Phenomenological Computation?

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> Upshot • The main problems with info-computationalism are: (1) Its basic concept of natural computing has neither been defined theoretically or implemented practically. (2). It cannot encompass human concepts of subjective experience and intersubjective meaningful communication, which prevents it from being genuinely transdisciplinary. (3) Philosophically, it does not sufficiently accept the deep ontological differences between various paradigms such as von Foerster's second- order cybernetics and Maturana and Varela's theory of autopoiesis, which are both erroneously taken to support info-computationalism.

« 1 » I have had the pleasure of discussing the info-computational (or pan-computational) paradigm several times before (Brier 2011a, 2013a, 2013b) in writing, and orally at several meetings and conferences, with my colleague Gordana Dodig-Crnkovic, and watched her paradigm develop to the present stage. See, in particular, Brier (2008), where most of my arguments present here are developed in greater detail.

« 2 » I find this article's transdisciplinary goal admirable, but also find its idea of an all-encompassing computation process for nature, society and consciousness to be too reductionist. This is first of all because the paradigm does not include first person experience or the phenomenological aspect, which I find crucial for human intersubjective production of knowledge and meaning. Secondly, because its idea of natural computation is a mere postulate based on a reductionist belief in present computers' production of what is called artificial intelligence to be the core of human cognition This paradigm gave rise to the reductionist view of cognitive science based on information processing. In latter years, the development of cognitive science has moved into brain sciences. It is now trying to model and emulate human emotions on one hand and one the other to correlate registration of neural activity with human first person experience, comparing analysis of behavior and linguistically based reports of experience – not the experience itself, which we cannot measure. But the idea of a general info-computation is a research program without any theory of what such a common denominator for all natural, social and conscious processes that have to go beyond the possibilities of a Universal Turing Machine should be, except some sort of universal concept of information processing. So far, it does not contain a theory of conscious awareness and meaning. The whole phenomenological and hermeneutical aspect of reality is not only missing, but simply not recognized and accepted as crucial to such a transdisciplinary paradigm. This is a considerable blow to its transdisciplinary aspiration in the sense of Basarab Nicolescu's (2002) *Manifesto of Transdisciplinarity*. To put it in another way, I do not think that "Messages are just a very special kind of information that is exchanged between communicating agents" (§18) but on the contrary, that information is a part of meaningful cognition and communication.

« 3 » I also find info-computationalism's blend of a sort of computational realism – even if it is only a variant of epistemic structural realism – with a declared constructivism based on, especially, second and third order cybernetics, paradoxical and confusing. This is of course because I base my views on a Peircean triadic pragmaticist semiotic realism that considers information only as a component of semiotic processes, which always include meaning.

« 4 » I am also a doubtful about the soundness of combining the idea of computation with the self-organizing paradigms of general system science and non-equilibrium thermodynamics, as long as this new conception of natural computation – call it actor-model or a general notion of computation – is not produced. It is like selling the skin before the bear is shot. After all, the concept of computation is developed on the basis of the Turing machine, which is not self-organizing but a fixed structure created and organized by the human mind. Although robots can be programmed to function with each other in self-organizing ways, the Turing machine in itself is sequential and linear; the problem is that most natural processes of the living systems are not. There is a huge gap between these two conceptual worlds. I do understand the need to bridge or merge them. But the mere talk of "if we had a model for natural computation" is not enough. It rather avoids the deep problem in my view. See, for instance, the many discussions about this in Swan (2013).

« 5 » As part of the group that has developed the idea of biosemiotics, I am inclined to believe that biosemiotics is a much better research strategy for understanding what sets the processes in living nature apart from computers and the processes in inanimate nature, namely that they are Peircean triadic semiotic. Heinz von Foerster is used as part of Dodig-Crnkovic's argument such as in §14: "…we see that information processing corresponds to von Foerster's operation on 'objects,' or their representations, 'symbols.'" However, he did not see computation as information processing either (Brier 1996). He wrote very critically against the general information concept. I therefore think he is misused here as a supporter of info-computationalism.

« 6 » From a Peircean ontology of continuity and view point of fallibility of all general knowledge, it is also worth remarking that mathematics and science are finite disciplines and are not identical with or prior to reality as such. We live in an immanent frame, which we continually expand and attempt to understand. Experience and cognizing reality is the starting point of all thought and cognition – not computation in my view.

« 7 » In the same way, I wonder how Dodig-Crnkovic uses the concept of "observer" (is a robot an observer?) and I do not think she interprets Floridi correctly here (§19) or Wheeler just after that (§20). His "it from bit" is based on a participatory universe, not a computer metaphor. Deep ontological issues seem to be treated a little superficially here. Pan- and info-computation views attempt to remove all mystery from the world by postulating computational agents without any experiential awareness. In §23 Dodig-Crnkovic claims: "Information is the difference in one physical system that makes a difference in another physical system," and a little later speaks of functional responses only. But then she re-

turns to her inspiration from second-order cybernetics that all information is observer dependent but that observer is never an experiential phenomenological first person one. In some other places Dodig-Crnkovic writes about perception as if subjective experience is taken for granted, but it does not really exist in the implicit paradigm the whole paper is written on. It is much as in Ernesto Laclau and Chantal Mouffe's (1985) discourse analysis, where the subject is what fills out the holes in a chain of arguments (Laclau 1990). It works like a negative definition in the hope of an "intuitive processor" as a form of neural network non-symbolic processor type of computation (§32) – now introducing biological (probably cybernetic) agents. As a biosemiotician, I agree that all biological systems produce knowledge, but not from the understanding of them as autopoietic machines (Brier 1995, 2011b).

« 8 » There are some further cases in which Dodig-Crnkovic may have misquoted other scholars. Humberto Maturana does not accept an information processing view either; neither did Francisco Varela, who was influenced by phenomenology. So they are misquoted here, even though their insights fit well with von Foerster's eigen-values and eigen-behaviors, and Luis Rocha's further development of his cognitive cybernetics. In §56 Stanley Salthe's pan-semiotism is ignored and instead he is portrayed as supporting constructivist info-computationalism. In reply to my earlier criticisms, Dodig-Crnkovic uses David Chalmers informational model of consciousness but misses mentioning his doublet aspect theory of information, which is pretty different from hers (although I do not agree myself with the way he introduces the experiential aspect). She deals with the doublet aspect philosophy in §62 with the help of the concepts *exo-* and *endogenic*, thereby dodging the experiential aspect of awareness. Dodig-Crnkovic combines the endo-exo-model with Gregory Bateson's "information as a difference, which makes a difference" omitting the fact that it applies only for a cybernetic mind that does not contain first person experience and qualia (Brier 1992). In §64, subjectivity becomes a question of levels, though such a qualitative emergent ontological organismic system thinking is not introduced or argued, but is again postulated in §65.

« 9 » In §66, intersubjectivity is seen as primary to first person subjectivity, which to me is the prerequisite for intersubjectivity and language. Here, however, it is made informational. This is an interesting attempt to place first person experience and perception as well as meaningful communication in a corner of a basic physicalistic information world view. But first person experience and meaningful communication are the prerequisite for the information science from which the info-computational view is argued. It is not the other way round.

« 10 » In general, I cannot help the impression that the philosophy behind info-computation is mixing apples, pears, and bananas by arguing that no matter how their taste is experienced, they are all fruits and that is the basic fact on which we should build transdisciplinarity.

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A Mathematical Model for Info-computationalism

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> Upshot • I propose a mathematical approach to the framework developed in Dodig-Crnkovic's target article. It points to an important property of natural computation, called the multiplicity principle (MP), which allows the development of increasingly complex cognitive processes and knowledge. While local dynamics are classically computable, a consequence of the MP is that the global dynamics is not, thus raising the problem of developing more elaborate computations, perhaps with the help of Turing oracles.

How can a mathematical approach to info-computationalism be developed?

« 1 » Gordana Dodig-Crnkovic proposes an info-computational framework for approaching cognition in living organisms and in embodied cognitive agents of any kind: the environment affords potential information that the agent can integrate into actual information and transform into knowledge by natural computation; perception acts as an information-processing and learning device, through dynamical processes of self-organization of the agent. While the objective is clear, the article remains in an abstract setting, without illustrating it with specific situations, and it does not raise the problem of mathematical modeling, with its possible contributions to a better understanding of the situation.

« 2 » Here I propose such a mathematical approach, namely the bio-inspired *Memory Evolutive Systems* (MES) methodology, which we have been developing for 25 years (cf. Ehresmann & Vanbremeersch 2007). It is based on a "dynamic" category theory, a recent mathematical domain (introduced by Samuel Eilenberg and Saunders MacLane in 1945) that stresses the role of relations over structures. It identifies some important properties of information processing and natural computation not discussed in the article, and shows their role in the non-(Turing-)computability of the global dynamics of the system.

Memory Evolutive Systems

« 3 » An MES gives a constructive model for a self-organized multi-scale cognitive system that is able to interact with its environment through information processing, such as a living organism or an artificial cognitive system. Its dynamics is modulated by the interactions of a network of specialized internal agents called *co-regulators* (CRs). Each CR operates at its own rhythm to collect and process external and/or internal information related to its function, and possibly to select appropriate procedures. The co-regulators operate with the help of a central, flexible *memory* containing the knowledge of the system, which they contribute to develop and adapt to a changing environment.