Can IT Support a Structural-Phenomenology Based on Category Theory?

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Abstract

In 2000 Mihai Drăgănescu published the work *Categories and Functors for the Structural-Phenomenologial Modeling* in which the idea of using category theory to address the limit problems of knowledge is developed in the form of an envelope theory. Thus is defined a mathematical structural-phenomenological theory of categories. In this paper we try to take the first steps towards a detailed theory. A first step involves considering categories defined as artificial neural networks, and a second step is based on a hybrid approach that brings circuits and living entities to the same silicon die.

Keywords: structural-phenomenology, category theory, deep neural networks, nonlinearity, non-formal.

Phenomenology, as the study of phenomena as they appear, is a philosophical approach instantiated in a number of versions equal with its promoters. In this situation, the way in which Mihai Drăgănescu uses the concept of phenomenology has a specificity that we have to mark in order to be able to define what is structural-phenomenology that he proposes. We do this not because his vision is very distinct from the ideas shared by the promoters of various phenomenologies, but because the specificity of Drăgănescu's approach will help us understand to what extent the structural-phenomenological knowledge he proposes is possible supported by the theory of categories practiced supported by information technologies. At the same time, further elaboration is needed due to the way in which mathematics, as a tool, and science as a rigorous mechanism of knowledge are exercised in long-term practice with a formal rigor that imposes increasingly embarrassing limits for a deep understanding of existential phenomena. Can the reductionist mechanisms underlying scientific knowledge be complemented by processes that allow access to the complexities that reductionism hides? Mihai Drăgănescu believed that yes, and offered, in the form of an envelope-type theory, the structural-phenomenology supported by the theory of categories. Can we go from an "envelope theory" to an "detailed theory" with the help of information technologies (IT)? We will try to answer this question in the following.

Formal-structural approach

The involvement of various formalisms in knowledge is a complex process that takes place in modernity. It begins, at the end of the Renaissance, with a slow process of detachment from the incidence of various esotericisms, and takes place through a slow transition in the Baroque period between 1600, the year of the burning of Giordano Bruno, for his attempt to bring Christianity closer of esotericism, magic, hermeticism, or astrology, and 1750, the year of Johan Sebastian Bach's death from a failed surgery. The dis-enchantment of the mechanisms of knowledge occurs through a transition characterized by spectacular hesitations. We mention in this sense the alchemical manuscripts of Isaac Newton which attest to esoteric reminiscences in the Newtonian mentality [Verle '93]. But also the exaggerated attraction to the fascination that forms exert that Johannes Kepler had when he proposed a model of the solar system based on the perfect bodies that Plato proposes in his *Timaeus* as elementary structures. Newton reluctantly detaches himself from the fascination of magic, and Kepler indiscriminately embraces the promise of the world of forms.

The process by which formal-structural knowledge was imposed was driven by the formation of scientific communities in which communication becomes one of the strongest mechanisms for increasing knowledge. The knowledge was organized in forms and structures that allowed the condensed representation of the empirically investigated reality. Kepler formulates the laws of planetary orbits based on detailed measurements made by Tycho Brahe. Brahe's tables could be condensed into formulas describing ellipses. Thus, science highlights the structures it represents using mathematical formalisms.

The success of the dis-enchantmented knowledge, caught in mathematical forms describing structures, has been so great that in about two centuries it has reached the limits from which this way requires major reconsiderations. How can we consider, as a source of knowledge, non-repetitive processes for which the Popperian principle of validation/invalidation cannot be applied? In this sense, since the first half of the twentieth century we have been warned by a Nobel Prize-winning physician about the relationship between complexity and reductionist formal-structuralism:

> *"Our mind is so constructed as to delight in contemplating simple facts. We feel a kind of repugnance in attacking such a complex problem as that of the constitution of living beings and of man. ... Geometry does not exist in the earthly world. It has originated in ourselves."* [Carrel '39]

The uniqueness as a source of structural-formal knowledge is impossible to grasp in the process of conventional knowledge. Often, the human ability to reveal a pattern in a data complex is limited, depriving us of the ability to identify a structure that we can capture in a form.

Phenomenon

We can try to define, following Drăgănescu's approach, phenomenology and the phenomenon in opposition to structuralism and structure, even if this opposition is not absolute. We

are encouraged in this sense by the Kantian distinction between the *object itself* and the *phenomenon*, the distinction which stands at the basis of an evolution which, at the beginning of the twentieth century, crystallized in Saussurean structuralism and Husserlian phenomenology. Between 1900 and 1913, Edmund Husserl published the founding texts of his phenomenology. In the same time de Saussure taught structural linguistics at the University of Geneva.

In the last quarter of the twentieth century, after contributions starting from the philosophy of Martin Heidegger and reaching as far as Francisco Valera's neurophenomenology, without ignoring precursors such as Kant and Hegel, Husserl's phenomenological approach imposes itself as a style of thinking that transcends the limits of the philosophical, just as the structural approach has transcended the limits of linguistics.

If structural thinking reduces the complexity oby providing "third-person" knowledge, phenomenological thinking, which tries to retain all the complexity of the cognitive interaction which it focuses on an experience, is lived in the "person first".

The elements of a system are no longer considered reductionistic, for the simple reason that the whole is not decomposed into elements, he is mentained as a totality that the intuition considers it as a "raw material" subject to the conscious approach.

Evidence, and not the truth is the product of the phenomenological approach. Truth is associated with formal-structured systems of axiomatic theories. Phenomenological objectivity is embodied in the evidence that emerges only in a process in which no form of structural reductionism cannot be accepted. The evidence is a "fragile" manifestation that the "brutality" of a formal approach destroys. Evidence versus truth: it is the most succinct way in which the phenomenology and structuralism can be demarcated. Between them we can highlight an opposition, but also a complementarity. It is a problem of intentionality, which arises in the face of the complexity of the process of knowledge. Drăgănescu believes that existence is a phenomenon and structure an useful representation. We practice the conscious confrontation with existence mainly phenomenologically "in the first person" or structurally "in the third person". Is there a "second person" approach? We ask ourselves if a "dialogical" path is possible, a path on which interaction, direct or mediated by a (intelligent) computer tool, with the reality subject to knowledge is possible and superiorly useful.

Structural-fenomenology

It is no coincidence that the twentieth century begins under the auspices of three challenges whose synchronization brings us to the end of the same century in the face of a fundamental stalemate: a useful *distinction*, between structural and phenomenological, degenerates in a blocking *disjunction*.

The first challenge : David Hilbert holds in Paris, at the International Congress of Mathematicians in 1900, the famous conference [Hilbert '00] in which the problem of decision was implicit in the way Problem 10 is stated, thus referring to an obsessive, seemingly legitimate, aspiration: finding an algorithmic procedure for deciding the truth of correctly formulated mathematical sentences. Structural mentality receives a decisive

blow by proving that the problem of decision has no solution [Gödel '31], a blow that will be surprisingly successful by substantiating science and information technology.

The Second Challenge : Max Planck announced in 1900 the famous equation by which he introduced the concept of quantum energy. From this moment on, the continuous processes in physics are accompanied, even dominated, by discontinuous processes. Planck later acknowledges that the introduction of the energy quantum was perceived by himself as a desperate act of abandoning classical physics, an act imposed by experimental evidence.

The Third Challenge : In 1900 Sigmund Freud published *Interpreting Dreams*. Man ceases to be exclusively a conscious being, who can share with others his whole mental experience. The revelation of the beyond of consciousness in the human mind has opened new avenues for understanding what man and existence might be. The multiplicity of states of consciousness, as an experimental fact, provided the context of much enriched approaches to man's relationship with existence.

These three events, produced in completely distinct fields, will have consequences that will converge, in the second half of the twentieth century, on fundamental reconsiderations, still in the process of assimilation. What could be the way forward to unify the dispersing views imposed by the three challenges? The following paths are possible in this context:

- Accepting some limits as fundamental from the point of view of approaching the rigorous formal-structural sciences
- Trying to develop a theory of everything that unifies areas that are currently addressed separately
- Clumsy attempts to formalize areas that cannot be and do not deserve to be formalized (for example: mathematical poetics).

In this conditions, the answer given by Mihai Drăgănescu was: the ***structural-phenomenological approach***, a method of investigation that can take into account both the aspects that can be reduced to formalizable structures, and aspects of reality that maintain their character as a phenomenon due to the fact that submission to any reductionist attempt affects their essence. In other words, structural-phenomenology presupposes an approach through which we manage to involve in the process of knowing formal entities with non-formal entities.

Mixing non-formal with formal entities

Information technology (IT) allows, in the current stage of development, the definition and realization of devices in which the formal and the non-formal can interact. We will consider only two examples. Both are related to the use of artificial neural networks (NNs).

Non-formalizable "patterns"

The phrase "non-formalizable patterns" sounds somewhat oxymoronic. Not in the case of the very subtle effects of using well-trained NNs. In addition to identifying patterns that are accessible to the human mind, an NN can also take into account subtle patterns that escape the ability with which even the experienced investigator reveals regularities in the training data used to train an NN. These are subtle regularities that escape our formalizing ability, which is why we can consider them "informalizable" and qualified as informal. The way in which the result of training an NN is presented, a lot of matrices of numbers (weights), has a complexity that hides the pattern identified by training, informalizable included.

We thus have a first way in which the Deep Convolutional Neural Network (DCNN) technology allows a mixture of the formal approach with the non-formal one. It should be noted that this mixing is only possible at the level of a technical object. The human mind intervenes only in the design of this process and in its running. It is a form of mixing that takes place in an experiment coordinated by the human mind by selecting the appropriate training data. We can speak of a form of *exteriorization*, in the sense of André Leroi-Gourhan [Leroi-Gourhan '64-65], in a technical object of man's ability to identify patterns.

This first step can take into account manifestations of the real that is approaching the non-formalizable phenomenality. Consequently, we can hope for a structural-phenomenological technology that could emerge in this way.

The special ability that DCNNs have comes from the nonlinear nature of the activating function of neurons. The nonlinearity of these functions (Sigmoid, ReLU, Tanh, ...) is what brings the NN behavior closer to reality which, before being purely phenomenological, is nonlinear. We can take a step forward if we manage to replace non-linear functions with non-formal ones.

Live neurons & silicon chips

If the nonlinearity of NN activation functions brings us closer to non-formal behaviors, from the use of non-formal activation functions we expect the emergence of a phenomenologically induced behavior. Such an approach already exists in the attention of start-up researchers who promote AI-based products enhanced with integrating living cells on silicon dies [Koetsier '20].

Cortical Labs team leader Hon Weng Chong said *"we've taken live neurons that we've extracted from mice embryos or we've differentiated them from stem cells and grown neural networks on the actual chip surface"* [Koetsier '20]. From the same paper we learn that:

> *"...it's all about creating computer system that learn — and that learn faster with less training data. That requires a different approach than standard Intel, Nvidia, or AMD chips ... Cortical Labs hope is that biologically-enhanced AI systems would be able to learn complex actions as well: manufacturing, driving, building, cleaning, and so on. And that the biological chips will learn faster."*

Combining on the surface of silicon circuit structures and living components, a device is obtained that has structural-phenomenological behaviors that reach complexities that circuit structures cannot have. The limitations of the structural-structural are thus transcended by the contribution of the non-formal phenomenology of the living components.

Permissiveness of the category to the non-formal

For the study of phenomena related to consciousness, M. Drăgănescu proposes in [Drăgănescu '00] the use of category theory, motivating this option through the permissiveness that this approach has towards the manipulation of objects that exceed the complexity of the formal-structural ones.

> *"Because in the definition of a category, it is not required that its objects should be sets with elements [Bucur '68], that is usual mathematical objects, a category with its objects being phenomenological senses is called phenomenological category."* [Drăgănescu '00]

At the same time, M. Drăgănescu talks about the possibility of extending phenomenological objects beyond phenomenological meanings (phenomenological information):

> *"When the theory of categories is used for physical theories and especially for the structural-phenomenological realms of reality, it has to be adapted to these."* [Drăgănescu '00]

We believe that we can adapt the phenomenological objects associated with a phenomenological category using the openings offered by IT.

NN-based phenomenological category

The connection that M. D. makes between the theory of automata and the theory of categories will allow us to offer technological support to some phenomenological categories. We quote from the same paper:

> *"A neurobiological structure may be a category of neuronal automata, and in general categories of automata are also to be considered. An automaton may be considered as a category, of which objects are its states. Each state is a structure, a set, and the morphisms between the objects are therefore also functions (from a functional point of view, relations and functions among sets were named formal functions [Bucur '68]). A category of automata is then a category of categories. Each object is a category with an automaton with many states that are the objects of this automaton."*

If we consider a Recurrent NN a generalized form of automaton, then its description will be able to benefit from the integration of a model based on category theory. Thus, even a

conventional NN will be able to provide access to aspects that we have considered phenomenological by opening to aspects that explicit formal-structural approaches cannot achieve. It is a first step that allows the consideration of some phenomenological categories useful for the structural-phenomenological investigation.

Integration of non-formal complexity

A major step will be possible by considering some hybrid structures: integration on silicon of digital circuits with living neurons. It results, in this case, devices whose representation and theoretical manipulation will fall exclusively in charge of approaches based on the theory of categories.

When we facilitate the interaction between circuit structures and living structures, we can also expect behaviors that we can determine from the reductionist perspective of some strictly formal-structural theories. We are not sure that we will get effects that we can capitalize on in useful products. But we must hope that the living involved opens the way to behaviors beyond what the logos can trigger. We will be able to arouse creative processes or, moreover, ethical attitudes.

It should be noted, however, that we are limiting the discussion for the time being to the unconscious living involved in a hybrid device. As the complexity of the living components involved increases, additional problems of opportunity will arise.

Concluding remarks

We conclude that there is a real chance to formulate and develop "detailed theories" to approach knowledge from a structural-phenomenological perspective formulated as an "envelope theory" by Mihai Drăgănescu in 2000. The first steps are outlined in the form:

1. consideration of (recurrent) integrated NNs as complex sets of categories
2. hybrid implementation of NNs using living parts

In the first case, the non-linearity of NN activation functions allows access to patterns that the human mind cannot reveal using its formal abilities. We could talk about hidden forms, but we prefer to consider the knowledge we access in this way as informal. This is a first step towards a structural-phenomenological approach.

In the second case, hybrid devices – circuits & mouse neurons – are used to train, faster and with less training data, NN to perform functions with increased complexity. The activation function is upgraded from non-linear (characteristic of real physical structures) to non-formal (characteristic of real life). One can thus obtain, perhaps, a research environment in which the structural-phenomenological approach supported by the mathematics of category theory to allow overcoming the limits that knowledge has today.

In M. Drăgănescu's vision structural-phenomenology supported by category theory is established as a tool of knowledge usable in solving problems raised by understanding what

consciousness is. In this context, we mention that many authorized voices consider the development of a theory of everything, which unifies the theory of gravity with the quantum one, will not be possible until a theory of consciousness is accepted by the scientific community.

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