



Western Institute for Advanced Study

2024
Annual
Report

Board of Directors



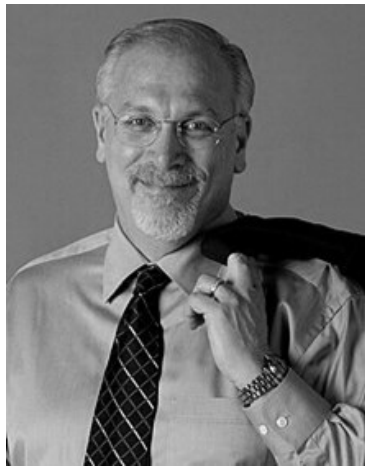
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Chris Frangione



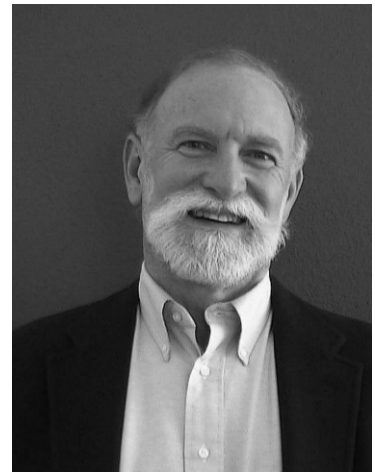
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Board of Advisors

The Board of Directors wishes to thank our Governance Advisors:

Ben Nelson, Founder, Minerva University

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The Board of Directors wishes to thank our Scientific Advisors:

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The Board of Directors wishes to thank the team of researchers working on our first Grand Challenge, The Physical Basis of Consciousness:

Karl Friston, Professor of Neurology, University College London

Damian Rouson, Senior Scientist and Group Lead, Berkeley Lab

David Redish, Professor of Neuroscience, University of Minnesota

Stuart Firestein, Professor of Biological Sciences, Columbia University

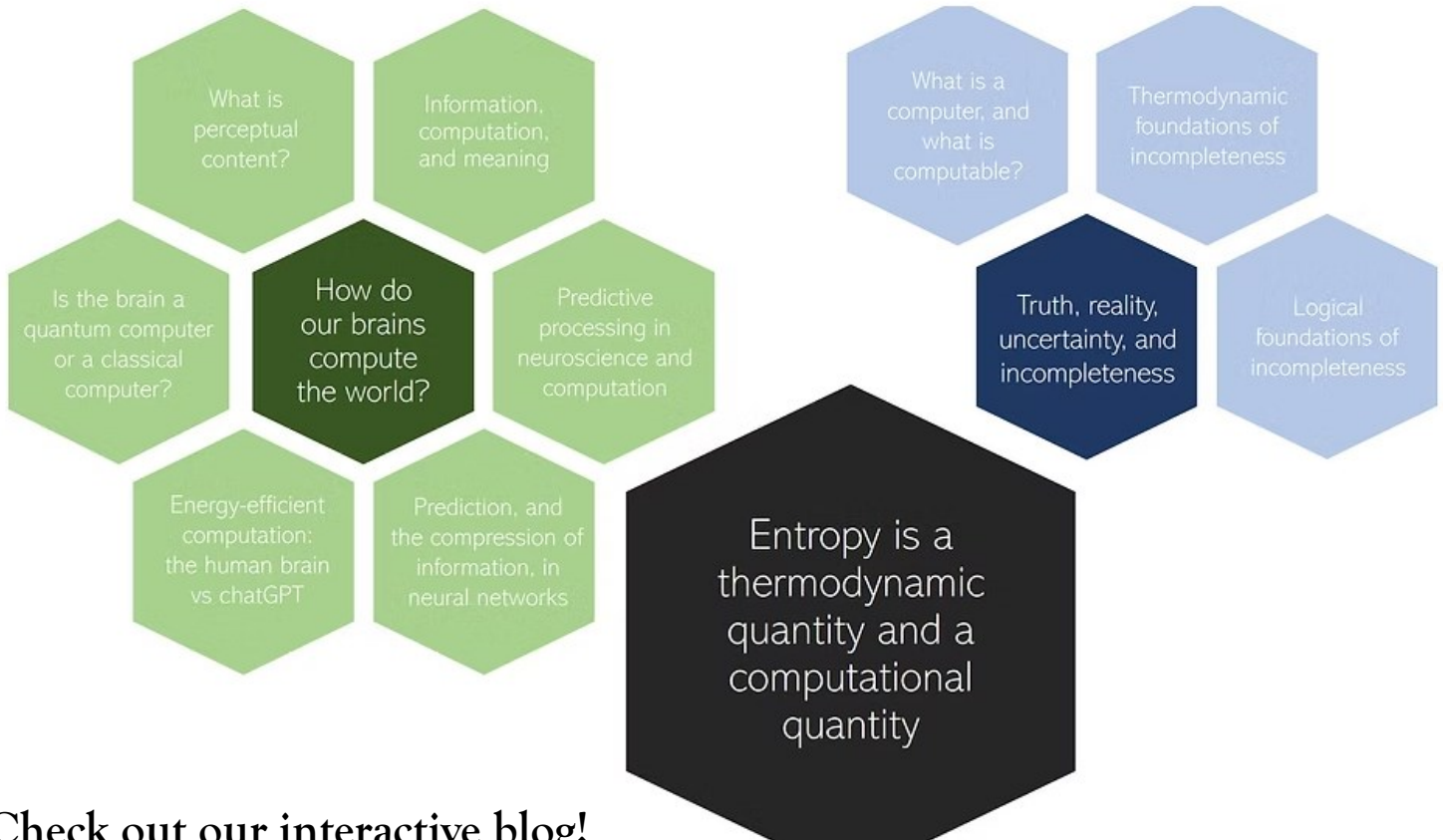
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Marco Nathan, Professor of Philosophy, Denver University

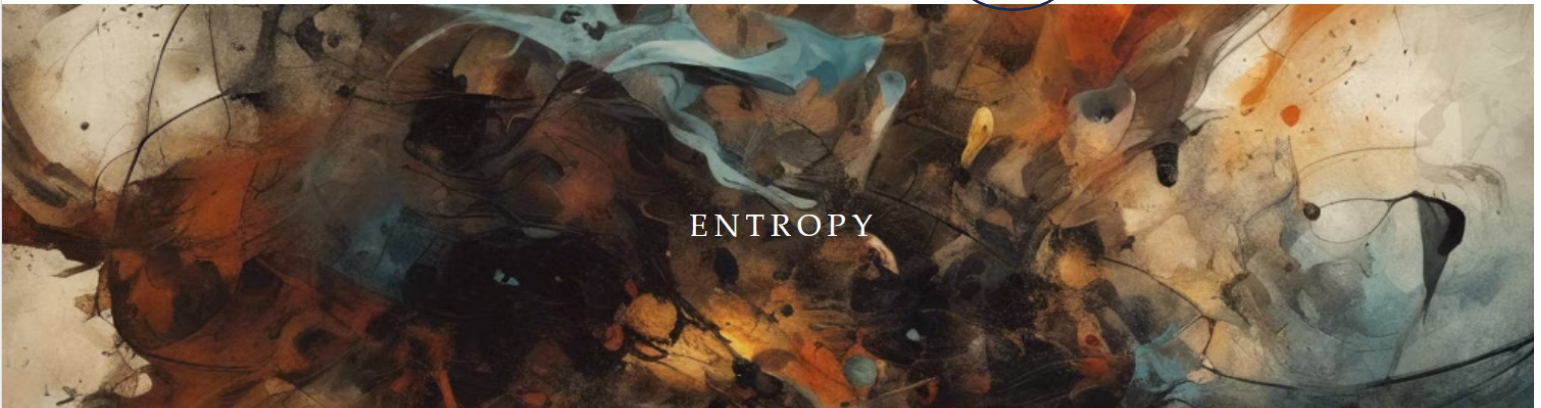
Chris Viger, Professor of Philosophy, Western University

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The concept of entropy is challengingly abstract -
but entropy is a physical quantity, in terms of
both thermodynamics and computation.

Scientific Progress

Stoll, E.A. (2024) An energy-efficient process of non-deterministic computation drives the emergence of predictive models and exploratory behavior. *Frontiers in Cognition* 2:[1171273](#).

This study illustrates how a cortical neural network encodes the state of its surrounding environment, through a non-deterministic computational process, by thermodynamically favoring the selection of an optimal system state from a large probability distribution. This work provides a mechanism for Bayesian inference in neural circuits. Each iterative computational cycle results in a decision – to engage in further exploration, in order to acquire more predictive value, or to exploit the predictive value already gained. Critically, this model demonstrates that fundamental thermodynamic constraints provide a limit on the predictive power of the system, with the amount of energy entering the system restricting both the amount of information generated and the amount of predictive value extracted.

Stoll, E.A. (2024) A thermodynamical model of non-deterministic computation in cortical neural networks. *Physical Biology* 21(1): [016003](#).

This study presents a model of thermodynamic computation in cortical neural networks, with energy being expended to produce a quantity of information entropy. This information entropy – both a thermodynamic quantity and a computational quantity – is compressed during the computational process, culminating in a release of free energy as uncertainty is reduced. This [Gibbs] free energy restores the [Nernst] membrane potential, so that free energy is converted into the *work* of achieving neuronal signaling outcomes. This paper shows that the extraordinary energy efficiency of the brain is consistent with non-deterministic, rather than classical, computation.

Stoll, E.A. (2024) The mechanics underpinning non-deterministic computation in cortical neural networks. *Applied Math* 4(3): [806-827](#).

This study presents a model for probabilistic computation in cortical neural networks. Classically, the neuron is modeled as a binary computational unit, in an on- or off-state, encoding Shannon entropy. In this study, each neuron computes the probability of transitioning from an off-state to an on-state, thereby encoding von Neumann entropy. Component pure states are integrated into a physical quantity of information, and the derivative of this high-dimensional probability distribution yields eigenvalues across the multi-scale quantum system. In accordance with the Hellman–Feynman theorem, the resolution of the system state is paired with a spontaneous shift in charge distribution across each extracellular ion, so this defined system state instantly becomes the past as a new probability distribution emerges. This mechanistic model produces testable predictions regarding the wavelength of free energy released upon information compression and the temporal relationship of these events to physiological outcomes.

Financial Support

The Board of Directors wishes to thank our amazing donors, who make our continued research efforts possible. Our donors include:

Bala Parthasarathy, Managing Partner, Prime Ventures
Jason Palmer, General Partner, New Markets Venture Partners
Dave Parker, Founder and CEO, Benchmark Wine Group
Stephanie Smith, Founder and COO, Eolian Renewable Energy
Patrick Kohl, Physics Professor, Colorado School of Mines
Nathan Cassell, Patent Attorney, Acuity Intellectual Property
Amy Farrar, Family Physician, Kaiser Permanente
Philip Tilker, Senior Software Developer, Amazon Logistics
And several anonymous donors who have supported our efforts.

Thank you for your incredible support!





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