Triadic Automata and the General Theory of Information: Study Group Goals and Objectives

(www.triadicautomata.com)

Introduction:

Our knowledge of information processing mechanisms stems from three important advances in:

1. Our understanding of the Genome, neuroscience and cognitive behaviors of biological systems,
2. Our use of digital computing machines to unravel various mysteries about how our physical world works and to model, monitor and manage it, and
3. A new set of mathematical tools, derived from the general theory of information (GTI), in the form of named sets, knowledge structures, cognizing oracles and structural machines which allow us to not only explain how information processing structures play a key role in the physical world but also to design and implement a new class of digital automata called autopoietic machines which advance our current state of information technologies by transcending the limitations of classical computer science as we practice it today.

The science of information processing structures (SIPS), based on strong theoretical foundation of GTI, is still in its infancy and has the potential to upgrade systems based on the theory of Universal Turing Machines and data structures to the new science based on the theory of structural machines and knowledge structures. The transition from the classical computer science to SIPS provides a path to evolve current information processing systems using symbolic and sub-symbolic computing to super-symbolic computing structures with autopoietic and cognitive behaviors. Symbolic computing uses algorithms to operate on data structures which are sequences of symbols representing the knowledge of a state of the system involved in the computation. Sub-symbolic computing uses algorithms that mimic the neural networks in the brain to process information from various forms of data (text, audio, video etc.) collected from observations. Autopoiesis and cognitive behaviors possessed by all living organisms process information gathered by their senses and use the knowledge to improve their resilience and intelligence in preserving the stability in the face of disturbances caused by fluctuations in their state within their bodies and in their interactions with their environment.

Recent advances in our understanding of genomics and neuroscience are throwing light on how living organisms process information to become autopoietic and cognitive. Autopoiesis refers to a system with well-defined identity and is capable of reproducing and maintaining itself. Cognition, on the other hand, is the ability to process information, apply knowledge, and change the circumstance. Information processing in biological systems is both symbolic and sub-symbolic having the form of genes and neural networks. Nevertheless, in their evolution, biological systems have advanced their abilities one step further by developing super-symbolic information processing and evolving symbiotic information processing that performs information processing on the combined knowledge in the brain from both symbolic, sub-symbolic and super-symbolic information processing to derive higher order autopoietic and cognitive behaviors. Performing all forms of information processing, biological systems achieve much higher cognitive and intelligence level with higher degree of resilience and efficiency. The purpose of the study group is to consider a new type of computing automata called structural machines with the

goal of transferring these advantageous features of biological systems to the existing information processing technology.

Goals and Objectives of the Study Group:

The long-term goal of this study group is to deeply understand the theory and practice of the new science of information processing structures and pave the path to a new generation of distributed computing systems with higher degree of resilience, intelligence and efficiency at scale. Learning how autopoiesis and cognition are implemented in living organisms and harnessing the fusion of our understand of genomics, neuroscience and the general theory of information provide the tools for creating a new class of autopoietic machines which supersede the current state of the art information technologies based on symbolic and sub-symbolic computing. The expected result is the design of a super-symbolic overlay that integrates current symbolic and sub-symbolic computing structures to provide a system-level autopoietic and cognitive behaviors well equipped to deal with disturbances in the system, maintain stability and mitigate risk with predictive reasoning just as living organisms do.

Short term objectives are designing the tools and processes that are required:

1. ***From Turing Machines to Structural Machines:*** Evolve current computing structures based on Turing machines to the structural machines based on the general theory of information.
2. ***From Data Structures to Knowledge Networks:*** Introduce super-symbolic computing that executes operations on graphs representing knowledge networks which manage operations based on symbol-based data structures in both symbolic and sub-symbolic computing.
3. ***From 4E Cognition to Elevated Cognition:*** Symbolic and sub-symbolic computations provide domain specific information processing which extracts knowledge from observations and data gathered from multiple sources. This is accomplished by symbolic and sub-symbolic computing structures executing embedded, embodied, extended and enactive (4E) cognition. The super-symbolic computing provides integrated knowledge representation with elevated cognition in the form of knowledge networks where the nodes that are wired together fire together to exhibit collective behavior.
4. ***From Algorithm-based Changes in System Behavior to Self-Regulating System Behavior Using Functional Communication Among the Knowledge Nodes*****:** Symbolic and sub-symbolic computing structures are dependent on third party intervention to manage fluctuations which disturb the stability of the system. For example, if the demand for computing resources or their availability fluctuates rapidly, third party intervention is required to reconfigure the computing structures often spanning across multiple geographical locations and heterogeneous local resource management systems operated by different vendors with different profit motives. Autopoietic and cognitive systems on the other hand, have a system-level identity and awareness of the global knowledge network and use super-symbolic computing to sense, predict and manage the impact of local fluctuations on global stability.

The objective of the study group is to understand the theory and practice of implementing autopoietic machines that improve sentience, resilience and intelligence of current information technologies by reusing current symbolic and sub-symbolic computing structures with a super-symbolic overlay just as the neocortex repurposed the reptilian brain. Currently, the study group is limited to seven members with M S or PhD and will be selected through a pre-requisite quiz and an essay on why the member wants to spend time in this endeavor and the qualifying characteristics.