

ANTICIPATION CONCERNS US ALL

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Many years ago I wrote: *Among the scientists dealing with animate systems, it was a biologist--Ludwig von Bertalanffy--who long ago perceived the essential unity of system concepts and techniques in various fields of science....* Professor Nadin took early on a system's view of anticipatory processes. When he joined us at BISC (University of California at Berkeley) he had a good record of work in fuzzy logic and possibility theory—his articles reached me sporadically, and were always thought inspiring. Masoud Nikkravesh, BISC Executive Director during Nadin's fellowship, in writing about the evolution of fuzzy logic associated Professor Nadin's book *The Civilization of Illiteracy* to the work of our group. Indeed, in spirit, this is an example of how we can deal with important matters from the perspective of their implicit imprecision. The quote from my article from 1962—while I was focused on control systems—begs for an addition:

[...] The work of Bertalanffy and the School, being motivated primarily by problems arising in the study of biological systems, is much more empirical and qualitative in spirit than the work of those system theorists who received their training in exact sciences.[...] There are some who feel that this gap reflects the fundamental inadequacy of conventional mathematics.

Professor Nadin will recognize in these words what years later we discussed many times. He and I share in the realization that [...]. *We need a radically different kind of mathematics, the mathematics of fuzzy or cloudy quantities that are not describable in terms of probability distribution.* For a while, like Joseph Goguen who studied with me and later came close to Mihai Nadin, he worked with Category Theory (and contributed to the study of fuzzy machines for describing semiotic processes, while writing a book on Sign and Value). I am mentioning all these details because to define Nadin's work one has to understand how wide open his perspective is. When he offered me the last book he edited (*Anticipation and Medicine*, Springer Publishers) I wrote to him: *You deserve our respect for writing books which are very scholarly, very incisive and very erudite. They contribute greatly to human thought and knowledge. (November, 2016)*

Of course, at this moment in life, I am limited to some concise commentaries when it comes to anyone I want to aid in making their work appreciated as they deserve. Therefore, I will use the rest of my space, reproducing some thoughts prompted by a previous book of his: *Anticipation: The end is where we start from*. I was honored to write a Foreword to it.

Professor Mihai Nadin scholarly treatise, "Anticipation—'The End is Where We Start From,'" or *Anticipation*, for short, addresses an issue that does not have high visibility; and yet, as Professor Nadin convincingly argues, it is an issue that is of fundamental importance.

What is anticipation? Putting aside a dictionary definition, Professor Nadin guides us, with insight and high expository skill, through a sequence of twelve nuanced definitions. The first definition reads: *An anticipatory system is a system whose current state is determined by a future possible state.* As stated, the definition raises a question in my mind. However, my question can easily be resolved by qualifying "future possible state" with "a perception of future possible state," leading to the amended definition, "An anticipating system is a system whose current state is determined by a perception of a future possible state." I will have more to say about this suggestion at a later point.

¹ https://en.wikipedia.org/wiki/Lotfi_A._Zadeh

The leitmotif of Anticipation is that everything humans do involves anticipation and, more specifically, that anticipation, as a characteristic of the living, can be seen as a realization in the domain of possibilities. In developing this theme, Professor Nadin examines the concept of anticipation in twelve different contexts, starting with system theory, moving through prediction, correlation and quantum theory, and ending with possibility theory, feedback and power laws. Professor Nadin's guided tour throws much light on the concept of anticipation and underscores its basic role in science and human cognition.

Returning to the point which I made earlier, my suggested modification of Professor Nadin's definition of Anticipation leads to the concept of what may be called perception-based anticipation. The marriage of anticipation and perception has important implications. First, it highlights that all living organisms, including humans, employ perception-based anticipative control to guide decision-making on goal-oriented stage decision processes. More specifically, if at a stage of a decision process I have n alternatives, a_1, \dots, a_n , to choose from, then using a perception-based model of the underlying system, I form a perception of the next state and next output, and choose that a_i which brings me closer to the goal. As a simple example, this is what we do when we drive a car or balance a pile.

More generally, perception-based anticipation is what makes it possible for humans to perform a wide variety of physical and mental tasks without any measurements and any computations. It is this remarkable capability that machines do not have.

In my recent writings, I mentioned a theory, referred to as the computational theory of perceptions (CTP). In this theory, perceptions are dealt with through their descriptions in a natural language, e.g., traffic is heavy, Robert is very honest, speed is high, etc. The use of CTP opens the door to adding to machines the capability to operate on perception-based information expressed in a natural language. In particular, it makes it possible to train a neural network to produce perceptions in response to measurements. Such networks may be said to be neuroperceptive. Neuroperceptive networks may find important applications in automation of processes in which the output is a human assessment of, say, food or, more generally, of sensory perceptions.

Professor Nadin's treatise makes an important contribution to a better understanding of some of the most fundamental aspects of human cognition. He and the publisher deserve our thanks and congratulations.

References

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