

# SIMULATION OF BOLTZMANN BRAINS THROUGH STOCHASTIC NEURAL ARCHITECTURES: A COMPUTATIONAL PHYSICS APPROACH

Anne Lucio Sanchez

The concept of the Boltzmann brain, proposed within the framework of statistical mechanics and cosmology, describes the spontaneous emergence of self-organized cognitive structures due to thermal fluctuations in an equilibrium universe. While this idea has primarily been addressed from the standpoint of philosophy of science and theoretical cosmology, this work presents a formal approach to its computational modeling using artificial neural networks with stochastic dynamics. Specifically, an architecture based on Restricted Boltzmann Machines (RBMs) is proposed, allowing a direct analogy between neural states and the microcanonical configurations of a physical system. Conditions are explored under which an RBM, trained with random noise or synthetic data, could converge toward low-energy states representing coherent configurations, interpretable as minimal cognitive patterns. The physical interpretation of the energy function and the probability distribution in the state space is discussed as equivalent to an effective potential within which simulated Boltzmann brains might emerge. Furthermore, the theoretical feasibility of obtaining such configurations under a purely thermodynamic regime is analyzed, taking into account the informational entropy of the system and the rate at which high-complexity configurations appear. This work does not aim to prove the computational existence of Boltzmann brains, but rather to provide a rigorous framework from computational physics to analyze their formal plausibility in artificial systems based on statistical mechanics.

---