PCL EVOLUTION PROJECT, GATHERING INFORMATION TO IMPROVE TEACHING-LEARNING PROCESSES

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Abstract

Everyone has their own way of learning, understanding concepts and assimilating knowledge. A learning theory try to describe how people and animals learn, helping us to understand the complex process of learning. There exist different theories about learning.

How do we learn? Is the learning style of each individual something stable or changeable along his/her life? Why teachers are unable to achieve their students understand the knowledge they are trying to transmit? These are the questions, amongst others, that make us to think about whether commonly used teaching methods are the most suitable or not.

On the one hand it is necessary and essential a wider knowledge and understanding of each individual learning style. On the other hand, we must consider that the teachers’ teaching style is influenced by their own learning style, whereupon there will be also different teaching styles.

The Preferential Complementary Learning (PCL) is a new style model that facilitates various aspects of teaching-learning processes: the understanding of students’ learning processes, an individualized guide according to their learning profile, and, in general terms, the improvement of teaching-learning processes. The whole group of learning style that compose this new model can be found in the human nature, but only one of them is a preferential one and describes the role developed by the individual when he or she learns.

A very interesting field of research that contributes to the research of both, learning and learning styles is artificial life, a field of study which examines systems related to life, its processes, and its evolution through simulations using computer models, robotics and biochemistry. A cellular automaton is a discrete model studied in computability theory, mathematics, physics, and complexity science, amongst others. This area and model of the artificial intelligence field could be used in the learning field to simulate and study the progress of a student population. This is the main challenge of PCL evolution project.

The aim of PCL evolution project is to study the evolution of a student population with different learning styles. This study is made using artificial intelligence techniques: cellular automata which can develop -using the rules observed- an estimation of what will happen with this population in the future.

This paper exposes the experience acquired in the study of different evolutionary algorithms to be used in the monitoring of a student population according to their learning profiles and the learning methodology used for each group. Besides, shows the different stages of the development process, which includes from planning to development and analysis of information. This work has been developed within the frame of an innovation project for various official degrees from the University of Las Palmas de Gran Canaria.

Keywords: Artificial intelligence, natural computing, evolutionary algorithms, cellular automata, computability theory, learning process, preferential complementary learning, learning processes, learning styles, educating methods.

1. INTRODUCTION

The transmission of scientific and technological knowledge goes beyond the exposition of contents thinking that all the students understand the same way. Each person has his/her own way to learn. We can find a huge amount of literature that deals with learning styles, concerning locations, profiles, context or contents among other parameters.
1.1. Teaching learning processes

The most recent studies have been led to search methodologies focused on learning, in which it is necessary to take into account the student’s personal development according to their preferences and active participation, both individually and in collaboration with others. In this line, this work explores an innovation education project that deals with a new model of learning styles Preferential Complementary Learning, APC, [1] with the aim to investigate how to improve the teaching learning processes.

1.2. Artificial intelligence

Some authors consider the artificial intelligence as the intelligence of the machines. A branch of computer sciences that builds processes which main objective is to maximize a measure. Some textbooks define it as the study and design of intelligent agents [2] [3] where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success [4][5][6]. John McCarthy, who coined the term in 1956 [7], defines it as "the science and engineering of making intelligent machines."

In classical planning problems, the agent can assume that it is the only thing acting on the world and it can be certain what the consequences of its actions may be.[8]

The evolutionary computation is a very interesting branch of this science. It makes use of iterative progress -such as growth or development in a population- to solve problems which defy solution could be inspired by biological mechanisms of evolution.

Evolutionary computation uses iterative progress, such as growth or development in a population. Evolutionary algorithms generally involve techniques implementing mechanisms such as: reproduction, mutation, recombination, natural selection and survival of the fittest [9]. The evolution of the population then takes place after the repeated application of the above mechanisms in the individuals of each generation. A group of entities symbolize the the possible solutions, which live, they combine together and compete with each other, in such a way that those with higher fitness have higher probability of selection.

This type of algorithms provide satisfactory results for different problems, this generality is shown by successes in fields as diverse as physics, chemistry, engineering, biology, economics or marketing among others.

Artificial intelligence is a field that has been used with a pedagogical orientation, from automatic assessments to intelligent tutoring systems, including game based learning [10].

The automatic assessments apart from the tests evaluation can acquire knowledge about the skills and behaviours of the students in the evaluated subject.

The intelligent tutoring systems are software applications which provide direct customized instruction or feedback to students. More specifically expert systems that simulate all the aspects of a human tutor.

Game based learning, through narrative or storylines, games can engage players in learning activities. Children can be motivated by educational video games. They demand a wider range of skills as well as a high tolerance for frustration. They deal with intellectual and expressive motivations, challenge an mastery, experimentation with different identities, expressing creativity, curiosity, discovery and –of course– learning.

2. PREFERENTIAL COMPLEMENTARY LEARNING

The Preferential Complementary Learning [11], [12] can be explained according to the possible roles a person can perform in the professional sphere. To distinguish the learning styles we can use the demand of necessities that the individual expresses in the sense of his discourse, understanding this according to the theory of the sense [13], [14]. We have to take into account that all the styles are possible, but there exists a thematic preference, which is stable and even unconscious, due to the fact that each person chooses from the different possible styles one which he continues improving along his life through culture. A person can act in a determined circumstance following some aspect of the styles proposed, but there is always one which is dominant. None of the styles is superior or inferior to another one. They are different, each of them with its strength and weakness. The human progress or
evolution would be conditioned by the complementarity of the learning styles. All of them contribute from their specialization and improve in their no specialization. When the dominant style reaches a high degree of development then we get the excellence. The aim of education for each individual must be to boost the characteristics of each style, developing to the maximum effect those belonging to his own style, so as to make possible an effective integration in a group in any sphere, particularly the professional.

It can be said that when a person learns he acts developing one of the possible roles:

### 2.1. Field-oriented

He learns by planning the way to follow to get to a new reality. He can be apparently uninhibited until he finds the signals or signs: “what is it for?”, “is it new?”, “is it favourable?” He bases on the common factor, that is to say, on the general sense that the orientation stresses. To identify it he has the ability to interact with the others, he is dynamic. He reflects discovering new realities. He gets ready and turns to the expert to develop the plan. His capacity for memorizing stands out. The links to reality, novelty and usefulness are factors that encourage his interest in information.

### 2.2. Strategist

He learns pursuing the game and studying the behaviour of the players in order to understand their strategy. He can be apparently changeable until he manages to establish the criteria: “what does he do?” “Where does he come from?” He compiles information about the facts. He studies cases and precedents critically. He makes judgements based on internal evidences or external criteria. His photographic memory stands out.

### 2.3. Rationalist

He learns associating what is new with an experience remembered through evolution. He can be apparently still while he expects to find the meaning: “what does it mean?” “what has happened?” He remembers the acquired knowledge, understands the meaning of the information and reasons starting from the cause to the effect. He takes risks. He is interested in experimenting to find the flow, the development, the natural evolution towards the consequence.

### 2.4. Creative

He compares searching resemblances, that is to say, he establishes parallelisms and confirms that there is a common structure. This is the summary. He may be apparently diverging since he consults different sources until he finds the idea: “how is it?”, “what is it similar to?”, “what does it seem?” He bases on the concepts, organizing the information. This action gives him a spatial geometric mental-vision. He studies in depth. He is interested in knowing the bottom, the origin, the source and, from there, he creates new ideas or ramifications. He is autonomous and independent, getting involved until reaching the knowledge searched.

### 2.5. Perfectionist

He compares searching differences (changes), getting a scheduling (calendar, discontinuity) of work to distribute the effort and reach the objective. He can be apparently tireless until he discovers the clues: “what makes it different?”, “does it work correctly?”, “when does it happen?” His visual and auditory perceptions stand out. He compares models, detects the changes focusing on the clues. He improves by making a thorough monitoring of the function. If it is not correct he corrects it.

### 2.6. Constructivist

He compares searching the classification based on the definitions of the forms. He can be apparently rigorous, meticulous, until he manages to discover the features: “what does the definition say?”, “it classifies into.” He bases on the laws, formulae, to establish formal definitions. He analyzes, divides into simpler parts and combines them to get the result. His capacity to perceive the beauty of images stands out. He trains applying the acquired knowledge, laws and rules to practical situations.
2.7. Methodical

He compares searching peculiarities, trying to complete the collection enumerated according to a scale in which each element gives something which did not exist previously. He can be apparently monotonous because he repeats the task until discovering the basic thing: “what is missing?”, “what is necessary?” “what shall I put?” Starting from the basic elements he searches for the guiding thread to advance step by step until obtaining the method. This activity allows him to improve the method, to generalize it. His capacity to detect the extreme cases stands out. He completes, is interested in the balance and to achieve it he detects the lacks, He organizes the work and he commits himself with its realization.

To identify each of these roles it will only take to visualize the profile that the interlocutor presents. A way to do it is by means of measuring instruments which help to determine the learning style of each individual, since being the own subject unconscious of it this cannot help directly. With a questionnaire, the direct observation and active listening it is possible to identify the PCL style of a person. It must be highlighted that it is the person who shows his role and no one must be forced to fulfil a role.

3. PRACTICAL PROPOSAL

This work has been developed as a proposal for using evolutionary computation in students’ populations. It is intended to study these populations through successive generations.

3.1. PCL evolution project. Cellular automaton

3.1.1. Approaches.

This work could be developed under two different approaches:

The coming generation or generational evolution. Consist of the study of each generation interested in the involved subjects. In this case, over the academic years and the learning styles of each generation, the rules and the initial conditions of the grid could be established. Its obvious advantage is that the study becomes more general and broader in scope. Its main disadvantage is that we should wait for a number of academic years to set the rules.

The current generation or lateral evolution. Here the changes within one generation are studied, through lateral or horizontal transfer. This study could be developed evaluating the students’ population of the same generation with regular periodicity. It could be evaluated along one academic course or along a few of them. Its advantage is that, depending on the population, it is possible to study or to observe changes in a short period. Its main disadvantage is that the probability that it could happen is low if we use PCL tests.

3.1.2. Previous study

Before we get started, we made a previous study about some evolutionary algorithms well known in the Artificial Intelligence field.

Conway’s Game of Life

The Game of Life, also known as Life, has been devised by the British mathematician John Horton Conway in 1970.[15]. It is a zero-player game, which evolution is determined by its initial state, requiring no further input. The way of interaction with the Game of Life by creating an initial configuration and observing how it evolves.

In a two-dimensional orthogonal grid of square cells, each of which is in one of two possible states, alive or dead, every cell interacts with its eight neighbours. These are the cells that are horizontally, vertically, or diagonally adjacent located. At each step in time, the following transitions may occur:

Any live cell with fewer than two live neighbours dies, as if caused by under-population.
Any live cell with two or three live neighbours lives on to the next generation.
Any live cell with more than three live neighbours dies, as if by overcrowding.
Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.
The initial pattern constitutes the seed of the system. The first generation is created by applying the above rules simultaneously to every cell—births and deaths occur simultaneously. The rules continue to be applied repeatedly to create further generations.

**Cells program by Peter Donnelly.**

The program "cells" it is in essence a curiosity scientific proposal by Peter Donnelly of the University College of Swansea, and Dominic Welsh, of the University of Oxford. In the article "Five easy pieces" for Scientific American, A.K. Dewdney [16] [17] exposes how it works. It is known as "Voting", since it intends to simulate a political voting system. Features:

The cells are coloured in black or white randomly. Each colour corresponds to the political opinion of the person represented in the cell. One colour would represent the democrat vote and the other one the republican vote.

At each step, it selects randomly one cell and its political opinion change according to this rule: one of its eight neighbours is selected randomly, the political opinion of the cell change to the one of this neighbour, independently of its previous opinion.

Although this model of the political process is quite simple, it shows different behaviors in different stages. We can find large blocks of homogeneous votes. These blocks are geographic locations where there is only one political opinion. At each step these blocks change their political vote and for a while they seem to fight for the predominance. Finally the two-party system disappear since the vote is the same

It is easy to see quasi-biological behaviors. If we observe the evolution of the population as an example of coexistence-competitiveness of two similar species in the same environment with abundance of food, we can have another interpretation:

Each cell represents one specie. At each step, one of the cells of the grid is chosen randomly. That cell die, leaving a free space in the grid, which is immediately occupied as follow: One of its eight adjacent neighbours is chosen to be reproduced and the free space will be occupied with a new cell, a daughter cell, of the same specie.

From this simple behavior we can see how the initial chaos, where cells of both species are mixed, yields in an organization where the cells of the same specie make wide groups that move, stretch, and contract while trying to survive.

**Cellular automaton model of wildfire spread**

Several modelling approaches have been developed to simulate wildfire behaviour ranging in sophistication and representation of the processes controlling wildfire propagation, [18] provides a good review of different options.

Different models use a grid-based fire simulation, they divide a landscape into finite cells, -the grid- and then, considering the state of a cell as uniform, treats spread within and between cells on an individual basis. The rules can use a wide variety of parameters from fuel (its load, type, or moisture), slope of terrain, and wind direction or strength.

Additionally other cellular automata have been reviewed: Langton’s ant [19], wireworld [20], rule 30 [21] or Von Newman Cellular automaton [22]. All of them contribute with information that will help us to develop our PCL cellular automaton.

### 3.2. Stages of the development process

**Planning of educative projects**

The creation of educative multimedia contents implies a structuring of the process [23]. Fig 1. This formal method will define what to do, what resources to use, the estimated schedule, mistakes' correction and revisions. [24].

**Planning**

At this first stage of the process several activities which will start the project are developed.

To determine the objectives, which will be set out according to a subsequent comparison between the model predictions and the reality.
To select the criteria which will define the cellular automaton to be implemented.

To define the functionalities of the cellular automaton.

To plan the work’s coordination according to a schedule. At each of the stages the schedule of meetings, either virtual or on-site, will be fulfilled. These meetings are set out for the exchange of ideas, revisions and the profile of the developing elements as well as for corrections or changes according to the evolution of the project.

Tests

Considering that we will be working with Preferential Complementary Learning, the tests planning, studies of results and groups creation, will be made according this project.

Rules an initial conditions

These two elements will be established according to Preferential Complementary Learning as well.

At this stage, in a second phase, these rules and initial conditions should be checked just to make sure the project is well defined.

Cellular automata tests

This is the stage where the cellular automaton will work to reach the final configuration of the grid.

Results comparison

One of the main elements of this work is the creation of models. Thus, according to the results comparison and the objectives previously stated, it will be considered whether it is a suitable model or not.

There are no doubts about the evolution of populations; however, the mechanisms driving this diversity are an important research issue. The models’ development will help in the study of the factors that lead to these changes.

4. CONTRIBUTIONS AND CONCLUSIONS

The concern to improve the relationship teaching-learning in any field motivates the orientation of research towards the learning styles. It is necessary and essential to take into account the knowledge of each student's way of learning, after verifying the existence of different learning styles, and it also has be taken into account the teaching style of the lecturer, which depends on his way of learning and therefore implies different teaching styles. It is important to consider Felder’s statement [25] when he
says that it makes no sense to apply the same teaching technique to all the students, but it is also desirable to be able to use all the learning styles in a class.

This work shows how to plan a study where artificial intelligence models are used, in particular cellular automata, to establish how the learning styles progresses in different student generations.

4.1.1. Contributions
The main contributions include aspects of both: preferential complementary learning and artificial intelligence.

From the first one:
How to schedule the study of the tests that should make the student to indentify their learning style.
How to set styles from the tests results.
How to perform the decision making regarding the learning methodology to be used.

From the second one:
How, from the styles obtained, the rules (generally, a mathematical function) are fixed. These rules determine the new state of each cell in terms of the current state of the cell and the states of the cells in its neighborhood.
How to establish the initial state of the regular grid of cells.
How to set the automata stop conditions.

From the beginning the main objective has been to see how this work could be developed, since a new line of research is opened up. This will help to evaluate and predict about the learning styles of different student generations. Therefore a new research field, has been introduced. This one will allow to conjecture about the need for new methodologies, new ways of learning or the adjustment of the existing to a new perspective of work.

4.1.2. Elements
Rules
The rules are the foundations of the transition from one generation to another. They should be established with a high precision, since they determine the operation of the implemented cellular automaton. Also the neighborhood selection criteria, which could be from different types, must be done carefully.

The neighbourhood or rules could change over time or space. That is, initially the new state of a cell could be determined by parameters that could be reconsidered with some periodicity.

Proposed system
The teaching work and research line that should be developed with the learning styles and its evolution should be flexible. This way, the work could be adapted to the circumstances and resources of different institutions, students or teachers profiles.

Experiment
For the practical work should be established a new framework, to develop, using the information of the initial tests, a set of transition rules and the initial conditions of the collection of cells. Later, these rules will be applied in this collection of cells -the grid- a number of discrete time steps.

Scientific Models
The element that contains the essence of this work is the creation of scientific models to contrast and compare with the reality. Very important in scientific activities, these models make possible to check the prediction accuracy and possible deviations.

Patterns variability and development contribute with a huge amount of information and, as in other researches using cellular automata, they are a good example of emergence and self-organization in teaching dynamical system.
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REFERENCES


[2] Poole, Mackworth & Goebel 1998, p. 1, which provides the version used in this article. Note that they use the term "computational intelligence" as a synonym for artificial intelligence. http://en.wikipedia.org/wiki/Main_Page


