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On the Autopoietic and Cognitive Behavior

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Abstract:

This paper states the Burgin Mikkilineni (BM) thesis. The ontological BM thesis states that the autopoietic and cognitive behavior of artificial systems must function on three levels of information processing systems and be based on triadic automata. The axiological BM thesis states that the efficient autopoietic and cognitive behavior has to employ structural machines.

We discuss the autopoietic and cognitive behaviors both in the living systems where the genome plays a role and also in the digital world, where a digital genome plays a similar role.

Keywords

Autopoietic behavior, Cognitive behavior, Digital Genome, Genome, Information processing structures

What we Know

The genome in the physical world is knowledge coded in executable form in deoxyribonucleic (DNA) and executed by ribonucleic acid (RNA). DNA and RNA use the knowledge of the physical and chemical processes to discover the resources in the environment using the cognitive apparatuses in the form of genes and neurons. They build and evolve the hardware utilizing various embedded, embodied, enacted, elevated and extended (5E) cognitive (sentient, resilient, intelligent and efficient) processes to manage both the self and the environment. The genome encapsulates both autopoietic and cognitive behaviors. The autopoietic behaviors are capable of regenerating, reproducing and maintaining the system by itself with production, transformation and destruction of its components and the networks of processes in these components. The cognitive behaviors are capable of sensing, predicting and regulating the stability of the system in the face of both deterministic and non-deterministic fluctuations in the interactions among the internal components or their interactions with the environment.

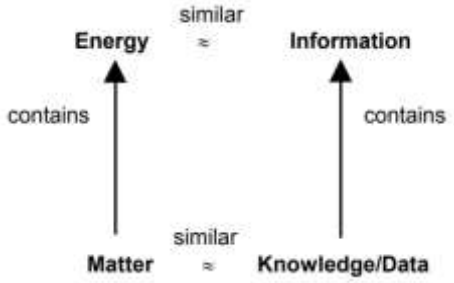
The Theory

A genome in the language of General Theory of Information (GTI) [1] encapsulates a "knowledge structures [2]" coded in the form of DNA and executed using the "structural machines [3 - 5]" in the form of genes and neurons which use physical and chemical processes (dealing with conversion of matter and energy). The information accumulated through biological evolution is encoded into knowledge to create the genome which contains the knowledge

network defining the function, structure and the autopoietic and cognitive processes to build and evolve the system while managing both deterministic and non-deterministic fluctuations in the interactions among the internal components or their interactions with the environment.

GTI tells us that information is represented, processed and communicated using physical structures. The physical universe, as we know it, is made up of structures that deal with matter and energy. As Mark Burgin [1] points out energy and matter are different but intrinsically connected with one another. Matter cannot exist without energy (at least, zero energy), while energy is always contained in physical bodies.

Similarity of matter and knowledge means that they may be considered in a static form, while energy and information exist only in (actual or potential) dynamics. In addition, similarity of



energy and information signify that both these entities cause change in systems: energy does this in physical systems, while information does this in structural systems such as knowledge and data. In other words, the figure below states that information is related to knowledge and data as energy is related to matter.

Information unit is described by the existence or non-existence (1 or 0) of an entity or an on object that is physically observed or mentally conceived. The difference between an entity and an object is that the entity is an abstract concept with attributes such as a computer with memory and CPU. An object is an instance of an entity with an identity, defined by two components which are the object-state and object-behavior. An attribute is a key value pair with an identity (name) and a value associated with it. The attribute state is defined by its value.

The knowledge about the genome and the GTI allow us to postulate a thesis that allows us to design a new class of digital automata by infusing autopoietic and cognitive behaviors.

The Thesis[1]

Ontological BM Thesis. **The autopoietic and cognitive behavior of artificial systems must function on three levels of information processing systems and be based on triadic automata.**

Axiological BM Thesis. **The efficient autopoietic and cognitive behavior has to employ structural machines.**

[1]Thesis is a statement or idea that is put forward as a premise to be maintained or proved.

Being a form and component of autopoietic and cognitive information processing systems, the digital genome is a collection of "knowledge structures [2]" coded in executable form to be processed with "structural machines [3]" implemented using digital genes (in the form of symbolic computing algorithms) and digital neurons (in the form of sub-symbolic neural net algorithms) both of which use stored program control implementation of Turing machines. The digital genome enables digital process execution to discover the computing resources in the environment, use them to assemble the hardware, cognitive apparatuses in the form of digital genes and digital neurons and evolve the process of sentient, resilient, intelligent and efficient management of both the self and the environment with embedded, embodied, enacted and extended (4E) cognitive processes.

The digital genome incorporates the knowledge in the form of hierarchical intelligence with a definition of the sentient digital computing structures that discover, monitor and evolve both the self and the interactions with each other and the environment based on best practices infused in them.

The digital genome specifies the execution of knowledge networks using both symbolic computing and sub-symbolic computing structures. The knowledge network consists of a super-symbolic network of symbolic and sub-symbolic networks executing the functions defined in their components. The structure provides the system behavior and evolution maintaining the system's stability in the face of fluctuations in both internal and external interactions.

The digital genome encapsulates both autopoietic and cognitive behaviors of digital information processing structure capable sentience, resilience and intelligence.

The digital genome typifies infused cognition as opposed to evolved cognition in biological systems. The infusion is made by the human operators who teach the machines on how to evolve. Self-learning and self-evolution with consciousness are not yet present in these digital structures.

This brings about profound implications on how we design, build and operate digital information processing systems. It allows us to create zero-touch remote configuration, monitoring and management of current digital information processing systems.

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