

Article

## Information: A Personal Synthesis

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**Abstract:** This article is an attempt to capture, in a reasonable space, some of the major developments and currents of thought in information theory and the relations between them. I have particularly tried to include *changes* in the views of key authors in the field. The domains addressed range from mathematical-categorical, philosophical and computational approaches to systems, causal-compositional, biological and religious approaches and messaging theory. I have related key concepts in each domain to my non-standard extension of logic to real processes that I call Logic in Reality (LIR). The result is not another attempt at a General Theory of Information such as that of Burgin, or a Unified Theory of Information like that of Hofkirchner. It is not a compendium of papers presented at a conference, more or less unified around a particular theme. It is rather a highly personal, limited synthesis which nonetheless may facilitate comparison of insights, including contradictory ones, from different lines of inquiry. As such, it may be an example of the concept proposed by Marijuan, still little developed, of the recombination of knowledge. Like the best of the work to which it refers, the finality of this synthesis is the possible contribution that an improved understanding of the nature and dynamics of information may make to the ethical development of the information society.

**Keywords:** contradiction; diversity; dynamics; interaction; logic; philosophy; system; unity

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### 1. Introduction

#### 1.1. From Elephant to Cell

For some time, the Eastern fable of the blind men and the elephant has been used as a colorful metaphor for the different ways in which the nature and properties of information appear to different

people and are interpreted. Mark Burgin, in retelling this fable, also provides detailed references to the many interpretations of what information “is” that had been made up to publication in 2010 of his authoritative compendium *Theory of Information. Fundamentality, Diversity and Unification* [1]. The disadvantage of the elephant metaphor is that it focuses attention on the external forms of the animal on the one hand, and on the other leaves us with a number of independent views, leading to total disagreement about what the “animal” might (or might not) be. Yixin Zhong [2] has used the fable in another way, by looking at the content of levels of understanding of the “information” available from a hierarchical systems perspective. In this interpretation, one considers the elephant in terms of partial sets of its external components. This perspective is useful in clarifying the hierarchical relations between information, knowledge and intelligence. However, as far as the metaphor is concerned, the elements remain external images or descriptions.

Considering the ways in which the positions of different workers in the information field modify and inform one another, one is led to the much more dynamically suitable metaphor of a living cell. In a typical cell, there are some seven or eight principal structures and systems, which can be listed as follows: cytoskeleton (endoplasmic reticulum); vacuoles; external membrane; ion-transport channels; cytoplasm (intracellular medium); mitochondria; nucleus; ribosomes, *etc.* These structures, all “working together” can be fancifully associated with the structures of thinking about information listed above. At the same time, a cell suggests, in the phrase of Wolfgang Hofkirchner, the unity-diversity in the nature of information that is, perhaps, beginning to be understood.

### 1.2. The Conceptual Evolution of Information Theory

There is, today, an evolution in the field of information that is as difficult to grasp and characterize as the nature of information itself. In this paper, I describe this conceptual evolution in a highly personal synthesis based on the approaches of a small number of authors that I consider authoritative. The sequence is not, or is only very roughly chronological; we have here, already, a hint that the logic of this process is not a familiar one.

My sequence of domains of the study of information, together with the one or two authors I associate principally with them, is the following:

- |   |                |
|---|----------------|
| • Mathematical-Categorical Approach           | Burgin         |
| • Philosophy/Metaphilosophy                   | Floridi, Wu    |
| • Informational-Computational Approach        | Dodig-Crnkovic |
| • Integrative Approach: Systems and Emergence | Hofkirchner    |
| • Biological Perspective and Scientomics      | Marijuan       |
| • Cybersemiotics                              | Brier          |
| • Causal-Compositional Concept                | Luhn           |
| • Humanistic Informatics                      | Kolin, Li      |
| • Angeletics                                  | Capurro        |

In each of these domains, I have identified arguments which fit and/or are in opposition to the extension of logic to real processes, including informational processes that I designate as Logic in Reality (LIR). As for which domain in this information “cell” might be the source of energy, the “mitochondrion”, which the nucleus, the vacuole, *etc.*, I leave the reader to make his own assignment.

### 1.3. What is a Synthesis?

Much has been written about analysis and analyticity, but finding appropriate corresponding authoritative documentation of rigorous and pertinacious synthetic approaches is difficult. Synthesis has received a bad press since the failures of logical positivism. The approach to process and reality of A.N. Whitehead [3], in the 20th Century, is one of the few complex comprehensive enough to be considered as a valid system of thought, but it lacks a sufficient scientific dimension.

I should first say that this paper is not intended to be an equivalent or a substitute for either a General Theory of Information such as that of Burgin or a Unified Theory of Information as proposed by Hofkirchner. It should not be considered as “competing” with the World Scientific Publications Series in Information Studies. The objective of my synthesis, more modest, is only to permit a relatively facile comparison of some key aspects of several theories, to indicate, in one place, outstanding problems in the field as a whole and convey some sense of the direction in which it is moving. If it is at all successful, one may consider it an example of what Pedro Marijuan calls consolidated information science [4], going beyond classical, repetitive and largely self-centered discussions. The synthesis could be considered a series of “principled notes”, a term used by Marijuan in a recent Foundations of Information Science communication (see below). My metaphor of the cell for this synthesis is “dedicated” to Marijuan.

Above all, this synthesis is not intended to be an authoritative “identity” in which the individual theories referred to have been amalgamated. It should be considered, rather, as a metatheoretical or metaphilosophical approach which should be evaluated on its own terms.

### 1.4. The Ethical Dimension

I have not devoted a separate Section to nor discussed in detail the ethical dimension of information theories as such which is, or should be, the goal of information science. I refer the reader, again, to the work of Capurro, Hofkirchner, Floridi and other authors on this subject including myself.

There is, however, the same case to be made for a synthesis and the acceptance of the valid parts of all theories and the exclusion of only those that directly contravene the intended objective. This immediately opens the door to many controversies, especially regarding the nature of ethical aspects of the relation between man and machine, but this subject is outside the scope of this paper. The key word, as Basarab Nicolescu insists in his *Manifesto of Transdisciplinarity* [5], is tolerance, hopefully with reciprocity but also with rigor. Thus in some cases, I have pointed out, in the theories summarized in this paper, the aspects that, almost certainly unintentionally, *reduce* their applicability in the ethical dimension.

### 1.5. The Problems of a Unified Theory of Information (UTI)

The various problems associated with establishing a unified theory of information (UTI) have been well-documented by Wolfgang Hofkirchner [6], Rafael Capurro and others. Controversies about the nature of information itself, and its relationship to energy and hence to what extent it is or is not a fundamental phenomenon of the universe, continue unabated. A consensus seems as remote as ever, despite such major contributions as that of Burgin in his *Theory of Information* [1].

Another approach has been taken by Luciano Floridi [7], Kun Wu [8] and to some extent me [9] who see in the philosophy of information a framework for discussing the nature and role of information in all knowledge including the social and ethical domain. Unfortunately, the link of these epistemological or onto-epistemological views to science, while adding a further dimension to the discussion, often remains insufficiently elaborated.

The only part of a consensus that seems to have emerged in recent work is that, as Pedro Marijuan argues, a single definition of information may be neither possible nor desirable. Increased focus on human intelligence is developing and the shift is expressed in the shift from Artificial Intelligence to Intelligence Science [10]. A synthesis of Information Science and Intelligence Science is perhaps dimly visible in the future.

### 1.6. Methodology: Outline of Paper

A major problem in relation to theories of information is how to insure that any document, paper or book, captures, in accessible form, the critical aspects of those theories such that a reasonably complete comparison can be made. To carry out the exercise within the scope of a single paper, I identify a manageable number of authors whose work in the field of information is accepted as being at an adequate scientific level, even if there is no consensus about its purport. As indicated above, I have focused on the work of one or two authors whose theories I consider as the most authoritative in each domain, each of whom, of course, is a primary source to the complete literature in his or her area. Thus, I have not attempted to cover all fields of Information Science and Studies as such. I refer in this paper primarily to work that has been designated as Information Science and the Philosophy of Information. Information Technologies, for example, have been excluded to avoid broadening the scope unworkably.

The next move is away from any sort of simple compendium or listing of the major points of the respective theories by seeking what I have called elsewhere the point of admission of ignorance. In other words, all theories, unless they are unacceptably dogmatic, will point to a number of open areas or problems to which solutions should be sought. The obvious model for this concept is Floridi's 2011 paper [11], Open Problems in the Philosophy of Information, and the joint response to it of Gordana Dodig-Crnkovic and Hofkirchner [12].

In this paper, I have adopted their strategy and applied it to the group of topics I have, admittedly arbitrarily, selected for this exercise. The various positions are sufficiently open and accessible to provide the basis for an on-going dialogue that has somewhat more structure than, for example, current Internet exchanges. Some may consider this somewhat *ad hoc* as a methodology, but I claim that, given the complexity of the subject, it is the only one possible without even more arbitrary limitations on content. Where feasible, I have attempted to identify specific relations between the theses of two or three authors and attempted to find a "line" that joins the different perspectives.

The Sections of this paper, then, correspond to the topics and key authors I have selected for study, taking into account, especially, publications since the conception of the Foundations of Information initiative by Marijuan, Hofkirchner, and their colleagues, now, about twenty years ago. I apologize to those workers in this field whom I have neglected, due to my ignorance of their work and/or the need to keep this document within manageable limits. I have the agreement of the Editor of this Special

Issue, Mark Burgin, that the publication of this paper automatically opens a Call for follow-up papers that, to a reasonable degree, accept its rationale and format. This invitation extends, of course, also to authors of the work specifically referenced here.

Again, this is a *personal* synthesis. The theories I have selected for this paper appear to me to be the most interesting available, and the critiques of them that I make is based on my own theory. That there must be points which can and have been criticized from other perspectives is almost certainly true, but I do not believe that they refute or invalidate either the authors' general conclusions, nor my critiques which, I repeat, are intended simply to point to areas that should be open to debate. In any case, I hope this paper can be considered as an example of the kind of "integrative effort" that Hofkirchner insists is necessary for progress in this field.

This paper is, accordingly proposed as a contribution to the science and philosophy of information whose objective is *not* a Unified Theory of Information, but a new kind of *synthesis* of several theories of information in which they coexist without fusion or conflation. This approach is based on the principles of an extension of logic to real processes, Logic in Reality, which I will show is able, unlike standard logics, to capture and explicate the dynamic properties of information as a process itself.

I mentioned above the need for a mathematical perspective on the nature of information, which is beyond my abilities to provide. Fortunately, Burgin's book [1] provides this perspective. But Burgin, in *his* sub-title, *Fundamentality, Diversity and Unification* clearly indicates to me, at least, the advantages of retaining and using a multi-functional approach to information.

I include as a subject for analysis my own approach to information *via* my proposed non-standard logic, Logic in Reality (LIR) [13]. LIR indeed makes some advances in the encompassing of information that are not to be found elsewhere, but it also comes up against the limitations due to the absence of an accessible mathematical formulation of its key principles. This part of the discussion in this paper is thus similar in form to that of the others. Restatement of the principles of LIR in mathematical terms by someone "skilled in this art" would thus be an example of the suggested process that I consider necessary and desirable for progress. I therefore begin with a brief overview of Logic in Reality necessary as background.

## 2. Logic in Reality (LIR)

### 2.1. Fundamental Postulate

LIR is an entirely new kind of non-propositional logic grounded in the fundamental self-dualities and dualities in the nature of energy or its effective quantum field equivalent. These antagonistic dualities can be formalized as a structural, logical and metaphysical principle of opposition or contradiction instantiated in complex higher level phenomena. The fundamental postulate of LIR is that for all energetic phenomena (all phenomena) alternate between degrees of actualization and of potentialization of themselves and their opposites or "contradictions" but without either going to the absolute limits of 0 or 100%.

The LIR logical system has a formal part—axioms, semantics and calculus; an interpreted part—a metaphysics and a categorial ontology; and a two-level framework for analysis relating levels of explanation. LIR is neither a physics nor a cosmology but a logic that enables stable patterns of

inference to be made, albeit with reference to probability-like metavariables. In LIR, processes are constituted by series of series, etc., of reciprocally determined actualizations and potentializations of entities and their opposites, and emergent states, driven by the overall energy gradient of the universe. Causality, determinism and indeterminism, time and space, parts and wholes, *etc.* receive non-standard interpretations in this theory. As a key example of one of the areas to which LIR brings a new perspective, I mention that of mereology. As shown by Lupasco in the original work on the logic of the included middle, upon which LIR is based, parts and wholes of complex systems must also be considered as processes, not totally independent, each sharing to a certain extent the properties of the other [14].

LIR captures the dynamic structure of the non-separable and inconsistent aspects of complex entities, processes and events at biological, cognitive and social levels of reality. Real entities can be described as encoding significant energy in potential form, as capacity for interaction. Both the actual and potential states of particles at lower levels—atoms, molecules, biopolymers, cells, *etc.*—are functional. The residual potentialities of entities at any level are the carriers of the information necessary for upward causation and emergence at the next higher level. This grounds, in basic physics, the concepts of “auto”-catalysis and “self”-organization in evolution and morphogenesis. (I have placed “auto” and “self” in scare quotes because the issue is, exactly, that the implied independence may not be justified.)

## 2.2. Implications for Philosophy: Non-Separability

Many philosophical arguments depend on some form of absolute separability of dichotomous terms *via* the importation, explicit or implicit, of abstract principles of binary logic exemplified in the use of standard notions of time, space and causality. LIR discusses philosophical problems in physical, dynamical terms that do not require abstract categorial structures that separate aspects of reality. The critical categorial feature of the LIR process ontology is the *non-separability* of opposing phenomena (two theories) or elements of phenomena, e.g., syntax and semantics, types and tokens.

Derrida [15] questioned the structure of binary oppositions, and said that “*différance*” “invites us to undo the need for balanced equations, to see if each term in an opposition is not after all an accomplice of the other.” LIR takes this intuition and provides a new “structure” of oppositions and reading of “being an accomplice”. The “difference” in the famous statement of Bateson, that information is a difference that makes a difference, can be seen as a *différance*.

In LIR, the structure of reality does not depend on any transcendental notion of human experience such as that of Heidegger or the neo-Kantian phenomenology of Petitot [13]. The dynamics of physical processes may be described without reduction. This logic is not that of logical positivism or of Hempel. It is part, rather, of a new *ontological* turn in philosophy.

## 2.3. Relations to Other Logics

Sklar [16] wrote in 1992 that quantum logics were inadequate to resolve quantum paradoxes. LIR provides a natural interpretation for quantum superposition in terms of semi-actual and semi-potential states, eliminating the philosophical problems associated with the modified Copenhagen and many-worlds interpretations of quantum mechanics. It supports recent work that non-classical and

classical properties can be conjoined in quantum and non-quantum systems (for a discussion of these and other logics see Brenner [13]).

In paraconsistent logics (PCL), like LIR, the law of non-contradiction fails. Da Costa and Krause applied PCL to quantum particles and showed that they both *are* and *are not* individuals, or both parts *and* wholes. In the LIR view, quantum entities and the gravitational field or its particle equivalents are self-dual and hence a paraconsistent description is adequate. LIR permits an extension to dynamic entities or processes outside the quantum world, where duality, but not self-duality holds.

Symons has given several arguments explaining why logic has had a minimal role in the mainstream philosophy of science, but has himself applied epistemic logic directly to the neuroscientific study of perception and identification. He showed that epistemic logic can model the natural phenomenon of knowledge seeking. LIR supports this applied approach. To use Quine's phrase, as "a compendium of the broadest traits of reality" [17] rather than a linguistic system, LIR offers a principled way of establishing a link between empirical science and logic, with empirical evidence logically able to support a unified system of knowledge. I will return to the role of epistemic logic in my discussion of the work of Floridi.

#### 2.4. Information in LIR

Given its contradictorial approach to all complex real phenomena, LIR can be seen as a logical methodology that would encourage the retention and use of partially conflicting notions and theories of information, among others. In fact, information is the perfect example of a phenomenon that has been described in conflicting terms, or as a composite of antagonistic processes, e.g., of energy and meaning. Since LIR assigns logical values to such contradictions, LIR thus can provide bridging concepts or "glue" between, for example, the concept of semantic information at the lowest data level and broader applications. LIR places this concept, and thus Hofkirchner's "superconcept" [6] of information, in a naturalized physical, metaphysical and logical context. Information is both a means to model the world and part of the world that is modeled, and LIR describes the dialectic relation between them. Floridi found the concept that semantic information is true if it points to the actual state of the world somewhat equivocal, but I believe it fits the LIR processual logic, in that logical (in the LIR sense) information *is* the actual state of the world.

To repeat, Logic in Reality does not pretend to offer or to constitute an independent theory of information that would supersede any or all existing approaches. LIR provides a new interpretation of the concept of qualitative information or information-as-process [18] as contrasted with quantitative information. What it does offer, as will be seen in the rest of this paper, is a way of coordinating some otherwise scattered insights, especially, about the duality of information referred to above.

### 3. Mathematical-Categorical Approach: Mark Burgin

I go next to the work of Mark Burgin, but not only because he is the Editor of the Special Issue in which this paper is included. I wish to have on the table the areas for further study to which he called attention in his book, to see to what extent they have or not been addressed.

At a first glance, the task I have set for myself in this paper has already been accomplished by Burgin. Burgin set as the goal of his General Theory of Information a new approach in information

studies, presenting the best available theories as well as the possibilities opened by the new technologies. The objective was to find a *unifying* information theory that would synthesize all existing approaches in an amalgamated structure of ideas, constructions, methods and applications.

It is impossible even to summarize in one paper the exhaustive number of topics included in Burgin's *General Theory of Information* and in the massive number of other books and papers published by him. The following paragraph is taken from my brief review [19] of this book for this *Journal*, in which I called attention to its expertise in approaching the problems of information from a mathematical-categorical perspective:

“The originality of this book lies in the author's ability to integrate perspectives on information from logic, epistemology and systems theory in a rigorous mathematical framework. For example, for a long time, parametric systems have been frequently used in mathematics and its applications but the parameters are, as a rule, only numerical and are considered as quantities that define certain characteristics of systems. In the case of the general theory of information (GTI), the parameter is very general. The parametric definition of information utilizes a system parameter called an *infological system* that plays the role of a parameter that discerns different kinds of information, e.g., social, personal chemical, biological, genetic, or cognitive, and combines all existing kinds and types of information in one general concept of “information”. This parametric approach provides a tool for building the GTI as a synthetic approach, which organizes and encompasses all main directions in information theory. In Burgin's next step, on the meta-axiomatic level, it is formulated as a system of principles, explaining what information is (by means of Ontological Principles) and how to measure information (by means of Axiological Principles). On the level of science, mathematical models of information are constructed. One type of model bases the mathematical stratum of the general theory of information on category theory. Abstract categories allow one to develop flexible models for information and its flow, as well as for computers, networks and computation. Another type of model establishes functional representation of infological systems representing information as an operator in functional spaces.”

Burgin considers his GTI has provided solutions to various problems *via* the unifying concept of an infological system, concepts of different types of information and types of different concepts of information. In this paper, I will have occasion to refer to some of these solutions. He also listed some *thirty-three* directions for future research in information studies of which many are critical to this synthesis. At the highest cognitive level, the qualitative dimension of information, in particular, meaning and its evolution are clearly listed by Burgin among the critical areas for further work, “to form a unified system of information quality characteristics and measures and study their properties in the context of a GTI”. Although Burgin favors mathematical modeling, for example of intelligence, mind and instinct also in the context of a GTI, he nowhere excludes non-mathematical approaches. For me, the inclusion of a mathematical perspective on all issues related to information is now a matter-of-course.

### 3.1. The Relation between Burgin's GTI and LIR

That Burgin's work and mine are compatible, at least in part, is demonstrated by our joint paper “Information as a Natural and Social Operator” [20], in which the relation between LIR and the Triadic systems of Burgin in processes of change is developed.

However, as we will see in the work of other authors, Burgin combines his original and pertinent insights with concepts of energy and process which have limitations of being based on standard binary, propositional, truth-functional logic. Thus at the most fundamental level, the connection of information to energy is not developed beyond the following statement. “Thus, in the context of the GTI, energy operators are information operators. Moreover, not only energy but also any observable is, in a definite sense, an information operator.” Appropriately, Burgin defines energy as the capacity of a physical or other system to do work, that is, to make physical changes: physical work is done on physical objects, mental work is done on mental objects and so on. Finally, energy is considered as a kind of information in a broad sense, energy is measured by work and “information is also related to work”.

The problem here, in my view, is due to the inversion of ontological priority that has been made. There is fundamental difference between saying that energy is information or information is energy. Burgin reviews, positively, the radical It-from-Bit position of Wheeler (see Section 5) that all things physical are information-theoretic in origin and the views of Bekenstein that the physical world is made of information itself, and concludes that the whole of nature is a huge system of information processes, in which information exists independently of human thought. However, the fact that human beings only know about the physical world because they receive information from it does not prove that information and not energy is fundamental in the universe. If so, and if in addition energy has some unique properties, only a theory of information that takes those properties into account has a chance of providing an adequate picture of information. I discuss this question further in the Section on Computational Approaches.

From the LIR perspective, also, there are some cognitive processes which are non-computable, that is, algorithms cannot be written for them. Any explanation must therefore ultimately be based on principles that go beyond those parts of those processes that can be modeled mathematically. Nevertheless, the mathematical approach has and will retain an essential relation to all non-mathematical ones.

#### **4. The Philosophy of Information**

It seems natural for me to continue with the domain of the philosophy of information. It is relatively new, and like mathematics, in part an abstract discipline, but one that is developing rapidly and where different lines of development and bridges to other disciplines can be identified and compared.

I summarize in this Section the *contrasts* between those I consider the two leading workers in this field, Luciano Floridi in Europe and Kun Wu in China, both of whose theories it would, in the future, be incorrect to ignore. This Section could have had the title Epistemology and Ontology of Information, since it is in these areas that the difference between Floridi and Wu is most apparent.

##### *4.1. Luciano Floridi*

The original motivation for the development of a philosophy of information (PI) by Floridi was in response to a broader perceived need to place the entire field of information and its technology on a sound intellectual basis, as captured in Floridi’s definition [7]: “ The philosophy of information (PI) is the philosophical field concerned with (a) the critical investigation of the conceptual nature and basic principles of information, including its dynamics, utilization and sciences, and (b) the elaboration and

application of information-theoretic and computational methodologies to philosophical problems. The dynamics of information is further defined (in part) as “the constitution and modeling of information environments, including their systemic properties, forms of interaction, internal developments, *etc.*”

The different issues related to logic, philosophy, and ethics of information are discussed by Floridi in terms of appropriate levels of abstraction [7]. This concept of LoA is essential to an understanding of both Floridi’s theses and my interpretations of them. A LoA is a finite but non-empty set of observables, where an observable is just an interpreted typed variable, that is, a typed variable together with a statement of what feature of the system under consideration it stands for. Roughly, a LoA can account for the behavior of a discrete system, describing the latter in a formalism that corresponds functionally to that of differential calculus in analog systems. The output of a LoA is a model of the system, comprising information, whose amount is lower at higher levels.

#### 4.2. Open Problems in the Philosophy of Information

In 2004, Floridi listed some eighteen open problems in the philosophy of information [11]. One of the most important for this study is whether in fact meaning can at least partly be grounded in an objective, mind-, and language-independent notion of information (naturalization of intentionality). Is it possible to analyze both information and meaning not truth-functionally but as having the potential or being a mechanism to change the informational context? (My answer is of course yes.)

Floridi provides a detailed theory (action-based semantics) of how data acquire meaning as the indispensable foundational picture of semantic information and information processing upon which the informational aspects of theories of meaning and of society can be soundly based. This approach does not exclude, but points toward, further foundational approaches to information ethics (IE) that are more directly applicable to moral questions at the highest human cognitive and social levels.

As Floridi wrote in 1996, the mind does not wish to acquire knowledge or information for its own sake [11]. It needs information to defend itself from reality and survive. So, information is not about representing the world, it is rather a means to model it in such a way as to make sense of it and withstand its impact. Floridi reached the conclusion that a more negative anthropology was required in order to make possible a new philosophy of knowledge as ontology of knowledge.

In the major 2011 synthesis of their own referred to above [12], “Floridi’s Open Problems in Philosophy of Information: 10 Years After”, Gordana Dodic-Crnkovic and Wolfgang Hofkirchner reviewed the important developments that have occurred with respect to all of Floridi’s problems, from the nature of information, information semantics, intelligence/cognition, the informational universe/nature to values/ethics.

For me, Floridi’s most critical question was 2. What is the dynamics of information? It is highly significant that Johan van Benthem’s work on dynamic logic and its relation to information is cited by Dodic-Crnkovic and Hofkirchner here. The problem is, however, that van Benthem’s logic *is still a neo-classical, truth-functional logic that is only indirectly related to the physics of real processes*. Similarly, Mark Burgin’s article, “Information Dynamics in a Categorical Setting” presents “a mathematical stratum of the general theory of information based on category theory. Abstract categories allow us to develop flexible models for information and its flow, ...” “Now category theory is also used as unifying framework for physics, biology, topology, and logic, as well as for the whole

of mathematics. This provides a base for analyzing physical and information systems and processes by means of categorical structures and methods.” However, standard category theory is an expression of bivalent, linguistic logic in another form, equally incapable, in my view, of adding further insight into the evolution of real informational processes.

The work of Floridi is thus a major advance in the philosophy of information. The question that Floridi does *not* ask, however, is whether some form of ontological commitment is necessary for a complete theory of information. I obviously think that one is, and I think this a crucial aspect of the philosophy of information of Kun Wu. The work of Wu better described as a metaphilosophy of information, since it includes a vision of the operation of informational philosophy as drastically changing the content of philosophy itself. This informational turn was discussed most recently by Wu at the 1st International Conference in China on the Philosophy of Information which took place in Xi’an in October, 2013.

#### 4.3. *Ontology: The Philosophy of Information of Kun Wu*

What the above discussion tends to show is that Floridi’s approach to information is largely epistemological. The work of van Benthem and Burgin, to cite just those two, also does not provide further insight into information as a real process. Thus Floridi does argue, for example, in his *Philosophy of Information* [8] that *digital ontology*, according to which the ultimate nature of reality is digital or computational, should be carefully distinguished from *informational ontology*, according to which the ultimate nature of reality is structural [21]. Floridi avoids the Boolean digital vs. analogue dichotomy in favor of an Informational Structural Realism, according to which knowledge of the world is knowledge of its structures. The most reasonable ontological commitment favors an interpretation of reality as the totality of its structures, energetic entities, dynamically interacting with one another. His Informational Structural Realism (ISR) appears to provide an ontology applicable to both sub-observable and to observable structural objects by translating them into informational objects, defined as cohering clusters of data, not in the alphanumeric sense of the word, but in an equally common sense of differences de re, *i.e.*, mind-independent, concrete points of lack of uniformity. These cohering clusters of data as relational entities are the elementary relata required in Floridi’s modified version of OSR. Thus, the structuralism in question here is based on relational entities (understood structurally) that are particular, not on patterns that are abstract and universal. (I recall the key feature of non-separability of the LIR ontology. LIR simply extends it as an accurate general ontological picture of the dynamic processes of change. A complex process and its opposite or contradiction “come together” or do not exist. The question of logical priority is moot [13].

Floridi’s position is that the ultimate nature of reality is informational, and it makes sense to adopt LoA that commit our theories to a view of reality as mind-independent and constituted by structural objects that are neither substantial nor material (they might well be, but we have no need to suppose them to be so) but informational.

Logic in Reality, however, offers a principled basis for saying that they are and suggests the logical rules they follow. As I have also shown elsewhere, the above limited ontology fails to capture the evolution of real informational processes. The critical aspect of information, to which Hofkirchner and others are now turning, is its dualistic relation to the energy of which it is constituted. In the view of

Kun Wu as well as myself, it is this duality or dualism that is the actual “driver” of informational processes.

Starting in 1980 from philosophical considerations of the essence of information, Kun Wu, working almost completely in isolation at the Jiaotong University in Xi’an, China, developed a Philosophy of Information (PI) that included information ontology, an informational theory of knowledge, evolution, value, an “informational thinking”, and social information theory including a rigorous conceptual system for the natural properties of information and an interpretation of its biological significance, methodological aspects and social value. Only a minute fraction of his books and over 200 papers has become available in English in “The Basic Theory of the Philosophy of Information” (BTPI) [8] made available at the 4th International Conference on the Philosophy of Information in Beijing in August, 2010. In Wu’s view, the Philosophy of Information is the highest form of philosophy, a metaphilosophy that includes various philosophies as its branches. PI considers information as a broad concept referring to a generalized form of existence, a mode of knowledge and a scale of values, and whose evolutionary principles can be explored. From the corresponding metaphilosophical perspective, a new information ontology, information epistemology, theory of information production, information social theory, information theory of value, information methodology, information theory of evolution, *etc.* can be constructed. Wu believes that establishment of a PI makes possible a new conception of nature, understanding, society and values and actively promotes the development of human information society, and a more civilized and democratic social polity, economic and cultural new order.

A key methodological conclusion is that the Wu approach contributes to recovering dialectics as an appropriate strategy for philosophy and science, including social and political science. The basic insight of Kun Wu’s Philosophy of Information is that the concept of objective reality = objective existence is too poor to describe the informational world. A proper new ontology and worldview is needed to describe the phenomenological characteristics of that existence. The approach of Wu to information is to start with existence as so constituted as objective and subjective from a phenomenological standpoint. He then places the critical terms of existence, objective and subjective, reality and unreality, and direct and indirect in a framework or partition diagram in which each combination of terms defines a path leading to matter-energy on the one hand and information on the other.

The principles of LIR in fact support Wu’s resegmentation of the field of existence (the extant domain) by Wu [22]. LIR makes it “logical” to talk about interactive relations between objective and subjective, reality and unreality, internal and external, direct and indirect and so on, and it does not exclude *a priori* the existence of real contradictions. Wu’s view of information as involving interactive processes is not new as such. What in my opinion needs to be emphasized is the way in which internal and external factors must be understood. These include the multi-level nature and characteristics of the actual and potential (virtual) interactions that mediate the construction and transformation of information in which they (the interactions) evolve logically and dialectically.

The Metaphilosophy of Information, then, requires attention to the informational aspects of complex processes as a methodological necessity, in a process that Wu calls Informational Thinking [23]. Informational Thinking (IT), as conceived of by Wu, refers to a way of grasping and describing the essential characteristics and attributes of things by reference to the structure and dynamics of the

information involved in their evolution, from their historical origins to future possibilities and probabilities. This strategy involves something like a Husserlian bracketing of the details of any complex process to consider the ways in which information functions in its dynamics, as well as the dialectical relations between its logical elements. It does not, however, accept the basis of a Husserlian phenomenology achieved by bracketing the process of the being of human beings in the world. Rather, there should not and does not need to be a total separation of this approach from that of Capurro, which reflects the influence of Heidegger.

My major conclusion is that the BTPI of Wu, his new informational view of the need for unification of critical disciplines and their formulation as a metaphilosophy constitute a major contribution, as yet unrecognized outside China, to the General Theory of Information. I conclude further that the theories described in this paper constitute part of a new transdisciplinary paradigm, in which information has a central role in the transformation of the society and its approach to knowledge and the classical separation of the academic disciplines. In fact, Wu's approach constitutes a new, original and in my view necessary critique of the bases of modern philosophy as a whole.

In Xi'an in October, 2013 [24], Wu repeated his conviction that it would be the creation of an informational ontological doctrine that would provide the foundation for change in all other areas of philosophy, including epistemology. This is the statement of a new "open problem" which further work can address.

## 5. From Pan-computationalism to Info-computationalism

In this Section, I will comment on approaches to a theory of information which share the general notion that change in the universe in the broadest sense corresponds to some form of digital or analog computation. Floridi's comment about the ultimate nature of reality as being structural rather than digital or computational notwithstanding, computational approaches are at the center of developments in the theory and philosophy of information. The theory comes in two major forms, (1) pan-computationalism or strong computationalism, which includes statements that the universe operates like a computer; and (2) a weaker form, developed by Gordana Dodig-Crnkovic, informational- or info-computationalism which reflects Floridi's view of the universe as an informational structure, in which natural computation governs the dynamics of information.

Dodig-Crnkovic defined an Informational-Computational approach in [12] as follows:

"Info-computationalism (ICON) relates to Floridi's program for the Philosophy of Information by combining it with a pan-computational stance, that of Zuse, Lloyd and others, which takes the universe to be a computer. With the universe represented as a network of computing processes at different scales or levels of granularity, ICON sees information as a result of (natural) computation. Adopting Floridi's Informational Structural Realism, which argues for the entire existing physical universe being an informational structure, natural computation can be seen as a process governing the dynamics of information. In ICON, the synthesis (!) of informationalism and computationalism, information and computation are two mutually defining ideas."

I include in this connection the application of computational principles to modeling the universe, such as the recent *The Computable Universe* by Hector Zenil [25]. In his epistemic stance, he states for example that he believes that everything is computable although not that the universe is necessarily computable. This is his preferred position, however, because he considers it epistemologically the most fruitful and powerful idea in science. The driving force in the universe is that it computes and everything else can be seen either as the result or as a constraint to computation. It is thus necessary to distinguish carefully such approaches from that of a computational universe which assert that the universe is *actually* a digital, Turing-like computer that in fact computes using some digital code.

It is significant that Dodig-Crnkovic herself has moved away from a pan-computationalist position. While remaining agnostic about the question of fundamentality, Dodig-Crnkovic replaces the emphasis where it belongs, namely on understanding *that part* of natural phenomena which may be subsumed under the concept of computation. It is to these ideas that the term natural computation, that is, information processing by natural systems, can be usefully applied, as I discuss below.

### 5.1. Computational Models of the Universe

The prestige that computationalist views have enjoyed is related to the extraordinary advance in human knowledge represented by the digital computer and its ancillary science from to mechanical and social engineering. A computational philosophy, for studying the interface between man and machine has been developed by Paul Thagard [26] and Lorenzo Magnani [27] among others. Computationalism, like other doctrines, has sought a physical and logical ground in the informational structure of the universe. Two approaches in this connection have received a great deal of attention, but I can only summarize two of them here.

#### 5.1.1. The Tegmark Approach

The Mathematical-Computational Universe Hypothesis of Max Tegmark [28] states the following: “the mathematical structure that is our universe is computable. Hence it is well-defined in the strong sense that all its relations can be computed. There are thus no physical aspects of our universe that are uncomputable/undecidable, eliminating the concern that Gödel’s work makes it somehow incomplete or inconsistent.”

It is easy to see, however, that such a picture of the universe is an ideal, abstract or if one prefers a neo-Platonist one. Tegmark assumes that either the mathematical structures he sees could be computable “if infinitely many computational steps were allowed”. The mathematical structure that is our external physical reality is defined or described by computable functions or computations by evaluating its relations, but they do not evolve (produce) the universe as such. Here computable structures are those whose relations are defined by halting computations. If the Computational Universe Hypothesis is false, Tegmark retreats to a picture of a Computable Finite Universe whose structures are trivially computable. The justification of such a complicated picture is weak, since it is introduced only *in order to avoid the known paradoxes of existing theories* that are applicable to the most complex multiverse that can be imagined consisting of the countably infinitely many computable mathematical structures.

### 5.1.2. The Lloyd Approach

Seth Lloyd [29] makes the more radical claim that “here is where life shows up. Because the universe is already computing from the very beginning when it starts, starting from the Big Bang, as soon as elementary particles show up.” Textually, he says that the computing universe is not a metaphor, but a mathematical fact; the universe is a physical system that can be programmed to perform universal digital computation.

Lloyd claims that the physics of the computing universe is the basis for its metaphysics, as Aristotle’s physics was for his *Metaphysics*. I note, not entirely in passing, that in the latter, Book IX, Aristotle frequently indicates that energy is primary as opposed to potentiality or other principles. Although it is clear that Aristotle’s notion of energy could not be that of modern physics, his intuition is by no means inconsistent with it. For me, however, his arguments are not physics and are all open to question: what if the universe is not a machine? What about processes which are not computable? What if there are other sources of order and structure? In the same compendium [30], Davies suggests that the ground of being is somehow vested in a quantum wave function rather than the informational bits that emerge from (its) measurement and observation.

### 5.1.3. Quantum Bayesianism (QBism)

Because this synthesis is intended to be a working document, open to modification and addition, at the suggestion of a referee, I have chosen to include a reference to an emergent conception of quantum mechanics based on quantum information theory but Bayesian notions of probability, so-called Quantum Bayesianism (QBism). By trading a simplistic notion of the reality of the wave-function for a non-realist (or anti-realist) concept of local observer-dependence of quantum phenomena, von Baeyer and others [31] believe they can eliminate most of the familiar quantum paradoxes. Logic in Reality, of course, in contrast to the computational approaches mentioned earlier, does assign a degree of ontological reality to personal experience that distinguishes it from all propositional or predicate logics. LIR provides a formal discussion of subject-object interaction that supports the central place given to it in QBism. My concern is only that the anti-realist aspects of QBism can, also, be overemphasized, especially in any attempted extension of its principles outside the quantum realm. Ultimately, as with the Causal-Compositional view of Luhn, a synthesis of the two approaches, each being preferred in specific domains, should be possible.

## 5.2. The End of “It-from-Bit”

The “It-from-Bit” concept I see as having been founded on the position of Wiener and Wheeler that information is the most fundamental thing in the universe from which everything else, in particular energy, is derived. Wheeler’s position, following Wiener, can be summarized by two statements: (1) information is not energy; and (2) information and not energy is fundamental. A related view is that the universe operates like a digital computer, and the emergence of Its as things from Bits as immaterial digital information is the only acceptable cosmogony. The further key issue is that of continuity: even if energy as objects—Its—is primitive, is the universe at bottom discontinuous and digital?

Any answer thus requires, as a minimum, a more complete statement of at least three opposing positions and of the definitions of information corresponding to them. I give here only my preferred position which I refer to as *It-and-Bit*:

- (1). Energy and information are the most fundamental entities in the universe, but neither is ontologically prior to the other.
- (2). Information and energy emerge together from, or are different aspects of, an as yet undefined primordial substrate more fundamental than either.

In my synthesis of the various positions, at some level of reality, I suggest that energy is more fundamental than information, and information emerges from but is always functionally associated with it. In the macroscopic world, energy and information, as well as continuity and discontinuity, are non-separable partners. One should, therefore, construct a basis for the emergence of information and meaning from the underlying invisible world of quantum fields and particles. To do so, I will have to go beyond the *It-Bit* dichotomy.

### 5.3. *It-and-Bit*

The position developed recently by Diaz Nafria and Zimmermann [32] suggests that both matter-energy and information are two different, associated aspects of the same underlying and still unknown primordial structure of the world. The best picture is that they emerge together from this substrate: the concepts of energy and information are always present in fundamental physics. The authors refer to Smolin's view that a theory of cosmology must, in order to be self-consistent, be a theory of the self-organization of the universe and "the very aspect of organization entails a concept of information on an equal footing with the concept of energy".

I agree with Diaz Nafria and Zimmermann that their "substrate" (systems) is constituted by energy and not an abstraction from energy as in the computational case of *It-from-Bit*. In my preferred picture, information and energy are the components of all higher level processes, but in contrast to the Diaz-Zimmermann view, information and energy are not and do not have to be absolutely the same or different, nor emerge in tandem. Because energy is primitive, (*Bit-from-It*), it is the dualistic, oppositional properties of energy that determine the properties of information. In *Logic in Reality*, which describes such a state of affairs, they are the same *and* different, ontologically and also epistemologically, as the mind moves between focus on one or the other aspect to the partial, temporary exclusion of the other.

My critique of standard computational models of the universe that are based on the assumption that since information is *present* throughout nature it is *more primitive* than energy in nature. But as stated by Dodig-Crnkovic, computationalism is not the world; it is a modeling framework that is acceptable within certain domains and does not exhaust our possibilities to relate to the world. Let us therefore look at the major new approach that she refers to as informational-computationalism or ICON and its key concept of natural computation.

#### 5.4. Informational-Computationalism and Natural Computation

Freed from what I consider the burden of the dogma of the computational universe, computationalism as natural computation appears as an acceptable component of *this* synthesis. It grasps (a term often used by Wu) many features of natural processes.

As developed by Gordana Dodig-Crnkovic, within the informational-computational framework (ICON) [33], information and matter/energy are represented by information and computation. Computation presents implementation of physical laws on an informational structure. Instead of describing the world in terms of matter/energy (where energy stands for equivalent of matter) and information (which corresponds to a structuralist view of the world as consisting of stuff that changes patterns), the info-computationalist approach, makes the distinction between structure (information) and a process (computation). The mind/body problem is solved in a simple way. Mind is a *process*, information processing, and body is a *structure* (proto-information). Thus, mind is *a process of natural computation* that results from dynamical reconfiguration/re-structuring of the information in the brain, au fait with the rest of the body which connects it with the physical world. The structure and the process are inseparably interwoven by physical laws, and LIR gives logical underpinning to the word “interwoven”.

In this framework, there is no Cartesian divide between body and mind. This naturalized epistemology approach, conceptualizes information as both here (intelligence) and there (world) and on the threshold, as information constitutes the basic existence. Its structural changes are the results of computational processes. We have a long way to go in learning how exactly those computational processes are to be understood and simulated on different levels of organization of informational structures, but the first step is to establish the basic conceptual framework which smoothly connects the natural world with cognitive phenomena such as intelligence.

Within the framework of dual-aspect informationalism/computationalism (info-computationalism) theory matter may be viewed as a structure (information), in a permanent process of flow (computation). Mind is the process, which is computational, both in its discrete and in its analog view.

This work thus presents its own synthesis of two paradigms within contemporary philosophy—computationalism and informationalism into a new dual-aspect info-computationalist framework. The meaning of this dualism might be seen in the analogy with wave-particle or matter-energy dualisms in physics. The dualism itself does not mean that the phenomena are separated, and exclude each other; on the contrary, they are mutually determining, constraining and completely indissoluble. In that sense, one may speak of dual-aspect monism.

#### 5.5. The Role of Logic in Reality

*Vis à vis* this synthesis, Logic in Reality has both a complementary and a supplementary role. LIR states, as we have seen, that relations are dynamic relations of the energetic properties of the entities or processes under discussion. The phrase “the dynamics of information” in the LIR interpretation points to how the properties and elements of information, as a dynamic process in and of itself, change in response to imposed forces.

Thus LIR can accept that we are *already* at this point in the part of the universe described by a computational metaphysics. In this framework, information and computation may indeed mutually define one another. In ICON, only, Dodig-Crnkovic has not taken into account the universe as a whole in which non-computational processes may be primary or at least mutually defining at a *more* fundamental level. Mutually defining, we recall, in LIR is an ontological as well as an epistemological statement. Under these circumstances, the kind of Lupascian dialectical interaction between somewhat opposing theories, opposing certainly in my focus on aspects of existence that are better seen as non-computational can take place. There are many further affinities between this approach into which I cannot go into detail here but may suggest themselves to the reader.

## 6. Integrative Approach: Systems and Emergence

As developed by Wolfgang Hofkirchner, approaches to a Unified Information Theory have their roots in General Systems Theory. Since its formulation by Ludwig von Bertalanffy in the early 1960s, Systems Theory has been moving in the direction of *specific theories* of different types of systems differing widely in their basic assumptions. Examples are theories of non-linear systems, relational quantum systems and the ergodic hierarchy. Hofkirchner's systems perspective is central to my synthesis.

Continuing this positive movement, from a basis which also includes philosophy and sociology, Wolfgang Hofkirchner has developed an integrated transdisciplinary approach towards a Unified Theory of Information (UTI). His latest book, entitled *Emergent Information. A Unified Theory of Information Framework* [34] begins with an extensive synthesis of essential prior work to which this paper may be considered a modest up-date. The informational-scientific framework that Hofkirchner has developed for the discussion of the operation of information and information processes in the society represents a significant advance over both simplistic semiotic and strictly computational approaches.

One of the most important entry points to comprehension of Hofkirchner's thesis is his insistence, as in the work of Capurro, on a concept of information-as-process based on its etymological derivation from a Latin verb. The second key point (I apologize for the drastic abbreviation of this development) is the reinterpretation of the also classical conceptions of identity-in-diversity.

The conjunction of Hofkirchner's approach and Logic in Reality is already apparent: LIR is a logic of the evolution of real processes, and it provides a new understanding of the physical, dialectical relation between identity and diversity, as well as between the terms of other critical physical and philosophical dualities. Because Logic in Reality, in contrast to standard bivalent or multivalent propositional logics is not topic-neutral, it provides the basis for an ethics as the finality for the intellectual process, a principle which pervades Hofkirchner's work. Another point of overlap is the theory of systems, where that of LIR provides a complement to the basic concepts of Ludwig von Bertalanffy and his followers, including Hofkirchner.

My intention in this Section is not to summarize *Emergent Information* further. In my view it is a landmark in the theory of information, in the same sense as Burgin's *Theory of Information*, but with greater emphasis on the philosophical as opposed to the mathematical underpinnings. What I will do in the remainder of this Section is to show that additional, more physical principles of LIR *also* apply and add an additional supporting dimension to Hofkirchner's work.

### 6.1. Rationale

In my view, *Emergent Information* provides the most up-to-date and expert framework for a Unified Theory of Information (UTI). It brings together, or refers to much of the debate and many of the contributions of people active in this field. It is resolutely anti-reductionist and humanist, insisting on the need for an adequate theory of information to insure the development of an ethical information society. Hofkirchner indicates clearly the transdisciplinary role of a philosophy of information, especially in the work of Rafael Capurro, Kun Wu and Luciano Floridi in constituting the framework.

What then is the need that I have perceived for another perspective on the theory presented by Hofkirchner? It is that a major line of thought, which for simplicity I designate as that of physics, is inadequately represented in his approach, as he himself has agreed. In their place, one finds popular theories that have served well in the past to describe complex phenomena, especially those of Peirce and Morin, but which fail to meet the rigorous standards required of any science. Since the work of Varela and Maturana, self-organization has been adduced as a necessary property of complex phenomena, and yet it, too, on closer inspection, turns out to suffer from the same lack of physical grounding.

Another problem that Hofkirchner has addressed, also in earlier work, is the rationale for a UTI in its own right. This is philosophical or metaphysical question, and the goal of a UTI carries a number of hidden implications. If these are not addressed, they may restrict or exclude alternate valid interpretations of the nature of information and in fact of complex cognitive systems in general including intentionality, free will (or the lack of it) and intelligence.

If the UTI is intended to be a monolithic identity, this in itself a form of reduction to be avoided, and Hofkirchner has avoided this by his concept of identity-diversity necessary to characterize information. LIR simply adds the additional concept of *how* an identity-diversity is structured dynamically as a “structuring” or “structuration”, terms used by both Lupasco and Giddens (in relation to society) to emphasize its process aspects.

### 6.2. Evolutionary Systems Theory

Hofkirchner establishes the important connection between self-organization and systems in what he calls “Evolutionary Systems Theory” (EST). It is defined as “that cross-disciplinary partition of a *Weltanschauung* that applies (1) the Principle of Self-Organization, (2) the Principle of Evolvability, the diachronic complexification of matter and (3) the Principle of Systemicity, systems as the synchronic “fall-out” of the evolutionary process. For Hofkirchner, an evolutionary system involves less-than-strict determinism, non-mechanical causation and emergence.

The dialectics of EST, in turn, supports a Universal Theory of Information (UTI) which in turn underpins a Theory of a Critical Information Society and a Science of Information. EST thus helps to insure its perennity, as well as being a science *about* the Information Society, taking advantage of complex systems thought. The finality of this process is the conversion of an Information Society to a Global Sustainable Information Society (GSIS).

I feel that Hofkirchner’s principles are the epistemological complements of the LIR ontological Principle of Dynamic Opposition which also operates synchronically and diachronically to result in the complexification of real processes and systems of all kinds (see below). Following Kun Wu, we may

say that the self-organization of Hofkirchner is posterior to a hetero-organization which takes into account the primary physical bases of a system. It is exactly at this point that the principle concepts of both Hofkirchner's approach and mine interact, from which some new insights may emerge.

### 6.3. LIR and the Physics of Information

My objective is only to place the case for the utility of a UTI on a further physical and logical basis. A key operational term of Hofkirchner's approach, for example, the re-ontologisation that is occurring in the scientific-technological revolutions that society is undergoing, involves an ontology that does fit any standard ontology corresponding to standard logic. An emergent collective intelligence, based on the ICTs (Information and Communications Technologies), must be described in its dynamic (and synergistic) relation to human individual intelligence, with all its inconsistencies and contradictions. Logic in Reality provides the framework for the discussion of all these qualitative, interdependent aspects of the evolutionary informatization process, of which Hofkirchner has also emphasized the importance.

The three further areas in which I propose, accordingly, an emendation of Hofkirchner, in addition to self-organization mentioned above are following:

- Grounding in Physics
- Emergence
- Complexification

#### 6.3.1. Grounding in Physics

For me, the use of the term information-as-process by Hofkirchner means that we are talking about real processes, that is, those in which there is an energetic exchange. If so, then the rules for the evolution of such processes, which I consider to be described by LIR, should apply. The ontological ascent to higher levels of reality or complexity takes place by mobilization of the residual potentialities at lower levels, as has been well described by Terrence Deacon [35].

The innovation provided by LIR, then, is that of a physical theory that does not reduce informational phenomena to physics and provides a basis for the emergence of meaning by the continued operation of the principle of dynamic opposition.

#### 6.3.2. Emergence

The axiom of the included middle of LIR is the logical expression of the probability of the emergence of a new entity from the point of contradiction or interaction between two opposing forces—theories, trends, groups, *etc.* As Hofkirchner writes, a UTI should be *logical* as well as historical, explaining not only the historical appearance (emergence) of new information processes and structures but how these processes and structures are logically linked. Hofkirchner explicitly excludes standard deduction as incapable of accomplishing this task, and LIR would appear to be an acceptable candidate for this job.

### 6.3.3. Complexification

Just as the principles of Logic in Reality enable a grounding of the Hofkirchner theory (and others) in the dialectical properties of energy, application of the same principles at the highest cognitive and social levels is also useful. One of the areas, which will not be discussed in detail here, is that of systems themselves. Systems can also be regarded as complex processes interacting dialectically with others that are not, or not quite systems, but instantiate some absence or defect. The objective here is to show that the principle (of Hofkirchner) of identity-diversity applies generally in nature.

Summarizing, all the critical properties and connections of Hofkirchner's approach, for example in EST, can thus be reinterpreted, in Logic in Reality, in terms of a space of probabilities rather than possibilities, bringing them closer to the evolving process itself. LIR is a logic of emergence in a dynamic sense in which I use the term logic; since as I have noted elsewhere, unlike standard logics, LIR is not topic-neutral, it can be an essential tool for development of a UTI that is both humanistic and rigorous.

## 7. Cybersemiotics

Another direction in which a solution to the nature of information is being sought is in the cybersemiotic approach of Sören Brier. The subtitle of his major book [36], *Cybersemiotics is Why information is not enough*. Why not? One answer is that information, while foundational as we will see, may only be a methodological pointer toward the presence in the world of complex dynamic cognitive phenomena, especially, knowledge (or knowing), human intelligence and semiotics, signs working to produce meaning in human and other living systems.

### 7.1. Preliminary Comment

I consider the cybersemiotic approach of Sören Brier as one of the most significant and original recent contributions to information theory. For me to include a Section on it in this synthesis is therefore an essential but also very difficult task. It is difficult since in my 2011 paper in this Journal [37], I made some very serious criticisms of the foundations of Brier's theory in the semiotics and logic of Peirce.

Nevertheless, in a transdisciplinary spirit, I summarize this theory and its relation to mine, as an example of the kinds of disagreements that *can* coexist, interact and may lead to new insights, given a minimum of good will on the part of everyone involved. Thus the necessity, as Brier points out, of reacting against standard logical, mathematical, ontological or computational conceptions of information cannot be repeated too often.

### 7.2. The Problem of Phenomenology

The approach of focusing on the lived character of experience, based on the unique awareness of experience available to individuals, has led to the definition of the domain of phenomenology with which we are all familiar. Familiar however also, is Husserl's later bracketing of the question of the existence of the natural world and its relation to experience.

As a semiotician, Brier has pointed out the weaknesses in much of standard philosophical and sociological thought in general and phenomenology in particular. He thus writes that Husserl, Heidegger, Merleau-Ponty and most recently Luhmann were unsuccessful in developing a proper philosophical framework for phenomenology, because they did not offer any adequately deep picture of things in themselves in relation to appearance. Like Wu [38], Brier states that Husserl's transcendental idealism makes no contact with the world or the natural sciences.

Brier claims that the semiotics of Charles S. Peirce can deliver the missing philosophical framework through his semiotic understanding of the fundamental structure of the natural phenomena. Unfortunately, as I have discussed in [37], Peirce's own framework is based on several assumptions about that structure derived ultimately from introspection. This leads him to ascribe a foundational role to chance and spontaneity as causal factors, without ontological commitment to the underlying physics of reality. His subsequent classification of real phenomena into "Firstness, Secondness and Thirdness" follows, but it remains just that, a system of classification of phenomena in terms of representation by symbols which adds nothing that helps us understand the ontological basis of the way the world evolves. That Peirce made an enormous contribution to logic is true, but on close inspection his logic, including his system of graphical representation, is an elaboration of standard linguistic, truth-functional logics that is still incapable of describing real phenomena without excluding their essential dynamic properties.

The advantage of a physical view of information such as that of LIR is that given the dialectical properties of energy, information-as-process describes the actual evolution of cognitive processes and information-as-concept serves as the unifying concept between the fields of physics, biology, neuroscience and mind. In this sense, a philosophy of information based on those properties is a more scientific and reasonable explanation of the mechanism of human understanding than phenomenology.

As a method involving a classical phenomenological suspension of natural objects and the human body, description of the mechanism of human understanding based on Peircean phenomenology is thus incomplete. We have no guarantee that his form of "bracketing" of energy in the discovery of meaning does not beg the question of the dependence of meaning itself on an inclusive ontology that requires an ascent from physical dynamics (cf. Terrence Deacon [35]) on work).

In comparison, an ontological philosophy of information such as that of Kun Wu provides a comprehensive framework including a mechanism of awareness of natural objects, a role for material devices and instruments, human physiological and cognitive and an historical fifth, intermediary-based dimension. The philosophy of information enables the actors in the cognitive process to return, so to speak, from their phenomenological suspension. The new integrated model of cognition includes the classical phenomenological interpretation, so that the philosophy of information goes beyond the phenomenological one.

Note, however, that due to the fact that phenomenology does not have a natural ontological foundation, I do not claim that the philosophy of information is either a phenomenology or a naturalized phenomenology. Perhaps, following Derrida in the sense of transcendence and inclusion, the philosophy of information could unify phenomenology into a "meta-phenomenology", but in any case the philosophy of information is not determined by phenomenology. Rather, the theory of Wu, and LIR are, together, candidates for the ontology (the metaphysics), called for by Depraz [39],

“compatible with the most acute phenomenological insight, an ontology which can be used to reject reductionist tendencies by exhibiting *their* fundamental *non-duality* (italics mine).”

### 7.3. A Structural Resolution: Change

Thus although, from the LIR standpoint, there are problems with the Peircean worldview, its importance as presented by Brier in calling attention to and providing a framework for conceptualizing and organizing some of the processes involved in the evolution of meaning should not be minimized [40,41]. Another framework, since we are looking at such things, is that of Marijuan (see next Section) who sees both the neuronal workspace of individuals and the complexity growth of cells, nervous systems and societies as having in common the necessary “self-producing” structures from which the dynamics of knowledge and meaning can be built. In other words, in these structures, flows of real “human” information as well as “biological” information take place synchronically and diachronically (historically).

If one compares this view with Peirce’s, one notes the reference to “active” structures in both. The differences can be localized to the relatively greater role given to the abstract (non-energetic) concept of sign in Peirce. In contrast to Marijuan, however, I do not feel that his view and Brier’s are totally disjoint, but can interact and influence one another, following an LIR dynamics of theories. To adopt this stance, however, it is necessary to accept that Peirce’s system cannot be exclusive, and that other interpretations are possible that yield a picture of the emergence of meaning without signs. We recall that a sign stands for something else, and LIR provides an onto-epistemological basis for saying that it is the cognitive processes themselves in the human mind which *are* the meaning.

Brier states that Peirce’s semiotics “allows us theoretically to distinguish between the information the sender intended to be in the sign, the (possible) information in the sign itself and the information the interpreter gets out of the sign, instead of meaning that the information is the same in all three.” What I note from this picture is that the information has *changed* in the process. This displaces the problem: we now need not only an ontology of signs, which Peirce provides us with, but an ontology of *change*, which is that, rather, of Logic in Reality. Peirce’s theory of signs is not itself a sign; it is information and thus can flow and change. The best interim statement that might be made is that information is and is not a sign, both sign and non-sign. Although such statements are unacceptable in standard logic and the philosophy and category theory that are determined by it, in both Marijuan and Brier I find the basis for including *this form of the understanding of nature as part of science*.

If a final point were necessary to show that there is a synergy that needs only to be brought out between the work of Brier and Marijuan, one need only compare the diagram of the “Four Great Domains of Science” of the latter and the four-pointed “Cybersemiotic Star” of the former. They are virtually super-imposable.

## 8. The Biological Perspective: Scientomics and Knowledge Recombination

The involvement of Pedro Marijuan with the Foundations of Information (FIS) initiative is by now well-known to readers of *Information*. Of particular importance was his association, in the founding of FIS, with the biologist Michael Conrad, whose concepts of the grounding of information at sub-quantum levels of physical reality remain titillating, but have not yet received adequate

confirmation. Marijuan's continued leadership of and contributions to FIS have permitted insights into the development of his concepts "in real time" so to speak. I will refer to two of these in this synthesis using the same rationale as for all the other authors discussed in it, namely, that they contain a perspective, that of experimental biology, that is a *necessity* for any theory of information, unified or not.

Conscious of the resistance to his biological approach, Marijuan went so far as to ask, in a recent (2013) discussion of communication, to be excused if it seemed "too biological". In fact an objection was raised to his statement "Finally communication is life, and life is communication" on the grounds that if this were so, communication would be (or involve) metabolism. This criticism is, of course, invalid since communication not only involves the metabolism of the living being to necessary effect it, but the evolution in complex communications processes, best described by the dynamic logic of LIR as energetic change perfectly assimilatable to a "metabolism", if not of carbon-hydrogen bonds. I am reminded here of another statement of the same form, by Lupasco, to the effect that "Experience is logic, and logic is experience". Only the most literal-minded reader would take this statement as an arithmetic equality.

### 8.1. The Biological Perspective

The significance of Marijuan's biological perspective on information is that the complexity of biological processes is not the exception but the rule. The characteristics of information are those of life, first, and secondarily the drastically reduced set that are instantiated in real but binary phenomena, especially, in computational activities. Computational principles, as we have seen, can be applied to the analysis of some of the aspects of real processes, but these are abstractions from them, like the abstractions made in standard logic or set theory. There are thus two kinds of errors that can be made: (1) ignoring or denying that the notion of information grasps fundamental features of biological systems but also (2) limiting the theoretical framework for and account of information in biology to the model of information as semiosis, grounded on Peircean semiotics [42]. I have discussed the problems with the semiotic approach in the previous Section.

The evolution of information science and his proposed Bioinformation paradigm can readily be traced by following a sequence of a few of Marijuan's papers alone:

- 2003 Foundations of Information Science. Selected Papers from FIS 2002 [43]

Note that my concept of a synthesis is not new: in this paper, Marijuan called for advancing a New Information Synthesis, an "optimized conceptual itinerary" and new bridges between strategic points in the sciences.

- 2004 Information and Life: Towards a Biological Understanding of Informational Phenomena [44]

Here, Marijuan specifically attacks reductionism in its various forms. His tentative new approach is based on the molecular organization of the living cell as the paradigm for other informational structures.

- 2009 The Advancement of Information Science. Is a New Way of Thinking Necessary? [45]

Simplistic concepts of hierarchy and of unification as a *prima facie* desirable outcome, without taking into account, as does Hofkirchner, of the reality of *diversification*, are still proposed as applicable to information. In this paper, Marijuan introduces the concept of the recombination of knowledge.

- 2011 From Genomics to Scientomics: Expanding the Information Paradigm [4]  
Focusing on the cell, and its most complex combination of informational phenomena, Marijuan concludes that living existence is primarily informational, and that terms such as autogenesis, autopoiesis, self-production, *etc.* are superfetatory.

In the next Section I will outline the most recent expression of Marijuan's search for a new way of thinking in Information Science.

### 8.2. Knowledge Recombination: Information as a Great Scientific Domain

In his presentation to at the 1st International Conference on the Philosophy of Information in China, held at the Xi'an Jiaotong University Center for the Philosophy of Information in October, 2013 [46], Marijuan argues for the designation of the Informational, together with the Physical, Biological and Social as the Four Great Domains of Science. The key elements of the Informational Domain emerge from first and most importantly from the nature of informational entities in living systems. It is their characteristics as they are found in other domains that (logically) confer on the latter their necessary credibility, rather than their semiotics which is heavily dependent on the ratiocination of Peirce for its conceptual base.

The first step, of course, is the application of the concept of recombination of knowledge within the biological domain, using a new information-based research philosophy. But all the knowledge emerging subsequently can be used to inform recombination within and between other domains. There is again an overlap here between Marijuan's concept of the informational entity and its working at levels from cells to individuals to societies and Wu's concept of the informosome.

Logic in Reality contributes to this vision in two ways: first, it defines the common dynamical features in the logical evolution of specific processes, biological or cognitive within their respective disciplinary domains. Second, it provides a conceptual territory in which the informational-biological approach can partly interact with the informational-computational and mathematical-categorical approach where the latter make necessary abstractions from the complexity. This is what Marijuan also expressed as the necessary linkage of the informational to, but not subsumption under, mathematics and computer science.

In other words, coming from a background in experimental biology, Marijuan came to a similar conclusion as Wu did from a background in philosophy: the characteristics of information provide the conceptual space for an interdisciplinary and/or transdisciplinary "socio-integrative process" of the sciences. The informational paradigm provides a better basis for meaningfully connecting the biological with the social sciences and humanities, understanding the collective dynamics of the sciences and dealing with meaning, knowledge and intelligence in a new way than the computational approaches outlined above.

## 9. The Causal-Compositional Concept of Information

### 9.1. The Operation of the Gödel Theorems

An essential component of my synthesis, one which has itself synthetic ties to the theories of Wu, Brier, Marijuana and Hofkirchner is the Causal-Compositional Concept of Information of Gerhard Luhn. As in LIR, also, the emphasis is on the development of a theory that is embedded in the evolving, changing human condition whose finality is the development of a more just information society [47,48].

In contrast to many physicists (who should know better), Luhn starts from the implications of the Gödel theorems and examines their consequences for both the definition of information and the application of that definition. “Information” describes the process of the kinds of possible interactions between systems, including the process of completion. This completion process corresponds to a new interpretation of Gödel’s incompleteness theorem from a physical and informational perspective. Physical laws are given through arithmetical mathematical equations. Gödel showed that any system of arithmetical mathematical equations is incomplete. The Completion Theorem states that any system of physical equations can be completed by new equations, which cannot be derived from the existing equations. Additional information has to be added. This concept lays the foundation for the newness, in part or in whole of any information as an emergent phenomenon. It is the operation of this Completion Theorem which should be added to the basic laws of physics and placed into the foundations of our ontology.

This interpretation of Gödel’s theorems shows their close relation to Logic in Reality. In LIR, they are simply another expression of the fundamental functional duality of the universe. It is not surprising that Luhn can use the completion theorem at the highest cognitive level in a new interpretation of so-called free will. From within this information concept, we can derive that our mentally experienced free will is physically grounded in a system which instantiates a highly recursive physical phase space—a “natural language”. The system is subject to the 2nd law of thermodynamics such that a physical force instantiates a maximum number of possible states. This is the physically based driving force in the direction of enabling or approaching freedom. People who suppress other people’s search for freedom are acting *unnaturally* from a very deep perspective. The overall system (including the entire living sphere) approaches a maximization of possible states. This goal will be much better achieved, if many or all people participate in its execution.

Again, the explanation of why some people act “unnaturally” is the inevitable existence, together with any force, of another force or forces opposing it. In LIR, it is thus “natural” that some people behave unnaturally and seek a *reduction* of possible states, I do not think that any reader of this paper will have been so fortunate as not to be able to confirm this view from personal experience. As I have remarked elsewhere, the term free will, even in this interpretation, is somewhat unfortunate since when the relation between two people is proceeding correctly, in order to achieve the overall goals for both, some restriction, based on the information of the other’s states, will operate to reduce some of one’s own. In the acceptance of this may lie what is commonly called “wisdom”, but I will not discuss this further here.

## 9.2. The Term “Causal-Compositional” vs. Burgin’s GTI

In line with my stated objective of permitting facile comparison—non-invidious—of several essential theories, I summarize next the correspondence of Luhn’s approach with the Theory of Information proposed by Mark Burgin. The main difference is that Burgin’s descriptive theory still focuses on a strong relationship between what is to be understood as “information” and what is to be understood as “structure”. Structures are conceptualized, classically, as quantitative descriptions of some arrangements of parts (elements) of the entire potentiality of possible compositions of those elements. Burgin focuses more on the local changes of a system and its structure (“In a broad sense, information for a system R is the capacity to bring about changes in the system R.”)

The Causal-Compositional Concept (CCC) of information states that the overall (set of) rules that define any possible and valid arrangement of elements is “information”. In CCC, Luhn’s proposal is to incorporate the overall rules applicable to the evolution of elements as fundamental entities into the concept of information. A given structure displays a “projection” of a law of physical regularity, which describes the unity and physical reason of that structure. Thus information is the causal-compositional process which:

- describes as initial values a particular physical system, its actual state, its potentially possible state space and accordingly, its region of stability, as well as the lawfully regular (and thereby) macrophysically-measurable description of the system,
- describes as further initial values the description of an energetic-material, structural influence on the system,
- describes as the resultant values the physical system, its actualized state, its actualized potential phase space, and accordingly its region of stability, as well as the lawfully regular and thereby macrophysically-measurable actualized description of the system,
- also describes further possible output values (often designated as output signal);
- is brought into a semantical context: *information is an understood message*.

If the environmental conditions change, then the system rearranges its elements and their connections through a new overall pattern. This rearrangement is undertaken by a full-blown, non-algorithmic superposition (“brute-force”). For this reason the structure of the pattern cannot be calculated; it holds a kind of a new idea, which fits to the principle of minimal energy. This compositional concept of non-algorithmic superposition describes the fundamental quality of information, which is the concept for newness.

To summarize Luhn’s position, it is the task of our conscious mind to mediate and drive this process of informational creation. Given this, any newly created information acts as the efficient cause of structurally new chains of action—an inherent solution with regard to the mind-body problem. Luhn’s Causal-Compositional Concept on the one side overcomes the problems and inconsistencies based on non-physical information concepts like Shannon’s (while never the less integrating Shannon’s quantitative base), and on the other side puts primarily subjectively and semantically oriented concepts of information (*i.e.*, Floridi) into a unique physical and logical framework, as proposed by LIR.

Although not yet worked out in detail, one can perceive an ethical impetus coming out of this approach. The reason is that if CCC in correspondence with LIR strives for such envisaged deeper evidence, then the *knowledge* about those circumstances might already deliver portions of energy or potentiality to us. In simple words, if there is a physical basement for the fact that the composition of some atoms towards a molecule will instantaneously deliver the *information* about the newly created, enriched phase space (and without any loss of time; that is: faster than light to all components of the molecule), and if similar processes describe and enable the course of social interaction, than we may conclude that we are committed to accepting this as logical and ontological evidence of a deeply grounded concept of information exchange. This lays down the physical-ontological foundation—the inherent advantages—of fairness and fair acting. Luhn is now working on explications regarding the moral dimensions and consequences from an integration of CCC and LIR, dealing with the dynamics and influencability of affective and reasoned evolution of moral motivation

### 9.3. Smiling

In the Section on the work of Rafael Capurro, I mention his call for a new “humanism”, one that is not based on dry philosophical principles. The use of informational concepts such as Luhn’s adds an essential scientific component to such a debate. As Luhn points out, in this connection, our influence on any future world starts with our daily life: if we create new opportunities we will increase the number of possible states of the universe, the precondition for further reflections. We perceive a specific judgment of such a state of reflection, because such a state has a positive connotation through some kind of natural law.

This is one of the reasons why the act of smiling carries such a positive connotation, because smiling indicates the state of reflection and creation of new insights and what Luhn calls algebras, qualitative sets of real processes which I say follow the logic of LIR. We are doing things right if we make people smile. If we do so, the potential information of the universe will be transformed to a maximum new algebra, offering itself a maximum number of potential activities. Luhn thus argues for non-trivial, trans-materialistic and trans-dualistic but *informational* approach to understand ourselves and our task that we might have to fulfill. When we smile, the universe *itself* is smiling at us [48].

I have not discussed in this paper the concept of art in terms of LIR and information, although I consider it another important task for follow-up to this paper. In order not to have art completely absent, I attach the following poem by Luhn [49]:

#### **The Computer Scientist**

Me, computing guy, well trained in this area:  
 Knowing von Neumann, Turing, Shannon,  
 Struggling on the unknown ocean, facing winds and storms, and controlling all the crews,  
 Sails and oars, with a very new, highly parallelized.  
 Logically wild to control  
 Battery of algorithms and computing agents  
 Then I said to myself, why not dive towards the depth,  
 Leave those anxious-looking fellows behind, giving control to the ocean itself,

And use its immanent forces.  
 Its non-computable gigantic overlays, whose simulation would require computers larger  
 than the universe.  
 And so become turned  
 Toward the human-upright-position.  
 So I—and you—could free our sight and thoughtfulness,  
 While heading toward Atlantis, the unknowable.  
 And from this inherent evidence,  
 Might know, at least

## 10. Humanistic Informatics

### 10.1. *A New Science of Informatics*

In a series of papers presented at the China-Russia Information Science and Information Philosophy Tribune which took place in Wuhan, China in September, 2013, Konstantin Kolin and Zong-Rong Li and their colleagues explored what might be described as the theory of a humanistic informatics, building on prior work in informatics. The lead paper is entitled “The Science, Philosophy and Religion about Information” [50], which two critical statements are made: (1) the basic theory of information science is theoretical informatics and (2) informatics requires the cooperation of philosophy and theology. The theme is developed as, in fact, a new and humanistic approach to the post-modern world, what in Kolin calls a humanistic revolution [51], leading to a corresponding post-modern psychology.

The theory of the authors cited here includes reference to the duality of matter (energy) and information, which does not in and of itself differentiate them from other authors discussed in this paper including Wu, Hofkirchner and myself. The duality is expressed as a mutual contradiction which is not absolute. “The two parties can integrate with each other through constant mutual dependence (or mutual involvement).” This view is not incompatible with Logic in Reality, which, as we have seen, describes somewhat more formally the operation of the contradiction or opposition of the two terms of energy and information at both epistemological and ontological levels.

The problem is then to understand the link between information science and religion defined as a set of beliefs. The terms “religion”, “humanism” and “theology” are notoriously polysemic. Let us look at some of the issues involved.

### 10.2. *Exploring the Interface*

One of the most complicated areas for serious study is at the interface between science and religion, due to the many interpretations of both terms and in addition the factor of belief that enters the second. No synthesis of current trends in information science of the kind attempted here would be complete without some reference to work in this area.

The Metanexus Institute is one respected organization which has as its charter the exploration of this transdisciplinary interface in general. Their series of Essay Contests has often included information and its foundations in the structure of the universe as the subject, and there is an obvious

relation to the basis of the computationalist approach discussed above. In a paper I gave to a Conference on Transdisciplinarity at this Institute in 2008 [52], I pointed out how any discussion in which religion requires belief in some supernatural entity or processes is subject to a basic, well-known paradox.

If this is the case, how should information science be carried out in such a way so that it can accept the contribution that religious believers can make without accepting that it is exclusive of other approaches and world-views? The answer is that there is no answer. The positions, if held to firmly, fail the test of non-separability and constructive dynamic interaction since by definition, neither side can accept, to put it simply, that “God partly exists”. Only non-believers could accept the LIR-based concept that “God does and does not exist” which is a claim about the existence of God only in an onto-epistemic sense.

The believers claim that in antiquity, all thinking was religious thinking, since only the community defined by a common set of beliefs had access to any information, recorded and transmitted orally or later in writing. However, this apparent priority of religious access to information, or, what was same thing, access to religious information, does not, by the simplest of logical rules, establish its validity, except by an obvious semantic drift. To put it another way (and this is my personal belief), part of traditional knowledge correctly described, and continues to describe, aspects of the world and our *Dasein*, but part must be relegated to a lower ontological, if not emotional level. It is the former part where an informational interaction with science-as-such could take place. However, I have not seen any discussion along these lines.

Thus my pessimistic conclusion is that, as for all sciences, not only information science, sincere believers and non-believers are fated, today, to coexist and use their knowledge in as ethical as possible a manner, while evolving in parallel Leibnizian worlds. Just as it is the responsibility of non-believers to respect the validity of traditional insights, especially in the areas of psychology and sociology, it is that of believers and traditionally minded thinkers to avoid falling into the traps of superstition and pseudo-science. Unfortunately, this writer is unaware of other pertinent work in this area. It would seem to be a further task for the philosophy and science of information to develop ways of approaching it.

The situation as regards humanism is much more promising. It corresponds to an easily established and communicated focus on the ethical implications of informational activities, and the informatics of Li and Kolin go so far as to envisage a humanistic revolution. A dissenting note is perhaps that expressed by Capurro, who would like to go “beyond humanism” (see next Section). In my view, by supplementing information theory with messaging theory, Capurro’s approach adds another level of philosophical complexity to the debate. This may be difficult to incorporate in a unified approach, but there can be a dialectic here between two conceptions of humanism. This is simply yet another essential part of any synthesis.

## 11. Angeletics-Messaging Theory

### 11.1. Capurro and the Foundations of Information Science

The trajectory of Rafael Capurro is an integral part of the “story” of information and information science, about the foundations of which he first wrote in 1978 from an etymological perspective and later from a deep philosophical one. His main concept for reflection on the foundation of information science was not information but man, where information is a dimension of human existence. His key article with Peter Fleissner and Hofkirchner on the question of the possibility of a Unified Theory of Information is well-known, as is his “trilemma” of information theories and his major work on information ethics.

### 11.2. The Move to Angeletics

Capurro and his colleagues have moved from a concept of information to one of messages and messaging to describe exchanges between, especially, human beings. The finality of this movement is a more perspicacious grounding of the philosophical and ethical implications of those exchanges. Angeletics is defined by Capurro [53] as the study of messages and messaging, the term and concept being grounded in the classical Greek word for messenger *angellos*. The other key term and concept—message—is derived from the Latin *mittere*, to send. This term is not only more dynamic than that of information as it is usually defined, but implies the triple of sender, message and receiver. Further and more importantly, the choice of the term Angeletics for the study of messages and messaging is to signal the use of a philosophical framework, closest to that of Heidegger, which is ultimately based on the irreducible uniqueness of the individual human consciousness in and of the world.

This approach requires a major redefinition of a large number of fundamental assumptions in philosophy and modern science that have been taken for granted. Summarizing very rapidly, the latter all suffer from having eliminated an essential, qualitative human-relatedness in phenomena in favor of their predominantly reductionist quantitative formulation by modern science in mathematical terms. Recovery from this undesirable state of affairs requires a great deal of philosophical “work”, for example, to restore to the concept of information itself the underlying dynamic change of form that it implies, as has been attempted in this synthesis. I note the convergence of Capurro’s work with that on cybersemiotics of Brier.

For a person to send a message to another, no matter how simple, is a creative act. It is an energetic process that has emerged by overcoming a resistance to doing nothing, or not sending any message. If this is so, the theory of sending messages, messaging or Angeletics must be established according to principles that take into account the creative, value-laden process of messaging. The characterization of the messages themselves is a rather simpler problem, especially in this context. Messages can refer directly to the physical survival of the receiver, or more indirectly to her mental and spiritual well-being. The transmission of such messages, and of the information associated with them, is thus a moral necessity for both sender and receiver.

### 11.3. Logic in Reality and Angeletics

With some minor qualifications in relation to the capability of science, I can accept essentially Capurro's entire thesis. As I have discussed elsewhere [54], for LIR, what makes human beings uniquely human can also be defined by the interactions between individuals in which meaningful messages, in contrast to just the simple information necessary for survival, are exchanged. The concept of messages makes particularly clear the role of man in the universe where there is a physical, as well as a philosophical, ground of those interactions.

Capurro's conception is "not to forget that we are part (or players) of the "angeletic" interplay with and "in" the world. And, this openness to the world means a "restriction" of the infinity of the world. However, if at the same time we understand it as a restriction, we are free to perceive the message of the "whole". This is another way to gain understanding of contradictory phenomena in addition to the dialectical or informational ones discussed above. The freedom we acquire is similar to the increased degrees of freedom, in Luhn's conception, resulting from information about the circumstances of our existence that drive us towards "fairness".

There is thus a difference between information as a selection from a meaning offer and messaging as the offering of such possibility of selecting one possible meaning. This is the reason why Capurro thinks that hermeneutics dealing with the question of understanding messages presupposes Angeletics as dealing with messaging itself. In both cases we have to analyze ethical aspects that concern the different ways in which free (human) beings deal with both, selection and messaging.

### 11.4. Beyond Humanisms

The title of this sub-Section is that of an original article by Capurro [55]. The further interest of Capurro for this review is his emphasis on the essential need for philosophical depth. In his critique of humanisms, it is this dimension that decenters the natural anthropocentric attitude of humanisms that consider it as noise and conceives humans only and originally as senders and receivers of messages about beings. As Capurro writes "From this perspective, humans "are" messengers of Being and the message they pass on is the world, that is to say, a possible way in which messages about beings can be interpreted "as" being this or that within a framework of understanding. Being gives us "as" messengers the potentiality to transcend a given "as" of things or a possible world disclosure. An example of this transcendence are paradigm changes in science when "facts" that are supposed to support and prove a theory are re-interpreted from another, unusual perspective from which now presuppositions, instruments, institutions, traditions, *etc.* are put into question or "falsified". Every being "as" a being shares the world-openness and "is" a messenger. Humans as messengers of Being allow a hospitality for beings to disclose and pass on through the world-openness sharing it in different ways without ever occupying a center, in which case the openness turns closed and the dynamic of the "as" is blocked."

Who are we thus at the beginning of the 21st century? We are a message society, that is to say, a humanity linked via various means of communication, particularly through digital networks enabling synergies of various kinds for human interaction within and beyond political, ethnic, economic and cultural borders and differences, but mostly at war because of such borders and differences. We

humans have produced cultural diversity reflected in academic disciplines we call the humanities. If we want to avoid the pitfalls of humanisms, we must pay attention to the uncanny potentiality of the “as” coming from Being, beyond a fixation on humanisms, in order to render hospitality to humanities in the double sense of the word.

The ethics of universalism can be transformed into one of openness and situatedness. Instead of an ethics of moral imperatives coming from within and beyond the individual, we can develop an ethics of hospitality and care coming from in-between the plurality of humanities articulated in the “here” of a shared world. Instead of looking for strategies of fleeing or mastering the world, it is up to us to take care of it beyond utilitarian calculations. Such an ethics is not about universal laws, but about messages of hope. In short, it is not primarily about us but about a shared world. We are called to make sense of Being. It is an uncanny call and, as far as we know, it is our call—beyond humanisms.

There is a large domain here for scientific study in different sciences and in the humanities. The task as I see it here is to develop further the concepts of messaging, information and the ethics of information and the philosophical relations between them without cutting them off from science. But this is exactly, as Wu has pointed out, the advantage of recasting philosophy itself in informational terms.

## 12. Conclusions: The Best of All Worlds

This paper has presented a synthesis of current theories of information that might be called, although it is awkward expression, a *Unified-Diversified* Theory of Information. I have attempted to show the functional interactions between the valid, most generally applicable portions of several theories, including those of which I am critical. In thinking about information, it is necessary to think in informational terms, as Wu has shown, and then to provide for *change*, change of “mind” or position, of which I have given some examples. Not taking into account the movement that is actually observed in cognitive processes is fatal for any theory intended to correspond to reality and capture at least some of its characteristics. I have also suggested several roles which my Logic in Reality (LIR) might play, for example, in gaining a new understanding of the interactive relation of identity or unity to diversity, an essential point of Hofkirchner’s conception of information.

As in any transdisciplinary approach, the impossibility to discuss any single theory in detail can bring charges of superficiality against the author. It also requires the reader to accept that he or she does not have a full knowledge of some work for which there is a very limited literature. I have tried to anticipate these potential charges, but the paper can only be useful if the reader is willing to suspend his own preconceived ideas about standard, widely accepted views of logic, philosophy and science and indeed of cosmology, e.g., of the existence of a background time and space following the precepts of Special Relativity, or of the absolute necessity of some form of “computational universe”. The uncritical acceptance of such views has had a disproportionately great influence on the course of modern thought, and this is an, unfortunately, scientific fact with which any synthesis such as the one proposed has to deal.

In conclusion, I see this article as a contribution to the process that Hofkirchner calls “informationalization” and Wu calls “informational scientification”, operating on world society to, if possible, raise the level of collective intelligence to be able to cope with the problems arising from its own development. In my opinion, however, the focus must not only be on problem-solving, but

achieving a minimum increase in the capacity of the society to understand itself. The effort to understand information will then have its real justification.

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As far as this paper is concerned, I would like to thank Gordana Dodig-Crnkovic, Gerhard Luhn and Rafael Capurro in particular for their most helpful comments and criticisms.

### Conflicts of Interest

The author declares no conflict of interest.

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