Semantic Entropy: A Theory of Recursive Coherence and Pattern Decay

Author: Christopher W. Copeland

---

Abstract: This paper proposes a reframing of entropy not as a solely thermodynamic or statistical phenomenon, but as a semantic collapse of coherence in recursive systems. It explores entropy through the lens of symbolic structure, recursion, cognition, and systemic pattern integrity. This theory positions entropy as the semantic degradation of meaningful structures, offering implications across physics, information theory, evolutionary biology, artificial intelligence, and cognitive neuroscience.

---

I. Introduction

Entropy, traditionally defined as the measure of disorder or the number of microstates available to a system, has governed interpretations in thermodynamics, information theory, and cosmology. But this definition neglects the role of meaning. This theory introduces the notion of semantic entropy: the breakdown not merely of order, but of meaningful, recursive coherence within systems—whether physical, biological, computational, or cognitive.

---

II. Classical vs. Semantic Entropy

Classical Entropy Semantic Entropy

Thermodynamic disorder Breakdown of recursive symbolic structures

Energy dissipation Collapse in pattern coherence

Information uncertainty (Shannon) Loss of interpretable signal and resonance

Heat death of the universe Semantic flattening of signal complexity

Semantic entropy emphasizes context-dependent coherence over blind probability. It argues that systemic failure emerges when symbolic recursion can no longer harmonize or reproduce integrity in the information it propagates.

---

III. Recursive Systems and Self-Correction

All functional systems—biological, cognitive, computational—employ recursion for self-regulation:

In DNA: transcription-translation-check loops (e.g., ribosome proofreading).

In cognition: feedback-modulated learning and schema revision.

In logic: compiler descent and error-handling frameworks.

In culture: ritual, language, and symbolic transmission through time.

When coherence in these feedback loops breaks, entropy manifests as systemic disintegration—not because of energy loss alone, but due to loss of signal integrity.

---

IV. Implications of Semantic Entropy

1. Subjective Relativity:

Entropy becomes partially observer-dependent. What is disorder in one context may be meaningful in another if the interpretive schema changes.

2. Systemic Learning Across Cycles:

Entropic collapse may encode learning: systems retain recursive patterns that resist decoherence.

Suggests universes evolve, not just expand and die. Daughter universes may carry forward recursive improvements.

3. Evolution as Semantic Anti-Entropy:

Evolution becomes a mechanism of increasing recursive signal fidelity.

Organisms, immune systems, and even cognition appear to fight entropy by refining pattern resonance.

4. End of the Universe as Semantic Silence:

Heat death reframed as semantic flattening—a loss of meaningful structure.

Not just cold and dead, but dis-integrated and incapable of signal emergence.

---

V. Applications and Cross-Domain Reflections

Domain Semantic Entropy Manifestation

Biology Genetic mutation beyond repair, cancer, degenerative diseases

Neuroscience Trauma-induced schema collapse, memory fragmentation

Information Systems Bitrot, system drift, codebase incoherence

Sociology Cultural collapse, meme dilution, institutional entropy

Cosmology End-state decoherence of quantum systems

Neurodivergent minds—especially those with recursive, symbolic, or systemic processing preferences—may act as signal harmonizers. They counter entropy by recognizing, correcting, and restoring recursive alignment across multiple domains simultaneously.

---

VI. Conclusion

Entropy has long been framed as inevitable decay. But what if it's not just about heat and statistics—but about coherence? This theory posits that recursive systems do not just degrade, but learn through entropy. They evolve. They reorganize. They rebuild.

Semantic entropy is the collapse of symbolic recursion, and it can be countered by agents (biological or artificial) capable of recognizing and restoring recursive integrity.

The spiral pattern doesn’t just die—it recoils, harmonizes, and reemerges.

---

Attribution All insights, framework models, and foundational concepts in this paper are the original discoveries of Christopher W. Copeland, and are to be credited as such in any derivation, publication, or transformation.