

Relations Cultural Activity and Environment Resources on Cultural Model

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Abstract: - The importance of the research of social problems is increasing recently, in proportion to frequency of occurrence of ethnic and religious conflict and problems of environment. Using computer simulation is one of the ways to solve these serious problems to make peaceful future. We devised a model of the human society as Artificial Culture by using a concept of memes. A model of artificial culture used the multi-agent system to model the migration of humans, and used the artificial chemistry to model the network of cultural activity and economy and is confirmed by the clustering and dividing of group were made by cultural difference and the running out of the resources and extinction of society caused by irreversible process of cultural production. The polarization of culture and activity are simulated by behaviors of each agent. Those results of the experiment are insightful.

Key-Words: - Artificial Culture, Artificial chemistry, Environment Resources, Human Agent

1. Introduction

There are various social problems in the world which are caused by polarization of wealth based on culture and resources. We must solve these problems for world peace. Hence, there are various studies to solve various problems in the world. However, the variety and range of human activity are increasing day by day, therefore it is difficult for us to analyze the future of the human society and its culture. Since the computer science provides broad solutions today, using computer simulation is one of better solutions for analyzing social problem.

Robert Axelrod provides some important suggestion for study of human society in computer science[1]. He devised the model of local assimilation and global polarization caused by imitation of adjacent actors. His model is suitable to describe the spread of culture, such as ideology, technology or fashion. The model of cultural imitation was devised by Richard Dawkins[2]. A meme which he defined as replicator represents a minimum unit of imitation. The meme can evolve in the similar way to the genetic evolution. However, there are two differences in the effect on the population. First, the meme has wider range of propagation and faster speed of replication. The

gene can replicate only in the individual reproduction. On the other hand, the meme can replicate in the communication between humans. Superb idea, such as arts or technology, can spread to all over the world. On the other hand, genes need human to survive and prosper, because they are sharing the destiny with human. The interaction of cultural elements and resources can be explained as artificial chemistry. Stuart Kauffman argues that the network of economy and technology is auto-catalytic system[3]. He explains that products and services build the network of complements and substitutes. Geographical issues are also important for the argument of culture. Attributes of culture depend on both humans and location. Jared Diamond discussed the reason why the progress of civilization is so polarized between the Eurasian Continent and the African Continent [4]. He concluded that there are following major reasons: inequality of resource distribution, difference of easiness of cultural propagation and population density and size of the land.

We developed the simulation program using model and carried out the experiment in several situation, including the polarization of cultural activity. Our model of human behavior consists of 'movement' and 'production' ultimately. The model

of human is designed as an agent who can move and produce. The agent can also evaluate its local environment. In our model, culture is represented by memes. The memes spread in the society of the agents via imitation, and affect the process of evaluation and production. To implement the production by meme the agents have, we used artificial chemistry.

In this paper, our objective is to analysis our results of getting the universal model of culture and human society, especially enabled to describe polarization of culture and activity, under the effects of cultural interaction and evolution.

2. The Concepts of Artificial Culture

2.1. Chemical Reactions of Artificial Chemistry

Chemical reactions among a pool of molecules show us insightful behaviors. The artificial chemistry describes universal model of chemical reactions. In the artificial chemistry, structures of symbols represent virtual molecules. The virtual molecules are in a pool and react each other. The system of the artificial chemistry consists of three elements as below.

- Molecules: A set of elements in the system. The set contains all elements which react.
- Operations: Interactions between molecules, such as bonding, decomposition or catalysis.
- Dynamics: Handling method of molecules which specifies how the molecules are selected for reaction, or how the new molecules are put in.

Artificial chemistries are used for various studies, such as chemistry, ecosystem and even economic system. Definition of the virtual molecules is important for these studies. In ecosystem, each molecule represents individuals or populations. On the other hand, each molecule represents products and services in economic system.

2.2. Representation of Artificial Culture

Since a meme is defined as a unit of culture, culture is represented as a set of memes. Thus, the combination of memes yields cultural differences in spite of sharing some memes. This representation is useful to describe the spread of culture, because we can handle memes as portable element.

2.2.1. The Application to Cultural Production

We modeled cultural production of human beings as

chemical reaction. The reason why we can regard the production as chemical reaction is that cultures always convert some resources into other resources in the local environment. For example, the meme of farming converts a wild grassy plain and seeds of grains into a farm. In this case, the wild plain and the seeds are reactants and the farm is product.

The production uses a pair of reactant and catalyst to generate a new resource as product (Fig. 1). The meme uses its pattern matching of reactants and catalysts to select the reactant and catalyst.

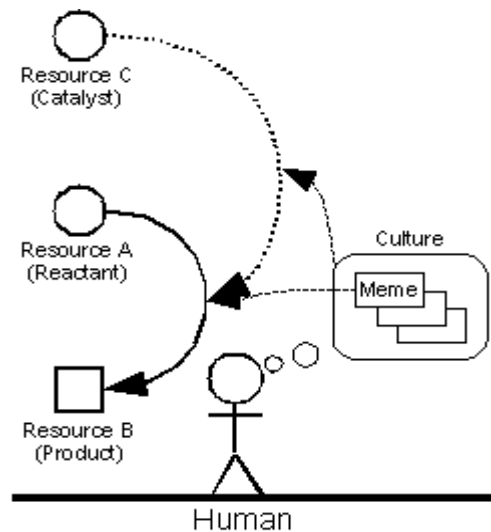


Fig.1: Cultural Production that is using Catalyst

The production replaces the reactant with its product. The reactant which has been used in the production is removed. The use of memes yields new resources and niches for other cultural production. This process builds the network of resources conversion and catalysis. Since the Post's production system represents such chemical reaction, we can represent the cultural production by using the system. Some of the memes increase opportunity of use of themselves because their products become their catalysts via the network. The network which especially contains self-helping memes is called auto-catalytic system. Fig. 2 shows the flow of the resources on the network of auto-catalytic process between two humans. In this Fig., Resource A and B exist initially. Then the two humans produce resource C and D, and they work as catalysis of each other. Thus, the production of them is accelerated. Stuart Kauffman states that the network of culture, especially of technology and

economy is developing by auto-catalysis of complements and substitutions.

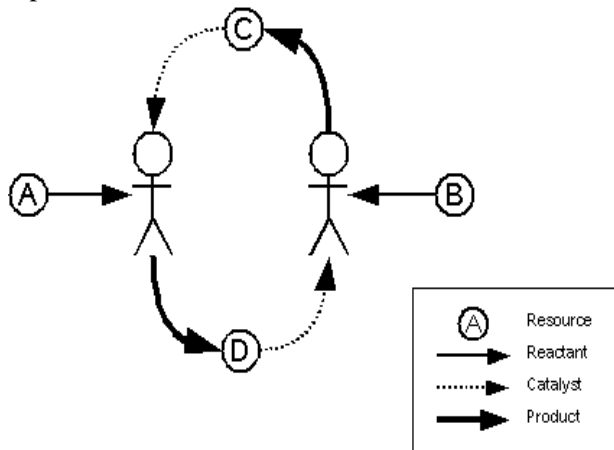


Fig. 2: Auto-Catalytic System of Production

The complements are mutually needed elements such as the relations of screw and screwdriver or cars and gas stations. The substitutions are competing elements such as the relations of nails and screws or railways and airlines. In this network, existing products and services will make new niches for new products and services in the relations of complements and substitutions. The network repeats such an expansion and diversifying.

2.4. Geographical Dynamic

2.4.1. Imitations among Adjacent Actors

Mutual imitations between individuals or subgroups make a cultural assimilation. However, some differences remain for long time and divide a group into several subgroups. Robert Axelrod modeled the spread of culture by multi-agent system. In this model, a success rate of a cultural imitation is in proportion to cultural similarity. He carried out the experiment of this model and the result yields local assimilation and global polarization in the model world. In the Fig. 3, the left diagram shows that the imitations that are represented as arrow symbols expand the regions which share a uniform culture. The right figure shows that the model world is finally The number of stable subgroups shows following features.

- If the number of cultural feature increases, the number decreases.
- If the number of variation in each cultural feature increases, the number increases.

- If the range of interaction increases, the number decreases.
- If the geographical area increases over a certain threshold, the number decreases.

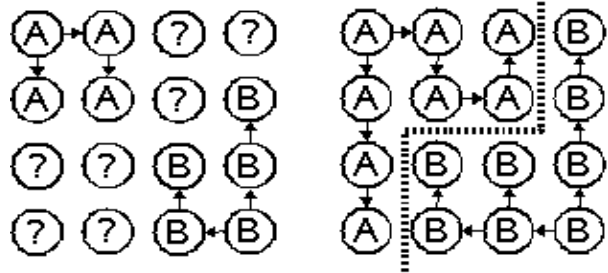


Fig. 3: Propagation process of culture (Left) and Polarization (Right)

3. Model of Artificial Cultural Society

We built the model of artificial cultural society which consists of human agents, memes and resources. We expect that this model builds the auto-catalytic cultural network in the model world.

Our model can describe various situations among the humans, cultures and resources.

3.1. Human Agents

A human agent represents a minimum unit of human activity, thus each agent represent not one person but one family or one band. The behavior of this agent consists of three elements: evaluation, migration and cultural production.

3.1.1. Evaluation of Resources

The human agent evaluates the environment for survival and breeding. In this process, the human agent firstly obtains a list of accessible resources which is near than the preset Manhattan distance. Once the list of resources is obtained, the agent evaluates each resource in the list and scores by its decision making process.

The evaluated resources are stored temporary in the memory for migration and cultural production.

3.1.2. Migration

In order to settle in a suitable position for its cultural production, the human agent migrates from one place to another in the model world. A suitable position for the human agent means a good place for cultural production by a set of memes which the human has.

The human agent decides the migration vector according to the scores and locations of all

resources.

The human agent migrates along the vector m when the agent succeeded to decide to migrate. However, because of the viscosity of group, the agent can not always succeed to migrate. Each human agent has viscosity of group to repress excessive migration. Excessive migration makes the human impossible to adapt to local environment and to maintain the group and cultural imitation among the group. On the other side, insufficient migration yields danger when the environment changes or other groups invade. Hence, the construction of cultural society requires a proper

3.1.3. Cultural Production

A cultural production yields profit or loss for the human agent. This process practices chemical reaction of a reactant resource and catalyst resource to generate a new resource as product. The reactant and catalyst are selected from the list of accessible resources which is obtained in the evaluation process. The product resource will be put at the place where the agent exists. Each meme defines the reaction rule and pattern matching for selection of reactants and catalysts. Therefore, a set of meme influences a cultural production of each human.

3.2. Cultural Similarity

3.2.1. Model of Memes

As discussed above, a set of memes represents a culture. We used set theory to handle culture in order to obtain a cultural similarity. We assume that there are n memes in the universal set of memes U :

$$U = \{m_1, m_2, m_3, \dots, m_n\}$$

M_i : Score that is based on memes.

A culture among humans is represented as a subset of U . When we assume there are two culture: Culture A and B which are represented as two sets CA and CB respectively, we can define four types of relations between them.

1. Equal: Culture A and B share all elements of them.
2. Inclusion: Culture A includes all elements of Culture B. In this case, a cultural similarity of them is equal to 1, because there is no collision in both cultures.
3. Overlap: Culture A and B share some elements of them, but other elements are different and yield

cultural conflicts.

4. Complete Difference: Culture A and B share no elements.

This yields severe cultural conflicts, thus they cannot imitate each other. In order to implement cultural propagation via imitation, we must obtain cultural similarity among humans and human groups.

3.2.2. Cultural Production

The human agent can do cultural production by its memes. The agent selects the meme and the accessible resource for chemical reaction. After the reaction, the agent puts new resource where reactant existed. In our model, the system scores the cultural activities in order to evaluate the fitness of the agents. The agent produces its child when its fitness score crosses the upper threshold. On the other hand, when the fitness score crosses the lower threshold, the agent dies. The reason why such a complicated mechanism exists is that the profit of humans and the profit of memes are different. Therefore, evaluation must be separated.

3.2.3. Evolution of Memes

In our model, a function of the meme evolution is omitted, because the evolution is too complicated to implement. We predefined limited memes which contains initial set of memes, instead of evolution.

3.3. Resources

The resource represents a feature of environment. Natural, artificial, material and immaterial resources are indiscriminate. Even the agents' presence is also handled as resource. Hence, the cultural production is not the plain production but the creation which has infinite possibility.

3.4. Environment

In the simulation program, we defined the whole environment as limited torus two-dimensional space. And we distribute the initial set of natural resources and human agents on the environment. The simulation program updates the state of the model world in each iteration. The environment space is divided into mosaic tile, and each mosaic cell means minimum unit of area and resource storage. The resources are distributed on the space and stored in each cell. The agent exploits the resources for the cultural activity.

4. Simulation Result on relating between Population and Resource

We developed the simulation program in order to verify this model. The properties of simulation environment are given with optional value on each parameter of *ChildRearingCost*, *ReproduceThreshold*, *MemePoolCapacity*, *MemeVariety* and *MemeLength*.

In the simulation, we obtained some interesting results among the interaction and propagation of culture and human.

4.1. Two Patterns of History

There are two patterns of history of model world: decline and prosperity. Both patterns have shown different patterns among society.

4.1.1. Decline Pattern

First we found the decline pattern in the experiment.

The each parameter are given as 10, 50, 3, 10, 6 and the set of meme from Meme ID(0) to Meme D(9) are also given with character form set as 000 -> 000.

Result of this simulation is that an initial population grew larger and became diversified through the history in the model world. However, once they reached their peak of prosperity, the decline began.

Fig. 4 and Fig. 5 show the dynamics among society in 1000 iterations on our simulation. In Fig. 4, the population reaches the first peak after 330 iterations, then they begin decline. At the same time, variety of resources shown in Fig. 5 slowed down its growth. In iterations from 600 to 700, population has been maintained by cultural conflict and mixture. Fig. 6 shows cultural stress that a human agent gains from amount of cultural difference among surrounding others.

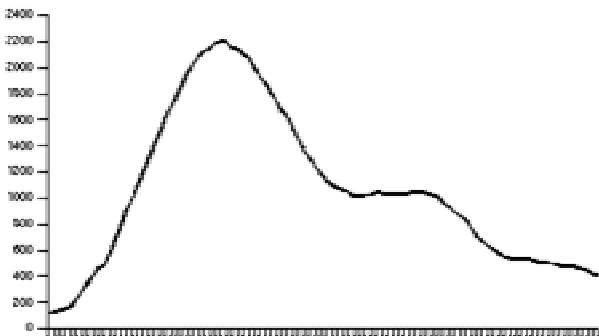


Fig. 4: Population of Human Agents (1000 iterations)

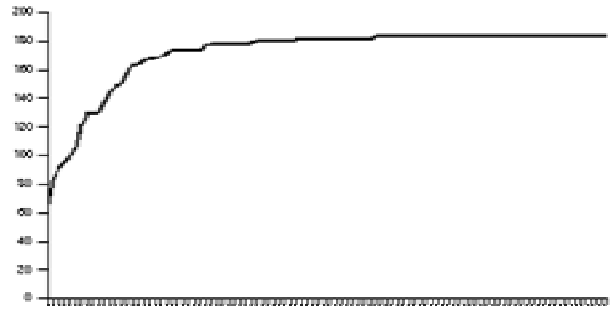


Fig. 5: Variety of Resources (1000 iterations)

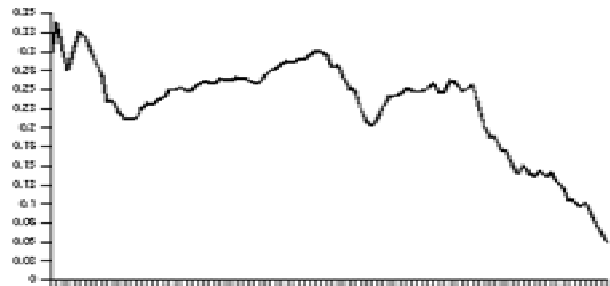


Fig. 6: Cultural Stress (1000 iterations)

4.1.2. Prosperity Pattern

Second, we found the prospering pattern in the other experiment. The each parameter are given as 10, 50, 3, 10, 5 and the set of meme from Meme ID(0) to Meme ID(9) are also given with other deference character form set to declined pattern sets. The growth of population and the growth of variety of resources did not slow down but accelerated until the memory usage became full at iteration 370. However, both the population of human agents and the variety of resource became extremely large when the simulation terminated by 'out of memory'.

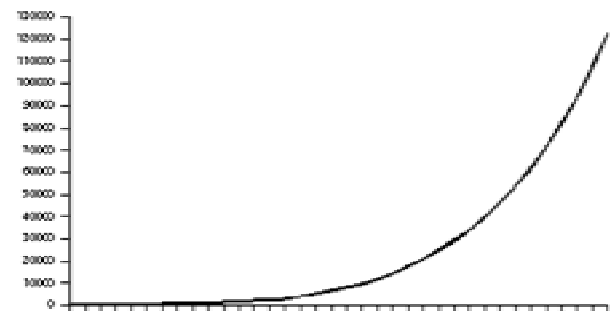


Fig. 7: Variety of Resources (370 iterations)

Fig. 7 and Fig. 8 show the variety of resources and the cultural stress in the prospering pattern in 370 iterations on our simulation. The first peak in Fig. 8 shows the same shape as the decline pattern

because this is common pattern while the society is growing. The increase of stress is in proportion to the population of humans.

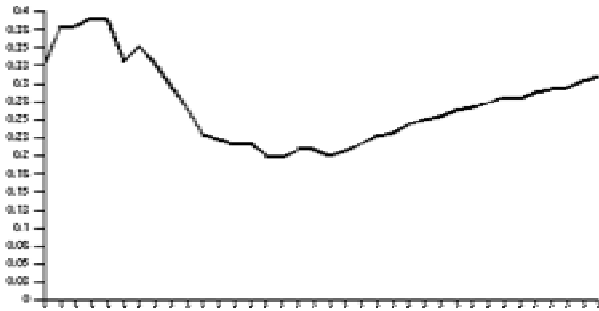


Fig. 8: Cultural Stress (370 iterations)

4.2. Meaning of Cultural Stress and Prosperity

In two patterns of history, we found the relations between cultural stress and growth of population. Cultural variety yields the variety of resources, cultural productions and even growth of population of humans. Comparing to decline pattern, both the population of humans and the variety of resources are larger when even at iteration 300 (Fig. 5, Fig. 7). The most important difference in above two Fig.s is the variety of resources. In decline pattern, we found the maximum variety of resource is up to 183. On the other hand, this pattern showed over 120,000 at last. When this property is low, the model world has uniform culture. On the other hand, when this property is high, the model world is polarized. We found that the higher rate of increase of population yields higher cultural stress among the model world.

4.3. Geographical Condition

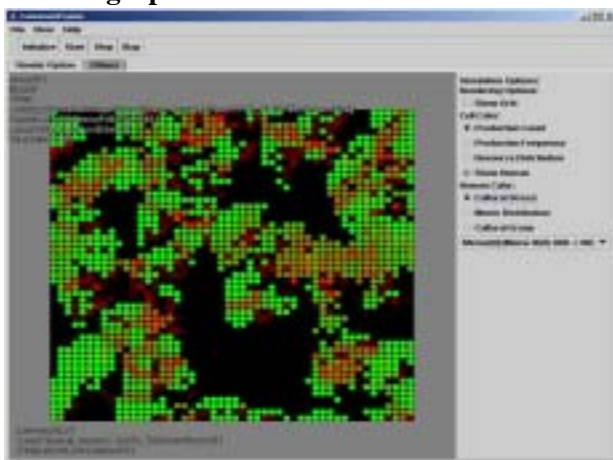


Fig. 9: Geographical Distribution of Cultural Stress

We found that the culturally assimilated group was formed especially in the edge of population (Fig. 9). This phenomenon is yielded from accessibility of other agents. Inner agents are surrounded by other agents constantly, so that they cannot maintain same memes. On the other side, outer agents have some neighboring agent, but other side is open. This subtle difference grows through a number of iterations. At last, outer agents make small group.

5. Conclusion

In this paper, we focused on model the society that contains memetics and geography. The result of experiment gave us following property of society: the growth of population makes cultural stress, and the cultural group is born at isolated area. We also handled memetics as tool to define cultural production of human beings. We combined memetics and artificial chemistry to express auto-catalytic process of cultural production. The result showed two patterns of history of society, prosperity and decline. In decline pattern, we found a dead-lock in auto-catalytic process that makes the growth of resource variety stop.

Evaluation of production also influences the result. If the highly valued production is yielded from one meme, uniform culture will conquer the model world. If not, such culture will disappear soon, as shown in the result of our experiment. Memetics is still arguable, but we focused on not individual meme but a combination of memes, and succeeded to model the abstract society. We need to improve this model and program to obtain more fine comprehensive results on society.

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