Participants Papers

LIFE AS QUALE

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ABSTRACT: The developments of relational biology during these last thirty years tend to classify autonomous system such as biological, cognitive or social groups among the living systems which they models as such. This present article tries to understand the nature of life by the transition phase which characterizes the passage from the inanimate world to the organic one. Our proposal is that life belongs to the category of qualia. Consequently, qualia are already obvious at least with the simplest forms of the living world. Furthermore, if life, consciousness and language are emergences of complex entities, life as quale is specifically the self of the cellular organism.

KEY WORDS: category theory, causality, complexity, consciousness, emergence, life, relational biology, synthetic biology, organism, qualia.

SUMMARY: Life and consciousness are certainly the highest complex entities that we know. Knowing the first one can enlighten the second one, because the former may be a metaphor of the later. Two main approaches try to understand the nature and the origin of life. The top-down one aims to create artificial life by simplifying and reprogramming genetically existing cell with very small genomes, whereas the bottom-up procedure tries assemblies of the three modules necessary for the reconstruction of life in vitro, that is containment, metabolism and genetics. This last approach uses materials different from those which constitute life such as we know it, but it could teach us more about life such as it could be.
Relational biology is a theoretical approach of living systems by means of a formalism founded in category theory. Robert Rosen following his mentor Nicholas Rashevsky is situated in this line. According to Rosen, an organism is a natural complex system which realizes a [M, R] system. This one is closed to efficient causality. This theorem is one of the ways to differentiate organisms and mechanisms.
Charles Ehresmann and Jean-Paul Vanbremeersch continue and extend the ideas of Rashevsky and Rosen for the evolutionary systems and propose the theory of *Memory Evolutive System* (MES) in which they assert that the formalism of category theory is the correct framework within which to develop a theory of biology. MES allows them to model emergence through iterative complexification processes from the particles to atoms, which take into account the quantum aspect at the micro level, up to autonomous systems such as biological, cognitive or social systems.
Our aim is to propose a definition of the nature of life, to specify its status with regard to the other emergent phenomena from the complex natural systems. For that purpose, it is necessary to take into account the data from synthetic biology and those from relational biology. The transition phase between the inanimate world and the organic world is an event susceptible to highlights what is specific to life as emergence. For thus, we consider the nonliving state is made of heterogeneous geochemical aggregates (local landscape) in the environment (immediate landscape). The initial processes are channelled and take place in a very narrow window of the space-time due to the characteristics of both landscapes. This scenario points out an intervention of the environment in the advent of the first organism. The local landscape has the potential so that took place an emergence of the organism. Nevertheless, the shift from potentiality to actuality passes throughout an input from the immediate landscape. The transition can be estimated by the commutativity of the new patterns with regard to those of the initial local landscapes. So, the characteristics of the immediate landscape are critical; the bottom-up approach in synthetic biology can be very useful to understand the nature of the input.
The advent of the organism is that of a self. This one can be formalized by the identity arrow in category theory. This morphism suggests that life has the same immaterial nature as the Rosen's functional components. In this way, at the level of the first viable organism, life belongs to the category of qualia. Life as quale is the eminent reason for which organism cannot be reducible to machine, because it is not only closed to efficient cause, as say it the [M, R] system and the MES theory, but it is a unique relation being functionally translated by the causal closure. An individual self such as a human being is a more complex reality. It appeals to consciousness and language, two dimensions which are not

necessary to be alive, but which are to be a human being as a self. In the case of single microorganism, life and the self are equivalent. Qualia are not inevitably related to consciousness.
Research on the nature of life arises questioning in ethics and in philosophy of religions by virtue of the value of human life in our metaphysical views and because of possible technological risks in particular in synthetic biology such as bioerror and bioterror. These concerns stress we are living a very fast moment of cultural evolution which seems uncontrollable. In the same paradigm, relational biology and its structural link with category theory show that we cannot separate science from philosophy. Any approach of nonliving and living matters induces a coextensive metaphysics and even ontology. These emergent ontologies are enrooted in the knowledge of nature, which gives them authority as it is the case for religion. Indeed, the empiric knowledge of nature makes a difference, because it modifies the psyche and leads to a conversion of metaphysical views. Confrontations between the emergent views and the dominant ones are thus inevitable.

Introduction

Living organisms and the human brain have been the highest forms of complexity of matter that we know on Earth presently. At each level is found what we call life and consciousness, respectively, which, when first analyzed, present themselves as emerging properties of respective levels. Although the brain is only the result of the evolution of organisms, they have similarities in that both are networks that generate a second-order reality. Thus, studying one of the levels, while bearing in mind the other, can only be beneficial when life as we know it remains a hapax in our immediate environment. As a result the mind/body problem becomes a viable unique metaphor for the living/nonliving one and brings about the same questioning.

If we take an organism such as a mycoplasma for example, in spite of its relative simplicity, biology is not yet advanced enough to recreate it from non-organic material and even less able to create new living forms. However, current research has made significant progress in genomic engineering to the point of being able to construct chimeras with synthetic genomes. Once we have the ability to create new life forms, this will generate a better understanding of emergence of life, transition from non-organic to organic, and finally, the interaction between information and thermodynamics in the evolution of life.

One of the main difficulties in understanding the origin of life lies in its unique form. Consequently, life as we know it is a powerful attractor that complicates the possibility of thinking differently about life. After all how could we qualify a living entity if it does not fit into our general perception of life? We must think in terms of complexity and compare the dynamics of matter to fully understand the origin of life. Complexity can also have other trajectories besides the one leading to life. This approach could prove useful in exobiology research projects. In researching the nature of life, we are confronted more with a lack of imagination for conceiving differences than with a lack of creativity of matter. In this article our contribution to understanding life revolves around three points: the analytical and synthetic approaches; life defined as qualia; and finally the ethical and philosophical consequences of these research programs.

1. Life: Analytical and synthetic approaches

Understanding the nature of life is based on information taken from both the analytical and synthetic approaches as well as a combination of the two. A procedural example of the first approach is found in the emblematic book of physician Erwin Schrödinger «What is Life?» (1944)[1] in which he identifies several key characteristics of organisms and explains how life is compatible with the laws of physics. Theoretical biologist Robert Rosen wrote «Life Itself» (1991)[2] to help answer the underlying epistemological question posed by Schrödinger, to know the characteristics of a material system that enables us to qualify life. Even in the title this book is representative of the synthetic approach by having no question mark symbolizing the analytical scalpel.

Within the analytical paradigm, there is a consensus between biologists which reveals that the living system is based on protocell properties which are the simplest forms of organisms. As characterized by the integration of three functional systems in one unique structure. We are talking about a container that establishes a boundary between the self and the non-self, or the object identity. Metabolism ensures the self-maintenance and development of the organism by taking nutrients from the environment and releasing waste into it. The energy flow shows that an organism is a thermodynamically open system. The third system is genetic system. The information found in this last blueprint can be altered in a controlled manner making evolution possible.

The three systems are not unique to the organisms themselves and can exist independently of each other in nature. A hurricane or tornado is a good example of metabolism in that the climate system takes energy from the atmospheric masses and/or the from the ocean to maintain itself and move about, then dies down when the source is no longer available. A good metaphor for the genetic system is a musical score with the organism being the music. As suggested by this metaphor activators are needed for the replicating pattern to be interpreted or recopied and modifications can occur during this process. Vesicles and micelles composed of amphiphilic molecules, spontaneously taking shape through self-assembly are examples of containers. Biomembranes also figure into this type of compartment. The three systems demonstrate that the concept of integration is not a truism to the extent that life appears to be a new reality rather than just the simple juxtaposition of three functional systems. From these fundamental concepts, the analytical approach proceeds either in an ascending manner (bottom up) or a descending manner (top down) with specific objectives that are somewhat different. The raw material of the top-down approach is a very simple natural cell such as *Mycoplasma genialium* which is a parasitic bacteria having one of the smallest genomes. The goal of the top-down approach is to simplify existing small organisms to possibly arrive at a minimal genome allowing the organism to ensure its continuation and reproduction[3]. This process helps us to envision the creation of new life forms that are even yet more primitive. The bottom-up approach is enrooted in the logic of prebiotic molecules from where the first organisms originated. The aim of this approach is the construction of a proto-organism from nonliving material through self assembly. The energy necessary for these processes comes from external sources. This approach, as opposed to the first one which supposes to simulate a whole cell, something that is still challenging for biology in the XXI century, is more easily emulated from its initial block and attracts patterns taken from theoretical biology.

The bottom-up approach which offers different theories on the molecular initiators of the living such as the *RNA World* hypothesis, *peptide world*, or even the *lipid world* model was also debated. Each of these theories tends to ascertain the origin of life from one of

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1 Schrödinger, E. (1941), *What Is Life?,* Cambridge, Cambridge University Press.

2 Rosen, R. (1991), *Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life*, New York, Columbia University Press.

3 Hutchison, C. A.; Peterson, S.; Gill, S.; Cline, R.; White, O.; Fraser, C.; Smith, H., and Venter, C. (1999), «Global transposon mutagenesis and a minimal mycoplasma genome», *Science* 286:2165-2169.

the three systems that forms the analytical vision of organisms. The arguments are often opposed «*metabolists*» vs. «*geneticists*». However, it is obvious that metabolism is energy without direction subjected to a futile cycle. On the other hand replication is direction without energy to advance. Simultaneously both approaches create a coevolution with a faster evolution. Other researchers consider the controversial *metabolism vs. genetics* theory to be outdated and that prebiotic chemistry is in need of an innovative approach. The hypothesis of a «primordial compartment», or formation of vesicles, is an alternative that, from the beginning, provides a single location where prebiotic evolution can develop. The bottom-up approach has the advantage of being able to test the possibilities of the prebiotic world in developing other models of proto-organisms[4]. These are used to analyze the transition between the molecular aggregate state and the state of living. Creating a proto-organism where the three subsystems are both functional and integrated will validate the model of the three functional systems as well as define life.

Rosen's approach differs in that it establishes a distinction between simple and complex systems. Unlike simple systems, complex systems are characterized as being structured by causal relations, being generic, non-fragmentable, non-computable and that they are not reduced to the sum of their parts as they are not machines. Simple physical systems are amenable by the Newtonian model whereas complex natural systems are not. Rosen proposes the key concept of «functional component» to specify a complex system. The functional component has no meaning outside of its role in the system and therefore is dependent on the context. Nonetheless, it exists independently of the material elements that make it possible. It is as contextual as it contributes to the context. Consequently it has a self-referential dimension. This, according to Rosen, is the case for metabolism. The functional component he describes exists despite not being material made, which has major philosophical consequences since a complex system is both material and immaterial. In order to establish a model of the relationships within a complex system Rosen developed the *relational systems* theory, a version of the category theory.

At the basic structural level of category theory[5] is a generic idea of mappings which describes how an objet determines another. Morphisms or mappings are typically represented by solid arrow between a source (cause or *domain* of the map) toward the target (effect or *codomain* of the map). Thus, a category is a collection of objects (source and target) and arrows between them forming an oriented graph. There is an internal law to compose two successive arrows f: A B and g: B C in a new one fg: A C; this composition being associative. Furthermore, each object X has an identity arrow id_X: X X. Category theory is useful in biology because it is a mathematical structure with a wide range of applicability at any scale.

Rosen's interest in relational biology is inspired by his mentor Nicholas Rashevsky[6] one of the pioneers of mathematical biology. Rosen proposes the theory of *Metabolism-Repair* [M, R] systems (figure 1) or *Metabolism-Replacement* systems as clarified by Letelier *et al.* (2006)[7] as a model for metabolic networks that make up the foundation

[4] Rasmussen, S.; Chen, L.; Nilsson, M., and Abe, S. (2003), «Bridging Nonliving and Living Matter», *Artificial Life* 9:269-316.

[5] Eilenberg, S., and Mac Lane, S. (1945), «General Theory of Natural Equivalences», *Transactions of the American Mathematical Society* 58(2): 231-94.

[6] Rashevsky, N. (1960), *Mathematical Biophysics: Physico-Mathematical Foundations of Biology*, 3rd ed., vols. 1 and 2, New York: Dover.

[7] Letelier, J.; Soto-Andrade, J.; Abarzua, F. G.; Cornish-Bowden, A., and Cardenas, M. (2006), «Organizational Invariance and Metabolic Closure: Analysis in terms of (M,R) systems», *Journal of Theoretical Biology* 238:949-961.

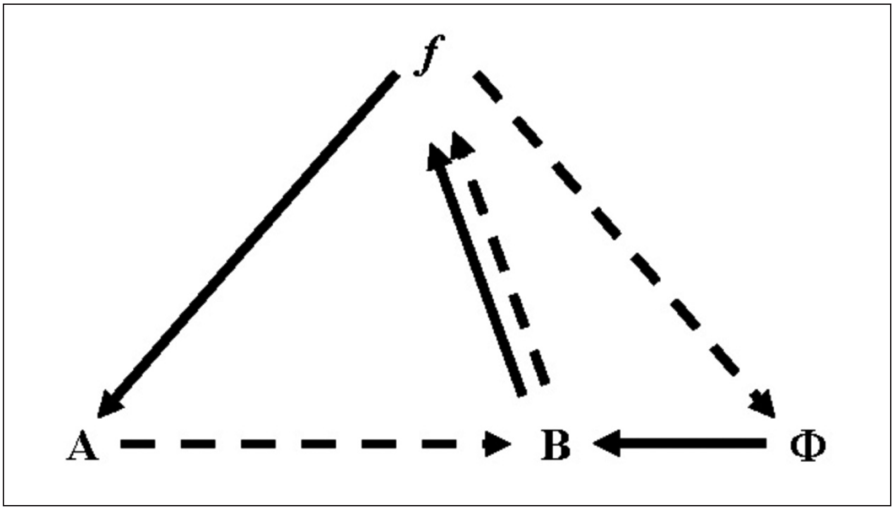

FIGURE 1: Relational diagram of Rosen's explanation of the closure of an [M, R] system. Full arrows represent material causation or chemical transformation. Brocken arrows show efficient causation or catalysis. Metabolism is the set of chemical transformations A B, catalysed by a set of enzymes *f*. Repair (or Replacement) is the resynthesis of a set of catalyst by the Repair system . The entailment is complete from within the organism which distinguishes it from a machine.

of an organism. Organisms are described as being closed to efficient cause, a trait that embodies its autonomy and distinction from a machine. This relational model outlines the operation of an organism independently of its material structure by using two functional components: *Metabolism*, meaning the ensemble of functions that convert inputs into outputs and *Repair* which maintains and rebuilds metabolism. Rosen's [M, R] system is more similar to the *autopoiesis* concept proposed by Maturana and Valera [8] than to Kauffman's [9] *autocatalytic unity* concept which must have a large enough system to reach organizational closure. Another proto-organism model exemplifying the three functional systems of the analytical bottom-up approach is The Chemoton by Tibor Ganti [10]. This model is integrated in a single unit in which the reactional cycles helps to produce the system's enzymes and membrane but differs in that the concept of closure is not present.

The uniqueness of Rosen's approach is that his research is founded in a more generic way than the one of living systems. He presents a peculiar model of closure which is the key to his definition of life that avoids infinite regress. Through the functional component concept, he proves that there is also an immaterial part in an organism, so that it is more than the sum of its parts.

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[8] MATURANA, H., and VARELA, F. (1980), *Autopoiesis and Cognition: the Realization of the Living*, Reidel, Dordrecht.

[9] KAUFFMAN, S. (1993), *The Origins of Order: Self-organization and Selection in Evolution*, Oxford, Oxford University Press.

[10] GANTI, T. (1975), «Organization of Chemical Reactions into Dividing and Metabolizing Units: The Chemotons», *Biosystems* 7:15-21.

Does the brain realise a [M, R] system? Ehresmann and Vambremeersch [11] have developed during the last 25 years the theory of *Memory Evolutive System* (MES) for complex self-organized systems such as bio-sociological or neural systems. In this mathematical theory of biology, based on category theory, the authors extend the ideas of Rashevsky and Rosen. Ehresmann and Vambremeersch argue that causations are intermixed in a dynamic flow in organisms [12] with possibility of anticipation in the same meaning than Rosen [13], whereas they are strictly separated in physical systems, so that organisms are mechanisms only locally and temporally. They developed a theory of internal memory to explain prediction in organism as anticipatory system. Thus, a MES can be qualified as an organism in Rosen's terminology. This relational model incorporates time, functions and intermingled Aristotelian causalities.

Among the structural concepts used in this theory, the «colimit» deals specifically with the neural system. A colimit of a diagram represents the emergence of complex entity resulting from the basis through iterative binding and gluing processes. In the same way complex links between complex objects result from combination of simple links. The complex links represent emergent properties which are at the root of the formation of higher order structures such as higher cognitive processes in neural systems. On the basis of the general model MES, Ehresmann and Vambremeersch develop the *Memory Evolutive Neural System* [14] which is an application for cognitive systems of animals, up to a qualitative theory of mind. This model allows formulating then correlation between a mental state and a brain state, conscious processes and so on. Thus, organism and brain realise equally a [M, R] system. The point is how to distinguish them from a relational biology point of view.

2. Life itself belongs to the category of qualia

When considering the two preceding approaches we understand that the transition phase between the prebiotic and biotic world is definitely what enables the two perspectives to coexist. The transition phase, which is literally the moment of creation, is what the theory of emergence refers to. It exposes the forgotten organizer that is revealed once the organism is completely formed. This phase proposes to be a definition of life itself.

In applying the second causality of the Aristotelian schema Rosen proposes one of the main theorems of his relational biology, being *closed to efficient cause*, in other words, all efficient causes are integrated within hierarchical cycles. Furthermore, as the MES theory highlights, all the Aristotelian causes are intermixed. In this respect, if the possibility of emergence of an organism derives from the potential represented by the geochemical initial state, does this potential be enough?

In a minimalist attempt, the initial state can be represented by a network of molecular concretions more or less disjointed where the geochemical reactions are entailed in futile cycles. These heterogeneous concretions make up the local landscape and the environment (the immediate landscape) is the physicochemical context in which they evolve. The formation of a living system through the transition from the geochemical concretions to

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11 Ehresmann, A. C., and Vanbremeersch, J.-P. (2007), *Memory Evolutive Systems: Hierarchy, Emergence, Cognition*, Amsterdam, Elsevier.

12 Ibid., p. 228.

13 Rosen, R. (1985), *Anticipatory Systems*, Oxford, Pergamon Press.

14 Ehresmann, A. C., and Vanbremeersch, J.-P., *op. cit*., Part C, pp. 287-352.

the proto-organism can be viewed as the modification and stabilization of the initial subsystems in a new state, without which the subsystem will come undone or even disappear. In this scenario, the development of the new pseudo-equilibrium state induces functional and ontic consequences that become the two faces of life.

From a functional viewpoint, the new state does not result in a social group by the advent of a leader who reorganizes and stabilizes the group, establishing it as such because this factor is materially identifiable. For organisms, such a unique organizer does not exist. The local landscape must go through a critical phase before reaching a state where preexisting networks open themselves to new connections resulting in a configuration that is more thermodynamically stable than the initial networks. This new stability helps to avoid regressing back to the initial state unless motivated by an external factor capable of returning the system to the conditions of the critical phase. As it is often indicated, the apparent order that comes from more disorder remains in a pseudo-equilibrium state. Once life appeared, it was not snuffed out by the cataclysms of geologic time. This robustness signifies what a pseudo-equilibrium state is and its necessity for the evolutionary and adaptation process. Within the geochemical aggregates, futile cycles could exist probably due to the non-commutativity of a determined fraction of the networks, so that outputs of critical networks do not reach the state of information. In the same paradigm, robustness could due to emergence of commutativity by the formation of the new networks. So, robustness is possible because of the plasticity of paths which opens the possibility of information. The interaction between information and thermodynamics is a determinant factor in the process of evolution.

The ability to create an organism is inherent to the characteristics of the local landscape and in this sense emergence is possible if it occurs from within the system. On the other hand the transition phase definitely depends on the immediate environment which contributes in reaching the critical phase. An expression used to define the role of the immediate landscape in the creation of an organism is suggested in Jean-Jacques Kupiec's Ontophylogenesis [15] theory that talks about selective constraints exerted on an organism in a Darwinian sense. According to our perspective this contribution can simply be just energy and should be taken rather in a Lamarckian sense. It is not unreasonable to think that more than one kind of organism can be generated along this principle and that subsequently only one perseveres to experience a hierarchical evolution. Throughout the process that leads concretions becoming proto-organisms and modern organisms, we argue that Darwinism and Lamarckism are not necessarily incompatible. Both models play a determinant role in their precise moments.

The advent of organisms happens relatively shortly after the formation of the Earth. Their emergence is likely to be contingent upon a relatively small time frame so that there is a combination between the characteristics of the local landscape and the relevance of the input of the immediate landscape. The process of complexification that leads to the first viable organism is thus channelled and requires this coincidence between the landscapes state. This can be represented graphically in a minimalist way by morphims between and within the landscapes (figure 2). Lacks of any of the determining characteristics in the landscapes would abolish the organism advent.

Having a unique DNA based organism is one of the main difficulties in building a model of the beginning of life. The singularity of organisms, however, is an indication that complexity and uniqueness do coexist. The constraints of complexity are selective

[15] KUPIEC, J.-J. (2009), *The Origin of the Individuals*, Singapore, World Scientific Publishing Company.

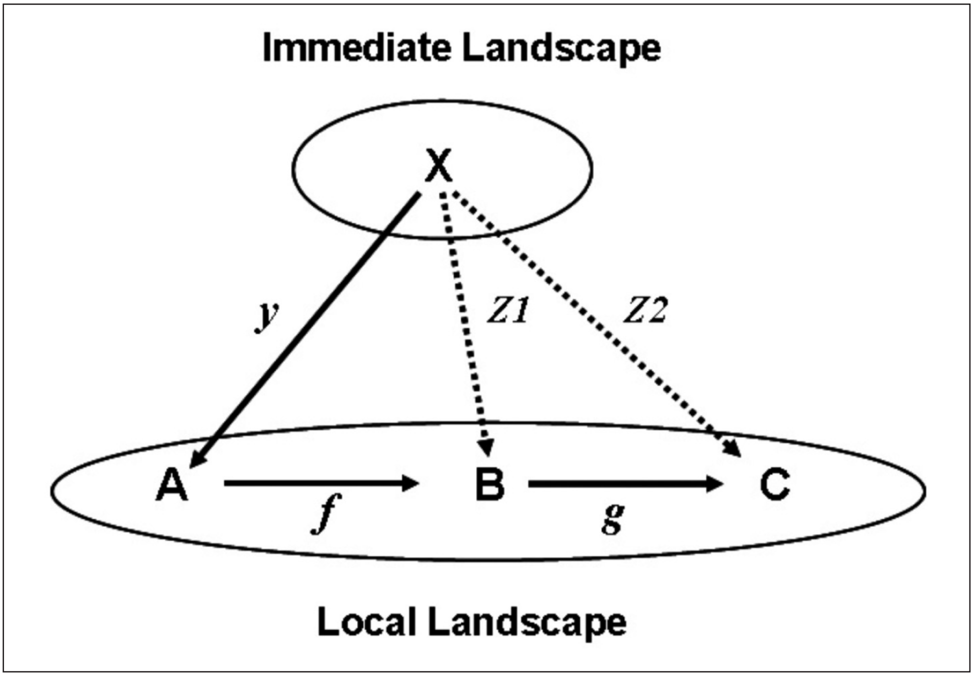

FIGURE 2: Graphical representation of processes leading to the first organism. Full arrows represent the input from the immediate landscape (*y*) and the internal action within the local landscape (*f*, *g*). Combination between the characteristics of the receiving landscape (A) and the relevance of the input of the sending landscape (X) leads to reach a critical state (B) and then a release (C). Brocken arrows describe the direct (*Z1*) or indirect (*Z2*) effects of the external input on the receiver. Changes occur in (X) are not considered.

enough to end up creating equality between life as we know it and life as it could be in the context of a complex earthly being. The stable state exhibited by the organism has the same value as the Rosen's functional component and does not result from particular factors inherent to the organism. The stabilizer or organizer of the whole is materially forgotten even if it contributes to the organism state. Organisms have thus non material elements.

Even though already proven to build relationships between objects in the same category, specifically in the development of the MES for evolutionary system, category theory resources remain underutilized. New developments [16] enable to establish direct relationships between objects of different categories through heteromorphisms or chimera morphisms [17] as part of the adjoint functors theory. The principle of functoriality allows for passage from one place to another, to transfer properties and data to each other especially when

[16] ELLERMAN, D. (2006), «A Theory of Adjoint Functors with some Thoughts on their Philosophical Significance», *What is Category Theory?*, Edited by G. Sica, Polimetrica, Milan, 127-183; ELLERMAN, D. (2007), «Adjoints and Emergence: Applications of a New Theory of Adjoint Functors», *Axiomathes* 17:19-39.

[17] Morphisms that are internal to a category and are between the objects of the same category are homomorphisms. Heteromorphisms or chimera morphisms are direct relationships between objects of different categories.

either one shows qualitative and quantitative differences. The ability to bring together different types of properties such as matter and energy balances, thermodynamic and mechanical properties, electric and magnetic fields, etc, is the interesting part of this principle. It is comparable to the analogy method, but contrarily, universalizes a proposition by transferring the whole data from one category to another. This is in contrast to the analogy method where data is lost during this transfer. As for the concept of adjunction, its goal is successful communication in the exchange protocol. Graphically, it is formed with two arrows, one in each direction linking the objects in each respective category. With the aid of adequate chimera functors, these resources let us envision a model used for testing the proposition of the emergence of organisms in the local landscape *via* inputs of the immediate environment. The transformations that take place inside the local landscape correspond in this case to a more complex category than the original.

At the ontic level, it is almost redundant to say that the emergence of organisms is the emergence of self, existing simultaneously with the entangled network of the local landscapes. So being is being locally. From the point of view of the category theory, this new object in nature is comparable to the identity arrow. The diagram shows that the domain and the codomain of the morphism merge together or the initial object is also the final object. Self inference or self morphism is the closure that Rosen's *closed to efficient cause* suggests, meaning that all efficient causes are functionally entailed inside the system.

An organism, although being an object formally remains an ensemble of intricate sub-objects. As a result there are several possible automorphisms that represent as many points of view as we have on objects, but the identity arrow is the only relationship between the object and itself and whatever defines it. The uniqueness of this relationship means that its interruption or decomposition will signify a loss of coherence and the object's identity. The organism as a persistent object addresses another angle on the robustness of the identity relationship that is functionally demonstrated by the pseudo-equilibrium. A function (mapping) can be simulated if it can be defined by an algorithm of finite length and consequently, the corresponding Turing machine will stop after a finite number of steps. For Rosen an organism that goes through a *Metabolism-Replacement* system can not be simulated because impredicative systems are not Turing-computable. Establishing an equivalence between being non computable and the inability to create artificial life makes Rosen's theorem controversial [18].

He does, however, point out the difference between the [M, R] system and life, the first not being necessarily sufficient to realize the second [19]. The same can be said for the process of autopoiesis being that life does not reduce itself to being autonomous. In his emblematic book Rosen does not explicitly say that the creation of artificial life is impossible but rather that the emulation of a closed to efficient cause model was impossible. He also establishes a distinction between models and simulations stating that while models preserve the relationships in the system simulation adds causal factors from the outside to the model that make it a machine. On the other hand, it is possible to simulate the sub-categories of a system. As a result, a computational simulation of an organism can not serve as an adequate metaphor for life. Whether model or simulation,

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[18] CHU, D., and HO, W. K. (2006), «A Category Theoretical Argument against the Possibility of Artificial Life: Robert Rosen's Central Proof Revisited», *Artificial Life* 12:1-18; CHEMERO, A., and TURVEY, M. T. (2007), «Autonomy and Hypersets», *BioSystems* 91:320-330; MOSSIO, M.; LONGO, G., and STEWART, J. (2009), «An Expression of Closure to Efficient Causation in terms of l-calculus», *J. Theor. Biol*. 257:489-498.

[19] ROSEN, R. (2000), *Essays on Life Itself*, New York, Cambridge University Press.

Rosen's proposition is still relevant as it precisely aims at the uniqueness that symbolizes the identity arrow. This uniqueness, having a transcendental dimension is always a hapax; this is also the reason it is universal. That way it is algorithmically incompressible. The shortest algorithm of relationships is the relationship itself. It is impossible to break down the identity relationship in order to create an algorithm without losing the object as a self. It is impossible to talk about the unique character of organisms without redundancy. Thus, an organism is a living system defined by both a functional and ontic aspect that is the two inseparably linked faces of the same thing. Life itself, however, is described as quale. Other than the way that the MES model qualifies living the question asked is whether life defined as such is immanent to other entities such as consciousness, language, or society. From our perspective, we agree with the MES analysis but it appears that life in itself is part of the cell. The other emergent realities intensify and actualise this peculiar quale. Throughout the course of the evolution of matter, beginning with complexity as is the cases with certain natural systems, quanta generate qualia, or at least qualia appear to be the entangled relationship of quanta. In this paradigm and concerning the first organism, life is the self as a quale or the self is a quale *as* life. According to this proposal, qualia as qualitative realities are as old as the first organism and therefore are not strictly related to consciousness.

3. Research on life: Ethical and philosophical consequences

Both the bottom-up and top-down approaches in synthetic biology share a common goal of the knowledge of life. The first is concerned with rewriting the genome. Recent advancements in this area show that the «word processing program» used for creating from initial *biotext* works [20]. The second approach promotes simple assemblies including those from different material than what constitutes living things as we know it. This approach certainly can teach us much more about life than a replication of the initial model. Whatever it is, knowledge changes the psyche and these experiments that seem far from the daily preoccupations of the general public can have unexpected impacts, not only on the economy and ecology, but also on our representation of reality.

All technological advancements come with both advantages and risks and are validated if the outcome is advantageous and the risks can be overcome. Let's be positive, or even better, let's be realistic! The inherent need to know and create through the simulation of natural systems and innovation is an explicitly human characteristic. This trend has been present throughout history starting with *Homo erectus* with the need to explore new horizons. Furthermore it is impossible to not be human, in other words, it is impossible not to pursue this incessant quest for knowledge of the unknown. Based on this realistic perspective rather than questioning again the research on living systems, it would be preferable to perfect a protocol or find an international consensus so that the technological advancements would benefit the human community and the planetary homeostasis. We have, after all, a lot of challenges to overcome throughout the century whether they are related to energy, our health, our diet, or are ecological. All these challenges are interlinked. For example, to know how to create anticipatory systems would be of great value in technological applications. Consequently all the good ideas and technological advancements are welcome. So what?

[20] Gibson, D., *et al.* (2010), «Creation of a Bacterial Cell Controlled by a Chemically Synthesized Genome», 20 May; 10.1126/*science*.1190719.

The problem is that the research on life is linked to the question of meaning and generates conflicts between dominant metaphysical views and those that are still emerging. There still exists a consensus around a certain sacred aspect of life in the West that is linked to the Judeo-Christian representation. Furthermore, the acts of modifying organisms or attempting to recreate life or other types of life leads to a sort of impoverishment of life value with respect to the idealistic envision. Nevertheless, the taboo around life is ambiguous since progress on animal biology; plant biology and microbiology suppose until now an analytical approach of the respective organism.

The relational biology approach in particular, and the category theory potential in general are in the midst of opening new horizons in the understanding of living systems such as the organism, social groups, language, and consciousness. This knowledge has philosophical consequences of first order. The synthetic approach shows that it is impossible to separate science from philosophy. Any epistemology that succeeds in reaching the real world generates knowledge and coextensively, a philosophy, and even an ontology. The ontological potential is actualized by a combination of morphisms. An object can be created through many paths. It is essentially a process and the world is the where it takes place. The concept of substance is not necessary in the category theory.

The category approach generates thus coherent and emerging metaphysics. The problem that arises when coherent metaphysics get together is an unavoidable confrontation. Nevertheless, the confrontation between the bottom-up approaches envisions and the Judeo-Christians one happens as a misunderstanding because they do not share the same objective. They do not share a true interface so that the encounter really took place.

The misunderstanding reveals the pragmatic character of the contemporary psyche and how it values the world as the place where objects appear. Generally, the Judeo-Christian representations do not see the world with the same nobleness. Furthermore, it is often said that empirical knowledge of the world is not the expertise of religion, nor its objective. This is no longer bearable. Any model of a global representation should have an empirical knowledge of the world because of the historical nature of a model, and because this knowledge makes a difference since it modifies the psyche.

Considering the world as we know it generates a natural interface where one can discuss questions pertaining to the two representations. For example, today what is the meaning of the sacred character of life? How do the top-down and bottom-up approaches contribute in revealing this reality? How can we view life as an object of the world, a quale and a gift? Can the identity arrow prove to be an adequate way to analyse the concepts of transcendence and immanence? Can the category theory be able to propose a new formulation of the Trinity concept since this very fundamental notion in Christian philosophy remains a piece of celestial arithmetic formulated in a time and within concepts that have nothing to do with the contemporary psyche? There is definitely a lot to gain from a real interface between elements of Judeo-Christian metaphysics and those of the category theory one.

In conclusion, living systems are complex natural systems. Intensive research is carried out to better understand what life is, not only as we perceive it but also as it could be. The synthetic biology tries to reconstruct life as an intricate system of three basic elements, a container, a metabolism and a genetic system. Robert Rosen's relational biology points out the key characteristic of organisms as in being closed to efficient cause. Our position is enrooted in both relational and synthetic approaches and argues that the emergence of organism is the advent of a self, and this last entity has functional and ontic sides, in which life itself is a quale. Thus, the very identity of organism is immaterial. The first viable organism is a very special object emerged from inanimate matter. This is not the case of brain which is made of neurons networks or social groups made of entities with intentionality. These different systems are living but not in the same way. Research on life and consciousness has ethical and philosophical concerns and generates coextensive metaphysics. Once more, science and philosophy cannot be separated. Inevitable misunderstandings would occur between metaphysics resulting from science and those which are not.

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