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Why Transdisciplinary Framework Is Necessary for Information Studies? †

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Abstract: Information studies pursuing a unified theory of information are now trapped in dilemmas because of the hard problems of information, which involve purpose, function, referen, value, etc. Pan-informationalism takes information for granted and considers it as a basic property of the cosmos or being priori to physical properties. It avoids rather than solves the problem. The mainstream of information studies takes the position of methodological reductionism that reducing information to a property that can be quantitatively measured. It is helpful but leaves something essential behind. Transdisciplinary approach takes information as a phenomenon has multiple levels and dimensions that cannot be reduced to but complementary to each other. Analogous to principle of complementarity in quantum mechanics, every level and dimension of information cannot be mathematically transformed to each other but are necessary for explaining information. The shifts between different levels and dimensions are not transformation in mathematic sense but perspective conversion like Gestalt switch. They constitute of ecology of information together. In this spirit, Brier's cybersemiotics and Deacon's theory nested hierarchy of information basing on emergent dynamics give us insightful framework to investigate information.

Keywords: information; unified theory of information; pan-informationalism; methodological reductionism; transdisciplinary framework; principle of complementarity; perspective conversion; ecology

1. Introduction

As information is a central unifying concept in science playing a critical role in many disciplines, scholars have a propensity to go beyond Shannon's classical information theory and to develop a unified theory of information (UTI). There is a faith among them that many hard problems involving purpose, function, meaning, consciousness and value can be solved, or be broken through in some aspect at least, with UTI. There are three ontological commitments of information in general: First, defining information as a basic property of the cosmos that it cannot be explained by other phenomenon but can help explain others. Second, information is computable and multiple realized by physical processes. Third, information is a complex phenomenon having multiple levels and dimensions, which cannot be reduced to but are complementary to each other. Correspondingly, there are three strategies to develop UTI: pan-informationalism, methodological reductionism and transdisciplinary approach.

In this paper, I will argue against pan-informationalism and methodological reductionism and argue that transdisciplinary approach is much more promising. The difficulty to solve those hard problems is that the properties involved are hard to be incorporated into scientific theories, while a satisfied theory of information should explain these properties on the one hand and be consistent with those relevant scientific theories on the other hand. The problem of pan-informationalism is that

it actually does not explain information except taking information a priori. In other words, it just names the difficulty rather than solves it. The problem of methodological reductionism is that it leaves something out while this is the very thing we want to explain. That is to say, it just solves the easy part of the problem while leaves the hard part behind.

Transdisciplinary approach takes every level and dimension seriously. Although each level and dimension cannot be reduced to others, it can converse to other levels and dimensions. Such conversion is not transformation in mathematical sense, which actually is a kind of reduction, but a perspective conversion like Gestalt switch. Specifically, information as a complex phenomenon comes across physical, individual and inter subjective level of the world; it has three dimensions: physical, referential and normative. Roughly, these levels and dimensions are one-to-one correspondence. A good way to study information should corporate these levels and dimensions into a coherent framework without taking information as the most primary or leaving something important out. Søren Brier's cybersemiotics and Terrence Deacon's model of nested hierarchy of information are such good transdisciplinary frameworks. Like different species cooperating with and being complementary to each other in a common ecological system, theories explaining different levels and dimensions in these two framework constitute an ecological system for information studies.

2. The Hard Problems of Information

Analogous to his distinction between easy and hard problem of philosophy of mind, Charmers distinguish information into physical and phenomenal aspect as a prototheory of the fundamental theory of philosophy of mind in his monumental work [1]. We will see later that this distinction is very useful for articulating theories in information studies. However, the problems of information are much more subtle than the problems of consciousness.

When Wiener gave his well-known slogan that, "Information is information, not matter or energy," [2] (p. 132) what in his mind is that information is implemented by but does not identify with physical processes, because what is caused physically by information cannot be measured by the energy costed by the information. That is to say, information is not something physical but has physical consequences. Then, what is it? Or what is its place in nature? How much can we understand information in terms of pure physical dynamics? These are ontological problems of information. There are also epistemological problems.

Colloquially, what we mean by the concept of information is its semantic content. This semantic content is "carried" by a sign in semiosis (or sign process, a meaning-making process). A sign has a referential capacity being about something else. The property of multiple realization of semantic content implies that the relation between the sign and the content is not intrinsic. But the relation is stable and reliable enough for players in a community to identify the content from the sign. In Millikan's term [3], some sign has a proper function that transmitting semantic content (as semantic mapping function). Then, the problems are, how can the relation be possible? How does a sign acquire such referential capacity?

As we can see, information studies share many common problems with philosophy of language and of mind, such as reference, meaning, intentionality, etc., it is easy to confuse information with linguistic symbols or signs in general. However, information is essentially different from them because it is intrinsically normative or end-directed. It is not just meaningful but also significant. In Shannon's classical paper [4], information is defined with respect to the selection which is always determined with respect to certain normative criterions. Additionally, a same piece of message (a meaningful sentence, for instance), can be information for one receiver but cannot for others. This is the pragmatic aspect of information.

The problem for UTI is that whether it is possible to solve all these problems in a unified theory. There are three strategies to deal with the problem in general: pan-informationalism, methodological reductionism and transdisciplinary approach.

3. Pan-Informationalism and Methodological Reductionism

An intuitive way to think of information is that, as information is not matter or energy and cannot be reduced to physical processes, it must be a basic property of the cosmos apart from physical properties. This is a strategy similar to the one taken by some philosophers on consciousness known as neo-dualism [1] and new mysterianism [5,6]. Despite of Charmers we have discussed in last section, John Wheeler [7] proposes a kind of information monism that "it from bit", and Tom Stonier [8] takes an explicit position of pan-informationalism that information is a property of the cosmos as basic as matter and energy and is ubiquitous in the cosmos.

The problem of this strategy is that it avoids the real problem rather solves it. It is not promising because we cannot go further on other relevant issues even taking information a priori.

As it is hard to grasp the nature of information, most of the researchers of information take another strategy: methodological reductionism. This strategy admits that information is something different from physical processes, but it is hard to deal with it directly. In order to handle it, they methodologically reduces information to a dimension that is easy to study with mathematics or logic. Shannon [4], for example, defines the quantity of information transmitted by a signal as the impossibility of the signal being selected, and then methodologically reduces the impossibility of the selection to impossibility of the state represented by the signal occurring in information source. Through such methodological reduction, he successfully transforms information to a quantitative attributes. Other mathematical theories of information [9–11] and semantic theories of information [12–14] also stand on this position.

This strategy has gotten lots of profound achievements and promoted information studies tremendously. However, when comes to the qualitative aspect of information, it is powerless or just claims that introducing non-quantifiable attributes to science is illegal. This is more a prejudice than a principle. If we want to explain information in full sense, we should go beyond the strategy.

4. Principle of Complementarity of Information

In order to explain the phenomenon in quantum physics that the particle and wave aspect of physical objects cannot be observed or measured simultaneously, Niels Bohr [15] formulates principle of complementarity that both descriptions of the objects are appropriate and are complementary to each other. An idea implied by complementarity is that it is impossible to regard objects governed by quantum physics as having intrinsic properties independent of determination of measuring tools. This is called "epistemic cut" by Howard Pattee [16]. He argues that the distinction between measuring tools and measured object is priori requirement for science. It is impossible to discuss an object independent of the conceptual system measuring it.

A fact behind the problem of UTI argued in section 1 is that information is a phenomenon with multiple levels and dimensions. Pan-informationalism tries to find information as a kind of entity in these levels and dimensions while methodological reductionism reduces different dimensions to one dimension methodologically. I think all these levels and dimensions of information are necessary for explaining information and complementary to each other according to principle of complementarity. We should consider different levels and dimensions with respect to different methodologies as different methodologies have different scope of application. We can distinguish information process into physical, individual and inter subjective level, and into physical, referential and normative dimension [17]. The former is formulated with regard to the genesis of information while the latter is formulated to function of information.

5. Perspective Conversions

A transformation in general in mathematics means a function. A function is the relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output (https://en.wikipedia.org/wiki/Function (mathematics)). A function is made up by two elements: function and variable (s). $f(x)$, for instance, is a function in which f is function and x is a variable. In the function, the relation represented by f does not vary while the variable x varies. We

can interpret function in the sense of epistemic cut that *f* is the conceptual system while *x* is the object. What *x* will vary depends on *f*. Some function transforms hard problem to an easy one. For instance, Fourier transformation, which is widely used in signal processing, decomposes a function of time (signal) to frequencies that constitute it. It is reductive in nature.

Another conversion often mentioned by psychologists and philosophers is Gestalt switch. Gestalt switch is used by psychologists to describe conscious experience which is globally when a person perceives the world outside. A famous example is "duck-rabbit" figure. If we consider Gestalt switch in terms of epistemic cut, what varies is not the object perceived but the way, or measuring tool/conceptual system, perceiving in contrast to transformations in mathematics.

The conversions from one level to other, from one dimension to other are perspective conversions like Gestalt switch because what changes in the conversions are measuring tools/conceptual system. Zhong [18] calls it intelligent conversion.

6. Ecology of Information Studies

In an ecological system, there are different species occupying different ecological niches. Obviously, every species is a unique living being. No one can be said that it subjects to other species because everyone of them is a subjective being in its Umwelt from the perspective of their own. There are complex relations between different species in an ecology system, including competition, cooperation, symbiosis, etc. In terms of ecology, these species are complementary to and interdepend on each other as a whole, namely the ecological system they constitute.

Analogously, we can compare perspectives of information on different levels and dimensions to species in an ecological system and information studies as a whole to the ecological system. Every perspective is special on its own that cannot be reduced to other perspectives. While for information studies as a whole, they are complementary to and interdepend on each other. This is where the principle of complementarity comes in.

In summary, the requirements a good conceptual framework of information in general should satisfy:

a. It admits that information is something different from but implemented by physical processes and is a complex phenomenon with multiple levels and dimensions;
b. It explains all levels and dimensions of information with proper methodologies rather than mystifies or reduces information to other properties;
c. It explains the relations between these levels and dimensions;
d. It formulates all these explanations into a coherent conceptual framework.

Søren Brier's cybersemiotics [19,20] and Terrence Deacon's model of nested hierarchy of information [17] are such candidates for information.

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