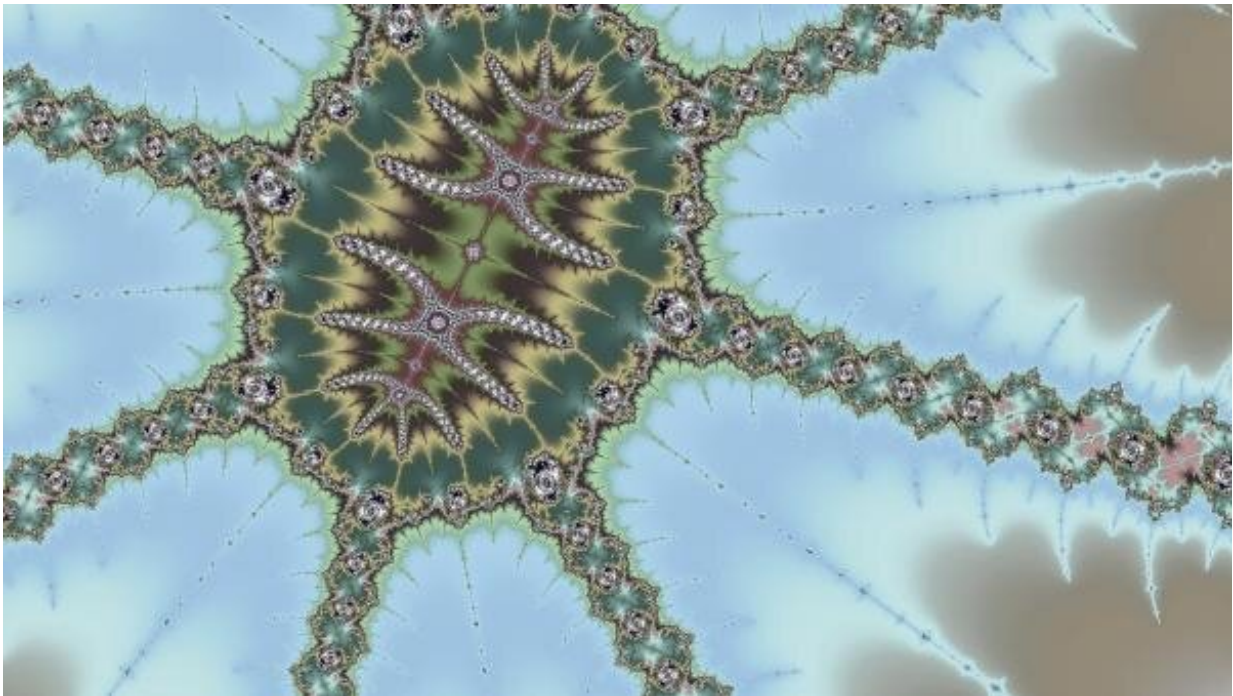


A novel definition of life and its implications to cybernetic systems

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A sample of self-organization mathematically generated by iteration of a simple feedback equation. Self-organization has been observed in a variety of biological processes, such as DNA condensation into chromosomes. Credit: O. Abramov, Planetary Science Institute

Perhaps the most fundamental puzzle in biology—"What is life?"—is addressed in a new paper by Planetary Science Institute Senior Scientist Oleg Abramov.

"This work presents evidence that the order observed in biological systems is fundamentally computational," said Abramov, lead author of "Emergent Bioanalogous Properties of Blockchain-based Distributed Systems" that appears in *Origins of Life and Evolution of Biospheres*. "A promising direction for future research is development of mathematical theories that calculate how biological systems order themselves."

Independent researcher Kirstin Bebell, and Stephen Mojzsis, director of the recently established Origins Research Institute at the Research Centre for Astronomy and Earth Sciences in Budapest, Hungary, are co-authors.

The paper uses a multidisciplinary approach incorporating theory, observations, and modeling. The theoretical foundation incorporates principles of self-organization and evolution across a wide variety of lifeforms. In so doing, the authors present a definition of biological systems based on first principles.

"This work presents observations of a [blockchain](#)-based distributed virtual machine (dVM) composed of thousands of nodes, or computers, which collectively function as a global general-purpose computer that for practical purposes cannot be turned off." Abramov said. "Observations in this study demonstrate that such dVMs possess characteristics associated with biological systems. For example, our observations reveal a number of functional and structural similarities between the blockchain and DNA, a self-replicating molecule that is the genetic blueprint for all known life. The blockchain is an append-only data structure composed of subunits called blocks, which are permanently 'chained' together using advanced cryptography. In practice, it is an immutable medium which contains instructions in the form of computer code and is replicated across thousands of nodes much like DNA in cells."

The paper states that such blockchain-based systems fit some criteria for life, such as response to the environment, growth and change, replication, and self-regulation. It further presents a conceptual model for a simple self-organizing and self-sufficient distributed "organism" as an operationally closed system that would fulfill all definitions of life, and describes developing technologies, particularly [artificial neural network](#) (ANN) based [artificial intelligence](#) (AI), that would enable it in the near future. Notably, such systems would have a number of specific advantages over biological life, such as the ability to pass acquired traits to offspring, significantly improved speed, accuracy, and redundancy of their genetic carrier, as well as a potentially unlimited lifespan. Public blockchain-based dVMs provide an uncontained environment for the development of artificial general intelligence, with the potential to self-direct their evolution. The study predicts that the integration of blockchain, which functions similarly to DNA, and ANN-based AI, which functions similarly to a brain, could enable complex systems fundamentally indistinguishable from biology.

More information: Oleg Abramov et al, Emergent Bioanalogous Properties of Blockchain-based Distributed Systems, *Origins of Life and Evolution of Biospheres* (2021). [DOI: 10.1007/s11084-021-09608-1](https://doi.org/10.1007/s11084-021-09608-1)

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