Editorial

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Special Issue, "What AI Can Learn from Biology"

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Abstract

This special issue uses AI to cast light on the nature of life. Many assume that life emerges from a blend of information and complexity. If this is the case, then we might expect a future generation of machines to exhibit lifelike behavior or, as some would claim, to come alive. Two perspectives are offered for considering the question of life: agency and intelligence. Intelligence is associated with information, rationality and consequent knowledge representations, while agency associates with embodiment, judgment and material organization. Predictions about machine life rely on conceptions of intelligence, but the addition of agency to the analysis of life and lifelike behavior results in nuanced conclusions that can beneficially inform regulation and future research.

Keywords: AI, cognition, worlding, thermodynamics

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Humanity has never been so successful, or so threatened, during its short time on earth. This special issue of *Organisms* addresses two challenges of the polycrisis described by Greg Anderson in "AI in This World and the Next": biology and intelligence. Contributors to this issue view these challenges through approaches which outrun dominant paradigms about information, emergence and complexity. One of the great conundrums of biology is its subject matter. Unlike other disciplines, notably physics and chemistry, the subjects of biology – organisms – self-organize, replicate, evolve and proliferate. The bright line between organisms and abiotic phenomena, including mechanisms, is the Second Law of Thermodynamics. Put simply but accurately, life does not run down, and any explanation of life must account for its persistence across four billion years. Though rarely addressed, the relevance of biology to AI is clear. Cognition evolved as a function of life, and, starting with imprints on bone, wood and clay, cognitive prostheses have accounted for humanity's early evolutionary success and our growing potential for failure. Humanity has a long history of engineering, and inventions which enhance our faculties have inspired awe since the first cities. Whether we take the perspective of life or history, AI is a step change not a revolution.

The concept for this special issue began in 2016 at the London-based think tank RUSI. I was asked by Randolph Kent, then a Fellow, to consider whether AI might become hostile. That inquiry resulted in the article, "Modelling the Threat from AI: Putting Agency on the Agenda", and responses from four biologists who informed my position. Denis Noble and Ray Noble emphasize the production of novelty by organisms, while Ana Soto and Carlos Sonnenschein emphasize the materiality of life. *RUSI Journal* published the articles in 2019 (in an issue also devoted to AI), and they are included here. Since then, I have continued to contemplate agency and intelligence as competing paradigms for our self-understanding. A happier world could keep these questions in the philosopher's den, but, in the present age, we project our self-understanding haphazardly and invisibly into engineering projects of increasing scale. By clarifying what intelligence is and contrasting it with agency, we also clarify our role – and that of engineering – in the life world.

We have decided to release the contents of this issue in themed instalments. Greg Anderson's aforementioned essay opens the section on agency, and the issue as a whole, with the argument that human conceptions are fundamentally fluid. In contrast to other contributors, Anderson is an historian. I have already called for a paradigm shift, and, if we want to achieve critical objectivity, historians have ready material to compare paradigms. Anderson's argument is twofold. The first branch reveals the benefits of studying cultures in their own terms. This is useful for Western scholars studying non-Western worldviews, a category which includes historical antecedents. The second argument criticizes Western scientific rationality. Contemporary science still bears the dualist metaphysics of its origin in European modernity, and its proponents assume that, because it straddles the globe, science as currently conceived is the most successful human enterprise – and thus the standard by which to judge others. Without dismissing the benefits of modernity, the reader may decide whether a world near catastrophe is humanity's best effort. By introducing the concept of 'worlding' from the humanities, Anderson's essay opens the scientific mind to rethinking what constitutes knowledge and its applications in engineering, medicine and other domains.

A microscopic study of behavior follows Anderson's macroscopic perspective. By examining multiple automata – chess pieces in a virtual game – David Kofman, Guillermo Campitelli and Michael Levin demonstrate how seemingly goal-oriented action can arise from multiple agents operating with limited visibility and broad autonomy. For context, I direct readers to the work of Levin and his collaborators on bioelectricity, embodied cognition and collective intelligence.

Levin, Campitelli and Kofman provide a hinge into next section, which discusses how thermodynamic entropy applies to biological systems. Again, we move from a macroscopic to microscopic perspective. Maël Montévil and Marie Chollat-Nemy offer a critical analysis of free-energy principle (FEP) and its potential role in directing cognition across life. They identify the limitations of treating organic cognition as an optimization algorithm and, thus, as a process similar to machine learning. Then José Manuel Nieto-Villar, Mariano Bizzarri and Ricardo Mansilla demonstrate how measuring the entropy production rate of tumor can be used to judge its malignancy. Both articles treat valuable subjects, but they also serve broader purposes: they probe the limits of mathematical approaches to biology; they establish concepts from thermodynamics within biology; and they offer alternatives to current methods of mathematical modelling.

Forthcoming in early 2026, the next section turns to quantum mechanics. Here, the authors apply theoretic lenses such as affordances and Kantian Wholes to quantum theoretical constructs. They extend quantum tools to new domains, advancing the development of quantum-like frameworks for analyzing complex systems, and they argue that biological phenomena, notably evolution and the production of novelty, require different, complementary principles to those that govern physics and chemistry.

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