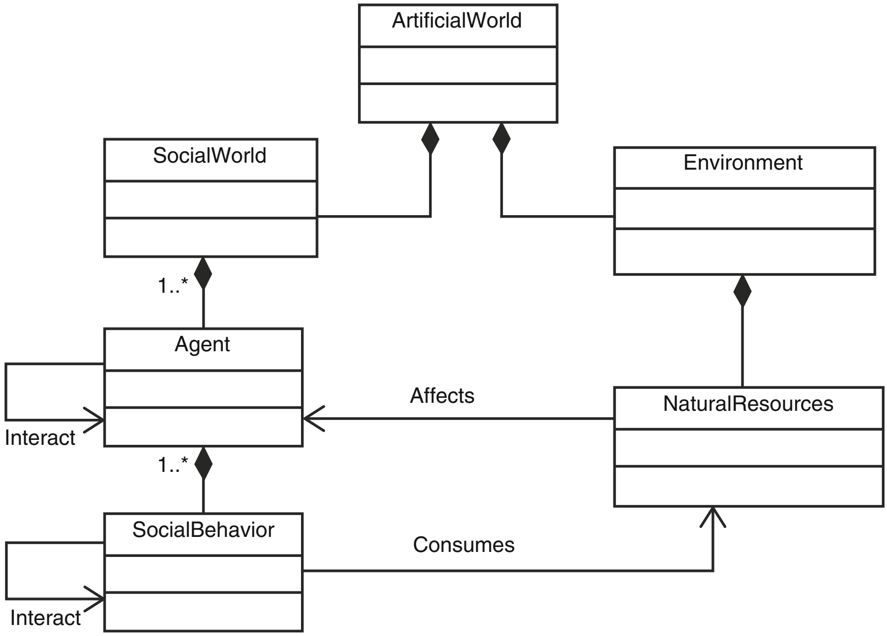

Fig. 1 Computational objects that compose the model (inspired from Cioffi-Revilla et al. 2007)

In the simulations, the dimension $\boldsymbol{m}$ takes values in the set $\{\boldsymbol{1,2,3,4}\}$. At the initialization ($\boldsymbol{t}=\boldsymbol{0}$) all the agents start with the same dimension $\boldsymbol{m}=\boldsymbol{1}$ (primitive society); this dimension increases over time under some conditions from 1 to the maximum value 4 in an autonomous way for each agent.

With the dimension increase we model the technological progress; the dimension $\boldsymbol{m}=\boldsymbol{2}$ can be interpreted by the agricultural revolution, $\boldsymbol{m}=\boldsymbol{3}$ by the industrial revolution and $\boldsymbol{m}=\boldsymbol{4}$ by a technological revolution.

4.1 The Environment Sub-model

The environment in which the agents evolve is a discrete spatial grid with dimensions $\boldsymbol{X}\times\boldsymbol{Y}$. Each cell $\boldsymbol{(x,y)}$ is defined by the current level of natural resources $\boldsymbol{K^t(x,y)}\in\boldsymbol{R}+$ and a maximum level $\boldsymbol{K_{max}}\in\boldsymbol{R^*}+$ (parameter, in this version is constant for all cells). This level will be increased every time-step following a fixed value $\boldsymbol{\rho}$ (natural resource growth rate, parameter constant of all cells) up to the $\boldsymbol{K_{max}}$ (maximum level of natural resources), and will be decreased if the agents consume them. In this model agents consume resources for satisfaction and repression. At the initialization, each cell $\boldsymbol{(x,y)}$ starts with a random initial level of resources $\boldsymbol{K^0(x,y)}\in\boldsymbol{R}+$ between $\boldsymbol{0}$ and $\boldsymbol{K_{max}}$.

When an agent occupies a cell ***(x,y)***, the value ***K(x,y)*** is updated as (Nemiche et al. 2013):

$$K^{t+1}(x,y) = max\left\{K^t(x,y) + \rho.K^t(x,y) - \left(CS^t + CR^t\right), K_{max}\right\}$$

where CS^t is the consumption of resources for satisfaction by the agent at time-step **t,** while CR^t is the consumption of resources for repression by the agent at time-step **t**.

In this model, a cell ***(x,y)*** only can be occupied by one agent at time-step ***t***.

When a cell ***(x,y)*** is unoccupied, the value of ***K(x,y)*** increases under following formula (Nemiche et al. 2013):

$$K^{t+1}(x,y) = max\left\{K^t(x,y) + \rho.K^t(x,y), K_{max}\right\} \tag{1}$$

4.2 Agents

This model is initially populated by ***N*** Agents located at random spatial coordinates ($N < X.Y$). Reminding that agents in this model represent artificial societies and each society is composed of a finite number of social behaviors in conflicting norms. En each time-step, each social behavior calculates its satisfaction/goal function:

4.2.1 Satisfaction Function

At each time-step ***t***, each social behavior ***B*** of each agent ***A*** evaluates its satisfaction according to the following formula:

$$S^t{}_A(B) = SC(B) \,.\, \left(1 - SR^t{}_A(B)\right) \tag{2}$$

where ***SC(B)*** is the satisfaction capacity of social behavior ***B***, and $SR^t{}_A(B)$ is the Social Suffered repression by the social behavior ***B*** of the agent ***A*** at the time-step ***t*** (Nemiche et al. 2013; Nemiche and Pla-Lopez 2003, 2000; Nemiche 2002; Pla-Lopez 2007, 1989, 1988; Pla-Lopez and Nemiche 2002).

We observe that, the satisfaction function of a social behavior ***B*** of an agent ***A*** at time-step ***t*** depends on:

- Its initial satisfaction capacity ***SC(B)*** (Internal factor);
- Its Social Suffered repression $SR^t{}_A(B)$ (external factor/social context).

If $SR^t_A(B) = 1$ (high suffered repression) then $S^t_A(B) = 0$; i.e. high values of Social Suffered repression by ***B*** decrease its satisfaction/goal.

If $SR^t_A(B) = 0$ (absence of Social Suffered repression) then $S^t_A(B) = SC(B)$; i.e. the satisfaction/goal of ***B*** depends only on its satisfaction capacity.

Now let's explain how to calculate the satisfaction capacity (internal factor) and the Social Suffered repression (external factor). We want that the satisfaction capacity of social behavior ***B*** increases with number of included properties between

Table 1 Satisfaction capacity of social behaviors

B (Binary representation)	B (Hexadecimal representation)	SC(B)
(0,0,0,0)	0	0
(0,0,0,1)	1	0.25
(0,0,1,0)	2	0.25
(0,0,1,1)	3	0.5
(0,1,0,0)	4	0.25
(0,1,0,1)	5	0.5
(0,1,1,0)	6	0.5
(0,1,1,1)	7	0.75
(1,0,0,0)	8	0.25
(1,0,0,1)	9	0.5
(1,0,1,0)	A	0.5
(1,0,1,1)	B	0.75
(1,1,0,0)	C	0.5
(1,1,0,1)	D	0.75
(1,1,1,0)	E	0.75
(1,1,1,1)	F	1

values ***0*** and ***1***. Tanking in consideration the binary representation of ***B*** a simple formula is

$$SC(B) = \left(\Sigma^{4}{}_{i=1}B_i\right) \ / \ 4 \tag{3}$$

In Table 1 we observe that the social behaviors ***B = (1), (1,1), (1,1,1)*** and ***B = (1,1,1,1)*** have the greatest satisfaction capacity in their dimensions.

4.2.2 Social Suffered Repression Function Used as a Mechanism for Social Change

Social suffered repression by a social behavior is considered as a negative influence (cause a satisfaction decrease) received by this social behavior from the other social behaviors of its neighborhood (von-Neumann neighborhood).

The equation used to calculate the Social Suffered repression by the social behavior ***B*** of the agent ***A*** at time-step ***t*** is:

$$\begin{aligned} SR^{t}{}_{A}(B) &= \left(\Sigma_{A' \in VA} \Sigma_{B' \neq B}\, p^{t}{}_{A'}\left(B'\right).RC^{t}{}_{A'}\left(B'\right).\ Imp\left(A' \to A\right)\ SD\left(B,\ B'\right)\right) / s \\ SR^{t}{}_{A}(B) &= 1\ if\quad SR^{t}{}_{A}(B) > 1 \end{aligned} \tag{4}$$

where ***s*** is the number of active agents in the neighborhood (V_A) of the agent A;

V_A is the von-Neumann neighborhood of range ***r*** (***r*** is a parameter of the model, see Fig. 2) (Nemiche et al. 2013). Note that $A \in V_A$

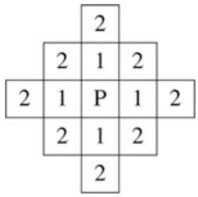

Fig. 2 Von-Neumann neighborhood of range $r = 2$ (Manhattan distance r = 2, wikipedia)

$p^t{}_{A'}(B')$ is the probability/weight of the social behavior B' of the agent A' at time-step t.
$RC^t{}_{A'}(B')$ is the repressive capacity of the social behavior B' of the agent A' at time-step t;
$Imp(A' \to A)$ is the impact coefficient of the agent A' over the agent A;
$SD(B, B')$ is the social distance between social behaviors B and B';

The order of social behaviors apparition is: firstly the appearance of social behaviors with one feature, secondly with the technological progress new social behaviors with two features appear, thirdly social behaviors with three features appear and finally social behaviors with four features appear. We think that the social distance between two social behaviors B and B' increases when the differences are in the features with small index:

$$SD(B, B') = \left(\Sigma^4{}_{i=1} w_i \left|B_i - B'_i\right|\right)/SD_{max} \tag{5}$$

with $w_i = w_{i-1}/2$ for $i = 2,3,4$

$$w_1 = 8$$

where SD_{max} is the maximal social distance between two social behaviors:

$$SD_{max} = SD\left((0,0,0,0),(1,1,1,1)\right) = 8 + 4 + 2 + 1 = 15$$

The impact of an agent A' over agent A calculation is seen in Eq. 5.

$$Imp^t(A' \to A) = \sum_B p^t{}_{A'}(B).imp\left(B, d(A', A)\right) \tag{6}$$

where $d(A', A)$ is the distance between A' and A;
$imp(B, d(A', A))$ is the impact of the social behavior B at the distance $d(A', A)$.

4.2.3 Probability/Weight Calculation: Learning Process

Each social behavior B of an agent A over time in updates its accumulated memory $F^t{}_A(B)$.

The accumulated memory $F^{t+1}{}_A(B)$ value of social behavior B of agent A at time-step $t + 1$ is calculated as a function of his former value $F^t_A(B)$ at time-step t.

This function depends also on how positively (or how negatively) social behavior $\boldsymbol{B}$ in the agent $\boldsymbol{A}$ evaluated the interactions with the other social behaviors in the neighborhood $\boldsymbol{V_A}$. In formula (Pla-López 1988):

$$\boldsymbol{F^{t+1}}_{A}(\boldsymbol{B}) = \boldsymbol{F^t}_{A}(\boldsymbol{B}) + \boldsymbol{\lambda}\left(\boldsymbol{S^t}_{A}(\boldsymbol{B}) - < \boldsymbol{S^t}_{A} >\right)$$

$$\text{If} \quad \boldsymbol{F^{t+1}}_{A}\,(\boldsymbol{B}) < \boldsymbol{0}\ \textbf{\textit{then}}\ \boldsymbol{F^{t+1}}_{A}\,(\boldsymbol{B}) = \boldsymbol{0} \tag{7}$$

where $\boldsymbol{\lambda}$ = change rate parameter;

$$< \boldsymbol{S^t}_{A} > = \left(\Sigma_{A' \in VA} \Sigma_{B'}\, \boldsymbol{p^t}_{A'}\left(\boldsymbol{B'}\right)\ \boldsymbol{S^t}_{A}(\boldsymbol{B'})\right) / \left(\Sigma_{A' \in VA} \Sigma_{B'}\, \boldsymbol{p^t}_{A'}\left(\boldsymbol{B'}\right)\right)$$
$$\text{(weighted mean)} \tag{8}$$

The probability/weight of social behavior $\boldsymbol{B}$ in the Agent $\boldsymbol{A}$ at the time $\boldsymbol{t}$ is obtained as:

$$\boldsymbol{p^t}_{A}(\boldsymbol{B}) = \left(\boldsymbol{F^t}_{A}(\boldsymbol{B})\right) / \Sigma_{B'} \boldsymbol{F^t}_{A}\left(\boldsymbol{B'}\right) \tag{9}$$

$\sum_{B'} \boldsymbol{F^t}_{A}\,(\boldsymbol{B'}) = \boldsymbol{M^t}_{A}$ is the accumulated memory in the agent $\boldsymbol{A}$ at the time $\boldsymbol{t}$;

At the initialization $\boldsymbol{F^0}_{A}(\boldsymbol{B}) = \boldsymbol{R^0}_{A}$ represents the level of natural resources available in the cell occupied by the agent $\boldsymbol{A}$.

We say that a social behavior $\boldsymbol{B}$ dominates in the agent $\boldsymbol{A}$ at the time-step $\boldsymbol{t}$ if $\boldsymbol{p^t}_{A}(\boldsymbol{B}) > \boldsymbol{0.5}$. In the simulation interface, in each step-time, we display only the hexadecimal representation of dominants social behavior of each agent. We call pseudo-state of an agent $\boldsymbol{A}$ at time-step $\boldsymbol{t}$ the social behavior B that has $\boldsymbol{p^t}_{A}(\boldsymbol{B}) > \boldsymbol{0.5}$. If all social behaviors of an agent $\boldsymbol{A}$ at time-step $\boldsymbol{t}$ their probability is strictly less than $\boldsymbol{0.5}$ we call this state "intermediate pseudo-state", in the simulation interface it is represented by the symbol "-".

4.2.4 Repressive Capacity Calculation

The repressive capacity of a social behavior $\boldsymbol{B}$ of an agent $\boldsymbol{A}$ evolves from the initial repressive capacity $\boldsymbol{RC^0(B)}$ to its social suffered repression with a delay Ta:

$$\boldsymbol{RC^{t+1}}_{A}(\boldsymbol{B}) = \boldsymbol{RC^t}_{A}(\boldsymbol{B}) + (\Delta \boldsymbol{t}/\boldsymbol{Ta})\,.\left(\boldsymbol{SR^t}_{A}(\boldsymbol{B}) - \boldsymbol{RC^t}_{A}(\boldsymbol{B})\right) \tag{10}$$

$\boldsymbol{RC^0}_{A}\,(\boldsymbol{B}) = \boldsymbol{RC^0}\,(\boldsymbol{B})$ the initial repressive capacity don't depends of $\boldsymbol{A}$.

Ta is a parameter of the model with which we can simulate different rhythms of repression adaptation.

Each agent $\boldsymbol{A}$ at time-step $\boldsymbol{t}$ consumes natural resources of its cell for repression (***CR***) and satisfaction (***CS***) according to:

$$\boldsymbol{CR^t_A = \sum_B p^t_A(B) \,.\, RC^t_A(B)} \tag{11}$$

$$\boldsymbol{CS^t_A = \sum_B p^t_A(B) \,.\, SC(B)} \tag{12}$$

This model can simulate the ecological holocaust in which the evolution ends due to the resources exhaustion (situation of high consumption of resources for satisfaction and repression).

The initial repressive capacity $\boldsymbol{RC^0}$ is the second attribute (static property) that characterizes social behaviors. We remind that the fist attribute (static property) is the satisfaction capacity.

The initial repressive capacity of a social behavior B depends on its force $\boldsymbol{\mu(B)}$ and its ferocity $\boldsymbol{\nu(B)}$. The initial repressive capacity of a social behavior is equal to zero when its force or its ferocity is equal to zero. The simple formula is the product (Rafael Pla-Lopez):

$$\boldsymbol{RC^0(B) = \mu(B) \,.\, \nu(B)} \tag{13}$$

which guarantees that $\boldsymbol{RC^0(B) = 0}$ if $\boldsymbol{\mu(B) = 0}$ or $\boldsymbol{\nu(B) = 0}$

We think that the force of a social behavior $\boldsymbol{B}$ increases with its dimension and with its included attributes; in a way that a social behavior with a great dimension possesses a great force. Taking into consideration the binary representation of social behavior, the simple function that satisfies these conditions is the decimal representation of the social behavior $\boldsymbol{B}$; i.e. $\boldsymbol{\mu(B) = (\sum_i 2^i.Bi)}$. So, $\mu(B) \in \boldsymbol{[0,15]}$. In order to normalize the values of the force we consider:

$$\boldsymbol{\mu(B) = \left(\sum_i 2^i.Bi\right) / 15} \tag{14}$$

We assume that the ferocity of a social behavior decreases for the more advanced social behavior $\boldsymbol{B}$ $\boldsymbol{(B4 = 1)}$, and increases for the social behaviors that are less advanced ($\boldsymbol{B4 = 0}$). The formula of the ferocity in this model is (see also Fig. 3):

$$\boldsymbol{\nu(B) = \left(1 - \left(\left(\left(2.\sum_i 2^i.Bi\right)/15\right) - 1\right)\right)^2} \tag{15}$$

As can be seen from Table 2 the social behavior $\boldsymbol{B = (0,1,1,1) = 7}$ has the greatest initial repressive capacity in its dimension ($\boldsymbol{m = 3}$), the social behavior $\boldsymbol{B = (1,1,1,1) = F}$ has an initial repressive capacity equal to zero (without initial repression) and a high satisfaction capacity. This is what Rafael Pla-Lopez called **Free Scientific Society** (theoretical social behavior).

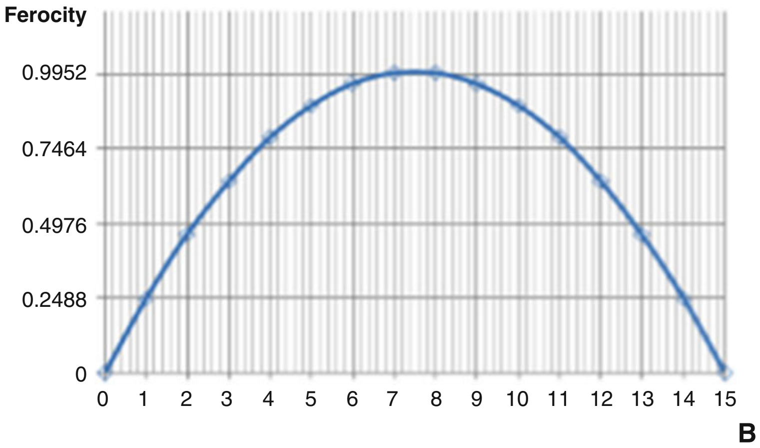

Fig. 3 Graphic representation of the ferocity function (source Nemiche et al. 2013)

Table 2 The values of force, ferocity and initial repressive capacity of social behaviors

B (Binary representation)	B(Hexadecimal representation)	μ(B)	ν(B)	RC^0(B)
(0,0,0,0)	0	0	0	0
(0,0,0,1)	1	0.066667	0.248889	0.016593
(0,0,1,0)	**2**	0.133333	0.462222	0.06163
(0,0,1,1)	**3**	0.2	0.64	0.128
(0,1,0,0)	4	0.266667	0.782222	0.208593
(0,1,0,1)	5	0.333333	0.888889	0.296296
(0,1,1,0)	**6**	0.4	0.96	0.384
(0,1,1,1)	**7**	0.466667	0.995556	0.464593
(1,0,0,0)	8	0.533333	0.995556	0.530963
(1,0,0,1)	9	0.6	0.96	0.576
(1,0,1,0)	A	0.666667	0.888889	0.592593
(1,0,1,1)	B	0.733333	0.782222	0.57363
(1,1,0,0)	C	0.8	0.64	0.512
(1,1,0,1)	D	0.866667	0.462222	0.400593
(1,1,1,0)	**E**	0.933333	0.248889	0.232296
(1,1,1,1)	**F**	1	0	0

4.2.5 Technological Progress

We simulate the technological progress of agent ***A*** with the increase of its dimension. The agent dimension increases one unit (in the simulation from ***1*** to ***4***) with a high probability when the value of its accumulated memory is approaching to a progress parameter ***prg*** (parameter of the model) (Nemiche et al. 2013; Nemiche and Pla-Lopez 2003, 2000; Nemiche 2002; Pla-Lopez 2007, 1989, 1988; Pla-Lopez and Nemiche 2002).

4.2.6 Reproduction and Death of Agents

In this model an agent A can die in two manners: (i) natural death, when its accumulated memory $\sum_B F^t{}_A(B)$ is approaching to the life expectancy value ***Thanatos*** (parameter of the model) and (ii) dissatisfaction death, when its accumulated memory is approaching to the value 0 $\left(\sum_B F^t{}_A(B) = 0\right)$ or when the level of natural resources of the cell occupied by A is zero.

The reproduction in this model is also produced in two ways (i) by relay, when an agent A dies naturally the relay is immediately produced with the appearance of a new agent 'neophyte' in the cell previously occupied by the agent A and (ii) by recuperation, when an agent dies by dissatisfaction; the recuperation mechanism takes some time-steps. We would facilitate the recuperation of the unoccupied cells previously predominated by less advanced social behaviors (Nemiche et al. 2013; Nemiche and Pla-Lopez 2003, 2000; Nemiche 2002; Pla-Lopez 2007, 1989, 1988; Pla-Lopez and Nemiche 2002).

4.2.7 Agent Mobility: Migration

In this version, the agents are mobile. They can move/migrate for two reasons (i) when its natural resources are unfavorable; its resource capacity (K_A^t) is less or equal to a threshold S_m ($K_A^t < S_m$). S_m is a parameter of the model and (ii) when the social suffered repression of its social behaviors is approaching to the value 1. In this situation the agent moves to a free cell with more natural resources in its social neighborhood. In this model we simulate only the forced migration.

The migration is another mechanism that makes it possible for agents to survive in war and adverse natural situations, looking for free cells in its neighborhood with more resources. An agent A can move/migrate only to a cell (x,y) within its perceptions. An agent A candidate for the migration at the time-step t, selects the first item (cell) in its table of resources perceptions. It is possible to have several agents who wish to move to the same cell. The management of this conflict consists of giving advantage to the agents with the biggest dimensions and in a random order in case of equal dimension. When the agent A is moved to this cell, at time-step t, the model updates its position, its resources and its perceptions, and the system deletes this cell from the resources perceptions of other agents (Nemiche et al. 2013).

5 East–West Divide (Collectivist Versus Individualist)

According to Maurice Godelier (1970), we could describe two main lines of social evolution: one which we could call "Occidental" had gone through phases: slavery, western feudalism, and capitalism with a significant role of the private property. In the second line ("Orient") the sense of collectivism dominated in all the phases beginning with what was called Asiatic mode of production and eastern feudalism and state socialism. Only at the end of twentieth century the two lines of evolution converge to which is called Globalized capitalism (globalization).

In order to simulate the East–West divide Rafael Pla-lopez and Mohamed Nemiche have supposed that the first feature ($\boldsymbol{B_1}$) of social behavior distinguishes between social individualistic and collective behaviors. Individualistic behaviors have $\boldsymbol{B_1 = 1}$ and collective behaviors have $\boldsymbol{B_1 = 0}$. As can be seen from Table 3 we have two families of social behaviors (Nemiche and Pla-Lopez 2003, 2000):

Note that in this model, the impact function ***Imp*** affects directly the suffered repression. Rafael Pla-Lopez and Mohammed Nemiche consider that there are two different impact functions: one for the individualist social behaviors and the other one for the collective social behaviors (Engels 1884). This differentiation in the impact function is the principal cause of the East-West divide:

1. The impact function of individualist social behaviors is $\boldsymbol{0}$ when the distance is equal to $\boldsymbol{0}$ (in self-society); that is to say, the individualist social behaviors does not repress the other social behaviors in self-agent (individual property), but they repress all social behaviors of the neighborhood agents.
2. The impact function of collective social behavior reaches its maximum in the self agent (collective property) and decreases with distance.

The Figs. 4 and 5 are a possible representation of the individualist and collective social behaviors respectively:

From the Figs. 4 and 5 we observe that the collective social behaviors repress in the agent more than its neighborhood. However, social individualistic behaviors repress in its neighborhood but not in the agent.

Table 3 Individualist and collective behaviors

Social Individualist behaviors	Social Collective behaviors
(0,0,0,1)	(0,0,0,0)
(0,0,1,1)	(0,0,1,0)
(0,1,0,1)	(0,1,0,0)
(0,1,1,1)	(0,1,1,0)
(1,0,0,1)	(1,0,0,0)
(1,0,1,1)	(1,0,1,0)
(1,1,0,1)	(1,1,0,0)
(1,1,1,1)	(1,1,1,0)

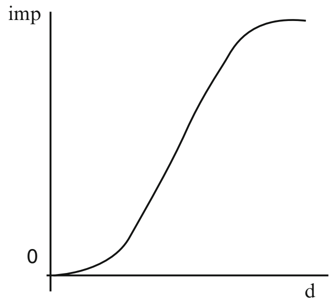

Fig. 4 Graph of the impact function of an individualist social behavior in the neighborhood

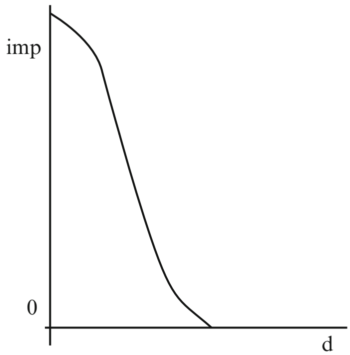

Fig. 5 Graph of the impact function of a collective social behavior in the neighborhood

A possible interpretation of the most important social behaviors of the Fig. 6:

B* = *(0,0,0,0) as the primitive society
B* = *(0,0,0,1) as the social behavior of "Slavery"
B* = *(0,0,1,0) as the social behavior of "Asiatic mode of production"
B* = *(0,0,1,1) as the social behavior of "Western Feudalism"
B* = *(0,0,1,0) as the social behavior of "Eastern Feudalism"
B* = *(0,1,1,0) as the social behavior of "State Socialism"
B* = *(0,1,1,1) as the social behavior of "Capitalism"
B* = *(1,1,1,1) as the social behavior of "Free Scientific Society"

6 North–South Divide (Fast Growing Technology Versus Slow Growing)

Rafael Pla-Lopez considers that the social evolution in the north has been faster than the south social evolution. He supposes that the agents situated in the north have a life expectancy (***Thanatos***) bigger than the south agents. So, the life expectancy will be a function that varies from north to south instead of considering it constant for all agents. The technological progress produces in the South through a Cultural and Technological Diffusion which can simulate the colonialism (Pla-Lopez 2007).

7 Preliminary Results

The model is implemented in java language; with its simulation we have obtained several types of social evolutions. In this chapter, we announce only three social evolutions:

- Perpetuity of the globalization with the repressive social behavior: evolutions where all the active agents end dominated by the repressive social behavior $\boldsymbol{B} = \boldsymbol{(0,1,1,1)} = \boldsymbol{7}$; i.e. repressive globalization state. The perpetuity of the capitalist globalization according to Fukuyama (Fukuyama 1995) can be a possible interpretation of this result.
- Overcoming of the repressive globalization with another globalization with the free scientific society $\boldsymbol{B} = \boldsymbol{(1,1,1,1)} = \boldsymbol{F}$: evolutions where the repressive globalization is overcome by another free scientific globalization ($\boldsymbol{B} = \boldsymbol{F}$), characterized by a great satisfaction and without initial repressive capacity.
- Ecological holocaust: death of all the agents due to exhaustion of resources (The collapse of the global ecology) or dissatisfaction.

These simulations were obtained using the parameters values of the former version. We need perhaps to re-calibrate these parameters in order to get an accurate simulation of the real social evolution of humanity until the present time, through different phases and with a different evolution between both East-West and North-South.

8 Conclusion and Perspectives

This chapter describes a generic model of social behaviors change. Modeling and simulation of soft systems, where the human factor is crucial, is a complex task. For lack of historical data we will only proceed to a qualitative validation of our model which is based on the historical schema presented in the Fig. 6. The presented results are a first stage of research that should be continued with a detailed sensitivity analysis. When we do this qualitative validation, we will be able to study the conditions and the possibilities of later local emergency of ways to a free scientific society $\boldsymbol{(1,1,1,1)}$ in front of “capitalism forever” or ecologic holocaust, and if this alternative social system can develop first in the South or in the North. Also, in the case of ecological holocaust, we would be able to forecast if this would begin in the North or in the South. This model can also help to understand the migration process (Pla-Lopez 2007).

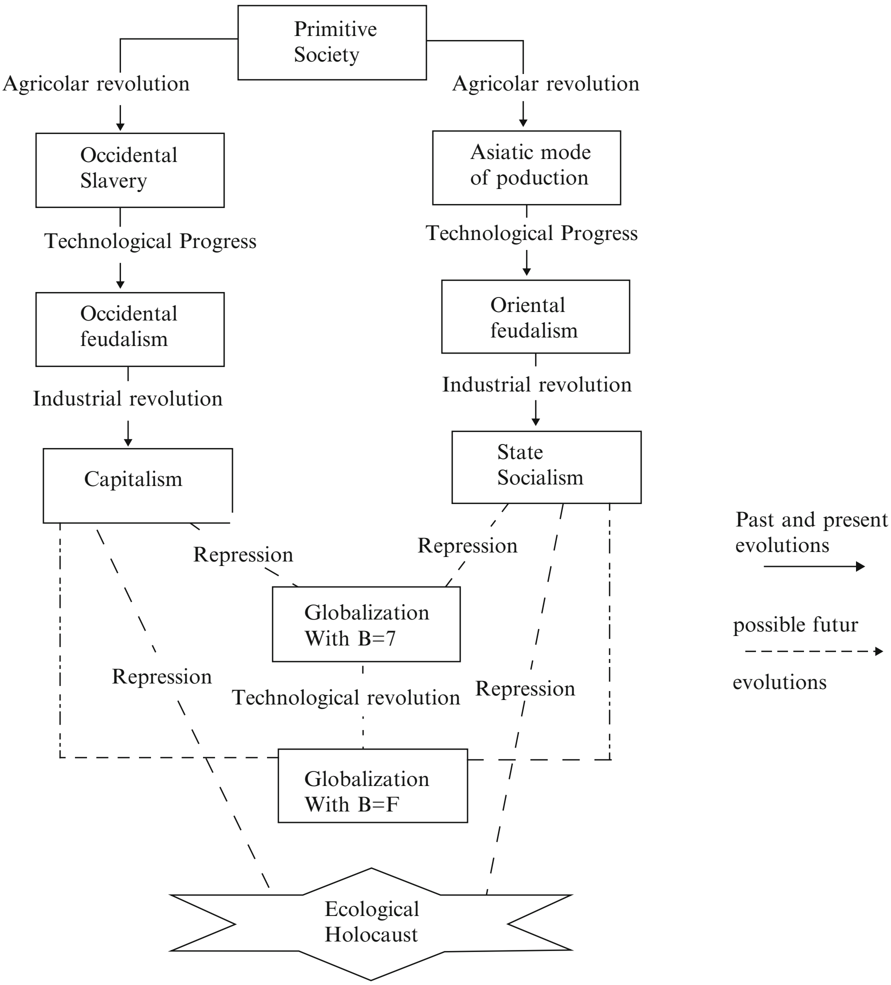

Fig. 6 East–West divide and some possible future evolutions (source Nemiche 2002)

Appendix

The model is implemented in java source code

1. Class ***SocialVisualizer*** that implements a graphical interface as a grid to visualize the dynamic model
2. Class ***SocialModel*** that implements the two-layer structure of Model (Resources and agents). The main tasks (methods) are:

   Initialization:
   - Initialize "constants" (parameters of the model) from configuration file

- Create resources
- Initializes resources
- Create agents (list of Societies Live)
- Initializes agents (Initializes memory, probability, Repressive Capacity and Suffered Social Repression)

Main loop

```
public void run() {
        for ( T=0 ; T <= Tmax ; T += deltaT ) {
               for ( nAgent = 0;   nAgent < listAgent.length;
                        nAgent ++) {
                        listAgent[nAgent].updateAgent(listAgent);
               }
               if ( getNumberAgentLive() == 0 ){
                        fLog.println("End: are not living systems.");
                        break;
              }
              migration();
              updateResources();
              sleep(delay);
    }
  }
```

3. Class ***Agent*** that implements dynamics and evolution of internal agent processes. The main methods are:

   Initialization:

```
public void init() {
                initAccumulatedMemory();
                initForce();
                initFerocity();
                initSatisfactionCapacity();
                initRepressiveCapacity();
    }
```

Update Agent:

```
public void updateAgent( Agent []  listAgents )  {
        if( this.isLive() ){
                updateProbability();
                updateSocialSufferedRepression(listAgents);
                updateRepressiveCapacity();
```

(continued)

```
                updateSatisfactionFunction();
                updateAccumulatedMemory();
                updateResourceAgent();
                if( ! this.isDeath() ){
                     checkProgress ();
                }
           }else{
                    checkRecuperation();
           }
    }
```

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Advances in Complex Societal, Environmental and Engineered Systems
Nemiche, M.; Essaaidi, M. (Eds.)
2017, XVI, 297 p. 74 illus., 47 illus. in color., Hardcover
ISBN: 978-3-319-46163-2