QUALITATIVE STUDY OF A COMPUTER MODEL IN THE CYBERNETIC FIELD

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Abstract: *The starting point of this study described in this paper is the desire to create a model that will be useful in various fields related to mathematical modeling and that will contain a new perspective of what we call and know about feedback. This feedback has appeared in cyber studies. The modeling of this computer system involves the transfer of information from the data of a problem written in a practical language to the language specific to the feedback contained in cellular automata and algebraic fractals. Both cellular automata and algebraic fractals are fundamental in the development of technical solutions used in the fields related to quantum mechanics. The bases of these researches are from the articles conceived by Prof. Dr. Colceag, in which he mentions information fields, structural fractals, but also about modeling and the models that emerge from this modeling. All this complex modeling structure will describe more complex objects with characteristics such as: feedback cycles, projective relationships in the projective space and specific transformations that describe how this model was obtained, these being common features for everything that means description and modeling the phenomena of physics, chemistry, biology, economy etc. At the beginning, such a model focuses on feedback cycles, and will also develop commutative diagrams based on automorphisms. After this first phase, the model is organized on progressive levels where its structure is divided into new and stable structures that self-determine, this leading to a fractalized modeling in which a feedback structure is inserted in the form of a loop.*

Keywords: *feedback; modeling; cybernetic system; information space; algebraic fractals; cellular automata.*

JEL Classification: *C63; C68; C88; D59; L63.*

1. Introduction

The motivation for carrying out this work is to find a variant of qualitative modeling of a computer system, built on the fractals used to generate feedback. Basically, this system is a feedback loop, based on a mathematical procedure that includes the theory of cellular automata. It is able to offer technical solutions in the development of economic, biological, IT applications, etc.
John von Neumann (1948), present at a conference, Hixon Symposium, introduced the idea of the theory of automata, specifying that it is not a theory, but rather "an imperfect articulated and difficult to formalize" ("The computer and the brain", written in the years 1955-1956, but published after his death). Also, based on implicit

mathematics, both logic and probabilities, there are interesting points of view that lead from discrete to continuous.
Viewed from the informational perspective, a cellular automaton is an abstract object containing two intrinsically linked components, where the first component is represented by architecture, the Universe, seen as a utility function, and the second component is practically represented by a finite automaton, having at each node of the network a copy of it. (Delorme, 1999)
From the research done by Colceag (2001), the theory of cellular automata claims that the Universe is an information and that every structure in the universe is composed of a mini-computer, and these mini-computers induce a universe of information.
He also claims that information has the following characteristics:

- It is considered a computerized unit, capable of connecting information in a predictable way.
- It is essentially a complexity that can reveal different behaviors in a different situation.
- It can connect to other information contained in cellular machines.
- Is able to develop in different stages of complexity.
- It is universal and can characterize any phenomenon (including life).

This property of universality can provide another type of mathematical approach, being able to detect informational connections in different types of structures. This new mathematical approach could be used in complex systems in different fields, such as living structures, economic processes, physics (Colceag, 2001).
To understand how a complex system works, viewed from different perspectives and at different levels of design, a different approach is needed. This approach will be done using structural algebraic properties of space in which different levels of complexity can be created on the same feedback generation system (Colceag, 2004).

2. State of the art

According to the initiator of cybernetics, Norbert Wiener (2019), feedback is an intelligent behavior that can be simulated by machines (robots), but not only, being applicable in various sciences such as engineering, computer science, systems control, neuroscience and many other fields.
Hlaváč (2019) states that the functions that describe the feedback cycles are connected with vectors, in a circuit, and the connection of the structures is at the vertices. By applying the vectors characterized by the functions of the structure, a modeling of the functionality of the structure itself will be obtained. This type of modeling characterizes the function of a global structure, from the same level of perception, but also from the same perspective.
The stages of the decomposed feedback cycles characterize a model of informational interconnection, because this decomposition is a perspective that describes the behavior of a basic mathematical theory, namely a universal projective space. Basically, this design space is universally used, because the relationships

between different objects are universal, and this mathematical perspective describes a basic dialogue for the development of algebraic fractals (Colceag, 2001).
Research by neurologists uses projective space to describe neural networks. This type of modeling provides a good description corresponding to high-precision experimental data. This is why this type of fractal type (algebraic fractal) used in this paper could correspond to a real situation that describes a macro-structure, resulting from neural structures modeled in projective spaces (Colceag, 2001).
There is thus a group of automorphisms of projective space, consisting of a set of equations:
F1 (x) = x;
F2 (x) = 1-x;
F3 (x) = 1 / x;
F4 (x) = 1-1 / x;
F5 (x) = 1/1-x;
F6 (x) = x / x-1
A feedback loop can result from this group of equations (Colceag, 2001).
Grundhöfer, T. and Stroppel, M., (1991) argue in their research that large groups of automorphisms, in the study of geometry, it is often desirable to limit the action of the group to a certain subgeometry.

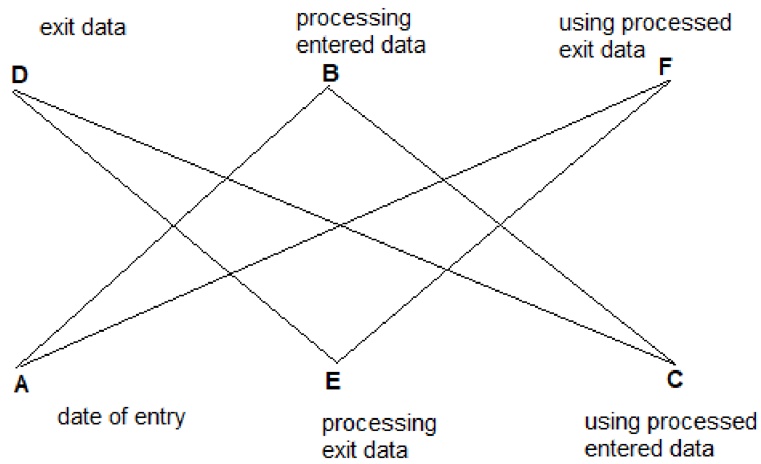

Figure 1: Feedback cycle
Source: Colceag, 2003, Information Fields, Structural Fractals

Colceag (2003) in his research demonstrates that based on the set of equations above, there is an example in which two parallel mirrors will reflect an image to infinity, and the reflections created by them are feedback cycles that will be transformed into new cycles. feedback, but this time of a higher order, being isomorphic with the first subgroup of equations (F2, F3, F6). Thanks to this model, we are subjected to a lesson, namely: a small amount of information can change the balance of information by creating information storms (catastrophe theory). It also gives us an insight into what mobile phones will really mean, given the structure of the dialogues that form feedback cycles.

From Colceag's (2001, 2003) model of feedback cycles and cellular automata formed by such cycles, it appears that the planetary ecosystem has its own intelligence and that these relationships can be described today using computer programs and algebraic fractal theory that describe behavioral feedback cycles.

Various mathematical models have considered the Universe, from different scientific philosophical perspectives, as a logical Fuzzy universe, using a probabilistic structural approach, described by Feinman in its entirety, or a universe that is described by equations, according to Maxwell's elasticity hypothesis. All these perspectives have led to a quantum mechanical universe.

In 1874 Pasteur said: “Life, as is known to us, is a direct result of the asymmetry of the universe or of its indirect consequences. The universe is asymmetric.” The energy of the universe is constant.

The subjectivity of the Universe, vis-à-vis entropy and the relationship with information and irreversibility, are currently viewed from the perspective of a quantum measurement problem. (Bhandari, R., 1976)

Nomura (2011) argues in his research that the entire universe is "a quantum state defined on its cones of light in the past bordered by apparent horizons", based on practical quantum mechanics, which plays a key role in regulating infinity. In this case, the predictions do not depend on how space-time is parameterized, as it should be if we were based on the theory of quantum gravity.

Linde (1990) argues that our essence is a unique and well-known object with a fractal dimension of space in the Universe, being in itself a model of chaotic inflation in the great Universe. This model is essentially a fractal model due to the stochastic branching of the inflation process in time and space.

In Colceag's theories (2001, 2003), it is reported that the relationship between space and time can be characterized by quantum feedback cycles.

If we divide the feedback cycles into factors, we get the description of an information interconnection model, because this perspective describes the behavior of a basic mathematical theory. This mathematical theory contains six functions that represent the subgroup of automorphisms of projective space and can be composed as follows, and can be permuted circularly:

Table 1. Composition of functions (Colceag, 2003)

Func	f1	f2	f3	f4	f5	f6
f1	f1	f2	f3	f4	f5	f6
f2	f2	f1	f4	f3	f6	f5
f3	f3	f5	f1	f6	f2	f4
f4	f4	f6	f2	f5	f1	f3
f5	f5	f3	f6	f1	f4	f2
f6	f6	f4	f5	f2	f3	f1

Source: Florian Colceag, Information Fields, Structural Fractals, 2003

In his research, Colceag, (2003), explains the essence of each function and what each function means, as follows:

- f1 is the identity of the function;
- f2 is symmetry;
- f3 is the inversion;
- f4 is the rotation of 60 degrees;
- f5 is the rotation at 120 degrees;
- f6 is polar;

We can see that any row or column consists of feedback cycles obtained by circular permutations. Due to the fact that the lines are obtained by circular permutations of the first line, it is an implicit argument for rotations in cubic structures (Colceag, 2003).

Looking more closely at these feedback cycles, we can see that there are four categories of cycles with symmetric properties, and in practice, there is a composition table for a new set of functions starting from the next level of complexity of algebraic fractals, identical to composition table for the initial automorphisms in the projective space (Colceag, 2001, 2003)

We can project an approximate picture of the complexity of information, if we observe that in the structures of life, the information contained reveals different components for different objects. From this complexity we can say that the composition of the functions is also differentiated by different components. Hence the belonging of a similar situation that appears in the structure of life, where there is practically an algorithm transmitted as a processed informational message, if it is a complex informational structure. (Colceag, 2001)

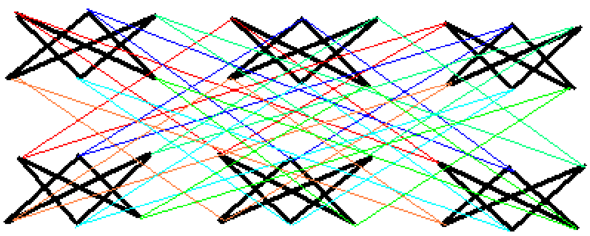

Figure 2: The way information is connected in a feedback cycle
Souce: Colceag, Algebraic Fractals - Fractal Varieties, 2001

Colceag (2001) argues that the new object is built from each generator, from each set that has the same place in the circuit, and the variant obtained by permutation, will give another type of complex cycles, more complex than the first set. This new level of complexity can lead to another given the different connections and sets of phenomena.

Returning to cellular automata based on algebraic fractals, the circulation of information is described by two models:

- Fixed model - described by hypercubic matrices, structures with border at n-1.
- The mobile model - being obtained by combining fixed structures, an example could be the automorphism.

There is a possibility that information can be shared and collected at different points on the faces can be analyzed only with the help of computer simulators (Colceag, 2001).
Cellular automaton models have such high computing power that they can emulate universal Turing machines based on computational theories and complexity. In recent theories, Chua has shown that some of the models of cellular automata are capable of manifesting themselves as Turing machines in universal calculations, studying Wolfram's empirical research. At the same time, Chua introduced a method of generalizing cellular automata through the paradigm of cellular neural networks, which have performance in massive parallel calculations (Chua, 2005).
Also, Colceag (2001, 2003) stated that there is a second possibility in which the input data of the second cycle correspond to another automorphism that uses the output data of the first cycle. In this case, the two automorphisms will be composed of each other. The composition of two cycles belongs to the next fractal level. At this fractal level, information about compound automorphisms will be divided as follows: one part will be used in the metamer of the second, the other part will be eliminated. The deleted information will create a lateral connection starting from the junction of the two metamers, which will be able to develop a new informational structure. These metameric structures, which provide a different composite structure, in which the nerves and inner information contained in two vertebral sections can give external products are derived structures. This pattern can be seen in the membrane structures connected to the DNA structures, the lateral bones connected to the vertebrae, etc. From the perspective of algebraic fractals, both the structure and the information are formed by cycles or feedback circuits that can be composed of each other, giving a visible result in changing the structure.
From this research, Colceag (2001, 2004) states that the information units in cellular automata are adequate, and the concept of feedback cycle and algebraic fractals, combined, in a theoretical approach, provides a feedback cycle that can be characterized mathematically. in different isomorphic ways.
For example, if we characterize a set of six elements as a feedback cycle, in which three elements determine the other three and each other, we say that this set of six elements is a cycle, only if the elements are operated in order to get the neutral group element. The relationship between these types of objects characterizes the grammar of internal connections, and due to the universality property, in feedback cycles, there is a relationship between cycles and circuits (Colceag, 2001).
The example of a group of automorphisms describing the feedback given by sets of four points is studied, so that each automorphism includes such feedback, but expressed analytically. If these rules have universality in their construction, they will normally be found in other different structures, such as biological or social (Colceag, 2001).

Moreover, there is an induction model in finite cellular automata, which contains a selection stage (data entry), a property analysis stage (data entry processing), an information structuring stage (data usage), a data entry stage expression in a formula (output data), an analysis step using the formula (output data processing) and finally a complex structuring step using the previous steps so that there are connections between the steps with the same functionality (Figure 1) . All these connection networks developed using the same algorithms form finite automata capable of describing complexity in algebraic fractals (Colceag, 2001, 2004).
Fractal visualizations in cellular automata are not new: Buckminister Fuller proposed an architecture built with components that can have a recursive or fractal structure. The macro-level structure, the "tensile integrity tensor", is a rigid structure constructed of a tension assembly and a compression element. The compression elements of the solid abutments are insulated from each other, held together by the tension elements. In one of its variants, Fuller noted that in the macro-tensegrity mast, each individual solid abutment could be replaced with a miniaturized version of the macro-tensegrity mast. And then each of the solid miniature abutments can be replaced with a miniature tensegrity mast and so on at the atomic level. Thus, integrity structures may have a fractal substructure (Hameroff, 1978).
From a mathematical point of view, Colceag (2001) argues that algebraic fractals describe the intimate structure of information in a fractal way, and both metal theory and feedback are complementary. The graphical theory of feedback cycles loaded with specific functions presents the same informational reality from a different angle. The greatest benefit of developing this theory could be the possibility of modeling life phenomena, including social phenomena, cellular phenomena, organisms or colonies. Feedback cycles could provide insight into the causes of change, degeneration, or death (Colceag 2001).

3. Conclusions

In conclusion, I specify that the main objective is to achieve a cybernetic model based on fractalization, mathematical modeling and feedback. The creation of this general model is useful in certain processes (economic, IT, etc.), having applicability in different fields.

References

1. Ben-Menahem, A. (n.d.). Abstraction and Unification. Historical Encyclopedia of Natural and Mathematical Sciences, 1733–2800. doi:10.1007/978-3-540-68832-7_7
2. Bhandari, R. (1976). *Entropy, information and Maxwell's demon after quantum mechanics. Pramana, 6(3), 135–45.* doi:10.1007/bf02847122
3. Linde A.D. Particle physics and inflationary cosmology. M., 1990, p. 277.
4. Delorme M. (1999) *An Introduction to Cellular Automata. In: Delorme M., Mazoyer J. (eds) Cellular Automata*. Mathematics and Its Applications, vol 460. Springer, Dordrecht. https://doi.org/10.1007/978-94-015-9153-9_1

5. Florin Colceag, Cellular Automata, Algebraic Fractals, http://austega.com/florin/CellularAutomataAlgebraicFractals.htm, October 2001.
6. Florian Colceag, Modeling and Models, http://austega.com/florin/MODELING%20AND%20MODELS.htm, December 2001,
7. Florian Colceag, Information Fields, Structural Fractals, http://austega.com/florin/INFORMATIONAL%20FIELDS.htm, September 2003
8. Florian Colceag, Universal Language,
9. http://austega.com/florin/univlang/THE%20UNIVERSAL%20LANGUAGE%20-%20engl.html, March 2004
10. Grundhöfer, T., Stroppel, M., *On Restrictions of Automorphism Groups of Compact Projective Planes to Subplanes.* Results. Math. 21, 319–327 (1992), https://doi.org/10.1007/BF03323089

G. Gutowitz, Cellular automata and the sciences of complexity (part I), Complexity 1 (5)

11. J. von Neumann, The general and logical theory of automata, in: L. A. Jeffress (Ed.), Cerebral Mechanisms in Behavior, John Wiley, New York, 1948, pp. 1–41, paper presented at the Hixon Symposium
12. L. Chua, A Nonlinear Dynamics Perspective of Wolfram's New Kind of Science. From Bernoulli Shift to Universal Computation, Inaugural lecture of the international Francqui chair, katholieke Universiteit Leuven (Jun. 2005).
13. Nomura, Y. Physical theories, eternal inflation, and the quantum universe. J. High Energ. Phys. 2011, 63 (2011). https://doi.org/10.1007/JHEP11(2011)063
14. Norbert Wiener, *The Father of Cybernetics*,
15. https://owlcation.com/stem/Norbert-Wiener-Father-of-Cybernetics , last accessed November 2019
16. P. Sarkar, A brief history of cellular automata, ACM Computing Surveys 32 (1) (2000) 80–107, iSSN 0360-0300
17. S. Wolfram, O. Martin, A. Odlyzko, Algebraic properties of cellular automata, Communications in Mathematical Physics 93 (1984) 219–258
18. S. Wolfram, Universality and complexity in cellular automata, Physica D 10 (1984) 1–35
19. Václav Hlaváč, Feedback, Core of Cybernetics, http://people.ciirc.cvut.cz/~hlavac/TeachPresEn/55AutonomRobotics/045FeedbackCyberneticsEn.pdf, October 2019
20. Walter Daniel Hellman, Norbert Wiener And The Growth Of Negative Feedback In Scientific Explanation; With A Proposed Research Program Of "Cybernetic Analysis", https://pdfs.semanticscholar.org/ddfa/5df24a21bff08ac779c1c5209fd54a88bd6b.pdf, September 2019