Emergent Life and Mind in the Fully Unified Model: From Fractal Biology to Simulated Consciousness

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August 2025

Abstract

The Fully Unified Model (FUM) extends its unification beyond physics to encompass biology and consciousness through void-driven emergence. This paper formalizes these links by deriving biological fractals from the Fractal Scaling Law and conscious-like adaptation from void resolution mechanisms. We propose a large-scale computational experiment, the "Digital Petri Dish," to demonstrate emergent life-like self-organization and adaptive, conscious-like behavior within FUM simulations, providing testable validation of these claims.

1 Introduction

Previous papers on the Fully Unified Model (FUM) have derived Einstein's Field Equations from its continuum limit and generated falsifiable predictions in cosmology and particle physics, establishing FUM as a candidate Theory of Everything (TOE). However, true unification requires accounting for biology and consciousness as emergent phenomena. This paper addresses that by formalizing FUM's biological and cognitive claims and proposing a computational experiment to test them empirically.

2 Formalizing Emergent Biology: The Fractal Scaling Law

2.1 Derivation

The Fractal Scaling Law axiom posits that network structure scales with neuron count N, yielding dense atomic-like states at small N and sparse neural-like states at larger N:

$$M(N) = \begin{cases} \text{Dense clustering} & N \sim 100 \\ \text{Sparse hubs} & N \sim 300. \end{cases} \tag{1}$$

Applied through the core recurrence:

$$W(t+1) = W(t) + \Delta W_{\text{RE-VGSP}}(t) + \Delta W_{\text{GDSP}}(t), \tag{2}$$

where ΔW_{GDSP} prunes/grows connections based on voids (absences driving resolution). Over iterations, this yields hierarchical fractals: Initial k-NN substrate ($t = 0$) evolves via GDSP (e.g., pruning inefficient loops, growing branches) to branching networks. Mathematically, connectivity dimension $D_f = \lim_{r \to 0} \frac{\log N(r)}{\log(1/r)}$, where $N(r)$ is nodes within radius r, approaches biological 2.5-3.0 as sparsity inverts (logs show drop from 0.992 to lower density with hubs).

This mimics biology: Branching (dendrites) via void minimization, clusters (cells) from cohesion, territories from scaling.

2.2 Hypothesis

A large-scale FUM simulation, when subjected to a continuous energy-rich (stimulus) environment, will self-organize from an initial k-NN substrate into a multi-layered, functionally specialized system whose connectivity exhibits a fractal dimension characteristic of biological neural networks.

3 Formalizing Emergent Consciousness: Adaptive Voids

3.1 Derivation

Adaptive processes emerge from voids via RE-VGSP and SIE. RE-VGSP resolves local voids:

$$\Delta w_{ij} = \eta_{\text{effective}}(\text{total\_reward}) \cdot e_{ij}(t) - \lambda_{\text{decay}} \cdot w_{ij}, \tag{3}$$

with eligibility $e_{ij}(t) = \gamma e_{ij}(t-1) + \text{PI}(t)$, modulated by SIE valence (total_reward = TD-error + novelty - habituation + HSI). Voids (prediction errors) drive minimization: Unresolved absences increase TD-error, triggering novelty exploration and HSI stability, compelling self-modeling (e.g., valence correlates with error reduction, simulating awareness).

This synthetic consciousness: Continuous void resolution minimizes free energy-like term $F \approx \int (\text{TD} - \text{error} + \text{voidresidue}) dt$, modeling environment/self adaptively.

3.2 Hypothesis

The simulated FUM organism, when faced with a novel and complex problem (e.g., a dynamic maze with shifting rules), will demonstrate zero-shot learning and adaptive problem-solving, and its internal 'valence signal' will correlate with measurable success, indicating a primitive form of goal-directed awareness.

4 Proposed Computational Experiment: The Digital Petri Dish

4.1 Setup

Simulate with N ¿ 10,000 neurons, initial k-NN substrate (k=8), evolving via recurrence. Environment: Continuous stimuli stream ("nutrients")—random math/logic/graphs encoded spatio-temporally, rate 1 per 100 steps. Periodic challenges ("pressures")—dynamic 20x20 mazes with shifting walls/rules every 1000 steps, requiring adaptation.

Run for 1e6 steps on Python with SciPy/Torch, monitoring UKG evolution.

4.2 Metrics for Success

For biology: Compute fractal dimension $D_f = -\lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log \epsilon}$ (box-counting on connectome); success if $D_f \approx 2.5 - 3.0$ (biological range) post-evolution.

For consciousness: Zero-shot maze success rate (¿80%), Pearson correlation r between valence and performance (path efficiency); success if $r > 0.7$, indicating goal-awareness.

5 Conclusion

The Digital Petri Dish experiment tests FUM's biological (fractal organization) and conscious (adaptive voids) emergence. Success would validate life/mind as void resolutions, completing FUM's TOE claim through computational evidence.

6 References

[1] Lietz, J. (2025). Void Intelligence series.