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Special Session "Information Phenomenon" †

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Abstract: The Special Session "Information Phenomenon" (SSIP) at the conference "Theoretical and Foundational Problems in Information Studies" (TFP), a part of the 2021 Summit of the International Society for the Study of Information (IS4SI), was dedicated to the foundational problems in information studies. The abstract (theoretical) models presented in this session addressed the problems of information definition, information quality, hylomorphic theory, structural analysis, phenomenology and ontology of information. In this overview, we outline the models presented in SSIP and published in the Proceedings of the IS4SI Summit 2021 based on the short abstracts submitted by the authors.

Keywords: information definition; information quality; hylomorphic theory; structural analysis; the paradigm of the information discipline; probability; phenomenology; ontology of information

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1. Introduction

In this overview, we outline the abstract models presented in SSIP and published in the Proceedings of the IS4SI Summit 2021 based on the short abstracts submitted by the authors. The order is alphabetical after the names of the first authors and does not reflect the importance of the presented models.

Let us remember that every theory is an abstract model, but not every abstract model is a theory. The more general aspects are modeled by the theory, the more general it is. As Marx Wartofsky remarks, the concept "model" has been used for denotation of the very large class of phenomena: mechanical, theoretical, linguistic, etc., constructions. The term "model" originally denoted the plans of a building in late 16th century English, and derived via French and Italian, and ultimately from Latin modulus, a measure. Wartofsky gave a good definition of the model relation and made clear what were the main characteristics of the models [1]. This definition is as follows: The model relation is triple M: (S, x, y), where "S" is subject for whom "x" represents "y". In other words, only in this relation and only for the subject "S", the entity "x" is a model of the entity "y". The models are simply a special way of reflecting real-world phenomena. Usually the model represents only a side of the phenomenon that is subject to study and omits other aspects that are less important or insignificant. The model is never a completely accurate representation of the real phenomenon. Therefore, there is a danger that the model may sometimes miss significant connections or misrepresent.

2. Overview

2.1. Materialization and Idealization of Information

The purpose of the work [2] is to resolve the described paradox by explaining the connections between the ideal and the material.

The author begins with the global structure of the world. It is modeled by the Existential Triad of the world, which consists of three components: the Physical (Material) World, the Mental World and the World of Structures. The Physical (Material) World represents the physical reality studied by the natural and technological sciences, the Mental World encompasses different forms and levels of mentality, and the World of Structures consists of different types of ideal structures.

While the Physical and Mental Worlds are accessible by the human senses, the World of Structures can only be achieved with the intellect, as Plato predicted. In order to better understand the World of Structures, it is useful to realize its need to complete and clarify the interaction between two sensible worlds. With the stipulation of increasing the sophistication of science and the complexity of the studied phenomena, the world of ideal structures becomes indispensable for the correct understanding of the Physical and Mental Worlds. Starting with physicists who have understood the key role of abstract mathematics in physics, people will begin to understand the necessity and expediency of structural reality.

According to the GTI Ontological Representability Principle, for each piece of information **I** there is always a representation **Q** of that piece of information for a system **R**. Often this representation is material and as a result, being materially represented, the information becomes physical. Therefore, the physical presentation of information can be treated as the materialization of that information.

Furthermore, according to the Ontological Embodiment Principle of the GTI, for each piece of information **I** there is always a carrier C of this piece of information for a system **R**. This carrier is, as a rule, material and this makes the information even more physical. The physical carrier of information can also be treated as materialization of this information or, more precisely, materialization at the second level.

We can now see that the paradox of the existing impact of such an ideal being as information in physical reality is caused by the very popular confusion of information per se, its representations, and carriers.

There is also the process of information idealization, which goes in the opposite direction and is reciprocal, but not always the inverse of the materialization of information.

2.2. Levels of Ontological Information

In General Theory of Information (GTI), the definition of information in the broad sense is given in the *Ontological principle O2* (the General Transformation Principle). In a broad sense, the information for a system R is the potential/cause of formations and transformations (changes) in the system R. Thus, we may understand information in a broad sense as the capacity (ability or potency) of things, material as well as mental and abstract, to change other things [3]. Information exists in the form of portions of information.

To define information per se, the GTI uses the concept of an infological system IF(R) of the system R to define the information. The elements from IF (R) are called infological elements. *Ontological principle O2a* (the Special Transformation Principle). The information in the strict sense or the proper information or, simply, the information for a system R, is the potentiality/cause of formations and transformations (changes) of the structural infological elements from an infological system IF (R) of the system R.

Information in the strict sense is stratified according to the global structure of the world, represented by the Existential Triad of the world, which is composed of the top-level components of the world as a unified whole, reflecting the unity of the world. This triadic structure is rooted in a long-standing tradition coming from Plato and Aristotle and consists of three components: the Physical (Material) World, the Mental World and the World of Structures. The Physical (Material) World represents the physical reality studied by the natural and technological sciences, the Mental World encompasses different forms and levels of mentality, and the World of Structures consists of various types of ideal structures.

The existential triad entails the differentiation of information into two main fundamental classes: ontological information and mental information.

Ontological information is the potentiality/cause of formations and transformations of structures in the physical world, i.e., of physical systems. Since ontological information functions in the physical world, it is natural to treat it as a natural phenomenon. Mental information is the potentiality/cause of formations and transformations of structures in the mental world, i.e., of mental systems. Ontological information is orthogonal and complementary to mental information. Epistemic information, which has been studied by different researchers, is a type of mental information and, thus, it is orthogonal to ontological information.

It is possible to ask a question as to how information belonging to the World of Structures can act on physical systems. To solve this puzzle, authors introduce two levels of ontological information: information IO, which belongs to the World of Structures, and ontological information O, which belongs to the Physical World. Connections between these two levels of ontological information are explained utilizing two more ontological principles of the GTI—the Embodiment Principle O3 and the Representability Principle O4. They postulate the existence of representations and carriers of information, which, in particular, can belong to the Physical World. In this framework, one may see that information O is a physical (material) representation of information IO. Information IO is embedded in physical objects becoming information and acquiring the ability to act on physical systems. In the same way, the mind embedded in the human body is able to operate in the physical world.

2.3. Phenomenology of Information

The purpose of the paper [4] is to lay bare the connection between info-autopoiesis, based on Bateson's difference which makes a difference, and Peircean phenomenology or phaneroscopy.

Info-autopoiesis is the self-referenced process of information self-production that engages all living beings in their efforts to satisfy their physiological and social needs. Bateson's difference which makes a difference incorporates the simultaneity of a quantitative/objective perspective with a qualitative/subjective perspective.

Peircean phenomenology is grounded in the categories of—Firstness, Secondness, Thirdness—which correspond to an exhaustive system of hierarchically organized classes of relations. In brief, the categories can be defined as: (1) "Firstness: what is such as it is, without reference to anything else"; (2) "Secondness: what is such as it is, in relation with something else, but without relation with any third entity"; (3) "Thirdness: what is such as it is, insofar as it is capable of bringing a second entity into relation with a first one in the same way that it brings itself into relation with the first and the second entities".

A congruent comparison between these two approaches requires the examination of a triadic relationship between elements in each approach, as well as establishing relevant connections between info-autopoiesis and phaneroscopy.

2.4. Ontological Information—Information as a Physical Phenomenon

Ontological information is information conceived as a natural phenomenon, i.e., as an element of the physical world. The author of [5] denotes such information with the predicate "ontological" as in "ontological information", as well as by the symbol "IO" and the indexed term "informationO".

The properties attributed to ontological information reflect its physical nature. The author claims that ontological information is characterized by epistemic neutrality (EN), physical embodiment (PE) and formative nature (FN).

The property of epistemic neutrality (EN) means that informationO has no meaning by itself. From specific ontological information, an agent may derive something (some value) that has significance for that agent's existence or functioning. The same ontological information may result in a different meaning for different agents. Likewise, this information may have no meaning at all to some agents.

The claim that "ontological information is a physical phenomenon" means several things. Ontological information is not an abstract concept in the way that mathematical objects, ideas or thoughts are abstract. Ontological information does not belong to the Platonic realm of Forms in either the classic or neo-Platonic sense. Ontological information is real, observable and measurable. Thus, it is possible to claim that information exists much like other physical phenomena exist because they exhibit the same class of properties (quantifiability, operational properties) as physical phenomena do. Furthermore, it seems that whatever exists in a physical sense contains information, so there is no physical phenomenon without information.

Finally, the property of formative nature (FN) means that information is responsible for the organization of the physical world, so information is expressed through structures/forms and the organization of things, but information is not a structure itself. Organization is a fairly broad concept that may be, and is, interpreted as structure, order, form, shape or rationality (if perceived by a cognitive entity). The author does not posit that information is structure, although this has been claimed several times. The problem with such a statement is that we do not know exactly what a structure is and what kinds of structures we would associate with information, as well as how this would be achieved. Information is certainly not the visible structure or shape of an object, but we concede that the shape or structure of an object is how information discloses itself or how we sense its presence. Thus, the shape of a tea cup is not information, but information is being expressed in the shape of a tea cup.

2.5. How Information Creates Its Observer: The Emergence of the Information Observer with Regularities

Vladimir Lerner's Information Macrodynamic (IMD) formalism is the first full application of John Archibald Wheeler's "It from Bit" approach to physical Information processes. The IMD formalism accounts for the evolution of Information physics from Quantum to Classical regimes, showing how intelligence and Wheeler's Observer–Participator are naturally emergent. Distinct from "digital physics" or simple coding–decoding schemes, the IMD formalism presents a continuous step-by-step physics of natural Information processes, from the first distinction to the emergence of the Information Observer [6].

At the beginning of this process, there are no facts about reality. The beginning is hidden in uncertainty. Now, let us imagine a featureless space or field. Of course, this is impossible because in the act of imagination we have made an observation—we have created a virtual object. The leap beyond uncertainty requires an Observer.

Virtual or quasiparticles are emergent.

First, a distinction emerges. Through interaction, and subsequent interactions, a process begins that leads from binary distinctions to Bits, and finally, something in the real world, an It. By interacting with the environment, yes–no actions begin to model Information Bits. In this way, an Information (IMD) process connects the virtual to reality, Information and the Observer.

As Wheeler predicted, the time and space of reality exist as units of Information. Cognition and intelligence emerge naturally, leading to the self-aware Observer–Participator.

2.6. Quality of Information

The change of the structure and/or functionality of an entity is due to the impact of another entity we denote with the notion "*reflection*". The author of [7] pays attention to complex entities with possibilities for self-reflection. To avoid misunderstandings with concepts subject, agent, animal, human, society, humanity, living creatures, etc., he uses the abstract concept "INFOS" to denote each of them as well as all of the artificial creatures that have features similar to the former ones.

INFOS has the possibility to reflect the reality via receptors and to operate with received reflections in its memory. The opposite is possible—via effectors, INFOS has the possibility to realize in reality some of its (self-) reflections from its consciousness. If the following diagram exists, and if it is commutative, then it represents all reflection relations: (1) in reality: entities and their reflections, (2) in consciousness: mental reflections of real or mental entities; (3) between reality and consciousness: perceiving data and creating mental reflections.

In the diagram on Figure 1: (1) in reality: "s" is the source entity and "r" is a reflection in the recipient entity; "e" is a mapping from s in r; (2) in INFOS′ consciousness: "s_i" is a reflection of the source entity and "r_i" is a reflection of the reflection of the "s"; "e_i" is a mapping from s_i in r_i. "s_i" is called "information expectation" and "r_i" is called "information" about "s" received from the reflection "r". Commonly, the reflection "r" is called "data" about "s". "s_i" and "r_i" may be coincident or different. In the second case, some "distance" between them exists. The nature of the distance may be different in accordance to the kind of reflections. In any case, as this distance is smaller, so the information "s_i" is more qualitative. In other words, *the "quality of information" is the measure of the distance between information expectation and the corresponded information*. As the distance $|e_i|$ becomes less, so the more qualitative is the information. The next formula is proposed taking into account that the $|e_i|$ may be a zero: $Q_i = 1/(1 + |e_i|)$.

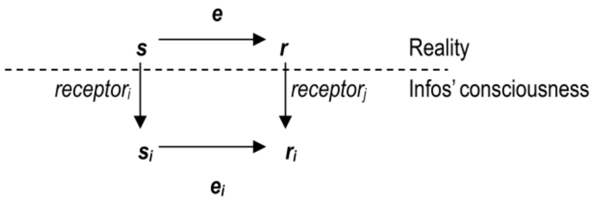

Figure 1. Diagram of reflections.

2.7. What Idea of Information Have the IT Practitioners in Mind?

The author of [8] means to reflect on the divide extant between theoretical studies on information and the knowledge of information shared by ICT (information and communication technologies) professionals. For example, many believe that the Shannon work provides significant support to ICT practitioners, while this myth is fading. The author put forward a new vein of research more adherent to the perspectives of practitioners.

The large divide, perceived between the practice and the theory, raises a certain intellectual desire to know how IT practitioners succeed in building up the astonishing assortment of information solutions. It is natural to wonder: What idea of information do IT experts use? The reason is under our eyes. Manuals and technical books exploit the semiotic notions of signifier and signified. Hardware and software experts invent, manipulate, arrange and process a large assortment of signifiers and signified usually called "forms" and "contents" or "meanings".

How can digital experts employ semiotic notions if they ignore and never mention this discipline? The base notions of semiotics turn out to be self-explanatory. Technicians as well as the common people, have acquired the ideas of form and content at school, and keep these ideas as a cultural background for their whole life.

Information is a key topic in TCS, yet it is treated by fragmentary, abstract and unrelated constructions, i.e., information theory, coding theory, cryptology, etc. It should be good to fill the gap between the philosophical reflections and the practical issues in computer science, and experts in information theory could make an excellent contribution.

2.8. Structural Analysis of Information: Search for Methodology

The main objective of the work [9] is to search for methodological tools for the study of information with the sufficient level of universality to relate studies of information within different disciplines. However, even with this much more restricted objective it is necessary to clarify some misunderstandings present in methodological analyses of practically all scientific disciplines and in all contexts.

The title of this contribution refers to the structural analysis of information as a distinctive methodological tool for two reasons. The first is that this form of inquiry is clearly underrepresented and inadequate in the study of information. The second, closely related reason is that there are many misconceptions about the distinction between different forms of inquiry with surprisingly little attention paid to the role of structural analysis, not only in the study of information but also in the majority of scientific and intellectual domains.

The latter, more general issue that is present not only in the study of information, can be identified in the representative example of the relationship between quantitative, qualitative and structural methodologies.

This work goes beyond the critical review of the hidden but omnipresent elements of structural methodology in the study of information. There is a legitimate question about the positive, creative aspect of the recognition of the role of structural analysis. The source of the conceptual tools necessary for further development of the structural methodology of information can be identified in the invariance with respect to transformations, the main methodological strategy of physics and several other natural sciences. Surprisingly, this idea was completely missing in the work of Shannon but was already present in the 1928 paper by R.V.L. Hartley cited by Shannon in the footnote to the first page. Hartley did not refer directly to structural analysis but used invariance as a tool to derive and to simpler interpret his work than Shannon's formula for the amount of information.

3. Conclusions

In this overview, we outlined the abstract (theoretical) models presented in SSIP and published in the Proceedings of the IS4SI Summit 2021.

From our point of view, the Information Science (IS) is a very large collection of models concerned with the information phenomena. It is very important to model IS itself, i.e., to create appropriate models that give a comprehensive representation of the interrelations between these models.

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