Abstraction as Entropic Necessity (AEN): Overview

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1. Central Claim

Any system that *persists* must continually reduce uncertainty about its environment while operating under finite energetic constraints. Persistence arises when informational gain (the coherence or predictive structure a system maintains) and energetic cost (the work needed to sustain that structure) reach a stationary balance.

2. Formal Statement (Conceptual)

Let C represent coherence or predictive information and E the energetic cost of maintaining it. AEN proposes that persistent systems evolve toward the marginal equilibrium:

$$\frac{dC}{dE} \approx 1$$

At this balance, additional energetic input produces diminishing informational returns; the system's **informational efficiency** is defined as

$$\eta_E = \frac{I_{\text{pred}}}{E_{\text{cost}}}$$

which stabilizes near a characteristic plateau.

3. Diagnostic Prediction

Across physical, biological, and computational systems:

1. Informational efficiency η_E rises during organization and saturates near persistence.
2. Departures from the plateau ($dC/dE < 1$ or > 1) precede dissipation or instability.
3. This pattern should appear as a measurable scaling law in energy-throughput data, learning curves, or metabolic efficiency traces.

4. Relation to Existing Frameworks

- **Stochastic thermodynamics / fluctuation theorems:** AEN generalizes their efficiency limits to any information-bearing process.
- **Thermodynamics of prediction (Still et al., 2012):** AEN extends predictive efficiency to open systems without explicit model structure.
- **Free Energy Principle (Friston):** AEN is a meta-constraint; it defines the informational–energetic boundary within which FEP-like dynamics can occur.

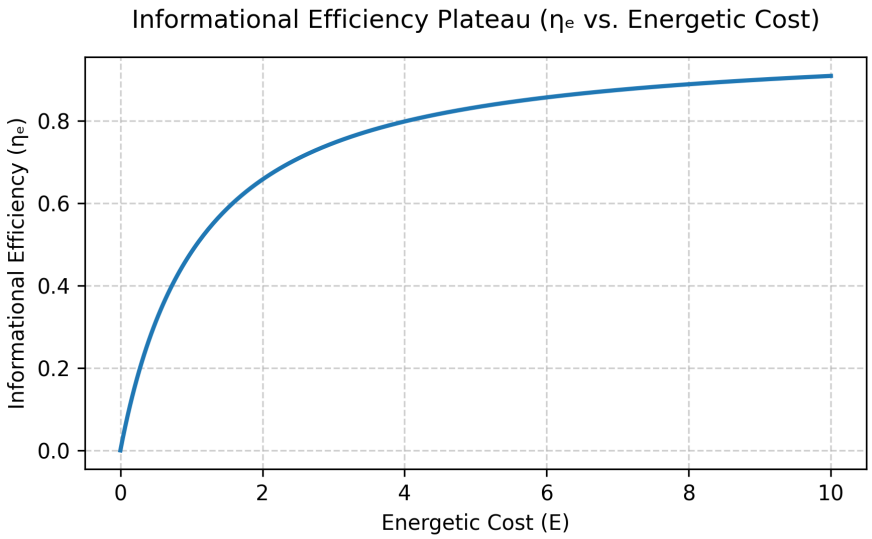
5. Minimal Empirical Tests

- **Driven oscillator or chemical oscillator:** compute predictive mutual information vs. power input; look for efficiency plateau.
- **Neural or ML model:** track prediction-error reduction vs. energy/compute cost; test for saturation region.
- **Metabolic network:** measure information flow (e.g., regulatory entropy) vs. ATP consumption.

6. Significance

AEN reframes persistence as a **scale-invariant informational law** rather than a property of particular materials or algorithms. It offers a simple, falsifiable criterion for coherence under constraint and suggests a quantitative bridge between thermodynamics, computation, and cognition.

7. Illustration (optional)



Placeholder: The informational efficiency η_E increases with abstraction depth until reaching a plateau at the balance point $dC/dE \approx 1$.

8. Contact

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