348 OPC on "Foresight Rather than Hindsight? Future State Maximization As A Computational Interpretation of Heinz von Foerster's Ethical Imperative" by Hannes Hornischer, Simon Plakolb, Georg Jäger & Manfred Füllsack

The Relation between Future State Maximization and von Foerster's Ethical Imperative

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Abstract: I review von Foerster's (bio)computational approach to cognition in relation to foresight and hindsight, and to his Ethical Imperative. For him ethics must remain implicit and becomes manifest through metaphysics and dialogics. Only under this condition the relevance of Future State Maximization for the system that is modelled can be established.

Cognition and computation

1. In "Notes on an Epistemology for Living Things" (Foerster 2003: 247) von Foerster describes cognitive processes as recursive computation, the eigenvalue of which is that what we refer to as the physical world. He takes "cognition for representing something which is computing a reality" (quoted in Müller 2008: 64). However, "[o]bjects and events are not primitive experiences. Objects and events are representations of relations" (Foerster 2003: 250). That which in everyday speech is referred to as the "external world" manifests itself through computations of specific relations which are representations of those relations: "Reality appears only implicit as the operation of recursive descriptions" (ibid: 216). The nervous system is (self-)organized so that it computes "a stable reality for an agent" (ibid: 244).

2. Von Foerster argues for recursive computation as an underlying principle of all cognitive processes, *of life itself*, as he illustrates on the evolutionary examples of independent sensorimotor units in protozoa (Foerster 2003: 217). Very much ahead of his time, von Foerster conjectured "molecular computation" arguing for the importance of molecules in the dynamic of cognition (ibid: 130). It is very important to note that von Foerster's notion of computation corresponding to biological processes denotes "any operation (not necessarily numerical) that transforms, modifies, rearranges, orders, and so on, observed physical entities ('objects') or their representations ('symbols')" (Foerster 2003: 216). About ordering he distinguishes between two levels:

> "The one is when we wish to make a description of a given arrangement of things. The other one when we wish to re-arrange things according to certain descriptions. It will be obvious at once that these two operations constitute indeed the foundations for all that which we call 'computation'." (ibid: 194)

3. Talking about computation processes in living organisms, von Foerster (2003: 194) argues that living organisms interact with their environment in one or both of the following ways:

- developing "languages" (sensors, neural codes, motor organs, etc.) increasingly adapting to the environment, and/or
- changing the environment according to their own needs.

He adds that "whatever option they take, *it will be done by computation*" (ibid, my emphasis).

4. Since biological systems have a recursive organization, programs in biological computers also can be computed on, so there are "metaprograms," "meta-metaprograms," etc. This is the kind of relationships found in organization of neural interactions. It is, according to von Foerster (2003: 70), "to a certain extent, the genetic program that produces anatomical – read 'geometrical' – constraints which prohibit, within certain limits, arbitrary developments of conceivable structures."[1]

Modelling physical objects and properties

5. In von Foerster's biocomputational definition of life, physical objects are at the bottom of computational recursion which constitutes cognitive processes. The more evolutionary developed (complex) organisms, the more levels of recursive computations and programs. Simple unicellular organisms such as bacteria are at the bottom of the computational hierarchy. Computational building blocks are molecular computations that constitute life processes of a cell. For a bacterium, its body serves as a model, in the sense of Rodney Brooks's "the world is its own best model" (Brooks 1991). His insectoid robots similar to Braitenberg's vehicles (Braitenberg 1989) function well without internal models of their environment. These cases are in contradiction to Hannes Hornischer et al.'s claim in §1 of their target article, "that space and time are constructions emerging from the use of models." Rather, for a bacterium space and time emerge directly from physics.

6. One of the abilities of biological systems that Robert Rosen (2012) studied is anticipation. Bacteria are learning directly through their adaptive morphology and by exchanging pieces of genetical code. They are an example of computation that "transforms, modifies, rearranges, orders, and so on, observed physical entities" (Foerster 2003: 216).

7. In more complex organisms, responses to environmental changes are computed recursively at different levels of organization, where memory and hindsight, together with perception and logical inference help to build foresight, anticipate and examine possible actions before executing them in the environment.

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[1] These insights into the nature of cognition as bio-computation make von Foerster the antecedent of contemporary natural computing and morphological computing (Dodig-Crnkovic 2017).

Ethics as an "underground river"

8. In their target article Hornischer et al. present Future State Maximization as a computational interpretation of Ethical Imperative, "Act always as to increase the number of choices." As they note in Footnote 1 later von Foerster changed it to separate ethics from morality. In an interview with Bernhard Poerksen he was very explicit about it:

> "I didn't choose my words very carefully when I said that. It would have been better if I had written, 'Heinz, act always as to increase the number of choices'." (Foerster & Poerksen 2002: 37)

9. With this, von Foerster expresses the idea that ethics must be in the background, serving as a basis, where it remains implicit. He referred to it as the "underground river of ethics" (Foerster 2003: 291). Only with the help of what he calls "metaphysics" and "dialogics" ethics can become manifest without becoming explicit. (Foerster 2003: 291). Von Foerster's *metaphysics* has a very specific meaning as it emerges in the realm of undecidable questions: "[W]e become a metaphysician any time we decide upon in principle undecidable questions" (ibid) which leads to his metaphysical postulate: "Only those questions that are in principle undecidable, we can decide." With this von Foerster draws attention to the necessity of choice, and that the concept of objectivity is nothing but a pretext for avoiding responsibility that comes with choice.

10. In *dialogics*, language reaches out to the others as the "root of conscience," such that "ethics invisibly manifests itself through dialogue" (Foerster 2003: 297). This communicative, social aspect of ethics is necessary, and it is implemented in a feedback loop where shared values are negotiated through a dialogue.

11. The maximization of future states is thus a metaphysical mechanism, but on top of the metaphysical principle there must be dialogics to provide context in which shared values are embedded, and to provide criteria for which of the many choices are good.

12. The connection made in the target article taking Future State Maximization to be a computational interpretation of von Foerster's Ethical Imperative prompts the question about how representative such a computational model can be for human agency. Here the historical connection can be instructive. In spite of being aware that autopoietic systems require embodiment, Ricardo Uribe, back then working in von Foerster's Biological Computer Laboratory, wrote the first computer programs that visualized autopoiesis (Varela, Maturana & Uribe 1974). The authors must have considered the model sufficiently representative of biological autopoietic mechanisms. But how far can one drive interpretations based on analogy between simulation and a physically embodied cognitive system when it comes to *human ethics*? If we follow von Foerster, the dialogic aspect must come in, establishing the relevance for the system that is modelled.

13. To summarize, given von Foerster's understanding of life as a bio-computational process one should acknowledge different organizational and functional levels of computational processes in living systems, from bacteria to humans. Evolutionary,

cognitively and historically there are clear differences between human ethics to which von Foerster refers, as a result of dialogic process providing criteria for maximization of choices and optimization processes such as suggested in the target article.

Foresight and simulation models

14. Foresight (the ability to foresee and prepare adequately for the future) is a result of envisaging possible futures so to be prepared to act under various scenarios. This acting will necessarily alter the future options as we are intervening in a dynamical and unpredictable system, "the white water world" (Pendleton-Jullian & Seely Brown 2019). In the spirit of cybernetics, one is navigating unknown waters which demands flexibility, agility and adaptation, thus both changing ourselves and changing the world around. Needless to say that in the current Covid-19 crisis foresight is essential, as we must act, and waiting for certitude about the current and the future situations can cost human lives.

15. What makes simulations important today, is not their internal maximization of space of choices for the agents in the model, but their connection to the problem they are a model of, thus providing good tools for foresight. Having maximal freedom of exploration within the model space does not guarantee the adequate solution of the problem that is modelled. In the case of Covid-19 pandemics, computational models were indeed used for foresight and they helped to understand possible future developments (Squazzoni et al. 2020). Along with the exploration of the space of possible future states, the dialogical process of examining values of possible alternative futures is central. In that process hindsight informs the foresight, while lessons learned from acting upon foresight form the basis for the future hindsight in a circular manner.

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