

A ROADMAP FOR A COMPUTATIONAL AND INFORMATIONAL THEORY OF LIFE

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ABSTRACT

Information plays a critical role in complex biological systems. Complex systems like immune systems and ant colonies co-ordinate heterogeneous components in a decentralized fashion. How do these distributed decentralized systems function? One key component is how these complex systems efficiently process information. These complex systems have an architecture for integrating and processing information coming in from various sources and points to the value of information in the functioning of different complex biological systems. This article proposes a role for information processing in questions around the origin of life and suggests how computational simulations may yield insights into questions related to the origin of life.

Such a computational model of the origin of life would unify thermodynamics with information processing and we would gain an appreciation of why proteins and nucleotides evolved as the substrate of computation and information processing in living systems that we see on Earth. Answers to questions like these may give us insights into non-carbon based forms of life that we could search for outside Earth.

We hypothesize that carbon-based life forms are only one amongst a continuum of life-like systems in the universe. Investigations into the role of computational substrates that allow information processing is important and could yield insights into: 1) novel non-carbon based computational substrates that may have “life-like” properties, and 2) how life may have actually originated from non-life on Earth. Life may exist as a continuum between non-life and life and we may have to revise our notion of life and how common it is in the universe. Looking at life or life-like phenomenon through the lens of information theory may yield a broader view of life.

Keywords: information theory, origin of life, artificial life, thermodynamics, evolution, energetics