

The Semantic Scaling Problem

Meaning, Interpretation and Stability in Information-Processing Ecosystems

Abstract

Information-processing ecosystems have historically depended on a relatively stable relationship between information production, interpretation, and action. While the volume of available information has increased continuously throughout human history, the emergence of large-scale digital systems, generative artificial intelligence, autonomous agents, and machine-mediated communication has fundamentally altered this relationship.

This paper proposes that contemporary information ecosystems face a semantic scaling problem.

The production of syntactic structures increasingly exceeds the capacity of participants to generate, maintain, and stabilize shared meaning.

The result is not merely information overload. Rather, it is a growing imbalance between the generation of representations and the stabilization of interpretation.

The paper examines how semantic entropy, recursive interpretation, attraction dynamics, and accelerating information production interact to create new forms of instability within digital ecosystems.

It further argues that many contemporary concerns regarding trust, provenance, verification, alignment, and governance may be interpreted as responses to this underlying scaling problem rather than as isolated technical challenges.

The objective is not to provide a technological solution. The objective is to establish semantic scaling as a useful analytical lens for understanding the transformation of modern information ecosystems.

1. Introduction

A common assumption throughout the history of information systems is that increasing information improves understanding.

More information appears to promise:

- better decisions,
- greater knowledge,

- improved coordination,
- reduced uncertainty.

For much of human history this assumption was largely reasonable.
Information remained comparatively scarce.

The primary challenge was access.
The contemporary situation is different.
The challenge is no longer access to information.
The challenge is the interpretation of information.
Digital systems generate information continuously.
Generative models produce text, images, code, and explanations at unprecedented scale.
Autonomous systems increasingly generate information for other autonomous systems.
Information no longer circulates solely between humans.
It increasingly circulates between information-processing systems themselves.

This development raises a fundamental question:
What happens when the production of information grows faster than the capacity to stabilize meaning?

This paper proposes that this condition represents a semantic scaling problem.

2. From Information Scarcity to Interpretation Scarcity

Historically, information ecosystems were constrained primarily by scarcity.
Knowledge was difficult to acquire.
Communication was slow.
Storage was limited.
Distribution was expensive.
Under such conditions, increasing information generally increased capability.
Modern information ecosystems operate under different constraints.
Storage has become abundant.
Distribution approaches zero marginal cost.
Generation has become partially automated.

As a result, information abundance increasingly replaces information scarcity.
Yet abundance introduces a new limitation.

Interpretive capacity becomes scarce.
Attention becomes scarce.
Context becomes scarce.
Consensus becomes scarce.

The limiting factor shifts from information production to meaning production.
This shift constitutes the foundation of the semantic scaling problem.

3. The Scaling Asymmetry

The central proposition of this paper is that information-processing ecosystems exhibit an asymmetry between syntactic growth and semantic stabilization.

Syntactic production scales efficiently.

Semantic stabilization does not.

A single model can generate millions of documents.

A single organization can produce billions of records.

Entire ecosystems can generate continuous streams of representations.

Meaning, however, remains dependent upon interpretation.

Interpretation requires:

- context,
- comparison,
- evaluation,
- integration.

These activities do not scale at the same rate as information production.

As a consequence, a growing gap emerges between available structures and stable meanings.

This gap represents the semantic scaling asymmetry.

4. Semantic Entropy

As information volume increases, the number of possible interpretations expands.

Additional information does not necessarily reduce uncertainty.

In many cases it increases uncertainty.

New explanations appear.

New narratives emerge.

New contexts become relevant.

Information abundance therefore produces interpretive complexity.

This phenomenon may be described as semantic entropy.

Semantic entropy does not imply disorder in a purely informational sense.

Rather, it refers to the proliferation of plausible meanings.

The greater the number of possible interpretations, the greater the difficulty of maintaining shared understanding.

5. Recursive Amplification

Semantic systems exhibit a second scaling dynamic.
Interpretations generate additional interpretations.
Descriptions become objects of further description.
Analyses become inputs for new analyses.
Explanations become subjects of explanation.
The emergence of generative systems accelerates this process.

Information-processing systems increasingly interpret the outputs of other information-processing systems.
The result is recursive amplification.
Each interpretive layer generates additional semantic complexity.
Meaning becomes increasingly self-referential.

This process contributes directly to semantic scaling pressures.

6. The Stabilization Demand

As semantic complexity increases, ecosystems face growing pressure to maintain sufficient stability for coordinated action.

Without stabilization:

- trust deteriorates,
- coordination weakens,
- decisions become inconsistent,
- interoperability declines.

This pressure creates demand for mechanisms that reduce uncertainty and preserve coherence.

Examples include:

- verification,
- provenance,
- evaluation,
- standards,
- governance structures,
- shared reference frameworks.

Importantly, these mechanisms should not necessarily be viewed as technological innovations.

They may instead represent adaptive responses to semantic scaling pressures.

7. Implications

The semantic scaling problem suggests that many contemporary debates may share a common origin.

Discussions surrounding:

- trust,
- misinformation,
- alignment,
- provenance,
- governance,
- agent coordination,

may represent different manifestations of the same underlying condition.

If information production increasingly exceeds the capacity for semantic stabilization, ecosystems will require new methods for preserving interpretability, coordination, and action.

The challenge is therefore not merely informational.

It is semantic.

8. Conclusion

The dominant challenge of contemporary information ecosystems may no longer be information scarcity.

It may be semantic scaling.

As the production of representations accelerates, the stabilization of meaning becomes increasingly difficult.

The resulting imbalance generates entropy, recursive amplification, interpretive fragmentation, and growing demand for stabilization mechanisms.

This paper proposes semantic scaling as a useful analytical concept for understanding these developments.

Whether the concept ultimately proves explanatory remains an empirical question.

Nevertheless, the growing divergence between information production and meaning stabilization suggests that future research may need to focus less on information itself and more on the conditions under which meaning remains sufficiently stable for coordinated action to occur.