

Information as signs

A semiotic analysis of the information concept, determining its ontological and epistemological foundations

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Abstract

Purpose – The purpose of this paper is to formulate an analytical framework for the information concept based on the semiotic theory.

Design/methodology/approach – The paper is motivated by the apparent controversy that still surrounds the information concept. Information, being a key concept within LIS, suffers from being anchored in various incompatible theories. The paper suggests that information is signs, and it demonstrates how the concept of information can be understood within C.S. Peirce's phenomenologically rooted semiotic. Hence, from there, certain ontological conditions as well as epistemological consequences of the information concept can be deduced.

Findings – The paper argues that an understanding of information, as either objective or subjective/discursive, leads to either objective reductionism and signal processing, that fails to explain how information becomes meaningful at all, or conversely, information is understood only relative to subjective/discursive intentions, agendas, etc. To overcome the limitations of defining information as either objective or subjective/discursive, a semiotic analysis shows that information understood as signs is consistently sensitive to both objective and subjective/discursive features of information. It is consequently argued that information as concept should be defined in relation to ontological conditions having certain epistemological consequences.

Originality/value – The paper presents an analytical framework, derived from semiotics, that adds to the developments of the philosophical dimensions of information within LIS.

Keywords Semiotics, Ontology, Epistemology, Information concept, Semiotic gap, Semiotics of information

Paper type Conceptual paper

A man denotes whatever is the object of his attention at the moment; he connotes whatever he knows or feels of this object, and is the incarnation of this form or intelligible species; his interpretant is the future memory of this cognition, his future self, or another person he addresses, or a sentence he writes, or a child he gets (CP 7.591)[1].

Introduction

The concept of “information” is complex and has been and still is the subject of a philosophical debate that in its core is related to the nature and status of experience. Is it objective? Is it subjective? Do we perceive the world as it is, or to what degree are our perceptions conditioned by our senses and intentions?

Different approaches to the information concept often favor either the objective side or the subjective side; “information,” thus being either objectively true and independent of subjective interferences, or considered to be conditioned by perception, and relative to experience, and therefore situated and conceptual.



The semiotic view put forward in this paper is elaborated from Charles S. Peirce's semiotics. The strong argument for basing our theoretical view on Peirce's semiotics is that it provides us with a holistic view that incorporates ontological conditions as well as making room for epistemological consequences. Consequently, a comprehensive understanding of information would, from a semiotic view, perceive objects of information as signs that hold objective (ontological) features having interpretive (epistemological) features as well.

The triadic structure of Peirce's sign, often formulated as the triadic interrelationship between "representamen," "object," and "interpretant" establishes an understanding of signs that is equally related to being real, as well as interpretation. The object merges with the representamen in interpretation - however, whether the interpretation is true or false is a matter of "inquiry" and "critique."

Let us say that the object in a sign-relation is information of a certain kind. It may be an event or it may be a physical phenomenon of some kind. The object thus possesses the property of being actual. Furthermore, an object motivates a certain perception, that is, an object may be perceived differently by different individuals, thus the perception of an object may be defined as a manifestation of a potential. Say that this object of information is a footprint made by a culprit at a crime scene: the footprint may reveal information about the culprit based on size, weight, gender, etc. This kind of information is qualities that can be identified by thorough and systematic observation; however, some of the observations are based on hypothesis, for example, weight and gender may be assessed by the firmness of the ground, and size. The point is that the information held by the object is real and motivated by the object, but the interpretation of information may differ based on the experience of the investigator, and his background knowledge, or his collateral experience, so to speak. The example also demonstrates that some interpretations are based on synthesis of different "clues" which enable the investigator to formulate more elaborate hypotheses. Again, these hypotheses may be affirmed or rejected, but they are never the less made possible by the actual object of investigation. In semiotic terms, the object is a manifestation of potentiality.

The information concept

To define a concept of information within the context of LIS is by no means a rare endeavor. The information concept and its conceptual presuppositions have been the subject of inquiry and debate among scholars on numerous occasions (see e.g. Buckland, 2005; Capurro and Hjørland, 2003; Floridi, 2011; Brier, 2006a,b; Belkin, 1978). And, as demonstrated by the following discussion of paradigmatic definitions, we are dealing with different concepts based on different formal philosophical and practical conditions. By paradigmatic, we mean that a conceptual view has influenced a particular development of the theory and methodology within LIS.

The diverse approaches and attempts to define an information concept within LIS may lead to frustration, and perhaps a sense of theoretical chaos. One may eventually ask as, as Boell and Ceez-Kecmanovic (2015) do in a recent conference paper whether information is: "[...] beyond a definition?" The paper, based in text studies, demonstrates how different LIS scholars have tried to pinpoint and define the concept of information. We share this "conceptual frustration," however, our take on the information concept is based on pragmatic philosophy, a philosophical approach, that argues for an analysis of the theoretical presuppositions in terms of consequences, practically as well as theoretically.

Because we also condone the practical consequences definitions of information, we appreciate the work done by Buckland (1991). He provides a thorough analysis of the information concept, and bases his analysis in the practical consequences of different understandings of information in relation to LIS. His analysis is condensed by the matrix (Table I) that, in many ways, echoes a classical philosophical debate related to externalism and internalism, where an externalist view of information considers information as objective

and quantifiable, opposed to internalist views that consider information only in relation to perception, interpretation, perspective, context and conceptualization.

As demonstrated by Boell and Cecez-Kecmanovic (2015), the diversity of definitions of the information concept cause reason to wonder if information can be clearly defined at all.

We consider the divisions of information in intangible/tangible and subjective/objective as untenable, and the question about what information is should be understood in relation to ontology and its epistemological consequences.

Based on pragmatic philosophy, our view and contribution to the debate, consider information in terms of semiotics. Semiotically, all information is signs but not all signs are information, and as such, information is the starting point of any meaning creation process whether the process is conscious or subconscious or whether it is scientific or non-scientific. Information is whatever may attract and may become an object of our attention, understanding and memory.

We will argue that a comprehensive theory of information should account for the four aspects discussed by Buckland, however, it should also be robust and theoretically sound. As demonstrated by Buckland, information is, in some situations, considered objective; in other situations, information is considered subjective, intersubjective, discursive and contingent. We believe that part of the confusion of the information concept is due to unclear thinking in terms of ontology and epistemology.

Consequently, we believe that there is more to the concept of information beyond a definition. An understanding of information that transcends nominalism – where nominalism is understood as a philosophical doctrine involving two different standpoints; either there are no universals or there are no abstract objects.

Besides being inspired by Peirce's semiotics and pragmatic philosophy, we are also aware that other LIS scholars have discussed the semiotic theory as part of a comprehensive theory of information. In particular, Søren Brier's (2006a, b) theory of cybersemiotics is an important contribution to a more transdisciplinary understanding of the what information is and its status within communication. Brier's errand is to move LIS from the mechanical information processing paradigm of information retrieval toward a theoretical view which incorporates human cognition, social organization, communication and language. Besides Peirce and Luhmann, Brier also incorporates the theoretical works of Kuhn (1962), Maturana and Varela (1980), and Bateson (1973), to name his most paradigmatic references.

Besides his excellent work in formation philosophy, Brier has also contributed to a critique of the information processing paradigm in LIS, which is based on an objective information concept, involving a general idea of computation, in favor of a semiotic communicational paradigm, where the information concept is dependent on meaningful communication:

We seem to have two completely distinct points of departure for these theories that both aim to be universal. The difference between the two paradigms is fundamental. The information paradigm is based on an objective, quantitative information concept working with algorithmic models of perception, cognition and communication. Semiotics, based in human language's meaningful communication, is phenomenological and dependent upon a theory of meaning (Brier, 2006a, b, p. 4).

Where Brier, in his dissertation, establishes a comprehensive philosophical work, analyzing the semiotics and systems theory, our perspective is more modest and focuses solely on the

Table I.
Four aspects of
information

	Intangible	Tangible
Entity	Information-as-knowledge	Information-as-thing
Process	Information-as-process	Information processing

Source: Buckland (1991)

semiotic relationship between ego and non-ego. And, our view on information differs on essential points. First, our understanding of communication is not exclusively linked to human communication. Humans communicate, and language plays an important part in communicative processes, however, we consider human communicative efforts as the consequences of using, producing and reading signs, the latter includes nature, not only the living nature. One may thus ask: does nature communicate? Our answer is yes – living nature of higher complexities does (sometimes) communicate intentionally, whereas innate nature communicates passively, by being open to interpretations. Second, we disagree with the classical notion that “Information is a difference that makes a difference.” According to our reading of Peirce, information is a sign and a sign is a difference, however, it does not make a difference before it is interpreted. Information requires a cooperation or synthesis between signs of being and signs of interpretation, or in slightly different terms, between objects of perception and a perceiving mind.

The remaining part of the paper is organized as follows: first, we will present an information concept inspired by semiotics. Second, we will demonstrate the conceivable consequences of seeing information as signs. Third, we will introduce the notion “the semiotic gap,” which is a metaphorical expression for the displacement between the phenomenological object of information and its interpretation. Our goal is to clarify that a semiotic theory of information is theoretically and practically robust as it draws attention to the intimate relation between ontological as well as epistemological consequences, and thus avoids what Roy Bhaskar (1978), in his seminal book *A Realist Theory of Science*, names the epistemic fallacy, clashing the ontological status of being into the realm of epistemology.

Some characteristics of the semiotic-inspired concept of information

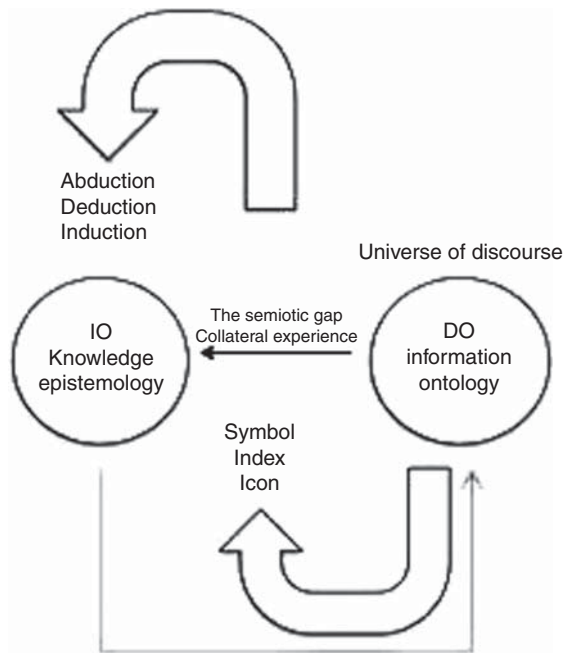
The third quote provided by Boell & Cecez-Kecmanovic suggests that information involves only an epistemological dimension. We disagree with this view as it clashes the ontological being into the epistemological realm of meaning and interpretation.

To escape a similar trap as suggested by Bhaskar, Peirce divided his notion of object into “dynamical object” and “immediate object.” The dynamical object (DO) is the object as it is, being real in its totality. The immediate object is the object perceived at any point in semiosis or meaning creating process. The immediate object thus reveals aspects of interest at a certain point in the semiotic process of perception and understanding. Likewise, the ontic nature of information refers to Peirce’s concept of the DO, and the epistemic nature of information refers to his concept of the immediate object, the latter being an actualization of the former. The semiotic information concept has the implication of information as being real. The DO represents the ontological dimension of information; the immediate object represents the perceived epistemological dimension of information. The immediate object is derived from the DO, consequently epistemology is derived from ontology. Figure 1 summarizes the relation between immediate object/knowledge/epistemology and the DO/information/ontology – also bringing Peirce’s three sign types, icon, index and symbol as well as reference into the picture.

Let us look at Figure 1: beginning with the circle to the right, we have the DO. This object has a being of its own: it is independent of what you and I may feel, think or communicate about it. According to Peirce, the DO has three modes of being: possibility, actuality and generality:

My view is that there are three modes of being. I hold them that we can directly observe them in elements of whatever is at any time before the mind in any way. They are the being of positive qualitative possibility, the being of actual fact, and the being of law that will govern facts in the future (CP 1.23).

Consequently, the DO of information conceived as potentiality is: information is capable of stimulating ideas in the mind of an interpreter or it just is. Thus, its being is not



Notes: The figure suggests a cognitive process involving information (icon, index or symbol) caused by a dynamical object (DO) that via icon, index or symbol enters the mind of an interpreter and leads to an immediate object (IO) and a semiotic gap. The semiotic gap occurs because the interpreter is in doubt: what is this information about? Using forms of inference, the interpreter draws on his/her collateral experience to bridge the gap. The model, as indicated by the arrow pointing from DO to IO, suggests that IO is motivated by DO, thus, epistemology or knowledge about reality is displaced from DO. As such, the model also illustrates that epistemology or knowledge about reality is biased or clouded by collateral experience. We cannot know the world as it is by itself, but only by semiosis or immediate understandings we may establish fallible knowledge about DO. Also, the model places semiosis within a universe of discourse, which is the contextual setting of the semiotic process

Figure 1.
The semiotic gab

dependent upon interpretation. The DO of information conceived as actuality is: information as something that happens here and now, or something that simply possess materiality. The DO of information conceived as generality is: information as generals or thirds: concepts, laws (both natural and social) and habits are all examples of generality.

This is the ontology of information; we may name it passive information, since it's being real does not depend on any active interpreter. For passive information to become active, interpretational signs must carry it; in this case, the signs are either rheme, dicent sign or arguments (EP II: 291)[2].

If we look at Figure 1 again, we have the DO: it is represented by either icons, indices or symbols, and combinations thereof. This means that the semiotic gap is a basic condition – the gap exemplifies the cognitive distance (metaphorically speaking) which exists between the DO of information and the IO of information, or, in other terms, between the ontological nature and the epistemological consequences of information. When information affects a mind, and becomes interpreted, it is no longer passive; it becomes active though the process of cognition and the meaning creation process beginning with perception. The mind works on the icons, indices and symbols, and the processes of inference follow the structure of retroduction (or abduction), deduction and induction. It is noteworthy that the inferences all are related to the immediate object, and that they are related to a similar structure representing the DO (Table II).

Let us return to Figure 1 and say that a mind has been exposed to some information. Based on the ontology of the information, the contextual settings (the universe of discourse) and the collateral experience of the interpreter, an understanding of the information is established. However, what evokes the understanding is the DO. Any understanding of the DO is an IO. Consequently, any IO reveals aspects of the DO, and establishes fallible knowledge about the DO.

Let us explain this by using an example. A book may be identified as an object by its materiality, being a phenomenon, with, for example, a tactile dimension, that makes possible certain interactions – we can hold it in our hands and turn its pages. A book (normally) contains text, which can be read, given the competences of the reader. However, a book may be read and interpreted indefinitely, and one can never state that one reading is the absolute true reading of the book. Time, culture and the collateral experience of the reader play an active role in interpretation. Not even the author can claim to have the right interpretation, since the words used in the book are general and possess an infinite potentiality. However, the book, nevertheless, limits certain interpretations (cf. Eco, 1990) making reliable and true interpretations possible, and thereby also misinterpretation. Plural interpretations may indeed be possible, or the book thus exemplifies a DO and multiple readings IO, however, the DO frames possibility, an interpretation (IO) must somehow be related to the DO by means of similarity, contiguity and generality.

We have shortly touched upon the three types of inferences. In the next section, we will discuss them in more detail.

Dynamical object	Immediate object	Mechanisms
Ontology – passive information	Epistemology – active information (or knowledge)	
Three modes of being	Three modes of being	
Possibility (icon)	Possibility (retroduction)	Relation by similarity
Actuality (index)	Actuality (deduction)	Relation by contiguity
Generality (symbol)	Generality (induction)	Relation by generality

Notes: The table demonstrates the relation between DO and IO, and expresses the structural resemblance between being real and being known. The DO thus being possible, actual or general establishes our understanding of passive information, that is, information that has being independently of perception. The IO establishes its relation with DO by relations of similarity, contiguity or by generality, and the relation is possible only by means of inferences. Similarity is thus recognized through retroduction (or abduction), contiguity is established by deduction (or critique), and generality is defined by induction (or habit). Whenever information is interpreted, it enters the mind of the interpreter causing doubt – and this doubt causes the interpreter to form hypotheses (possibility), deduce consequences from these hypotheses (actuality) and evaluate or test the hypotheses (generality)

Table II.
DO IO mechanisms

Inferences

It seems fair to say that inferences begin at an unconscious level as hunches or retroductions. When dealing with Peirce's concept of abduction, we can see that he gives the concept many names (cf. Paavola, 2014). One of these names is retroduction. We believe Peirce used retroduction instead of abduction or hypothesis when he wanted to stress the element of time within the inferential processes:

Retroductions is the passage of the mind from something observed or attentively considered to the representation of a state of things that may explain it. Its conclusion is usually regarded as a more or less likely conjecture; but it may be a mere suggestion of a question or, on the other hand, it may be the most confident of convictions. The essential point is that the consideration of what is observed or known produces some representation of something not so known (MS [R] 842: 29-30)[3].

Retroduction points to the past, to something that has happened – it points to our experience or what Peirce calls our collateral experience. Bearing this in mind, let us once again return to Figure 1 and present a short case with three different examples:

- (1) A patient comes into a doctor's office to get an examination. The doctor identifies symptoms of malaria and starts a treatment.
- (2) A patient comes into a doctor's office to get an examination. The doctor does not identify symptoms of malaria and the patient leaves again.
- (3) A patient comes into a doctor's office to get an examination. The doctor does identify symptoms of a bad cold.

Before we comment on these three examples, we need to know that the patients does indeed have malaria.

In the first case, the doctor discovers information (symptoms of malaria) that points to the DO (the disease). The symptoms he discovers are symbols dominated by indices. He is in doubt (to some degree may be just slightly) – what kind of disease is this, if any? The doctor interprets the symptoms: a semiotic gap exists. He then creates a hypothesis (retroduction); he asks the patient of his whereabouts, has he recently been to countries where the “malaria” mosquito lives (*Anopheles stephensi*)? He deduces some conceivable consequences from this hypothesis – if malaria – then these symptoms (deduction). Finally, he initiates some tests, for example, X-rays, a microscopic investigation of blood samples, etc. – all inductive methods; consequently, he evaluates his initial hypothesis. In this case, there is an intricate relation between the DO (malaria), the information it involves (icon, index and symbol) and the semiotic gap, caused by the information and the inferences he makes trying to overcome the semiotic gap enough to make a diagnosis. The gap can only be bridged based on the background of collateral experience and through inferences. The doctor is not able to affect the ontological dimension of the disease even though he, in this case, may be able to treat the disease. Our point is that when there is a disease called malaria, it will have an ontological dimension, which is what it is, in itself and by itself, regardless of any medical stand and its knowledge concerning the disease.

In the second example, the doctor does not identify the information caused by malaria and he sends the patient home again without any further actions. Here, the doctor oversees the information and does not detect the disease. The disease exists independently of the doctor's examination. The process will, in this situation, not go further than the existence of the DO.

In the third example, the doctor misinterprets the information pointing to the disease. Based on the symptoms caused by DO, he misinterprets the symptoms and comes to a wrong conclusion. The process runs all the way from the DO, through the symptoms, causing a semiotic gap, and the doctor uses his collateral experience to make inferences even though they are wrong.

Concerning the first conclusion “The patient may have malaria,” we have all three types of inferences represented. The initial observation of the symptoms of the patient compared with the doctor’s collateral experience – his hypothesis (retroduction) finding the symptoms; then follows deductions, and after that comes the general conclusion, “this is malaria” (induction). Here we have sketched the inferences in a professional context; however, these inferences take place all the time – in our waking as well as our unconscious life; the inferences are always inter-related and integrated, and they are based on information which affects our minds. Furthermore, the inferences bring unity to our conception of time and our conception of information: retroduction points to the past (our collateral experience – our ego), deduction points to the present (the here-and-nowness of our perception – brought on to us by non-ego, information), while induction points to the future (what may follow from observations and the information mediated by cognition) (Figure 2).

Understanding the inferences as a natural and central part of the meaning creation process (or the process of signification), we can place the inferences in relation to our semiotic-inspired concept of information, since information is, as said before, what initiates every process of signification (Figure 3).

As stated above, it is important to notice that inferences can be entirely subconscious and they most often are. You have a feeling of familiarity with the object you experience – for example, you see a spot in the horizon and it seems to be a dog (M): this is an retroduction based on hunches, you will tie your hunches to earlier experiences, you have probably seen a dog in the distance before running around playing – your memories involve similar observations (S), and you will make deductions (conceivable consequences of the hypothesis); and, finally, you will interpret this experience to be of the same general kind – the spot in the horizon is a dog (M is of the nature of S), which is an induction (you evaluate your hypothesis). In his Cambridge Lectures on Reasoning and the Logic of Things, Peirce formalized the initial part of this process in the following way:

Anything of the nature of M would have the character {p}, taken haphazard, S has the character {p}; Provisionally, we may suppose S to be of the nature of M.

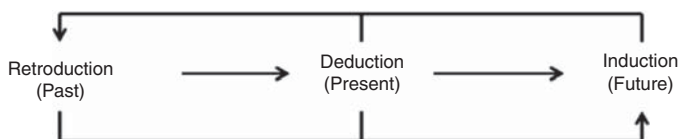
Still more convenient is the following conditional form of statement:

If {m} were true, {p}, {p}', {p}" would follow as miscellaneous consequences -

But {p}, {p}', {p}" are in fact true;

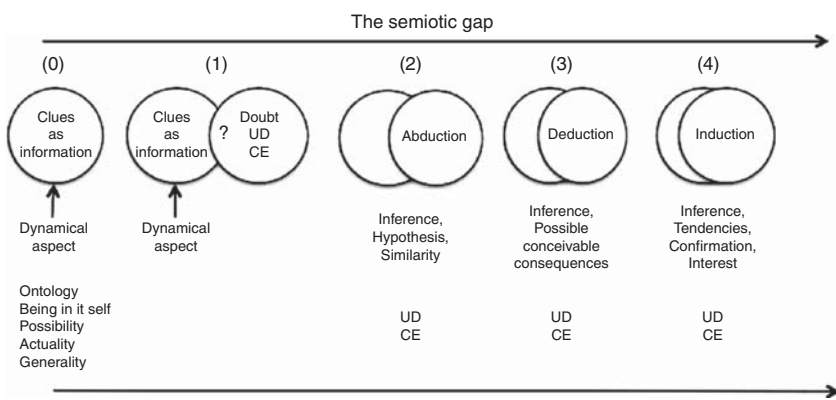
Provisionally, we may suppose that {m} is true.

This kind of reasoning is very often called *adopting a hypothesis for the sake of its explanation of known facts*. (RLT 140)[4]



Notes: The figure shows the temporal modes and the relations of the modes of inference. Retroduction points to the past—collateral experience or ego. Deduction is brought onto us by something outside ourselves, which is non-ego or information. Induction is our cognitive ability to make a general to mediate between ego and non-ego creating knowledge

Figure 2.
The temporal modes
of inference



Notes: UD, universe of discourse; CE, collateral experience. Every process of meaning creation begins with information, the dynamical aspect that catches our attention and leaves us in doubt (to some degree); in order to overcome this doubt, we infer as follows: we make hypotheses, we deduce conceivable consequences of these hypotheses and, finally, we evaluate our hypotheses. This process never ends as long as we are capable of feeling, acting and thinking. As we gradually learn more and more about the dynamical object (hopefully), the immediate object slides more and more over the dynamical object, which means that we are closing in on the dynamical object (or we are representing the dynamical object more and more fully) – one central point is, however, that the semiotic gap can never be fully filled, there will always remain some potentiality in the dynamical object that we cannot convert to knowledge, that is, a lot of things can make us happy, however, the sum of these things cannot actualize the full potential of happiness

Figure 3.
The semiotic
gab elaborated

However, as stated above, it is not possible to make retroductions out of nowhere – they occur forced onto our minds by information; information that will be compared (mostly unconsciously) with our collateral experience. This makes the concept of collateral experience very important – because it is the “width and depth” of our collateral experience that determine the “distance” of the semiotic gap. The more you know of something the smaller the gap will be, hence, the less your doubt will be; on the contrary, the less you know, the wider the gap will be, and the more you may be in doubt. To fill the gap, overcoming our doubt, inferences are needed.

Summing up, based on the semiotic view presented, information is what begins any process of meaning creation; it is what causes inferences to take place (even our perceptions are modes of unconscious inferences). Information is secondness or non-ego to firstness or ego and it is cognition that mediates between the effect of the information and the information itself. Or we might say that information has two different, but sometimes inter-related dimensions. This is summed up in the following table (Table III).

Ontology/epistemology Basic categories	Ontology Information	Epistemology Signification	Epistemology Inference
Thirdness	Symbol	Cognition	Induction
Secondness	Index	Non-ego	Deduction
Firstness	Icon	Ego	Retroduction

Table III.
The ontology/
epistemology of
information

Notes: Let us call the two last rows, signification and inference, the cognitive categories. Information is non-ego and does not belong to the cognitive categories but it is a condition for the cognitive categories, and the categories stand in a continuous relation to each other. The first row consists of the general categories – nature’s own categories – which function at all levels both ontologically and epistemologically

Conclusion

As stated in the beginning of this paper, the concept of information is complex and has been discussed within LIS on numerous occasions, and the debate has, as demonstrated, evolved around information seeking/searching, communication and knowledge. Our semiotic analysis has demonstrated that part of the confusion of a clear information concept is due to a mismatch between subjective and objective perspectives. Also, our analysis has shown that a focus on the objective or subjective side leads to either ontological or epistemological fallacies. In our view, an information concept should be defined ontologically having certain epistemological consequences.

The semiotic view introduces the concept of being as the DO, which holds the potentiality for numerous immediate objects. In other terms, any sign of being has multiple possible interpretations; however, this possibility precedes interpretation. It is information as DO that evokes the meaning creation process, it draws our attention and it will put us in doubt (to some degree), thus introducing the semiotic gap. We will – by aid of inferences – try to close the gap as much as we can and as much as we need. This gap may never be closed fully, however, it may be closed sufficiently for us to make sense of the given information. Yet, the information will be what it is, by itself and with itself.

Notes

1. CP: short for “Peirce’s Collected Papers,” followed by notation of volume and paragraph (Peirce, 1958-1966).
2. EP: short for “Essential Peirce: selected philosophical writings” (Peirce, 1992a).
3. MS = Peirce, Charles S. (1963-1966, 1979). The Charles S. Peirce Papers (30 reels, 3rd micro-film edition) Cambridge: The Houghton Library, Harvard University, Microreproduction Service (In-text references are to MS, followed by manuscript number according to Robin).
4. RLT: short for “Reasoning and the logic of things” (Peirce, 1992b).

References

- Bateson, G. (1973), *Steps to an Ecology of Mind*, University of Chicago Press, Chicago, IL.
- Belkin, N.J. (1978), “Information concepts for information-science”, *Journal of Documentation*, Vol. 34 No. 1, pp. 55-85.
- Bhaskar, R. (1978), *A Realist Theory of Science*, Harvester Press, Sussex.
- Boell, S.K. and Cecez-Kecmanovic, D. (2015), “What is ‘Information’ beyond a definition?”, *ICIS Thirty Sixth International Conference on Information Systems, Fort Worth, TX*, pp. 1-20.
- Brier, S. (2006a), “Cybersemiotics: why information is not enough! A transdisciplinary approach to information, cognition and communication studies, through an integration of Niklas Luhmann’s communication theory with C.S. Peirce’s semiotics”, doctoral thesis, CBS, Copenhagen.
- Brier, S. (2006b), “The foundation of LIS in information science and semiotics”, *Liberas*, Vol. 6 No. 1, pp. 1-26.
- Buckland, M. (1991), “Information as thing”, *Journal of the American Society for Information Science*, Vol. 42 No. 5, pp. 351-360.
- Buckland, M. (2005), “The philosophy of information”, *Journal of Documentation*, Vol. 61 No. 5, pp. 684-686.
- Capurro, R. and Hjørland, B. (2003), “The concept of information”, *Annual Review of Information Science & Technology*, Chapter 8, Vol. 37, pp. 343-411.
- Eco, U. (1990), *The Limits of Interpretation*, Indiana University Press, Bloomington, IN.
- Floridi, L. (2011), *The Philosophy of Information*, Oxford University Press, Oxford.

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- Kuhn, T.S. (1962), *The Structure of Scientific Revolutions*, The University of Chicago Press, Chicago, IL.
- Maturana, H.R. and Varela, F. (1980), *Autopoiesis and Cognition: The Realization of the Living*, Reidel, London.
- Paavola, S. (2014), "Fibers of abduction", in Thellefsen, T. and Sørensen, B. (Eds), *Charles Sanders Peirce in His Own Words: 100 Years Of Semiotics, Communication and Cognition*, De Gruyter Mouton, Boston, MA, pp. 365-371.
- Peirce, C.S. (1958/1966), *Collected Papers*, Belknap Press of Harvard University Press, Cambridge, MA.
- Peirce, C.S. (1992a), *The Essential Peirce: Selected Philosophical Writings*, Indiana University Press, Bloomington, IN.
- Peirce, C.S. (1992b), *Reasoning and the Logic of Things: the Cambridge Lectures of 1898*, Harvard University Press, Cambridge, MA.

Further reading

- Liszka, J.J. (1996), *A General Introduction to the Semeiotic of Charles Sanders Peirce*, Indiana University Press, Bloomington, IN.

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