A Game Board Implementing Data Mining and Cultural Algorithms

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Abstract. *Evolutionary computation is a generic term used to make reference to the solution of computational problems planned and implemented based on models of an evolutionary process. Most of the evolutionary algorithms propose biological paradigms. However, other paradigms that can be adopted in the creation of evolutionary algorithms exist. Many problems involve not structured environments that can be considered from the perspective of cultural paradigms; the cultural paradigms offer a wide range of categorized models that ignore the possible solutions to the problem, -a common situation in the real life-. The purpose of the present work is to apply the computational properties of the cultural technology; on this case, to corroborate them by means of data mining to propose the solution to a specific problem. The above mentioned, carrying out an adaptation from the perspective of the societies modeling. An environment to carry out tests of this type was developed to allow the learning on the not very conventional characteristics of a cultural technology. This environment is called Baharastar.*

Resumo. *Computação Evolutiva é um termo general usado pra fazer referencia a uma solução dos problemas computacionais planeados e com implementação em modelos de processos evolutivos Muitos dos algoritmos evolutivos propõem paradigmas biológicos. Ainda, outros paradigmas podem ser adotados em a criação dos algoritmos evolutivos. O propósito de este artigo é aplicar as propriedades da tecnologia cultural; em nosso caso mediante Data Mining pra a melhor solução da um problema especifico desde a perspectiva da modelado das sociedades. Um médio ambiente foi desenvolvido pra aprender da cultura tecnológica chamado Baharastar.*

1. Introduction

The most of computational problems found at real World, do not have a definitive (final) solution [Desmond, A. and Moore J. 1995]. Cultural Algorithms uses the culture like a vehicle to store accessible relevant information to the population's members during many generations, were developed to model the evolution of the cultural

component over the time and to demonstrate how this learns and acquires knowledge. A cultural algorithm can be described with the next pseudo code (Figure 1).

```
Begin
    t=0;
    Initialize POP(t);     /* Initialization of population */
     Initialize BLF(t);     /* Initialization of believing  space */
    Repeat
        Evaluate POP(t);
        Vote (BLF (t), Accept (POP(t))));
        Adjust (BLF (t));
        Evolve(POP(t), Influence(BLF(t)));
        t = t +1;
        Select POP(t) from POP(t-1);
    Until (Term condition is reached)
End
```

Figure 1. Pseudo code of Cultural Algorithms

Initially, a population of individuals that represents the solution space, which is represented as a group of solutions inside the search space, is randomly generated to create the first generation. In our example, the solution space contains a list of the attributes that can be used in the classification procedure. The space of beliefs is empty. For each generation, the Cultural Algorithm will be able to involve a population of individuals using the "frame" Vote-Inherit-Promote (VIP). During the phase of Vote of this process, the population's members are evaluated to identify their contribution to the space of beliefs using the acceptance function. These beliefs allow contributing in most of the solution of the problem and they are selected or put on voting to contribute to the current space of beliefs. The beliefs space is modified when the inherited beliefs are combined with the beliefs that have been added by the current generation, this is carried out using a reasoning process that allows updating the space of beliefs.

Next, the updated space of beliefs is used to influence in the population's evolution. The belief space is used to influence the path on which the population of variable combinations is modified. During the last phase a new population is reproduced using a basic set of evolutionary operators. This new population could be evaluated and the cycle continues successively. The VIP Cycle finishes when a condition of termination is introduced. This condition is usually reached when only a small or none change is detected in the population through several generations or when certain knowledge has emerged in the space of beliefs, as can be appreciated in the Figure 2.

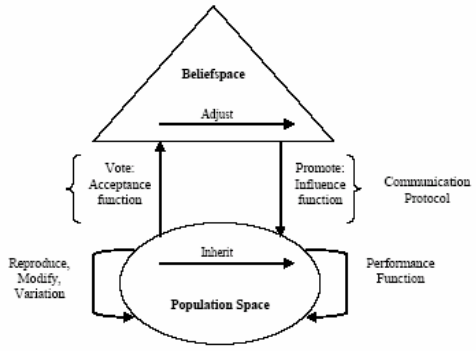

Figure 2. Conceptual Diagram of Cultural Algorithms

The human brain could be an instrument of cognitive metaphors –a metaphoric mind that could "to surmise" the obtained knowledge in previous way from previous experiences and to complete the missing knowledge to solve real world problems. The investigation on the topic has worked in gradual different form to the models offered by the biology [Pinker, S. 1999]. The Cultural Algorithms, for example, are based on the supposition of obtaining the best learning ranges, as it happens in an evolutionary algorithm (like in the genetic algorithms), adding to this an element more of the evolutionary pressure, called "space of beliefs", - a mechanism of cultural pressure. Another research topic called Artificial Societies, according to [Reynolds, R. G. 1998, Gessler, N. 1999], consist on the simulation of theories or social models expressed in the form of computer programs.

The main contribution of this paper, refers to the fact that the culture has its own cultural properties. In second place, we believe that some computational problems could benefit from a cultural method of resolution, and this can lead to the automation of processes by means of the use of intelligent agents [Ochoa A.et al. 2006].

Several authors have written about the confrontation between the individuals and the society, and how this last influences their behavior (changes of the society over the time) [Ochoa A.et al. 2006]. Taking into consideration these concepts, we are able to elaborate a representation of what could be described as an artificial culture of agents [Geertz, C. 1989].

2. Artificial Culture and its Protocol

In this article, we focus our attention on a practical problem adapted from the related literature within the Societies Modeling, "the negotiation toward a common well-being" for a set of societies: to find a safe place (a place where attacks don't exist) in an unknown place, inside a hostile environment with unknown dimensions and populated by attackers in unknown locations.

This type of optimization problem can be represented by a two-dimensional matrix, called "dimension", like is shown in the Figure 3, where A represents the group of societies, M and B the Goal and the attackers (both unknown for the societies) respectively, and the numbers in the dimension represent the experimentation cost for each space. The objective of the Cultural Algorithm is to find the goal in the minimum number of steps while the spaces are sorted where "attacks" can exist, characterized by penalties of anxiety.

The solution to this problem will be given by a sequence of agents' generations, denoted as "community." The agents can only know the adjacent spaces to them, like in the colonies carried out by a society that only knows finite distances. The group of spaces around the agent is denominated "quadrant." From the agent's point of view, this optimization problem is absolutely complex, because we don't know the location of the goal – or if some exists – and it cannot see the world beyond its quadrant. Besides doesn't have any previous heuristic to try to improve the optimization. For better understanding of the selected cultural algorithm used to solve the optimization problem, now we introduce some basic concepts and representations of the artificial culture related to this problem. These representations are abstraction levels located between (the unknown part of the agent), the domain problem (dimension) and the agents.

2.1. Agents

The agents are the actors those that will be able to experience each space in the dimension to what Freud refers as the "principle of satisfaction", according to this, the agent will be able to select the spaces with the lower experimentation cost.

2.2. Paradigm

The paradigm is the agents' personal representation for the space of beliefs (beliefspace) or its personal interpretation of the cultural references. According to Gessler, this is the agent's cognition and its private vision of the cultural interpretation of the World.

2.3. Space of beliefs (Beliefspace)

The space of beliefs is the collective representation of the real World. In other words, this is the world as it is interpreted by one culture of the community, where the agents find the way to interact and moral values.

2.4. Dimension

The dimension is the real world, which never can be entirely known by the agent. This contains the experimentation cost and on which the agents are able to live when the optimization is improved.

2.5. Exploration

The agents belonging to one community search inside the dimension for the most appropriated place to be developed (goal). The obtained solution for the agents whom find the goal in the lesser number of steps could be considered as the community "model", or the best paradigm (BestParadigm). The culture controls the behavior to be adopted as model, creating a strategy of global action –an ideology- regarding the given problem domain. The agent selects the cell with the minimum anxiety, as the indicated for the space of beliefs (Beliefspace) adding to this the cultural value, as:

$$\text{beliefspace}(x) = \text{beliefspace}(x) + \text{dimension}(x)$$

Where x is a set of spaces in the dimension. In this research the functions represent the agent-culture interaction and are selected according the adopted problem.

1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	1	1	1	1	1
1	1	B	3	1	1	1
1	B	B	B	1	1	1
1	B	1	1	1	1	1
1	1	1	2	1	M	1
1	1	A	1	1	1	1

Figure 3. Representation of the Dimension.

3. Cultural Algorithms Simulator

To prove and validate the theoretical concepts previously presented, we develop a Cultural Algorithms Simulator (Baharastar). Initially our intention was only to create an environment able to carry out analysis and experiments. The creation of systems with an individuality or "soul", are our contribution in the area. For such purpose, we select 27 societies described in Memory Alpha [Memory Alpha] and we characterize their behavior using seven base attributes (agility, ability to fight, intelligence, forces, resistance, speed and emotional control), those which allowed describe as well to the society as to the individual.

The development of Baharastar is based on our desire of sharing an intuitive understanding about the treatment for a new class of systems, individuals able to possess unexpected creativity, typical characteristic of living entities. Baharastar is shown in the figure 6, the user has the possibility to choose the starting point and the goal to reach, joined to the places where one can receive an attack by part of the enemy, and the quantity of anxiety associated to each space of the dimension where the societies reside in (agents' communities). Our prototype was developed using JBuilder X platform.

4. Complementary Methodology

Data mining is the search of global patterns and the existent relationships among the data of immense databases, but that are hidden in them inside the vast quantity of information. These relationships represent knowledge of value about the objects that are in the database. This information is not necessarily a faithful copy of the information stored in the databases. Rather, is the information that one can deduce from the database. One of the main problems in data mining is that the number of possible extracted relationships is exponential. Therefore, there are a great variety of machine's learning heuristics that have been proposed for the knowledge discovery in databases.

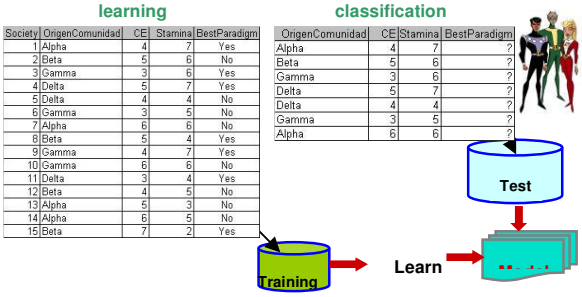

Figure 4. Proposed decision tree, used to characterize the negotiation level inside each community.

One of the most popular approaches to represent the results of data mining is to use decision trees. A decision tree provides a procedure to recognize a given case for a concept. It is a "divide and conquer" strategy for the acquisition of the concept (instance). The decision trees have been useful in a great variety of practical cases in science and engineering, in our case we use data mining to characterize the individuals of each society (agents' community) and to understand how they obtain the best paradigm, like it is shown in figure 4.

5. Experiments

In this section, we describe the developed experiments using Baharastar. We hope to contribute in the sense of making evident the importance of the creation of a new methodology to prove and to analyze the obtained results. This was not a trivial task, considering the diversity of behaviors of the provided solutions by Baharastar because it resembles more than a descriptive anthropology than a simple software test.

In the first experiment, we compared the performance of 27 communities of 50 agents, and on the other hand 27 communities of 500 agents each one. The associated points to the beginning and goal are shown in the figure 5. The optimal number of steps from the beginning to the goal is 12.

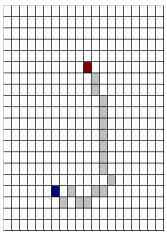

Figure 5. Evaluation of a optimization problem using Baharastar

One of the most interesting characteristics observed in this experiment is the diversity of cultural patterns established for each community. For the solutions with the same number of steps the provided result for the "beliefspace" is entirely different. The structured scenarios associated to the agents cannot be reproduced in general due they belong to a given instant in the time and space. They represent a unique, precise and innovative form of adaptive behavior which solves a computational problem followed by a complex change of relationships. The generated configurations can be metaphorically related to the knowledge of the community behavior regarding to an optimization problem (to make alliances, to defend from a possible invasion), or a tradition with which to emerge from the experience and with which to begin a dynamics of the process. Comparing the 50 agents of the first community regarding the 500 agents community, this last obtained a better performance in terms of the average number of steps from the beginning to the goal (13.05 versus 14.30), as well as a smaller standard deviation (1.96 versus 2.64). They also had a greater average number of changes in the paradigm (5.85 versus 4.25), which indicates that even the "less negotiating" generations, that explored less interesting parts of the dimension, could optimize their search to achieve better results. In the second experiment, we consider the same scenario for the experiment one, except that after having obtained a solution from a community of 50 agents, we place five near spaces to the goal and we begin with a new community of 500 agents. The new community was informed of the previous cultural configurations but should take into account the new scenario. The comparison among both solutions is not immediate, from the point of view that try to solve different problems. Developed Tool in Figure 6.

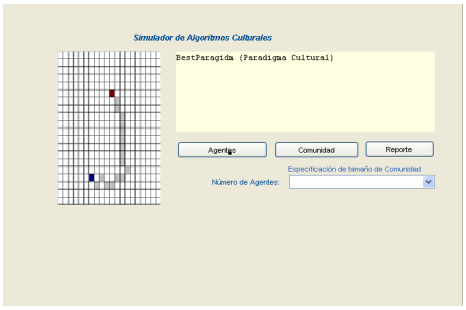

Figure 6. Developed tool called Baharastar.

In this experiment, it was surprising to see initially how the community of 500 agents uses the solution offered by the 50 agents, whenever these solutions were close the optimal grade, instead of finding entirely complete new solutions. These results make evident the conservation of a global action strategy which regulates the agents.

6. Conclusions

Using Data Mining we improve the understanding of change for the best paradigm substantially, because we classify the communities of agents appropriately based on their related attributes approach, this allows us to understand that the "negotiation" concept exists with base on the determination of acceptance function by part of the remaining communities to a particular proposed solution by a community.

Cultural Algorithms offers a powerful alternative for optimization problems. For that reason is that provides a comprehensible panoramic of the cultural phenomenon.

A new Artificial Intelligence that can be in charge of these systems, continues being distant into the horizon, in the same way that we still lack of methods to understand the original and peculiar things of each society.

7. References

Desmond, A. & Moore J. (1995). "Darwin – la vida de un evolucionista atormentado", Generación Editorial, São Paulo, Brazil.

Geertz, C. (1989). "La interpretación de las culturas", Editorial Guanabara, RJ, Brazil.

Gessler, N. (1999). "Artificial Culture – Experimemts in Syntethic Anthropology", http://www.soc.surrey.ac.uk/JASSS/1/1/4.html.

Memory Alpha., Proyecto de Wikipedia relacionado con Star Trek. http://www.**memory**-**alpha**.org/en/wiki/Main.

Ochoa A.et al. (2006) "Italianitá: Discovering a Pygmalion effect on Italian Communities Using Data Mining". In Proceedings of CORE'2006.

Pinker, S. (1999). ¿Cómo funciona nuestra mente?. Compañía de Letras, São Paulo, Brazil.

Reynolds, R. G. (1998). "An Introduction to Cultural Algorithms". Cultural Algorithms Repository, http://www.cs.wayne.edu/~jcc/car.html.