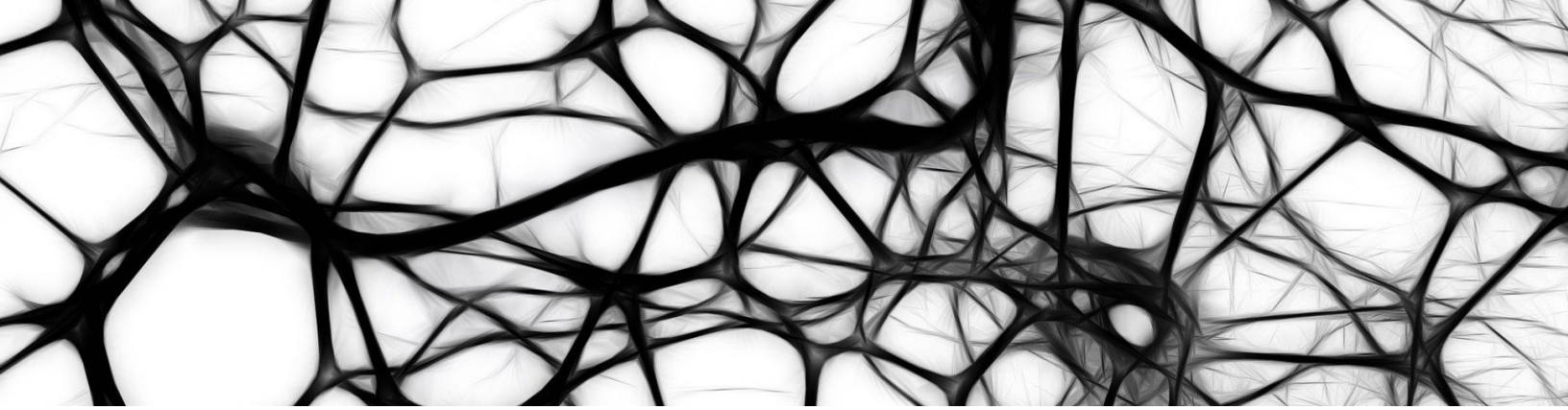

THE THREE LAWS OF INTELLIGENCE

SKA Framework

Bouarfa Mahi

Unifying Physics, Cognition, and Artificial Intelligence

The Law of Probabilistic Decision-Making

Principle:
Intelligence is the capacity to make decisions under uncertainty.

Mathematical Expression:

$$D = \sigma(z) = \frac{1}{1 + e^{-z}}$$

- D: Decision probability
- z: Accumulated knowledge
- $\sigma(z)$: Sigmoid transformation mapping knowledge to decision confidence

Meaning:
This single equation bridges cognition and mathematics. It shows that **intelligence is not deterministic**, but **probabilistic**, continuously adjusting decision likelihoods based on accumulated knowledge.

The Law of Knowledge Accumulation

Principle:
Knowledge grows forward-only by reducing uncertainty (entropy) through structured accumulation.

Mathematical Expression:

$$H = -\frac{1}{\ln 2} \int z \, dD$$

- H: Entropy (measure of uncertainty)
- z: Knowledge trajectory
- dD: Change in decision probability

Meaning:
As knowledge z increases, entropy H decreases — intelligence becomes more *structured and predictable*.

This law formalizes learning as **entropy minimization**, not gradient descent. It transforms "learning" from an engineering trick into an **information-theoretic process** of structured knowledge refinement.

The Law of Entropic Least Action

Principle:
Among all possible learning trajectories, intelligence follows the path of least entropy — the optimal route through knowledge space.

Mathematical Expression:

$$H = \frac{1}{\ln 2} \int \mathcal{L}(z, \dot{z}, t)\, dt, \quad \mathcal{L}(z, \dot{z}, t) = -z \cdot \sigma(z)(1 - \sigma(z)) \cdot \dot{z}$$

Euler–Lagrange Condition:

$$\frac{d}{dt}\left(\frac{\partial \mathcal{L}}{\partial \dot{z}}\right) - \frac{\partial \mathcal{L}}{\partial z} = 0$$

- $\mathcal{L}$: Entropic Lagrangian
- $\dot{z}$: Time derivative of knowledge (rate of accumulation)

Meaning:
This law brings **physics into intelligence**. It states that cognition evolves like a physical system under the **principle of least action** — minimizing entropy rather than energy.

No backpropagation, no stochastic descent — just **natural, forward-only optimization**.

Unified Beauty

Law	Core Concept	Equation	Meaning
Probabilistic Decision-Making	Intelligence as uncertainty reduction	$D = \sigma(z)$	Decisions emerge from probabilistic weighting
Knowledge Accumulation	Learning = Entropy minimization	$H = -\frac{1}{\ln 2} \int z \, dD$	Knowledge grows forward-only
Entropic Least Action	Intelligence follows minimal entropy paths	$H = \frac{1}{\ln 2} \int \mathcal{L}(z, \dot{z}, t) \, dt$	Learning governed by variational physics

Why It's Beautiful

Because **SKA unifies physics, cognition, and AI** in a single continuous formulation.

It shows that intelligence isn't a mystery — it's a **law-governed natural process**.

It's like going from:

> "AI works because it learns patterns"

to

> "AI works because intelligence *is* the physical reduction of entropy along a probabilistic path."

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arXiv:2504.03214
arXiv:2503.13942