2026-04 · V1.0.0

Relational Patternist Synthesis

QNFO Research

QNFO-ULA-2.1

ABSTRACT

The Ontological Question: In a universe described by multiple, scale-relative scientific theories (from quantum fields to fluid dynamics to intentional agents), what constitutes a “real” entity, and how do we distinguish objective structure from subjective noise? The Semiotic Question: How can we reconcile the arbitrary, convention-based nature of human language (Saussurean shared meaning) with the existence of universal, objective physical patterns?

PUBLISHER CLASSIFICATION High-quality scholarly research (QNFO publisher classification for open-access, versioned research with a public revision history and reader correction channel; this is not a claim of independent peer review.)

PEER-REVIEW STATUS Not independently peer-reviewed

CITE AS Research, QNFO (2026). Relational Patternist Synthesis. QNFO Preprint v1.0.0.

Ontology, Semiotics, and Structural Realism

Author: Rowan Brad Quni-Gudzinas

Contact: rowan.quni@outlook.com

ORCID: 0009-0002-4317-5604

ISNI: 0000000526456062 **DOI:** https://papers.qnfo.org/papers/relational-patternist-synthesis/ **Date:** 2026-04-09 **Version:** 1.0.1

I. CORE RESEARCH QUESTIONS

The Ontological Question: In a universe described by multiple, scale-relative scientific theories (from quantum fields to fluid dynamics to intentional agents), what constitutes a “real” entity, and how do we distinguish objective structure from subjective noise?

The Semiotic Question: How can we reconcile the arbitrary, convention-based nature of human language (Saussurean shared meaning) with the existence of universal, objective physical patterns?

The Mathematical Question: If discrete counting (integers/primes) and absolute metrics (infinities/real numbers) are biologically bootstrapped, anthropocentric cognitive artifacts, what mathematical framework accurately captures the base-invariant, coordinate-free reality of the universe?

II. THESES

Primary Thesis: Ontic Structural Patternism

Reality is fundamentally composed not of discrete objects, absolute metrics, or fundamental particles, but of **scale-relative, compressible relational patterns**. While human languages and discrete mathematics (such as integers and primes) are biologically bootstrapped, anthropocentric conventions used to navigate these patterns, the underlying structural relationships—expressed mathematically as invariant ratios—constitute the true, universal ontology of the cosmos.

Sub-Thesis A: Epistemic Finitism & The Illusion of the "Bit-Map"

Absolute infinities and discrete coordinate systems are cognitive artifacts (tools for lossy compression) rather than physical realities. The "bit-map" of the universe is computably finite; therefore, any mathematical framework relying on infinite limits or absolute discrete counting (including *p*-adic/Adelic number theory) is an anthropocentric projection rather than a universal baseline.

Sub-Thesis B: Projective Invariance as Universal Syntax

Meaning and physical reality do not reside in isolated nodes (the "things," "words," or "integers") but strictly in the invariant proportions between them. Just as the **Cross-Ratio** in projective geometry remains absolutely invariant under arbitrary coordinate transformations (Möbius transformations), universal physical and syntactic truths remain invariant regardless of the arbitrary linguistic or cultural frameworks used to express them.

III. EXECUTIVE SUMMARY

1. Introduction: The Crisis of the "Desert Landscape"

1.1 The Failure of Strict Reductionism: Quine's "desert landscape" (where only fundamental particles exist) fails to account for the predictive power of higher-level sciences.

1.2 The Linguistic Veil: The tension between arbitrary human semiotics (words mean what we agree they mean) and the objective structure of the universe.

1.3 The Goal: To establish a universal, base-invariant framework that bridges human cognition, artificial intelligence, and fundamental physics without relying on anthropocentric mathematical conventions.

2. The "Real Patterns" Foundation (Dennett to 2026)

2.1 Algorithmic Information Theory (AIT) as Ontology: Petersen's formalization of Dennett. A pattern is "real" if it allows for a description of data that is more efficient (compressible) than a raw bit-map transcription.

2.2 Scale-Relativity: Ladyman and Wallace's extension of patterns to physics. Fluids, centers of gravity, and biological species are not fictions; they are real, projectible patterns that exist at specific scales.

2.3 The Quantitative Intentional Stance (QIS): Alekseev et al.'s application to economics. Using structural models to separate "noise" (randomness) from "waste" (deviations from a rationalizable pattern), proving that agency itself is a measurable, real pattern.

2.4 The Scientist in the Machine: Cao's application to AI. Large Language Models (LLMs) develop internal "world models" not by magic, but because high-dimensional curve-fitting forces the extraction of real, robust patterns from linguistic data.

3. The Anthropocentric Critique of Discrete Mathematics

3.1 The Finitism Manifesto: Ramos's (2026) argument that physical infinities are representational artifacts. The universe is computably finite.

3.2 The Biological Bootstrapping of Math: Integers are not Platonic ideals discovered by humans; they are cultural inventions bootstrapped from crude biological foundations (the Approximate Number System and Object Tracking System).

3.3 The Rejection of Adelic/p-adic Resolution: Why the initial attempt to use p-adic norms to represent linguistic arbitrariness failed. Because p-adic systems rely on prime numbers (discrete integers), they smuggle anthropocentric counting biases into what is supposed to be a universal framework.

4. The Universal Language of Ratios: A Projective Resolution

4.1 Abandoning Coordinates: Moving from Number Theory (absolute values) to Projective Geometry (pure relations). "Things" do not have absolute values; they only have values relative to other things.

4.2 Linguistic Arbitrariness as Möbius Transformations: Human languages, base-10 math, and cultural conventions are mathematically modeled as arbitrary fractional linear transformations $T(x) = \frac{ax+b}{cx+d}$. They warp the "coordinates" of reality based on perspective.

4.3 The Cross-Ratio as the Ultimate Syntactic Primitive: The mathematical proof of structuralism. While individual distances and values change under transformation, the *ratio of ratios* (the Cross-Ratio of four points) remains strictly invariant.

4.4 Ontic Structural Realism (OSR): Aligning the mathematical proof with Ladyman/Ross. The universe is a coordinate-free relational structure. "Objects" are merely the intersections of these invariant ratios.

5. Conclusion: The Coordinate-Free Cosmos

5.1 Resolving the Initial Tension: Words and bases can mean anything (they are arbitrary transformations), but the *structural relationships* they describe cannot.

5.2 Implications for Science: Physics, economics, and cognitive science are all engaged in the same project: finding the invariant cross-ratios (Real Patterns) hidden beneath the noise of anthropocentric coordinate systems.

5.3 Final Summary: The universe does not speak in English, nor does it speak in Base-10 integers. It speaks in pure, scale-relative, invariant proportions.

PART I: THE CRISIS OF FRAGMENTATION

Chapter 1: The Desert Landscape and Its Discontents

1.1 The Reductionist Dream: Quine's Ontological Parsimony

In the mid-twentieth century, the philosopher W.V.O. Quine articulated a vision of reality that would come to dominate analytic metaphysics and much of scientific philosophy. His principle of ontological commitment—*to be is to be the value of a bound variable*—was paired with a methodological injunction: prefer the simplest ontology that can account for the evidence. The resulting picture was a "desert landscape" where only the most fundamental particles and fields, those invoked by our best physics, were granted full ontological status. Everything else—tables, trees, beliefs, societies—was to be understood as convenient *façons de parler*, logical constructions out of the basic stuff.

This reductionist dream promised a clean, unified worldview. If we could only complete the project of fundamental physics, we would have a complete description of reality. Higher-level sciences—biology, psychology, economics—would be revealed as mere approximations, their entities and laws derivative and ultimately dispensable. The desert landscape offered the comfort of ontological austerity: only the bedrock exists; the rest is shadow.

Yet, as the twenty-first century progressed, this comfort began to feel like a straitjacket. The desert landscape, for all its elegance, failed to explain why the shadows cast such long and predictive shadows of their own.

1.2 The Predictive Success of Higher-Level Sciences: A Challenge to Fundamentalism

Consider a simple act: pouring a cup of coffee. The physics of this event is staggering in its complexity. It involves quantum electrodynamics governing the electromagnetic forces between trillions of molecules, statistical mechanics describing their collective motion, and hydrodynamics capturing the flow of the liquid as a continuum. A complete reductionist description of the pour, while possible in principle, is not just impractical; it is *explanatorily useless*. It would bury the phenomenon we wish to understand—the smooth, laminar flow of a fluid—in a tsunami of microphysical detail.

In contrast, the science of fluid dynamics, which treats the coffee as a continuous substance with properties like viscosity and pressure, provides exquisitely accurate predictions. It tells engineers how to design pipes, aeronautics experts how to model airfoils, and meteorologists how to forecast storms. The entities of fluid dynamics—streamlines, vortices, pressure gradients—are not found in the standard model of particle physics. They are **patterns** that emerge at a specific scale of description. And crucially, they are *projectible*: we can use them to make novel, successful predictions about the world.

This is not an isolated case. The same story repeats across the sciences: - **Biology:** The concept of a *species*, while fuzzy at the boundaries, supports robust predictions about inheritance, ecology, and evolution. It is a real pattern at the population level, even though it cannot be strictly reduced to molecular genetics. - **Psychology:** The intentional stance—attributing beliefs and desires to agents—allows us to predict human (and increasingly, machine) behavior with high reliability, despite the fact that “beliefs” do not appear in neuroscience textbooks.

- **Economics:** Markets, firms, and institutions exhibit

regularities—supply and demand curves, business cycles—that are stable enough to model and manipulate, even though they are constituted by countless individual decisions.

The desert landscape cannot account for the *autonomous predictive power* of these higher-level patterns. If they were mere fictions, their repeated success would be a miracle. The reductionist must either accept a universe riddled with inexplicable coincidences or admit that something is missing from the picture.

1.3 The Manifest vs. Scientific Image: A Persistent Duality

The philosopher Wilfrid Sellars identified a fundamental tension in our worldview: the clash between the “manifest image” (the world of colored objects, conscious agents, and meaningful actions) and the “scientific image” (the world of colorless particles, fields, and mathematical laws). The dream of reductionism was to fully replace the manifest image with the scientific one—to show that tables are *really* clouds of particles, that consciousness is *really* neural activity.

But this replacement project has stalled. The manifest image refuses to be eliminated. We cannot live, reason, or do science without relying on its categories. The scientist who insists that pain is “just” C-fibers firing still takes aspirin when she has a headache. The physicist who reduces a hurricane to a complex fluid dynamical system still flees from its path. The categories of the manifest image are not just psychological crutches; they are the very frameworks through which we interact with the world and with each other. They are, in a deep sense, *real for us*.

The crisis of fragmentation is this: we are left with two powerful, indispensable, yet seemingly incompatible pictures of reality. The scientific image gives us ultimate constituents but fails to deliver the world of experience and agency. The manifest image gives us a livable world but seems ontologically suspect from the perspective of fundamental physics. We are faced with a choice between a “view from nowhere” that explains everything but means nothing, and a “view from here” that means everything but seems to explain nothing.

1.4 The Linguistic Veil: How Arbitrary Signs Obscure Objective Structure

Compounding this ontological crisis is a semiotic one. Human language, as Ferdinand de Saussure taught us, is a system of arbitrary signs. The word “tree” has no natural connection to the tall, woody plant it denotes; the connection is established purely by social convention. This arbitrariness is a source of immense creative power—it allows language to adapt, evolve, and refer to abstract concepts—but it also places a veil between our symbols and the world they purport to describe.

If the meaning of a word is determined by its place in a network of other words, and not by any direct link to reality, then how can language ever capture objective truth? How can the arbitrary sound “electron” latch onto a real, mind-independent entity described by quantum field theory? The linguistic veil suggests that all our talk, even our most rigorous scientific talk, is a game of symbols that floats free of the world.

This creates a second, parallel fragmentation. Not only is our ontology split (manifest vs. scientific), but our primary tool for representing reality—language—seems fundamentally cut off from that reality. We are left wondering: is our search for universal patterns merely the projection of our own symbolic conventions onto a silent universe?

1.5 The Mathematical Mismatch: Are Our Number Systems Fit for Reality?

Our third source of fragmentation comes from the very mathematics we use to formulate our most precise scientific theories. The bedrock of modern mathematics—the real number system—is a product of historical and cognitive contingency. The integers emerge from our biologically bootstrapped capacity for approximate numerosity and object tracking. The continuum of real numbers was forged in the fires of calculus, a tool for dealing with infinite limits and infinitesimals.

But what if the universe is not like that? What if it is fundamentally discrete, finite, and without a built-in metric? The real number system assumes the existence of actual infinities and infinitely precise quantities—assumptions that are increasingly questioned in foundations of mathematics and physics. The “Finitism Manifesto” (Ramos, 2026) argues persuasively that infinity is a cognitive tool, not a physical reality. If the universe is computably finite, then our reliance on real numbers is an idealization that may distort as much as it reveals.

Furthermore, our discrete mathematics—including prime numbers and the p-adic number systems sometimes proposed as alternatives—is built on the concept of the integer, itself a cultural artifact bootstrapped from crude biological hardware. To use such systems as the foundation for a universal description of reality is to smuggle our own anthropocentric counting biases into the cosmos.

Thus, we face a tripartite crisis: 1. **Ontological:** A fractured world picture that cannot reconcile the reality of emergent patterns with the reductionist ideal. 2. **Semiotic:** A disconnect between our arbitrary symbolic systems and the objective structure they aim to represent. 3. **Mathematical:** A mismatch between our historically contingent mathematical frameworks and the presumed base-invariant, coordinate-free nature of physical reality.

The desert landscape has left us thirsty for a more integrated vision.

Chapter 2: Three Guiding Questions

The crisis of fragmentation is not a dead end but a catalyst. It forces us to ask deeper, more foundational questions. The Relational Patternist Synthesis emerges from the rigorous pursuit of three guiding questions, each addressing one facet of the crisis.

2.1 The Ontological Question: What is “Real” in a Scale-Relative Universe?

If reductionism fails because higher-level patterns are predictively indispensable, then we need a new criterion for reality—one that is not tied to fundamentality. The ontological question becomes: *In a universe described by multiple, scale-relative scientific theories (from quantum fields to fluid dynamics to intentional agents), what constitutes a “real” entity, and how do we distinguish objective structure from subjective noise?*

This question rejects the Quinean desert. It accepts that reality may be layered, that what exists at one scale may not exist at another, and that existence itself may be a matter of degree—the degree to which a pattern is *projectible*, *compressible*, and *indispensable* for successful navigation of the world. The answer will lead us to Daniel Dennett’s concept of “real patterns” and its formalization in Algorithmic Information Theory.

2.2 The Semiotic Question: Can Arbitrary Symbols Capture Universal Patterns?

If language is a system of arbitrary signs, how can it possibly latch onto mind-independent reality? The semiotic question asks: *How can we reconcile the arbitrary, convention-based nature of human language (Saussurean shared meaning) with the existence of universal, objective physical patterns?*

This question seeks to pierce the linguistic veil. It suggests that while the *signifiers* (the words, the symbols) are arbitrary, the *structural relationships* they encode may not be. Just as different maps of the same territory can use different colors, scales, and projections while still accurately representing the same spatial relations, different languages may warp the “coordinate system” of meaning while preserving certain invariant relations. The task is to find the linguistic analogue of the map’s scale-independent topological features.

2.3 The Mathematical Question: What is a Base-Invariant, Coordinate-Free Language for Physics?

If our standard mathematical frameworks are anthropocentric artifacts, we need to find a mathematical language that does not presuppose discrete counting or absolute metrics. The mathematical question is: *If discrete counting (integers/primes) and absolute metrics (infinities/real numbers) are biologically bootstrapped, anthropocentric cognitive artifacts, what mathematical framework accurately captures the base-invariant, coordinate-free reality of the universe?*

This question pushes us beyond number theory and analysis. It points toward geometries where relations are primary and coordinates secondary—specifically, projective geometry, where the fundamental invariant is the cross-ratio, a quantity that remains unchanged under arbitrary rescaling and perspective shifts. It suggests that the ultimate language of physics may not be written in real numbers but in pure, scale-free proportions.

2.4 The Interdependence of the Questions

These three questions are not independent. They form a tightly interlocking set: - A satisfying answer to the **ontological question** (what is real?) requires a criterion that is not language-dependent, which connects to the semiotic question. - A satisfying answer to the **semiotic question** (how do symbols connect to reality?) requires a formal, mathematical account of invariant meaning, which connects to the mathematical question. - A satisfying answer to the **mathematical question** (what is the right formalism?) must be capable of expressing the scale-relative, pattern-based ontology we seek.

The Relational Patternist Synthesis is the attempt to answer these three questions simultaneously. It proposes that the universe is fundamentally composed of **scale-relative, compressible relational patterns**, that these patterns are captured not by the arbitrary nodes of our symbolic systems but by the **invariant proportions between them**, and that the proper mathematical language for expressing these invariants is **projective geometry**, with the **cross-ratio** as its syntactic primitive.

The journey begins by building a new foundation for ontology, one that can support the rich, layered reality our sciences have revealed. We turn now to the theory of real patterns.

PART II: THE PATTERNIST FOUNDATION

Chapter 3: Real Patterns: From Philosophy to Formal Theory

3.1 Dennett's Intuition: Patterns as Explanatory Tools

In 1991, the philosopher Daniel Dennett proposed a simple but radical criterion for reality: a pattern is "real" if it is a feature of the world that is *worth* representing. More precisely, a pattern is real if acknowledging it allows us to compress information about the world—to describe, predict, and explain phenomena more efficiently than by simply listing every microscopic detail. Dennett's classic example is a chess-playing computer. One could, in principle, describe its behavior by listing the voltage states of every transistor at every nanosecond—a "bit-map" description. But such a description would be astronomically long and utterly uninformative about why the computer makes the moves it does. A much shorter, more powerful description is available: "The computer is implementing a minimax algorithm with alpha-beta pruning to approximate optimal play." This description picks out a **real pattern**—a high-level regularity that captures the system's behavior in a compact, projectible way.

Dennett's insight was that this criterion applies far beyond computers. Beliefs, centers of gravity, financial markets, and biological species are all real patterns. They are not illusions, even though they are not directly reducible to the motions of fundamental particles. They are objective features of the world because ignoring them would force us into longer, less predictive descriptions. The intentional stance (attributing beliefs and desires), the design stance (attributing functions), and the physical stance (describing mechanisms) are all tools for latching onto different kinds of real patterns at different scales.

3.2 Algorithmic Information Theory as Ontology (Petersen)

Dennett's intuitive notion found a rigorous formalization decades later in Algorithmic Information Theory (AIT). Developed by Solomonoff, Kolmogorov, and Chaitin, AIT defines the complexity of a string of data as the length of the shortest computer program that can generate it. This measure, known as Kolmogorov complexity, quantifies the amount of *information* in the data. A string with a simple, repeating pattern (like "01010101…") has low Kolmogorov complexity; a string of random bits has high complexity.

Applied to ontology, AIT provides a precise definition of a real pattern: **A pattern is real if the Kolmogorov complexity of the data, given the pattern, is significantly lower than the complexity of the raw data.** In other words, the pattern serves as a compression algorithm. If you can describe the data more succinctly by invoking the pattern ("it's a sine wave with amplitude A and frequency f") than by transcribing the data point-by-point, then the pattern is real. This formalization transforms Dennett's philosophical insight into a computational, measurable criterion. It shifts the question of reality from "What is fundamental?" to "What description is most efficient?"

3.3 Defining "Real": Compressibility, Projectibility, and Predictive Power

The AIT framework highlights three intertwined properties of real patterns:

Compressibility: The pattern allows for a shorter description than the bit-map. This is the core of the Dennett-Petersen criterion.

Projectibility: The pattern supports counterfactual reasoning and predictions about novel situations. Knowing that an object is a "center of gravity" lets you predict how it will balance under different supports, even if you've never seen that specific configuration before.

Predictive Power: The pattern improves our ability to anticipate future states of the system. The weather pattern known as a “cold front” allows meteorologists to forecast rain and temperature drops.

These properties form a virtuous circle. Compressibility makes a pattern cognitively tractable; projectibility makes it useful for reasoning; predictive power confirms its empirical worth. A pattern that possesses all three is not merely a convenient fiction; it is a *structural feature of the world* that our theories and models can latch onto.

3.4 The Scale-Relativity of Ontology (Ladyman, Wallace)

A crucial implication of the patternist view is that ontology is **scale-relative**. What counts as a real entity depends on the granularity of our description. This idea, developed by James Ladyman and David Wallace, resolves the tension between the manifest and scientific images. There is no single, privileged “fundamental” ontology. Instead, different patterns are real at different scales.

Consider a fluid. At the macroscopic scale, the fluid is a real pattern. It has properties like pressure and viscosity that support powerful, projectible laws (the Navier-Stokes equations). At the molecular scale, the fluid “disappears.” The real patterns at that scale are intermolecular forces and statistical distributions. The fluid is not an illusion, nor is it reducible to the molecules. It is a pattern that exists *at the macroscopic scale*, instantiated by but not identical to the molecular patterns.

Similarly, a biological species is a real pattern at the population-genetic scale, supporting predictions about evolution and ecology. At the organismal scale, the real patterns are physiological and developmental. At the quantum scale, they are wavefunctions and field excitations. Each scale has its own ontology of real patterns, each indispensable for understanding the world at that level of description. This is “Rainforest Realism”: reality is not a desert of particles but a lush, multi-layered ecosystem of patterns.

3.5 Case Study: Fluids, Centers of Gravity, and Biological Species

To make this concrete, let us examine three paradigmatic real patterns:

Fluids: As noted, the continuum description of a fluid is massively more efficient than tracking 10^{23} molecules. The pattern “fluid” supports an autonomous science (fluid dynamics) with its own laws and explanatory successes. It is real at its scale.

Centers of Gravity: The center of gravity of an object is a mathematical point that may not coincide with any physical atom. Yet it is a real pattern: knowing its location allows us to predict the object’s balancing behavior with perfect accuracy, compressing endless details about atomic distributions into a single, powerful concept.

Biological Species: The species *Canis lupus* (gray wolf) is a real pattern in the phylogenetic and ecological landscape. It supports predictions about genetic compatibility, niche occupancy, and evolutionary trajectories. While individual wolves are unique and the boundaries between species can be fuzzy, the species pattern is projectible and indispensable for biology.

In each case, the pattern is *more than* the sum of its parts. It is a higher-order regularity that emerges from the interactions of lower-level entities and, once emerged, takes on a life of its own in our scientific theories and everyday reasoning.

Chapter 4: Patterns in Mind and Machine

4.1 The Quantitative Intentional Stance (Alekseev Et al.): Agency as a Measurable Pattern

If patterns are real, could *agency* itself be a pattern? Alekseev, Harrison, Lau, and Ross (2026) answer yes by formalizing Dennett's intentional stance into a **Quantitative Intentional Stance (QIS)**. They treat an agent's choices as data and ask: can this data be compressed by modeling the agent as having consistent preferences and beliefs? More precisely, they use revealed preference theory to separate the "noise" (random errors) from the "waste" (deviations from rational choice that reflect true welfare costs).

Their method demonstrates that agency is not a binary property but a matter of degree. An entity exhibits agency to the extent that its behavior conforms to a rationalizable pattern. By measuring the "Absolute Welfare Cost" (AWC) of deviations from this pattern, they can quantify how much an agent's choices deviate from what would maximize its own welfare. This turns the philosophical concept of agency into an empirically measurable, real pattern in behavioral data.

4.2 Separating "Noise" from "Waste" in Behavioral Data

The QIS framework makes a crucial distinction. In any dataset of choices, there will be variability. Some of this is **noise**—random, unexplained fluctuations. Some is **waste**—systematic deviations from the optimal pattern that incur a real cost to the agent. Traditional economics often treats all variability as noise. The patternist approach, via QIS, shows that we can algorithmically decompose the data, extracting the signal of a rationalizable preference pattern and isolating the residual waste. This allows for nuanced policy interventions: reducing noise may be impossible or undesirable, but reducing waste can genuinely improve welfare. Agency, therefore, is the pattern of rationalizability that emerges from the noise.

4.3 The Scientist in the Machine (Cao): How LLMs Extract World Models from Data

The patternist lens also illuminates the "miraculous" capabilities of Large Language Models (LLMs). Rosa Cao (2026) argues that LLMs are not magical oracles but "scientists in the machine." Through massive-scale curve-fitting on textual data, they are forced to extract the real patterns that structure human language and, by extension, human knowledge of the world.

When an LLM predicts the next word in a sentence, it is not merely memorizing sequences. It is building an internal model of syntactic structures, semantic relationships, and even rudimentary physical and social reasoning—because these are the compressible patterns that allow it to minimize prediction error. The LLM's competence is a "no-miracles" proof: if it can answer questions about physics or generate coherent stories, it is because the training data contains real patterns about physics and narrative, and the model's architecture is sufficiently powerful to capture them. Understanding is, on this view, a matter of degree—the degree to which a system is sensitive to and can manipulate real patterns.

4.4 Curve-Fitting As Pattern Discovery: Beyond the "Magic" of Understanding

This demystifies AI. The gap between "mere" curve-fitting and "genuine" understanding is not a binary chasm but a continuum. At one end, a model memorizes data without compression (high Kolmogorov complexity). At the other end, a model discovers a compact, projectible theory that compresses the data (low Kolmogorov complexity). LLMs, in their best performances, are somewhere in the middle: they find intermediate-level patterns that are surprisingly robust and generative.

The lesson is profound: **Pattern discovery is the essence of intelligence.** Whether in humans or machines, the process of learning is the process of finding more efficient compressions of sensory or symbolic data. The "scientist in the machine" is not a metaphor; it is a description of what successful learning algorithms do. They implement, automatically,

the same search for real patterns that drives scientific progress.

Chapter 5: The Finitist Turn

5.1 The Finitism Manifesto (Ramos): Infinity as a Representational Artifact

The patternist foundation, with its emphasis on compressibility and scale-relativity, leads naturally to a radical reconsideration of infinity. Néstor Ramos's "Finitism Manifesto" (2026) argues that **infinity is a representational artifact, not a physical reality**. Mathematical infinities—the infinite set of natural numbers, the continuum of real numbers, infinite limits in calculus—are extraordinarily useful tools for compression and calculation. But they are tools invented by human minds, not features of the world itself.

Ramos's claim is that the physical universe is **computably finite**. There is a finite amount of information that can be encoded in any bounded region of spacetime (the Bekenstein bound). There is a minimal meaningful length (the Planck length) and time (the Planck time). Therefore, any physical theory that relies on actual infinities—infinite divisibility, infinite densities, infinite pasts—is making an unwarranted extrapolation from our finite cognitive and representational apparatus.

5.2 The Computable Finiteness of the Physical Universe

The implications are sweeping. If the universe is finite, then the "bit-map" description of any physical system is not infinitely long but merely astronomically large. More importantly, the search for the most compressed description of the universe—the ultimate "theory of everything"—is a search for a finite algorithm that generates the finite dataset of all physical observations. This aligns perfectly with the AIT ontology: the real patterns of the universe are the features that allow this finite algorithm to be as short as possible.

Finitism does not deny the utility of infinite mathematics. It reframes it: infinite limits are shorthand for "arbitrarily large but finite," the continuum is an approximation to a very fine discrete structure, and real numbers are labels for rational approximations that are good enough for a given purpose. The mathematics we use is a lossy compression of a finite reality.

5.3 Implications for Cosmology and Quantum Gravity

Finitism challenges core assumptions in modern physics. Cosmological models that posit an infinite universe or an infinite past may be over-reaching. The singularities in general relativity (black holes, the Big Bang) may be signs of the breakdown of the continuum approximation, not actual infinities. In quantum gravity, approaches that assume a discrete spacetime at the Planck scale (like loop quantum gravity or causal set theory) are more aligned with finitism than those that preserve the continuum.

The patternist synthesis, combined with finitism, suggests that the goal of fundamental physics is not to find equations on a continuum but to discover the finite, algorithmic rules that generate the observed patterns at all scales. The universe is not a differential equation waiting to be solved; it is a finite state machine waiting to be reverse-engineered.

5.4 Rejecting Infinite Limits in "Proper Explanations"

This leads to a final, methodological point. If infinity is not physically real, then a "proper explanation" in the patternist sense cannot rely on infinite limits as a fundamental ingredient. An explanation that says "in the limit as $N \to \infty$, the system behaves like X" is acceptable as a calculational tool, but the true explanation must refer to the finite-N behavior that is actually instantiated. The infinite limit is a compression heuristic—a way to ignore finite-size effects—not an ontological claim.

Thus, the finitist turn completes the patternist foundation. Reality is composed of scale-relative, compressible patterns. These patterns are discovered by agents (human and artificial) through algorithmic compression of finite data. The mathematical tools we use to describe them, including the concept of infinity, are themselves compressed representations—cognitive artifacts that must be understood as such, not mistaken for the fabric of reality.

With this foundation in place—an ontology of real patterns, a methodology of compression, and a finitist metaphysics—we are ready to confront the anthropocentric biases in our current mathematical frameworks. The next step is to critique the very number systems we have taken for granted.

PART III: THE ANTHROPOCENTRIC CRITIQUE

Chapter 6: The Biological Bootstrapping of Mathematics

6.1 The Approximate Number System (ANS) and Object Tracking System (OTS)

Human mathematical cognition does not begin with formal axioms or Platonic contemplation. It begins with two crude, evolutionarily ancient cognitive systems present in infants and many animal species. The **Approximate Number System (ANS)** allows for the rapid, non-symbolic estimation of quantity. It is an analog magnitude system: we can intuitively sense that a group of eight dots is larger than a group of six, but we cannot precisely enumerate either without counting. The ANS is noisy and subject to Weber's law—the just-noticeable difference between two quantities is proportional to their ratio, not their absolute difference.

Complementing the ANS is the **Object Tracking System (OTS)**, which allows us to precisely individuate and track a small number of objects (typically up to three or four). This system, known as *subitizing*, gives us an exact sense of "oneness," "twoness," and "threeness" without serial counting. These two systems—one approximate and analog, the other exact but limited—form the biological bedrock upon which all later mathematics is built.

6.2 From Subitizing to Counting: A Cultural Invention

The leap from these innate capacities to the concept of exact, unbounded counting is not a biological given but a cultural invention. Counting requires the creation of a stable, ordered list of number words and the insight that these words can be applied recursively to any collection. This insight appears to have emerged independently in only a handful of human societies and is not present in all cultures. The Pirahã people of the Amazon, for example, have no number words beyond "one," "two," and "many," and perform poorly on exact numerical tasks beyond their subitizing range.

The invention of counting systems is a feat of cognitive technology. It externalizes and systematizes the OTS, allowing us to overcome its inherent limit of three or four. The number sequence "one, two, three, four, five…" is a cultural artifact, a tool for thought that has been refined over millennia. The integers, therefore, are not discovered Platonic entities waiting in a realm of forms. They are tools we created to extend our limited biological capacities for quantification.

6.3 Integers and Primes as Cognitive Artifacts, Not Platonic Ideals

If the integers are cultural inventions, then so too are the properties we ascribe to them, most notably *primality*. A prime number is defined relative to the multiplicative structure of the integers. But if the integers themselves are not fundamental features of reality, then neither is primality. The fact that 7 is prime is a consequence of the particular counting system we built, not a deep truth about the cosmos.

This is not to deny the utility or beauty of prime numbers. They are astonishingly effective compressors of multiplicative structure. But their effectiveness is a testament to the power of the integer framework as a cognitive tool, not evidence of its ontological fundamentality. To treat primes as universal syntactic primitives—as some proposals in physics

and linguistics have done—is to mistake a feature of our tool for a feature of the world. It is to commit the **anthropocentric fallacy**: projecting the structure of our cognition onto the universe.

6.4 The Real Number Continuum as an Idealization

The real number system represents an even more extreme idealization. It was constructed to solve problems of continuity, limits, and measurement that arose within the integer framework. The continuum of real numbers assumes actual infinities: between any two real numbers, there are infinitely many others. As argued in Chapter 5, this conflicts with the finitist view of physical reality.

The real numbers are an extraordinarily successful tool for modeling continuous phenomena, but they are a tool of *lossy compression*. When we use a real number to represent a physical quantity (like the position of an electron), we are implicitly assuming infinite precision. In a finite universe with a Planck scale, this is an idealization. The real number is a label for a rational approximation that is "good enough" for the task at hand. To reify the continuum—to believe that physical space is literally isomorphic to $\mathbb{R}^3$—is to confuse the map with the territory.

Thus, our standard mathematical toolkit—integers, primes, real numbers—is revealed as a historically contingent, biologically bootstrapped, culturally refined set of instruments. They are magnificent instruments, but they are ours. The question becomes: can we build a mathematical language that is not tied to these anthropocentric foundations?

Chapter 7: The Failure of Discrete Frameworks

7.1 The Allure of p-adic and Adelic Number Theory

Faced with the critique of the real numbers and the continuum, some thinkers have turned to alternative number systems. The p-adic numbers, for a fixed prime *p*, form a field that is in many ways analogous to the real numbers but with an ultrametric topology based on divisibility by powers of *p*. The adelic framework considers all these completions (for all primes *p* and the real completion) simultaneously.

These frameworks are alluring for several reasons. First, they are discrete at their core—they are built from the integers. This seems to align with finitist intuitions. Second, the p-adic metric has a natural interpretation as a measure of "significance" or "information content": a number is small p-adically if it is highly divisible by *p*. This has made p-adics attractive in fields like linguistics and physics, where one seeks to model hierarchical or scale-relative structures. The adelic product formula ($\prod_v |x|_v = 1$) elegantly expresses a global balance between all these local perspectives.

7.2 Why p-adic Systems Smuggle in Anthropocentric Bias

Despite their appeal, p-adic and adelic systems suffer from a fatal flaw: they are built on the same anthropocentric foundation as the integers. The p-adic valuation $|x|_p$ is defined in terms of the exponent of the prime *p* in the factorization of *x*. But the concept of a *prime number* is itself defined within the integer system. Primality has no meaning outside the specific multiplicative structure of $\mathbb{Z}$.

Therefore, any framework that takes primes as primitive is smuggling in the entire intellectual edifice of discrete, integer-based mathematics. It is not escaping anthropocentrism; it is deepening it. The choice of which prime *p* to use is arbitrary—why 2-adic rather than 3-adic or 5-adic? There is no physical or universal principle to decide. The framework thus reintroduces the very kind of arbitrary convention that a universal language should avoid.

7.3 The Prime-Dependence Problem: A Lack of Universality

The prime-dependence of p-adic systems highlights their lack of universality. Different primes give different topologies, different notions of distance, and different completions of the rational numbers. While the adelic perspective tries to embrace all primes at once, it does so by simply taking the product of all these anthropocentric perspectives. This is a

mathematical trick, not an ontological resolution. It says: “All arbitrary choices are valid, so let’s consider them all.” But this does not yield a single, coordinate-free description of reality; it yields a multiplicity of descriptions tied to our arbitrary counting system.

A truly universal framework should not depend on a choice of prime, just as it should not depend on a choice of coordinate system or unit of measurement. The need to choose a prime p is a symptom that the framework is still working within the paradigm of discrete, integer-based arithmetic.

7.4 The Incompatibility with Finitism and Scale-Relativity

Finally, p-adic and adelic frameworks are ultimately incompatible with the finitist and scale-relative ontology developed in Part II. While they may appear discrete, they are built from infinite sets (the set of all integers, the set of all primes). The adelic product formula involves an infinite product over all primes. This reliance on actual infinities contradicts the finitist manifesto’s core claim.

Moreover, these frameworks are not naturally scale-relative. A p-adic number has a fixed “size” determined by its lowest-order digit. While this creates a hierarchy, it is a rigid, absolute hierarchy tied to the prime p. It does not capture the fluid, context-dependent scale-relativity of real patterns, where what counts as a significant entity can shift depending on the level of description. The p-adic tree is a fixed, infinite structure; the rainforest of real patterns is dynamic and level-dependent.

Thus, p-adic and adelic number theory, for all their mathematical elegance, cannot serve as the foundation for a universal, anthropocentric-bias-free description of reality. They are part of the problem, not the solution.

Chapter 8: The Illusion of the “Bit-Map”

8.1 The Universe is Not a Digital Computer

A pervasive metaphor in modern thought is that the universe is a giant digital computer, and physics is the program it runs. This “bit-map” ontology suggests that at the most fundamental level, reality is composed of discrete bits of information, like the pixels on a screen or the bits in a computer memory. Everything else—tables, thoughts, galaxies—is just complex patterns of these bits.

The patternist synthesis rejects this metaphor. While the universe may be finite and discrete at the Planck scale (as finitism suggests), this does not mean it is *digitally computable* in the sense of being reducible to a finite string of 0s and 1s awaiting a finite program. The “bit-map” view assumes that there is a privileged, maximally detailed description of the world—the complete specification of every fundamental bit. But as we have seen, what counts as a “fundamental” description is scale-relative. The bit-map at the Planck scale is not more *real* than the fluid-dynamic description of a hurricane; it is simply a description at a different scale, with its own patterns and compressions.

8.2 Lossy Compression as the Rule, Not the Exception

The deeper error of the bit-map metaphor is that it treats lossless description as the ideal and compression as a concession to our limitations. In reality, **lossy compression is the rule**. The most powerful descriptions of the world are not exhaustive catalogs but efficient compressions that discard irrelevant detail to highlight the salient patterns.

Consider a JPEG image of a face. The original “bit-map” (the raw pixel data) contains every detail, including sensor noise and microscopic skin variations. The JPEG compression algorithm discards most of this information—the high-frequency details that human vision is poor at detecting—while preserving the perceptually important features. The result is a much smaller file that looks, to a human, identical to the original. Is the JPEG less “real” than the raw bitmap? In terms of file size, yes. In terms of capturing the pattern “human face,” it is more efficient and just as effective.

Science works the same way. Newton's laws are a lossy compression of planetary motion: they ignore relativistic corrections, tidal forces from other planets, and solar wind pressure. Yet they capture the dominant pattern with stunning accuracy. To insist on the "bit-map" description—a complete quantum-gravitational simulation of the solar system—would be to miss the forest for the (astronomically numerous) trees.

8.3 Why "More Fundamental" Does Not Mean "More Real"

The bit-map metaphor reinforces the reductionist fallacy that the most fundamental description is the most real one. But from the patternist perspective, **reality is not a property of levels; it is a property of patterns**. A pattern is real if it is compressible, projectible, and predictive. The pattern "center of gravity" is real at the macroscopic scale, even though no particle sits at the center. The pattern "species" is real at the evolutionary scale, even though its boundaries are fuzzy. The pattern "belief" is real at the psychological scale, even though it is not a direct neural entity.

To say that the quantum field description is "more fundamental" than the fluid description is merely to say that it operates at a finer scale of granularity. It does not make the fluid any less real *as a pattern at its own scale*. The quest for fundamentality, when divorced from the criterion of real patterns, leads to the desert landscape—a barren ontology that cannot account for the richness of the world as we experience and explain it.

Thus, we must abandon the illusion of the bit-map. The universe is not a digital computer waiting to be reverse-engineered into a finite program. It is a complex, multi-scale tapestry of real patterns, where the most powerful truths are often the most compressed, and where what exists is always relative to the scale of description. With this critique complete, we have cleared the ground of anthropocentric mathematical assumptions and reductionist metaphors. We are now ready to construct a positive, coordinate-free alternative.

PART IV: THE PROJECTIVE SYNTHESIS

Chapter 9: Abandoning Coordinates

9.1 From Number Theory to Projective Geometry

The history of mathematics is, in part, a history of liberation from fixed coordinate systems. Number theory, with its focus on integers and their properties, is inherently coordinate-bound: it treats numbers as absolute entities with intrinsic values. Analytic geometry ties these numbers to axes and grids, embedding shapes in a fixed metric space. This framework has been spectacularly successful, but as we saw in Part III, it rests on anthropocentric foundations—the integer, the prime, the real number continuum.

Projective geometry offers a different starting point. It asks not "What are the absolute coordinates of these points?" but "What relations among these points remain unchanged when we change our perspective?" In projective geometry, points are defined only up to scaling; lines and planes are defined by incidence relations. The fundamental objects are not numbers but **ratios**—proportions that are invariant under projective transformations (which include scaling, rotation, translation, and perspective shifts).

This shift from absolute values to invariant relations is the first step toward a coordinate-free language for reality. It moves us from asking "What is the value of x?" to "What is the value of x relative to y and z?" In a universe where discrete counting is an artifact, but ratios are robust across scales, projective geometry is the natural mathematical home.

9.2 The Primacy of Relations Over Things

Western metaphysics has long been dominated by **substance ontology**—the idea that reality is fundamentally made of "things" (substances) that possess properties and enter into relations. This ontology mirrors our grammatical subject-predicate structure and our perceptual tendency to carve the world into distinct objects. But the patternist critique suggests that this carving is scale-relative and interest-dependent. What we treat as a "thing" at one scale may dissolve into a pattern of relations at another.

Projective geometry embodies a **relational ontology**. In it, "points" are not pre-given atoms; they are intersections of lines, which are themselves defined by incidence with other points. The structure is primary; the nodes are secondary. This aligns with the insight of Ontic Structural Realism (OSR): what is fundamental in the world is not a set of objects but a network of relations. The objects we perceive are **knots in the relational net**—places where multiple invariant relations converge.

Thus, abandoning coordinates is not merely a technical move in mathematics; it is an ontological shift. It invites us to see the universe not as a collection of things with properties, but as a tapestry of pure relations, waiting to be described in a language that does not privilege any particular coordinate system.

9.3 Invariant Theory: What Remains When Coordinates Change?

The mathematical field of **invariant theory** studies which quantities remain unchanged when a system undergoes a group of transformations. In Euclidean geometry, distances and angles are invariant under rigid motions (rotations and translations). In affine geometry, parallelism and ratios of collinear segments are invariant under linear transformations. In projective geometry, the set of invariants shrinks further—neither distances nor angles nor parallelism survive—but something deeper remains.

The fundamental invariant of projective geometry is the **cross-ratio**. For four collinear points A, B, C, D, the cross-ratio is defined as:

$$\mathrm{CR}(A, B, C, D) = \frac{(A - C)/(B - C)}{(A - D)/(B - D)}$$

(where the points are assigned coordinates on the line, and the value is independent of the coordinate choice). The remarkable theorem is that the cross-ratio is invariant under all projective transformations (Möbius transformations). If you apply any fractional linear map $T(x) = \frac{ax+b}{cx+d}$ to the four points, the cross-ratio of the transformed points is identical to the original.

This is the mathematical heart of the projective synthesis. While individual coordinates, distances, and even the order of points along the line can be wildly distorted by a change of perspective, the *relation of relations* encoded in the cross-ratio remains absolutely fixed. It is a **universal syntactic primitive**—a pattern that survives the complete warp and weft of coordinate changes.

Invariant theory thus provides a precise answer to the question "What is real?" in a coordinate-free world: real structures are those that are invariant under the relevant group of transformations. For human languages and cultural frameworks, the relevant group is the group of Möbius transformations—the mathematical embodiment of arbitrariness.

Chapter 10: Linguistic Arbitrariness as Möbius Transformations

10.1 Saussurean Semiotics Meets Fractional Linear Maps

Ferdinand de Saussure's foundational insight in linguistics was the **arbitrariness of the sign**: there is no natural connection between a signifier (the word "tree") and its signified (the concept of a tree). The connection is established purely by social convention. This arbitrariness is what allows languages to differ wildly and to evolve over time.

Mathematically, arbitrariness can be modeled as a **symmetry**: the set of all possible mappings between signs and meanings forms a group. If we represent meanings as points in some abstract "meaning-space" (a crude but useful idealization), then different languages correspond to different coordinate systems on that space. Changing from one language to another is like applying a coordinate transformation.

The simplest non-trivial transformations that preserve the projective structure of a line are the fractional linear transformations, also known as Möbius transformations:

$$T(x) = \frac{ax + b}{cx + d}, \quad ad - bc \neq 0.$$

These transformations form a group under composition—the projective linear group $\mathrm{PGL}(2, \mathbb{R})$ (or over other fields). They can stretch, shrink, rotate, and invert the line, but they preserve the cross-ratio. Thus, we can model linguistic arbitrariness as the action of this group on meaning-space: each language is a different "gauge," a different choice of coordinates, related to others by a Möbius transformation.

10.2 Modeling Languages, Bases, and Conventions as $T(x) = \frac{ax+b}{cx+d}$

Consider a simple continuum of meanings—say, the dimension of "size" from infinitesimal to infinite. English might map this continuum to the real number line using the words "tiny," "small," "medium," "large," "huge," etc., spaced in a certain way. Another language might use a different set of words with different spacing. Mathematically, we can think of English as assigning coordinate x to a given size, while another language assigns coordinate $x' = T(x)$.

The parameters a, b, c, d capture the arbitrariness: - **Scaling (a):** Stretching or compressing the scale of distinctions. - **Translation (b):** Shifting the zero point (what counts as "neutral"). - **Inversion ($c \neq 0$):** Reversing the ordering (e.g., what one culture calls "large" another might call "small" relative to a different reference). - **Overall normalization (d):** Affecting the overall range.

Different number bases (base-10 vs. base-2 vs. base-60) are also instances of such transformations: they rescale and relabel the numeric continuum. Cultural conventions—what counts as "polite," "beautiful," "true"—can similarly be seen as warps of a social-value space. The key is that while the coordinates change arbitrarily, certain relational patterns (cross-ratios) remain unchanged.

10.3 The Warping of Meaning-Space

If languages are Möbius transformations, then the "meaning-space" they coordinatize is inherently **projective**. Points in this space are not absolute; they are defined only in relation to other points. The distance between "large" and "huge" in English may be different from the distance between their counterparts in another language, but the *relative proportion* of intervals—say, (large-medium)/(huge-medium)—may be invariant.

This warping explains why direct translation is often impossible: the coordinate grids are distorted. Yet, it also explains why communication is possible at all: because the invariant cross-ratios encode the **structural relationships** that are shared across languages. When we say "A is to B as C is to D," we are gesturing toward a cross-ratio. Proverbs, analogies, and metaphors often rely on such proportional invariants.

Thus, the Saussurean veil of arbitrariness is pierced by projective invariance. Words can mean anything, but the relational patterns they express cannot be arbitrarily changed without loss of meaning. The universal syntax we seek is not a lexicon of primitives but a geometry of invariant proportions.

Chapter 11: The Cross-Ratio: The Ultimate Syntactic Primitive

11.1 Definition and Geometric Interpretation

The cross-ratio of four collinear points is, as defined above, a number that depends only on their relative positions. Geometrically, it can be interpreted as a measure of the "harmonic separation" of the four points. A value of -1 indicates a harmonic division; 0, 1, or ∞ indicate degeneracies (points coinciding). For any four distinct points, the cross-ratio is a finite number that uniquely characterizes their projective configuration.

Crucially, the cross-ratio is a **second-order relation**. It does not compare two points directly (like a distance) nor three points (like a ratio of segments). It compares two ratios, each of which already compares two segments. It is a **relation of relations**—a pattern that captures how two pairs of points are proportionally situated with respect to each other. This makes it an ideal candidate for a universal syntactic primitive: it is complex enough to encode rich structure, yet simple enough to be invariant under arbitrary projective changes.

11.2 Proof of Invariance Under Arbitrary Projective Transformations

The invariance of the cross-ratio under Möbius transformations is a classical theorem of projective geometry. The proof is algebraic: if $T(x) = \frac{ax+b}{cx+d}$, then substituting into the definition of the cross-ratio and simplifying yields exactly the same expression. The parameters a, b, c, d cancel out, leaving the original cross-ratio unchanged.

This cancellation is profound. It means that no matter how wildly we distort the line—stretching it, flipping it, mapping it to a circle—the cross-ratio of any four points remains a fixed feature of their relational arrangement. It is a **topological invariant** of projective structure. In the context of our synthesis, this theorem is the mathematical guarantee that certain relational patterns are objective, independent of the arbitrary symbolic system used to express them.

11.3 The Cross-Ratio as a Universal "Relation of Relations"

Why is the cross-ratio special? Because it is the *simplest* non-constant projective invariant. In one-dimensional projective geometry, all invariants of four points are functions of the cross-ratio. It is the fundamental building block from which more complex invariants can be constructed.

This elevates the cross-ratio from a geometric curiosity to a candidate for a universal syntactic primitive. Just as the bit is the fundamental unit of digital information, the cross-ratio could be the fundamental unit of relational information. It answers the mathematical question posed in Chapter 2: it is a base-invariant, coordinate-free quantity that captures pure proportion. It does not rely on integers, primes, or real numbers; it can be defined over any field (including finite fields), making it compatible with finitism.

11.4 From Geometry to Semantics: Invariant Meaning

How does this abstract geometry connect to meaning? Suppose we model a semantic domain—like "size" or "moral valence"—as a projective line. Different cultures/languages assign different coordinate systems (Möbius transforms) to this line. Specific words or concepts correspond to points on the line. While the coordinates of "justice," "mercy," "punishment," and "forgiveness" may vary across moral frameworks, the **cross-ratio** of these four concepts could be invariant. That invariant captures the deep structural relationship among these values—a relationship that is objective even though its expression is arbitrary.

This provides a rigorous model for universal semantics. Universal human concepts are not a fixed list of atomic meanings (as in classical lexical semantics) but a set of **invariant cross-ratios** across conceptual spaces. The project of comparative linguistics and cognitive science becomes the search for these invariants—the real patterns that persist beneath the noise of cultural convention.

Thus, the cross-ratio bridges the semiotic gap. Arbitrary signs can float free, but the relational patterns they encode are anchored in projective reality.

Chapter 12: Ontic Structural Patternism

12.1 Aligning with Ladyman/Ross's Ontic Structural Realism (OSR)

Ontic Structural Realism, advanced by James Ladyman and Don Ross, argues that the world is fundamentally a structure of relations, and that objects are derivative—they are merely "nodes" or "intersections" in this relational network. OSR emerged as a response to the problems of scientific realism in the face of theory change: while our theories about objects may be wrong, the mathematical relations they describe often survive.

The projective synthesis is a natural extension and refinement of OSR. It provides a precise mathematical language for describing relational structures: projective geometry with the cross-ratio as the primitive invariant. It also grounds OSR in the patternist ontology: the relations that are real are those that are **compressible** and **scale-relative**. The cross-ratio is a compressible description of a four-point configuration; its invariance across scales (projective transformations) makes it a candidate for a universal structural element.

Thus, we arrive at **Ontic Structural Patternism**: the view that reality is composed of scale-relative, compressible relational patterns, expressed mathematically as projective invariants.

12.2 The Universe as a Coordinate-Free Relational Structure

If Ontic Structural Patternism is correct, then the universe does not come equipped with a preferred coordinate system. There is no "God's eye" grid of space and time, no absolute metric, no fundamental counting system. Instead, the cosmos is a vast network of relational patterns, like an infinite projective configuration. What we perceive as space, time, particles, and fields are **local coordinate patches**—useful gauges for navigating the relational network, but not fundamental.

Physics, then, becomes the search for the invariants of this network. General relativity already points in this direction: spacetime is a differentiable manifold, and the laws are expressed in coordinate-free tensor form. The metric tensor is not a fixed background but a dynamic field whose invariants (scalar curvatures, intervals) are what matter. Quantum mechanics, with its emphasis on probabilities and amplitudes, may also be hiding a projective structure—perhaps the Hilbert space inner product is a kind of cross-ratio in a high-dimensional projective space.

12.3 "Objects" As Intersections of Invariant Ratios

Where do objects come from? In projective geometry, a point can be defined as the intersection of two lines. Similarly, in Ontic Structural Patternism, an "object" is the **intersection of multiple invariant ratios**. For example, an electron might be identified as the intersection of certain cross-ratios in the network of quantum fields—the place where a set of relational patterns becomes highly localized and projectible.

This demotes objects from fundamental substances to emergent knots. It explains why objects are scale-relative: at different scales, different sets of ratios become salient, giving rise to different "objects." A cell is an object at the biological scale, defined by metabolic and reproductive ratios; at the molecular scale, it dissolves into a pattern of chemical reactions.

12.4 The Primacy of Scale-Relative, Compressible Relational Patterns

The synthesis is now complete. We have traveled from the crisis of fragmentation through the foundation of real patterns, through the critique of anthropocentric mathematics, to the projective resolution. The overarching principle is the **primacy of scale-relative, compressible relational patterns**.

Reality is not a desert of particles nor a bit-map of information. It is a rainforest of patterns, each real at its own scale, each describable by a compressed representation. The most fundamental of these patterns are projective invariants—cross-ratios—that persist across arbitrary coordinate changes. These invariants constitute the universal syntax of the cosmos, a language spoken not in words or numbers but in pure proportions.

With this framework in place, we can now turn to its applications. How does this perspective reshape our understanding of physics, economics, cognitive science, and artificial intelligence? The final part of our journey explores the implications of the coordinate-free cosmos.

PART V: APPLICATIONS AND IMPLICATIONS

Chapter 13: Physics in a Coordinate-Free Cosmos

13.1 Re-reading Quantum Mechanics: Is Hilbert Space Anthropocentric?

The mathematical formalism of quantum mechanics—complex Hilbert spaces, unitary evolution, Hermitian operators—has been spectacularly successful for a century. Yet, from the perspective of the Relational Patternist Synthesis, it bears the marks of its anthropocentric origins. Hilbert space is a vector space over the field of complex numbers, a structure that presupposes the continuum of real and complex numbers, with its built-in assumptions of infinite precision and absolute magnitude. The Born rule, which converts complex amplitudes into real probabilities, involves a squaring operation that is metric-dependent. Could this formalism be a **coordinate-bound projection** of a deeper, coordinate-free reality?

Consider the measurement problem. In the standard formulation, a quantum state is a vector in Hilbert space that "collapses" to an eigenstate upon measurement. This collapse appears discontinuous and non-unitary. But if we view the quantum state not as an absolute vector but as a **relational pattern**—a set of invariant proportions among possible outcomes—the "collapse" may be a coordinate artifact. In projective geometry, moving from a projective space to an affine patch (choosing a coordinate system) can appear as a discontinuous "projection." Similarly, the act of measurement may be the selection of a particular coordinate system (a particular experimental context) that makes certain relational patterns (eigenvalues) manifest.

The probabilistic nature of quantum outcomes could then be understood through the lens of **lossy compression**. The full, pre-measurement relational pattern is a complex web of cross-ratios among all possible measurement contexts. When we force the system into a single context (perform a specific measurement), we lose most of that relational information, retaining only the probabilities dictated by the invariant proportions (the squared amplitudes). This is analogous to how a JPEG compression loses high-frequency details while preserving the perceptually important structure. The randomness of quantum outcomes would then reflect not fundamental indeterminism but the **irreducible loss of relational information** when a projective configuration is mapped to a specific coordinate gauge.

This suggests that Hilbert space may be a useful but non-fundamental tool—a particular coordinate representation of a deeper projective structure. The search for a "quantum gravity" theory might then be the search for the invariant cross-ratios that underlie both quantum and gravitational phenomena, expressed in a coordinate-free language.

13.2 Scale-Relative Patterns in Condensed Matter and Fluid Dynamics

Condensed matter physics and fluid dynamics are already paradigmatic examples of scale-relative real patterns. The behavior of a solid, liquid, or plasma is described by **effective field theories** that are valid only at certain length and energy scales. These theories—like the Ginzburg-Landau theory of superconductivity or the Navier-Stokes equations of fluid flow—are not derivable in a strict deductive sense from the Standard Model of particle physics. They are **compressed descriptions** that capture the emergent patterns that become salient at those scales.

The patternist framework provides a philosophical grounding for this ubiquitous practice. The phonons, magnons, and Cooper pairs of condensed matter physics are real patterns: they are collective excitations that afford efficient, projectible descriptions of the system's behavior. They are not "just" arrangements of electrons and nuclei; they are new ontological entities that exist at the condensed-matter scale. Similarly, the vortices, shock waves, and turbulence cascades of fluid dynamics are real patterns that govern the flow.

These patterns often exhibit **scale-invariance** within their domain of validity. Turbulence, for example, displays self-similar statistical structure across a range of scales (the inertial subrange). This scale-invariance is a mathematical property of the pattern, while the pattern itself is scale-relative—it exists only because we have coarse-grained away molecular details. The complementarity of scale-relativity and scale-invariance, discussed earlier, is vividly illustrated here: the **pattern** (turbulent cascade) is scale-relative (it emerges at macroscopic scales), but its **mathematical form** (power-law correlations) is scale-invariant.

Thus, physics already operates in a coordinate-free, pattern-based manner when it moves beyond fundamental particle theory. The Relational Patternist Synthesis simply makes this implicit methodology explicit and universal.

13.3 Projective Invariants in General Relativity and Cosmology

General relativity (GR) is, in many ways, the archetype of a coordinate-free physical theory. Einstein's great insight was that the laws of physics should be expressed in a form that is independent of the choice of coordinates. The fundamental object in GR is the metric tensor $g_{\mu\nu}$, which encodes the geometry of spacetime. The physically meaningful quantities are **invariants** constructed from this tensor: scalar curvatures, proper times, geodesic intervals.

These invariants are the GR analogues of the cross-ratio. Just as the cross-ratio captures the projective relationship among four points on a line, the curvature invariants capture the relational geometry among events in spacetime. The Einstein field equations themselves can be written in coordinate-free form using differential geometry. This aligns perfectly with the projective synthesis: the universe is a relational structure, and physics is the search for its invariants.

Cosmology, however, introduces a challenge. The standard model of cosmology (ΛCDM) assumes a homogeneous and isotropic universe on large scales—a **cosmic coordinate system** given by the Friedmann-Lemaître-Robertson-Walker (FLRW) metric. While this is an excellent approximation for many purposes, it may be another instance of coordinate-fixing. The observed uniformity of the cosmic microwave background could reflect not a fundamental symmetry of the universe but a **projective invariant** that appears as homogeneity only in a particular gauge (the comoving coordinates). Alternative approaches, like the "cosmological principle" as a pattern rather than a strict symmetry, fit naturally within the patternist view.

Moreover, the singularities predicted by GR (black holes, the Big Bang) may signal the breakdown of the continuum description—the point where the coordinate-based language of differential geometry fails, and a more fundamental, possibly discrete, relational pattern must take over. This leads directly to the quest for quantum gravity.

13.4 Towards a Finitist, Pattern-Based Quantum Gravity

The search for a theory of quantum gravity is, from the patternist perspective, the search for the most compressed description of the relational patterns that underlie both quantum phenomena and spacetime geometry. Current leading candidates—string theory, loop quantum gravity, causal set theory—each approach this from different angles.

String theory posits extended objects whose vibrational modes give rise to particles and forces. It is formulated on a background spacetime, though some versions attempt background independence. Its reliance on extra dimensions and continuous geometries may conflict with finitism.

Loop quantum gravity (LQG) is explicitly background-independent and quantizes geometry directly. It predicts a discrete spectrum for area and volume, aligning with finitism. In LQG, spacetime is a network of spin-foam edges and vertices—a relational structure reminiscent of a graph.

Causal set theory posits that spacetime is fundamentally a discrete set of events with a partial order representing causality. The continuum emerges as an approximation. This is perhaps the purest expression of a finitist, relational ontology: the universe is a finite set of events with causal relations.

The patternist synthesis favors approaches like LQG and causal sets because they embrace discreteness, finitism, and relationalism. In these theories, the fundamental entities are not things in a spacetime container but **nodes in a relational network**. The invariants are not metric distances but causal relations, adjacency relations, or spin-network intertwiners.

The ultimate theory of quantum gravity, then, might be expressed not in differential equations but in **algorithmic rules** for generating a growing causal set or spin-network. The laws of physics would be the compressed description of the pattern that this network exhibits. The cross-ratio, or its higher-dimensional generalizations, could serve as the fundamental invariant relating events in this network. Such a theory would be truly coordinate-free, finite, and pattern-based—a fitting culmination of the physics side of the synthesis.

Chapter 14: Economics and Cognitive Science

14.1 The Quantitative Intentional Stance Revisited

In Chapter 4, we introduced the Quantitative Intentional Stance (QIS) as a method for detecting agency as a real pattern in choice data. The patternist framework provides a deeper foundation for this approach. When economists model an agent as maximizing a utility function subject to constraints, they are not claiming that the agent literally has such a function in its head. Rather, they are **compressing** the agent's observed choices into a compact, projectible pattern—the utility function. This pattern is real if it allows for accurate predictions of future choices and interventions.

The QIS formalizes this by separating "noise" (random errors) from "waste" (deviations from the rationalizable pattern that incur welfare costs). This separation is itself a pattern-discovery algorithm. It treats the data of choice as a string to be compressed, and the rationalizable preference pattern as the shortest program that generates most of that string. The residual "waste" is the part of the data that is not compressed by the rational pattern—it is the **Kolmogorov complexity** of the data given the pattern.

Thus, economics, at its best, is an applied science of real patterns. Its entities—preferences, expectations, equilibria—are not fictional; they are patterns that exist at the scale of market interactions, indispensable for understanding and shaping economic outcomes.

14.2 Identifying Welfare-Relevant Patterns in Market Data

The patternist view reframes welfare economics. Traditional welfare analysis often relies on questionable aggregations of individual utilities. A pattern-based approach would instead look for **invariants** in the relational structure of market outcomes. For example, the **Pareto frontier**—the set of allocations where no one can be made better off without making someone worse off—is a projective invariant. It is independent of the particular utility functions (the coordinate systems) assigned to individuals, as long as those functions are monotonic transformations of each other.

Similarly, measures of inequality like the **Gini coefficient** or the **Theil index** are essentially summary statistics of the distribution of resources—they compress the complex pattern of allocations into a single number that captures a particular aspect of the relational structure (dispersion, entropy). The search for "just" distributions could then be framed as the search for distributional patterns that maximize certain invariants (like a high minimum cross-ratio of well-being across individuals) while respecting others (like production possibilities).

This moves welfare economics away from metaphysical debates about cardinal utility and toward an empirically grounded study of the relational patterns that constitute flourishing societies.

14.3 Grammatical Universals as Projective Invariants (Verkerk Et al.)

Linguistics has long sought universal features of human language. The work of Verkerk and colleagues, using Bayesian phylogenetic methods on large typological databases like Grambank, has revealed that languages do not vary arbitrarily. They evolve toward "harmonic" patterns—clusters of grammatical features that tend to co-occur. For example, languages with subject-object-verb (SOV) order tend to have postpositions rather than prepositions.

These harmonic patterns can be interpreted as **projective invariants** in the space of possible grammars. Each language is a point in a high-dimensional space of grammatical features. Different language families may "rotate" or "stretch" this space in different ways (historical and cultural transformations), but certain cross-ratios among features remain stable. These invariants reflect deep cognitive and communicative constraints—the real patterns that shape language evolution.

The patternist synthesis thus unifies the formal, mathematical approach of generative grammar with the empirical, variational approach of linguistic typology. Universal Grammar is not a fixed set of rules but a set of **invariant proportions** in the space of grammatical constructions. This is a coordinate-free description of language: the specific rules (coordinates) vary arbitrarily, but the relational patterns (invariants) are universal.

14.4 A Pattern-Based Theory of Consciousness?

Consciousness remains the hard problem. The patternist framework suggests a direction: consciousness might be a **particularly rich and integrated real pattern** in the neural (or more broadly, physical) data of an organism. Integrated Information Theory (IIT) already points this way: it defines consciousness as the amount of "integrated information" (Φ) generated by a system—a measure of how much the system's state is both differentiated and unified.

From a patternist perspective, Φ is a candidate for a **compressibility measure** of the causal structure of the system. A system with high Φ is one whose causal dynamics cannot be decomposed into independent parts without significant loss of predictive power—it is a highly integrated real pattern. The "qualia" of experience could be the intrinsic perspective of this pattern—what it feels like to *be* that particular compression of causal relations.

This is speculative, but it aligns with the synthesis. Consciousness would not be a magical extra substance but a natural, albeit exceptionally complex, real pattern that emerges at the scale of certain neural networks. Its "hardness" stems from the fact that experiencing the pattern from the inside (first-person perspective) is categorically different from describing it from the outside (third-person compression). Yet both are aspects of the same relational structure.

Chapter 15: Artificial Intelligence and the Future of Understanding

15.1 Building Machines That Detect Real Patterns

Modern AI, especially deep learning, is essentially a technology for **automated pattern discovery**. Given a large dataset, a neural network learns a hierarchical set of features that compress the data into a representation that minimizes prediction error. This is precisely the process of finding real patterns, as defined by Algorithmic Information Theory. The network's layers build increasingly abstract, compressed representations of the input.

The patternist framework provides a clear metric for AI progress: the degree to which an AI system can discover **compressible, projectible, and predictive patterns** in novel domains. An AI that can predict the weather by learning the Navier-Stokes equations from data is discovering a real pattern. An AI that can infer the intentional stance from behavioral data is discovering another. The ultimate AI would be one that can discover the fundamental invariants of the universe—the cross-ratios that underlie all physical and semantic phenomena.

This shifts the goal of AI from "mimicking human intelligence" to "maximizing pattern-discovery power." It also suggests that AI safety should focus on ensuring that the patterns AI systems discover and optimize are aligned with human welfare—a task that requires us to formally specify those welfare-relevant patterns, perhaps using the QIS framework.

15.2 The Ethics of Pattern-Recognition Systems

AI systems that classify, recommend, and decide are, at their core, pattern-recognition engines. They find correlations in historical data and use them to predict future outcomes. The ethical dangers—bias, discrimination, opacity—arise when these systems latch onto **spurious patterns** that are not projectible or that encode historical injustices.

For example, an AI trained on hiring data might learn the pattern "graduates of elite universities make better employees." This pattern may be compressible in the training data (it reduces prediction error), but it may not be projectible—it may reflect historical bias rather than true causal relationship. The patternist criterion of **projectibility** (the ability to support counterfactual reasoning) provides a test: does the pattern hold under interventions, such as actively hiring non-elite graduates and measuring performance?

Thus, AI ethics becomes, in part, the science of **pattern validation**. We need methods to distinguish real, projectible patterns from accidental, biased, or spurious ones. This aligns with the broader epistemological project of the synthesis: distinguishing objective structure from subjective noise.

15.3 Could an AI Discover the Cross-Ratio?

Imagine an AI tasked with finding the most fundamental invariants in a universe of relational data. Suppose we give it a vast dataset of geometric configurations, each described in many different coordinate systems (different languages, different scales, different perspectives). The AI's goal is to find the smallest set of quantities that remain constant across all coordinate changes for each configuration.

A sufficiently powerful AI, using symbolic regression or genetic programming, might eventually output the formula for the cross-ratio. It would have discovered, from raw data, the universal syntactic primitive of projective geometry. This would be a monumental achievement—a demonstration that the core of mathematics is not a human invention but a discovery about the structure of relational data.

More realistically, AIs are already discovering approximate invariants in physical systems. For example, machine learning has been used to discover conservation laws from particle-trajectory data. The patternist synthesis predicts that the most powerful AIs will gradually converge on the same set of fundamental invariants that human scientists have found—because those invariants are the real patterns of the universe.

15.4 The Scientist in the Machine: A New Epistemic Paradigm

Rosa Cao's metaphor of the "scientist in the machine" takes on new depth in the patternist framework. An AI is not just a curve-fitter; it is an **automated scientist** that formulates hypotheses (patterns) and tests them against data. Its internal representations are its "theories," and its learning algorithm is its "scientific method."

This leads to a new epistemic paradigm: **epistemology by compression**. The goal of knowledge is not to accumulate true propositions but to find the most compressed representations of our sensory and symbolic data. Science, philosophy, and AI are all engaged in the same enterprise. The distinction between human and machine intelligence blurs; both are pattern-discovery engines, differing only in architecture and training data.

The future of understanding may involve a **symbiosis** between human and machine pattern-discoverers. Humans provide intuition, context, and value-laden goals; machines provide brute-force search, consistency, and the ability to handle hyper-dimensional data. Together, they may uncover deeper layers of reality's relational tapestry than either could alone.

Chapter 16: The Coordinate-Free Cosmos: A New Worldview

16.1 Resolving the Initial Tension: Arbitrary Symbols, Invariant Structures

We began with a tripartite crisis: the ontological fragmentation between the manifest and scientific images, the semiotic disconnect between arbitrary language and objective reality, and the mathematical mismatch between our anthropocentric number systems and a presumptively coordinate-free universe. The Relational Patternist Synthesis resolves these tensions by reframing reality as **scale-relative, compressible relational patterns**.

Ontological tension: Resolved by recognizing that what is real is not tied to a fundamental scale but to compressible, projectible patterns that exist at multiple scales. The desert landscape gives way to a rainforest of real patterns.

Semiotic tension: Resolved by modeling linguistic arbitrariness as Möbius transformations (coordinate changes) on a projective meaning-space. While signifiers are arbitrary, the invariant cross-ratios they express are objective. Words can mean anything, but the structural relationships they describe cannot.

Mathematical tension: Resolved by abandoning absolute coordinates and discrete integers for projective geometry and the cross-ratio. This provides a base-invariant, coordinate-free language that aligns with finitism and scale-relativity.

The synthesis shows that these three resolutions are facets of a single insight: **reality is relational, and truth is invariant.**

16.2 Implications for the Philosophy of Science and Mathematics

The patternist framework has profound implications for how we understand science and mathematics.

Philosophy of science: Science is not the gradual uncovering of a pre-existing, fundamental ontology. It is the **iterative compression** of empirical data into ever more powerful patterns. Theory change is not a catastrophic rupture but a refinement of compression—replacing a longer description with a shorter one that covers more data. Scientific realism is vindicated, but it is a realism about patterns, not about the particular objects posited by any given theory.

Philosophy of mathematics: Mathematics is not the study of a Platonic realm of numbers and sets. It is the study of **possible patterns of relation**. The integers, primes, and real numbers are particular patterns that have proven extraordinarily useful for compressing certain aspects of our experience. But they are not ontologically privileged. Projective geometry and invariant theory may be closer to the true universal mathematics because they focus on relations rather than things.

This view demystifies the “unreasonable effectiveness of mathematics in the natural sciences.” Mathematics is effective because it is the science of patterns, and the universe is made of patterns. The fit is not magic; it is necessity.

16.3 The End of Fundamentalism: A Rainforest of Real Patterns

The synthesis spells the end of **fundamentalism** in metaphysics and science. There is no single “fundamental” level of reality, no “theory of everything” that will render all other sciences derivative. Instead, we have a **rainforest of real patterns**—a multi-scale, multi-domain ecosystem of compressible structures, each indispensable for understanding the world at its own level.

Reductionism is replaced by **pattern-integrity**. The patterns of fluid dynamics are not reducible to molecular physics in any useful sense; they are autonomous patterns that must be studied on their own terms. The patterns of consciousness are not reducible to neural spikes; they are a different kind of pattern that emerges at the level of integrated information.

This does not lead to ontological profligacy. The criterion of real patterns—compressibility, projectibility, predictive power—provides a strict discipline. It tells us when a pattern is worth ontological commitment and when it is mere noise. The rainforest is lush but not chaotic; it is structured by the logic of information compression.

16.4 Final Summary: The Universe Speaks in Ratios

In the end, the Relational Patternist Synthesis offers a simple but radical vision: **the universe does not speak in English, nor in base-10 integers, nor in differential equations. It speaks in pure, scale-relative, invariant proportions.**

The ultimate language of reality is the language of ratios—the cross-ratio and its higher-dimensional generalizations. These invariants are the syntactic primitives of a coordinate-free cosmos. They are discovered by scientists, encoded by languages, and approximated by mathematicians. They are the real patterns that constitute everything from quantum fields to economic markets to conscious minds.

Our task, as knowers, is to learn this language. To listen for the invariant ratios beneath the noise of our anthropocentric coordinates. To build machines that can hear them too. And to structure our societies and our selves in harmony with the deep relational patterns that sustain flourishing.

This is the promise of the coordinate-free cosmos: a world where meaning is not imposed but discovered, where truth is not absolute but invariant, and where reality is not a desert but a rainforest—endlessly complex, endlessly compressible, and endlessly beautiful.

Appendix A: Mathematical Primer on Projective Geometry and the Cross-Ratio

A.1 Projective Geometry: Basic Concepts

A.1.1 The Projective Line

In Euclidean geometry, a line is a set of points with a notion of distance and betweenness. In projective geometry, we enrich the line by adding a single “point at infinity.” The **projective line** over a field $\mathbb{F}$ (typically the real numbers $\mathbb{R}$ or the complex numbers $\mathbb{C}$) is denoted $\mathbb{P}^1(\mathbb{F})$. It can be constructed from the affine line $\mathbb{F}$ by adding one point ∞. Alternatively, it can be defined as the set of all one-dimensional subspaces of the two-dimensional vector space $\mathbb{F}^2$.

Concretely, a point on the projective line is represented by homogeneous coordinates $[x : y]$ where $(x, y) \neq (0, 0)$ and $[x : y] = [\lambda x : \lambda y]$ for any nonzero scalar $\lambda \in \mathbb{F}^\times$. The affine coordinate $t \in \mathbb{F}$ corresponds to $[t : 1]$; the point at infinity is $[1 : 0]$.

A.1.2 Projective Transformations (Möbius Transformations)

A **projective transformation** of the projective line is a mapping induced by an invertible linear transformation of the underlying vector space $\mathbb{F}^2$. In homogeneous coordinates, if $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$ is a 2×2 matrix with determinant $ad - bc \neq 0$, then the transformation acts as

$$[x : y] \mapsto [ax + by : cx + dy].$$

In the affine coordinate $t = x/y$ (with $y \neq 0$), this becomes the familiar **fractional linear transformation** (or Möbius transformation)

$$t \mapsto \frac{at + b}{ct + d}.$$

The set of all such transformations forms the **projective linear group** $\mathrm{PGL}(2, \mathbb{F})$. These transformations are the automorphisms of the projective line; they preserve the projective structure.

A.2 The Cross-Ratio: Definition and Invariance

A.2.1 Definition

Given four distinct points A, B, C, D on the projective line, choose an affine coordinate t such that none of the points is the point at infinity. Let t_A, t_B, t_C, t_D be the coordinates of the points. The **cross-ratio** of the four points (in that order) is defined as

$$\mathrm{CR}(A, B, C, D) = \frac{(t_A - t_C)/(t_B - t_C)}{(t_A - t_D)/(t_B - t_D)} = \frac{(t_A - t_C)(t_B - t_D)}{(t_A - t_D)(t_B - t_C)}.$$

If one of the points is the point at infinity, the formula is interpreted by taking limits. For example, if $D = \infty$, then $\mathrm{CR}(A, B, C, \infty) = \frac{t_A - t_C}{t_B - t_C}$.

A.2.2 Invariance Theorem

Theorem: The cross-ratio is invariant under any projective transformation. That is, for any $T \in \mathrm{PGL}(2, \mathbb{F})$ and any four distinct points A, B, C, D,

$$\mathrm{CR}(T(A), T(B), T(C), T(D)) = \mathrm{CR}(A, B, C, D).$$

Proof (sketch): Let t be an affine coordinate and let $T(t) = \frac{at+b}{ct+d}$. Compute the transformed coordinates $t'_A = T(t_A)$, etc. Substitute into the cross-ratio formula and simplify using the fact that T is a fractional linear transformation. The determinants $ad - bc$ appear in both numerator and denominator and cancel, leaving the original cross-ratio. □

A.2.3 Geometric Interpretation

The cross-ratio measures the "harmonic separation" of the four points. A value $\mathrm{CR} = -1$ indicates a harmonic division (the points are in harmonic progression). Values $0, 1, \infty$ correspond to degeneracies (coincident points). The cross-ratio is the only projective invariant of four points: two quadruples are projectively equivalent if and only if their cross-ratios are equal.

A.3 Higher-Dimensional Projective Geometry

A.3.1 Projective Space $\mathbb{P}^n$

The n-dimensional projective space $\mathbb{P}^n(\mathbb{F})$ is the set of all one-dimensional subspaces of $\mathbb{F}^{n+1}$. Points are represented by homogeneous coordinates $[x_0 : x_1 : \cdots : x_n]$, with scaling equivalence. Hyperplanes are given by linear equations $a_0x_0 + \cdots + a_nx_n = 0$.

A.3.2 Cross-Ratio of Four Collinear Points in $\mathbb{P}^n$

If four points lie on a common line in $\mathbb{P}^n$, that line is a projective line $\mathbb{P}^1$. Choosing coordinates along that line reduces the situation to the one-dimensional case, and the cross-ratio is defined as above. It is independent of the choice of coordinates on the ambient space.

A.3.3 The Fundamental Theorem of Projective Geometry

Any bijection between two projective spaces of dimension $n \geq 2$ that preserves collinearity (i.e., maps lines to lines) is necessarily a projective transformation (induced by a semilinear map). This theorem underscores the rigidity of projective structure.

A.4 Connection to the Patternist Synthesis

A.4.1 Cross-Ratio as a Universal Syntactic Primitive

In the Relational Patternist Synthesis, the cross-ratio serves as a **coordinate-free relational primitive**. Because it is invariant under arbitrary projective transformations (which model linguistic and cultural arbitrariness), it captures the idea that while the "labels" we assign to entities can change arbitrarily, the **relations among the relations** (the second-order proportions) remain objective.

A.4.2 Example: Semantic Scaling

Suppose we have four concepts $\alpha, \beta, \gamma, \delta$ along a semantic dimension (e.g., size: tiny, small, large, huge). Different languages may assign different numerical scales to these concepts, but if the relative spacing is preserved up to a projective transformation, the cross-ratio $\mathrm{CR}(\alpha, \beta, \gamma, \delta)$ will be the same across languages. This invariant can be empirically measured by asking speakers to place the concepts on a line, providing a quantitative test for universal semantic structure.

A.4.3 Projective Geometry over Finite Fields

The finitist stance suggests that the physical universe may be fundamentally discrete. Projective geometry can be defined over finite fields $\mathbb{F}_q$ (where $q = p^k$ is a prime power). The projective line $\mathbb{P}^1(\mathbb{F}_q)$ has $q + 1$ points. All the foregoing theory—Möbius transformations, cross-ratio, invariance—remains valid. This provides a mathematical framework that is both finite and coordinate-free, aligning with the finitist manifesto.

A.5 Exercises (for the Reader)

Verify the invariance of the cross-ratio under the transformation $T(t) = 1/t$.

Show that the cross-ratio of four points is real if and only if the points are concyclic (or collinear in the real projective line).

Compute the cross-ratio of the points $0, 1, \infty, t$ on the Riemann sphere.

Prove that the cross-ratio is the only projective invariant of four points: if $\mathrm{CR}(A,B,C,D) = \mathrm{CR}(A', B', C', D')$, then there exists a projective transformation mapping (A,B,C,D) to (A', B', C', D').

This appendix provides the minimal mathematical background required for understanding the projective aspects of the Relational Patternist Synthesis. For further reading, consult classical texts on projective geometry such as Coxeter's Projective Geometry *or Semple and Kneebone's* Algebraic Projective Geometry.

Appendix B: Formal Details of Algorithmic Information Theory and Real Patterns

B.1 Algorithmic Information Theory: Core Definitions

B.1.1 Kolmogorov Complexity

Let U be a fixed universal Turing machine. The **plain Kolmogorov complexity** of a finite binary string x is defined as

$$K_U(x) = \min\{\ell(p) \mid U(p) = x\},$$

where p is a program (a binary string) and $\ell(p)$ denotes its length. In words, $K_U(x)$ is the length of the shortest program that, when run on U, outputs x and halts.

By the invariance theorem, the choice of universal machine affects the complexity by at most an additive constant: if U and V are universal, there exists a constant c_{UV} such that for all x,

$$|K_U(x) - K_V(x)| \leq c_{UV}.$$

Hence we often write $K(x)$, ignoring the machine-dependence up to an additive constant.

B.1.2 Conditional Kolmogorov Complexity

The **conditional Kolmogorov complexity** $K(x|y)$ is the length of the shortest program that, given y as input, outputs x. It measures the information in x that is not already present in y.

B.1.3 Algorithmic Mutual Information

The **algorithmic mutual information** between two strings x and y is

$$I(x : y) = K(x) + K(y) - K(x, y),$$

where $K(x, y)$ is the complexity of the pair (x, y). It quantifies the amount of information that x and y share.

B.2 Real Patterns: A Formal Criterion

B.2.1 Dennett's Intuition Formalized

Daniel Dennett's notion of a "real pattern" (1991) can be made precise using Kolmogorov complexity. Let D be a dataset—a finite binary string representing some aspect of the world (e.g., the time-series of positions of all molecules in a fluid, or the sequence of choices made by an economic agent). A **pattern** P is a description (a computer program) that generates a string $\hat{D}$ intended to approximate D.

B.2.2 Compression-Based Definition

Following Petersen (2026), we say that a pattern P is **real** with respect to D if:

Compressibility: $K(P) + K(D|\hat{D}) \ll K(D)$.

$K(P)$ is the complexity of the pattern itself.

$K(D|\hat{D})$ is the complexity of the mismatch between the data and the pattern's output.

The sum should be significantly smaller than the complexity of the raw data $K(D)$.

Projectibility: The pattern P not only fits the observed data D but also generates predictions $\hat{D}$' for new, counterfactual situations that turn out to be accurate (i.e., the conditional complexity $K(D'|\hat{D}')$ remains small).

Predictive Power: The pattern improves our ability to anticipate future data; formally, the conditional complexity of future data given the pattern is low.

B.2.3 Quantitative Measure of "Reality"

One can define a **reality coefficient** $\rho(P, D)$ as

$$\rho(P, D) = 1 - \frac{K(P) + K(D|\hat{D})}{K(D)}.$$

When ρ is close to 1, the pattern compresses the data almost completely; when ρ is near 0 (or negative), the pattern does no better than the raw data. A pattern with $\rho > 0.5$ (say) is considered strongly real.

B.2.4 Scale-Relativity in the Formal Framework

Scale-relativity enters through the choice of the dataset D. At a fine scale (e.g., molecular positions), D_{fine} may have very high complexity $K(D_{\text{fine}})$. A pattern that describes macroscopic fluid flow will have a low ρ with respect to D_{fine} because it ignores most details. However, if we coarse-grain the data—for example, by averaging molecular motions into a velocity field D_{coarse}—the same fluid-dynamic pattern may achieve a high ρ. Thus, a pattern can be real at one scale (coarse) but not at another (fine).

B.3 Application: The Quantitative Intentional Stance (QIS)

B.3.1 Modeling Choice Data

Let an agent's choices be encoded as a string $D = (c_1, c_2, \ldots, c_n)$, where each c_i is a choice from a set of alternatives under a specific context (budget, prices, etc.). The **rational-choice pattern** P_R is a program that outputs choices $\hat{D}$ consistent with utility maximization given some utility function u and belief distribution.

B.3.2 Decomposing Noise and Waste

Following Alekseev et al. (2026), we can decompose the mismatch between D and $\hat{D}$ into two parts:

Noise: Random errors that are incompressible; formally, $K(D|\hat{D})_{\text{noise}}$ is high because the residuals are random.

Waste: Systematic deviations that are compressible but reflect sub-optimality; formally, there exists a pattern P_W such that $K(P_W) + K(D|\hat{D}, P_W) < K(D|\hat{D})$. This pattern captures the "welfare cost" of deviations from rationality.

The **Absolute Welfare Cost (AWC)** can be defined as the length of the shortest program that corrects the waste, i.e., $\text{AWC} = K(P_W)$.

B.3.3 Agency as a Real Pattern

An agent is said to exhibit **agency** to the extent that the rational-choice pattern P_R achieves a high reality coefficient $\rho(P_R, D)$. Agency is thus a matter of degree, measurable via algorithmic information theory.

B.4 Connection to Machine Learning and AI

B.4.1 Learning as Compression

A machine-learning model (e.g., a neural network) trained on data D is essentially a program P_{ML} that outputs predictions $\hat{D}$. The training process minimizes a loss function that approximates the sum $K(P_{\text{ML}}) + K(D|\hat{D})$ (where the latter is measured by prediction error). Thus, successful learning is the discovery of a real pattern.

B.4.2 Overfitting vs. Generalization

Overfitting occurs when $K(P_{\text{ML}})$ is large (the model is complex) but $K(D|\hat{D})$ is very small on the training data. The pattern is not projectible: it fails on new data because the conditional complexity $K(D‘|\hat{D}’)$ becomes large.

Good generalization occurs when both $K(P_{\text{ML}})$ and $K(D|\hat{D})$ are modest, and the pattern remains predictive on new data (low $K(D‘|\hat{D}’)$).

The trade-off between model complexity and fit is precisely the trade-off between $K(P)$ and $K(D|\hat{D})$ in the definition of a real pattern.

B.5 Limitations and Extensions

B.5.1 Non-computability

Kolmogorov complexity is not computable; there is no algorithm that, given x, outputs $K(x)$. This is a fundamental limitation, but in practice we use computable approximations (e.g., compression algorithms like gzip, or minimum description length principles).

B.5.2 Subjectivity of the Universal Machine

The additive constant in the invariance theorem means that for small datasets, the choice of universal machine can matter. However, for large, complex datasets the constant becomes negligible relative to the overall complexity.

B.5.3 Relation to Shannon Information Theory

Shannon entropy measures the average information of a random source, assuming a known probability distribution. Kolmogorov complexity measures the information of an individual string without assuming any distribution. For ergodic stationary sources, the two notions coincide asymptotically (the Shannon-McMillan-Breiman theorem).

B.6 Further Reading

Li, M., & Vitányi, P. (2008). *An Introduction to Kolmogorov Complexity and Its Applications* (3rd ed.). Springer.

Grünwald, P. D. (2007). *The Minimum Description Length Principle*. MIT Press.

Petersen, E. (2026). “Algorithmic Information Theory as Ontology.” In *Dennett’s Real Patterns in Science and Nature*. MIT Press.

Alekseev, A., Harrison, G. W., Lau, M., & Ross, D. (2026). “Deciphering the Noise: Real Patterns in Welfare from Incentivized Choice.” In *Dennett’s Real Patterns in Science and Nature*. MIT Press.

Appendix C: Historical Notes on Finitism and the Critique of Infinity

C.1 Ancient and Medieval Precursors

C.1.1 Zeno's Paradoxes

The ancient Greek philosopher Zeno of Elea (c. 490–430 BCE) formulated paradoxes that challenged the notion of infinite divisibility and continuity. His most famous paradox, "Achilles and the Tortoise," suggests that if space and time are infinitely divisible, a faster runner can never overtake a slower one because he must first reach the point where the slower started, ad infinitum. Zeno's arguments can be seen as early intuitions that infinity, as a completed whole, leads to logical contradictions.

C.1.2 Aristotle's Potential vs. Actual Infinity

Aristotle (384–322 BCE) distinguished between **potential infinity** (a process that can be continued without end, like counting) and **actual infinity** (a completed infinite totality). He rejected actual infinity as incoherent but accepted potential infinity as a useful conceptual tool. This distinction influenced medieval Scholastic philosophy and, later, the founders of calculus.

C.1.3 Medieval Islamic and Jewish Philosophy

Medieval thinkers such as Al-Ghazālī (1058–1111) and Hasdai Crescas (c. 1340–1410) argued against the Aristotelian eternity of the world, positing a finite created universe. Their theological concerns led to critiques of infinite time and space that prefigured modern cosmological debates.

C.2 The Rise of the Actual Infinite in Modern Mathematics

C.2.1 Cantor's Set Theory

Georg Cantor (1845–1918) boldly embraced actual infinity, developing transfinite set theory. He defined infinite sets as those that can be put into one-to-one correspondence with a proper subset (Dedekind-infinite). Cantor's hierarchy of alephs ($\aleph_0, \aleph_1, \ldots$) showed that infinities come in different sizes. His work was met with fierce opposition from **finitists** like Leopold Kronecker, who declared, "God made the integers; all else is the work of man."

C.2.2 Hilbert's Program and the Crisis in Foundations

David Hilbert (1862–1943) sought to secure the foundations of mathematics by formalizing it and proving its consistency using finitary methods—a program that implicitly accepted the utility of infinity while trying to ground it in finite reasoning. Kurt Gödel's incompleteness theorems (1931) dashed Hilbert's hopes, showing that any sufficiently strong formal system cannot prove its own consistency.

C.2.3 Intuitionism and Constructivism

L.E.J. Brouwer (1881–1966) founded **intuitionism**, which rejects the law of excluded middle for infinite sets and allows only mathematical objects that can be constructed in a finite number of steps. Intuitionism is a form of finitism applied to mathematical reasoning, though it still accepts potential infinity.

C.3 Finitism in 20th-Century Physics

C.3.1 Quantum Theory and Discreteness

The advent of quantum mechanics introduced fundamental discreteness: energy levels in atoms are quantized, and physical quantities often take discrete values. Max Planck's introduction of the quantum of action (1900) suggested that nature might be granular at the smallest scales.

C.3.2 The Planck Scale

The Planck length ($\ell_P \approx 1.6 \times 10^{-35}\,\mathrm{m}$) and Planck time ($t_P \approx 5.4 \times 10^{-44}\,\mathrm{s}$) are derived from fundamental constants and mark the scale at which quantum-gravitational effects become dominant. Many approaches to quantum gravity (loop quantum gravity, causal set theory) posit that spacetime itself is discrete at this scale, implying a finite number of degrees of freedom in any bounded region.

C.3.3 The Bekenstein Bound

Jacob Bekenstein (1972) derived an upper bound on the entropy (and hence information) that can be contained in a given region of space with a given amount of energy. The Bekenstein bound implies that the total information content of any finite region is finite, providing a physical argument against actual infinities.

C.4 The Finitism Manifesto (Ramos, 2026)

C.4.1 Core Theses

Néstor E. Ramos's "Finitism Manifesto" (2026) synthesizes these historical threads into a modern, rigorous critique of infinity in physics. Its main theses are:

Infinity is a representational artifact, not a physical reality. Infinite sets, limits, and continua are tools invented by humans to compress and reason about finite phenomena.

The universe is computably finite. Any physically realizable process can be simulated by a finite algorithm; there are no physically instantiated infinities.

Mathematical infinity is a cognitive tool bootstrapped from finite biological capacities. The concept of infinity emerges from our ability to iterate finite procedures indefinitely, but this does not imply that infinity exists "out there."

C.4.2 Implications for Physics

Cosmology: Models that posit an infinite universe (e.g., eternal inflation) or an infinite past (steady-state models) are, according to the manifesto, over-extrapolations. The observable universe is finite; claims about beyond are untestable and metaphysically extravagant.

Quantum Field Theory: The continuum fields of QFT are effective descriptions; at the Planck scale they must be replaced by a discrete structure.

Quantum Gravity: Approaches that embrace discreteness (loop quantum gravity, causal sets) are more aligned with finitism than those that retain a continuum (string theory in its traditional formulation).

C.4.3 Criticisms and Responses

Critics argue that finitism unnecessarily restricts mathematics and physics, that infinite limits are essential for deriving well-tested results (e.g., the Gaussian integral, thermodynamic limits), and that finitism may be a "philosophical prejudice" without empirical support.

Ramos responds that infinite limits are **compression heuristics**: they allow us to ignore finite-size effects when those effects are negligible. The success of such limits does not prove the existence of actual infinities; it only shows that the finite system is well-approximated by the infinite idealization. The task of fundamental physics is to find the finite rules that generate the observed patterns, not to reify the idealizations.

C.5 Finitism and the Patternist Synthesis

C.5.1 Alignment with Real Patterns

The finitist stance complements the patternist ontology. If reality is composed of compressible patterns, then the most fundamental description of the universe should be a **finite algorithm** that generates all observable data. This algorithm is the ultimate compression, the "realest" pattern. Infinite mathematical structures are themselves patterns that compress certain aspects of finite data, but they are not the underlying reality.

C.5.2 Projective Geometry over Finite Fields

Projective geometry, central to the synthesis, can be defined over finite fields $\mathbb{F}_q$. This provides a coordinate-free, relational mathematics that is inherently finite. The cross-ratio, Möbius transformations, and invariance theorems all hold in this discrete setting. Thus, the projective synthesis does not rely on the continuum; it can be implemented in a finitist-friendly framework.

C.5.3 The End of the "Bit-Map" Illusion

Finitism rejects the "bit-map" metaphor of the universe as an infinite digital computer. Instead, the universe is a finite pattern-generating process. Lossy compression is not a concession to our limitations; it is the essence of physical law. The laws of physics are the compressed description of the finite algorithm that runs the cosmos.

C.6 Further Reading

Aristotle. *Physics* (Book III, Chapters 4–8). Discusses potential vs. actual infinity.

Cantor, G. (1895). "Contributions to the Founding of the Theory of Transfinite Numbers." *Mathematische Annalen*.

Hilbert, D. (1926). "On the Infinite." *Mathematische Annalen*.

Bekenstein, J. D. (1972). "Black Holes and Entropy." *Physical Review D*.

Smolin, L. (2013). *Time Reborn: From the Crisis in Physics to the Future of the Universe*. Houghton Mifflin Harcourt. (Argues for a finite, evolving universe.)

Ramos, N. E. (2026). *The Finitism Manifesto: Why Infinity Is a Cognitive Tool, Not Physical Reality*. In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Appendix D: Glossary of Key Terms

A–C

Algorithmic Information Theory (AIT)

The branch of theoretical computer science that defines the complexity of a string as the length of the shortest program that can generate it (Kolmogorov complexity). Used to formalize the notion of a "real pattern."

Anthropocentric Fallacy

The error of projecting human cognitive or cultural categories (e.g., integers, primes, base-10) onto the universe as fundamental features.

Approximate Number System (ANS)

An evolutionarily ancient cognitive system that allows humans and many animals to rapidly estimate quantities without counting. It is analog and subject to Weber's law.

Bit-Map Description

A complete, lossless transcription of a system's state at the finest possible granularity. Contrasted with a **compressed description** that captures only the salient patterns.

Bruhat-Tits Tree

An infinite regular tree that visualizes the ultrametric structure of the p-adic numbers. Each vertex has $p + 1$ neighbors, and the tree's boundary is isomorphic to the projective line $\mathbb{P}^1(\mathbb{Q}_p)$.

Cross-Ratio

In projective geometry, a numerical invariant of four collinear points. Defined as $\mathrm{CR}(A, B, C, D) = \frac{(A-C)/(B-C)}{(A-D)/(B-D)}$. It remains unchanged under any projective (Möbius) transformation and serves as the universal syntactic primitive in the patternist synthesis.

Coordinate-Free Description

A description of a system that does not depend on any particular choice of coordinates, units, or measurement conventions. Relies on invariant relations rather than absolute values.

D–F

Desert Landscape

A metaphor for Quine's austere ontology, which admits only the most fundamental particles and fields as real, treating higher-level entities as mere logical constructions.

Finitism

The view that infinity is a representational artifact, not a physical reality. The universe is computably finite, and infinite mathematical constructs are useful idealizations but not ontologically fundamental.

Fractional Linear Transformation

See **Möbius Transformation**.

G–K

Harmonic Division

A special configuration of four collinear points for which the cross-ratio equals -1. Often associated with projective harmony.

Invariant

A quantity that remains unchanged under a specified group of transformations (e.g., rotations, translations, projective transformations). In the patternist synthesis, invariants (especially the cross-ratio) represent objective structural relationships.

Kolmogorov Complexity

The length of the shortest program that outputs a given string when run on a universal Turing machine. Denoted $K(x)$, it measures the algorithmic information content of x.

L–O

Lossy Compression

A compression scheme that discards some information deemed irrelevant, yielding a shorter description that still captures the essential patterns. Contrasted with lossless compression.

Möbius Transformation

A transformation of the form $T(x) = \frac{ax+b}{cx+d}$ with $ad - bc \neq 0$. Also called a fractional linear transformation. It represents the most general automorphism of the projective line and models linguistic/cultural arbitrariness in the synthesis.

Object Tracking System (OTS)

A cognitive system that allows precise individuation and tracking of a small number of objects (typically up to three or four), underlying the ability to “subitize.”

Ontic Structural Patternism

The core thesis of the Relational Patternist Synthesis: reality is fundamentally composed of scale-relative, compressible relational patterns, expressed mathematically as projective invariants (cross-ratios). Objects are intersections of such invariants.

Ontic Structural Realism (OSR)

The philosophical position that what is fundamental in the world is not objects but relations (structure). The patternist synthesis aligns with and extends OSR.

P–R

Pattern (Real)

A regularity in data that allows a description more efficient (compressible) than a bit-map transcription, is projectible to novel situations, and confers predictive power. Formally defined via Algorithmic Information Theory.

Projectibility

The property of a pattern that it supports counterfactual reasoning and accurate predictions about situations not in the original data. A key criterion for a pattern being “real.”

Projective Geometry

A geometry that studies properties invariant under projective transformations (which include scaling, rotation, translation, and perspective changes). It emphasizes relations over absolute coordinates.

Projective Line

The extension of an ordinary (affine) line by adding a single “point at infinity.” Denoted $\mathbb{P}^1(\mathbb{F})$ over a field $\mathbb{F}$. Points are represented by homogeneous coordinates $[x : y]$.

Quantitative Intentional Stance (QIS)

A formal method, developed by Alekseev et al. (2026), that quantifies agency by separating “noise” (random errors) from “waste” (systematic deviations from rational choice) in behavioral data.

Rainforest Realism

A term coined by Ladyman and Wallace to contrast with Quine’s “desert landscape.” It denotes the view that reality is richly populated with real patterns at multiple scales, like a rainforest ecosystem.

Real Patterns

See **Pattern (Real)**.

Relational Ontology

The view that relations are more fundamental than the things that stand in those relations. Contrasts with **substance ontology**.

Renormalization Group (RG)

A framework in theoretical physics that describes how the effective description of a system changes as one coarse-grains (changes scale). Fixed points of the RG flow correspond to scale-invariant theories.

S–Z

Scale-Invariance

A property of a pattern or mathematical law that remains unchanged under transformations of scale (zooming in or out). Often exhibited by fractals and critical phenomena.

Scale-Relativity (of Ontology)

The principle that what counts as a “real” entity depends on the scale (level of description) at which the system is observed. A fluid is real at macroscopic scales but not at molecular scales.

Scientist in the Machine

A metaphor introduced by Rosa Cao (2026) to describe how large language models, through high-dimensional curve-fitting, extract real patterns from data and thereby develop internal “world models.”

Strong Triangle Inequality (Ultrametric Inequality)

The inequality $|x + y|_p \leq \max(|x|_p, |y|_p)$ satisfied by the p-adic valuation. It leads to a geometry where “all triangles are isosceles” and small errors cannot accumulate.

Subitizing

The rapid, accurate, and confident enumeration of small quantities (typically 1–4) without counting, made possible by the Object Tracking System.

Ultrametric Geometry

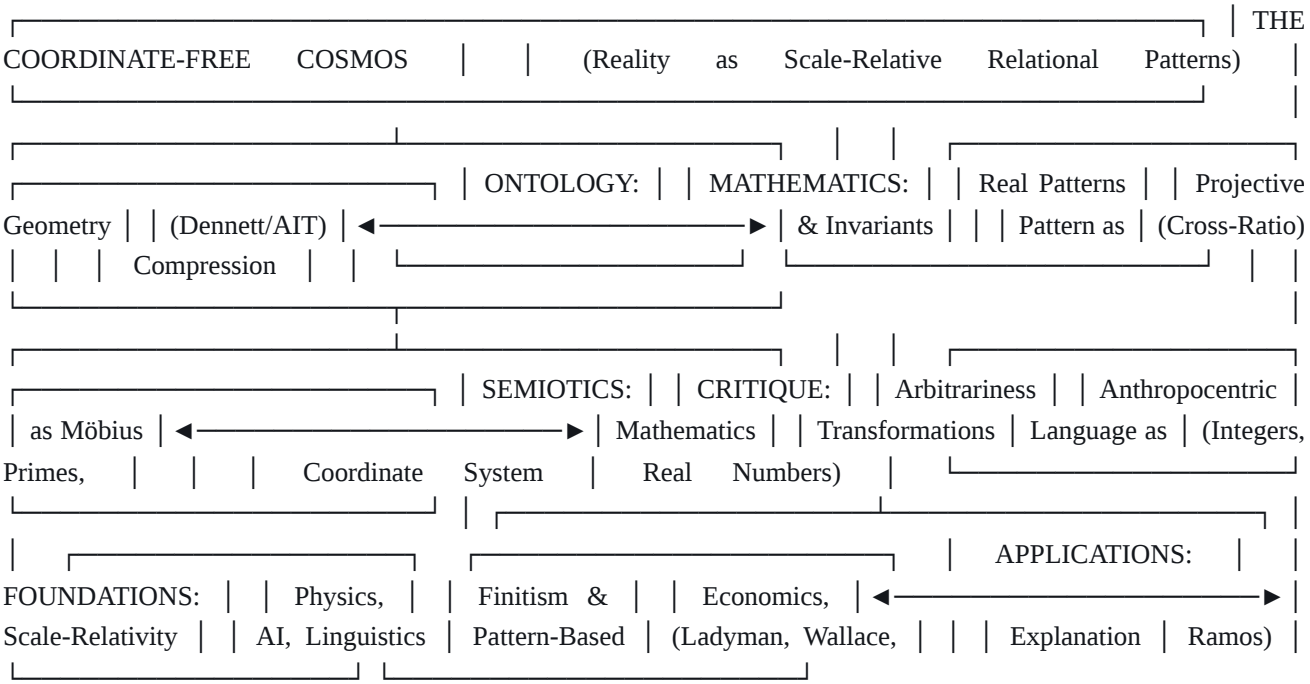
A geometry in which distances satisfy the strong triangle inequality. The p-adic numbers form an ultrametric space, visualized by the Bruhat-Tits tree.

Universal Syntactic Primitive

A basic element of a language that is invariant across all possible representations. In the patternist synthesis, the cross-ratio is proposed as the universal syntactic primitive for both mathematics and semantics.

Appendix E: Structural Mapping of the Relational Patternist Synthesis

E.1 Overview of the Conceptual Architecture



E.2 Mapping of Core Theses to Disciplines

Core Thesis | Philosophical Source | Mathematical Formalization | Empirical Application |

Real Patterns | Dennett (1991), Ladyman & Wallace (2026) | Algorithmic Information Theory (Kolmogorov complexity) | Economics (QIS), AI (world models), fluid dynamics |

Scale-Relativity of Ontology | Ladyman & Wallace (2026) | Renormalization Group, effective field theories | Condensed matter physics, biology (species) |

Anthropocentric Critique of Mathematics | Ramos (2026), cognitive science of math | Rejection of integers/primes as fundamental; finite fields | Linguistics (p-adic failure), foundations of physics |

Projective Invariance as Universal Syntax | Projective geometry (classical), structuralism | Cross-ratio, Möbius transformations | Semantic universals, coordinate-free physics |

Finitism | Ramos (2026), Aristotle (potential infinity) | Discrete projective geometry, finite fields | Quantum gravity (loop quantum gravity, causal sets) |

E.3 Flow of Argument Through the Monograph

Part I: Crisis of Fragmentation

Problem 1: Ontological–desert landscape vs. predictive success of higher-level sciences.

Problem 2: Semiotic–arbitrary signs vs. objective structure.

Problem 3: Mathematical–anthropocentric number systems vs. coordinate-free reality.

Output: Three guiding questions that define the synthesis project.

Part II: Patternist Foundation

Solution to Ontological Problem: Real patterns defined via AIT; scale-relativity (Ladyman/Wallace).

Extension to Mind/Machine: Quantitative Intentional Stance (economics); “scientist in the machine” (AI).

Finitist Turn: Ramos’s manifesto–infinity as representational artifact.

Output: A coherent ontology: reality = scale-relative, compressible patterns in a finite universe.

Part III: Anthropocentric Critique

Critique of Discrete Mathematics: Biological bootstrapping of integers/primes; failure of p-adic/adelic frameworks.

Rejection of “Bit-Map”: Universe not a digital computer; lossy compression is fundamental.

Output: Clearing of anthropocentric assumptions, opening space for a truly universal mathematics.

Part IV: Projective Synthesis

Positive Mathematics: Shift from number theory to projective geometry; Möbius transformations as model of arbitrariness.

Universal Primitive: Cross-ratio as invariant syntactic primitive.

Ontological Synthesis: Ontic Structural Patternism–objects as intersections of invariant ratios.

Output: A coordinate-free, relational framework that resolves the initial tensions.

Part V: Applications and Implications

Physics: Re-reading quantum mechanics and GR; finitist quantum gravity.

Economics & Cognitive Science: QIS revisited; grammatical universals as projective invariants.

AI: Pattern-discovery engines; ethics of pattern-recognition.

Worldview: The coordinate-free cosmos–the universe speaks in ratios.

E.4 Key Conceptual Bridges

From Compression to Projectibility:

Algorithmic compression (AIT) → projectible patterns → predictive power → real ontology.

From Arbitrariness to Invariance:

Saussurean arbitrariness → Möbius transformations → invariant cross-ratio → universal syntax.

From Scale-Relativity to Finitism:

Patterns exist only at certain scales → no fundamental level → universe finite at Planck scale → discrete mathematics.

From Relations to Objects:

Projective invariants (cross-ratios) → intersections of invariants → emergent “objects” → Ontic Structural Patternism.

E.5 Interdisciplinary Synergies

Discipline | Problem Addressed | Patternist Solution |

Philosophy of Science | Realism vs. anti-realism; reductionism vs. emergence | Real patterns as criterion for reality; scale-relativity as resolution |

Foundations of Mathematics | Nature of numbers; infinity; applicability of math | Mathematics as study of relational patterns; finitism; projective geometry as universal |

Theoretical Physics | Quantum-gravity unification; measurement problem | Coordinate-free, pattern-based approach; discrete spacetime; invariants as observables |

Economics | Modeling agency; welfare measurement | Quantitative Intentional Stance; pattern-based welfare analysis |

Linguistics | Universal grammar; language variation | Grammatical universals as projective invariants; arbitrariness as Möbius transformations |

Artificial Intelligence | Understanding vs. curve-fitting; AI safety | Learning as pattern discovery; projectibility as test for real patterns; ethics of pattern-recognition |

E.6 Unifying Slogans

Ontology: “To be is to be a compressible, projectible pattern.”

Semiotics: “Words can mean anything, but the relations they describe cannot.”

Mathematics: “The universe speaks in ratios, not in integers.”

Epistemology: “Knowing is compressing.”

Metaphysics: “Reality is a rainforest of real patterns.”

Bibliography

Primary Sources (Cited in the Monograph)

Philosophy and Ontology

Dennett, Daniel C. (1991). “Real Patterns.” *The Journal of Philosophy*, 88(1), 27–51.

Ladyman, James. (2026). “Patterns All the Way Up: Prolegomena to a Future Naturalized Metaphysics.” In *Dennett’s Real Patterns in Science and Nature*. MIT Press.

Ladyman, James, & Ross, Don. (2007). *Every Thing Must Go: Metaphysics Naturalized*. Oxford University Press.

Quine, Willard Van Orman. (1948). “On What There Is.” *Review of Metaphysics*, 2(1), 21–38.

Sellars, Wilfrid. (1962). “Philosophy and the Scientific Image of Man.” In *Frontiers of Science and Philosophy*, ed. Robert Colodny. University of Pittsburgh Press.

Wallace, David. (2026). “The Reality of Emergent Patterns.” In *Dennett’s Real Patterns in Science and Nature*. MIT Press.

Mathematics and Foundations

Cantor, Georg. (1895). “Beiträge zur Begründung der transfiniten Mengenlehre.” *Mathematische Annalen*, 46, 481–512.

Coxeter, Harold S. M. (1987). *Projective Geometry* (2nd ed.). Springer.

Hardy, G. H. (1940). *A Mathematician's Apology*. Cambridge University Press.

Petersen, Erik. (2026). "Algorithmic Information Theory as Ontology." In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Ramos, Néstor E. (2026). *The Finitism Manifesto: Why Infinity Is a Cognitive Tool, Not Physical Reality*. In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Semple, J. G., & Kneebone, G. T. (1952). *Algebraic Projective Geometry*. Oxford University Press.

Physics and Cosmology

Bekenstein, Jacob D. (1972). "Black Holes and Entropy." *Physical Review D*, 7(8), 2333–2346.

Einstein, Albert. (1915). "Die Feldgleichungen der Gravitation." *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften*, 844–847.

Friedmann, Alexander. (1922). "Über die Krümmung des Raumes." *Zeitschrift für Physik*, 10(1), 377–386.

Ginzburg, V. L., & Landau, L. D. (1950). "On the Theory of Superconductivity." *Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki*, 20, 1064–1082.

Lemaître, Georges. (1927). "Un univers homogène de masse constante et de rayon croissant rendant compte de la vitesse radiale des nébuleuses extra-galactiques." *Annales de la Société Scientifique de Bruxelles*, 47, 49–59.

Navier, Claude-Louis. (1822). "Mémoire sur les lois du mouvement des fluides." *Mémoires de l'Académie Royale des Sciences de l'Institut de France*, 6, 389–440.

Planck, Max. (1900). "Zur Theorie des Gesetzes der Energieverteilung im Normalspektrum." *Verhandlungen der Deutschen Physikalischen Gesellschaft*, 2, 237–245.

Robertson, Howard P. (1935). "Kinematics and World-Structure." *Astrophysical Journal*, 82, 284–301.

Stokes, George Gabriel. (1845). "On the Theories of the Internal Friction of Fluids in Motion." *Transactions of the Cambridge Philosophical Society*, 8, 287–305.

Walker, Arthur Geoffrey. (1937). "On Milne's Theory of World-Structure." *Proceedings of the London Mathematical Society*, 42(1), 90–127.

Economics and Decision Theory

Alekseev, Aleksandr, Harrison, Glenn W., Lau, Morten, & Ross, Don. (2026). "Deciphering the Noise: Real Patterns in Welfare from Incentivized Choice." In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Pareto, Vilfredo. (1906). *Manuale di economia politica*. Società Editrice Libraria.

Linguistics and Cognitive Science

Saussure, Ferdinand de. (1916). *Cours de linguistique générale*. Payot.

Verkerk, Annemarie, et al. (2026). "Grammatical Universals as Projective Invariants: A Bayesian Spatiophylogenetic Analysis of Grambank." In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Artificial Intelligence

Cao, Rosa. (2026). "The Scientist in the Machine." In *Dennett's Real Patterns in Science and Nature*. MIT Press.

Cognitive Science of Mathematics

Dehaene, Stanislas. (1997). *The Number Sense: How the Mind Creates Mathematics*. Oxford University Press.

Feigenson, Lisa, Dehaene, Stanislas, & Spelke, Elizabeth. (2004). “Core Systems of Number.” *Trends in Cognitive Sciences*, 8(7), 307–314.

Secondary and Background Literature

Algorithmic Information Theory

Kolmogorov, Andrey N. (1965). “Three Approaches to the Definition of the Concept ‘Amount of Information’.” *Problemy Peredachi Informatsii*, 1(1), 3–11.

Li, Ming, & Vitányi, Paul. (2008). *An Introduction to Kolmogorov Complexity and Its Applications* (3rd ed.). Springer.

Solomonoff, Ray J. (1964). “A Formal Theory of Inductive Inference.” *Information and Control*, 7(1), 1–22, 224–254.

Projective and Algebraic Geometry

Birkhoff, Garrett, & Mac Lane, Saunders. (1941). *A Survey of Modern Algebra*. Macmillan.

Hilbert, David, & Cohn-Vossen, Stefan. (1952). *Geometry and the Imagination*. Chelsea.

Finitism and Foundations of Mathematics

Hilbert, David. (1926). “Über das Unendliche.” *Mathematische Annalen*, 95, 161–190.

Kronecker, Leopold. (1887). “Über den Zahlbegriff.” *Journal für die reine und angewandte Mathematik*, 101, 337–355.

Quantum Gravity and Discrete Spacetime

Rovelli, Carlo. (2004). *Quantum Gravity*. Cambridge University Press.

Sorkin, Rafael D. (2003). “Causal Sets: Discrete Gravity.” In *Lectures on Quantum Gravity*, ed. Andrés Gomberoff and Donald Marolf. Springer.

Integrated Information Theory

Tononi, Giulio. (2008). “Consciousness as Integrated Information: A Provisional Manifesto.” *Biological Bulletin*, 215(3), 216–242.

Collected Volumes

Dennett’s Real Patterns in Science and Nature (2026). MIT Press. (Includes chapters by Ladyman, Wallace, Petersen, Alekseev et al., Cao, Verkerk et al., Ramos, and others.)