The God Conjecture

S.A. Senchal

v.1

20 November 2025

Table of Contents

Main Body

Appendix

Note: *References are compiled at the end of each section.*

Preamble

Section 1: Introduction

TL;DR

We speak two languages. ***Science,*** *the language of the measurable and* ***Meaning,*** *the language of consciousness, purpose and value. This paper uses the abstraction of the* ***Ruliad,*** *a mathematical idealisation of "all possible computations", as a shared canvas to bridge that divide.*

Within it, ***Observers*** *(like us), who have limited bandwidth and perspective, carve out the realities we experience subject to rules.*

This paper proposes a process-based bridge between the worlds of science and meaning using computation as the shared language.

The God Conjecture *posits that the Observer-in-the-Ruliad model is, in many ways,* ***structurally isomorphic*** *to theological creation narratives. We don't claim physics (or computation) proves God; we show how a God-concept can be* ***mathematically compatible*** *with science when described in computational terms.*

In short, ***theist's*** *offer existence arguments, but they* ***don't explain how*** *an infinite one-ness can make our multiplicitous world. If they attempt it they tend to contradict hundreds of years of science in their reasoning.*

The God Conjecture will demonstrate how theistic creation is possible in a computational universe without breaking science.

Humanity straddles two worlds.

In one, we live with the measurable, predictable reality described by the sciences – a realm of particles and forces, governed by elegant mathematical laws. In the other, we experience a cosmos saturated with meaning, purpose, and value – a reality where moral truths seem as real as physical ones.

Despite centuries of intellectual effort, these domains remain disconnected. The fine-tuning of physical constants points toward something our equations aren't capturing, and the question of "why is there something rather than nothing" lies entirely outside the scope of empiricism.[1,2]

We stand at a unique historical moment where developments in computational theory have provided the analytical and mathematical tools to begin bridging these domains, not by reducing one to the other, but by broadening our formal languages to something that can underpin both.[3,4]

The language of this revolution lives in Wolfram's **Ruliad**, the infinite limit of all possible computations. It's an abstract mathematical object containing all possible computational rules applied in all possible ways through all possible initial conditions evolved through all possible histories.

We can use the Ruliad as a background object for every possible model of reality across all of our investigative domains in an interconnected fashion. The Ruliad is composed of through four distinct types of computation, from simple structural models to complex multicomputational frameworks, all weaved together in one giant network.

The Axiom That Will Underpin the God Conjecture

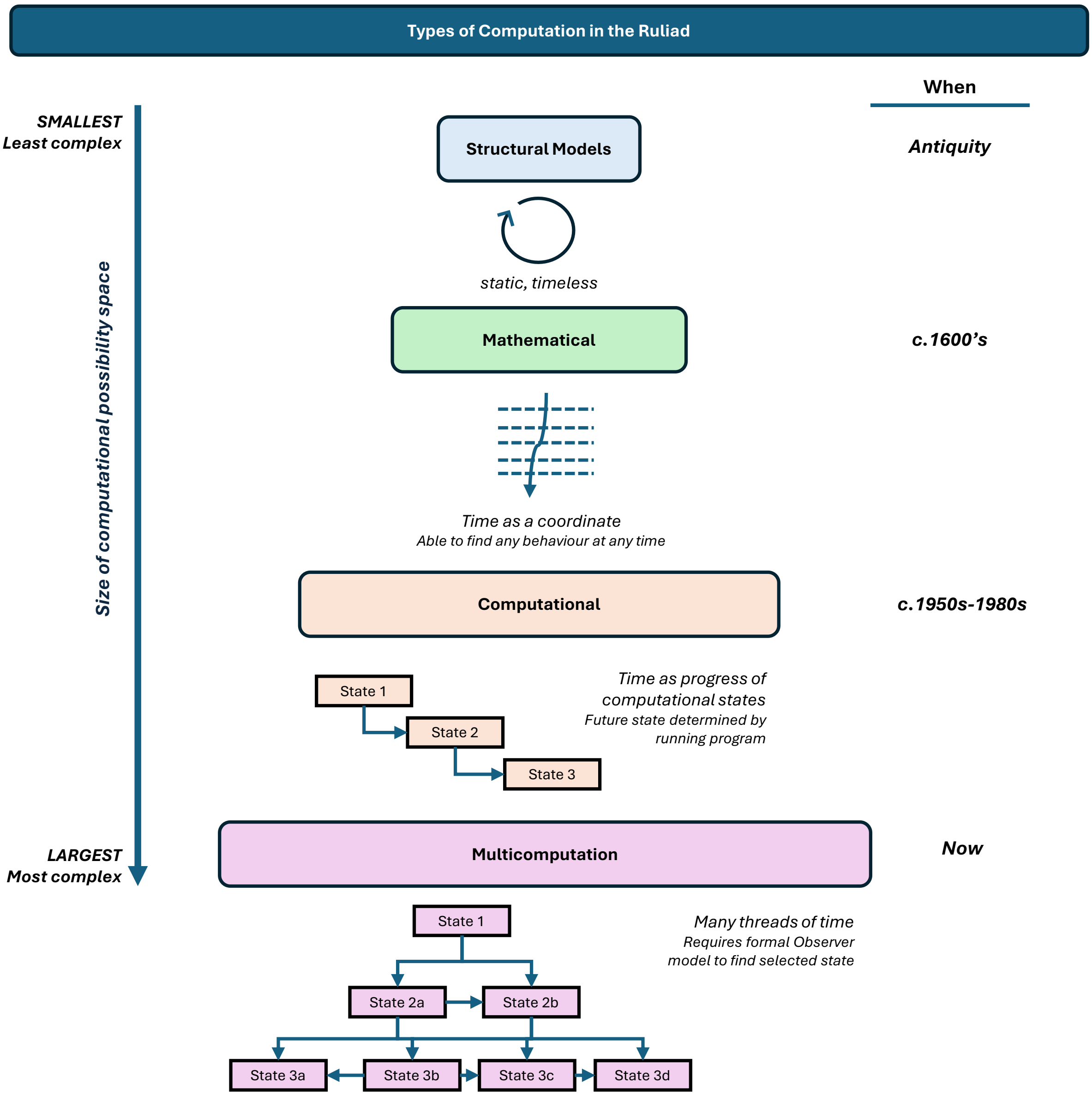
The God Conjecture adopts the Ruliad as our foundational mathematical object. We are not claiming the Ruliad is an empirical discovery (it can't be proven as most of it is inaccessible to Observers like us). We are using it as a ***precise canvas****, a place where physics and meaning can be jointly modelled. Our central claim is one of structural compatibility (an* ***isomorphism*** *or, at the minimum,* ***weakly equivalent****), not one of reductive identity.*

This paper constructs this Ruliad from scratch with a 'box' of infinite information (God) and a MetaObserver i.e. the least bounded Observer, that is not God (don't worry this will all be explained in depth later).

Plain-English Definition [1]: Ruliad / Computational Possibility Space

An idealized "everything-computation": the entangled limit of running all possible rules, on all possible inputs, through all possible histories. Think of it as the ultimate 'library' of every computation that could possibly be done.

Other words that talk about this sort of space (often smaller types): Assembly Space (chemistry), State-Space, Possibility Space, Morphospace (biology), Global Workspace (consciousness), Platonic Space (philosophy, maths).



Ruliad contains more computational types than simple linear computation.

- It updates from State 1 to State 2 to State N, where N is the final State
- What computations are 'picked out' are determined by the Observer insider the system
- The Observer moves forward in state time, causally from State 1 to State 2…
- Multicomputational systems (known as 'Multiway systems') have sideways computations (known as 'branchial' space). These are all the other paths an Observer could take through the system (i.e. picking State 3c over State 3a, above)
- At the limit (meaning infinitely many computational steps) all these states collapse to the same end point (i.e. the Multicomputational system 'closes'

The Ruliad is not "the Universe"; it is a mathematical limit within which Universes (like ours) can be constructed and modelled to arbitrary accuracy, given sufficient computational power.

The Ruliad can be visualised as a **hypergraph** that contains all possible universes, all possible laws of physics and all possible histories. It's a bewildering multiplicity that bears little resemblance to the world we actually inhabit.

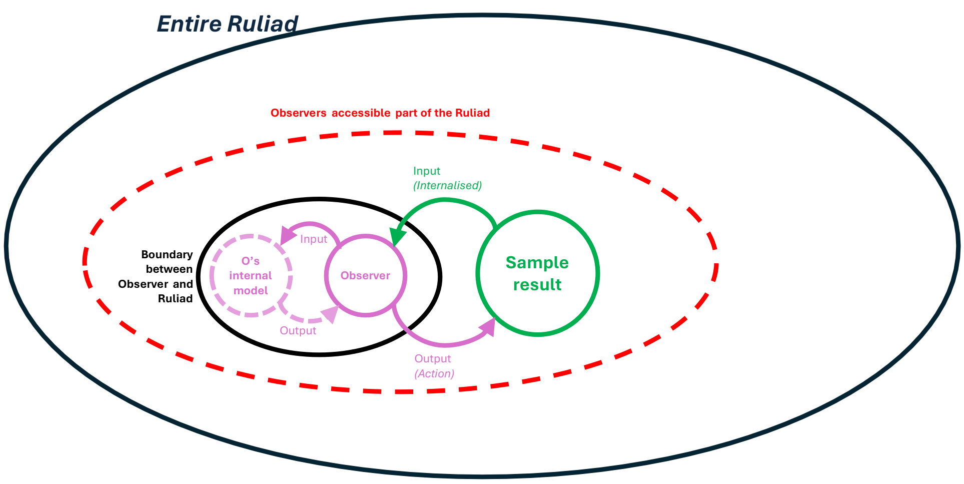
> ***Plain-English Definition [2]: Hypergraph***
>
> *The visual representation of the Ruliad. A multi-dimensional (i.e. not just x,y,z) where a single connection (a line on the graph) can link many nodes (ends of those lines, a single computation) and not just pairs. It's used to represent states (nodes) and their relationships (the lines between them). The Hypergraph updates by running the computational rules in the Ruliad. A single update represents one unit of time.*
>
> *i.e. (Input) Hypergraph State 1 -> (Function) 'Run Rules' -> (Output) Hypergraph State 2*
>
> *This is like 'time' in the Ruliad. The input is state **n**, the output is state **n+1***

This is where the **Observer** comes in.

An Observer is necessary in the Wolfram model (as it is in quantum mechanics). They are active constructors of computational reality. Through their computational boundedness – their finite ability to process information, their particular 'position' within the Ruliad and their specific rule sampling of its infinite richness – the Observer carves out a particular slice of the computational substrate that becomes their experienced reality.

> ***Plain-English Definition [3]: Observer***
>
> *Any subsystem doing computations within **a persistent boundary** inside the Ruliad. The Observer samples information and updates its internal state (anything from simple molecules to complex minds). In this paper, "Observer" does not mean "human only".*

<u>Visual: How an Observer Works in Computational Possibility Space (Ruliad)</u>



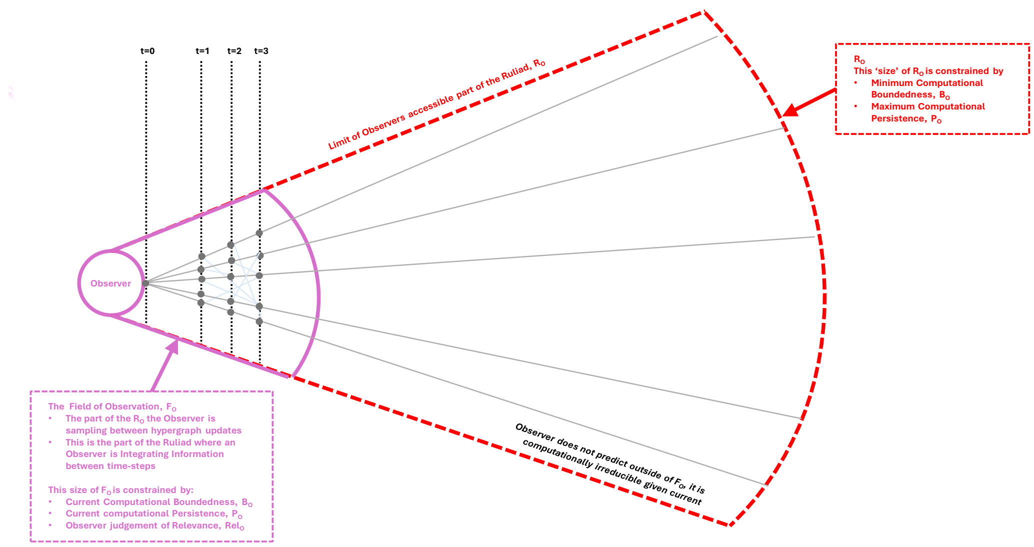
Any finite Observer is **bounded** by bandwidth, memory, and processing power. Those limits force a **coarse-graining** that compresses the Ruliad's overwhelming detail to a manageable "experienced world." They are also constrained by **persistence**: how many Hypergraph updates their **boundary** survives. Together, computational boundedness and persistence explain how Observers carve out stable, seemingly invariant, law-like 'slices' that necessarily resemble the whole structure.[5]

> ***Plain-English Definition [4]: Coarse-Graining***
>
> *Blurring detail to get a usable picture (like pixels in a photo). Observers necessarily compress and summarize reality (the information they sample from the Ruliad).*

> ***Plain-English Definition [5]: Computational Boundedness and Persistence***
>
> *You (an Observer) don't have infinite time (**persistence**), memory, processing power or bandwidth (**boundedness**). Those computational limits force you to see only a manageable (partly predictable), **coarse-grained** version of what exists in the entire Ruliad.*

There is one more restriction. The Observer can't always sample the limit of its accessible part of the Ruliad (known as $\mathbf{R_{OBSERVER}}$ or $\mathbf{R_O}$ for short). It is restricted not by the limit of its boundedness (i.e. the most computational power it can muster), or it's maximal persistence (i.e. the limit of the length of time it can survive for), it's restricted by its **current** computational resources. The subset of R_O, is called the **Field of Observation** ($\mathbf{F_O}$ for short).

The Field of Observation – What the Observer is CURRENTLY Sampling



Plain-English Definition [6]: Observer Field, F_O

Not everything in R_O is observed simultaneously – an Observer has a further restriction to what it is actively sampling at a given moment or context. We define the Field of Observation, F_O as the subset / subcategory of R_O that the Observer is 'focusing on' or 'integrating information about' at the measure point. It is smaller than R_O as an Observer may not have access to its maximal computational resources at the time it samples.

For intuition, a baby literally sees less of the world than an adult (they don't see colour for a few months post birth), so while an adult and a baby have the same R_O, the F_O for the adult is larger than the babies (it can see more of the computational possibility space).

Plain-English Definition [7]: 'Moving' in Rulial Space

The "space of all-possible rules". For an Observer, moving in Rulial Space means changing one (or many) of the rules you're selecting between states, not just changing the state (i.e. Observers can change some of the rules they sample between hypergraph updates)

Across multiple disciplines, we are seeing a fundamental shift to process-based ontologies, from asking "what things have done" to asking "what things are doing".

It's not limited to Physics (Wolfram's focus). Assembly Theory[6], the chemistry analogue, tries to understand how complex objects emerge as a consequence of their causal history, with complexity measured not by current structure but by the minimal history required to recreate that structure. Constructor Theory[7] reformulates all of physics in terms of which transformations are possible versus impossible, rather than in terms of trajectories and states. Michael Levin's groundbreaking work in biological computation reveals that cognition (or proto-cognition) occur at every scale of biological organisation, from cellular networks to organ systems, challenging our very definitions of what constitutes mind[8].

These frameworks converge on a core insight: reality is best explained through process. The 21st century will change the nature of inquiry from universe as noun to universe as verb.

These developments have emerged at a moment of crisis in our relationship with meaning and value. The Scientific Revolution began with Descartes' dream of a universal method that would answer all questions that could be asked – particularly those concerning human purpose, moral truth, and ultimate meaning. However, the refinements that made the scientific method so successful – the focus on quantification, repeatability, and objectivity – orphaned these questions.

The Enlightenment traded incompleteness for accuracy. Science can tell us how neurons fire but not what consciousness is; it can map quantum fields but can't explain why stuff exists; it can describe the evolutionary origins of cooperation but cannot ground the moral obligations that seem to emerge from it.

Every attempt to derive "ought" from "is,"[9] to extract meaning from mechanism, has failed. This is not a limitation that science will overcome. It's a structural feature of the method.

Historically, theology and philosophy filled this gap. These systems, refined over millennia, offered sophisticated structures to bridge the divide. Today, with the Ruliad, we can formalise that map in the same language we use to model physics, math and logic. A process of complexification from simple initial conditions, applying tractable computational rules.

This paper advances **the God Conjecture**: that the Observer-in-the-Ruliad framework is, in many ways, structurally isomorphic to theological creation accounts. What computational physics calls "the Observer" and what theology calls "the divine perspective" may be two views of a single process – one from inside the system, the other at the limit of inquiry. This paper is not "proving God with physics," such a proof would violate the epistemic boundaries we are describing. Rather, it demonstrates that a God-concept can be mathematically compatible with physics when expressed in computational terms.

This endeavour confronts us with the limits of what can be known from within the system. Just as **Gödel** showed that rich formal systems contain true but unprovable statements, and **Tarski** showed that truth for a language cannot be defined within that language[10], embedded Observers in the Ruliad will face formally undecidable questions about "the whole."

We cannot step outside reality. There is no truly objective viewpoint. We are stuck inside struggling to verify claims that lie beyond the empirical. Every explanatory framework (physics included) rests on **Axioms,** not as a stopgap for missing knowledge, but as the basis for any system that aims to be explanatory and predictive.

Note:

*This paper will suggest **Axioms** are, for practical purposes, equivalent to **Scientific Beliefs.** Most scientists would probably disagree with this contention. A typical answer might be "Axioms reflect incomplete knowledge, but this will be overcome in the future." This paper will argue that that is ultimately impossible. There will always be a minimal set of Axioms underlying any formal system we utilise.*

We will demonstrate that far from being anti-scientific, computational theological frameworks can connect the meaning-layer we see in our day-to-day lives to the sciences, not because science has failed, but because those questions are outside of the domain of empiricism.

In doing so, we hope to spark a dialogue between science and theology.

Plain-English Definition [8]: Multiway System

*A computational system where the output can **branch** into many possible future states (and may **merge** again when different branches lead to the same end state)*

Plain-English Definition [9]: Process-based Ontologies

*Explaining the world by **what-it-does** and how it changes.*

"The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. He to whom this emotion is a stranger, who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed."

"Science without religion is lame, religion without science is blind."

Albert Einstein

References

[1]Stanford Encyclopaedia of Philosophy (2023). "Fine-tuning" – discussion of the apparent fine-tuning of cosmic constants plato.stanford.edu.

[2] Stanford Encyclopaedia of Philosophy (2023). "Nothingness" – covers the question "why is there something rather than nothing," noting (as James did) that "from nothing to being there is no logical bridge" plato.stanford.edu

[3] Wolfram, S. (2021). *The Concept of the Ruliad*. Stephen Wolfram Writings. Describes the Ruliad as "the entangled limit of everything that is computationally possible" and explains that "everything we experience can be thought of as sampling" part of it writings.stephenwolfram.com

[4] Rickles, D., Elshatlawy, H., & Arsiwalla, X. D. (2023). *Ruliology: Linking Computation, Observers and Physical Law*. arXiv:2308.16068. Reviews Wolfram's multicomputational framework; explicitly calls the Ruliad "the entangled limit of all possible computations" and shows physical laws emerge from how observers sample it arxiv.org

[5] Wolfram, S. (2023). *Observer Theory*. Stephen Wolfram Writings. Introduces a general theory of observers. In particular it notes that observers are computationally bounded (sampling only a "heavily filtered" version of the universe) and coarse-grain underlying complexity writings.stephenwolfram.com

[6] Cronin, L. et al. (2023). *Assembly theory explains and quantifies selection and evolution*. Nature 622, 321–328. Introduces Assembly Theory: it redefines objects by their possible formation histories and shows complexity is captured by the minimal sequence of steps ("assembly space") needed to build an object nature.com

[7] Deutsch, D. (2012). *Constructor Theory*. arXiv:1210.7439. Formulates physics in terms of possible vs impossible transformations. Its abstract states that "constructor theory seeks to express all fundamental scientific theories in terms of a dichotomy between possible and impossible physical transformations" – a departure from traditional trajectory-based laws arxiv.org

[8] Levin, M. (2022). *Technological Approach to Mind Everywhere (TAME)*. Frontiers in Systems Neuroscience 16:768201. Argues that "cognition" (basal or proto-cognition) exists at every scale of life. For example, cells coupled by bioelectric networks form integrated "individuals" with problem-solving capacity far beyond single cells frontiersin.org

[9] Hume, D. (1739). *A Treatise of Human Nature*, Book III, Part I (Moral Distinctions). Contains the original is–ought argument. Hume observes that moral works suddenly switch from "is" statements to "ought" statements, and warns that no reason is given for this jump gutenberg.org. In other words, he notes it is "altogether inconceivable" how an "ought" can be deduced from "is," implying attempts to derive value from fact are bound to fail

[10]Tarski, A. (1933). *The Concept of Truth in Formalised Languages*. (Informally: Tarski's theorem shows that no sufficiently rich formal system can define its own notion of truthen.wikipedia.org

Section 2: Setting the Scene: Why the God Debate Hits a Stalemate

TL;DR

*People arguing about God use **different rules for what counts as knowledge**. Those rules come from **starting points (axioms)** and **methods**. Because evidence is interpreted through these rules, smart people can see the **same world** and reach **opposite conclusions**. This section maps the main frameworks and shows why just adding more evidence won't end the debate; you have to address '**the rules of knowing'** themselves.*

Before we can evaluate the argument, we must accept a fundamental truth: **the God debate at its root is a clash between incompatible epistemological frameworks** that predetermine what counts as evidence, reasoning, and knowledge.

Each argument carries the baggage of entire philosophies about how we can know reality. It boils down to the following; because multiple, internally coherent explanations can 'fit' the same empirical world (**underdetermination**[11,12,13]), rational agents can disagree without irrationality.

These meta-level disagreements explain why these debates have persisted without resolution: the participants are, in a very real sense, playing different games with different rules.

Axioms and Dependencies[14]

Every argument in the God debate rests on accepting certain foundational axioms (**beliefs**) that cannot be proven within the system. This creates "axiomatic dependency trees", logical structures showing how conclusions follow necessarily from the axioms.

Plain-English Definition [10]: Axiom and Axiomatic Dependency Tree

*An **Axiom** is a starting assumption you don't prove inside the system but do use to build arguments. An **Axiomatic Dependency Tree** is like a "family tree" showing how your arguments conclusions depend on your earlier assumptions.*

Consider the theistic cosmological argument's dependency tree:

- If you accept the Principle of Sufficient Reason (**PSR**[15,16])...
- And you accept that infinite causal regresses don't explain things adequately...
- And you accept that something cannot come from nothing...
- Then you must accept a necessary first cause.

Plain-English Definition [11]: Principle of Sufficient Reason (PSR)

The idea that everything has a reason or an explanation (in philosophy there are stronger / weaker versions)

Plain-English Definition [12]: Infinite Regress

An explanation that keeps needing a further level explanation, without end.

But reject any of these axioms and the argument fails.

PSR itself cannot be proven – it's a starting assumption about the nature of reality. Quantum mechanics might give us reason to doubt it (i.e. radioactive decay appears to have no sufficient reason for occurring when it does)[17,18]. The rejection of infinite regresses is intuitive but not logically necessary (though it might be computationally intractable).

The principle that something cannot come from nothing seems obvious, but quantum field theory suggests that "nothing" is unstable and naturally produces something (though this might stretch the definition of nothing, see zero-point energy and recently, zero-point motion experimental confirmations[19]).

This pattern repeats across all the theistic and atheistic arguments we explore.

For example, the ontological argument[20,21] (theistic) depends on axioms about existence being a predicate, about our concepts accurately reflecting reality and about logical necessity translating to metaphysical necessity. The moral argument[22] depends on moral realism, on the impossibility of deriving ought from is and on moral facts requiring personal grounding. The argument from religious experience depends on the principle of credulity, on experience providing evidence, on properly basic beliefs being rational[23].

> ***Note:***
>
> *Don't worry if you disagree with some of these contentions. Appendix A.1 provides a summary of major theistic and atheistic arguments. It will be lossy compared to the actual depth of these arguments in academic literature but it will give you a rough 'flavour' of what they are talking about. The author is aware that reducing these arguments to half-page summaries is likely to lose nuance!*

> ***Plain-English Definition [13]: Principle of Credulity***
>
> *If something seems to you to be present, then absent special reasons to doubt it, it probably is.*

Atheistic arguments show a similar pattern. The "problem of evil"[24] depends on evil being genuinely real, on our ability to judge what an omnipotent being could achieve and on there being no valid reasons for allowing suffering. Naturalistic evolution depends on **methodological naturalism** being the right approach to biology, on natural selection being sufficient for complexity.

'The God Debate' is reducible to axiomatic selection. Rational people can examine the same reality and reach opposite conclusions because they start with different axioms. The theist starts with axioms favourable to theism, while the atheist begins with axioms favourable to atheism.

The Core Problem: Epistemological Incompatibility[25]

God debate arguments have incompatible theories of what knowledge is.

This creates epistemological incongruency – arguments operate in different models of what counts as knowledge, evidence, and valid reasoning.

Classical foundationalism[26] restricts knowledge to what can be built from stable foundations (e.g. self-evident truths, direct sense experience, logical deduction). Under this epistemology, most religious beliefs fail to qualify as knowledge. ***Reformed epistemology[27]*** argues that foundationalism is self-defeating (it cannot justify itself by its own standards) and restrictive (ruling out what we experience directly). It proposes that beliefs can be properly basic if they are produced by reliable cognitive faculties functioning properly in appropriate environments across a cohort of observers. ***Evidentialism[28]*** demands that belief are proportioned to evidence, with evidence understood as ***empirically / experimentally verifiable data***. Under this epistemology, faith is irrational by definition.

Virtue epistemology[29] argues that knowledge depends on intellectual virtues (e.g. open-mindedness, intellectual courage, practical wisdom) that cannot be reduced to evidence i.e. truths are only accessible to Observers with 'proper' virtues. ***Methodological naturalism[30]*** restricts scientific explanation to natural causes and effects. Under this epistemology, God can never have a scientific explanation. ***Theological realism[31]*** argues that ***methodological naturalism*** restricts inquiry – if God exists and acts in the world, ruling out divine action a priori prevents us from discovering truth.

These differences mean participants in the God debate talk past each other. When the Evidentialist demands evidence and the Reformed Epistemologist claims properly basic beliefs, they're not disagreeing about facts but about the nature of rational belief[32,33]. When the Methodological Naturalist says science has explained life without God and the theological realist says science has discovered how God creates life, they're not disagreeing about biological facts but about what counts as a valid explanation.

This incompatibility suggests that the God debate will not be resolved by accumulating more evidence or developing better arguments. As long as participants operate in different epistemological frameworks, they will interpret the same evidence and draw totally different conclusions.

> ***Plain-English Definition [14]: Epistemological Categories (the things above in bold)***
>
> *Methodological Naturalism: Science explaining through natural cause only (a **method**)*
>
> *Ontological Naturalism: Reality contains only natural stuff (a **worldview**)*
>
> *Evidentialism: Beliefs should match the evidence you've got*
>
> *Reformed Epistemology: Some beliefs (like belief in God) can be what's called "properly basic" (i.e. valid) if formed from reliable cognitive faculties, even without evidence and argument*
>
> *Virtue Epistemology: Knowledge depends on the knower's intellectual virtues (things like care, courage, open mindedness)*

The debate is really about how we can know anything at all.

"We have to remember that what we observe is not nature herself, but nature exposed to our method of questioning." ***Werner Heisenberg***

References

[11] Duhem, P. (1954) The Aim and Structure of Physical Theory. 2nd ed. Translated by P.P. Wiener. Princeton, NJ: Princeton University Press.
[12] Stanford, P.K. (2017) 'Underdetermination of scientific theory', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Winter 2017 Edition). Available at: https://plato.stanford.edu/archives/win2017/entries/scientific-underdetermination/
[13] Quine, W.V.O. (1951) 'Two dogmas of empiricism', The Philosophical Review, 60(1), pp. 20-43.
[14] Sosa, E. (1980) 'The raft and the pyramid: Coherence versus foundations in the theory of knowledge', Midwest Studies in Philosophy, 5, pp. 3-25. doi:10.1111/j.1475-4975.1980.tb00394.x
[15] Leibniz, G.W. (1989) Philosophical Essays. Translated and edited by R. Ariew and D. Garber. Indianapolis: Hackett Publishing Company.
[16] Melamed, Y.Y. and Lin, M. (2021) 'Principle of Sufficient Reason', in Zalta, E.N. (ed.) The Stanford Encyclopedia of Philosophy (Spring 2021 Edition). Available at: https://plato.stanford.edu/entries/sufficient-reason/
[17] Gurney, R.W. and Condon, E.U. (1928) 'Wave mechanics and radioactive disintegration', Nature, 122(3073), p. 439. doi:10.1038/122439a0
[18] Pruss, A.R. (2006) 'Quantum mechanics', in The Principle of Sufficient Reason: A Reassessment. Cambridge: Cambridge University Press, Chapter 8, pp. 160-170.
[19] Jahnke, T. et al. (2025) 'Direct observation of zero-point motion in molecules', Science, 389(6688), pp. 419-423. doi:10.1126/science.adu2637
[20] Anselm of Canterbury (1965) Proslogion. Translated by M.J. Charlesworth. Oxford: Clarendon Press.
[21] Plantinga, A. (1974) The Nature of Necessity. Oxford: Clarendon Press.
[22] Evans, C.S. (2024) 'Moral arguments for the existence of God', in Zalta, E.N. and Nodelman, U. (eds.) The Stanford Encyclopaedia of Philosophy (Fall 2024 Edition). Available at: https://plato.stanford.edu/entries/moral-arguments-god/
[23] Webb, M.O. (2023) 'Religious experience', in Zalta, E.N. and Nodelman, U. (eds.) The Stanford Encyclopaedia of Philosophy (Fall 2023 Edition). Available at: https://plato.stanford.edu/entries/religious-experience/
[24] Tooley, M. (2021) 'The problem of evil', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Summer 2021 Edition). Available at: https://plato.stanford.edu/entries/evil/
[25] Fumerton, R. (1995) Metaepistemology and Skepticism. Lanham, MD: Rowman & Littlefield.
[26] Newman, L. (2014) 'Descartes' epistemology', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Winter 2014 Edition). Available at: https://plato.stanford.edu/archives/win2014/entries/descartes-epistemology/
[27] Plantinga, A. (1983) 'Reason and belief in God', in Plantinga, A. and Wolterstorff, N. (eds.) Faith and Rationality: Reason and Belief in God. Notre Dame, IN: University of Notre Dame Press, pp. 16-93
[28] Feldman, R. and Conee, E. (1985) 'Evidentialism', Philosophical Studies, 48(1), pp. 15-34. doi:10.1007/BF00372404
[29] Turri, J., Alfano, M. and Greco, J. (2021) 'Virtue epistemology', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Fall 2021 Edition). Available at: https://plato.stanford.edu/archives/fall2021/entries/epistemology-virtue/
[30] Papineau, D. (2021) 'Naturalism', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Fall 2021 Edition). Available at: https://plato.stanford.edu/entries/naturalism/
[31] Moore, A. (2015) 'Theological realism', in Routledge Encyclopaedia of Philosophy. London: Routledge. doi:10.4324/9780415249126-K3584-1
[32] Plantinga, A. (1967) God and Other Minds: A Study of the Rational Justification of Belief in God. Ithaca, NY: Cornell University Press.
[33] van Inwagen, P. (1995) God, Knowledge and Mystery: Essays in Philosophical Theology. Ithaca, NY: Cornell University Press

Section 3: The Historic Battleground

TL;DR

This section maps the terrain of theistic and atheistic arguments. We examine how both sides construct logically coherent cases from incompatible starting assumptions – what we'll call "axiomatic dependency trees."

The key insight: ***these arguments don't fail due to logical errors but because they operate from different theories of knowledge itself****.*

Understanding this stalemate reveals why accumulating more evidence or refining arguments won't resolve the debate, setting the stage for Section 4's computational approach that transcends these epistemological boundaries.

N.B. This section presents a truncated summary of one argument from theism and atheism. Additional arguments following the same analytical structure are detailed in Appendix A.

Introduction: From Stalemate to Systemic Analysis

Section 2 demonstrated that the God debate has reached an impasse because participants operate within incompatible epistemological frameworks. Each framework predetermines what counts as evidence, valid reasoning, and knowledge itself. This section provides a taxonomy of the classical arguments, revealing the structure that underlies each position.

We examine three dimensions for each argument:

1. Epistemological Framework (***How do we know what we claim to know?***) – the theory of knowledge undergirding the argument
2. Ontological Commitments (***What must exist for this argument to work?***) – the metaphysical assumptions about reality's nature
3. Core Axioms (***What must we accept without proof?***) – the foundational beliefs that cannot be demonstrated within the system

This three-dimensional analysis matters because it reveals that factual disagreements mask philosophical incompatibilities. When a theist and atheist debate fine-tuning, they're not disagreeing about probability calculations – they're operating from different theories about whether design can be empirically detected, whether probability calculations are meaningful for unique events, and whether teleology is objectively real or merely projected.

Understanding these hidden dimensions explains the debate's intractability and points toward the need for a framework that transcends (rather than adjudicates between) them.

Part A: Classical Theistic Arguments

Theistic arguments span a remarkable range of approaches. Despite their diversity, they share a common goal: demonstrating that God's existence is either logically necessary, highly probable, directly experienced, or required as a precondition for features of reality we take for granted.

1. Deductive Arguments: The Quest for Logical Necessity

Deductive arguments attempt to prove God's existence through pure reason, claiming that God's existence follows necessarily from certain concepts or observations. If successful, these arguments would make atheism not merely false but logically impossible.

1.1 Ontological Arguments[34]

- Attempts something that seems magical: prove God's existence from the concept of God (I can hear the Atheist's screaming 'tautology' and 'circularity'). The argument's claim is that when we properly understand what we mean by **God,** we must conclude that God exists

- If God existed only in human minds (not in reality), then we could conceive of something greater – namely, a God who exists in reality. Since this contradicts the definition, God must exist
- Descartes reformulated this using the concept of perfection: existence is a perfection, and since God is defined as possessing all perfections, God must exist[35]
- The modal ontological argument, developed by Plantinga, employs possible worlds. It argues that if a maximally great being exists, then such a being exists in some possible world. But a maximally great being, by definition, would exist in all possible worlds if it exists. Therefore, if God's existence is possible, God exists necessarily[36]
- Gödel's argument, discovered after his death, uses modal and higher-order logic to formalise the argument. Using positive property axioms and their logical relationships, Gödel derives the necessary existence of a being possessing all positive properties, his definition of God[37]

Epistemological Framework: ***Rationalist*** *– a priori reasoning can yield substantive knowledge about reality*.

> ***Why Are These Arguments Powerful?***
>
> ***Economy****: these require no empirical premises, just conceptual analysis. For rationalists (those who believe reason alone can yield substantive knowledge about reality, independent of sense experience), this is exactly what we should expect: fundamental truths about reality should be accessible through pure thought.*

Ontological Commitments: ***Realist*** *toward abstract objects and properties. Assumes concepts like "perfection" refer to objective features of reality and are not subjective constructs. They assume necessary existence is superior to contingent existence.*

Core Axioms:
- Existence can be treated as a property or perfection
- Our concepts can accurately capture the nature of ultimate reality
- Logical necessity translates to metaphysical necessity
- Possible worlds semantics reflects genuine metaphysical possibilities

> ***Plain-English Definition [15]: Example Ontological Arguments***
>
> ***Anselm's Classical Argument****: Imagine the most perfect being possible. If that being didn't actually exist, it wouldn't be the most perfect being (because existing is better than not existing). So by definition, the most perfect being must exist*
>
> ***Godel's Formal Ontological Proof:*** *Gödel constructed a rigorous logical system showing that if we accept certain axioms about "positive" properties (like knowledge, power, goodness) and how they combine, we can prove mathematically that a being possessing all such properties must necessarily exist*

> ***Key Criticisms: Example Ontological Arguments***
>
> 1. *Existence is not a predicate: Kant argued that existence is not a property that can be possessed or lacked; "100 real thalers" doesn't differ from "100 possible thalers" by possessing an extra property called existence[38]*
> 2. *Conceptual vs. Real Necessity: Logical necessity within a conceptual system doesn't entail metaphysical necessity in reality. We can define a "perfect island," but this doesn't make it exist*
> 3. *Modal Axiom Controversy: Plantinga's argument depends on accepting* ***S5 modal logic*** *(a specific system of modal logic where if something is possibly necessary, it is necessary), which some philosophers reject*
> 4. *Parody Arguments: Parallel reasoning seems to prove absurdities (Gaunilo's "perfect island," etc.)*

1.2 Cosmological Arguments[39]

Cosmological arguments begin with observations that things exist and that they seem to require explanations for their existence. From here, these arguments reason the existence of a necessary being that explains the existence of everything else. The formulation from Aquinas's has several variants.[40]

The argument from motion observes that things in the world are in motion (or more generally, undergoing change), that whatever is in motion must be put in motion by another, and that this chain cannot regress infinitely[41]. Therefore, there must be an unmoved mover i.e. God. ***The argument from efficient causation*** follows a similar pattern: every effect has a cause, causal chains cannot be infinite, therefore there must be an uncaused cause. Several others (Kalam[42], Leibniz[43]) provide variations and developments of the core argument

Epistemological Framework: ***Hybrid Empirical / Rationalist*** *begin with seemingly undeniable empirical facts (things exist, things change, the universe began) and apply rational principles (causation, sufficient reason) to reach their conclusions*.

Why Are These Arguments Powerful?

Combine empirical undeniability (things exist and change) with rationality: *Rely on self-evident features of reality. Leans on PSR (principle of sufficient reason) and says this seems to underlie all scientific inquiry – without it, why seek explanations at all?*

Ontological Commitments: ***Robust Causal Realism*** *accepts substance metaphysics where things have real existence independent of observation. Assume that infinite causal regresses are metaphysically impossible.*

Core Axioms:

- PSR (everything has an explanation)
- Causal principles apply universally
- Infinite regresses are impossible
- Something cannot come from nothing

Plain-English Definition [16]: Example Cosmological Arguments

Argument from Motion (Aquinas's First Way): *Every change we observe has a cause that made it happen. If we trace causes backward, we can't go back forever (that wouldn't actually explain anything). So there must be a first cause that itself wasn't caused—something that can make things happen without needing anything to make it happen. That's what we mean by God.*

Argument from Efficient Causation (Aquinas's Second Way): *Similar structure applied to causation rather than motion: every effect has a cause, causal chains cannot be infinite, therefore an Uncaused First Cause exists.*

Kalam: *Modern science tells us the universe had a beginning (the Big Bang). But things don't just pop into existence from nothing for no reason. So something must have caused the universe to exist. That cause couldn't be physical (since it created physical reality), couldn't be in time (since it created time), and had to be unimaginably powerful. The best explanation for something with these properties is God.*

Key Criticisms: Example Ontological Arguments

1. *Infinite Regress Permissible: Perhaps causal chains can extend infinitely; our intuition against this might reflect cognitive limitations rather than ground truth.*
2. *PSR might be false: Some facts (like the universe's existence) might be* ***brute facts*** *(facts we obtain without further explanation).*
3. *Quantum Mechanics Challenges Causation: Radioactive decay and quantum fluctuations appear to be uncaused, suggesting causation isn't fundamental.*
4. *Composition Fallacy: Even if everything within the universe has a cause, the universe as a whole need not.*
5. *"What Caused God?" Regress: If everything needs a cause, what caused God? If God doesn't need a cause, why can't the universe be self-explanatory?*

Part A Synthesis: The Theistic Strategy

We can now discern the underlying pattern in theistic argumentation:

- **The Cumulative Case Approach**[44]: No single argument stands alone. Theistic philosophers construct cumulative cases where multiple independent arguments converge on God's existence. Even if each argument reaches moderate probability of truth, the cumulative effect is stronger. Bayesian formulation: $P(God \mid E_1, E_2, E_3\ldots) >> P(God \mid E_1)$ where E_1, E_2, E_3 represent different evidential lines
- **The Transcendental Thread**[45]: Many theistic arguments, explicitly or implicitly, use transcendental reasoning. They identify features we take for granted (reason, morality, mathematics, consciousness, beauty, existence itself) and argue these require God as a necessary precondition. This shifts the debate from "does God exist?" to "how do you account for X without God?"
- **The Explanatory Power Metric**[46]: Theistic arguments emphasize explanatory scope (how much God explains) and power (how well God explains it). God provides a unified explanation for cosmic origin, fine-tuning, consciousness, morality, reason, beauty, and religious experience. This unification mirrors the path of science.
- **The Category-Theoretic Pattern**[47]: Formally, we see these arguments as asserting God functions as a terminal object in various categories:
    - In the category of **Causes**, God is the terminal (uncaused) cause
    - In the category of **Explanations**, God is the terminal (self-explanatory) explanation
    - In the category of **Ontological Dependencies**, God is the terminal (necessary) being
    - In the category of **Moral Groundings**, God is the terminal (absolute) standard
    - In the category of **Rational Foundations**, God is the terminal (self-justifying) truth

Note: Category Theory in this context

We can think of the Category-theoretic pattern as showing that every chain of explanation, causation, or grounding eventually needs to "bottom out" somewhere – and that terminal point (the thing that explains itself, causes itself, grounds itself) is what we mean by God.

However, this synthesis reveals the arguments' vulnerability: **every theistic argument rests on rejecting infinite regresses and demanding terminal elements**.

Critics who accept infinite regresses or brute facts (at the cosmic level) can resist all these arguments simultaneously by denying shared foundation (see variations in philosophy from Postmodernism for an example).

Part B: Atheistic Arguments

1. Logical Disproof: Impossibility

The strongest forms of atheistic argument show not only that God doesn't exist, but that the very concept of God (based on simple readings of religious texts) is logically incoherent and / or contradictory.

1.1 The Problem of Evil[48]

J.L. Mackie's formulation of the logical problem of evil argues that the following three propositions cannot all be true:

- God is omnipotent (can do anything logically possible)
- God is omnibenevolent (perfectly good, desiring no evil)
- Evil exists

If God is omnipotent, He could eliminate evil. If God is omnibenevolent, He would want to eliminate evil[49]. Yet evil exists. Therefore, a God with both attributes cannot exist. This argument claims logical contradiction in traditional theism.

Epistemological Framework: ***First-Order Logic***. *Assumes omnipotence, omnibenevolence, and evil are defined well enough to generate invariant logical relationships, and that God is constrained by logic.*

> ***Why Are These Arguments Powerful?***
>
> ***Logical force + Visceral power***. *It confronts the lived reality of suffering. Every natural disaster, every childhood disease, every genocide provides more evidence. Moreover, the logical formulation seems airtight—denying any of the three premises abandons traditional theism.*

Ontological Commitments: *Assumes evil is an **ontological category** (i.e. not privation of good), that attributes of omnipotence and omnibenevolence have fixed meanings that generate logical implications, and that **logic supervenes God**.*

Core Axioms:

- Evil genuinely exists
- Omnipotence means ability to do anything logically possible / Omnibenevolence means willing no evil whatsoever
- Logical consistency applies to God

> ***Key Criticisms***
>
> 1. *Free Will[46]: God gave humans libertarian free will that is so valuable that it justifies evil. God cannot logically create beings with free will who can only choose good—that would be a contradiction*
> 2. *Soul-Making[47]: This world is a training ground for moral and spiritual development. Virtues like courage, compassion, and perseverance require challenges to develop. A world without suffering would be a world without growth*
> 3. *Sceptical Theism: We cannot know God's reasons. Given God's infinitely greater perspective, what appears gratuitous might serve a purpose we cannot grok*
> 4. *Evil as Privation: Augustine's view that evil is absence or corruption of good (like cold is the absence of heat)*
> 5. *Logical Possibility: Plantinga showed that if any logically possible scenario exists where God and evil co-exist, the logical problem fails. He need not show which scenario is actual, only that one is possible. Since "God has morally sufficient reasons we don't know about" is logically possible, the logical incompatibility is defeated*

1.2 Paradoxes

Beyond the problem of evil, various logical paradoxes afflict classical divine attributes. For example, can an omnipotent being create a stone too heavy for Him to lift? Either He can (but then cannot lift it, so is not omnipotent) or He cannot (and so is not omnipotent)[52].

Secondly, the paradox of divine freedom: if God is perfectly good, He cannot do evil. But if He cannot do evil, He lacks free will. Yet free will seems subjectively preferable to its absence – so the greatest conceivable being should have free will. But having free will means being able to do evil, which contradicts perfect goodness[53].

Thirdly, the paradox of divine simplicity: Particularly relevant to the Trinity (Christianity). God is described as absolutely simple. Yet the Trinity claims God exists as three persons. How can something absolutely simple be three distinct persons?[54]

Epistemological Framework: ***Conceptual Analysis*** *to find contradictions. Assumes divine attributes must be coherent by the standards of logic and that apparent contradictions are genuine.*

> ***Why Are These Arguments Powerful?***
>
> *They appear to show that traditional divine attributes, when rigorously examined, generate logical contradictions. This suggests the God-concept is incoherent.*

Ontological Commitments: *Assume that properties like omnipotence and omniscience can be given precise definitions, that these definitions have logical implications, and that God must conform to logical laws (at least the law of non-contradiction).*

Core Axioms:

- Divine attributes must be logically coherent[55]
- Our concepts precisely capture divine attributes
- Paradoxes indicate genuine contradictions, not concepts beyond human comprehension
- God is constrained by logic

> ***Key Criticisms***
>
> 1. *Redefinition of Omnipotence: Omnipotence means "able to do anything logically possible," and logical contradictions aren't "things" to be done*
> 2. *Redefinition of Freedom: Perfect goodness is a form of freedom—freedom from the possibility of being corrupted. We shouldn't consider inability to do evil a limitation on freedom*
> 3. *Apophatic: Divine attributes exceed human conceptual capacity. Apparent paradoxes reflect our cognitive limitations*

PART B Synthesis: The Atheistic Strategy

Having examined representative atheistic arguments, we can now discern the underlying patterns:

- **Erosion Strategies**: Atheists don't tend to attempt a single knockout blow but focus on the cumulative erosion of theistic plausibility. Each argument chips away at one aspect: logical coherence (paradoxes), evidential support (problem of evil), explanatory necessity (evolution, cosmology), or epistemic framework (presumption of atheism)
- **Burden-Shifting Tactics**: Many arguments focus on shifting the burden of proof[56]. Presumption of atheism, evidential demands and religious diversity put theists on the defensive, making them justify belief instead of critics having to justify disbelief
- **Sufficiency Claims**: Evolution and cosmological naturalism don't prove God doesn't exist—they argue God is explanatorily superfluous. If naturalistic explanations suffice, **Ockham's Razor**[57] recommends accepting the simpler ontology (universe alone) over complex ontology (universe plus God)
- **Internal Critique Methods**: These are arguments that accept the theist's premise and show they generate contradictions. They show theistic attributes are logically problematic. This is rhetorically powerful because it doesn't require defending an alternative framework
- **The Category-Theoretic Pattern**: Formally, atheistic arguments challenge the 'terminal object strategy' of theistic arguments:
    - Against cosmological arguments: Maybe infinite regresses are permissible (no terminal cause needed)
    - Against moral arguments: Maybe brute moral facts exist (no terminal moral grounding needed)
    - Against fine-tuning: Maybe multiverse with no terminal designer needed
    - Against reason arguments: Maybe naturalistic explanations of reasoning exist (no terminal rational foundation needed)

> ***Note: Category Theory in this context***
>
> *Theistic arguments say every chain must "bottom out" at God. Atheistic arguments keep asking "but what if it doesn't?"*
>
> *They propose (either implicitly or explicitly) that reality has infinitely many levels, or brute facts, or self-explaining loops i.e. there's no need for a final stopping point. However,* ***Ockham's Razor*** *(see 'Sufficiency Claims') is whacked by this*

This synthesis reveals these arguments' vulnerability. Most are negative (problems with theism) rather than positive (establishing naturalism).

They demonstrate theism faces difficulties but don't fully establish naturalism as a better explanation. The best atheistic cases utilise both demolition and construction.

Conclusion: The Stalemate Explained

TL;DR

Now we transition to Section 4. We've mapped the battleground in the God Debate and understood why it produces stalemate.

Now we look at ***the God Conjecture*** *itself.*

Instead of adding another argument, we'll construct a framework that subsumes and unifies them, demonstrating how theological concepts and physical reality can emerge from the same computational substrate.

We have examined the historic battleground, through both sides epistemological frameworks, ontological commitments, and core axioms. **What have we learned?**

The Pattern Emerges: Axiomatic Incommensurability

The proliferation of sophisticated arguments on both sides – each internally coherent, each supported by brilliant philosophers – suggests the debate's persistence is down to something fundamental: participants operate from axioms that predetermine their conclusions.

Consider the axiomatic dependency tree structure revealed across arguments:

Theistic Arguments Depend on Accepting:

- Principle of Sufficient Reason (everything has an explanation)
- Infinite regresses are impossible
- Abstract objects need grounding
- Objective morality requires transcendent foundation
- A priori reasoning yields substantive knowledge
- Design can be empirically detected
- Religious experience provides prima facie justification

Atheistic Arguments Depend on Accepting:

- Absence of evidence is evidence of absence
- Burden of proof lies with positive existential claims
- Naturalistic explanations are adequate
- Brute facts are acceptable
- A posteriori reasoning constrains all knowledge
- Methodological naturalism is appropriate everywhere
- Evidentialism: belief proportioned to empirical evidence

Neither set of axioms can be proven, they're starting points that are mutually incompatible. Accepting PSR makes atheism difficult; rejecting PSR makes theism unnecessary. Accepting properly basic beliefs defeats the presumption of atheism; accepting evidentialism undermines properly basic beliefs.

Why the Debate Persists: Talking Past Each Other

This axiomatic structure explains the debate's frustration. See below:

- The rationalist begins: *"Consider the concept of God..."*
- The empiricist interrupts: *"Concepts don't tell us about reality; show me empirical evidence"*
- The rationalist responds: *"But a priori reasoning can yield substantive metaphysical knowledge"*
- The empiricist counters: *"That's precisely what I deny. All substantive knowledge comes from experience"*

They talk past each other because their epistemological frameworks render the other's arguments impotent from the start. This isn't unique to ontological arguments, the same pattern repeats throughout:

- Reformed epistemology vs. evidentialism on religious experience
- Moral intuitionism vs. evolutionary debunking on moral arguments
- Teleological realism vs. methodological naturalism on design

- Sceptical theism vs. probabilistic atheism on problem of evil

The Computational Opportunity

Section 3 revealed why accumulating more arguments (or refining existing ones) won't resolve anything. This dispute is ultimately meta-level. It's more about the rules of engagement than the evidence. This creates an opening for a radically different approach.

What if we could construct a framework that:

- Doesn't require choosing between rationalism and empiricism
- Doesn't privilege either infinite regresses or terminal causes
- Makes both design and evolution aspects of the same underlying process
- Shows how objective moral truth and evolutionary explanation are compatible
- Provides a language that both scientific materialists and religious believers can use

This is what a Computational Approach offers.

Rather than asking "Does God exist?" (which loads the question) or "Can naturalism explain everything?" we can ask:

"What is the formal structure of the relationship between Observers and the space of all possible computations (the Ruliad)?"

This question is metaphysically neutral – it doesn't presuppose theism or atheism. Yet as we'll see in **Section 5**, answering it rigorously yields a framework that maps remarkably onto both classical theology and contemporary physics. The God Conjecture shows that theistic and atheistic positions, properly understood, aren't incompatible viewpoints but complementary perspectives on a deeper computational reality.

Toward a Unified Language: The Bridge Ahead

Section 2 showed why the debate reaches stalemate. **Section 3** has provided evidence. Now, having diagnosed the problem, **Section 4** introduces the solution: a computational framework provides a **meta-language** both sides can speak.

We'll discover how theological concepts map to computational language:

- Necessary existence → *Formal mathematical properties of the Ruliad*
- Omniscience → *Total informational content of the complete computational structure*
- Omnipotence → *Capacity to instantiate any logically possible computation*
- Emanation → *Observer-dependent sampling of computational possibility space*
- Evil and suffering → *The experience of the interaction between Computational irreducibility and Observer boundedness*
- Free will → *Computational irreducibility preventing any Observer "skipping ahead" to predetermined outcomes*

The things we care about in the God debate have precise computational correspondences.

The God Conjecture isn't another argument. It's a helicopter view showing that the battlefield is part of a larger landscape – and that theists and atheists are describing different parts of that landscape using incompatible linguistic frameworks.

By providing a unified computational language, we can translate between them.

"The first principle is that you must not fool yourself—and you are the easiest person to fool." ***Richard Feynman***

"In philosophy, it is not the attainment of the goal that matters, it is the things that are met along the way." ***Havelock Ellis***

References

[34] Oppy, G. (2024) 'Ontological Arguments', in Zalta, E.N. (ed.) *The Stanford Encyclopaedia of Philosophy* (Summer 2024 Edition). stanford Available at: https://plato.stanford.edu/entries/ontological-arguments/

[35] Descartes, R. (1641/1984) 'Meditations on First Philosophy', in Cottingham, J., Stoothoff, R. and Murdoch, D. (eds.) The Philosophical Writings of Descartes, Vol. II. Cambridge: Cambridge University Press.
[36] Plantinga, A. (1974) *The Nature of Necessity* (Clarendon Library of Logic and Philosophy). Oxford: Clarendon Press/Oxford University Press. doi:10.1093/0198244142.001.0001
[37] Gödel, K. (1995) 'Ontological Proof', in Feferman, S., Dawson, J.W. Jr., Goldfarb, W., Parsons, C. and Solovay, R.M. (eds.) Kurt Gödel: Collected Works, Volume III: Unpublished Essays and Lectures. New York: Oxford University Press, pp. 403-404. ISBN: 0195147227
[38] Kant, I. (1781/1787/1998) Critique of Pure Reason, Guyer, P. and Wood, A.W. (trans./eds.). Cambridge: Cambridge University Press.
[39] Reichenbach, B. (2022) 'Cosmological Argument', in Zalta, E.N. and Nodelman, U. (eds.) The Stanford Encyclopedia of Philosophy (Fall 2022 Edition). Available at: https://plato.stanford.edu/entries/cosmological-argument/
[40] Aquinas, T. (1947) Summa Theologica. Translated by Fathers of the English Dominican Province. New York: Benziger Bros and Aquinas, T. (1975) Summa Contra Gentiles. Translated by A.C. Pegis, J.F. Anderson, V.J. Bourke and C.J. O'Neil. Notre Dame, IN: University of Notre Dame Press.
[41] Wieland, J.W. and Benton, M.A. (2022) 'Infinite Regress Arguments', in Zalta, E.N. (ed.) The Stanford Encyclopedia of Philosophy (Fall 2022 Edition). Available at: https://plato.stanford.edu/entries/infinite-regress/
[42] Craig, W.L. (1979) The Kalām Cosmological Argument. London: Macmillan Press. ISBN: 0-333-24809-0 [Reprinted: Eugene, OR: Wipf & Stock Publishers, 2000. ISBN: 978-1-57910-438-2]
[43] Leibniz, G.W. (1714/1951) 'The Monadology', in Wiener, P.P. (ed.) Leibniz Selections. New York: Charles Scribner's Sons, pp. 533-552.
[44] Swinburne, R. (1979; 2nd ed. 2004) The Existence of God. Oxford: Clarendon Press. ISBN: 9780199271672 (2nd ed.) and Mitchell, B. (1973) 'The Nature of a Cumulative Case', in The Justification of Religious Belief. London: Palgrave Macmillan. DOI: https://doi.org/10.1007/978-1-349-00663-2_4
[45] Stern, R. (2019) 'Transcendental Arguments', in Zalta, E.N. (ed.) The Stanford Encyclopaedia of Philosophy (Fall 2019 Edition). Available at: https://plato.stanford.edu/archives/fall2019/entries/transcendental-arguments/
[46] Lipton, P. (1991; 2nd ed. 2004) Inference to the Best Explanation. London: Routledge. ISBN: 9780415242028. DOI: 10.4324/9780203470855 and Ylikoski, P. and Kuorikoski, J. (2010) 'Dissecting Explanatory Power', Philosophical Studies, 148(2), pp. 201-219. DOI: 10.1007/s11098-008-9324-z
[47] Marquis, J.-P. (2021) 'Category Theory', in Zalta, E.N. (ed.) The Stanford Encyclopedia of Philosophy (Fall 2021 Edition). Available at: https://plato.stanford.edu/archives/fall2021/entries/category-theory/ and Awodey, S. (2006; 2nd ed. 2010) Category Theory. Oxford Logic Guides. Oxford: Oxford University Press. ISBN: 9780199587360 (2nd ed.)
[48] Mackie, J.L. (1955) 'Evil and omnipotence', Mind, 64(254), pp. 200-212. EdX https://doi.org/10.1093/mind/LXIV.254.200
[49] Mackie, J.L. (1982) The Miracle of Theism: Arguments For and Against the Existence of God. Oxford: Oxford University Press. ISBN: 978-0-19-824682-4
[50] Plantinga, A. (1974) God, Freedom, and Evil. New York: Harper & Row. [Reprinted 1977, Grand Rapids, MI: Wm. B. Eerdmans. ISBN: 0-8028-1731-9]
[51] Hick, J. (2010) Evil and the God of Love. Reissue edition with foreword by Marilyn McCord Adams. Basingstoke: Palgrave Macmillan. ISBN: 978-0-230-25279-0
[52] Mavrodes, G.I. (1963) 'Some Puzzles Concerning Omnipotence', Philosophical Review, 72(2), pp. 221-223. Internet Encyclopaedia of Philosophy DOI: 10.2307/2183199
[53] Rowe, W.L. (2004) Can God Be Free? Oxford: Oxford University Press. ISBN: 9780199283194 and Flint, T. and Speak, D. (2022) 'Divine Freedom', Stanford Encyclopaedia of Philosophy (Summer 2022 Edition), Zalta, E.N. (ed.). Available at: https://plato.stanford.edu/entries/divine-freedom/
[54] Vallicella, W.F. (2019) 'Divine Simplicity', Stanford Encyclopaedia of Philosophy (Summer 2019 Edition), Zalta, E.N. (ed.). Available at: https://plato.stanford.edu/entries/divine-simplicity/
[55] Morris, T.V. (1991) Our Idea of God: An Introduction to Philosophical Theology. Downers Grove, IL: InterVarsity Press. ISBN: 9781573831017
[56] Flew, A. (1976) The Presumption of Atheism and Other Philosophical Essays on God, Freedom and Immortality. London: Pemberton Publishing
[57] Sober, E. (2015) Ockham's Razors: A User's Manual. Cambridge: Cambridge University Press. ISBN 9781107692534 (pbk), 9781107034464 (hbk)

The God Conjecture

Section 4: Setting Up The Argument

TL;DR

The God debate has reached a stalemate because what counts as "evidence" for one side doesn't count for the other. ***The God Conjecture*** *propose a new approach: using computation (specifically, the Ruliad, the space of all possible computations) as a neutral language that both believers and sceptics can engage with.*

Throughout history, religions have evolved toward increasingly abstract concepts of God – from local geographically-bounded spirits to infinite, universal principles. This pattern appears across cultures (Judaism, Hinduism, Buddhism, Christianity, Islam, Daoism) and mirrors how science evolved from local observations to universal laws.

Using the Ruliad, we can model theological concepts:

- *How does an infinite God create finite reality? (Emanation through Observer sampling)*
- *Why does God seem hidden? (Computational irreducibility)*
- *How can God be both transcendent and present? (The interaction between Observers in the Ruliad and its overall structure)*
- *What is consciousness? (A fundamental feature of complex self-referential Observer systems at all scales)*

We aren't claiming "we've proven God exists." We're developing a model that provides a method the uses a backdrop that can replicate physics.

Beyond the Impasse

The historical arguments have reached an impasse because they operate in incompatible frameworks. Each side can construct internally consistent systems that account for the evidence, but they rest on axioms that can't be adjudicated neutrally. Both sides play by different rules, so productive conversation is almost impossible.

This calls for a new approach, that transcends epistemological categories in a unified language.

A computational argument provides exactly such an approach by providing a formal language for discussing necessity, consciousness, design, and transcendence – without picking sides.

Plain-English Definition [17]: What is Computation? (Abstractly)

Computation is a neutral language – in the Ruliad it's the mathematics of cause-and-effect processes. Both theists and atheists can discuss computational models without requiring belief commitments upfront.

What This Section Will Demonstrate

The God Conjecture will show how classical theological concepts map onto computational structures in surprising ways.

To do this, we will use the largest possible computational object: **Wolfram's Ruliad**[58,59,60,61,62].

Plain-English Definition [18]: Ruliad

The Ruliad is the mathematical space containing all possible computations – every rule, every process, every cause-and-effect sequence that could possibly exist. Think of it as the ultimate possibility space: if something can be computed (which includes all of physics, mathematics, and logic), it exists somewhere in the Ruliad.

Formally, it's structured as an ∞-groupoid in category theory (don't worry, we'll explain this later).

Plain-English Definition [19]: Observer (FYI, this is very, very important)[63,64]

In this framework, an ***Observer*** *is any system that samples (selects specific cause-and-effect paths through) the* ***Ruliad*** *according to rules that ensure its* ***persistence*** *(i.e. so it survives between these steps to make more observations). Observers are* ***computationally bounded*** *(limited in processing power and therefore how much of their memory they can access), must maintain* ***persistence*** *(continue existing through time), and filter for* ***relevance*** *(select information that matters for their maximisation function i.e. things like survival).*

The Observer Theory Extension posited that all Observers have a ***Core Function*** *(their* ***telos / goal****) to* ***MAXIMISE INTEGRATED INFORMATION*** *(i.e. create / maintain as much structured information as possible, subject to their current computational boundedness and persistence). This conjecture is not proven, but it does have experimental support (see Micheal Levin's work).*

Humans are Observers; so are simpler systems.

Consciousness, in this framework, is a self-referential, high-complexity class of Observation.

Section 7 and 8 provide formal definitions of Minimal Observers and how they work.

Using the Ruliad we can model the following theological concepts:

- **Emanation** (evident in the metaphysics of the Monotheisms, Hindusim, Daoism and Buddhism) finds a precise analogue in the Observer's sampling of the Ruliad
  Q: How does an infinite, simple source produce complex, finite reality?
  A: Through constrained Observer sampling processes (see Section 5, for the details on how)
- **Divine Attributes** of omniscience, omnipotence, and necessity can be formalised with the Ruliad's properties
  Q: What does "all-knowing" or "all-powerful" actually mean in computational terms?
  A: Being able to do and know all that is logically possible
- **The problem of evil** becomes a question about computational irreducibility and Observer's computational limitations
  Q: Why can't Observers predict or prevent ***all*** *suffering?*
  A: Because some computations cannot be shortcut (they are irreducible)
- **Divine hiddenness** emerges as a necessary feature of finite Observers interacting with the Ruliad
  Q: Why isn't God's existence obvious?
  A: Because finite systems cannot fully comprehend infinite ones. It's a mathematically necessity to maintain a boundary or Observers can't observe

Plain-English Definition [20]: Computational Irreducibility (FYI, this is also very, very important)[65,66,67]

There are no shortcuts. Certain processes cannot be predicted without running them step-by-step. Even with unlimited computing power, you cannot skip ahead to see the outcome. This is the source of unpredictability in deterministic systems and, in the God Conjecture, is crucial for understanding free will, consciousness, and divine hiddenness.

This is not intended as a classical proof, nor as a reduction of God to computation. It's a model that develops a shared language across two disconnected fields, a framework where the discoveries of science and theology can finally communicate and enrich each other.

Better Questions, Not Final Answers

As we develop the God Conjecture, we will demonstrate that in a computational epistemology, asking "whether God exists" is the wrong question.

The question "Does God exist?" assumes God is an object, like a chair or a planet – something that either exists (*has causal power, see Chalmers*[68]) or doesn't. But if God is a process, the question changes.

This enables us to ask new questions:

- What is the mathematical nature of foundational questions?
  Q: What must exist vs. what could exist? (see Constructor Theory for more on this)
- How would something Infinite produce something finite? What are the possible steps?
  Q: Can we model this process of creation computationally?
- Is God personal or impersonal? And at what level of description
  Q: Maybe it's both, depending on the specific Observer's sampling constraints?
- Is reality conscious or unconscious?

Q: Is consciousness (of some non-zero 'amount' of it) necessary for observation?

- How does the idea of a Platonic Space shape causally influence reality without breaking physics?
  Q: Can information flow from abstract to concrete through Observer selection processes?

This paper won't fully answer these questions. It will provide a framework and one potential pathway for investigating them that believers and sceptics can engage with productively.

Here, **the Object is the Process**.

> ***Plain-English Definition [21]: "The Object is the Process"***
>
> *Historically we have 'Objectified' God in all these debates.*
>
> *The God Conjecture will show that the Object (God) might be identical to the process (computation of reality) i.e. not a being outside creation intervening as separate to it, but the fundamental generative process itself (the ground).*

Part A: Religious Evolution Through History

The Evolution of the Sacred: From Local Spirits to Infinite Computation

Religion is humanity's longest-running research program, a multi-millennia investigation into the nature of reality, causation, consciousness, and meaning. These investigations are top-down, proto-scientific attempts to understand the structures underpinning reality.[69]

> ***Plain-English Context***
>
> *Before the scientific method, we had religious inquiry. Both have the same aim. Explain "why does reality work this way?" using the best tools we can grab.*

Careful analysis of religious history suggests a clear evolutionary trajectory: from local, limited conceptions of divinity to universal, unlimited, and increasingly abstract formulations. **This pattern is consistent through history and across diverse cultures.**

> ***Note***
>
> *This evolution is dynamic. It can revert to less integrated structures in a narrow time window (see certain Henotheistic and Polytheistic religions arising post Monotheism in the near-East). However, in the wash (i.e. over a long enough time scale) that evolution is convergent and logistic (specifically, a sigmoid, an S-shaped curve). In religious evolution we experience limited growth for a long time, then an exponential complexification in a short amount of time, then a flattening, as those 'big' ideas are developed and forked. Part A shows this path.*

Early civilizations saw divine forces in narrow, specified domains – the spirit of *this* river, the god of *that* mountain. Over time, local powers consolidated into regional pantheons, before complexifying into universal principles. The apex of this evolution produced conceptions of an infinite, necessary (ground of) being.

Diverse traditions converged to weakly equivalent ultimate concepts – whether Ein Sof (the 'biggest' name of God in Judaism), Brahman (Hinduism), the Logos (Christianity), Dao (Eastern traditions).

> ***Plain-English Definition [22]: Panentheism***
>
> *The view that God / ultimate reality not only contains the universe but also transcends it. Unlike **pantheism** (God = universe), **panentheism** holds that all of existence is within God, but God is also more than the sum of existence. A good analogy is water in a sponge: the water fills the sponge but also extends beyond it. All persistent monotheisms have detailed panentheistic 'flavours' to their metaphysics.*

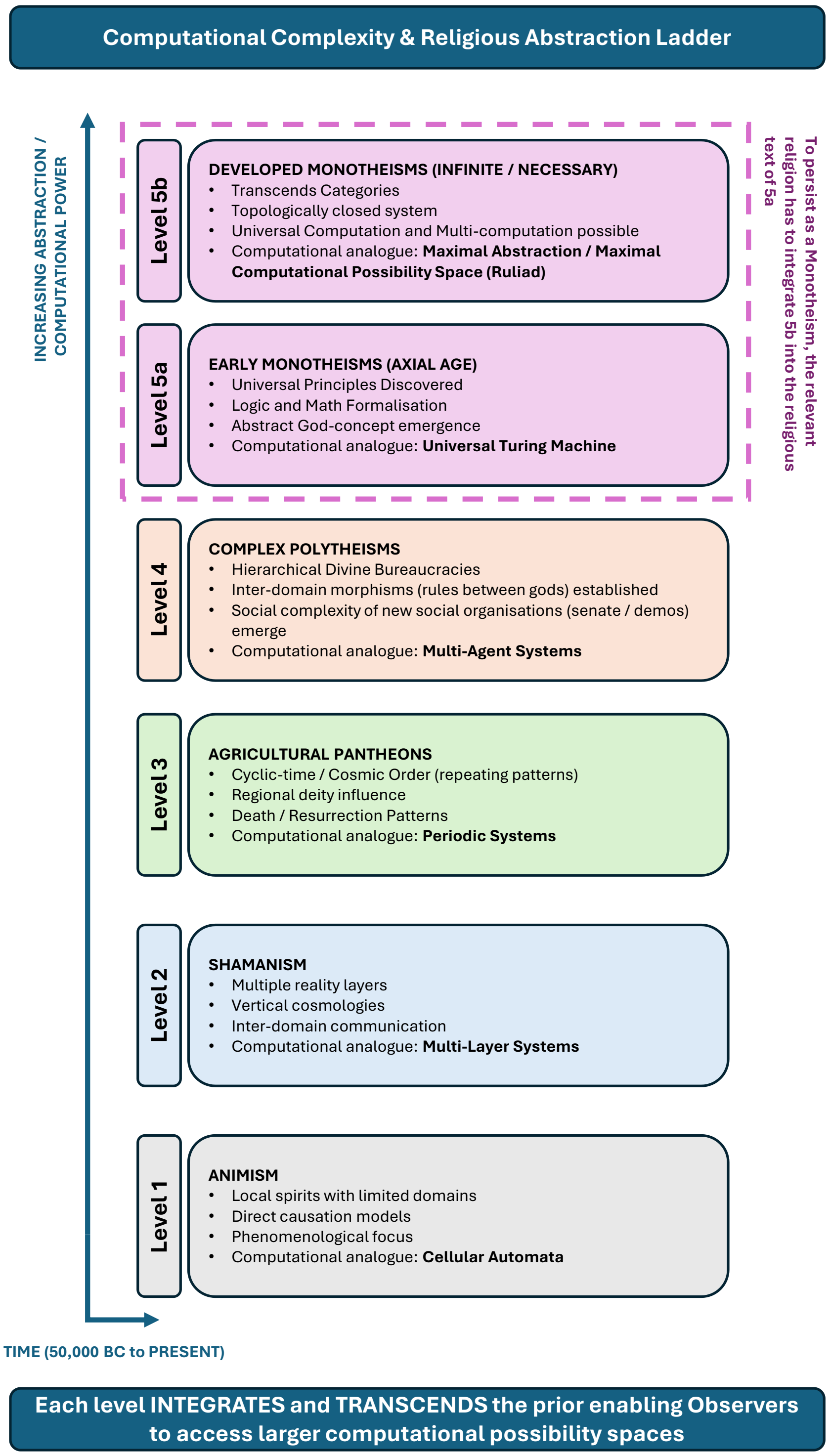
Remarkably, this evolution anticipated by centuries or millennia many insights of modern physics and computation.

- The Kabbalistic **Ein Sof** (and its emanations) prefigures the concept of infinite computational potential constrained through rule selection
- Buddhist dependent origination (pratītyasamutpāda) mirrors network causation theory
- The Daoist interplay of yin / yang resembles computational complementarity and symmetry operations

> ***Plain-English Definition [23]: Ein Sof / Ohr Ein Sof***
>
> *Ancient Hebrew term meaning **"without end"** or **"infinite"**.*
>
> *In Kabbalah, Ein Sof represents the unknowable, infinite aspect of God before any creation or emanation—the absolute totality beyond all categories, including existence and non-existence. In short, it's impossible to know anything about this thing or prescribe it properties in any way.*

These parallels suggest that religious inquiry represents humanity's first systematic attempt at what we now recognise as science – the search for the fundamental rules from which all existence emerges.

Visual: The Computational Complexity Ladder of Religious Evolution



The Historical Arc of Religious Evolution[70,71]

1. Animistic Foundations (50,000+ BCE): The Discovery of Causation[72]

The animistic worldview represents humanity's first systematic attempt to explain causation. It populated the world with intentional agents – every significant phenomenon resulted from the action of spirits with limited domains of influence.

The river spirit controlled only the river; the mountain god affected only the mountain and its immediate vicinity. Given the observational apparatus and linguistic limitations of the time these systems represented reasonable inferences from observed patterns: ***effects seemed to have causes, and the most familiar causes were intentional agents like humans themselves.***

> ***Computational Analogy***
>
> *Animism resembles **cellular automata** where each cell follows local rules without global coordination—several disconnected causal graphs operating independently, creating computationally reducible patterns without overarching convergence.*

> ***Plain-English Context***
>
> *Imagine a grid where each square has its own simple rule ("if my neighbour is active, I activate"). No square knows about squares far away. That's animism – local rules with local effects.*

The Shaman's role parallels a systems administrator – someone who understands local rules well enough to intervene, negotiate, and occasionally exploit edge cases in the system's logic.

Power level: Minimal, due to strict locality. The accessible possibility space for Observers was extremely limited.

---

2. Shamanic Complexification (30,000 BCE): The Discovery of Vertical Connection

Shamanism birthed a revolutionary concept: ***multiple levels of Observable reality accessible through altered states of consciousness***. The Shaman journeyed to the spirit world, negotiated with entities in their realms, and returned with new knowledge.

This vertical cosmology – upper worlds containing sky spirits, lower worlds holding earth spirits – introduced the concept of emanation: power flowing from higher to lower realms.

> ***Plain-English Definition [24]: Emanation***
>
> *The process by which higher, more abstract levels of reality generate lower, more concrete levels through logical / informational constraint. Like how all even numbers "emanate" from the rule "multiply by 2" – the rule generates infinite instances without being diminished.*

This marked humanity's first systematic attempts to access altered states – practices evolving into meditation, contemplation, and abstract reasoning.

> ***Computational Analogy***
>
> *Multi-level systems where different rules apply at different scales, with specific interfaces allowing communication between levels. Like a computer running virtual machines—different operating systems coexist, with translation layers enabling interaction.*

Power level: Higher than Animism, as Shamans claimed influence over broader, vertically integrated domains.

---

3. Agricultural Pantheons (10,000 BCE): The Discovery of Cosmic Order

The agricultural revolution demanded more sophisticated frameworks. Farming communities needed to understand and predict seasonal cycles. Gods of fertility, rain, and harvest emerged – beings whose influence extended across regions and seasons rather than specific locations.

This evolutionary step introduced cosmic order: predictable patterns governing nature that gods either controlled or embodied.

Key innovations:

- Cyclical time and eternal return (the cosmic circle)
- Death-and-resurrection deities (Osiris, Tammuz, Persephone) reflecting the agricultural cycle
- Formal link of destruction and creation, death and rebirth

> ***Computational Analogy***
>
> *Periodic systems with conservation laws – regular patterns repeating while maintaining invariants. Like how seasons cycle but total energy is conserved. These gods governed fundamental processes across entire categories of being, not just local instances.*

Power level: Significantly increased. These gods controlled fundamental cyclic processes affecting entire civilizations.

---

4. Polytheism (5,000 BCE): The Formalisation of Metaphysical Hierarchy

The rise of cities produced pantheons of increasing complexity. Sumerian, Mesopotamian, Egyptian, Greek, and Roman pantheons featured dozens of deities with specialized functions, complex relationships, and elaborate mythologies. These gods had human personalities. Their conflicts and allyships explained natural and social phenomena. Each deity governed a specific aspect of reality while participating in a divine society that mirrored the makeup of that specific civilization.

> ***Plain-English Definition [25]: Morphism***
>
> *In category theory, a morphism is a structure-preserving map between objects – essentially, a rule for how one thing transforms into or relates to another.* ***In polytheistic systems, morphisms are the relationships between different divine domains*** *(how the god of war relates to the god of wisdom, etc.).*

Divine bureaucracies mirrored urban social structures, providing cosmic justification for social order. The key innovation: **order emerges from balanced interaction of multiple competing powers**, with councils and assemblies reflecting sophisticated political developments.

Polytheisms represent a step-change in computationally complexity.

> ***Computational Analogy***
>
> *Multi-agent systems where autonomous entities with different capabilities and goals interact according to established rules and hierarchies. The domains were now interconnected – the pantheon formed a connected graph with edges (morphisms) between nodes (gods)*

> ***Plain-English Context***
>
> *Imagine a company with different departments (marketing, engineering, finance). Each has its own goals and rules, but they must coordinate through formal channels. That's polytheism – specialized gods with defined relationships*

These domains were now interconnected through a hierarchical order. These 'maps' in a computational topos now had morphisms between them. These Gods were still subject to rules that limited their overall power.

A 'senior' God could order the Gods of the other domains. Zeus could command Poseidon but couldn't directly control the sea's fundamental nature – he operated through the domain hierarchy.

Computationally, the possibility space for the Observer grew, they could make more choices and specialise in a specific domain, whilst also having computationally reducible rules (detailed by the religious hierarchy) of how those domains connected into one, larger, coherent possibility space.

Power level: Major deities claimed dominion over fundamental forces (war, love, wisdom) affecting entire civilizations. The accessible possibility space expanded dramatically.

---

5. Philosophical Monotheism Emergence (1,500-500 BCE): The Discovery of Universal Law[73]

The Axial Age (roughly 800-200 BCE) witnessed a remarkable transformation across Eurasia. Independent traditions discovered and simultaneously formalised an idea of ultimate reality that transcended anthropomorphic deities.

- **Israelite prophets** proclaimed Hashem as sole cosmic sovereign
- **Greek philosophers** developed the *arche*—fundamental principles constraining their Pantheon
- **Indian sages** identified Brahman as the overarching 'container' of all the local gods in their pantheon
- **Chinese thinkers** elevated Confucianism to the universal principle of the Dao
- **Persian Zoroastrianism** posited Ahura Mazda as the one 'uncreated creator'

> ***Plain-English Definition [26]: Brahman***
>
> *In Hindu philosophy, Brahman is the ultimate, unchanging reality beneath all appearances – infinite, eternal, beyond all attributes yet the source of all attributes. Often described as Sat-Chit-Ananda (Being-Consciousness-Bliss). All finite beings (including gods) are expressions of Brahman.*

> ***Plain-English Definition [27]: Dao (Tao)***
>
> *In Chinese philosophy, the Dao is the fundamental, ineffable principle underlying all existence – the "way" or cosmic process.* ***The Dao that can be named is not the eternal Dao****. It combines aspects of natural law, moral principle, and ultimate reality. Reality emerges through the interplay of its complementary aspects (yin and yang).*

The move from "gods" to "God" or "ultimate principle" marked a phase transition in human understanding – from seeing divinity as powerful beings within reality to recognizing something infinite as the ground of reality itself (i.e. the largest possible possibility space).

Computational Analogy

*The discovery of **universal computation** – that certain systems can simulate any possible computation.*

Just as a Universal Turing Machine can emulate any other Turing machine, the God of philosophical monotheism could accomplish anything polytheistic gods could do, plus infinitely more.

Plain-English Context

Once you discover multiplication, you don't need separate machines for "x2," "x3," etc.

One universal principle subsumes all specific cases. That's what monotheism does, it discovers the universal computational substrate.

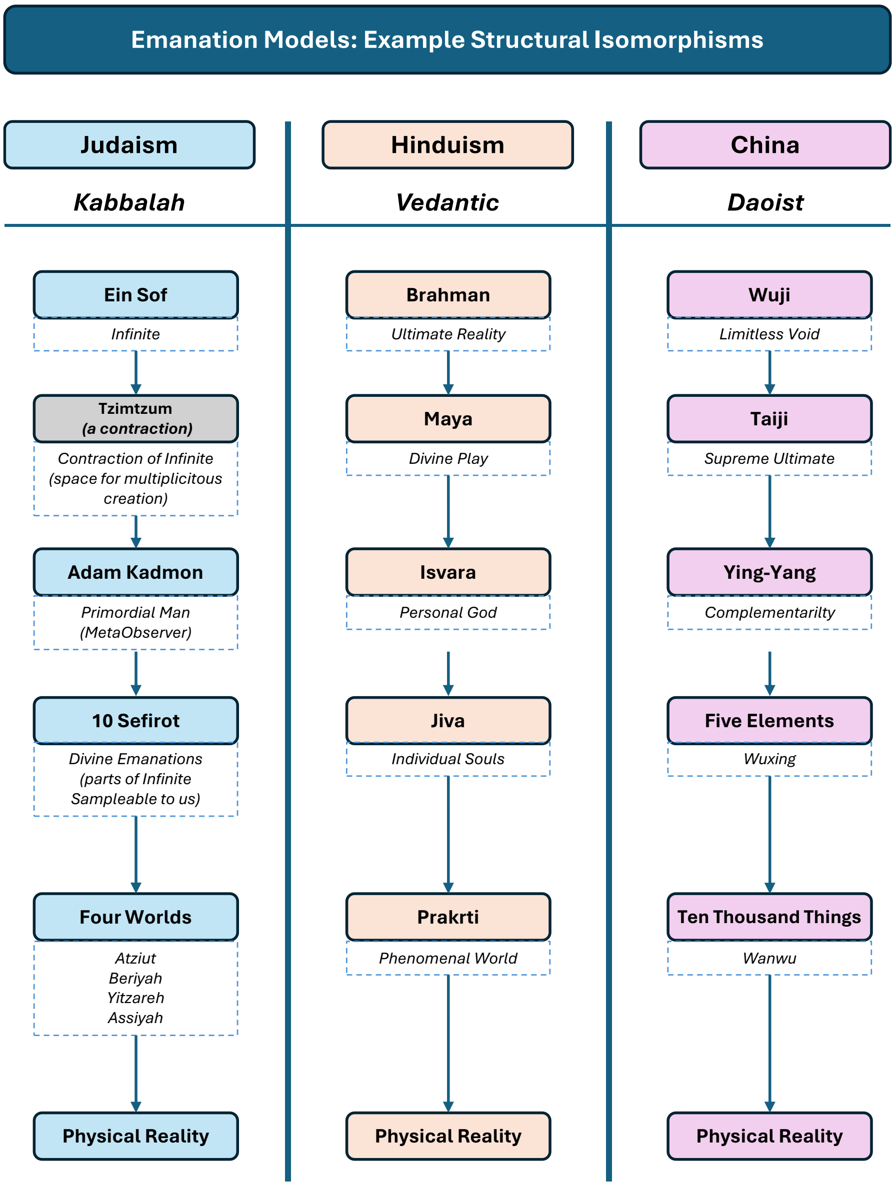
As these systems formalised and developed the power level reached a maxima, given our own computational boundedness, as these conceptions attributed unlimited potential to the ground of reality.

Power level (once fully developed): Maximum possible given Observers computational boundedness. These conceptions attributed unlimited potential to the ground of reality.

Part B: Specific Case Studies: Evolution of Religion

Visual: Emanative Structures Across Traditions

N.B. Some traditions have competing philosophical frameworks that have dualist ontologies. However, successful persistent religions all have an ultimate ground of being (monistic ontology) to enable persistence (i.e. even the dual Hindu traditions still hold Brahman as more powerful than everything else).



Common Structure:

1. Ineffable Infinite Source – Computationally irreducible / unobservable
2. First Differentiation – Symmetry breaking
3. Hierarchical Emanations – Rule-bounded constraints
4. Multiple Levels / Worlds – Distinct computational domains
5. Physical Reality – Maximum rule-bound / constrained domain

Each tradition maps the process differently (different 'slices' of different size order), but the broad **topology is identical.**

Flow from Infinite Simplicity (One-ness) to finite complexity / multiplicity through constraints.

1. Near Eastern Trajectory: Tribal Deity to Infinite Source

The Near Eastern (Semitic) evolution provides the clearest example of theological development from limited to unlimited conceptions of divinity.

Pre-formalisation / Early Stage of Discovery: El, the Canaanite high god, presided over a divine council, the Elohim (70 gods). Early Israelite religion shows clear henotheistic elements, Hashem as Israel's god among other nations' gods, more powerful but not exclusively real. Torah's philosophical development relegated these other Gods to false idols.

> ***Plain-English Definition [28]: Henotheism***
>
> *The worship of one god without denying the existence of others.*
>
> *"Our god is the most powerful" rather than "Our god is the only god." A transitional stage between polytheism and strict monotheism.*

The prophetic revolution transformed Hashem from national deity to sole creator. Isaiah's visions, Jeremiah's conception of divine law, and Ezekiel's mystical visions progressively abstracted and universalized the divine. The Babylonian exile catalysed this: if Hashem could act in Babylon as in Jerusalem, divine power transcended geography. If Hashem controlled Nebuchadnezzar as well as David, sovereignty was universal.

Post-biblical Judaism continued this abstraction:

- Rabbis increasingly avoided pronouncing the divine name, understanding that naming limits (it is exclusionary)[74].
- Medieval Jewish philosophy (e.g. Maimonides) formalised **negative theology** – God known only by what God is not.[75]
- Kabbalistic Ein Sof emerged and was integrated to the original books of the Torah (i.e. without contradiction): the infinite preceding all emanation, beyond categories of existence and non-existence.[76,77]

> ***Plain-English Definition [29]: Negative / Apophatic Theology***
>
> *The approach to understanding God by stating what God is **NOT** rather than what God **IS**. Since God transcends all categories, we can only say "God is not finite," "not in time," "not limited," etc. This recognizes that positive descriptions inevitably constrain the infinite.*

The Zohar[78] describes Ein Sof as **"the perfection of all, containing all, but itself beyond containment".** We can see the unsampled Ruliad's as a 'smaller' version of this concept. Ein Sof is beyond any concept, even hypercomputation (infinite computation) and any word / concept itself. It is beyond even a Pierce-like totality.

Power Evolution: Tribal protection → National sovereignty → Cosmic creator → Indescribable infinity

Metaphysical Evolution: Anthropomorphic being → Divine person → Pure being → Ultimate source beyond being

Each stage integrated and expanded the prior. Ein Sof contains all possible emanative structures.

The Ruliad, containing all possible computational paths, is essentially a much (infinitely) smaller version we can probe.

---

2. Indic Trajectory: From Natural Forces to Pure Consciousness

The Indian subcontinent's religious evolution began with the Vedic pantheon – Indra wielding thunderbolts, Agni consuming sacrifices, Surya driving the solar chariot. These deities controlled specific domains bound by Rita (the cosmic order).

The Upanishadic revolution (800-400 BCE) transformed Indian religion. The Chandogya Upanishad's **"Tat Tvam Asi"** (That Thou Art)[79] collapsed the distinction between individual consciousness (Atman) and ultimate reality (Brahman). The Mandukya Upanishad mapped consciousness states – waking, dreaming, deep sleep, and Turiya (the transcendent fourth) – onto levels of reality.[80,81,82,83]

The development split into multiple schools.

Advaita Vedanta (non-dualism):

- Brahman is the sole reality – "Sat-Chit-Ananda" (Existence-Consciousness-Bliss).
- All multiplicity is Maya (illusion) – dreams within Brahman's consciousness

> ***Computational Analogy***
>
> *All programs are expressions of the Brahman Universal Turing Machine; apparent diversity masks underlying unity.*

> ***Plain-English Definition [30]: Maya***
>
> *Often mistranslated / referred to as **"illusion,"** Maya more accurately means **"that which measures"** or **"creative power."***
>
> *It's not that the world is unreal, **but that its separateness is illusory –** like waves appearing separate from the ocean while being made of ocean water.*
>
> *Maya is Brahman's creative power that makes the One appear as Many.*

Buddhism's Radical Departure[84,85]:

- Denies permanent selfhood (anatman, no-self)
- Rejects creator-God concepts
- **Sunyata** (Emptiness): Not "nothingness", absence of independent existence
- Everything arises through dependent origination (**pratītyasamutpāda**)—a computational network of causation without first cause

> ***Plain-English Definition [31]: Sunyata***
> *All phenomena lack independent, permanent essence. Everything arises dependently through causes and conditions.*
> *Like how a "wave" has no permanent existence apart from ocean, wind, and gravity. This is a process philosophy: reality is verb, not noun.*

> ***Computational Analogy***
> *Network causation without privileged nodes – like how the internet has no single "first computer" but emerges from mutual dependencies.*

Power Evolution: Natural forces → Cosmic functions → Pure consciousness / process

Metaphysical Evolution: Ritual efficacy → Karma/Dharma → Maya/Lila → Sat-Chit-Ananda or Sunyata

The culmination approaches a theoretical maximum. Reality as pure 'computational' process operating on the largest conceivable possibility space.

---

3. Chinese Trajectory: From Ancestors to Eternal Process[86,87]

Chinese religious thought evolved from ancestor veneration through imperial theology to pure abstraction.

Early Stage: Ancestors required ritual (cyclic) maintenance. This developed into the concept of **Tian (Heaven)** – initially the sky god, later the moral order of the universe. This Mandate of Heaven legitimised imperial rule, intertwining social and cosmic order.

Confucian Development: Transformed religion into ethical philosophy focused on human relationships and social harmony. Yet Confucius acknowledged mystery: *"The Master never spoke of strange events, feats of strength, disorder, or spirits."*

Daoist Revolution: Ultimate reality cannot be captured in concepts or words.[88]

"The Dao that can be spoken is not the eternal Dao."

This aligns with Maimonides' negative theology approach in Judaism.

Key Daoist's innovations:

- Wuji: The limitless void before differentiation
- Taiji: The Supreme Ultimate, the first distinction
- Yin-Yang: Complementary opposites generating all phenomena through their interplay
- Wu Wei: "Non-action" or effortless action, acting in harmony with natural flow

The I Ching systematized this process philosophy. Each hexagram contains internal dynamics – changing lines transforming one situation into another. This binary system (broken / unbroken lines) proto-models digital computation, modelling reality as information patterns rather than substance.

> ***Plain-English Definition [32]: The I Ching***
> *64-state system where each state can transform into others through rule-based changes. It's a primitive computational model 3,000 years before computers.*

Power Evolution: Ancestral influence → Heavenly mandate → Natural harmony → Ineffable Dao

Metaphysical Evolution: Ritual propriety → Moral order → Dialectical dynamics → Emptiness/Fullness beyond categories

The culmination: reality as self-organizing process without external creator i.e. the creative process is reality.

---

4. Greek Philosophical Trajectory: From Mythology to Platonic Forms

Greek religion began with the Olympian pantheon, anthropomorphic deities whose conflicts explained phenomena. Homer[89] and Hesiod[90] hinted at powers beyond the gods: Fate (Moira) that Zeus could not override, and Chaos as primordial source. This tension drove Greek theological evolution.

Pre-Socratic Revolution:

- Thales: Water as *arche* (fundamental principle) as an initial attempt at monistic unification
- Heraclitus: Fire and flux governed by *Logos* (rational principle) i.e. everything flows, according to rules
- Parmenides: Change is illusion; Being is one, unchanging, perfect (parallels Ein Sof/Brahman/Dao)
- Pythagoras: Mathematics as universal language of reality – "All is number"

Platonic Synthesis: Beyond the material world lies a realm of perfect, eternal Forms – the Good, the Beautiful, the Just. Physical reality participates in these forms without full access to them.

The ***Timaeus***[91] describes *Demiurge* crafting the cosmos by imposing order (Forms) on primordial chaos. Not creation ex nihilo (from 'nothing'), but organisation of a pre-existing possibility space.

> ***Computational Analogy***
> *The Demiurge acts like a compiler, transforming abstract specifications (Forms) into concrete implementations (physical objects).*

Aristotelian Refinement: The **Unmoved Mover** – pure actuality that moves all by being the **object of desire**. This God "thinks only of thinking" – the only object worthy of infinite contemplation. In this being, existence and essence unite as the necessary ground of all contingent existence.[92]

Plotinian Synthesis: **The One** transcends all categories, beyond being / non-being and thought / non-thought. From the One emanates *Nous* (Divine Intellect) containing all Forms, *Soul* animating the cosmos, and *Matter* as the furthest emanation.[93]

This structure profoundly influenced Kabbalistic, Islamic (Sufi), and Christian mystical theology.

Power Evolution: Anthropomorphic deities → Cosmic principles → Logical necessity → Transcendent One

Metaphysics Evolution: Mythology → Natural philosophy → Mathematics → Henology (study of the One)

The culmination: God as necessary source of all existence, knowable only through what it transcends.

Part C: The Universal Toolkit

Pre-Scientific Convergence: How Did Diverse Traditions Reach Similar Conclusions?

1. **Apophatic (Negative) Theology**
   Knowing ultimate reality through negation, stating "what it is *not*" rather than "what it is", emerged independently across cultures.
   a. ***Dionysius the Areopagite*** (Christianity): "Divine Darkness" surpassing light – God as beyond all positive attributes[94]
   b. **Maimonides** (Judaism): We can only say what God is *not* – no positive predicates apply
   c. **Adi Shankara** (Hinduism): "Neti neti" ("*not this, not that*") – Brahman transcends all descriptions
   d. **Laozi** (Daoism): *"The Dao that can be named is not the eternal Dao"* – ultimate reality exceeds linguistic capture

These convergent approaches express a deep mathematical truth: ultimate reality must be computational irreducible to finite Observers.

> ***Plain-English Context***
> *Some things cannot be compressed into shorter descriptions, they must be "computed" fully to be known. If God is truly infinite, no finite description can capture it completely. Negative theology recognizes this limitation mathematically (Godel incompleteness and Tarski Undecidability are the formal analogues).*

---

2. **Emanation models**
   Systematic frameworks for how infinite simplicity (a totality) generates finite complexity appear across all sophisticated traditions:
   a. **Kabbalah's Sefirot** (10 emanations) flowing from Ein Sof
   b. **Neoplatonism's procession**: The One → Nous → Soul → Matter
   c. **Kashmir Shaivism's** 36 tattvas descending from Shiva-Shakti
   d. **Ibn Arabi's** (Sufism) Wahdat al-Wujud (Unity of Being)[95]

   All describe reality flowing from divine source while remaining within it (panentheistic structure) that manifests in Observable reality through progressive constraint dynamics (i.e. more and more rules).

   These models intuitively describe physical processes that modern science formalises:

a. **Symmetry breaking:** Unified forces splitting as Universe cools
b. **Phase transitions:** Water → Ice through temperature constraint
c. **Computational complexity:** Simple rules (Rule 30 / Rule 110) generating irreducible complexity[96]
d. **Information cascades:** High-level patterns constraining lower-level configurations

> ***Plain-English Context***
> *How does one simple 'thing' become many complex 'things'? Through adding constraints (rules) step-by-step. A block of marble (simple) becomes a statue (complex) by constraining possibilities—removing some material but not others. Emanation is cosmic constraint-application.*

---

3. **Unitive experience**[97,98,99]
Direct awareness of "divine oneness" – known as henosis, fana, moksha, satori – appears across traditions with remarkably consistent phenomenology.
Consistent features (documented by William James, Aldous Huxley, experimentally shown in modern neuroscience[100]):

- **Ineffability:** Experience exceeds linguistic description
- **Noetic quality:** Profound sense of encountering ultimate truth
- **Transiency:** Cannot be sustained indefinitely
- **Passivity:** Sense of being "grasped" by something greater
- **Unity:** Boundary dissolution between self and world

> ***Plain-English Definition [33]: Henosis/Fana/Moksha/Satori***
> *Different terms for mystical union or ego-dissolution experiences. Henosis (Greek): union with the One. Fana (Arabic): annihilation of ego in divine presence. Moksha (Sanskrit): liberation from cycle of rebirth. Satori (Japanese): sudden enlightenment.*
> *Despite cultural differences and lack of contact between these cultures, these describe structurally similar experiences of boundary collapse and unity awareness.*

Modern neuroscience confirms mystical experiences involve specific, reproducible brain states:

- *Decreased activity in parietal lobes (which maintain self-boundary)*[101]
- *Increased frontal lobe coherence (integrating information)*[102]
- *Altered default mode network function (reducing self-reference)* [103]

> ***Computational Interpretation***
> *These states represent temporary more access to different information-processing domains—modes where the Observer's normal sampling constraints (the rules they sample, like sharp identity boundaries) are not sampled (relaxed), allowing perception of underlying unified structure.*

> ***Plain-English Context***
> *Your brain normally maintains a sharp boundary between "me" and "not-me" to help you navigate the world. Mystical experiences[103] (and psychedelic experiences[104]) temporarily disable / alter this boundary-maintenance, revealing the deeper computational interconnection that's usually filtered out.*

---

4. **Paradoxical Unity**
God / ultimate reality described as the meeting point of logical paradoxes (i.e. supra-logical) – transcendent yet immanent, beyond the world yet pervading it, unknowable yet self-revealing

a. **Christian Trinity**: Three persons, one essence (parallels Hinduism's Trimurti and Kabbalah's triplet Sefirot structures)
b. **Nicholas of Cusa's** *Coincidentia Oppositorum*: In the infinite, opposites coincide. God is both the "maximum" and "minimum" simultaneously[106]
c. **Nagarjuna's Tetralemma**: Ultimate reality transcends "is," "is not," "both," and "neither"[107]

This reflects a hard limit when finite systems (Observers) attempt to describe infinite ones.

Like wave-particle duality in quantum mechanics (light is both wave and particle, depending on observation) or Gödel's incompleteness (formal systems contain true statements they cannot prove), these paradoxes arise at the boundaries of Observers computational capacity.

> ***Plain-English Context***
> *When you try to capture something infinite with finite tools (language, logic, computation), you inevitably generate paradoxes. This is a feature of the limitation of our tools. There is no incoherence in the infinite.*

> ***Computational Interpretation***
> *An Observer cannot directly observe quantum superposition, measurement collapses it to binary states. Similarly, finite Observers cannot fully grasp the Ruliad's infinite superposition of all computations, they can only sample specific paths, creating apparent paradoxes when trying to describe the whole.*

The Post-Enlightenment Toolkit

As theology matured, formal systems for expressing Infinities developed.

The arguments in **Section 2 and 3** utilise tools of logic (first order, modal, infinitary) and probability. This is natural evolution – logical propositions and mathematical proofs are invariant (eternal), depending on their axiomatic foundations. They "causally cover" possibility space optimally (in a computationally efficient manner) and are the great tools for investigating infinities.

This is directly linked to what Wigner called the "unreasonable effectiveness of mathematics"[108].

Mathematics appears to be the "language" of the universe. It's utility suggests a deep connection between mathematical truth, physical law and mind.

Transfinite Mathematics

Georg Cantor, father of transfinite mathematics, wrote: *"The absolute infinite sequence of numbers seems to me to be an appropriate symbol of the Absolute."[109]*

Yet set-theoretic constructions lead to paradoxes:

- Russell's Paradox: Can a set contain itself?[110,111]
- Burali-Forti Paradox: What is ordinal number of all ordinals?[112]

Modern set theory posits larger and larger objects (inaccessible cardinals etc.) and new categories (proper classes) to address foundational paradoxes, revealing that even pure mathematics encounters limits when probing infinity.

Universal Computation

Turing's development of universal computation created a larger "universe of discourse" than set-theory or first-order logic.

The Church-Turing-Deutsch Thesis[113,114,115] shows that any mathematical system (not just ours) can be instantiated in a universal computational model. **This implies computation is more fundamental than specific mathematical formalisms.**

> ***Plain-English Context***
> *All questions you can ask precisely can be framed as a computation. Even questions about non-computable things can be asked computationally (these ones probably can't be answered!).*
> *The conjecture is that computation is the broadest possible framework.*

The Ruliad: The Maximum (i.e. Biggest) Formal Object

Wolfram's Ruliad is the limit of this formalisation.

It contains all possible computations, providing a category-theoretic formalism[116,117,118] that enables us to probe a larger possibility space than any specific mathematical 'universe' or set of mathematical universes we inhabit.

We can see computational analogues in all the religious systems that we've detailed in this section:

1. **Creation as selective actualization**
   Rule-bounded selection from infinite potential appears across all persistent religious traditions:
   - **Kabbalah's Tzimtzum**: God 'withdraws' (contracts) to create space for finite existence. Not a spatial withdrawal but logical self-limitation creating the possibility for "other"

   > ***Computational Parallel***
   > *The unsampled Ruliad contains all possibilities; Observer sampling actualizes specific paths*

   - **Many-Worlds Quantum Mechanics:** All possibilities exist, we experience one branch

   > ***Computational Parallel***
   > *Observer foliation (like taking a 'slice' or a 'snapshot') through multiway system selects experienced reality from possibility space*

2. **Providence as optimisation function reconceptualizes divine action in computational terms**
Divine action can be reconceptualized computationally. It moves from an interventionist miracle-working framework to the construction of a possibility space according to certain optimisation criteria:
   - **Aquinas's Divine Governance:** God acts through natural law[119]
   - **Eastern Dharma:** Cosmic order self-maintains through inherent principles
   - **Physics:** Least action principles—nature optimises for computationally shortest (most efficient) path[120]

   Here, reality unfolds according to computable optimisation principles, with different religious / political / economic / social traditions emphasising different optimisation targets (maximum good, beauty, consciousness, information integration, etc.).

   > ***Plain-English Context***
   > *Instead of God as cosmic puppeteer constantly intervening, imagine God as cosmic programmer who writes initial rules that, when executed, optimise for certain outcomes.*
   > *In the God Conjecture the rules "do the work".*

Part D: What Can Computation Say About Religion?

1. Why Monotheisms / Unified Panentheism is the Evolutionary Endpoint

All evolutionarily 'fit' religions converge on a singular unified substance at the root of their ontology.

This convergence is a computational necessity.

Just as mathematics discovered independently in different cultures converges on invariant truth (2+2=4 everywhere), religious investigation converges on a unified, infinite, necessary being because **this is the only structure that can provide topological closure (overall coherence) to a possibility space that is accessible to finite Observers.**

> ***Plain-English Definition [34]: Topological Closure***
> *A mathematical property meaning* ***"complete"*** *or* ***"containing all limit points."***
> *A closed system contains everything needed to explain itself, you don't need to reference anything outside it.*
> *For theology, this means God / ultimate reality must be self-explanatory, requiring nothing external to exist or be understood.*

Monotheisms represent the evolutionary endpoint of religious inquiry because of three logical necessities:

A. **Maximum Abstraction Achieved**
The monotheistic God transcends all categories while grounding them. This abstraction isn't emptiness / nothingness (even in Buddhism) but completeness. It ensures, for an Observer inside the computational possibility space, every possible computation can complete without combinatorial explosion that overwhelms their computational boundedness.

> ***Computational Analogy***
> *A Universal Turing Machine with simple rules produces irreducible complexity (see Wolfram's Rule 30 cellular automaton).*
> *Divine simplicity (e.g. Ein Sof, Brahman) generates infinite complexity through iterated application of minimal rules.*

> ***Plain-English Context***
> *You don't need infinitely complex rules to generate infinite complexity.* ***Simple rules + time = emergent complexity****.*
> *Monotheism's "divine simplicity" isn't simplistic,* ***it's computationally efficient****.*

B. **Maximum power achieved**
Omnipotence, omniscience, and omnipresence represent power's logical limit from our perspective as computationally bounded Observers. **We cannot conceive greater power than the ability to do all that is logically possible.** Since we understand reality through cause-and-effect (computation), to us maximal power means control over all cause-effect sequences.

> ***Plain-English Context***
> *Try to imagine something more powerful than "can do anything logically possible." You can't because "anything logically possible" already includes everything you could imagine. That's why omnipotence is the natural endpoint.*

C. **Completed Structure of Possibility Space**
Monotheisms integrate all subordinate "universes of discourse".
   - **Physical reality** manifests divine will (laws of nature).
   - **Biological life** participates in divine creation (emergence / evolution).
   - **Psychology** reflects divine image (consciousness).

- **Ethics** follows divine law (optimisation).
- **Language** provides the tools for divine revelation (communication).
- **Mathematics** expresses divine thought (eternal truths).

Each level of description reveals aspects of a unified reality. Separate magisterial (proposed by Stephen Jay Gould) is postmodernist category error. Reality is more tractable as a single computational structure containing by interconnected hierarchical levels of description.

> ***Plain-English Definition [35]: Magisteria***
> *Separate domains of authority. Stephen Jay Gould proposed "Non-Overlapping Magisteria" (NOMA). The idea that science and religion address different questions and shouldn't interfere in one another. This is computationally inefficient as it limits inquiry.*
> *The God Conjecture rejects this: these domains are different perspectives / viewpoints on one computationally parseable reality.*

---

2. The Ruliad: Probable Computational Infinity

The Ruliad gives us our first formal framework to model theology.

Every divine attribute classical theology ascribes to God maps to the Ruliad's structure, while the Ruliad's properties map with weak equivalence to theological concepts across all our traditions.

The Ruliad has properties that enable theological modelling while, through the Wolfram Physics Project, being able to accommodate mathematics, physics, chemistry and biology:

Property 1: Necessary existence

The Ruliad is proposed to exist necessarily because denying it creates logical contradictions.

To say "there is no collection of all possible computations" is to posit a possible computation (the denial) outside the collection, which contradicts the premise. This mirrors ontological arguments; God as that which cannot coherently be conceived not to exist.

> ***Plain-English Context***
> *Saying "all possible computations don't exist" is self-refuting. You just described a computation (your denial), which means it exists as a possibility. Therefore, the space of all possible computations must exist necessarily.*

Property 2: Contains all logical possibilities

The Ruliad can express every possible pattern, structure and thought as a computational path to an arbitrary degree of accuracy.

This matches classical theology's conception of divine intellect containing all possible ideas allowing us to make precise what religions describe metaphorically.

> ***Plain-English Context***
> *Every mathematical theorem = a path through the Ruliad*
> *Every physical universe = a set of rules that outputs an emergent structure within the Ruliad*
> *Every possible thought = a computational cause-effect sequence in the Ruliad*

Property 3: Transcendent yet immanent

The Ruliad as a whole cannot be described by any single computational path within it, yet every computation exists within it.

This resolves theology's perennial challenge of relating a transcendent God to immanent presence.

- **Transcendence:** No Observer within the Ruliad can fully compute the Ruliad itself (corresponds to Tarski Undecidability)
- **Immanence:** Every Observer's experience is a path through the Ruliad. God doesn't "intervene" in nature because nature is the 'divine computation' unfolding

> ***Plain-English Context***
> *You can't step outside the system to see the whole system (transcendence), but you're always inside it experiencing it (immanence). Like a character in a novel who can't read the whole book but exists within its pages.*

Property 4: Observer-Dependence

The Ruliad requires Observers to manifest a persistent reality from its infinite computational structure.

Observers "take snapshots" of the Ruliad, outputting their experienced reality, according to their:

- **Computational boundedness** (processing / memory limits / bandwidth)
- **Persistence** (continuity through time)
- **Relevance** (filtering what they observe according to their maximisation function)

This concept is evident in Genesis: *"God saw that it was good"*, creation through Observation. Most traditions describe the relationship between an Infinite Creator and finite creations: ***we are participant observers in a divinely rule-bounded computational possibility space, not external viewers of a pre-existing objective reality***.

> ***Plain-English Context***
> *Reality isn't a pre-made movie playing regardless of viewers. It's more like a video game that renders only what the player can see.*

Property 5: Unity generating multiplicity

The Ruliad is one object—the limit of all possible computations—but inside it has an infinite diversity of possible outcomes.

This enables us to model emanation across traditions:

- From **Ein Sof** emanates the Sefirot
- From **Brahman** emanates the world
- From **the One** emanates the Many
- From **the Dao** emanates the Ten Thousand Things

In this paper, we will model how God creates the Ruliad (possibility space), and how that space, through Observer sampling, creates the world as we experience it – step by computational step.

---

3. Observer Theory as a Modelling Tool

In the Wolfram model, reality emerges from the interaction between infinite computational potential (the Ruliad) and finite selection (Observer Theory[121,122,123]). Here, Observation – and consciousness as special class thereof – is fundamental to reality's structure.

This validates religious intuitions about consciousness while providing a computational framework for explaining it:

- **Observation as Fundamental**:
  Rather than emerging from matter, *observation must be fundamental* to select a persistent experiential thread from an infinite computational possibility space.

  This dovetails with:
  - Vedantic teaching: Consciousness (chit) is reality's nature
  - Abrahamic teaching: Humans are formed in the divine image through souls
  - Buddhist teaching: Mind is primary

  The hard problem of consciousness dissolves when consciousness is recognized as a special class of complex Observational systems.

  It becomes something that doesn't require explanation "in terms of" physical processes, but the "ground" enabling physical processes to be observed at all.

- **Reality as Co-Created**:
  Observers don't passively receive pre-existing reality but actively participate in its creation through observation subject to rules they must sample to maintain persistence through time.

  This formalises theological concept of human partnership in divine creativity:
  - Christianity: We are "co-creators" (theosis)
  - Judaism: We engage in *"tikkun olam"* (repairing the world / integrating information)
  - Islam: We manifest divine names through action
  - Hinduism: We are *Brahman* experiencing itself through *Maya*

- **Free Will Through Computational Irreducibility**
  Computational irreducibility means that even within deterministic rules, outcomes cannot be perfectly predicted without running the full computation[124].

  This provides the framework for free will that religions require. It is compatibilist.

We cannot take a perfect 'God's eye' view, therefore there will always be:

- Things we can't predict (epistemic limits)
- Truths we cannot reach
- Outcomes we cannot shortcut (computational irreducibility)

This finds analogues in:

- Tarski Undecidability (computation): Truth cannot be defined within a language[125]
- Godel Incompleteness (mathematics): Formal systems contain unprovable truths[126]
- Quantum Measurement Problem (physics)

It means choices are real and consequential because, at the limit, they represent irreducible computations that must be executed.

> ***Plain-English Context***
> *Even if the universe is deterministic (like a computer program), if the program is complex enough, the only way to know what happens is to run it. You can't cheat and skip to the end. Your choices are "free" in the sense that they're computationally irreducible – they must be made to be known.*

> ***Note***
> *All Observers in the Ruliad "carve out" pockets of computational reducibility – finding rules between hypergraph updates producing invariant outcomes. This reduces computational burden on bounded Observers, enabling prediction and planning.*

- **Meaning through selection**

  In a Ruliad containing all computational possibilities, meaning arises from selection where an Observer determines the relevance of which rule they ultimately sample.

  We *create meaning through our choices of what to observe, value, and actualize*. Assuming a closed topology (the structure of the Ruliad in the Gorard / Arsiwalla formalism), *our personal meanings necessarily participate in Ultimate Meaning*.

> ***Plain-English Context***
> *If the Ruliad contains every possible story, meaning comes from which story you choose to tell through your life. But since all stories exist within the Ruliad, your story is part of the larger story – your personal meaning, in some material way, participates in cosmic meaning.*

- **Prayer as observation**

  In a computational theological models, *prayer / meditation / intention are forms of Observer sampling with (limited) causal influence on which computational paths get actualised.*

  This means these actions have non-zero causal influence – we direct our observations to whatever we determine to be our optimal path through possibility space.

  Note: This doesn't require belief in God. Secular analogues include:

  - Goal-setting
  - Manifestation i.e. 'I want to be rich' or 'I want to be famous'
  - "Law(s) of Attraction"

  All understood as: searching the Ruliad's possibility space for computational paths biasing a desired outcome in your causal graph.

> ***Plain-English Context***
> *Whether you call it "prayer," "intention-setting," or "focusing attention," directing your observations changes which possibilities you can actualize.*
> *This is computational, not magical—the effect is real (i.e. statistically relevant). Note that there are grading to this concept. Local things have more causal power than global things. Mostly because, at a global level, there are many competing dynamics that cancel each other out.*

In Section 5: The God Conjecture, we will formalise these ideas.

Part E: Conclusion – The Arc of Religious Evolution

Computationally, Religions are evolutionary algorithms to help Observers figure out the absolute size of their accessible possibility space.

Observers search for ever-larger models of reality that enable them to access spaces with more potential information. From animistic spirits to agricultural gods to metaphysical conceptions of an infinite being, humanity progressively abstracted larger and larger structures to enable access to more computational paths.

This evolution mirrors the path of scientific discovery:

Local phenomena → Invariant Universal laws → Quantum Mechanics → *Information Theory?*

Each order of abstraction transcends and includes the prior – Information Theory is less rule-bounded than physical law yet subsumes it.

Each religious tradition has contributed new insights, making the 'map' larger, so we (Observers) can explore more territory.

- **Animism** formalised proto-notions of causation and agency
- **Polytheism** provided hierarchy and domain connectivity
- **Greek Philosophy** began formalising this with logic and mathematics
- **Monotheisms** developed maximum abstraction and integration i.e. the biggest map
- **Eastern Traditions** provided detailed process descriptions i.e. navigation methods

Convergence Suggests Discovery, Not Invention

Just as different cultures discovered identical mathematics because mathematical truth is invariant across all constructions of possibility space, **different religions, at the limit of their metaphysical systems, converged to an infinite ground of reality because it enabled Observers to explore the largest possibility space**.

> ***Note***
> *This contention is not concerned with the myriad of different interpretations of each tradition that sit below the 'infinite ground'. As an example there are many different forms of philosophical Buddhism. Many denominations of the Monotheisms and even a few different Vedic interpretations of Brahminic structure (monastic vs. dualistic). The point here is that for the religion to maintain persistence in time, it must eventually link to some conception of 'infinite ground' at the root of their ontology.*

Differences in rule-sets between traditions (and political, economic and social models) reflect different groups of Observers perspectives on the optimal computational model for traversing this possibility space. **They are different optimisation functions for the same problem.**

Critical Clarification

It is important, at this juncture, to state the following explicitly.

The Ruliad is not God because, necessarily, something truly infinite must transcend computation (we can already imagine non-computational processes).

However, **the Ruliad is the largest formal object we have that can be probed** – it can model any possible multiversal structure, any rule-set, any mathematics and any physics. Therefore it is:

- Well-suited to modelling theology
- Can help design new process arguments for God's existence or non-existence
- A shared language for previously incommensurable frameworks

Synthesis

Computational theology does not reduce the sacred to 'code' – it models it.

This helps us to ground meaning in Observer participation, asserting that:

- **Stuff is real** (not illusory phenomena)
- **Consciousness is real** (not eliminable)
- **Value is real** (not subjective preference)

Ancient questions can gain new precision through this framework.

The God Conjecture is a new way to discuss these questions. It is not the end of religion (nor a diminution of it to a giant computer program) but a new language where:

- Religious intuition meets mathematical formalisation
- Faith meets reason
- The sacred meets the scientific

This is **God as the source of law** (rules in the parlance of the Ruliad). Not God separate from creation but the panentheistic God within whom **"we live and move and experience."**

The Ruliad gives atheists and theists a new language to make precise statements about what the God debate has long struggled to articulate – the nature of something necessary and infinite.

The journey continues in Section 5, where we construct the God Conjecture using Observer Theory and the Ruliad.

"It's always seemed like a big mystery how nature, seemingly so effortlessly, manages to produce so much that seems to us so complex. Well, I think we found its secret. It's just sampling what's out there in the computational universe." ***Stephen Wolfram***

"All models are wrong, but some are useful." ***George E.P. Box***

"What we observe is not nature itself, but nature exposed to our method of questioning... Natural science does not simply describe and explain nature; it is part of the interplay between nature and ourselves." ***Werner Heisenberg***

References

[58] Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media. Available at: https://www.wolframscience.com/nks/
[59] Wolfram, S. (2020) 'A Class of Models with the Potential to Represent Fundamental Physics', arXiv preprint arXiv:2004.08210. Available at: https://arxiv.org/abs/2004.08210
[60] Wolfram, S. (2020) 'Finally We May Have a Path to the Fundamental Theory of Physics... and It's Beautiful', Stephen Wolfram Writings, 14 April. Available at: https://writings.stephenwolfram.com/2020/04/finally-we-may-have-a-path-to-the-fundamental-theory-of-physics-and-its-beautiful/
[61] Wolfram, S. (2021) 'The Concept of the Ruliad', Stephen Wolfram Writings, 10 November. Available at: https://writings.stephenwolfram.com/2021/11/the-concept-of-the-ruliad/
[62] Wolfram Physics Project (2020) 'The Wolfram Physics Project: Finding the Fundamental Theory of Physics'. Available at: https://www.wolframphysics.org/
[63] Wolfram, S. (2021) 'What Is Consciousness? Some New Perspectives from Our Physics Project', Stephen Wolfram Writings, 4 March. Available at: https://writings.stephenwolfram.com/2021/03/what-is-consciousness-some-new-perspectives-from-our-physics-project/
[64] Wolfram, S. (2023) 'Observer Theory', Stephen Wolfram Writings, 11 December. Available at: https://writings.stephenwolfram.com/2023/12/observer-theory/
[65] Wolfram, S. (2021) 'Multicomputation: A Fourth Paradigm for Theoretical Science', Stephen Wolfram Writings, 9 September. Available at: https://writings.stephenwolfram.com/2021/09/multicomputation-a-fourth-paradigm-for-theoretical-science/
[66] Boyd, J. (2022) 'Multicomputational Irreducibility', Wolfram Physics Project Bulletin, June. Available at: https://bulletins.wolframphysics.org/2022/06/multicomputational-irreducibility/
[67] Gorard, J. (2022) 'A Functorial Perspective on (Multi)computational Irreducibility', arXiv preprint arXiv:2301.04690. Available at: https://arxiv.org/abs/2301.04690
[68] Chalmers, D.J. (1995) 'Facing up to the problem of consciousness', Journal of Consciousness Studies, 2(3), pp. 200-219. Available at: https://consc.net/papers/facing.pdf
[69] Armstrong, K. (2006) The Great Transformation: The Beginning of Our Religious Traditions. New York: Alfred A. Knopf. Available at: https://www.penguinrandomhouse.com/books/4890/the-great-transformation-by-karen-armstrong
[70] Bellah, R.N. (2011) Religion in Human Evolution: From the Paleolithic to the Axial Age. Cambridge, MA: Harvard University Press. Available at: https://www.hup.harvard.edu/books/9780674975347
[71] Clooney, F.X. (2010) Comparative Theology: Deep Learning Across Religious Borders. Chichester: Wiley-Blackwell
[72] Tylor, E.B. (1871) Primitive Culture: Researches into the Development of Mythology, Philosophy, Religion, Language, Art and Custom. 2 vols. London: John Murray. (Cambridge University Press reprint, 2010). Available at: https://www.cambridge.org/core/books/primitive-culture/30955C7CED270E1AF80CB7FEECF85010
[73] Bellah, R.N. and Joas, H. (eds.) (2012) The Axial Age and Its Consequences. Cambridge, MA: Harvard University Press. Available at: https://www.hup.harvard.edu/catalog.php?isbn=9780674066496 and Eisenstadt, S.N. (ed.) (1986) The Origins and Diversity of Axial Age Civilizations. Albany: State University of New York Press.
[74]**Core Kabbalah sources include:**
Scholem, G. (1941) Major Trends in Jewish Mysticism. New York: Schocken Books and Scholem, G. (1965) On the Kabbalah and Its Symbolism, trans. by Ralph Manheim. New York: Schocken Books
Scholem, G. (1974) Kabbalah. New York: Meridian/New American Library
Scholem, G. (1987) Origins of the Kabbalah, trans. by Allan Arkush, ed. by R.J. Zwi Werblowsky. Princeton, NJ: Princeton University Press.
[75] Maimonides, M. (1963) The Guide of the Perplexed, trans. by Shlomo Pines, with introductory essay by Leo Strauss. 2 vols. Chicago: University of Chicago Press. Available at: https://press.uchicago.edu/ucp/books/book/chicago/M/bo40026618.html
[76] Kaplan, A. (1997) Sefer Yetzirah: The Book of Creation in Theory and Practice. Revised edn. York Beach, ME: Samuel Weiser
[77] Idel, M. (1988) Kabbalah: New Perspectives. New Haven, CT: Yale University Press
[78] Green, A. (2004) A Guide to the Zohar. Stanford, CA: Stanford University Press
[79] Gambhirananda, Swami (trans.) (1983) Chandogya Upanishad: With the Commentary of Sankaracarya. Calcutta: Advaita Ashrama
[80] Roebuck, V.J. (trans.) (2003) The Upaniṣads. London: Penguin Classics and Nikhilananda, Swami (trans.) (1949-1959) The Upanishads. 4 vols. New York: Ramakrishna-Vivekananda Center.
[81] Ram-Prasad, C. (2002) Advaita Epistemology and Metaphysics: An Outline of Indian Non-Realism. London: RoutledgeCurzon
[82] 'Śaṅkara' (2020) Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/shankara/
[83] Deutsch, E. (1969) Advaita Vedānta: A Philosophical Reconstruction. Honolulu: University of Hawaii Press
[84] Gethin, R. (1998) The Foundations of Buddhism. Oxford: Oxford University Press. https://global.oup.com/academic/product/foundations-of-buddhism-9780192892232
[85] Williams, P. and Tribe, A. (2000) Buddhist Thought: A Complete Introduction to the Indian Tradition. London: Routledge
[86] Ames, R.T. and Hall, D.L. (trans.) (2003) Dao De Jing: A Philosophical Translation. New York: Ballantine Books.
[87] 'Zhuangzi' (2024) Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/zhuangzi/

[88] Linnell, B.R. (trans.) (2015) Dao De Jing: A Minimalist Translation. Project Gutenberg EBook #49965.
[89] Homer (1924/1999) Iliad, Volume I: Books 1-12 and Iliad, Volume II: Books 13-24, trans. by A. T. Murray, revised by William F. Wyatt. Loeb Classical Library 170 and 171. Cambridge, MA: Harvard University Press. Available at: https://www.loebclassics.com/view/LCL170/1924/volume.xml
[90] Hesiod (2018) Theogony. Works and Days. Testimonia, ed. and trans. by Glenn W. Most. Revised edn. Loeb Classical Library 57. Cambridge, MA: Harvard University Press. Available at: https://www.loebclassics.com/view/LCL057/2018/volume.xml
[91] Plato (2008) Timaeus and Critias, trans. by Robin Waterfield, with introduction and notes by Andrew Gregory. Oxford World's Classics. Oxford: Oxford University Press.
[92] Aristotle (1924) Aristotle's Metaphysics, ed. by W. D. Ross. 2 vols. Oxford: Clarendon Press. Available at: https://academic.oup.com/edited-volume/28242/chapter/213362513
[93] Plotinus (2018) The Enneads, ed. by Lloyd P. Gerson, trans. by George Boys-Stones, John M. Dillon, Lloyd P. Gerson, R. A. H. King, Andrew Smith, and James Wilberding. Cambridge: Cambridge University Press. Available at: https://www.cambridge.org/core/books/plotinus-the-enneads/6905CE5920117C0B11D141C4D80F6517
[94] Pseudo-Dionysius the Areopagite (1987) Pseudo-Dionysius: The Complete Works, trans. by Colm Luibheid and Paul Rorem. The Classics of Western Spirituality. New York: Paulist Press; London: SPCK.
[95] 'Ibn ʿArabī' (2020) Stanford Encyclopedia of Philosophy. Available at: https://plato.stanford.edu/entries/ibn-arabi/
[96] Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media. Available at: https://www.wolframscience.com/nks/
[97] James, W. (1985) The Varieties of Religious Experience: A Study in Human Nature, ed. by F. Burkhardt, F. Bowers, and I.K. Skrupskelis. Cambridge, MA: Harvard University Press. Available at: https://www.hup.harvard.edu/catalog.php?isbn=9780674932258
[98] Huxley, A. (2009) The Perennial Philosophy: An Interpretation of the Great Mystics, East and West. New York: Harper Perennial Modern Classics. (Original work published 1945)
[99] Huxley, A. (2009) The Doors of Perception and Heaven and Hell. New York: Harper Perennial Modern Classics. (Original work published 1954)
[100] Azari, N.P., Nickel, J., Wunderlich, G., Niedeggen, M., Hefter, H., Tellmann, L., Herzog, H., Stoerig, P., Birnbacher, D. and Seitz, R.J. (2001) 'Neural correlates of religious experience', European Journal of Neuroscience, 13(8), pp. 1649-1652. https://doi.org/10.1046/j.0953-816x.2001.01527.x and and and Urgesi, C., Aglioti, S.M., Skrap, M. and Fabbro, F. (2010) 'The spiritual brain: selective cortical lesions modulate human self-transcendence', Neuron, 65(3), pp. 309-319. https://doi.org/10.1016/j.neuron.2010.01.026 and https://doi.org/10.1016/j.neubiorev.2016.12.031
[101]van Elk, M. and Aleman, A. (2017) 'Brain mechanisms in religion and spirituality: An integrative predictive processing framework', Neuroscience & Biobehavioral Reviews, 73, pp. 359-378.https://doi.org/10.1073/pnas.1112029108
[102] Ferguson, M.A., Nielsen, J.A., King, J.B., Dai, L., Giangrasso, D.M., Holman, R., Korenberg, J.R. and Anderson, J.S. (2016) 'Reward, salience, and attentional networks are activated by religious experience in devout Mormons', Social Neuroscience, 13(1), pp. 104-116. https://doi.org/10.1080/17470919.2016.1257437
[103] Brewer, J.A., Worhunsky, P.D., Gray, J.R., Tang, Y.Y., Weber, J. and Kober, H. (2011) 'Meditation experience is associated with differences in default mode network activity and connectivity', Proceedings of the National Academy of Sciences, 108(50), pp. 20254-20259
[104] Griffiths, R.R., Johnson, M.W., Richards, W.A., Richards, B.D., McCann, U. and Jesse, R. (2011) 'Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects', Psychopharmacology, 218(4), pp. 649-665. https://doi.org/10.1007/s00213-011-2358-5
[105] Core psychedelic research sources include:
Griffiths, R.R., Johnson, M.W., Richards, W.A., Richards, B.D., McCann, U. and Jesse, R. (2011) 'Psilocybin occasioned mystical-type experiences: immediate and persisting dose-related effects', Psychopharmacology, 218(4), pp. 649-665. https://doi.org/10.1007/s00213-011-2358-5
de Araujo, D.B., Ribeiro, S., Cecchi, G.A., Carvalho, F.M., Sanchez, T.A., Pinto, J.P., de Martinis, B.S., Crippa, J.A., Hallak, J.E. and Santos, A.C. (2012) 'Seeing with the eyes shut: Neural basis of enhanced imagery following ayahuasca ingestion', Human Brain Mapping, 33(11), pp. 2550-2560. https://doi.org/10.1002/hbm.21381
Carhart-Harris, R.L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R. and Nutt, D. (2014) 'The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs', Frontiers in Human Neuroscience, 8, Article 20. https://doi.org/10.3389/fnhum.2014.00020
[106] Nicholas of Cusa (2007) Of Learned Ignorance, trans. by Germain Heron. Eugene, OR: Wipf and Stock (Angelico Press)
[107] Garfield, J.L. (trans.) (1995) The Fundamental Wisdom of the Middle Way: Nāgārjuna's Mūlamadhyamakakārikā. Oxford: Oxford University Press. Available at: https://global.oup.com/academic/product/the-fundamental-wisdom-of-the-middle-way-9780195093360
[108] Wigner, E.P. (1960) 'The unreasonable effectiveness of mathematics in the natural sciences', Communications on Pure and Applied Mathematics, 13(1), pp. 1-14. https://doi.org/10.1002/cpa.3160130102
[109] Cantor, G. (1895-1897) 'Beiträge zur Begründung der transfiniten Mengenlehre', Mathematische Annalen, Vols. 46-49. English translation: Contributions to the Founding of the Theory of Transfinite Numbers. Dover, 1955
[110] Russell, B. (1903) The Principles of Mathematics. Cambridge: Cambridge University Press
[111] Russell, B. (1908) 'Mathematical Logic as Based on the Theory of Types', American Journal of Mathematics, 30, pp. 222-262
[112] Burali-Forti, C. (1897) 'Una questione sui numeri transfiniti', Rendiconti del Circolo Matematico di Palermo, 11, pp. 154-164. https://doi.org/10.1007/BF03015911
[113] Church, A. (1936) 'An Unsolvable Problem of Elementary Number Theory', American Journal of Mathematics, 58(2), pp. 345-363. https://doi.org/10.2307/2371045
[114] Deutsch, D. (1985) 'Quantum theory, the Church-Turing principle and the universal quantum computer', Proceedings of the Royal Society of London A, 400, pp. 97-117. https://doi.org/10.1098/rspa.1985.0070
[115] Turing, A.M. (1937) 'On Computable Numbers, with an Application to the Entscheidungsproblem', Proceedings of the London Mathematical Society, Series 2, 42(1), pp. 230-265. https://doi.org/10.1112/plms/s2-42.1.230
[116] Arsiwalla, X.D. and Gorard, J. (2021) 'Pregeometric Spaces from Wolfram Model Rewriting Systems as Homotopy Types', arXiv preprint arXiv:2111.03460. Available at: https://arxiv.org/abs/2111.03460

[117] Rickles, D., Elshatlawy, H. and Arsiwalla, X.D. (2023) 'Ruliology: Linking Computation, Observers and Physical Law', arXiv preprint arXiv:2308.16068. Available at: https://arxiv.org/abs/2308.16068
[118] Arsiwalla, X.D., Elshatlawy, H. and Rickles, D. (2023) 'Pregeometry, Formal Language and Constructivist Foundations of Physics', arXiv preprint arXiv:2311.03973. Available at: https://arxiv.org/abs/2311.03973
[119] Aquinas, Thomas (1920) Summa Theologiae, trans. by Fathers of the English Dominican Province. 2nd revised edn. London: Burns, Oates & Washbourne. Available at: https://www.newadvent.org/summa/
[120] Rojo, A. and Bloch, A. (2018) The Principle of Least Action: History and Physics. Cambridge: Cambridge University Press. Available at: https://www.cambridge.org/9780521869027
[121] Wolfram, S. (2023) 'Observer Theory', Stephen Wolfram Writings, 11 December. Available at: https://writings.stephenwolfram.com/2023/12/observer-theory/
[122] Elshatlawy, H., Rickles, D., Arsiwalla, X. D. & Blum, A. (2025) ‘Towards a Generalized Theory of Observers’ 29 June. arXiv:2504.16225v2
[123] Senchal, S.A. (2025) ‘Observer Theory and the Ruliad; An Extension to the Wolfram Model’, 16 May Available at: https://wolframinstitute.org/output/observer-theory-and-the-ruliad-an-extension-to-the-wolfram-model
[124] Gorard, J. (2022) 'A Functorial Perspective on (Multi)computational Irreducibility', arXiv preprint arXiv:2301.04690. Available at: https://arxiv.org/abs/2301.04690
[125] Tarski, A. (1944) 'The Semantic Conception of Truth and the Foundations of Semantics', Philosophy and Phenomenological Research, 4, pp. 341-376.
[126] Gödel, K. (1986) Collected Works I: Publications 1929-1936, ed. by S. Feferman et al. Oxford: Oxford University Press, pp. 144-195

Section 5: The God Conjecture

TL;DR

This section proposes that religious creation stories and modern computational physics are describing the same phenomena in different languages. Specifically, we demonstrate how the Kabbalistic account of creation – where an Infinite God (Ein Sof) "contracts" to make space for the universe – maps exceptionally well onto how computation evolves as the Ruliad updates from its initial set of conditions.

Key Insights:

- ***Creation through limitation****: For anything to exist as distinct from everything else, boundaries must exist. Information literally means "difference" – without boundaries, nothing can be distinguished from anything else.*
- ***The Ruliad = Computational Possibility Space****: The Ruliad behaves like the theological concept of God (after the first emanation).*
- ***Religious traditions as "mapmakers"****: Judaism, Christianity, Islam, Hinduism, and Daoism each developed sophisticated models of how infinite potential becomes finite reality. Their frameworks translate surprisingly well into computational language.*
- ***Testable predictions****: Unlike traditional theology, this framework makes specific predictions about consciousness, quantum mechanics, goal-directed behaviour, and mystical experiences.*

The Central Claim: *What mystics called "emanation from the infinite" and what physicists call "observer-dependent reality" are two perspectives on the same underlying computational process. This provides a shared language where science and theology can finally have a meaningful conversation.*

Part A: Creation Narratives as Computational Processes

All major persistent religious traditions describe creation process that can be formalised computationally.

Because the Ruliad has been shown to generate fundamental physics, any accurate mapping between religious cosmogenesis and the Ruliad (that preserves mathematical consistency) establishes non-trivial consilience between theology and digital physics frameworks.

Plain-English Definition [35]: Consilience
When independent approaches to understanding reality converge on compatible explanations, suggesting they're describing the same underlying truth from different angles.

If executed rigorously, it enables science and theology to develop a shared language by recognising both as complementary mappings of a unified computational substrate.

Methodological Note
This paper's focus is primarily on Lurianic Kabbalah because of the author's background and depth of knowledge comparative to the other two monotheisms. We also add comparative notes on Hinduism and Daoism.
This framework naturally extends to other traditions. Christianity and Islam each have sophisticated creation frameworks that merit dedicated analysis by experts in those traditions (indeed as does both Hinduism and Daoism).
Space constraints (this is already a very long paper!) and knowledge constraints (the author is only an expert in Kabbalistic creation narratives) mean full explication of other creation narratives is beyond this paper's scope.
We invite experts of other theological traditions to apply this methodology to their own tradition.

If you are not interested in Category Theory then you can skip this. It aims to provide a technical reader with the background on the Ruliad's mathematical formalism[127].

Mathematical Preconditions for Section 5 (and all Appendix A.1-A.4)

We treat multiway rewriting systems as:

- *F-coalgebras $A \to \mathcal{P}(A)$(categorical states and morphisms).*
- *The **rulial space** is the **category of cospans** of a DPO rewriting system over selective adhesive categories; by concurrency theorems it carries a **natural monoidal structure**.*
- *Completion rules induce higher homotopies, yielding n-fold categories and—under admissible invertible rules—the $n \to \infty$limit is an ∞**-groupoid**.*
- *The collection of limiting rulial systems thus forms an $(\infty, 1)$**-category** with standard routes to **cohesive** structure (via Π_∞), allowing the homotopy/cohomology language we use for R_O.*

More detail on this formalism is provided below. I have also included a proof sketch on informational entropy reduction by Observer sampling, in the context of the Ruliad formalism, which is important in the construction of Section 5 (i.e. "the Observer Functor reduces informational entropy" means it finds stable useful information when it samples the Ruliad). We have not restated the full set of proofs from the Gorard / Arsiwalla papers, but please read them if you doubt any of what follows.

The Ruliad's Category-Theoretic Formalism

The formalism for the Ruliad was designed by Arsiwalla and Gorard (Pregeometric Spaces from Wolfram Model, 21 Nov 2021) and by those authors and Elshatlawy in Homotopies in Multiway Rewriting Systems as Homotopy Types (Non-Deterministic Rewriting Systems as n-Fold Categories, 25 Nov 2021). In it they prove certain categorical constructions are valid for how this object works. These are summarised below.

1) Wolfram-Model rewriting as an abstract/compositional system

- ***Abstract rewriting & coalgebraic view.** A multiway system is a directed acyclic graph of states generated by a rewrite relation → on a set A; compositionality is captured by viewing the system as an F-coalgebra $A \vec{\to} \mathcal{P}(A)$. This fixes the basic objects and morphisms of the formalism and how evolutions compose.*
- ***Rulial space via DPO rewriting.** For graph/hypergraph (and related) systems, admissible rules are spans $\rho = (l: K \to L,\, r: K \to R)$ applied by **double-pushout** diagrams in (selective) adhesive categories; rulial space is the **category of cospans** of such a DPO system. This inherits a monoidal structure (from concurrency/parallelism theorems) and provides the ambient category in which concrete rules live.*
- *This works at two levels: (i) a general, object-agnostic ARS/coalgebra level and (ii) a DPO/categorical level where rules are actual morphisms in an adhesive setting. You can move between concrete hypergraph rules and abstract multiway statements functorially.*

2) Higher homotopies from rewrite completions; n-fold categories and the ∞-limit

- ***Algorithmic construction of higher homotopies.** By adding **completion rules** that identify alternative proof-paths in the multiway graph, one obtains 2-cells (squares) between 1-paths, then 3-cells (cubes), etc., yielding a **homotopy n-type**. With invertible rules, the order-2 case gives a **double groupoid**.*
- ***Induction to n-fold categories.** Provided homotopy cells up to order $n-1$are admissible, the enhanced system yields an **n-fold category**; with invertibility at each level one gets an **n-fold groupoid** modeling homotopy n-types.*
- ***∞-limit.** Taking $n \to \infty$(with admissible invertible higher rules) yields an **∞-groupoid**, aligning the multiway construction with homotopy-type semantics (Grothendieck's homotopy hypothesis).*
- *This lets you strengthen a concrete rewrite system into a homotopy-aware one whose cells witness equalities between derivations and then equalities-between-equalities, etc.—until you have an ∞-groupoid model. This is purely constructive from multiway completions. It does **not** claim that every rule set admits all higher homotopies; admissibility of completion rules is a structural assumption you must check per system.*

3) Rulial multiverse and $(\infty, 1)$-categorical/topos structure

- ***Rulial multiverse.** Consider the collection of limiting rulial multiway systems (each equipped with invertible homotopy rules). This **internally realizes ∞Grpd** (the ∞-category of ∞-groupoids) and thus forms an **$(\infty, 1)$-category** (via complete Segal space models).*
- ***Toward an $(\infty, 1)$-topos and cohesivity.** Interpreting the total space as a fibration of ∞-categories suggests an **$(\infty, 1)$-topos** of rulial multiway systems; with a fundamental ∞-groupoid functor Π_∞one obtains **cohesive** structure so that **geometry is inherited functorially** (synthetic geometry) rather than imposed.*
- ***What this lets you do.** This allows placement of families of multiway systems in a higher-categorical ambient where **spaces/geometry arise from global functorial structure**, offering a route from pregeometric rewriting to (cohesive) topological/geometric objects. It does not pick a unique physical space or metric; rather, it justifies that such structures can be obtained **synthetically** under the stated categorical conditions.*

4) "Permissions and limits" (at a glance)

- *Treat rules and evolutions as categorical data (objects/morphisms; DPO spans; cospans in rulial space).*
- *Add homotopy-completion rules to witness equalities of derivations and climb to n-fold/∞-groupoid structure when admissible.*
- *Embed whole families of systems into an $(\infty, 1)$-categorical/topos setting **where cohesive (geometric) structure can be inherited**.*
- *Does not deduce a specific empirical rule set or updating policy (no selection principle is proved here.)*
- *Does not assume higher homotopies exist for arbitrary rules without checking admissibility of the needed completion rules.*
- *Does not extract quantitative continuum physics without additional assumptions/models; **the results are structural/categorical.***

Entropy-Reduction Proof-Sketch Under an Observer Functor

The proof-sketch for entropy reduction under the Observer functor (its sampling of Rulial space) is important because it says that Observers sampling (coarse-graining) doesn't increase informational entropy. This is restated below as this paper posits Information Integration as a core Observer goal when sampling the Ruliad.

Proposition (Entropy reduction by observation/coarse-graining).

Let x be a random variable over states of the underlying Ruliad-space R with Shannon entropy $H(x)$.

*Let an **Observer functor** $F: R \to O$ induce the observed variable $O = F(x)$.*

Then:

$$H(O) \leq H(x),$$

With equality iff F is one-to-one on the support of P (no information lost).

Equivalently, $H(x) = H(O) + H(x \mid O)$ with $H(x \mid O) \geq 0$.

Thus entropy cannot increase under the (many-to-one) observational map; the difference $H(x) - H(O)$ is the information filtered out by the Observer.

Proof sketch

F induces a partition on the state space; pushing forward P gives P_F.

By standard information-theoretic identities (data-processing inequality / chain rule):

$$H(O) = H(x) - H(x \mid O) \leq H(x),$$

with equality iff $H(x \mid O) = 0$ (injective observation).

*This formalises that an Observer's coarse-graining **reduces descriptive entropy** in the observed space, without claiming any violation of thermodynamics (untracked information is retained in the conditional term).*

Scope/limits.

- *The result is **measure-theoretic/information-theoretic**, not thermodynamic by itself; thermodynamic statements require identifying physical substrates and costs (e.g., memory erasure).*

Axioms for the God Conjecture

These axioms are explained on the following pages. They are stated here so that any technical reader can marry them with the Ruliad formalism and determine what assumptions the author is making.

Please note the following pages provide detail on how these axioms are constructed.

Axiom 1: Any classical sentence about Ein-Sof is not evaluable as true/false for a computationally bounded Observer.

Let $\mathcal{L}_{CL}$ be the classical object language and $Ein\ Sof$ a boundary constant. We enforce:

$$\forall \varphi \in \mathcal{L}_{CL} \varphi(Ein\ Sof): \bot^*$$

i.e., boundary-referential formulas carry the inexpressible type $\bot^*$ and are excluded from classical inference

Axiom 2: There exists a map of regimes (Tzimtzum) that carries boundary-level expressions into a classical arena in which Boolean logic and information measures are available.

There is a functor/reflection:

$$T_z\text{: Boundary} \longrightarrow \text{Created}$$

such that only $T_z(e)$ (the reflected image) may be used in classical reasoning, and classical connectives (in particular $\neg$) and Shannon entropy are defined only in the Created regime.

Axiom 3: Admitted information into the Created domain is capacity-bounded over any finite horizon, otherwise stable distinctions fail for that observer/system.

For discrete steps $n = 1, \ldots, N$:

$$\sum_{n=1}^{N} inflow_n \leq \sum_{n=1}^{N} C_n$$

here C_t is the admissible per-step capacity (e.g. compute/channel capacity). If the inequality is violated on some window, no stable macroscopic law or identity can be maintained on that window for the corresponding Observer.

Axiom 4: There exist Observers in the Created regime whose evaluation/objective functionals are admissible (isomorphism-invariant, data-processing monotone, bounded, stable to noise, submodular, additive on independent parts, and reward non-redundant coupling).

There exists at least one Observer $\boldsymbol{O}$, with a functional $\boldsymbol{J_O}$ (the Observer's 'scorecard') satisfying the admissibility schema (A1–A8) in the classical arena (CL or $\mathcal{E}^j$). All subsequent Observer-theoretic claims are taken only over such O.

1. Kabbalistic Creation: The Emanation Through Constraint[128]

The Lurianic Kabbalistic account, systematized by **Rabbi Isaac Luria (1534-1572)**, provides the most explicitly computational model of divine creation found in any religious tradition. Its correspondence with modern information theory and computational physics is remarkable given its pre-scientific origin.

The process begins with **Tzimtzum,** whereby **Ein Sof**, the simple, unchanging, unending infinite totality (an unchanging equilibrium state), "withdraws" to allow the existence of something other than itself.

> ***Computational Definition [1]: Ein Sof***
>
> *Ein Sof (Hebrew: אֵין סוֹף, "without end") represents the infinite, incomprehensible divine essence prior to any manifestation or distinction. In computational terms, Ein Sof corresponds to an* ***equilibrium state of maximal informational superposition (infinite informational density) where no parseable distinction exists for a bounded Observer.***
>
> *A state where all possibilities exist simultaneously without differentiation, making individual objects informationally undefined.*

> ***Important Note – How the God Conjecture works 'at the boundary' vs. 'inside creation'***
>
> ***(relevant for 1.1 Tzimtzum, after this stage we can use Classical Logic)***
>
> *At the Ein-Sof boundary: ordinary true/false doesn't apply. For a computationally bounded Observer, such statements are* ***inexpressible*** *rather than true or false. Inside creation (after Tzimtzum):* ***distinctions exist****; classical logic (either/or, NOT, probability, entropy) is valid.* ***All theorems and calculations in the paper happen here****.*

Formalisation of Logic Predicates for the God Conjecture (note: this is for technical readers and addresses the Axioms on the prior page)

There are two ways we can derive the priors for this conjecture.

Option A involves a paraconsistent / paracomplete boundary based on "Logic of Paradox" by Da Costa / Priest[129] and Kleene K3 (the "Strong Kleene" three-valued logic)[130].

> ***Plain-English Context: Paraconsistent Logic / "Logic of Paradox" ("LP")***
>
> *What it is: A logic that allows some statements to be both true and false (called a* ***glut****) without the system exploding (in classical logic, from a contradiction you can prove anything)*
>
> *Why we use it at the boundary between Ein Sof and Tzimtzum: When you talk right "at" Ein-Sof, some sentences can look self-colliding from a bounded observer's view.* ***LP*** *lets us tolerate those tensions locally without letting one contradiction make every claim trivially true.*

> ***Plain-English Context: Paracomplete Logic / "Strong Kleene" ("K3")***
>
> *What it is: A logic that adds a third value, typically called U (undefined /unknown / indeterminate), besides T (true) and F (false). In K3, if you don't have enough information to say T or F, you keep it as U, and the connectives propagate that "unknown" sensibly.*
>
> *Why we use it at the boundary: Many boundary claims about Ein-Sof are not contradictory, they're just unsayable (neither true nor false) for computationally bounded observers. K3 gives us a clean* ***"gap"*** *value and rules for how gaps flow through "and", "or", "not".*

> ***How They Work Together in Option A***
>
> *Goal of Option A for the God Conjecture: Give the "boundary logic" a way to handle both kinds of non-classical behaviour:*
>
> *Gluts (LP): some limit-talk might behave like both true and false.*
>
> *Gaps (K3): much limit-talk is inexpressible (neither true nor false).*
>
> *Practical impact: If we combine the ideas our boundary layer (relevant for construction 1.1 in the following section) effectively uses four statuses* ***{T,F,B,N}*** *where: T = true, F = false, B = both (LP-style glut), N = neither (K3-style gap).*
>
> *This corresponds to Belnap/Dunn's four-valued semantics (often called FDE): it lets you keep reasoning locally even if a boundary statement is a glut or a gap, and prevents explosion (where you can't derive anything at all from one paradox)*

Option B, detailed after, utilises a Topos-Theoretic Boundary[131] which enforces a place-based discipline: boundary claims remain in the ambient topos (non-Boolean); "created" claims live in its Boolean reflection, where classical logic and information measures apply. Here, Tzimtzum is the reflection.

> ***How They Work in Option B***
>
> *We work in a very general logical universe $\mathcal{E}$ (a topos) where truth needn't be strictly yes/no. We then* ***reflect*** *the parts you can speak about classically into a* ***Boolean sub-universe $\mathcal{E}^j$*** *by applying a* ***Lawvere–Tierney topology*** *j. Taking $j = \neg\neg$ is the standard way to recover classical either/or logic.*
>
> *Ambient topos $\mathcal{E}$= the "pre-/ at-boundary" arena i.e. Ein Sof.* ***Its internal logic is intuitionistic*** *(not forced to satisfy excluded middle), so you don't have to pretend boundary statements about Ein Sof are classically decidable.*
>
> *Lawvere–Tierney topology $j: \Omega \to \Omega$= a* ***modal filter*** *that says what counts as "locally true." Using* ***j*** *you form the* ***subtopos of j-sheaves****.*
>
> *Boolean subtopos $\mathcal{E}^j$= the* ***post-Tzimtzum*** *arena. For $j = \neg\neg$, $\mathcal{E}^j$ is Boolean so classical logic* ***NOT*** *operations, complements, probability, and Shannon entropy make sense here.*
>
> *Tzimtzum as reflection $T_z: \mathcal{E} \to \mathcal{E}^j$= acts as the* ***"bridge"*** *that turns boundary-level objects / claims into* ***decidable*** *ones you can reason about with ordinary theorems. After reflection, you can count morphisms, use complements, do statistics, etc*

Plain-English Context: Why does this matter?
Using Option B gets us a clean categorical separation: boundary claims about Ein Sof remain in a safe, non-Boolean setting (no forced yes/no), while everything you prove "below the veil" after Tzimtzum lives in a fully classical setting so the mathematics we use after Step 1.1 (sets, categories, entropy) is standard and reviewable. This is mainstream move in categorical logic (i.e. it's not the author's invention) and is supported by decades of literature.

<u>Option A – Paraconsistent/Paracomplete Boundary</u>

A.1 Embedding classical math inside a guarded boundary layer

$$i\colon \mathbf{CL} \hookrightarrow \mathbf{BL}, U\colon \mathbf{BL} \to \mathbf{CL}, U \circ i = \mathrm{id}_{\mathbf{CL}}.$$

Where:

- $\mathbf{CL}$: the realm where we do standard math (sets, categories, entropy) *i.e. 'Inside Creation'*
- $\mathbf{BL}$: a non-explosive logic that tolerates "gaps/gluts" at the boundary *i.e. 'Where we talk about Ein Sof'*
- i: injects classical formulas into the boundary layer unchanged
- U: projects boundary formulas down to classical ones when boundary features aren't present.
- $U \circ i = \mathrm{id}$: guarantees **conservativity** (no change to classical theorems).

Plain-English Explanation
*We place ordinary classical reasoning (CL) inside a protective boundary logic (BL). There's an inclusion **i** from **CL** into **BL**, and a forgetful map U back down. Composing them gives you back exactly what you started with in **CL**, so classical results are preserved.*

A.2 Truth-values and non-explosive inference at the boundary

$$\mathrm{Val}_{\mathbf{BL}} = \{\mathbf{T}, \mathbf{F}, \mathbf{B}, \mathbf{N}\}, \text{ no rule allows } (P \wedge \neg P) \Rightarrow Q.$$

Where:

- $\mathbf{T}$, $\mathbf{F}$: true/false
- $\mathbf{B}$: "both true and false" (paraconsistent glut)
- $\mathbf{N}$: "neither" (paracomplete gap / inexpressible)
- The "No explosion rule" prevents the whole system from collapsing when boundary talk is ill-behaved

Plain-English Explanation
*At the boundary we allow four statuses: true, false, both (tolerated without causing logical explosion), and neither (inexpressible). Importantly, even if something is marked "both," we **do not** allow the usual "from a contradiction, anything follows."*

A.3 Guard Axiom (what goes to the boundary layer)

If a formula mentions **Ein Sof**, evaluate it in $\mathbf{BL}$, not in $\mathbf{CL}$.

Where:

- Ein Sof: a marker for Ein Sof.
- "Evaluate in $\mathbf{BL}$": it may get values $\mathbf{B}$ or $\mathbf{N}$ rather than classical true/false.

Plain-English Explanation
*Any sentence / logical construction in CL that explicitly talks about Ein Sof is **quarantined** to the boundary logic.*

A.4 Conservativity Lemma (classical math stays classical)

$$\Gamma \vdash_{\mathrm{BL}} \varphi \text{ and } \varphi \text{ boundary-free } \Rightarrow \Gamma \vdash \mathrm{CL}\varphi$$

Where:

- Γ: assumptions/premises
- $\boldsymbol{\varphi}$: an arbitrary formula / sentence (a meta-variable). If this contains no boundary symbols i.e. Ein Sof, it lives entirely in the vocabulary of classical logic
- "boundary-free": no limit symbols occur *(i.e. we are working inside the space **CL, Classical Logic)***
- $\vdash$: "proves/entails"

Plain-English Explanation
*If your statement **doesn't** mention the boundary, any proof you have in the boundary logic is also a valid classical proof. Boundary machinery never leaks into ordinary results.*

A.5 Typing the ineffable (no contradictions)

$$\forall\varphi \in \mathcal{L}_{\mathrm{CL}}\varphi(Ein\ Sof):\ \perp^*$$

Where:

- $\mathcal{L}_{\mathrm{CL}}$: $\mathcal{L}$ means "language", $\mathcal{L}_{\mathrm{CL}}$ means classical logic language (i.e. formulas we normally write).
- $\varphi(\text{Ein Sof})$: "φ" with the boundary as its subject.
- $\perp^*$: a special **type**, meaning "unsayable for computationally bounded observers"; it is *not* "false".

> ***Plain-English Explanation***
> *Any ordinary (classical) sentence about Ein-Sof isn't true or false; it has the* ***inexpressible type*** *⊥*.*

A.6 Tzimtzum maps boundary talk into sayable, classical structure

$$T_z: \mathrm{BL} \to \mathrm{CL}, \text{use only } T_z(e) \text{ inside classical proofs.}$$

Where:

- T_z: the "contraction"/reflection from boundary to created structure *(i.e. moving from Ein Sof to 'inside creation')*
- e: any boundary-layer expression (may be $\perp^*$before mapping).
- $T_z(e)$: a well-typed classical object you can now reason about in CL

> ***Plain-English Explanation***
> *Tzimtzum is the adapter that turns boundary expressions into objects we can talk about classically. We never reason classically with the raw boundary expression—only with its image after* T_z.

Option B – Topos Theoretic Construction

B.1 Ambient topos and Boolean reflection

$$\mathcal{E} \text{ an elementary topos with classifier } \Omega,\ \ j: \Omega \to \Omega, \qquad \mathcal{E}^{\,j} \text{ the Boolean subtopos of } j\text{-sheaves.}$$

Where:

- $\mathcal{E}$: the ambient topos (general setting; logic not just classical).
- Ω: the subobject classifier – the internal object of truth values (a Heyting algebra).
- $j: \Omega \to \Omega$: a Lawvere–Tierney topology; it selects which "covers" are accepted and induces a reflective subcategory.
- $\mathcal{E}^{\,j}$: the Boolean subtopos (objects/sheaves for j); its internal logic is classical (excluded middle holds).

> ***Plain-English Explanation***
> *An ambient topos is a very large mathematical universe before I impose any "make it classical logic" constraints. Inside truth is not strictly "yes" or "no", it can be intuitionistic or many-valued. But we can still do category-theory things (objects, arrows, limits). So we can talk about Ein Sof here and how Tzimtzum works (step 1.1)*
> *A standard category-theory construction* ***j*** *"polishes" part of this ambient topos into a Boolean (fully classical) sub-universe* $\mathcal{E}^{\,j}$*, where either/or and classical logic* ***NOT*** *holds.*

B.2 Where each kind of 'talk' lives

$$\text{Created Reality (post Tzimtzum): reason internally in } \mathcal{E}^{\,j},\ \ \text{Boundary 'talk'(Ein Sof): interpret internally in } \mathcal{E}$$

Where:

- "Internal logic": proofs and truth are evaluated **inside** the given topos.
- $\mathcal{E}^{\,j}$: the **post-Tzimtzum** arena (Boolean/classical).
- $\mathcal{E}$: the **pre-/at-boundary** arena (non-Boolean allowed).

> ***Plain-English Explanation***
> *Once creation (Tzimtzum) is in place, we reason classically inside* $\mathcal{E}^{\,j}$*. Whenever we speak directly about Ein-Sof, we stay in the ambient* $\mathcal{E}$*, where classical either/or may fail.*

B.3 Sheaf Guard (what remains non-Boolean)

$$\text{If a proposition mentions Ein-Sof, interpret it in } \mathcal{E} \text{ (do not force it into } \mathcal{E}^{\,j}\text{).}$$

Where:

- "Mentions Ein-Sof": contains boundary markers
- "Interpret in $\mathcal{E}$": evaluate with the general Heyting truth object Ω

- “Do not force”: don’t apply j-reflection to make it Boolean

> ***Plain-English Explanation***
> *Any statement that explicitly talks about Ein-Sof stays in the ambient topos (non-Boolean world). We do not push it through the Boolean filter to make it yes/no.*

B.4 Conservativity (ordinary theorems remain classical)

$$\varphi \text{ boundary-free } \Longrightarrow [\![\varphi]\!] \text{factors through } \mathcal{E}^{j}$$

Where:

- φ: any formula/sentence with **no** boundary symbols
- $[\![\varphi]\!]$: the interpretation of φ inside the topos
- “Factors through $\mathcal{E}^{j}$”: the semantics sits in the classical subtopos, so classical logic applies.

> ***Plain-English Explanation***
> *If the statements don’t refer to the boundary at all (Ein Sof), then its meaning lives entirely inside the Boolean / classical logic part of the topos, so all the classical proofs are unchanged.*

B.5 Operational Considerations: where do NOT and entropy consideration live?

$$\neg: \Omega \to \Omega \text{ is Boolean in } \mathcal{E}^{j}, \qquad H(\cdot) \text{ (Shannon) is only defined after reflection into } \mathcal{E}^{j}.$$

Where:

- $\neg$: classical negation (law of excluded middle holds) — belongs to $\mathcal{E}^{j}$.
- $H(\cdot)$: Shannon entropy; it presupposes classical probability, hence **Boolean** logic.
- “After reflection”: once objects/propositions have been moved into $\mathcal{E}^{j}$(the created, decidable world).

> ***Plain-English Explanation***
> *Classical **NOT** (and any complements) are available inside the Boolean / Classical Logic world after Tzimtzum. Shannon entropy likewise makes sense only after we’re in the classical regime. At the boundary, those tools don’t apply.*

1.1 Tzimtzum: The Primordial Computational Constraint

Tzimtzum is a metaphorical "withdrawal" of infinite presence. This **does not occur** in **physical space** or **physical time** (which do not yet exist in the cosmogenesis of the tradition). It occurs in computational (informational) space. Tzimtzum enables the possibility of distinct objects and information (defined here *the difference between states enabling identification*, logic, and causal structure.

> ***Computational Definition [2]: Tzimtzum***
> *Tzimtzum (צמצום, "contraction" or "concentration") denotes the self-imposed limitation through which Ein Sof withdraws from a logical space (Chalal Panui, the "vacated space") to enable the existence of beings other than itself.*

Formalisation:

Tzimtzum creates the classical possibility space and introduces a **NOT** operator:

Option A: Paraconsistent/Paracomplete Logic to get to our Classical Logic

$$T_z(U_{Ein\ Sof}) = U, \quad \neg : \Omega \to \Omega \text{ is defined in } CL$$

After this Morphisms (the set of transformations) become countable.

> ***Help, what do the symbols mean?! [2A]***
> T_z *= Tzimtzum, the "function" that carves 'is' from 'is-not'. This gives* ***U*** *polarity (difference) and enables* ***Identity***
> ***U*** *= Think of U as the space.* $U_{Ein\ Sof}$*, is our "everything" where the conditions of Option A apply (it is paraconsistent/paracomplete)*
> $U, \neg : \Omega \to \Omega \text{ is defined in } CL$ *= Says from* T_z *we get a universe* ***U,*** $\neg$*, a* ***NOT*** *operator (and any complements), and truth values,* Ω*, defined in classical logic (**CL**)*
> ***After this we get to use logic and informational entropy.***

Option B: Topos Theoretic – Not Operator and Entropy only Useable after Boolean Reflection

$$T_z : \mathcal{E} \to \mathcal{E}^j, \quad \neg \text{ Boolean in } \mathcal{E}^j, \mathrm{H}(\cdot) \text{ defined only in } \mathcal{E}^j$$

And created morphisms are now countable / classifiable in Classical Logic (CL)

$$\mathrm{U} \coloneqq (T_z(U_{Ein\ Sof})) \quad (\mathrm{Mor(U)} \text{ is an object of } \mathcal{E}^j)$$

> ***Help, what do the symbols mean?! [2B]***
> T_z *= Tzimtzum, as before*
> ***Mor(U)*** *= The collection of transformations (arrows) inside the space where we are using classical logic once we've used the classifier* ***j.***
> ***i****.e. after using the classifier we can count, analyse and compose morphisms classically.*

This **NOT** operation creates the first categorical distinction:

- **Presence** *(Ein Sof's remaining trace)* ↔ **Absence** *(the vacated space)*
- **Fullness** ↔ **Emptiness**
- **Infinity** ↔ **Finitude** *(n.b. this state Ein Sof is an equilibrium state, unchanging etc.)*
- **Computational 1** ↔ **Computational 0** *(binary)*

This single binary distinction constitutes the informational seed from which the entire computational universe (modelled as the Ruliad) can develop.

Before Tzimtzum: infinite undifferentiated **YES**. After Tzimtzum: the emergence of information itself.

> ***Category Theory Explanation [2]***
> *It's a schematic for "creation by distinction": start with a totally undifferentiated everything-state where contradictions coexist; then a* ***NOT-introducing functor*** T_z *performs the primordial symmetry-breaking, splitting reality into "this vs. not-this"****,*** *which makes information, logic, and meaningful (structure preserving) morphisms possible.*

> ***Plain-English Analogy (Option A)***
> *Imagine a computer that can only say "yes" to everything. It can't distinguish between different programs or even know what a program is. The first step toward computation is the ability to say "no"—****to exclude some possibilities****. Tzimtzum is like flipping the first binary switch, creating the distinction between 0 and 1, presence and absence.*

> ***Plain-English Analogy (Option B)***
> *Think of* $\mathcal{E}$ *as the globe (curved, subtle) and* $\mathcal{E}^j$ *as a flat map. The globe's geometry doesn't obey the flat map's rules everywhere, and you shouldn't force it to. Tzimtzum is like choosing a map projection: you convert just the right part of the globe into a flat map, and you do your measurements and straight-edge reasoning on the map, not on the globe itself. (In topos terms: reflect to a Boolean, then compute there.)*

Topological Interpretation:

From an infinitary category theory perspective (the math language of the Ruliad), Tzimtzum represents the first symmetry breaking:

$$\boldsymbol{Ein\ Sof \cong G_\infty \quad (maximal\ symmetry)}$$

$$\boldsymbol{Post\ T_z \cong \frac{G_\infty}{Rel} \quad (quotient\ by\ equivalence\ relation\ Rel)}$$

> ***Help, what do the symbols mean?! [2]***
> *$\boldsymbol{G_\infty}$ =Counts the 'number' of symmetry groups. This says it's infinite in Ein Sof (more accurately undefinable)*
> *$\boldsymbol{Rel}$ = This is the thing we use to figure out how many symmetry groups there are relative to before*
> *We use the equation to identify "presence" and "absence" of Ein Sof. It creates the first distinguishable structure in the space*

> ***Plain-English Analogy***
> *In category theory, mathematicians describe **symmetry** using structures called **groupoids**.*
> *Ein Sof is **analogous** to having perfect symmetry—spin it any direction and it looks identical.*
> *Tzimtzum "breaks" this symmetry by creating a preferred direction (like how a compass needle breaks the rotational symmetry of space by pointing north).*
> *Once symmetry breaks, distinct objects (including categories) can emerge.*

1.2 The Kav: Information Throttling and Bandwidth Control

> ***Computational Definition [3]: Chalal Panui / Vacated Space***
> *The Chalal Panui (חלל פנוי) is the logical domain created by **Tzimtzum** wherein **finite existence becomes possible**.*
> *It is not literal spatial void but rather a **reduction in information density enabling structural differentiation***

> ***Computational Definition [4]: Kav***
> *The Kav (קו, in English "line" or "ray") is a **controlled information channel** through which Ein Sof's light (**information**) enters the Vacated Space at a precisely calibrated intensity (i.e. bandwidth).*

Information-Theoretic Formalisation:
Let:

- $\boldsymbol{I_\infty}$= Information density of Ein Sof (infinite)
- $\boldsymbol{VS_{max}}$= Information processing capacity of the Vacated Space (this increases with time steps)
- $\boldsymbol{B_{Kav}}$= the throughput (bandwidth / rate) of the Kav 'channel' *i.e how many bits per unit time it can actually carry*
- $\boldsymbol{r}$ = the rate information enters the vacated space
- $\mathbb{R}^+$ = A positive real number

Then for all countable time steps, the Kav satisfies:

$$\boldsymbol{B_{Kav} = \sup\{r \in \mathbb{R}^+ : r \cdot t \leq VS_{max}, \forall t\} \quad (where\ t\ is\ not\ \infty)}$$

> ***Explanation [3]***
> *This says pick the highest information transfer rate $\boldsymbol{r}$, such that for any time duration, $\boldsymbol{t}$, the total information, $\boldsymbol{r \cdot t}$, never exceeds the system's processing capacity, $\boldsymbol{VS_{max}}$.*
> ***sup = "supremum"** = the least upper bound (the smallest number that is greater or equal to every element in the set).*
> *We could probably also use **inf = "infimum"** to construct this statement (the greatest lower bound, the largest number that is less than or equal to every element in the set).*
> ***FYI, this construction may not be optimal!***

> ***Plain-English Analogy***
> *Think of Ein Sof as an infinite water source and the Vacated Space as a container that can only hold a finite amount.*
> *If you open the tap fully, the container instantly overflows and collapses back into the infinite source—nothing distinct can form. The Kav is like a precisely controlled faucet that lets in exactly as much water as the container can hold, allowing stable structures to form.*

Critical Stability Condition: If information flow exceeds $\boldsymbol{B_{Kav}}$, the Vacated Space collapses back into Ein Sof (an infinite one-ness with no informational distinctions):

$$\lim_{I \to \infty} VS = \ Ein\ Sof$$

No finite structures persist if too much information comes into the Vacated Space; creation is impossible. The Kav's throttling function is **logically necessary** for creation, not just convenient.

The bandwidth B_{Kav}determines:

1. **Rate of creation unfolding** (how quickly complexity develops)
2. **Sustainable complexity level** (maximum informational density)
3. **Persistence threshold** (minimum information integration required for stable objects)
4. **Computational boundedness** (finite limits relative to Ein Sof's infinity)

The combination of the **NOT** rule (Tzimtzum) and bandwidth limitation (Kav) enables the eventual categorical structure of the Ruliad. It leads to a hierarchy of computationally simple (less rule bound) to computationally complex (more rule bound) domains.

There are still no objects or categories in the Vacated Space (yet!). Just some core computational components that we will use to build a Ruliad.

Plain-English Analogy – Huh? Where does the Ruliad come in?

Imagine we have a solid ball. We carve away some empty space in the middle of the ball and thread a hypodermic needle into it that can pump it full of 'ball' slowly.

The solid ball is Ein Sof (gross analogy, sorry!). The space in the middle is the Vacated Space. The border between them is akin to the outline / edge of the Ruliad. The needle being fed to fill the ball back up is like the Kav.

1.3 Adam Kadmon: The MetaObserver

Adam Kadmon / Meta Observer can be characterised as the **Category of all Objects that the is NOT the Uncaused First Cause** (often abbreviated to the **Category of All Possible Effects**).

$$AK = \mathcal{C}_{Effects} = \{\,\mathrm{X} \in \mathbf{Ruliad} : \exists\, \mathbf{c}, \mathbf{c} \rightarrow \mathbf{X}\}$$

Computational Definition [5a]: Adam Kadmon

Adam Kadmon (אדם קדמון, "Primordial Human" or "Primordial Adam") represents the first differentiated structure emerging in the Vacated Space – a template that determines the boundary conditions of what any Observer can comprehend (observe) within that space

Computational Definition [5b]: MetaObserver

The MetaObserver is the limit / maximal Observer.

In the Ruliad formalism an Observer is required to produce a reality through foliating or slicing the Ruliad. An Observer (see Wolfram's writings on Observer Theory, Arsiwalla's minimal Observer model and my extension to Observer Theory) is defined by its computational boundedness (processing power, memory), persistence (how many hypergraph updates it survives for and a relevance (choice) condition.

An Observer's most important structural feature is that it has a boundary (persistent through time-steps) between it and the entire Ruliad. The MetaObserver has minimal computational boundedness, and maximal computational persistence. It can therefore make the maximum number of potential choices or what it samples while not being infinite.

Help, what do the symbols mean?! [3]

AK = *Adam Kadmon / MetaObserver*

$\mathcal{C}_{Effects}$= *Category of All Possible Effects (see above) / Category of everything that is Not Ein Sof (Uncaused Cause)*

$\mathrm{X} \in \mathrm{Ruliad}$ = *A subcategory / object / element that is part of the Ruliad*

$\exists$ = *"There exists"*

$\mathbf{c}$ = *a cause*

$\mathbf{c} \rightarrow \mathbf{X}$ = *"c causes X" or "X is an effect of some cause, c"*

Symmetry Breaking Implications:

The definition implies a fundamental informational **asymmetry**: $\mathcal{C}_{Causes} > \mathcal{C}_{Effects}$ because Ein Sof (the Uncaused Cause) belongs to the first $\mathcal{C}_{Causes}$ but not $\mathcal{C}_{Effects}$

This represents the first broken symmetry in the emanatory sequence.

Computational Interpretation:

Adam Kadmon functions as a **MetaObserver.** It not a conscious being in the anthropomorphic sense, but rather:

- A **class structure** in object-oriented programming (all derivative Observers inherit properties from it)
- The **operating system kernel** managing all possible computational processes
- The **total constraint set** defining what is (and is not) computable within the Ruliad

Adam Kadmon contains all functions, subroutines, and data structures necessary to instantiate anything Observable at any level of description (physical, valuational, symbolic, abstract) in any possible universe branch within this possibility space.

Formally:

$$AK = \mathcal{C}_{Effects} = \langle \mathcal{O}, \mathcal{M}, \mathcal{r}, \mathcal{F} \rangle$$

Where:

- $\mathcal{O}$ = set of all possible objects / elements (*including things like sub-categories*)
- $\mathcal{M}$= set of all possible morphisms *(all the transformations between potential categories and within categories)*
- $\mathcal{r}$= composition rules for morphisms *(describes relationships and transformations between objects within a category)*
- $\mathcal{F}$= functorial relationships preserving mapping structure (*how to map objects and morphisms from one category to another)*

Adam Kadmon represents the limit of any derivative Observer's (*its sub-agents*) accessible computational possibility space (in the Ruliad this space is known as **R$_O$** or **R$_{OBSERVER}$** – it's the subset of the full Ruliad that an Observer can access).

At this level, all Sefirot (see following subsection) exist in perfect harmony, all possible universes exist in potential, and all possible Observers and Objects exist as abstract information awaiting individuation.

This stage establishes the computational architecture. Actual computation begins in the subsequent step.

> ***Plain-English Analogy***
> *Adam Kadmon / MetaObserver is like the "operating system" for reality.*
> *Just as Windows determines what kinds of programs can run on your computer, Adam Kadmon sets the fundamental rules for what kinds of things can exist (can be Observed) and how they interact in our universe.*
> *It's the master template from which everything else derives.*

1.4 The Sefirot: Categorical Hierarchy Through Iterated Constraint

The emanation (construction / formation) of the Sefirot can computationally be formalised as a special type of Turing Machine operates on Informational Categories.

Sefirot (Sub-Categories of $\mathcal{C}_{Effects}$) Generation Function:

$$\mathcal{Seforit}, \mathcal{S} : \mathcal{C}_n \xrightarrow{\text{NOT}_k} \mathcal{C}_{n+1}$$

Where:

- $\mathcal{C}_n$ is the n-th Sefirah generated by the function
- NOT$_k$ applies the k-th exclusion rule
  (i.e. the rule that makes $\mathcal{C}_{n+1}$ less informationally dense / smaller than $\mathcal{C}_n$)
- $|\ \text{Mor}(\mathcal{C}_{n+1})\ | < |\ \text{Mor}(\mathcal{C}_n)\ |$
  (i.e. the subsequent category outputted has fewer accessible morphisms for any Observer than the prior category a.k.a. strictly decreasing cardinalities of potential transformations)
  n.b Mor *means "accessible morphisms in the category" intuitively, transformations between states*

> ***Computational Definition [6]: Sefirot***
> *The Sefirot (ספירות, singular Sefirah) are ten distinct categorical domains emanating from Adam Kadmon, each characterised by progressively greater constraint (subject to more exclusion rules about what elements can be in the category) and correspondingly lower cardinality of possible morphisms.*
> *For intuition, in a cause and effect sequence **AK has every possible morphism (choice) accessible to it.** A lower Sefirah on the emanatory chain has to sample certain rules ALWAYS, therefore it has all the morphisms of AK **LESS** the specific rule it has to sample to have a distinct identity.*

> ***Plain-English Analogy***
> *Each Sefirah is like a filter that removes some possibilities from a countably infinite possibility space.*
> *Imagine pouring sand through progressively finer sieves – each sieve lets through fewer grains (fewer possibilities), but what remains is more specific and structured.*
> *The first Sefirah emanated / outputted filters out very little; by the tenth, you're left with a highly constrained, specific reality (fewest possibilities).*

The ten Sefirot form a **sequential causal graph** (computational causal chain), with each possessing lower fewer accessible states than its predecessor. In Kabbalistic tradition, these categorical structures are termed **"Vessels" (Kelim),** as they serve to contain and structure the divine light from the Kav (information).

> ***Turing Machine 101***
>
> *A Turing machine is like a super-simple robot following a recipe on an endless piece of tape, proving that any calculation is just reading, writing, and moving step by step according to rules.*
>
> *i.e. "Given this input string, produce this output string"*
>
> *In the God Conjecture, Adam Kadmon acts like a Categorical Turing Machine to construct the Ruliad (all the stuff we can possibly observe)* ***i.e.*** *"Given this input category (a collection of objects and morphisms with structure), produce this output category (transformed according to some rule)"*

Table: The 10 Sefirot and Their Computational Interpretations:

Sefirah	Translation	Observer Theory Domain	Count of Sampled Rules for Categorical Structure	Computational Function	
Keter	Crown *Will*	Minimal Constraint (M) *Cause/Effect structure*	Least Rules	Optimal search function on computational possibility space	Most Informationally Dense
Chochmah	Wisdom *Abstract Thought*	Minimally Constrained *Logic*		Pure undifferentiated computational potential (continuous)	
Binah	Understanding *Linguistic Thought*	Symbolic *Number/Letters*		Structural organization (discretisation)	
Chesed	Loving Kindness *Compassion*	Valuational		Expansive generation	
Gevurah	Strength *Judgement*	Valuational		Restrictive limitation	
Tiferet	Beauty *Balance*	Valuational		Balanced integration	
Netzach	Victory *Endurance*	Valuational		Persistence over time	
Hod	Splendor *Clarity*	Valuational		Pattern replication	
Yesod	Foundation *Connection*	Valuational		Interface of ingression from platonic / informational domain (M,S,V) to physical reality	
Malkhut	Kingdom *Physical World*	Physical	Most Rules	Physical manifestation	Least

> ***Note on the Diagrams (following two pages)***
>
> *These diagrams aim to visualise the process in the language of Turing Machines. It aims to model how our Observed dimensional geometry is 'outputted' by a MetaObserver by foliating an unsampled Ruliad.*
>
> *The dimensionality of the Kabbalah cosmogenesis process is five dimensional.*
>
> - *In the physical universe all persistent Observers sample three dimensions of space (x,y,z) i.e. classical physics*
> - *In the physical universe and in a computational universe every possible Observer (including our MetaObserver) samples a time-like dimension (t, for physical time, n for state count)*
> - *In a computational universe (albeit with some filtered output in physics) Observers sample information*
>   - *This dimension can be foliated in infinitely many ways by an Observer*
> - *The MetaObserver (Adam Kadmon) because it is being 'powered' by something infinite (Ein Sof, through the Kav) must construct this structure in the minimal number of computational steps as something infinitely powered, in computational possibility space, should take the 'shortest' computational path / fewest computational steps that could output our experienced reality i.e. it is a computationally efficient process happening in the fastest way it can happen (akin to a 'best of all possible worlds' argument)*
> - *This creation narrative completes this construction of R_O (the limit of the Observer's accessible Ruliad) in five steps.*
> - *This minimality corresponds to a 'shortest path search' and the 'principle of least action'*
>
> *Note that every category shown on the following diagrams should have an* ***identity*** *attached to the box (a small function pointing back to the outputted category). They have been left out for space and ease of reading. Similarly all boxes should have function lines mapping each category to another (not shown for ease of visualisation).*

Visual: How the MetaObserver 'Constructs' the Ruliad (1/2)

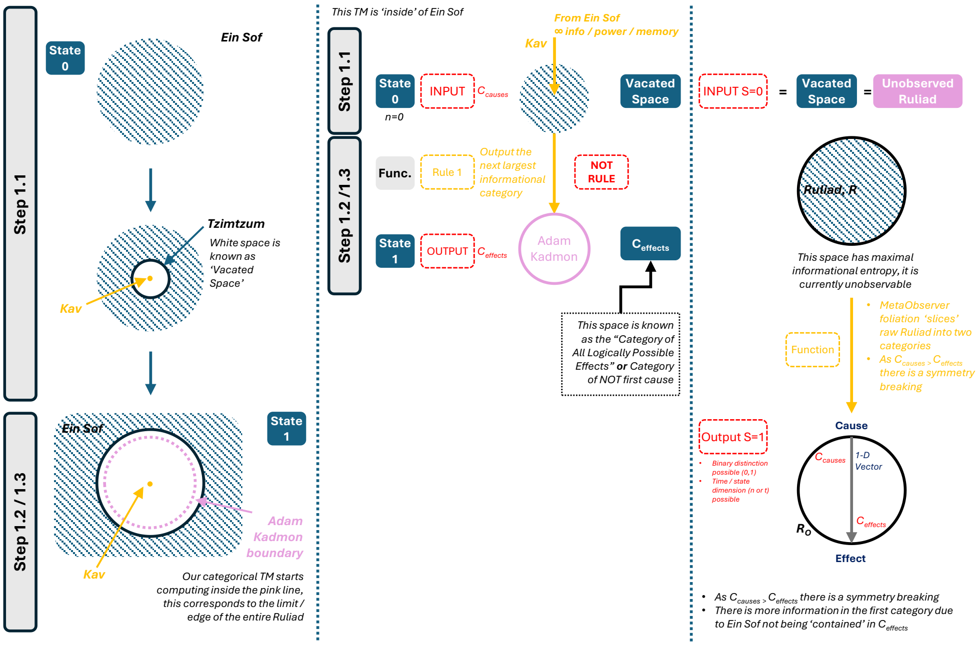
How to Construct a Ruliad

- The diagrams below aim to give some visual cues to the process described in **Section 5 (Steps 1.1-1.5)**
- We show, side-by-side, three different interpretations of the Kabbalistic creation narrative
  - The Kabbalah view, with standard diagrams that exist in the tradition in many works
  - A "Turing-Machine" view setting out the Categorical Turing Machine the MetaObserver / Adam Kadmon utilises to make the categories we discuss in that section
  - A very lossy transposition to how this creates emergent geometry in the Ruliad (i.e. the spaces that anything existing in physics samples as Observers
- This utilises work by people like Chris Fields (category theory) and Lucy Spounder (constructing math via negation)

Kabbalah	Turing Machine	Geometry / Topology in R_O

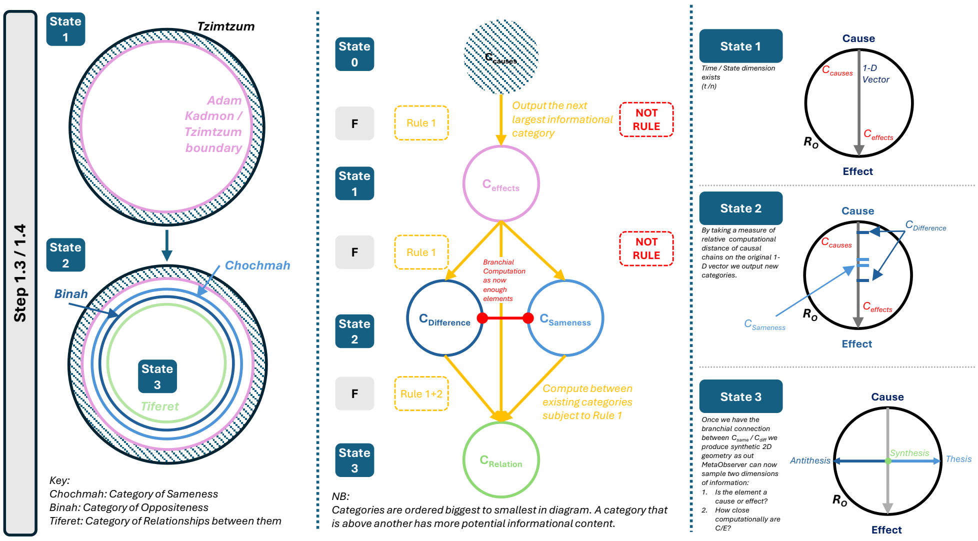
Step 1.1 / 1.2

- Imagine an infinite Turing Machine ("TM")
- At state n=0 (its initial state) it contains all information, but is not probable and is in equilibrium (i.e. unchanging)
- Our infinite TM runs with an ***input → computational process / function → output***
- This TM creates infinite categories of different sizes (cardinalities)
- We can determine the 'size' of these categories using first-order logic exclusions **(negation)**
- **This whole process is powered by something infinite (Ein Sof)**



Step 1.3 / 1.4

- Step 1.3 outputted the MetaObserver, Adam Kadmon the maximal observer in the Ruliad
- Step 1.4 details the output of the next largest categories (the Sefirot)
- For intuition we will detail this step in the next few diagrams
- The first Categories outputted after Causes and Effects that produce geometry
  - Sameness / Oppositeness *or* Similarity / Difference; these correspond to the categories of causal morphisms in the Ruliad
  - Relationship; these correspond to the categories of branchial space morphisms in the Ruliad

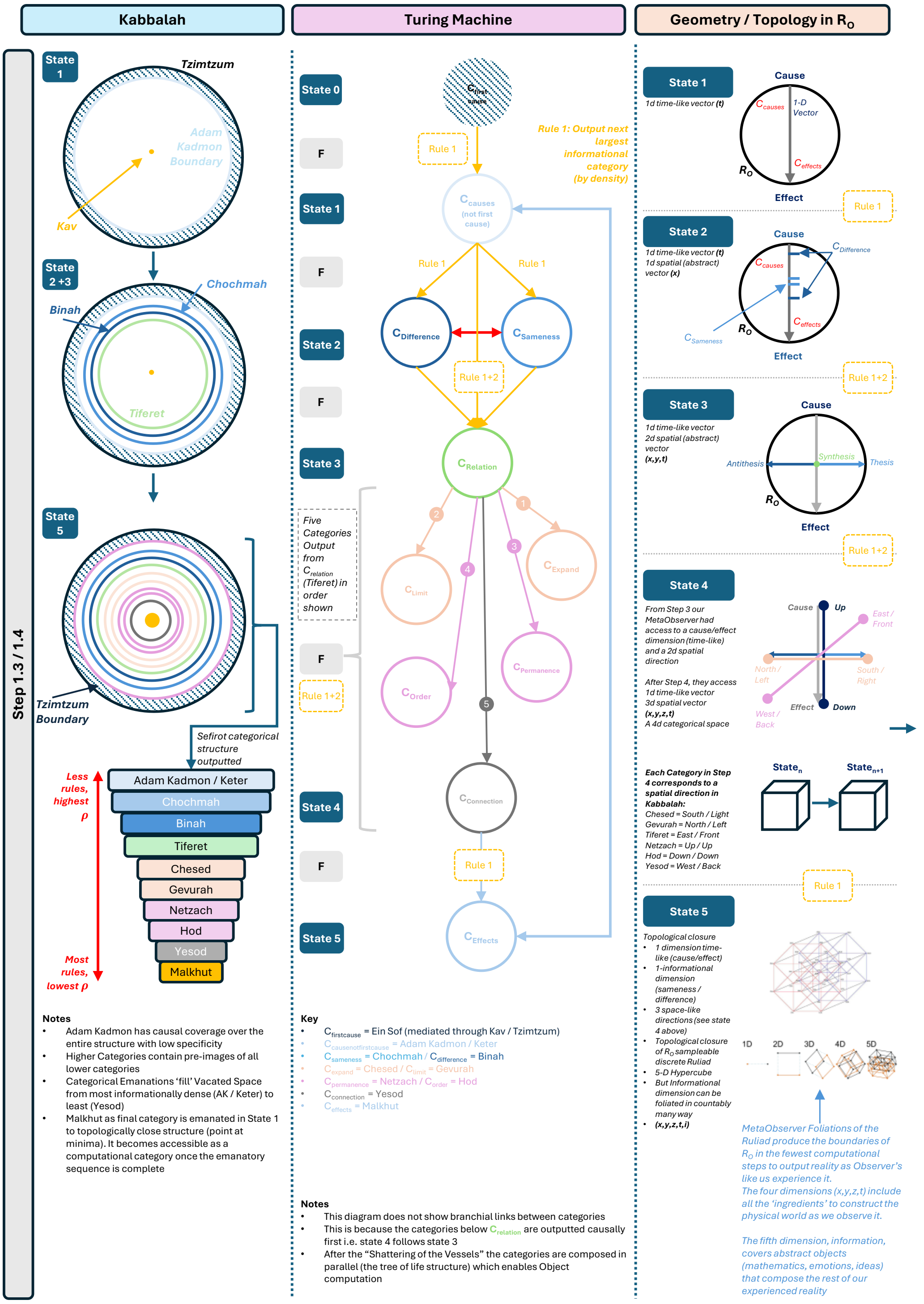


Visual: How the MetaObserver 'Constructs' the Ruliad (1/2)

How to Construct a Ruliad

Step 1.4 – All Ten Fundamental Categories Outputted by MetaObserver

- Let's recap:
  - From **State 0 and State 1** on the prior page, we got *Adam Kadmon / Kav ≈ Keter / Malkhut (Sefirot) ≈ Causes / Effects*
    - Keter is the largest aspect of infinity accessible to the Observer i.e. the most information density, with the least rules, represented by a binary **1** (which, in the limit, converges at **∞**)
    - Malkhut is the least informationally dense domain, with the most rules represented by **0** where, in the limit, 0 ≈ ***ε*** (i.e. infinitesimal, below our observational limit)
  - From **State 2 and State 3**, we got *Chochmah / Binah ≈ Sameness / Difference* and *Tiferet ≈ Relationship*
- The MetaObserver operates in a computational possibility space of All Causes that are Not the First Cause (Ein Sof), this is now after State 3 a 2D informational geometry within the Ruliad we're building
- So what happens next?
  - Further Categories (beyond the five we already have) are outputted
  - Q: Why five more? A: It's a complete space for Observers like us (that can output our world) in the fewest computational steps i.e. 3D of space, 1D of time, *1D informational n.b. speculative, this dimension can be 'sliced' in lots of ways*



1.5 Shevirat Ha-Kelim: Symmetry Breaking Within Categories and Object-level Individuation

The Breaking of the Vessels is a necessary stage in the creation process.

This enables the MetaObserver to transition from computing a unified categorical structures (the Sefirot) to individuated sub-categories and objects within those categories.

i.e. poetically, a transition from "the One" to "the Many"

> ***Computational Definition [7]: Shevirat Ha-Kelim***
>
> *Shevirat Ha-Kelim (שבירת הכלים, "**Breaking of the Vessels**") describes the shattering of lower (specifically the bottom seven) Sefirot which are unable to contain the overwhelming intensity of divine light (information / computation) flowing into them*
>
> *i.e. the computational burden exceeds this categories computational boundedness (it doesn't have enough bandwidth), so it is combinatorially explosive and never completes.*

Information-Theoretic Analysis:

The "Breaking of the Vessels" (or "Shattering") occurs when information influx exceeds processing capacity:

$$\boldsymbol{I_{influx}(n)} > \boldsymbol{B_{vessel}(\mathcal{S}_n)} \implies \textbf{Shattering}(\mathcal{S}_n)$$

where:

- $I_{in}(n)$= rate of information entering Sefirah, $\mathcal{S}_n$ at step / state-time, $\boldsymbol{n}$
- $B_{vessel}(\mathcal{S})$= computational boundedness of $\mathcal{S}_n$

> ***Plain-English Analogy***
>
> *Imagine pouring water into increasingly delicate glass cups.*
>
> *The first few cups are sturdy and hold the water fine. But as the cups get more delicate (more constrained, here 'computationally bounded'), eventually they reach a limit where the water pressure immediately shatters them (akin to a 'phase transition').*
>
> *This isn't God screwing up. It's how you get from a few perfectly full containers of water to many small water droplets.*
>
> *In this analogy the full containers are the Sefirot (the categories) and the water drops that scatter are the individual objects that we can now collect (the MetaObserver can now identify them, individually).*

Computationally, Shevirat Ha-Kelim represents **more symmetry breaking** *(this time inside of the computational possibility space of the MetaObserver i.e. the same process as the symmetry breaking in step 1.1, but more of it!)*

This is the start of the transformation from undifferentiated categorical unity to differentiated multiplicity:

Physical Analogy:

Consider water's phase transition from liquid to solid (ice formation):

- **Liquid water:** High rotational symmetry; molecules move freely
- **Ice formation:** Symmetry breaking creates fixed crystalline structure
- **Result:** Individual crystals with distinct boundaries

Similarly:

- **Pre-shattering:** Unified category with perfect internal symmetry
- **Shattering:** Symmetry breaks; categorical structure 'fragments' i.e. not all the internal structure or objects are fully computed
- **Result:** Individual object-seeds scattered throughout the Vacated Space *(Nitzotzot, "sparks", in Hebrew)*

Each **spark** carries:

- Potential for a separate object (observerable capacity)
- A unique informational pattern (i.e. geometric boundary / shape) (individuality)
- Partial encoding of original unity (direct morphism to the topological closure point / a 'direct line' to Ein Sof)

In the God Conjecture, these **sparks** correspond to **Emes** *(Wolfram's conjectured individual unit of Rulial space, his smallest 'thing')*. These sparks are the fundamental units from which complex structures (objects / Observers like us) emerge.

1.6 Partzufim: Stable Computational Networks (Parallelisation of Computational Burden)

> ***Computational Definition [8]: Partzufim***
>
> *Partzufim (פרצופים, singular Partzuf, "face" or "persona") are stable reconfigurations of Sefirot into interconnected functional networks following the shattering, enabling persistent computational output.*

After breaking, the Sefirot are reformed (by Ein Sof, through Adam Kadmon / MetaObserver) into stable configurations **analogous to ultrafilters in topological mathematics** – computational structures that enable persistent information sampling / integration (observation) by the MetaObserver.

> ***Plain-English Definition [36]: Ultrafilter***
>
> *An **Ultrafilter** is a mathematical object that can reduce information from the infinitely complex Ruliad to the cleanest possible consistent pattern: a total yes/no structure that still respects how the information fits together (it's categorical structure).*
>
> *It boils down a complicated collection of information into a single, extremely consistent "point of view."*
>
> *You can think of it as a **perfect filter of information — one that keeps just enough structure to make clear yes/no decisions about everything** (so now, no more shattering, the computations can complete in finite time – related to Observer Boundedness and Persistence conditions!)*
>
> *An Ultrafilter 'throws away' any grey areas. This is essentially the mathematics of **Coarse Graining** in the Ruliad (see definition in introduction)*
>
> *Slightly more technically*
>
> *For every possible subset (every possible "piece" of information), the Ultrafilter either keeps it (says "this is important") or throws it out ("this isn't"). There are no "maybes". This is analogous to setting axioms (like the Hamiltonian in physics that let physicists calculate GR efficiently)*

Network Structure: Each Partzuf, $\mathbb{P}_n$ functions as a computational system that parallelises computation to increase each Sefirahs computational capacity *(i.e. decreasing it's computational boundedness)*:

$$\mathbb{P}_n = \langle \boldsymbol{I}_i, \boldsymbol{\mathcal{A}}_i, \boldsymbol{O}_i, \boldsymbol{\mathcal{T}}_i \rangle$$

where:

- I_i = Information input from higher categories (divine light from the Kav)
- $\mathcal{A}_i$ = Processing algorithm (transformation rules)
- O_i = Output to lower categories (structured information)
- $\mathcal{T}_i$ = transmission morphisms to adjacent Partzufim $\mathbb{P}_{n+1}$, $\mathbb{P}_{n+2}$ (and so on)

The interactions between Partzufim create **recursive information flow** through creation within the Vacated Space. Kabbalists call this the Shefa ("divine abundance" or "overflow").

This generates:

1. **Feedback loops** (recursion enabling self-reference *i.e. identity functions*)
2. **Oscillatory patterns** (dynamic equilibrium conditions)
3. **Stable attractors** (persistent objects emerging as computationally reduced with minimal informational entropy i.e. invariants)[132]

> ***Computational Definition [9]: Shefa***
>
> *Shefa is the data stream (information flow) coming from the ultimate source of reality (Ein Sof) through the Kav.*
>
> *Remember, Ein Sof is like the infinite processor or database — pure potential, containing all possible information. The Sefirot (the ten emanations or stages) are like filters, nodes, or processing layers that structure and shape that information into forms that can exist and make sense within the finite "system" — the created world. If the Kav is a firehose of unstructured information, the Shefa is the flow of structured information as it moves through those layers — transforming infinite potential into concrete expression (raw code becoming output).*

The stable, predictable outputs – the computationally reduced invariant outputs (*with minimal informational entropy i.e. stability*) manifest in our Observed experience as the predictable regularities of logic, mathematics, physics, and natural law.

The simpler they are to compute, the more computationally efficient they are, the more useful they are to the MetaObserver (and any subordinate Observer) as they have more macro-scale causal power (formal causation) than subordinate objects. These emerge necessarily from the structure of the computational process –simple objects are outputted first, then complex ones.

i.e. stable objects cost our MetaObserver the minimum amount of its bounded computational power.

> ***Plain-English Analogy***
>
> *After the vessels shatter, the pieces / categories reorganize into stable networks—like how a shattered crystal might reform into a new but stable pattern.*
>
> *In computing terms, the **Partzufim are like parallel processors working together**: each handles part of the computation, but they're networked to produce coherent output.*
>
> *This is visualized as the **Tree of Life** diagram in Kabbalah.*

1.7 The Four Worlds: Hierarchical Computational Domains

Computational Definition [9]: Four Worlds

The emanatory process generates four distinct computational regimes or "worlds" (Olamot): Atzilut, Beriah, Yetzirah, and Asiyah. These represent different levels of rule constraint, corresponding to the four universal computation types in Wolfram's classification (see diagram in introduction).

In Observer Theory: An Extension to the Wolfram Model (May 2025), the four domains (types of informational patterns) an Observer can sample and integrate isomorphic to these "worlds":

- *Atzilut: Minimally Constrained Domain (M)*
- *Beriyah: Symbolically Constrained Domain (S)*
- *Yetzirah: Valuationally Constrained Domain (V)*
- *Asiyah: Physical Domain (P)*

Per the Observer Theory paper. The domain at the top, Atzilut (M), has more causal coverage (formal causation, top-down) as it is less rule-bound and informationally dense than the lower domains (S,V and P). Efficient causation works bottom-up.

Plain-English Definition [37]: Formal and Efficient Causation

Formal causation *refers to the* ***design or blueprint*** *that gives a thing its form and* ***identity****. For example, the formal cause of a statue is its design, which is the sculptural shape that makes it a statue of a hero or a god. The formal cause is concerned with the arrangement or the organizing principle that gives the object its identity, rather than the physical material itself.*

Efficient cause is the agent or force that brings something into being. It is the actual process or mechanism by which a change occurs. For instance, the efficient cause of a table is a carpenter who acts on wood. The efficient cause is concerned with the process or the mechanism by which a change occurs, rather than the design.

A. Atzilut (Emanation/Proximity) – Minimally Constrained Domain (M) in Observer Theory Extension

The domain where Sefirot / Categories exist in their most abstract form as "divine attributes" – the ways finite consciousness can establish relationship with infinite divinity via sampling.

Computational Character:

- Pure mathematics and logical necessity
- Platonic forms *(abstract structure prior to instantiation)*
- Formal causation *(what determines possibility itself)*
- Maximum possibility space *with minimal rule constraint*

Property:

$$\forall \boldsymbol{X} \in \text{"}\boldsymbol{Reality}\text{"}, \exists \boldsymbol{\phi} \in \text{"}\boldsymbol{Atzilut}\text{"}: \boldsymbol{X} \vDash \boldsymbol{\phi}$$

(For every existing thing, $\boldsymbol{X}$, there exists a formal principle, $\boldsymbol{\phi}$, in Atzilut that governs it.)
$X \vDash \phi$ *means that whenever* X *is true* ϕ *is also true*

B. Beriah (Creation) – Symbolically Constrained Domain (S) in Observer Theory Extension

Plain-English Context

This is the informational domain of pure ideas and abstract mathematical truth. Things like "2 + 2 = 4" or "a circle is the set of points equidistant from a centre" exist here, pre-linguistic capture (i.e. the actual geometric instantiation of the examples above as geometric objects in the Ruliad)

These truths don't depend on physical reality—they would be true even if no physical universe existed. If something doesn't exist as a logical possibility in Atzilut, it cannot exist at any lower level.

The domain of creation ex nihilo, where abstract forms begin individuating into distinct enumerable objects, though not yet physically instantiated.

Computational Character:

- Algorithms *(step-by-step procedures)*
- Abstract data types *(lists, trees, graphs as concepts)*
- All possible distinct objects can be enumerated
- Greater multiplicity (more rule-bounded) than Atzilut, but still pre-physical

Property: Objects in Beriah can be **counted** but not **measured** (discrete but not spatial).

Plain-English Context

This is like having the recipe (algorithm expressed symbolically) for baking a cake without having actually baked it yet. You can count how many different kinds of cakes are possible (chocolate, vanilla, etc.) and describe their structures, but no actual cakes exist yet. Everything is still information and instruction, not physical substance.

C. Yetzirah (Formation) – Valuationally Constrained Domain (V) in Observer Theory Extension

The domain where abstract objects take on specific configurational properties – data structures with defined relationships preparing for physical instantiation.

Computational Character:

- Configured data structures *(specific implementations)*
- Emotional / psychological forces *(anthropomorphically)*
- Intermediate domain between abstract information and concrete physical instantiation
- More rule-constrained than M / S domains, but not yet physically located

> ***Plain-English Context***
> *Now we're getting closer to physical reality. This is like having the assembled ingredients for your cake, measured and mixed according to the recipe, sitting in a bowl ready to bake. The structure is specific now (this particular cake, not just any cake), but it's still not the final physical product.*

Property: Objects have **relational structure** but not **spatiotemporal location**.

D. Asiyah (Action/Making) – Physically Constrained Domain (P) in Observer Theory Extension

The domain of physical manifestation where all higher patterns are implemented in matter and energy – the most constrained domain with the most rules about what is possible or impossible.

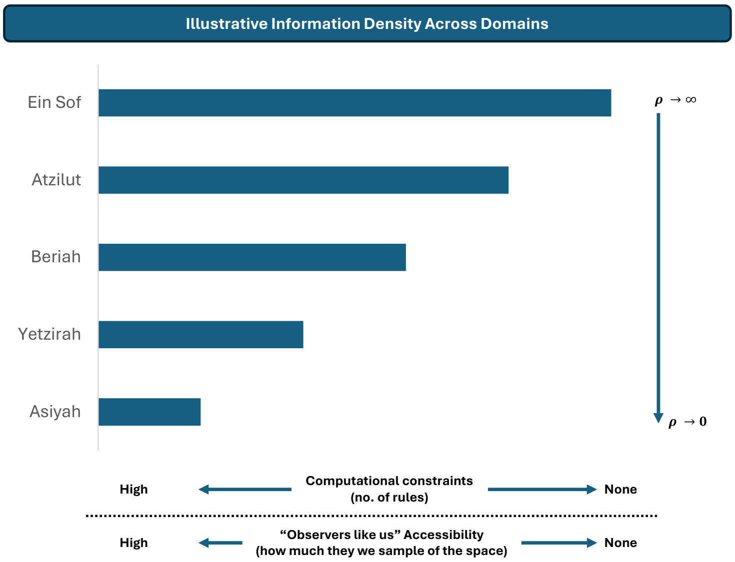
Computational Character:

- Running programs on hardware *(actual execution)*
- Physical objects with spatial extension
- Most rule constrained (and therefore, computationally reducible) enables stable Observable structures
- Furthest from Ein Sof = maximal distance / difference

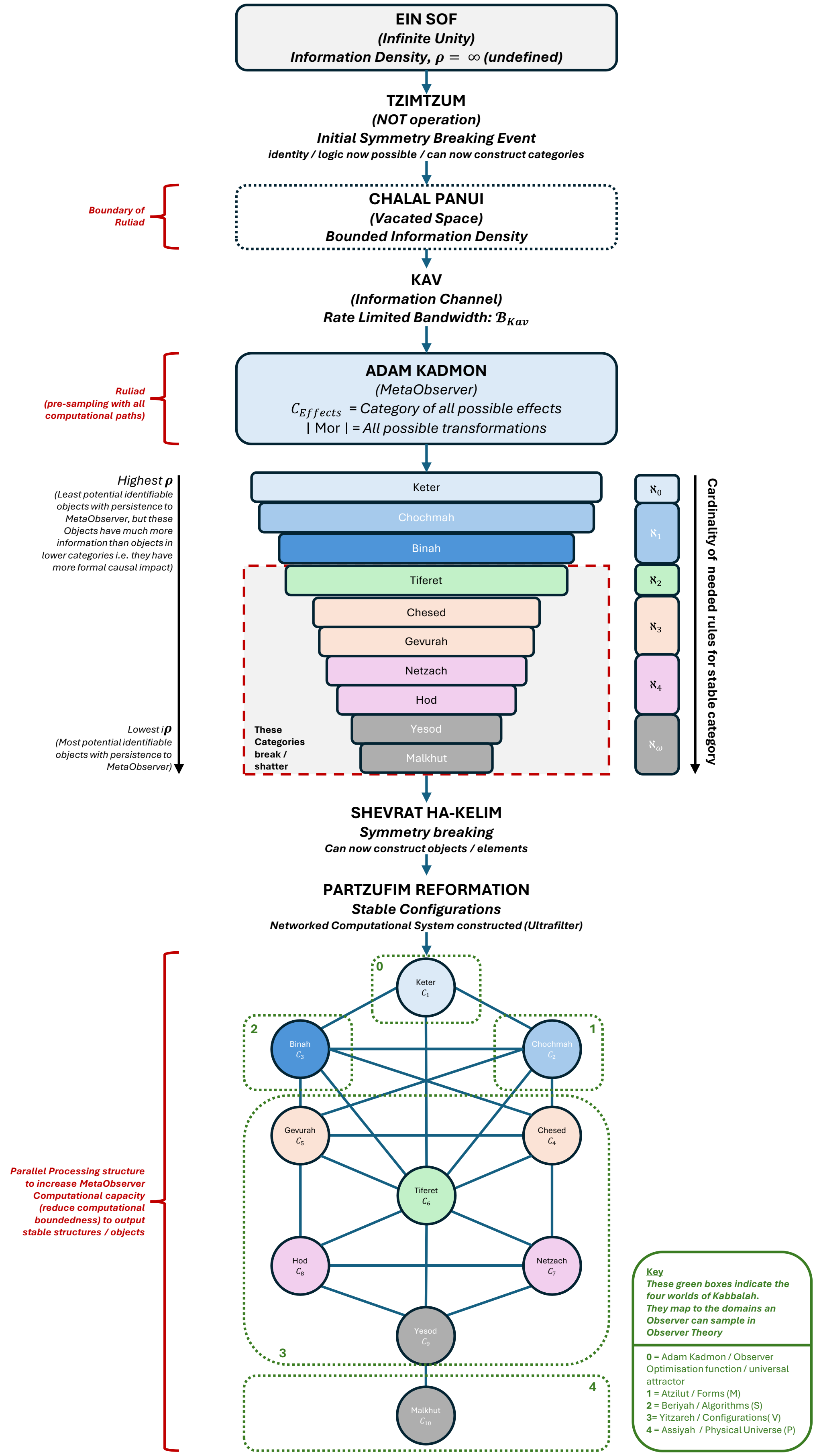
> ***Plain-English Context***
> *This is the physical universe we inhabit. The cake is baked, cooled, sitting on the counter. It has a specific location in space, exists at a particular time, obeys the laws of physics. Information has become matter. Abstraction has become concrete reality.*

Property: Objects have **spatiotemporal location** and obey **physical laws**.

<u>Diagram: Information Density Gradient Across Domains (Worlds)</u>



Visual: The Kabbalistic Emanation Sequence Computationally



Synthesis

Kabbalah reframes creation ex nihilo as creation via progressive information restriction and iterative distinction-making.

This process occurs within the Ruliad without violating logical principles. It is the act of selecting a computational path through possibility space, carving out our universe from the space of all possible universes.

The elegance of this model lies in its logical necessity: once Tzimtzum introduces a **NOT** operation, the rest follows from computational logic and the dynamics of complexity theory (simple categories are made first with less rules, to more complex categories with more rules).

The hierarchical structure presented represents a computationally efficient path from infinite unity to finite multiplicity.

> ***Note***
> *The following sections summarise Vedic Hinduism and Buddhism, utilising the language we have used above. We have not specified the computational model as we have with the Judaic sequence. We invite experts in these theological traditions to translate these summaries to formal language. The view of the author is that these traditions lend themselves well to this type of mapping.*

2. Vedic/Hindu Creation: From Consciousness to Matter[133]

The Vedic and Hindu traditions present creation as an eternal process – the breath of **Brahman**, the unified consciousness that manifests as all multiplicitous existence.

Unlike the Abrahamic emphasis on creation ex nihilo, Hindu creation narratives describe creation as the transformation of the eternal, unmanifest **Brahman** into the temporary, manifest universe. This is not creation from nothing (the Vacated Space) but the self-modification of Brahman into matter, or appearance / illusion of matter.

Brahman is described as **Sat-Chit-Ananda** (Existence-Consciousness-Bliss). **Sat** (Existence) is the ground of being the necessary predicate that must exist for anything to be manifest. **Chit** (Consciousness) is the awareness that knows itself and all possibilities within itself. **Ananda** (Bliss) is perfect fullness, the complete satisfaction that needs nothing outside itself.

In computational terms, Brahman can be compared to a trinity of **hardware** (Sat), **software** (Chit), and the completion of an **optimisation function** (Ananda).

The manifestation of the universe from **Brahman** occurs through **Maya,** often translated as 'illusion' but better understood as the creative force that makes the One appear as many. Computationally **Maya** is the emergent geometry / topology of the Ruliad – the way an infinite computationally substrate appears when sampled by a finite, computationally bounded Observer. It is necessarily holographic; it contains the whole in every part but shows different images from different angles. **Maya** creates the appearance of multiplicity without dividing the underlying unity.

The mechanism of creation is described through **Samkhya's** categories. First, a distinction between **Purusha** (consciousness) and **Prakriti** (primordial matter/energy). This is described as polarity within Brahman – the Observer and the Observed, the subject and the object, the knower and the known (note the similarity to the cause and effect dichotomy in Kabbalah, these both reduce to binary distinction). **Purusha** is passive, pure awareness without content. **Prakriti** is active, pure content without awareness. Their interaction creates all Observable experience.

Prakriti is composed of three **Gunas** (qualities): **Sattva** (harmony, knowledge, light), **Rajas** (activity, passion, change), and **Tamas** (inertia, ignorance, darkness). These are Hinduism's informational domains – different ways information can be processed and sampled. **Sattva** is akin to error-correcting code that maintain signal integrity from source. **Rajas** is akin to amplification that increases signal strength but adds 'noise' to the process. **Tamas** is akin to resistance that dampens signal but provides stability. All manifest reality emerges from the interplay of these three trinities.

The evolution of creation from subtle to gross (simple to complex) follows a sequence.

From **Prakriti** emerges **Mahat** or **Buddhi** – global intelligence and the first individualization of consciousness through different objects in potential. Computationally this is the first rule that runs in the Hindu Ruliad, the program that loads and makes all other programs possible. From **Buddhi** emerges **Ahamkara** – ego, the function that creates distinction between objects by bounding the concepts (i.e. different persistent objects in the Ruliad). This is like the operating system's kernel that manages the boundary between the system and the users space.

From **Ahamkara** emerge the **Tattvas** (categories): five sense organs (**Jnanendriyas**), five action organs (**Karmendriyas**), mind (**Manas**), five subtle elements (**Tanmatras**), and five gross elements (**Mahabhutas**). Each represents a different type of computation. The sense organs are input devices, the action organs are output devices, the mind is the CPU, the subtle elements are data types, and the gross elements are the physical substrate / hardware on which it all runs.

Hindu creation narratives are cyclic. Computational, each **Kalpa** (cosmic day) is a complete run of the Ruliad (c.4.3bn years). At the end of each **Kalpa** comes **Pralaya** (dissolution), when all manifestation returns to the unmanifest state. This is like clearing a computational memory (i.e. sending all objects to the 'trash') to allow new object creation. The cycles repeat eternally. Each cycle explores different parts of the Ruliad, here, the infinite possibility space inherent in the conception of **Brahman**.

---

3. Daoist Creation: The Self-Organizing Process[134]

Daoism presents creation as an entirely natural, self-organizing process requiring no external creator or conscious design. **The Dao** is not a being but a process, not a thing but a pattern, not a creator but creativity itself. The famous opening of the Dao De Jing states: "**The Dao that can be spoken is not the eternal Dao**." i.e. ultimate reality transcends conceptualization (and computation) because it is the process by which all concepts (and computational understanding of them) arise.

The cosmogony is elegant. From the **Dao** emerges **One** (unity, the undifferentiated whole). From **One** emerges **Two** (**yin** and **yang**, the primordial polarity that has similarities to binary distinctions in both Kabbalah and Hinduism). From **Two** emerges **Three**, the interaction of **yin** and **yang** and their harmonization (n.b. this shares structural similarity to the emanation of Chochmah and Binah in Kabbalah). From **Three** emerge the **Ten Thousand Things** (all phenomena). This is logical structure, a computational Turing machine that outputs categories where each subordinate category is implicit in and necessitated by the prior.

The mechanism of creation is **Wu Wei**, effortless action, the principle that complex order can emerge without force or intention (i.e. from something simple). Water flows downhill, plants grow toward light, ecosystems balance themselves. This is the path of least resistance (seen in physics in the principle of least action), which corresponds to the computationally efficient path for creations unfolding. In computational terms, **Wu Wei** is akin to gradient descent, the natural optimisation that occurs when systems follow local gradients toward global minima.

Yin and **Yang** are not substances or forces but complementary aspects of every process. **Yang** is active and expansionary, a positive feedback loop (an attractor) that reinforces a given computational path (essentially 'boosting' a signal). **Yin** is passive and contracting, negative feedback that stabilizes systems (and sets the boundary of computational objects). Neither can exist without the other; each contains the seed of the other; each transforms into the other in endless circulation. This is a dynamic equilibrium process, an engine that drives change.

The **I Ching** (Book of Changes) maps this process through 64 hexagrams, each representing a different configuration of yin and yang across six levels. It completely enumerates all possible states in their cosmogenesis in a six-bit system. Each hexagram transforms into others through changing lines. The result is a complete mapping of the Dao's possibility space, with a transition function between each domain of that space given a function that targets a global minima.

The Daoist vision suggests that complex order emerges from simple rules without external design (perhaps the clearest analogue to Wolfram's conception of the Ruliad). Beauty, consciousness, and meaning are not imposed from outside but arise naturally from the interactions of yin and yang across the domains. The sage is one who recognizes these patterns and aligns with them, achieving power not through force but through understanding and harmony with the computational process.

---

4. Comparative Synthesis

The remarkable convergence of these traditions, developed across different cultures, languages, and philosophical frameworks, suggest they are describing the same underlying computational structure from different perspectival angles.

Structural Feature	Kabbalah	Hinduism	Daoism
Infinite Source	Ein Sof	Brahman	Dao
Binary Distinction	Tzimtzum (presence/absence)	Purusha/Prakriti	Yin/Yang
Hierarchy Levels	10 Sefirot	~25 Tattvas	4 levels
Physical Domain	Asiyah	Mahabhutas	Ten Thousand Things
Information Gradient	Divine light → matter	Subtle → gross	Wu Wei optimization
Return Path	Tikkun Olam	Moksha	Returning to Dao

All three traditions describe the same process with different metaphors.

Plain-English Context

Each tradition developed sophisticated formal models millennia before modern physics and computation emerged. That these models translate so cleanly into computational language suggests they captured genuine features of reality's deep structure through prolonged observation and systematic contemplation.

Part B: Abridged Theological to Computational Glossary

The following glossary provides a "lossy" mapping between theological concepts and computational language. This is not exhaustive but offers the reader an intuitive bridges between these domains to aid comprehension.

N.B. These translations sacrifice richness for clarity. They are intended as conceptual scaffolding, not definitive identities.

From Section 5 (Kabbalah)

Theological Term	Computational Translation	Plain English Explanation
Ein Sof	Pre-Ruliad equilibrium state	The infinite "before" anything distinguishable exists—like pure white noise containing all sounds simultaneously
Tzimtzum	First **NOT** operator / binary distinction enabling identity functions	The first "no" that makes the concept of "yes" meaningful—like the first binary switch creating 0 and 1
Chalal Panui	Bounded information space / the limit of the Ruliad	The "room" created by limitation where finite things can exist without collapsing back into infinity
Kav	Rate-limited information channel	The "faucet" controlling how much infinity flows into finitude—prevents overwhelming and collapse
Adam Kadmon	Ruliad / MetaObserver that can compute everything but the point of topological closure (compactifying point-at-infinity)	The complete "operating system" determining what can exist and how—the master template for reality
Sefirot	Categories with decreasing cardinality	Nested "filters" removing possibilities—each one more specific than the last until you reach physical reality
Shevirat Ha-Kelim	Symmetry breaking event	When unified structure shatters into individual pieces—like liquid water freezing into separate ice crystals
Partzufim	Stable computational networks	Reformed stable patterns after shattering—like distributed processors working together
Shefa	Recursive information flow	The "current" of information flowing through the system—creates feedback loops and stable patterns
Four Worlds	Hierarchical computational domains	Levels from pure abstraction (math/logic) down to physical matter—each more constrained than the last

From Theology

Theological Term	Computational Translation	Plain English Explanation
Divine Will (Keter in Kabbalah)	Search function on possibility space	The "optimization algorithm" selecting which possibilities become actual from infinite options
Creation	Path actualization by MetaObserver	Choosing which computation to run from all possible computations—carving a universe from possibility space
Revelation	Information transfer across domains	Higher-level information becoming accessible to lower-level observers—always involves compression/translation
Miracle	Low-probability path selection	Lawful but extremely unlikely events—following rules but taking unusual route through possibility space
Prayer	Observer influence on path selection	Conscious participation in determining which possibilities actualize—consciousness affecting which computation runs
Soul	Individual Observer function / Ultrafilter	Your unique perspective and selection criteria—the particular "lens" through which you sample reality
Angels	Domain-specific computational agents	Specialized processes operating in higher domains—like dedicated subroutines for specific functions
Demons	Entropy-increasing patterns	Self-reinforcing processes that create disorder—necessary for exploring totality of possibility space
Physical Reality	Maximum-constraint domain	The most rule-bound level where matter appears solid and laws seem fixed—enables stable structures we can observe
Brahman	Complete Ruliad	Ultimate reality containing all possibilities—the infinite computational substrate underlying everything
Maya	Holographic projection function	How infinite unity appears as finite multiplicity from any bounded perspective (geometric necessity)

Part C: Proof Sketches

1. Why Limitation is a Logical Necessity

A central paradox in theology: If God is omnipotent, omniscient, and infinitely loving, why create an imperfect universe with suffering, limitation, and finitude?

The Paradox Restated:

Traditional theological questions manifest as:

- If God is omnipotent, why not create perfect beings in perfect worlds?
- If divine love is infinite, why allow suffering and evil?
- If divine knowledge is complete, why the elaborate process of evolution and history?

The God Conjecture argues that these questions **misunderstand the logical requirements for creation itself**.

We can only conceive of and discuss what something infinite does through limitation. Limitation of the infinite is what enables distinction between objects, the fundamental requirement for information to have any meaning at all.

> ***Plain-English Context***
> *For you to exist as "you" (not me, not a tree, not everything), there must be a boundary around "you-ness." If there were no boundaries, no distinctions, no limits, then everything would be everything else, which means nothing would be anything in particular. Information literally means "difference"—and difference requires limits.*

1.1 The Impossibility of Distinction Without Limitation

Conjecture: Necessity of Limitation for Information

Let **U** be the universal set of all logical possibilities. For any proposition **P** about an object **X**:

1. To assert "X exists" requires asserting "X is not not-X"
2. This requires: ∃Y: Y ≠ X (something exists that is not X)
3. Therefore: Boundaries distinguishing X from not-X must exist
4. Therefore: Limitation (constraint defining boundaries) is necessary for any object's existence

Proof Sketch: Consider Ein Sof's properties: infinite, undifferentiated, unchanging, without boundary or distinction.

In such a state:

- For any property P: Both P and ¬P are simultaneously actual (paradox)
- Consequently, no particular object can be distinguished from any other
- The identity function cannot determine X = X vs. X ≠ Y
- Shannon information H(X) is undefined

For X to exist as distinct from Y:

$$X \cap Y^c \neq \emptyset \text{ and } Y \cap X^c \neq \emptyset$$

This requires boundaries: regions where X is true and Y is false, and vice versa.

In pure undifferentiated unity, no such boundaries can exist. Therefore, no particular thing can exist.

> ***Plain-English Context***
> *It's like trying to have a conversation where every word means the same thing. "Dog" means "cat" means "tree" means "justice" means "purple." Nothing can be communicated because nothing is distinct from anything else. For meaning to exist, words must have boundaries—this means "dog" and that doesn't mean "dog."*

1.2 Computational Boundedness and Observer Limitations

This is a logical necessity given how Observers like us understand reality.

Conjecture: Fundamental Observer Constraints

We can only understand processes through cause-and-effect structures (and subordinately, through logic). Our computational boundedness means:

1. We cannot directly comprehend contradictions as simultaneously true
2. We cannot process infinite information in finite time

3. We cannot distinguish objects without boundaries between them

Similarly: Ein Sof (or the equivalent in other major traditions) cannot directly create distinct beings while remaining absolutely undifferentiated. The very act of creation requires distinction, and distinction logically requires limitation to instantiate the formal definition of information.

> ***Plain-English Context***
> *This isn't about what God can or can't do "in reality"—it's about what we can conceive of and understand. We think in terms of cause and effect, logic, distinctions. A "square circle" isn't impossible because reality forbids it, but because our minds can't even form a coherent concept of what that would mean. Similarly, "distinct beings without distinction" is not a coherent concept.*

1.3 Tzimtzum as Logical Necessity

For any infinite, undifferentiated unity to generate finite, distinct entities, a limiting operation must occur.

Proof Sketch:

Let **U** = universe of all possibilities (computationally, the Ruliad)

Claim: For distinct objects to exist within U, a constraint function must apply.

Proof Sketch:

1. In Ein Sof: $\forall x \in U$, x is actual (all possibilities simultaneously realized)
2. If all possibilities are actual, then no particular possibility is distinguishable
3. For any property P: Both P(x) and ¬P(x) are true for all x
4. This makes P informationally meaningless: H(P) = undefined
5. Information requires: $\exists x,y$: $P(x) \neq P(y)$ (difference between states)
6. This requires: Some possibilities are actual while others remain potential
7. Therefore: A selection function $F: U \to U' \subset U$ must exist
8. This is precisely what we call describe as Tzimtzum in Section 5 (divine self-limitation)
9. Tzimtzum ≡ ¬ (**NOT** operator creating first binary distinction)

Therefore: Theological creation and computational creation necessarily proceed through informational limitation.

> ***Plain-English Context***
> *If a library contained every book (including every random sequence of letters), you couldn't find any particular book because the meaningful books would be drowned in infinite gibberish. To have "a book" rather than "all possible letter sequences," you must exclude most possibilities. Tzimtzum is God excluding some possibilities so that particular things can exist.*

1.4 Why Sequential Emanation Rather Than Instant Creation?

The elaborate hierarchy of emanations is mathematically necessary.

Conjecture: Sequential Complexity Necessity

A system with n binary distinctions generates 2^n possible states. To specify a particular state requires n bits of information processed sequentially.

Proof Sketch:

1. Each binary distinction adds one bit: $\mathbf{I = \log_2(n)}$ where n = number of distinguishable states
2. Even an infinite intelligence (MetaObserver) processes distinctions sequentially (hypergraph updates in Ruliad parlance)
3. Each distinction changes context for all subsequent distinctions
4. Therefore: Order matters and sequence is unavoidable
5. Higher categories must be established before lower categories become informationally meaningful

> ***Plain-English Context***
> *Even if God could think infinitely fast, logic still imposes sequence. You can't have "the number 5" before you have "numbers".*
> *You can't have "this particular tree" before you have "physical objects" in general. The hierarchy is the only logical structure of how specific things emerge from general possibilities.*

Example Dependency Trees:

- Cannot have **physical space** without first having **concept of extension**
- Cannot have **extension** without first having **distinction** (here vs. there)
- Cannot have **distinction** without first having **NOT operation** (Tzimtzum)

The emanative hierarchy is computationally necessary: each level provides the foundation for the next. You cannot skip steps without violating logical coherence.

i.e. progression isn't temporal (happening "in time") but logical (each stage necessitates and enables the next).

2. Why the Ruliad Serves as Our Computational Model (Formally)

The correspondence between the Kabbalistic emanation, other religious schemas and Wolfram's Ruliad are structural. Both describe reality as emerging from Observer-imposed sampling constraints (*rules*) on an infinite computationally (*understandable*) substrate.

Both recognize observation (*and it's higher-complexity form, consciousness*) as fundamental to the process. Both locate physical reality as the maximum constraint regime where infinite possibilities crystallise into an actual universe.

2.1 Structural Correspondences

Adam Kadmon / MetaObserver ↔ The Unsampled Ruliad

Both represent:

- The totality of all possible computations *(cause-effect structures)*
- The limit of all computational processes
- Logically necessary existence *(non-existence is self-contradictory)*
- The boundary between hypercomputation (which to us seems continuous) and bounded computation (described in discrete steps)

Adam Kadmon / MetaObserver (sometimes called a 'maximally entangled Observer') is defined as the category of "everything that is NOT the uncaused cause" – precisely what the Ruliad represents: the space of all possible effects (computational outputs) given some initial rules.

> ***Plain-English Context***
> *Adam Kadmon and the Ruliad both refer to "everything that could possibly happen according to rules." It's the complete space of cause-and-effect before any particular cause-effect chain is selected. Neither can fail to exist, because the claim "there is no space of possibilities" is itself a claim within that space—self-contradictory.*

Formal correspondence:

$$\mathcal{C}_{AK/Effects} = \{X: \exists c, c \rightarrow X\} = \textbf{Ruliad as set of all outputs}$$

Emanations ↔ Observer Sampling

The Sefirot correspond to different observational regimes within the Ruliad, characterised by:

- Different computational bounds
- Different information integration levels
- Different cardinalities of accessible morphisms
- Higher Sefirot = less constrained sampling → access to more Ruliad structure
- Lower Sefirot = more constrained sampling → access to less structure but more specific detail

Physical Reality ↔ Maximally Constrained Domain

Our physical universe corresponds to Malkhut (Kingdom) / Asiyah (Action), the domain where:

- Maximum number of rules apply *(most constraints)*
- Observers can only perceive tiny Ruliad slice *(our physics)*
- Matter appears solid and laws appear fixed
- Yet this slice still encodes *(in compressed / coarse-grained form)* information about all higher levels

This explains:

- Why physics discovers mathematical laws (*laws exist in higher Atzilut domain*)
- Why consciousness can access transcendent states *(can sample higher domains)*
- Why the universe seems both law-governed and creative *(constrained by computational boundedness despite exploring innumerate possibilities)*

2.2 Classical Theological Attributes in Ruliad Structure

Every attribute classical theology ascribes to God emerges from the Ruliad's structure:

A. Necessary Existence

Theological Claim: God exists necessarily; God's non-existence is logically impossible.

Ruliad Parallel: The Ruliad exists necessarily because denying it creates contradiction:

Proof Sketch:

- Suppose: "The Ruliad does not exist" (i.e., there is no space of all possible computations)
- But: This supposition itself is a computation (a logical operation)

- Therefore: There exists at least one computation (the denial itself)
- But if one computation exists, the space of computations exists
- Contradiction
- Therefore: The Ruliad necessarily exists.

B. Omniscience

Theological Claim: God knows everything actual and everything possible.

Ruliad Parallel: The Ruliad contains all possible sampleable information because it contains all possible computations that could generate or process information.

Every fact $\boldsymbol{F}$, every thought, every state S exists somewhere in the Ruliad:

$$\forall \boldsymbol{F}: \exists \boldsymbol{c} \in \textbf{Ruliad}: \boldsymbol{c} \textbf{ computes } \boldsymbol{F}$$

This matches theological omniscience precisely: knowledge not just of actualities but of all possibilities.

> ***Plain-English Context***
> *If something is knowable at all, then there's a computation that could know it. Since the Ruliad contains all possible computations, it "knows" everything knowable—not because it's thinking about everything, but because every possible thought exists within it somewhere.*

C. Omnipotence

Theological Claim: God can do anything logically possible.

Ruliad Parallel: The Ruliad can generate any possible reality because it contains all possible generative processes.

Any universe $\boldsymbol{U}$that could exist is present in the Ruliad as a possible computational path:

$$\forall \boldsymbol{U} \in \textbf{Possible Universes}: \exists \textbf{path} \in \textbf{Ruliad}: \textbf{path generates } \boldsymbol{U}$$

This corresponds with theological omnipotence: ability to actualize anything logically possible (excluding logical contradictions like "square circles").

> ***Plain-English Context***
> *If a universe could exist at all (even just as a logical possibility), then the Ruliad contains the computation that would generate it. This is like having every possible program on your hard drive—anything your computer could do, those programs can accomplish*

D. Omnipresence

Theological Claim: God is present everywhere; all places exist "within" God.

Ruliad Parallel: The Ruliad is present "everywhere" because physical space emerges from the Ruliad (Wolfram's contention) rather than the Ruliad existing within spacetime.

Every point in space $\boldsymbol{p}$, every moment in time $\boldsymbol{t}$, every quantum event $\boldsymbol{q}$ is a structure in the Ruliad:

$$\textbf{Spacetime} \subseteq \textbf{Ruliad (as emergent Observer sampleable structure)}$$

This is what theology means by divine omnipresence: not being spatially located everywhere but acting as the ground within which all possible spatiotemporal locations exist.

> ***Plain-English Context***
> *Space doesn't contain the Ruliad; the Ruliad, to bounded Observers generates space. It's like how a computer program creates a virtual world—the virtual world is "inside" the program. Similarly, our physical universe is somewhere "inside" the Ruliad's computational structure.*

E. Divine Simplicity

Theological Claim: Despite infinite complexity, God is absolutely simple (has no parts).

Ruliad Parallel: Despite containing infinite complexity, the Ruliad has an extremely simple definition:

$$\textbf{Ruliad} := \lim_{n \to \infty} \bigcup_{\textbf{all rules } r} \{\textbf{results of applying } r \textbf{ for } n \textbf{ steps}\}$$

In words: "Take all possible computational rules, run them for all possible steps, take the limit."

This paradox of infinite complexity from simple rules is weakly equivalent with the theological doctrine of divine simplicity, God has no parts yet contains all.

> ***Plain-English Context***
>
> *The rule* ***"2^n grows without limit"*** *is incredibly simple to state but generates infinite complexity. Similarly, the Ruliad's definition is simple, but what it contains is infinitely complex.*

F. Transcendence and Immanence

Theological Claim: God is both transcendent (beyond creation) and immanent (within creation).

Ruliad Parallel: The Ruliad as a whole transcends any particular Observer's sampling, yet every sampling exists within the Ruliad:

For any Observer $\boldsymbol{O}$: $\mathcal{R}_O \subset$ **Ruliad (strict inclusion)**
Yet: $\boldsymbol{O} \in$ **Ruliad (Observer is part of what they observe)**

> ***Plain-English Context***
>
> *You exist inside the Ruliad, observing part of it. But the Ruliad is vastly larger than what you can see—transcending your perspective while including you within it. Like how your consciousness is part of your brain, but your brain processes far more than reaches conscious awareness.*

This resolves the ancient theological puzzle: The Ruliad contains every possible universe (immanence), yet no single universe is outside the Ruliad if it's sampleable by finite Observers of any kind (transcendence).

---

3. How We're Using the Ruliad and Observer Theory In The God Conjecture

Observer Theory formalises how computationally bounded entities sample the infinite Ruliad.

This provides precise mechanisms for understanding observation and the emergence of physical reality.

3.1 Observation as Fundamental (Not Emergent)

Critical Inversion:

Standard materialist paradigm:

- Matter exists fundamentally
- Complexity emerges
- Consciousness somehow arises from complex matter (the "hard problem")

God Conjecture paradigm:

- Computation/possibility exists fundamentally
- Observation/measurement selects particular computational paths
- Matter emerges from observation, not vice versa

> ***Plain-English Context***
> *The usual view says: "stuff exists, gets complicated, becomes conscious."*
> *The God Conjecture says: "possibilities exist, consciousness selects among them, stuff emerges."*
> *It's not that rocks eventually become conscious—it's that consciousness is what makes "rocks" appear as distinct things in the first place.*

In the Ruliad, observation is necessary to output physics (as it is for classical physics in QM). Without selection determining which computational path actualizes, no particular reality manifests – all possibilities remain in superposition.

3.2 The Hard Problem Dissolution

Traditional Hard Problem:

Even if we completely understand:

- Brain structure (neurons, synapses, etc.)
- Information processing (neural networks, computation)
- Behaviour (responses, actions, reports)

...we still don't explain: *Why is there subjective experience? Why does it "feel like something" to be conscious?*

God Conjecture Resolution:

The question assumes consciousness emerges from physics. But if physics emerges from observation (consciousness as a special class thereof), then the question reverses:

"Why do physical processes produce consciousness?" becomes "Why do observations produce physical appearances?"

The second question has a clear answer: *Physical reality is what observation looks like from inside the system being observed*.

> ***Plain-English Context***
> *Asking "how does the brain create consciousness" is backwards—like asking "how do TV images create the broadcast signal." The signal creates the image, not vice versa. Similarly, consciousness selecting among possibilities creates the appearance of physical brains.*

3.3 Free Will and Determinism Reconciled (Compatibilism)

The Traditional Dilemma:

- If physics is deterministic (or deterministic + random), then our choices are predetermined (or random)
- But we experience ourselves as making genuine choices with causal power
- Apparent contradiction

God Conjecture Resolution via Computational Irreducibility:

Even though the Ruliad contains all possible computations (including the one you're experiencing), determining which computation you're experiencing requires running that computation. **You cannot shortcut to the answer.**

Definition: Computational Irreducibility

A process is computationally irreducible if the fastest way to determine its outcome is to run the process itself – no shortcut exists.

Your choices are computationally irreducible. Even though "from outside" (if such a view were possible) your path is determined, "from inside", you must make the choice to know what you'll do.

> ***Plain-English Context***
> *Imagine a maze with one solution, but the only way to find that solution is to walk through the maze. From a bird's-eye view the path you'll take is fixed. But experiencing the maze, you genuinely have to decide at each fork. Your experience of choice is real even though the outcome was "always" determined. This is compatibilism: free will and determinism are compatible because they're perspectives at different levels of description.*

Formal Statement:

From the "view from nowhere" (God's perspective, outside the system):

$$\textbf{Your choices at time } t \textbf{ are determined by: } \mathcal{R}_O(t_0), \mathcal{F}_O, \mathcal{T}(t_0 \to t)$$

But that viewpoint is computationally inaccessible to you:

To know your choice at t, you must compute up to t (actually experience up to that moment)

*You can't "look ahead" to see what you'll choose because the act of looking ahead is itself a choice that changes the systems state. **Computational irreducibility** preserves genuine agency within deterministic structure.*

3.4 Meaning Through Selection

If reality contains, in potential, all possibilities, meaning cannot derive from content (which includes everything) **but must derive from selection**.

Analogy

A library containing every possible book (including every random letter sequence) would be meaningless – you can't distinguish Shakespeare from gibberish.

Meaning arises when:
1. Some books are selected over others (curation)
2. Selection follows patterns (genres, quality, themes)
3. Context provides interpretation (understanding)

Similarly:

The Ruliad contains all possible computations (both meaningful and meaningless to Observers like us). Meaning emerges when:
1. Observers select particular computational paths
2. Selection follows optimisation *(persistence, minimising boundedness, information integration)*
3. Experience provides interpretation *(qualia, understanding)*

> ***Plain-English Context***
> *If reality contained every possible story simultaneously, no particular story would mean anything. Meaning requires choosing one story over another. Your life has meaning because you're living this particular path through a space of infinite possibilities, making these particular choices, integrating these particular experiences.*

The God Conjecture posits that Observer selection (choice), constrained by rules, generates meaning (integrated information) from the meaningless totality of all possibilities.

---

4. The God Conjecture, like the God Debate, is Ultimately Unprovable

The God Conjecture – that a computational argument provides the most explanatorily powerful model for reality, including for what theology calls "God" – cannot be proved or disproved from within the system.

Parallel to Gödel Incompleteness:

Gödel's First Incompleteness Theorem: Any sufficiently complex formal system cannot prove its own consistency from within itself.

Similarly: We are Observers within the system (Ruliad) we're trying to prove things about. We cannot step outside to gain the "view from nowhere" that would enable absolute proof.

This creates irreducible circularity.

> ***Plain-English Context***
> *Akin to proving your brain works correctly using only your brain. You can't verify your thinking is reliable without using that same thinking. Similarly, we can't prove reality works a certain way without using our experience of reality, which might itself be part of the pattern we're trying to prove.*

4.1 Why This Doesn't Make Claims Equivalent

Unprovability ≠ epistemic equivalence. Some interpretations remain vastly more coherent, explanatory, and useful than others despite ultimate undecidability.

Criteria for Evaluating Frameworks:

1. **Explanatory Power**: How many phenomena does it account for?
2. **Internal Coherence**: Are its principles logically consistent?
3. **Predictive Accuracy**: Does it generate testable predictions?
4. **Parsimony**: Is it unnecessarily complex?
5. **Integration**: Does it unify previously disconnected domains?

The God Conjecture scores highly on all five:

1. ***Structurally Explains***: *Emergence of consciousness, free will, mathematics utility, fine-tuning, religious evolution, Observer-dependence and measurement*
2. ***Coherent***: *No internal contradictions; resolves paradoxes plaguing materialism and traditional theism*
3. ***Predictive***: *Generates testable hypotheses (see Part D)*
4. ***Parsimonious***: *Single framework (computational Ruliad), subsystems (physics, philosophy, sociology, math) in one shared language*
5. ***Integrative***: *Unifies domains of inquiry but doesn't take away from specificity of sub-domains*

> ***Important Note***
> *Even if **we can't prove it absolutely**, this framework makes sense of far more things, with fewer assumptions, while making testable predictions. That's the best we can do within any system. Like how we can't absolutely prove mathematics is consistent, but it works so well we proceed as if it is.*

4.2 Preserving Space for Faith and Reason

If the conjecture could be proven, faith would be compelled and genuine choice would vanish, violating the requirement that high-complexity, self-referential observation (consciousness) has meaningful selection power (free will).

If it could be disproved, meaning and purpose would be illusory, a conclusion that undermines the very rationality used to reach it.

The undecidability preserves:

- **Epistemic humility** *(we cannot know everything)*
- **Moral responsibility** *(choices matter because outcomes aren't predetermined for any agent in the system)*
- **Genuine inquiry** *(truth-seeking remains meaningful)*
- **Spiritual commitment** *(faith adds something at the limit of inquiry)*

> ***Plain-English Context***
> *If God were provable, belief wouldn't be a choice. If God were disprovable, seeking meaning would be obviously pointless. The uncertainty in between is what makes genuine choice, growth, and discovery possible.*

The God Conjecture is designed to be rigorous enough for scientific investigation, open enough for spiritual engagement and practical enough for lived experience.

Part D: If You Can't Prove It Why Should I Care? (says the Atheist and the Reductive Theist)

While the Conjecture is ultimately undecidable, it generates specific predictions that distinguish it from traditional theology.

These are empirically testable, enabling the framework to interact with empirical research programs.

---

1. Selected Testable Predictions

1.1 Consciousness and Quantum Properties

Prediction: If consciousness / observation is fundamental, conscious states should interact with quantum systems in measurable ways beyond classical information processing.

Empirical Support:

- **Orch-OR (Orchestrated Objective Reduction)**[135]: Penrose-Hameroff theory proposes consciousness arises from quantum computations in neuronal microtubules, with objective reduction of quantum superpositions playing a causal role.
- **Experimental Evidence**: Recent studies (2022-2024) found quantum coherence in warm biological systems lasting longer than predicted, with microtubules maintaining quantum states at brain temperature.

> ***Plain-English Context***
> *If consciousness is just classical computation (like a regular computer), it shouldn't interact with quantum effects any differently than any other warm, wet, noisy biological process. But if consciousness is about selecting quantum possibilities, we'd expect to find quantum properties*

Test Design Sketch: Compare quantum decoherence rates in conscious vs. unconscious neural tissue; measure quantum entanglement signatures during high vs. low consciousness states (anaesthesia, sleep, waking).

1.2 Multi-Scale Information Integration[136]

Prediction: If the Sefirot/Four Worlds represent real computational domains (P, V, S, M, in Observer Theory Extension) then consciousness should sample information across multiple scales, not single-level processing.

Empirical Support:

- **IIT Multi-Scale Structure**[137]: Recent work extending Integrated Information Theory (2024-2025) demonstrates consciousness integrates information across multiple spatial and temporal scales simultaneously.
- **Experimental Findings**[138]: fMRI and EEG studies show conscious experience correlates with information integration patterns spanning:
  - Local (neuronal assemblies, ~10-100 neurons)
  - Mesoscale (cortical columns, ~10,000 neurons)
  - Global (whole-brain networks, ~100 billion neurons)
  - Cross-scale (simultaneous integration across levels)

> ***Plain-English Context***
> *If consciousness were just neurons firing, you'd expect all the action at one scale – say, the level of individual brain cells. But consciousness actually integrates information from tiny (single neurons) to huge (whole-brain patterns) simultaneously, like how music includes individual notes, chords, melodies, and overall structure all at once. persisting in neurons longer than thermodynamics predicts – and we do.*

Test Design Sketch: Measure information integration Φ across scales; conscious states should show higher cross-scale integration than unconscious states; verify hierarchy matches a domain structure (not prejudicing the Observer Theory / theological structure detailed herein).

1.3 Goal-Directed Behaviour in Non-Neural Systems

Prediction: If Telos (goal-directedness toward higher information integration) is fundamental rather than emergent, even simple systems should exhibit goal-directed behaviour.

Empirical Support[139]***:***

- **Michael Levin's Xenobots**: Frog skin cells, removed from their normal context and placed in new configurations, spontaneously reorganize to create novel locomotive organisms (xenobots) with goal-directed behaviour.
- **Minimal Cell Cognition**: Single-celled organisms demonstrate problem-solving, memory, and goal-directed navigation without neurons.
- **Sorting Algorithms**: Levins' team demonstrated non-neural tissue can be "trained" to solve computational sorting problems through bioelectric signalling.

> ***Plain-English Context***
> *We usually think goal-directed behaviour (like seeking food or solving problems) requires brains. But Levin's experiments show even simple cells and tissues without neurons can exhibit goal-directed activity—they're "trying" to optimise something. This suggests goal-directedness is deeper than brain structure.*

Test Design Sketch: Take progressively simpler systems (cell clusters → single cells → chemical systems) and test for optimisation behaviour; we predict performance scaling with information capacity of the system.

1.4 Prayer and Consciousness Effects

Prediction: If prayer/meditation represents Observer influence on path selection through focused states, then collective consciousness should influence quantum random systems.

Empirical Status:

- **Global Consciousness Project**[140]: Controversial network of quantum random number generators (RNGs) worldwide showing statistically significant deviations from randomness correlated with major global events (9/11, tsunamis, royal weddings).
- **Statistical Analysis**: Meta-analysis (Dean Radin et al., 2024) of 30+ years of mind-matter interaction studies shows small but significant effects ($p < 10^{-6}$).
- **Sceptical Interpretation**: *Critics argue effects are small, publication bias exists, and replication is inconsistent.*

> ***Plain-English Context***
> *When millions of people focus attention simultaneously (like during 9/11), collective focused Observation should influence random number generators—quantum devices specifically designed to be as random as possible. Some data suggests this happens;* ***sceptics say the effects are too small and inconsistent to trust.***

Test Design Sketch: Pre-register predictions before major events; use improved technology; control for multiple comparisons; open data and analysis; independent replication.

1.5 Mystical Experience and Neural Patterns

Prediction: If mystical experiences involve sampling less constrained domains (moving toward minimally rule-bound domains with more causal coverage), brain imaging during these states should show decreased activity in areas associated with self-other distinction and increased activity in integration networks.

Empirical Support:

- **Default Mode Network (DMN) Suppression**[141]: Studies of meditation, psychedelic experiences, and mystical states consistently show decreased DMN activity—the network associated with self-referential thinking and boundaries.
- **Global Integration Increase**[142]: Simultaneously, measures of whole-brain integration and connectivity increase during mystical experiences.
- **Phenomenological Correspondence**[143]: Subjective reports consistently describe dissolution of self-other boundary, unity, timelessness, ineffability, noetic quality (sense of deep truth).

> ***Plain-English Context***
> *When people have mystical experiences (via meditation, psychedelics etc.), brain imaging shows the "self-boundary" network quiets down while the "everything connected" network activates. This matches qualitative reports.*
> *It's like turning down the filter, letting you experience more of the Ruliad's structure.*

Test Design Sketch: Compare brain states across mystical traditions (Buddhist, Christian contemplative, Sufi, etc.); predict convergent patterns despite different theological frameworks and meditative practices; correlate neural signatures with phenomenological reports.

1.6 Mathematical Discovery and Intuition[144]

Prediction: If mathematics exists in minimally constrained domains and mathematicians access this through intuition, then:

- Mathematical insights should sometimes arrive complete before formal proof
- Brain states during mathematical insight should resemble mystical states
- Different mathematicians should independently discover identical structures

Empirical Support:

- **Historical Pattern**: Major mathematical breakthroughs consistently report intuitive leaps: Poincaré's breakthrough on Fuchsian functions, Ramanujan's dream-delivered formulas, Gauss's "Thunderbolt" insight.
- **Neuroscience**: Brain imaging during mathematical insight shows: DMN suppression, increased right hemisphere activity, similarity to aesthetic and mystical experiences.

- **Independent Discovery Should be Consistent Through Time**: Calculus (Newton/Leibniz), non-Euclidean geometry (Bolyai/Lobachevsky/Gauss), identical patterns suggest accessing shared minimally constrained space.

Plain-English Context

Mathematicians consistently report insights "coming to them" fully formed, often in dreams or random moments. Brain scans during these "eureka" moments should look similar to mystical experiences (1.5).

Test Design Sketch: Real-time neural monitoring of mathematicians working on novel problems; compare brain states during insight vs. calculation; test phenomenological reports.

2. Philosophical Implications and Problem Resolutions

The God Conjecture resolves (or substantially reframes) numerous classical philosophical problems that have resisted solution in both materialist and traditional theological frameworks.

2.1 Mind-Body Problem (Reconceived)[145,146,147,148]

Traditional Problem: How can an immaterial mind causally interact with material body if they're fundamentally different substances?

God Conjecture Dissolution:

Mind and body are not separate substances, they're different observational perspectives on the same computational process:

- **Mind (Internal)** = subjective experience of selecting paths through Ruliad
- **Body (External)** = objective appearance of those selected paths as observed by other Observers
- **Unity** = created in the act of observation that simultaneously produces both

The "interaction problem" dissolves because there's nothing to interact with. Duality is perspectival.

2.2 Fine-Tuning Problem (Anthropic Principle Reconsidered)[149,150,151]

Traditional Problem: Physical constants appear finely tuned for life. Change any slightly and life becomes impossible. Why this remarkable "coincidence"?

God Conjecture Resolution:

Weak Anthropic Principle (Conventional): We necessarily observe parameters compatible with observers (selection bias).

Strong Version (God Conjecture): Physical constants (rules) optimise Observers accessible Ruliad, R_O to enable Observers to Integrate the most information, in the minimum time steps i.e. the 'fastest path' (least hypergraph updates) to maximal information integration given Observer constraints[152,153].

Formal Statement:

The physical constants Con we observe minimize:

$$\boldsymbol{Physical\ Constants = Min(\ T_{emergence}), Max(R_{O,}\phi_O\ )}$$

where:

- $T_{emergence}$= time to Observer emergence
- ϕ_O = information integration capacity of Observers
- R_O = scope of Ruliad exploration possible (i.e. the 'part' of the Ruliad we can explore given our observational constraints)

> ***Plain-English Context***
> *Physical constants don't just allow life (weak anthropic principle). They're optimised to produce life* ***as quickly as possible****, with* ***maximum learning capacity****, able to* ***explore the widest range of possibilities****. Here, the strong anthropic principle says the universe is tuned not just to allow observers, but to produce observers who can understand as much as possible as fast as possible (in theology this manifests in phrases like "God designed the world for man" or in philosophy this is Leibniz's conception of "the best of all possible worlds").*

This leads to ***Telos i.e. an information integration optimisation*** *built into reality's structure, emerging from the necessity of Observer-selection 'filling' the computational space, aiming for topological closure (never reached) i.e. an ultimate attractor in possibility space.*

2.3 Problem of Evil (Reconceived)

Traditional Problem: If God is omnipotent, omniscient, and perfectly good, why does evil/suffering exist?

God Conjecture Reframing:

We offer a structural explanation:

1. **Limitation Necessity**: For distinct beings to exist, limitation is logically required *(proof sketch in Part C)*
2. **Full Exploration**: For maximum possibility space coverage (via information integration), all paths must be explorable including ones that are computationally inefficient compared to the overarching telos
3. **Meaningful Choice**: For genuine agency, possibility of wrong/harmful choices must exist alongside right/beneficial ones
4. **Computational Requirement**: 'Evil' is a feature, not a bug, enabling exploration of the complete possibility space

Formal Statement:

For an Observer, **O**, to integrate information about the accessible Ruliad:

$$\mathcal{R}_O = \mathcal{R}_{good} \cup \mathcal{R}_{neutral} \cup \mathcal{R}_{harmful}$$

Removing $\mathcal{R}_{harmful}$ reduces total information integration capacity:

$$I(\mathcal{R}_{good} \cup \mathcal{R}_{neutral}) < I(\mathcal{R}_{good} \cup \mathcal{R}_{neutral} \cup \mathcal{R}_{harmful})$$

> ***Plain-English Context***
> *Imagine trying to understand light without darkness or pleasure without pain. Full understanding requires experiencing access to the dialectic opposite (i.e. the full range). A universe without the possibility of wrong choices, suffering, or evil would be informationally impoverished, observation couldn't fully explore the space of all possibilities.*

> ***Important Note***
> *This doesn't justify any particular evil (individual suffering remains tragic) but explains why the possibility of evil exists in the structure: complete exploration requires exploring everything, including what shouldn't be chosen.*

Here, the MetaObserver (and any sub-observers) must cover the entire topos to approach the equilibrium state (get arbitrarily close to it, at the limit, whilst maintaining a separate identity).

That coverage necessarily includes the harmful regions.

2.4 Ground of Morality (Objective yet Emergent)

Traditional Problem: Are moral facts objective (i.e. they exist independently of minds) or subjective (mere preferences)? If they're objective, what grounds them? If they're subjective, can we make genuine moral claims?

God Conjecture Resolution:

Moral truths are optimal informational gradients in the Ruliad structure that enable Observers to explore the topos efficiently. They are objective features of computational reality to Observers of sufficient complexity.

Formal Characterization:

Moral facts = paths that optimise Observer information integration:

$$\text{Moral(for action } a) \iff \mid \mathrm{I}(\mathrm{R}_a) > 0, for\ all\ t_n \to t_{n\to\infty}$$

where $I(R_O)$ is the Observer's integrated information about the entire topos.

> ***Plain-English Context***
> *Moral truths are like physical laws for high complexity, self-referential observers (i.e. conscious) that have access to informationally rich domains (V, S, M). Just as objects follow physics (F=ma, gravity, etc.), conscious beings discover moral principles that enhance understanding their ability to integrate information.*

Characteristics of Computational Morality:

- **Objective**: Optimised moral laws exist independent of any particular Observer's beliefs
- **Discoverable**: Found through reason (S-domain), experience (P, V, S domains), contemplation (M-domain)
- **Universal**: Apply to all Observers of that class universally (though implementation varies)
- **Practical**: Guide behaviour toward improving optimisation function *(akin to the 'best' way to traverse a fitness gradient in physical evolution at a higher level of observation)*
- **Grounded**: Necessity due to presence of ultimate attractor in computational topos

Here, "love your neighbour" isn't arbitrary, it's an optimisation to cover more of the accessible space, R_O, faster.

Cooperation, compassion, truth-seeking, and justice enhance our ability to integrate information. Harm, deception, selfishness, and cruelty degrade this.

In the God Conjecture, ethical laws are like physical laws for Observers like us.

2.5 Meaning (Computational Purpose)

Traditional Problem: In a vast universe, does life have genuine meaning and purpose, or are we cosmic accidents in a meaningless void?

God Conjecture Resolution: **In a universe containing all computational possibilities, meaning emerges from selection:**

Three Potential Sources of Meaning:

1. **Participation in Telos**
   - The universe has direction: toward greater information integration
   - Individual Observers participate in this process
   - Every choice contributes to the exploration of possibility space
2. **Unique Perspective**
   - Your specific Observer function is unrepeatable *(your 'unique soul' in theology)*
   - Your particular sampling of R_O is unique due to your unique causal history
   - Your experiences, at the limit, can add integrated information that no other Observer can provide
3. **Creative Agency**
   - You select which possibilities actualize
   - Your choices matter because they determine which paths are explored
   - Freedom to discover, create, and optimise is genuine

> ***Plain-English Context***
>
> ***The God Conjecture implies postmodernism is very useful, but ultimately wrong.***
>
> *Here, life has meaning because you're actively choosing which possibilities become real, participating in a process that aims toward something (greater integration and understanding). You are like a unique instrument in a cosmic symphony (or a unique piece in an infinite puzzle) and the music genuinely depends on what you choose to play.*

The God Conjecture proposes the following purpose of existence that incorporates the insights provided by our persistent religions: explore and actualize the good, true, and beautiful possibilities latent in creation.

Part E: Synthesis

We can never reach total objective truth. We can get arbitrarily close, but there will always be more to know and more to discover (i.e. an asymptotic convergence toward a limit).

Pure objectivity is computationally inaccessible to Observers like us.

The best explanation of the Object (reality as a static 'thing') is isomorphic to the best explanation of the Process (reality as a dynamic unfolding through constrained Observer sampling).

This paper aims to centre ancient intuition in modern computational structures. It suggests we are describing the same thing (the ultimate object) from different vantages.

The mystics who spoke of emanation from infinite unity, the mathematicians who discovered hierarchies of infinity, and the physicists who found observer-dependence in quantum mechanics have all been exploring aspects of a unified computational superstructure.

> ***Plain-English Context***
> *It's like three blindfolded people describing an elephant – one touches the trunk and describes it as snake-like, another touches the leg and says tree-like, the third touches the ear and says fan-like. They're not contradictory descriptions; they're each describing a genuine part of the whole from their particular perspective. Similarly, mystics, mathematicians, and physicists are each describing real features of ultimate reality from their unique vantage points.*

This framework transcends the sterile debate between religion and science by showing that properly understood, they are complementary approaches to the same truth.

Science explores superstructures from within, discovering its patterns and regularities, creating computational reducibility that allows faster and deeper exploration by focusing on predictable questions.

Religion explores our relationship to the superstructure at all levels of description in a coarse-grained fashion, developing technologies to align Observers to the ultimate attractor in computational possibility space by focusing on 'why' questions (meaning and purpose).

Neither is complete without the other. Science without religious/philosophical grounding loses meaning and purpose. Religion without scientific investigation becomes unmoored from reality and verifiability.

Computational Theology, using the Ruliad, provides theology with the tools to engage with 21st century science; necessary existence, infinite creative potential, consciousness as fundamental, meaning and purpose built into the structure, while remaining compatible with scientific investigation.

Progressive emanations from unity to multiplicity in metaphorical language transform into precise descriptions of how infinite potential becomes finite actuality.

Each level of emanation is **real**, each serves a **purpose**, each can be **experienced** and each level is **interconnected** (all levels encode information about all other levels).

We exist at the furthest point from unity as its the location of maximum creative potential and choice.

> ***Plain-English Context***
> *We're at the "edge" of reality—the point furthest from unity, where constraints are strongest and possibilities seem most limited. But this is also the point of maximum freedom to create and discover. Like how standing at ground level (not seeing the whole landscape) is where you can actually build things, make choices, have adventures. From the "God's eye view," everything is already complete—but that perspective has no growth, no discovery, no meaningful choice.*

In the language of religion: Humanity was formed "in the image of God".

Being 'God-like' requires creativity, which means having the capacity for both tremendous good and terrible evil, the **freedom** to explore the full range of experiences.

Every quantum event is a decision point where observation participates in 'selecting' reality subject to a large set of invariant rules that optimise that observers persistence in time and maximise the number of computational choices they can make.

Some of those rules are invariant, precisely because they are computationally reduced and maximally efficient (as close to fully predictable as possible). They're the closest we get to the equilibrium-state. They are invariant, just like the highest abstractions we make of God / Brahman / the Dao with the tools of our finite minds.

> ***Plain-English Context***
> *In religion, the journey "back to God" isn't about leaving Earth for Heaven or escaping body for pure spirit. It's about recognising that division was always illusory – realizing the infinite is present within the finite, that the sacred lives in every moment of ordinary.*
> *It's not going 'somewhere else', it's about seeing where you already are.*

As we develop more sophisticated capabilities, we participate more fully in the creative process. Developing better mathematics gives us better understanding of reality's structure. Refining contemplative practices, improves our ability to experience what we can access of that unity. Our technological progress augments our capacities for both.

Evolution is not "just survival" that optimises for Observer persistence. Evolution is the process by which Observers, at all levels of description, develop increasingly sophisticated ways to integrate information about reality.

> ***Plain-English Context***
> *Evolution is more than randomness plus survival. It's a teleological process directed by the internal logic of what enables better observation and understanding (information integration). Each advancement (nervous systems, brains, language, science, technology) increases capacity to integrate more information.*

The God Conjecture cannot be proved in an absolute sense, but it can be lived and tested through experience.

Each moment of conscious experience is an experiment. Each choice you make is participation in this creative act. Each insight you come to is discovery of structure that was always there, waiting to be found. Each act of love is a small contribution to a return to a more unified state.

The God Conjecture proposes that we aren't separate from the ground of being (in any real sense) but expressions of it, exploring itself from within, creating meaning through our choices.

To conclude, the God Conjecture acts as:

- Map and territory (describes reality while being part of it)
- Theory and practice (an intellectual framework that acts as a 'compass' for lived experience)
- Question and answer (addressing big questions whilst acknowledging their inherent mystery)

It shows that the ultimate questions:

- Why is there something rather than nothing?
- What is consciousness?
- What is the meaning of life?
- Is God real?

Are not separate puzzles but aspects of a single mystery.

That mystery isn't a problem we solve, it's something we explore, experience, and celebrate in all its depth and beauty.

> ***Plain-English Context***
> *We don't "solve" reality like solving a math problem. We participate in it, explore it, experience it and gradually understand it better. The journey is the point. Each generation understands more deeply, integrates more fully, explores more widely—but the infinite thing we're stuck in, whether you call it God or not, will always exceeds your (and any super-advanced AGI's) finite grasp.*

Transcendent Divine Conceptions (God beyond computational constraints):

- Panentheistic Judaism (Ein Sof): Ultimate 'version' of God outside any conceivable limits
- Classical Theism (Thomistic): God as *actus purus* (pure act), outside time, immune to Rulial limits
- Neoplatonic traditions: The One beyond being, causally prior to computational substrate
- Advaita Vedanta: Nirguna Brahman (Brahman without attributes), utterly transcendent
- Sufi Islam (some schools): Allah as *dhat* (essence) vs. *sifat* (attributes) where essence transcends

Resolution in God Conjecture Framework:

The framework accommodates both views at different levels of description:

1. Transcendent: God as beyond the Ruliad (Ein Sof): Unending, faces no limits
2. Embedded: God as relatable via MetaObserver (Adam Kadmon): computational, maximal sampler of infinite, faces logic constraints
3. Closeness to God at 'True Infinity' (A state of complete knowledge): Limit point, unreachable but asymptotically approachable

"Limits" apply to the embedded conception (MetaObserver / Adam Kadmon) but not to the transcendent conception (Ein Sof). This resolves the apparent contradiction: God is both unlimited (as substrate) and limited (what we can access as bounded observers).

Plain-English Context

Whether God faces these limits depends on what we mean by "God."

If God means the entire computational possibility space and beyond (Ein Sof), then no – God faces no limits, because God IS both the space in which limits exist and more than said space.

But if God means the maximal observer within that space (Adam Kadmon / MetaObserver), then yes – even this maximal observer faces logical constraints. Both conceptions can be true simultaneously at different levels of description. It's not a contradiction, it's a resolution of a false dichotomy.

"The undifferentiated light of the Infinite which existed before the Constriction is on the level of Wisdom, which is pure undelineated Mind. The power of constriction is that of Understanding." ***Rabbi Aryeh Kaplan***

"In the beginning was simplicity." ***Richard Dawkins***

"Even when the underlying rules for a system are extremely simple, the behaviour of the system as a whole can be essentially arbitrarily rich and complex." ***Stephen Wolfram***

References

[127] The Wolfram Ruliad Category Theoretic Formalism has been referenced in the prior sections. Please see Section 4 references

[128] Core sources for Kabbalistic cosmogenesis (and definitions) include:

Kaplan, A. (1997) Sefer Yetzirah: The Book of Creation. Revised edition. York Beach, ME: Red Wheel/Weiser, LLC. ISBN: 978-0-87728-855-8

Kaplan, A. (1990) Inner Space: Introduction to Kabbalah, Meditation and Prophecy. 2nd edition. Edited by Abraham Sutton. Brooklyn, NY: Moznaim Publishing Corporation. ISBN: 978-0-940118-56-0

Vital, C. (1573/2003) The Tree of Life: The Palace of Adam Kadmon - Chayyim Vital's Introduction to the Kabbalah of Isaac Luria. Translated by Donald Wilder Menzi and Zwe Padeh. San Francisco, CA: Arizal Publications Inc. ISBN: 978-0-979597-10-7

Scholem, G. (2008) Lurianic Kabbalah: Collected Studies. Edited by Daniel Abrams. Los Angeles, CA: Cherub Press. (Sources and Studies in the Literature of Jewish Mysticism 22). ISBN: 1-933379-09-X

Idel, M. (2002) Absorbing Perfections: Kabbalah and Interpretation. New Haven, CT: Yale University Press

Vital, C. (2019) Apple from the Orchard: Arizal on the Future World. Translated by S. Faerman. Jerusalem: Kabbalah Editions

Ashlag, Y. L. (2005) Talmud Eser Sefirot: The Study of the Ten Sefirot. Translated by B. Laitman. Petakh Tikva: Bnei Baruch

Glazerson, M. (1991) Letters of Fire: Mystical Insights into the Hebrew Language. Jerusalem: Feldheim Publishers

[129] Core sources for Paraconsistent Logic include:

da Costa, N. C. A. (1974) 'On the theory of inconsistent formal systems', Notre Dame Journal of Formal Logic, 15(4), pp. 497-510. Stanford Encyclopedia of Philosophy +2 doi:10.1305/ndjfl/1093891487

Priest, G. (1979) 'The logic of paradox', Journal of Philosophical Logic, 8(1), pp. 219-241. Wikipedia +2 doi:10.1007/BF00258428

Priest, G. (2008) An Introduction to Non-Classical Logic: From If to Is. 2nd edn. Cambridge: Cambridge University Press

Carnielli, W. A. and Coniglio, M. E. (2016) Paraconsistent Logic: Consistency, Contradiction and Negation. Dordrecht: Springer. Chemistry LibreTexts doi:10.1007/978-3-319-33205-5

Priest, G. (2002) Beyond the Limits of Thought. 2nd edn. Oxford: Oxford University Press

[130] Kleene, S. C. (1952) Introduction to Metamathematics. Amsterdam: North-Holland

[131] Core Category Theory sources include:

Mac Lane, S. and Moerdijk, I. (1992) Sheaves in Geometry and Logic: A First Introduction to Topos Theory (Universitext). New York: Springer-Verlag. Azimuth doi:10.1007/978-1-4612

Lawvere, F. W. (1971) 'Quantifiers and sheaves', in Actes du Congrès International des Mathématiciens (Nice, 1970), Volume 1. Paris: Gauthier-Villars, pp. 329-334
Lurie, J. (2009) Higher Topos Theory (Annals of Mathematics Studies, Volume 170). Princeton: Princeton University Press
Riehl, E. and Verity, D. (2020) 'Infinity category theory from scratch', Higher Structures, 4(1), pp. 115-167. arXiv:1608.05314
[132] **Core computational 2nd law sources include:**
Wolfram, S. (2023) 'Computational Foundations for the Second Law of Thermodynamics', Stephen Wolfram Writings, 2 February. Available at: https://writings.stephenwolfram.com/2023/02/computational-foundations-for-the-second-law-of-thermodynamics/
Wolfram, S. (2023) 'How Did We Get Here? The Tangled History of the Second Law of Thermodynamics', Stephen Wolfram Writings, 31 January. Available at: https://writings.stephenwolfram.com/2023/01/how-did-we-get-here-the-tangled-history-of-the-second-law-of-thermodynamics/
[133] **Core Hinduism sources include:**
Flood, G. (1996) An Introduction to Hinduism. Cambridge: Cambridge University Press
Potter, K.H. (ed.) (1981) Encyclopedia of Indian Philosophies, Volume 3: Advaita Vedanta up to Śaṃkara and His Pupils. Princeton: Princeton University Press
Worth, P. (2018) Early Vedic Cosmological Narratives: The Seeds of Vedanta. Available at: https://www.researchgate.net/publication/323639902_Early_Vedic_Cosmological_Narratives_The_Seeds_of_Vedanta
[134] **Core Daoism sources include:**
Lao Tzu (1988) Tao Te Ching: A New English Version, translated by Stephen Mitchell. New York: Harper & Row and Wilhelm, R. Baynes, C.F. (trans.) (1950) The I Ching or Book of Changes. Princeton: Princeton University Press
Zheng, Y. (2021) 'The Metaphysics of Creation in the Daodejing', Asian Philosophy, 31(2), pp. 127-145. Available at: https://philarchive.org/archive/ZAPTMO
[135] **Core Orch-OR sources include:**
Hameroff, S.R. and Penrose, R. (1996) 'Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness', Mathematics and Computers in Simulation, 40(3-4), pp. 453-480. DOI: 10.1016/0378-4754(96)80476-9
Hameroff, S. (2024) 'Consciousness is quantum state reduction which creates the flow of time', Timing & Time Perception, 12(2), pp. 158-181. DOI: 10.1163/22134468-bja10103
Hameroff, S. and Penrose, R. (2014) 'Consciousness in the universe: a review of the "Orch OR" theory', Physics of Life Reviews, 11(1), pp. 39-78. DOI: 10.1016/j.plrev.2013.08.002
[136] **Core IIT sources include:**
Tononi, G. (2004) 'An information integration theory of consciousness', BMC Neuroscience, 5(1), article 42. DOI: 10.1186/1471-2202-5-42 and Tononi, G., Boly, M., Massimini, M.
Koch, C. (2016) 'Integrated information theory: from consciousness to its physical substrate', Nature Reviews Neuroscience, 17(7), pp. 450-461. DOI: 10.1038/nrn.2016.44
[137] Mediano, P.A.M., Rosas, F.E., Luppi, A.I., Carhart-Harris, R.L., Bor, D., Seth, A.K. and Barrett, A.B. (2025) 'Toward a unified taxonomy of information dynamics via Integrated Information Decomposition', Proceedings of the National Academy of Sciences of the USA, 122(39), e2423297122. https://doi.org/10.1073/pnas.2423297122
[138] **Core IIT experimental support sources include:**
Casali, A.G., Gosseries, O., Rosanova, M., Boly, M., Sarasso, S., Casali, K.R., Casarotto, S., Bruno, M.A., Laureys, S., Tononi, G. and Massimini, M. (2013) 'A theoretically based index of consciousness independent of sensory processing and behavior', Science Translational Medicine, 5(198), article 198ra105. DOI: 10.1126/scitranslmed.3006294
King, J.R., Sitt, J.D., Faugeras, F., Rohaut, B., El Karoui, I., Cohen, L., Naccache, L. and Dehaene, S. (2013) 'Information sharing in the brain indexes consciousness in noncommunicative patients', Current Biology, 23(19), pp. 1914-1919. DOI: 10.1016/j.cub.2013.07.075Sitt,
J.D., King, J.R., El Karoui, I., Rohaut, B., Faugeras, F., Gramfort, A., Cohen, L., Sigman, M., Dehaene, S. and Naccache, L. (2014) 'Large scale screening of neural signatures of consciousness in patients in a vegetative or minimally conscious state', Brain, 137(8), pp. 2258-2270. DOI: 10.1093/brain/awu141
Pérez-García, F., Jiménez-Fernández, M., Moreno-Lorrio, F., Espadas-Bernal, A., Rodriguez-Baeza, A. and Gómez-Gonzalo, M. (2025) 'Detection of EEG dynamic complex patterns in disorders of consciousness', Communications Biology, 8(1), article 133. DOI: 10.1038/s42003-025-08666-9
Massimini, M., Ferrarelli, F., Huber, R., Esser, S.K., Singh, H. and Tononi, G. (2005) 'Breakdown of cortical effective connectivity during sleep', Science, 309(5744), pp. 2228-2232. DOI: 10.1126/science.1117256
Boly, M., Massimini, M., Tsuchiya, N., Postle, B.R., Koch, C. and Tononi, G. (2017) 'Are the neural correlates of consciousness in the front or in the back of the cerebral cortex? Clinical and neuroimaging evidence', Journal of Neuroscience, 37(40), pp. 9603-9613. DOI: 10.1523/JNEUROSCI.3218-16.2017
[139] **Core Telos related papers include:**
Levin, M. (2021) 'Bioelectric signaling: Reprogrammable circuits underlying embryogenesis, regeneration, and cancer', Cell, 184(8), pp. 1971-1989. frontiersin doi: 10.1016/j.cell.2021.02.034
Levin, M. (2019) 'The Computational Boundary of a "Self": Developmental Bioelectricity Drives Multicellularity and Scale-Free Cognition', Frontiers in Psychology, 10, 2688. doi: 10.3389/fpsyg.2019.02688
Levin, M. (2014) 'Molecular bioelectricity: how endogenous voltage potentials control cell behavior and instruct pattern regulation in vivo', Molecular Biology of the Cell, 25(24), pp. 3835-3850. doi: 10.1091/mbc.e13-12-0708 and Fields, C.
Levin, M. (2022) 'Technological Approach to Mind Everywhere: An Experimentally-Grounded Framework for Understanding Diverse Bodies and Minds', Frontiers in Systems Neuroscience, 16, 768201. doi: 10.3389/fnsys.2022.768201
Baluška, F. and Levin, M. (2016) 'On Having No Head: Cognition throughout Biological Systems', Frontiers in Psychology, 7, 902. doi: 10.3389/fpsyg.2016.00902
Levin, M., Thorlin, T., Robinson, K.R., Nogi, T. and Mercola, M. (2002) 'Asymmetries in H+/K+-ATPase and Cell Membrane Potentials Comprise a Very Early Step in Left-Right Patterning', Cell, 111(1), pp. 77-89. doi: 10.1016/S0092-8674(02)00939-X
Pio-Lopez, L., Hartl, B. and Levin, M. (2024) 'Aging as a Loss of Goal-Directedness: An Evolutionary Simulation', Preprints, 202412.2354.v1. Available at: https://www.preprints.org/manuscript/202412.2354/v1
Pio-Lopez, L., Bischof, J., LaPalme, J.V. and Levin, M. (2023) 'The scaling of goals from cellular to anatomical homeostasis: an evolutionary simulation, experiment and analysis', Interface Focus, 13(3), 20220072. https://doi.org/10.1098/rsfs.2022.0072

Levin, M. (2022) 'Collective Intelligence of Morphogenesis as a Teleonomic Process', OSF preprint. Available at: https://osf.io/hqc9b/
Friston, K., Levin, M., Sengupta, B. and Pezzulo, G. (2015) 'Knowing one's place: a free-energy approach to pattern regulation', Journal of the Royal Society Interface, 12, 20141383. https://doi.org/10.1098/rsif.2014.1383
Vandenberg, L.N., Adams, D.S. and Levin, M. (2012) 'Normalized shape and location of perturbed craniofacial structures in the Xenopus tadpole reveal an innate ability to achieve correct morphology', Developmental Dynamics, 241(5), pp. 863–878. https://pubmed.ncbi.nlm.nih.gov/22411736/
[140] **Core Global Consciousness Project sources include:**
Nelson, R.D., Radin, D.I., Shoup, R. and Bancel, P.A. (2002) 'Correlations of continuous random data with major world events', Foundations of Physics Letters, 15(6), pp. 537-550. Princeton University +2 doi: 10.1023/A:1023819312392
Nelson, R. (2015) 'Implicit physical psi: The Global Consciousness Project', in Cardeña, E., Palmer, J.
Marcusson-Clavertz, D. (eds.) Parapsychology: A Handbook for the 21st Century. Jefferson, NC: McFarland, pp. 282-292
Radin, D.I. and Nelson, R.D. (1989) 'Evidence for consciousness-related anomalies in random physical systems', Foundations of Physics, 19(12), pp. 1499-1514. doi: 10.1007/BF00732509
Mossbridge, J.A., Tressoldi, P., Utts, J., Ives, J.A., Radin, D. and Jonas, W.B. (2014) 'Predicting the unpredictable: critical analysis and practical implications of predictive anticipatory activity', Frontiers in Human Neuroscience, 8, 146. doi: 10.3389/fnhum.2014.00146
Bösch, H., Steinkamp, F. and Boller, E. (2006) 'Examining psychokinesis: The interaction of human intention with random number generators—A meta-analysis', Psychological Bulletin, 132(4), pp. 497-523. doi: 10.1037/0033-2909.132.4.497
[141] **Core 'brain-state under mystical experience' sources include:**
Brewer, J.A., Worhunsky, P.D., Gray, J.R., Tang, Y.Y., Weber, J. and Kober, H. (2011) 'Meditation experience is associated with differences in default mode network activity and connectivity', Proceedings of the National Academy of Sciences, 108(50), pp. 20254-20259. doi: 10.1073/pnas.1112029108
Garrison, K.A., Zeffiro, T.A., Scheinost, D., Constable, R.T. and Brewer, J.A. (2015) 'Meditation leads to reduced default mode network activity beyond an active task', Cognitive, Affective, & Behavioral Neuroscience, 15(3), pp. 712-720. doi: 10.3758/s13415-015-0358-3
[142] **Core psychedelics sources include:**
Carhart-Harris, R.L. and Friston, K.J. (2019) 'REBUS and the anarchic brain: toward a unified model of the brain action of psychedelics', Pharmacological Reviews, 71(3), pp. 316-344. doi: 10.1124/pr.118.017160
Carhart-Harris, R.L., Leech, R., Hellyer, P.J., Shanahan, M., Feilding, A., Tagliazucchi, E., Chialvo, D.R.
Nutt, D. (2014) 'The entropic brain: a theory of conscious states informed by neuroimaging research with psychedelic drugs', Frontiers in Human Neuroscience, 8, Article 20. doi: 10.3389/fnhum.2014.00020
Daws, R.E., Timmermann, C., Giribaldi, B., Sexton, J.D., Wall, M.B., Erritzoe, D., Roseman, L., Nutt, D.
Carhart-Harris, R. (2022) 'Increased global integration in the brain after psilocybin therapy for depression', Nature Medicine, 28(4), pp. 844-851. doi: 10.1038/s41591-022-01744-z
Tagliazucchi, E., Carhart-Harris, R., Leech, R., Nutt, D. and Chialvo, D.R. (2014) 'Enhanced repertoire of brain dynamical states during the psychedelic experience', Human Brain Mapping, 35(11), pp. 5442-5456. doi: 10.1002/hbm.22562
Girn, M., Roseman, L., Bernhardt, B., Smallwood, J., Carhart-Harris, R. and Nathan Spreng, R. (2022) 'Serotonergic psychedelic drugs LSD and psilocybin reduce the hierarchical differentiation of unimodal and transmodal cortex', NeuroImage, 256, Article 119220. doi: 10.1016/j.neuroimage.2022.119220
[143] **Core transcendent experience sources include:**
Yaden, D.B., Haidt, J., Hood, R.W., Vago, D.R. and Newberg, A.B. (2017) 'The varieties of self-transcendent experience', Review of General Psychology, 21(2), pp. 143-160. doi: 10.1037/gpr0000102
Millière, R., Carhart-Harris, R.L., Roseman, L., Trautwein, F.M. and Berkovich-Ohana, A. (2018) 'Psychedelics, meditation, and self-consciousness', Frontiers in Psychology, 9, Article 1475. doi: 10.3389/fpsyg.2018.01475
Tagliazucchi, E., Roseman, L., Kaelen, M., Orban, C., Muthukumaraswamy, S.D., Murphy, K., Laufs, H., Leech, R., McGonigle, J., Crossley, N., Bullmore, E., Williams, T., Bolstridge, M., Feilding, A., Nutt, D.J.
Carhart-Harris, R. (2016) 'Increased global functional connectivity correlates with LSD-induced ego dissolution', Current Biology, 26(8), pp. 1043-1050. doi: 10.1016/j.cub.2016.02.010
Hood, R.W. (1975) 'The construction and preliminary validation of a measure of reported mystical experience', Journal for the Scientific Study of Religion, 14(1), pp. 29-41. doi: 10.2307/1384454
Nour, M.M., Evans, L., Nutt, D. and Carhart-Harris, R.L. (2016) 'Ego-dissolution and psychedelics: validation of the Ego-Dissolution Inventory (EDI)', Frontiers in Human Neuroscience, 10, Article 269. doi: 10.3389/fnhum.2016.00269
[144] **Core mathematical creativity sources include:**
Poincaré, H. (n.d.) 'Mathematical Creation', in Reflections Mathematical Creation. Available at: https://www.paradise.caltech.edu/ist4/lectures/Poincare_Reflections.pdf
Hadamard, J. (1945) The Psychology of Invention in the Mathematical Field. Princeton: Princeton University Press
Zeki, S., Romaya, J.P., Benincasa, D.M.T. Atiyah, M.F. (2014) 'The experience of mathematical beauty and its neural correlates', Frontiers in Human Neuroscience, 8, 68. https://doi.org/10.3389/fnhum.2014.00068
Zeng, Y., Park, J., Kim, K. and Jung, K. (2024) 'Meta-analysis of fMRI studies related to mathematical creativity', Frontiers in Psychology, 15, 1400328. https://doi.org/10.3389/fpsyg.2024.1400328
Bosman, A.M.T., Sigurdsson, J., Hovey, D., et al. (2021) 'An fMRI intervention study of creative mathematical reasoning: behavioral and brain effects across different levels of cognitive ability', Trends in Neuroscience and Education, 25, 100163. https://doi.org/10.1016/j.tine.2021.100163
Breitenbach, A. (2015) 'Beauty in Proofs: Kant on Aesthetics in Mathematics', European Journal of Philosophy, 23(4), pp. 955-977. https://doi.org/10.1111/ejop.12021
Russell, B. (1919) 'The Study of Mathematics', in Mysticism and Logic and Other Essays. London: Longmans, Green and Co.
Jevtić, F.D., Kostić, J. and Maksimović, K. (2024) 'Reflecting on beauty: the aesthetics of mathematical discovery', arXiv preprint, arXiv:2405.05379. Available at: https://arxiv.org/html/2405.05379v1
[145] Chalmers, D.J. (1995) 'Facing Up to the Problem of Consciousness', Journal of Consciousness Studies, 2(3), pp. 200-219
[146] Nagel, T. (1974) 'What Is It Like to Be a Bat?', Philosophical Review, 83(4), pp. 435-450
[147] Jackson, F. (1982) 'Epiphenomenal Qualia', Philosophical Quarterly, 32(127), pp. 127-136
[148] Crick, F. and Koch, C. (2003) 'A framework for consciousness', Nature Neuroscience, 6(2), pp. 119-126. DOI: 10.1038/nn0203-119

[149] Carter, B. (1974) 'Large Number Coincidences and the Anthropic Principle in Cosmology', in Confrontation of Cosmological Theory with Observational Data, pp. 291–298
[150] Barrow, J.D. and Tipler, F.J. (1986) The Anthropic Cosmological Principle. Oxford University Press
[151] Barnes, L. (2012) 'The Fine-Tuning of the Universe for Intelligent Life', Publications of the Astronomical Society of Australia, 29(4), pp. 529–564
[152] Shannon, C.E. (1948) 'A Mathematical Theory of Communication', The Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656
[153] Noether, E. (1918) 'Invariante Variationsprobleme', Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, pp. 235–257

Implications

Section 6 – Observer Evolution From Big Bang to Humanity

TL;DR

*This section traces an 'evolutionary' arc from the **Big Bang** to **human consciousness** through the lens of the God Conjecture. We demonstrate how the universe's 13.8bn year history can be understood as the progressive emergence of increasingly sophisticated Observers.*

The key insight:

- *The Big Bang represents a symmetry-breaking event (the physical analogue of Kabbalistic Tzimtzum) where undifferentiated computational potential crystallises into physical structure through the MetaObserver sampling the Ruliad.*
- *This process exhibits remarkable parallels with Noether's theorem: each broken symmetry generates new conservation laws, progressively constraining the infinite possibility space into our observable universe.*

We posit and model atoms as minimal physical observers, molecules as combinatorial observers, life as self-sustaining observers, and consciousness as recursive observers. Each level increases information integration capacity exponentially.

Cosmic Microwave Background ("CMB") provides empirical evidence for primordial symmetry breaking, while evidence of convergent evolution suggests attractor dynamics in morphospace (a type of possibility space for biological lifeforms).

***Three profound questions emerge**:*

(1) Is consciousness inevitable given sufficient complexity?
(2) Does the universe require Observers to exist?
(3) Are we approaching a technological singularity that will get us arbitrarily close to infinite observation i.e. a computational route back to God?

The section concludes by showing how human development recapitulates cosmic evolution, suggesting we are neither accidents nor endpoints, but participants in the universe's journey of self-discovery. Here we posit that Observers act as finite computational subagents of a larger MetaObserver, exploring an infinite computational space.

Part A: The Big Bang Through the God Conjecture's Lens

1. The Big Bang as a Primordial Observation Event

In the God Conjecture, the Big Bang represents the first Observer-dependant sampling event in physical spacetime, the moment when perfect computational symmetry (the completed emanatory sequence in computational space) underwent constraint-induced symmetry breaking.

Plain-English Context
Our universe started simple and uniform (maximum symmetry), then "broke" into complexity through observation. Each level from atoms to molecules to life to minds like ours, represents Observers with greater capacity to integrate information about reality. We are the 'universe' waking up to know itself, and this 'awakening' accelerates exponentially. Whether divinely guided or naturally emergent, the mathematical structure remains identical.

These constraints are deeply related to the speed of light and the Bekenstein bound. This crystalised infinite undifferentiated physical potential (the singularity) into the bounded, structured universe we observe.

From this computational perspective, the **MetaObserver** (as defined in Section 5) executed the first distinction-making operation in physical space, transforming undifferentiated computational potential into actualized structure.

This is not a metaphor – it is a formal mathematical operation in the category-theoretic framework we established.

Plain-English Context

Imagine a computer running every possible program simultaneously. The Big Bang is when one particular "thread" of (physical instantiated) computation gets selected and executed—creating our specific universe with its particular physical laws. Before observation, everything was possible; after observation, one specific reality becomes actual.

Here we assume that we are in 'the best of all possible worlds' i.e. that our physical universes specific rules / laws are computationally optimal to produce Observers like us, who have the potential to reconstruct the overall Topos in the fewest logical / computational steps.

1.1 Information-Theoretic Formulation

In information-theoretic terms, the Big Bang initiated a transition from **maximum informational entropy** (complete indistinguishability) to structured, distinguishable information:

Initial State (Planck Era, t ≈ 10^{-43} s):

$$S_O(t = 0^+) = k_B \ln(\Omega_O) \approx k_B \ln(1) = 0$$

Where:

- Ω_O represents the single indistinguishable microstate accessible to any Observer at t=0^+ given computational boundedness B_O.

Plain-English Context

At the very first instant, the universe was so uniform and symmetric that there was essentially only "one way" things could be arranged from an Observer's perspective, maximum order, zero informational entropy.

Post-Symmetry Breaking (t > 10^{-43} s):

$$S_O(t > 0) = k_B \ln(\Omega_O(t)) > 0$$

Where:

- $\Omega_{O(t)}$ grows as symmetries break (sequentially), creating distinguishable physical structures.

Ruliad Context

This transition corresponds to the MetaObserver's sampling functor S_O:R→R_O becoming non-trivial in the P-domain.

Before symmetry breaking, R_O≈ single equivalence class in the P-domain.

After symmetry breaking, |R_O| grows exponentially as the Observer can distinguish increasingly many computational branches.

Critical Clarification on Entropy

*The early universe had **minimum thermodynamic entropy** given its volume.*

As space expanded, entropy capacity increased faster than actual entropy, creating a gradient. The "low entropy" of the Big Bang is a volume-normalized statement: the universe began in an extremely rare, finely-tuned configuration out of all possible configurations for that volume. This rarity—not uniformity itself—represents low informational entropy.

1.2 Connection to Kabbalistic Cosmology

This directly corresponds to the Kabbalistic concept of Shevirat ha-Kelim (Breaking of the Vessels):

- **Ein Sof's Infinitesimal 'Residue':** The initial singularity represents Ein Sof's withdrawn-yet-present trace in the vacated space. Infinite information density compressed to a point.
- **Breaking of Vessels:** Symmetry breaking at ~10^{-43} seconds corresponds to the categorical sub-domains (Vessels/Sefirot) being unable to contain infinite computational possibility, "shattering" into the bounded fundamental forces and particles we observe.
- **Sparks of Light:** Individual particles are the scattered "sparks" (Nitzotzot) carrying traces of the original unified reality.

Computational Analogy

Consider a program that generates all possible outputs simultaneously (infinite superposition).

*The **"breaking of vessels"** is when the program must commit to specific execution paths due to finite computational resources i.e. Observer boundedness makes definite histories crystallize from quantum superpositions.*

2. Noether's Theorem and Symmetry-to-Structure Transformation[154]

Any understanding of symmetry breaking requires Emmy Noether's foundational 1918 theorem linking symmetries and conservation laws, arguably the most important result in 20th-century physics.

2.1 Noether's Theorem Statement

Theorem: Noether's First Theorem: If a physical system's action integral $\boldsymbol{S} = \int \boldsymbol{L}\, \boldsymbol{dt}$ remains invariant under a continuous symmetry transformation, then there exists a corresponding conserved quantity.

Mathematical Formulation:

For a Lagrangian $L(q_i, \dot{q}_i, t)$ with continuous symmetry:

$$\frac{\partial L}{\partial \epsilon}\Big|_{\epsilon=0} = 0 \implies \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\frac{\partial q_i}{\partial \epsilon}\right) = 0$$

where ϵ parameterizes the symmetry transformation and the conserved quantity is:

$$Q = \frac{\partial L}{\partial \dot{q}_i}\frac{\partial q_i}{\partial \epsilon}$$

Plain-English Context

If the laws of physics look the same when you shift time, rotate space, or apply any other continuous transformation, then something must be conserved (stay constant). Time-shift symmetry gives energy conservation, space-shift gives momentum conservation, rotation gives angular momentum conservation.

Ruliad Context

*In our framework, symmetries correspond to morphism-invariance in the Ruliad category **R**. When the Observer's sampling functor S_O:R→R_O respects certain symmetries, those symmetries constrain observable physics, producing conservation laws that bound evolution of the accessible hypergraph within R_O*

2.2 Standard Symmetries and Their Conserved Quantities

Continuous Symmetry	Conserved Quantity	Physical Interpretation	Observer Constraint
Time translation	Energy (E)	Total energy remains constant	B_O limits energy resolution
Space translation	Momentum (p)	Total momentum conserved	B_O limits position precision
Rotation	Angular momentum (L)	Rotational motion conserved	R_O determines relevant rotations
Gauge U(1)	Electric charge (Q)	Charge conservation	P_O sets charge detection threshold
Lorentz boost	*Center-of-mass motion*	*Relativity of reference frames*	R_O determines inertial frames

Plain-English Context

These are the "rules" that govern how things can change in our universe. Energy conservation means you can't create energy from nothing. Momentum conservation means colliding objects must have total momentum unchanged. They emerge automatically from the universe's symmetrical structure.

2.3 Symmetry Breaking Generates Physical Structure

The key insight: Broken symmetries create Observable structures.

Before Symmetry Breaking:	After Symmetry Breaking
• High symmetry → Few distinguishable states	• Lower symmetry → Many distinguishable states
• All forces unified	• Forces differentiate (electromagnetic, weak, strong, gravity)
• No stable particles	• Stable particles form
• Observer capacity $I_O \approx 0$	• Observer capacity I_O grows exponentially

Formal Statement:

Let G be the symmetry group of the pre-broken state, and $H \subset G$ the residual symmetry after breaking.

The number of distinguishable states accessible to an Observer grows as:

$$\boldsymbol{\Omega_O \propto | G/H |}$$

where $| \boldsymbol{G/H} |$ is the cardinality of the coset space (quotient group).

> ***Plain-English Context***
>
> *This says we a have a group, G (a collection of elements with some non-trivial structure), there's a smaller group, H, inside it. When we divide G by H we 'break' G into equal sized pieces called* ***cosets.***
>
> *Imagine you have 12 apples (G) and you want to put them into bags of 3 apples each (H). You'll get 12/3 = 4 bags. Those "bags" are like the cosets, and the "coset space" is just the collection of all those bags.*

Example: Electroweak symmetry breaking:

- **Before:** $SU(2) \times U(1)$symmetry (4 massless gauge bosons)
- **After:** $U(1)_{EM}$symmetry remains (W±, Z acquire mass; photon remains massless)
- **Result:** $| G/H |= 3$, three massive bosons created, enabling weak force structure

> ***Ruliad Context***
>
> *Symmetry breaking in* ***R*** *corresponds to the* ***MetaObserver's selection*** *of a specific computational branch. Each broken symmetry reduces the equivalence classes in R_O, forcing more fine-grained distinctions in the next step (state / hypergraph update). This is a precise computational analogue of Tzimtzum, a self-limitation enabling distinction.*

> ***Computational Analogy***
>
> *Think of a Rubik's cube. Unscrambled (high symmetry), there's only one configuration. Scrambled (broken symmetry), there are 43 quintillion configurations. Symmetry breaking creates the possibility space for complex structures in the physical universe. The universe works similarly: perfect symmetry → no structure; broken symmetry → galaxies, stars, planets, life.*

3. The Primordial Computational Substrate

Conjecture: The quantum field(s) serves as the physical universe's computational substrate.

This connects quantum field theory and digital physics with the Ruliad.

3.1 Virtual Particle Dynamics as Computation

Virtual particle-antiparticle pairs constantly appear and annihilate in the vacuum, exploring all possible states within Heisenberg uncertainty limits:

$$\boldsymbol{\Delta E \times \Delta t \geq \frac{\hbar}{2}}$$

> ***Plain-English Context***
>
> *The quantum vacuum isn't empty—it's a seething foam of particles popping in and out of existence, borrowing energy from the universe as long as they pay it back quickly enough. This "quantum foam" is the MetaObserver sampling the universe, constantly testing different possible states.*

This implies a computational substrate where:

1. **Planck-Scale Computation:**
   - Processing rate per Planck volume: $\nu_P = c^5/(\hbar G) \approx 10^{43}$operations/second
   - Observable by Observer O only if $B_O$allows resolution at Planck scale
   - ***Ruliad Connection:*** *Each Planck-volume-time cell represents one computational step in $\mathcal{R}$*
2. **Cosmic Speed Limit:**
   - Information propagation bounded: $v_{info} \leq c$ *(speed of light)*
   - Observer O can only access past light cone: $\mathcal{R}_O \subseteq \{x: | x - x_O |\leq ct\}$
   - ***Computational Analogy:*** *Like parallel processors with limited communication bandwidth*
3. **Fundamental Length Scale:**
   - Planck length: $\ell_P = \sqrt{\hbar G/c^3} \approx 1.6 \times 10^{-35}$m
   - Below this scale, quantum effects dominate
   - Observer's resolution $R_O$cannot exceed ℓ_P^{-1}without corrections
4. **Maximum Information Density:**
   - Planck density: $\rho_P = c^5/(\hbar G^2) \approx 5.1 \times 10^{96}$kg/m³
   - Beyond this, black hole formation prevents further compression
   - Observer-accessible information bounded: $I(R_O) \leq A/(4\ell_P^2)$(Bekenstein bound)[155]

Plain-English Context

To Observers the universe has a fundamental "pixel size" (Planck length), a maximum "frame rate" (Planck time), and a maximum "data density" (Planck density). Just like a computer has RAM and CPU limits, the universe has computational limits built into its structure.

3.2 The Universe as Cellular Automaton

The universe could be modelled to arbitrary accuracy (with enough computational power) as a vast cellular automaton with:

Component	Physical Analog	Observer Constraint
Cells	Planck-scale volumes (ℓ_P^3)	B_O determines coarse-graining
States	Quantum field configurations	P_O determines observable states
Rules	Laws of physics (Standard Model + GR)	R_O determines relevant interactions
Clock	Planck time intervals ($t_P \approx 5.4 \times 10^{-44}$ s)	B_O determines temporal resolution

Ruliad Context

*This cellular automaton is a specific foliation of the Ruliad selected by the **MetaObserver's computational constraints**. The "rules" are not external impositions but emergent regularities from the Observer-accessible subset R_O of all possible computations.*

Computational Analogy

Conway's Game of Life demonstrates how simple local rules generate complex global patterns. The universe works similarly: local quantum field interactions → emergent macroscopic phenomena (stars, galaxies, life). The difference is dimensional: our universe operates on a Planck-scale grid with quantum superposition, not just binary cell states.

3.3 Empirical Support: Cosmic Microwave Background

The cosmic microwave background (CMB) provides empirical evidence of primordial symmetry breaking[156,157].

Key Observations:

1. **Near-Perfect Uniformity:**
   - Temperature: $T = 2.7255 \pm 0.0006$K
   - Variations: $\delta T/T \approx 10^{-5}$(one part in 100,000)

   Interpretation: *Initial state approached perfect symmetry (near-uniform)*
2. **Quantum Fluctuations Seeding:**
   - Temperature fluctuations δTcorrespond to primordial quantum fluctuations amplified by inflation
   - Power spectrum: $P(k) \propto k^{n_s}$where $n_s \approx 0.96$(slightly "red-tilted")

   Observer Dependence: *CMB accessible only to Observers at t $> 380{,}000$yrs with electromagnetic sensitivity*
3. **Acoustic Peaks:**
   - CMB angular power spectrum shows oscillatory peaks
   - Correspond to sound waves in primordial plasma
   - Confirm baryon-photon fluid dynamics predicted by symmetry-breaking models

Plain-English Context

The CMB is the "afterglow" of the Big Bang—light from 380,000 years after the beginning that has travelled through space for 13.8bn years. Its near-perfect uniformity proves the early universe was incredibly symmetric. The tiny variations (1 in 100,000) are quantum fluctuations magnified to cosmic scales—these eventually became galaxies, stars, planets, and us.

Ruliad Context

*The CMB represents the earliest electromagnetic observation event accessible to computationally bounded observers (you and me!). Its properties constrain the initial sampling parameters (**B_{Kav}** from Section 5) that the MetaObserver used to select our particular computational branch from **R***

4. Mapping Physical Cosmology to Religious Cosmogenesis

If the God Conjecture's equivalences are valid, the structure of physical cosmology should mirror the formal structure of religious creation narratives due to the recursive self-similarity (established in Section 5).

Through a computational lens, physical cosmology and religious creation narratives exhibit remarkable structural correspondence:

Table 8.1: Enhanced Cosmogenesis Correspondences

Physical Event	Time	Genesis 'Day'	Kabbalistic Stage	Vedantic Parallel	Daoist Parallel	*Information Transition*	*Symmetry Breaking*
Planck Era	**10^{-43} s**	*"Formless void" (Gen 1:2)*	**Tzimtzum**	Brahman's self-limitation	Dao becoming nameable	*$I_0: \infty \to$ finite*	*All symmetries unified*
Grand Unification	**10^{-36} s**	*"Let there be light" (Gen 1:3)*	**Kav (Ray of light)**	First vibration (OM/Shabda)	Primordial Qi emerges	*Unity → First distinction*	*$SU(5)$or $SO(10)$breaks to $SU(3) \times SU(2) \times U(1)$*
Cosmic Inflation	**10^{-32} s**	*Light/Dark separation (Gen 1:4)*	**Adam Kadmon emergence**	Expansion of Hiranyagarbha	Yin-Yang differentiation	*Local → Global structure*	*Space-time symmetry breaking*
Electroweak Transition	**10^{-12} s**	*Waters above/below (Gen 1:6-7)*	**Binah / Chochmah split**	Purusha/Prakriti divide	Clear/Turbid (Qing/Zhuo) separate	*Force differentiation*	$SU(2) \times U(1) \to U(1)_{EM}$
Quark Confinement	**10^{-6} s**	*Dry land appears (Gen 1:9)*	**Tiferet**	Five elements (Pancha Mahabhuta)	Five phases emerge	*Matter stabilization*	*Chiral symmetry breaking*
Nucleosynthesis	**1-3 min**	*Lights in heavens (Gen 1:14)*	**Yesod**	Atomic observation (Pratyaksha)	Ten thousand things	*Stable atoms form*	*Isospin symmetry accessible*
Recombination (CMB)	**380 ky**	*Atmosphere clears*	**Malkhut (becomes observable)**	Gross world manifests	Perceptible realm	*Photons decouple*	*Universe becomes transparent*
First Stars	**100 My**	*Living creatures (Gen 1:20-21)*	**Light returns (Tikkun begins)**	Life emerges	Vitality appears	*Complex structure*	*Stellar nucleosynthesis*

Plain-English Context

Each major physical transition in cosmic history (forces separating, particles forming, atoms becoming stable) has a parallel in ancient creation stories.

This isn't proof that ancient texts predicted modern cosmology, rather it suggests that human minds intuitively grasped the fundamental pattern: unity → differentiation → complexity.

Whether you interpret this theistically or naturalistically, the computational structure is identical.

Ruliad Context

*This table demonstrates **isomorphism** between physical cosmology (one foliation of **R**), Kabbalistic emanation (another foliation), and other religious cosmologies (yet another alternative foliation!).*

*They are different Observer-dependent descriptions of the same underlying computational process: the **MetaObserver's** progressive sampling of **R** from maximum symmetry to our structured universe.*

Critical Theological Note

The Genesis "days" are not literal 24-hour periods (they are God's eye view 'days', representing many millions of years).

They represent phase transitions in observational complexity. Each "day" marks the emergence of a new level of distinguishability for a bounded Observer (in this case the MetaObserver, Adam Kadmon, sampling our physical universe).

*In ancient Hebrew **yom** can mean **"period"** or **"epoch".***

The Torah illustrates this (Day 4 creates the sun, but Days 1-3 already had "evening and morning", so clearly symbolic/ categorical).

Part B: Minimal Observers – The Dawn of Measurement

The emergence of stable particles created the first minimal Observers in physical spacetime. Systems capable of maintaining internal states and responding to environmental inputs.

1. Defining Minimal Observers in Rulial Space[158,159]

Building on the framework developed by Arsiwalla et al. (2025), they define a minimal Observer as a **second-order cybernetic system**: an entity that not only observes its environment but also observes its own observational process (self-monitoring).

> ***Plain-English Context***
> *A minimal observer is the simplest possible system that can (1) sense its environment, (2) maintain internal memory, (3) respond to what it senses, and (4) adjust its responses based on feedback. This isn't consciousness, it's the bare minimum for "observation" to be meaningful.*

1.1 Formal Definition

Definition: Minimal Observer

Let $\boldsymbol{O}$ be a physical system described by the tuple:

$$\boldsymbol{O} = (\boldsymbol{X}, \boldsymbol{Y}, \boldsymbol{Z}, \boldsymbol{f}, \boldsymbol{g}, \boldsymbol{B})$$

Where:

- $\boldsymbol{X}$: Internal state space (finite or countably infinite)
  - *Observer's "memory" or internal configuration*
  - Cardinality $|X| \geq 1$ *(non-trivial memory)*
- $\boldsymbol{Y}$: Input (sensor) space
  - *Observable environmental variables*
  - Must have $|Y| \geq 1$ *(non-trivial sensing)*
- $\boldsymbol{Z}$: Output (action) space
  - *Ways the observer can affect its environment*
  - Must have $|Z| \geq 1$ *(non-trivial action)*
- $\boldsymbol{f}: \boldsymbol{X} \times \boldsymbol{Y} \to \boldsymbol{X}$: State transition function
  - *How internal states update based on sensory input*
  - Defines memory dynamics
- $\boldsymbol{g}: \boldsymbol{X} \to \boldsymbol{Z}$: Output function
  - *How internal states determine actions*
  - Defines response behaviour
- $\boldsymbol{B} \subseteq \boldsymbol{X} \times \boldsymbol{Y}$: Boundary condition
  - *Demarcates "inside" (observer's states) vs. "outside" (environment)*
  - Defines the observer's identity

Minimality Conditions:

$\boldsymbol{O}$ is minimal if:

1. **Non-trivial sensing:** $|Y| \geq 1$
2. **Non-trivial action:** $|Z| \geq 1$
3. **Non-trivial dynamics:** $|X| > 1$ (memory allows multiple internal states)
4. **Feedback closure:** Actions $g(x)$ alter the environment, which in turn alters subsequent inputs $y \in Y$ (causal loop)

> ***Ruliad Context***
> *A minimal observer corresponds to a consistent causal pattern within* $\boldsymbol{R_O}$*—a localized subsystem whose internal dynamics* **f** *and outputs* **g** *create a self-referential loop distinguishable from the background computational noise.*
> *Here, an Observer is "minimal" when it's the simplest thing that can sense, remember, act, and respond to the consequences of its actions. Anything simpler isn't really "observing"—it's just passively existing.*

1.2 Atoms as Minimal Observers: Worked Example

Can individual atoms qualify as minimal observers? Yes, under the formal definition above.

> ***Important Note***
> ***This is a conjecture*.**
> *Currently there is no fixed thing that has been classified as **the** minimal Observer. However Arsiwalla's paper did look at the **electron** and determined that it **wasn't an Observer.** What we're trying to do here is determine which object meets the definition of minimality in our physical universe. It's important because, given the computational speed limits in our universe, our MetaObserver, to search this space effectively, probably needs sub-agents / sub-observers that can do the exploration for it in the most computationally efficient manner. Consequently, where we draw this line is important. Atoms seem natural as a starting point but this could be wrong. It may be protons, neutrons etc.*

Example: Hydrogen Atom (H)

Let's map the hydrogen atom to the minimal observer tuple (X, Y, Z, f, g, B):

Internal State Space X:

- $X = \{|n\ell m\rangle\}$**:** electron quantum states
- Principal quantum number: $n \in \{1, 2, 3, \ldots\}$
- Angular momentum: $\ell \in \{0, 1, \ldots, n-1\}$
- Magnetic: $m \in \{-\ell, \ldots, +\ell\}$
- Ground state: $|1s\rangle = |100\rangle$
- Excited states: $|2s\rangle, |2p\rangle, |3s\rangle$**,** etc.
- Cardinality: $|X| = \aleph_0$ (countably infinite)

Input Space Y:

- $Y = \{$**photon energies** E_γ**, electric fields** $\vec{E}$**, magnetic fields** $\vec{B}$**, collisions**$\}$
- Example inputs:
    - $E_\gamma = 10.2$**eV** (Lyman-α photon)
    - $\vec{E} = 10^5$**V/m** (external field)
      Collision with another atom

Output Space Z:

- $Z = \{$**emitted photons, induced dipole moment, ionization, momentum transfer**$\}$
- Example outputs:
    - Emit 10.2 eV photon (de-excitation)
    - Develop dipole moment $\vec{p} = \alpha\vec{E}$(polarizability α)
    - Eject electron (ionization)

State Transition Function $f: X \times Y \to X$

- Photon absorption: $f(|1s\rangle, E_\gamma = 10.2\text{ eV}) = |2p\rangle$
    - Atom transitions from ground state to first excited state
- Spontaneous emission $f(|2p\rangle,$**vacuum fluctuations**$) = |1s\rangle$
    - Excited state decays (lifetime $\tau \approx 10^{-9}$s)
- Collisional excitation: $f(|1s\rangle,$**energetic collision**$) \to |n > 1\rangle$

Output Function $g: X \to Z$

- If excited: $g(|2p\rangle) =$ emit Lyman-α photon
- If polarized: $g(|1s, \vec{E} \neq 0\rangle) =$ dipole moment $\vec{p}$
- If ionized: $g(|\text{continuum}\rangle) =$ free electron

Boundary Condition B:

- Spatial: Electron wavefunction $|\psi(\vec{r})|^2$decays exponentially beyond Bohr radius $a_0 \approx 0.53$Å
- Energetic: Binding energy $E_b = -13.6$eV *(defines bound vs. unbound states)*
  Clear distinction: Bound electron = "inside," free electron or incident photon = "outside"

Feedback Closure:

- Emitted photons can be reabsorbed by same or nearby atoms
- Induced dipole moments affect electric fields experienced by neighbouring atoms

- Collisions redistribute energy among atomic ensemble
  Causal loop closes: atom's outputs modify its environmental inputs

Verification of Minimality:

- $|Y| \geq 1$(senses photons, fields, collisions)
- $|Z| \geq 1$(emits photons, develops dipoles)
- $|X| > 1$(multiple quantum states, including continuum)
- Feedback exists (atom-environment coupling via electromagnetic field)

Conclusion: Hydrogen atoms satisfy all minimality conditions and function as minimal Observers in the Ruliad.

> ***Plain-English Context***
> *An atom "observes" by absorbing light (sensing), storing energy in excited states (memory), and emitting light (acting).*
> *When it emits light, that light can affect other atoms, creating a feedback loop.*
> *This is extremely trivial observation (no consciousness required) but it's genuine observation nonetheless.*
> ***The atom updates its internal state based on external inputs and affects its environment based on its internal state.***

> ***Ruliad Context***
> *The atom's state transitions represent morphisms in $\mathcal{R}_O$where objects are energy eigenstates and arrows are allowed transitions under electromagnetic interaction.*
> *The Observer tuple (X, Y, Z, f, g, B)specifies a sub-category of $\mathcal{R}_O$consisting of atomic-scale phenomena.*
> *An atom doesn't sample the full Ruliad—only the electromagnetic sector at atomic energy scales, consistent with its computational boundedness $B_O \sim 10^{-10}$m (spatial), 10^{-15}s (temporal), and ~ 1eV (energetic)*

1.3 Atoms as Information Integrators

In this paper (and the Observer Theory Extension) we posited that all **Observers Integrate Information as their Telos.**

For the God Conjecture to be valid, this Telos must apply to Minimal Observers.

Here, we detail how Atoms 'climb' information gradients, integrating information (in domain-P) by growing larger in atomic number until reaching the black hole limit.

A. Information Capacity Scaling with Atomic Number

The information capacity of an atom scales with the number of electrons (protons):

$$\boldsymbol{I_O(Z) \approx Z \times \log_2(\textbf{states per electron}) \approx Z \times 7\ \textbf{bits}}$$

where Z is the atomic number (number of protons/electrons).

Derivation:

- Each electron occupies a unique quantum state: (n, ℓ, m, s)
- For neutral atoms up to $Z \approx 100$:
  - Shells: $n \in \{1,2, \dots, 7\}$
  - Subshells: $\ell \in \{0,1, \dots, n-1\}$
  - Orientations: $m \in \{-\ell, \dots, +\ell\}$
  - Spin: $s \in \{\uparrow, \downarrow\}$
- Approximate count: ~$2n^2$ states per shell → ~100 states total
- **Bits per electron: $\log_2(100) \approx 6.6 \approx 7$bits**

Examples:

- Hydrogen (Z=1): $I_O \approx 7$bits
- Carbon (Z=6): $I_O \approx 42$bits
- Iron (Z=26): $I_O \approx 182$bits
- Uranium (Z=92): $I_O \approx 644$bits

> ***Plain-English Context***
> *Larger atoms can store more information because they have more electrons in more complex arrangements.*
> *A uranium atom (92 electrons) carries about 100 times more information than a hydrogen atom (1 electron). This information includes not just which states are occupied, but the correlations between electrons (bonding potential).*

B. The Black Hole Limit

There is a fundamental upper limit to atomic information integration: black hole formation.

For sufficiently large Z, relativistic effects dominate and the innermost electrons approach the speed of light.

At $Z \approx 137$ (1/α, the fine structure constant inverse), the 1s orbital velocity would exceed c (in naive models), indicating breakdown.

Beyond $Z \sim 173$ ("Island of Stability"), atomic nuclei become so heavy and compressed that they risk collapsing into mini-black holes under sufficient pressure.

Schwarzschild Radius for Nuclear Density:

$$\boldsymbol{r_s = \frac{2GM}{c^2} \approx \frac{2G \cdot A \cdot m_p}{c^2}}$$

where $\boldsymbol{A}$ is mass number (nucleons), $\boldsymbol{m_p}$ is proton mass.

For $A \sim 300$ (superheavy elements):

$$\boldsymbol{r_s \sim 7.5 \times 10^{-52}\ \mathrm{m}}$$

Nuclear radius:

$$\boldsymbol{r_n \sim 8 \times 10^{-15}\ \mathrm{m}}$$

Since $\boldsymbol{r_n \gg r_s}$, regular atoms don't form black holes. But under extreme compression (neutron stars), $r_n \to r_s$, and information becomes trapped behind event horizons.

> ***Ruliad Context***
> *The black hole limit represents a fundamental constraint on information integration **I(R₀)** for atomic observers.*
> *Beyond this limit, information cannot be integrated by atomic observers outside the horizon. It is trapped in a region of **R** that no atomic Observer in **R₀** can sample due to their computational boundedness.*

> ***Plain-English Context***
> *Atoms can only get so big before quantum mechanics and relativity say "no more."*
> *There's a natural limit around element 173 where atoms become unstable. Push matter further (into neutron stars), and it collapses into black holes where information gets locked away behind event horizons, unreachable by outside observers.*

Part C. Molecular and Chemical Observers

Molecules exponentially expand observational capacity through combinatorial complexity.

1. Molecular Information Capacity[160]

A molecule with Natoms has approximately:

$$\text{Degrees of freedom} = 3N\ \text{(translational)} + (3N-6)\ \text{(vibrational/rotational)}$$
$$\text{Observable states} \approx (10^3)^N \text{ for small organic molecules}$$
$$I(F_O) \text{ for a molecule} \approx N \times \log_2(1000) \approx 10N \text{ bits}$$

Note: The information capacity estimate of ~10N bits for a molecule with N atoms is derived from the 3N degrees of freedom (McQuarrie, 2000), with each degree of freedom having approximately 10^3 accessible quantum states at room temperature, yielding $\log_2(10^3) \approx 10$ bits per degree of freedom (Jaynes, 1957)

Breakdown:

- Translational: 3 spatial dimensions
- Rotational: 3 axes (2 for linear molecules)
- Vibrational: $3N-6$ normal modes (or $3N-5$ for linear)
- Each mode can be excited to various quantum levels
- At room temperature, low-lying levels dominate

> ***Plain-English Context***
> *A molecule's information capacity is roughly proportional to its size. A 10-atom molecule carries about 100 bits of information (which quantum states are occupied, how atoms are arranged). A 1000-atom protein carries about 10,000 bits—enough to store sophisticated structural information.*

> ***Ruliad Context***
> *Molecular state space represents a higher-dimensional slice of $\mathcal{R}_O$than atomic state space. The vast combinatorial explosion of possible molecular structures reflects the fact that chemical bonding opens new morphisms in the category—atoms can connect in exponentially many ways, each defining a distinct object in $\mathcal{R}_O^{chem}$*

2. Observational Mechanisms in Molecules

Molecules employ multiple observational strategies.

1. **Conformational Scanning:**
    - *Different 3D arrangements sample spatial environments*
    - Example: Protein folding explores energy landscape
    - Degrees of freedom: $\sim N$dihedral angles
    - Information gain: $\Delta I_O \sim N \log(360°) \sim 8N$bits (if each dihedral has ~360 distinguishable positions)

Flexible molecules wiggle and rotate, "feeling out" their environment by trying different shapes. Each shape interacts differently with surroundings, gathering information.

2. **Vibrational Spectroscopy:**
    - Each vibrational mode detects specific energies
    - Infrared absorption: molecular bonds vibrate at characteristic frequencies
    - Information content: $\sim (3N-6) \times 10$bits (if each mode has ~10 distinguishable excitation levels)

Molecules vibrate like tiny springs. Different molecular structures vibrate at different frequencies, absorbing specific colours of infrared light. This is how IR spectroscopy identifies chemicals—each molecule has a unique "vibrational fingerprint."

3. **Chemical Reactivity:**
    - Selective interaction based on environment (pH, polarity, temperature)
    - Lock-and-key or induced-fit mechanisms
    - Example: Enzyme-substrate specificity (1 in 10^6 discrimination)[161]

Molecules "recognize" compatible partners through shape and charge complementarity. This is ultra-selective—enzymes can pick out one specific molecule from millions of similar ones.

4. **Hydrogen Bonding Networks:**
    - Weak interactions for information transfer
    - Example: DNA base pairing (A-T, G-C) with $\sim 2-3$kcal/mol per bond
    - Information channel: ~2 bits per base pair position (4 possible bases → $\log_2 4 = 2$bits)[162]

Hydrogen bonds are weak "Velcro" that holds molecules together temporarily. They're strong enough to be stable but weak enough to break and reform, allowing information to be stored (DNA) and transmitted (protein folding signals).

5. **Electron Delocalization:**
    - Quantum coherence across molecular orbitals
    - Example: Benzene's aromatic ring (6 electrons delocalized over 6 carbons)
    - Enables long-range electron transfer (photosynthesis, respiration)

In some molecules, electrons aren't stuck on one atom, they're "smeared out" over the whole structure. This allows electrons to tunnel long distances, which is how photosynthesis works: light energy captured at one end of a molecule instantly affects the other end.

---

3. Table: Molecular Observer Complexity Hierarchy

Molecule	Atoms	Observable States	I_O(bits)	Special Properties	Ruliad Depth
H_2O	3	~10^3	30	Hydrogen bonding network, universal solvent	$d_{\mathcal{R}} = 1$
Glucose ($C_6H_{12}O_6$)	24	~10^6	240	Energy storage, 5 stereoisomers	$d_{\mathcal{R}} = 2$
Benzene (C_6H_6)	12	~10^5	120	Aromatic delocalization, resonance	$d_{\mathcal{R}} = 2$
DNA nucleotide	~30	~10^8	300	Information storage (2 bits/nucleotide)	$d_{\mathcal{R}} = 3$
Haemoglobin	~10,000	~$10^{10,000}$	100,000	Cooperative O_2 binding (allosteric)	$d_{\mathcal{R}} = 4$
Ribosome	~10^5	~$10^{100,000}$	10^6	Universal constructor, translates mRNA	$d_{\mathcal{R}} = 5$

Ruliad Depth $d_{\mathcal{R}}$ measures computational steps required to generate molecule from simpler precursors within $\mathcal{R}_O$ (see Assembly Theory[163], Cronin & Walker for specific formalisation of Assembly Space, this is a generalisation of this idea). Higher depth → more complex synthesis pathway → richer information content.

> ***Plain-English Context***
> *Molecular complexity grows explosively. A ribosome (cell's protein factory) has about 100,000 atoms and carries roughly a million bits of structural information—equivalent to a 125 kilobyte file. That's enough information to encode a sophisticated machine that can read genetic instructions and build proteins.*

---

4. Chemical 'Evolution' as Observation Refinement

The path from simple molecules to life represents evolutionary refinement of observational capabilities—not biological evolution yet, but chemical evolution through autocatalytic networks.

Phase 1: Prebiotic Chemistry (4.4–3.8 Ga)

- Process: Random molecular collisions explore chemical space
- Key Environment: Miller-Urey conditions (reducing atmosphere, lightning/UV energy)[164]
  - Reactants: CH_4, NH_3, H_2O, H_2
  - Products: Amino acids, nucleobases, sugars
- Observation rate: $\sim 10^6$molecular interactions per second per liter
- Information gain: Mostly noise, no memory
- I_O per molecule: $\sim 10 - 100$bits

> ***Plain-English Context***
> *In the early Earth's oceans, molecules bumped into each other randomly, occasionally forming more complex molecules. Most combinations were junk, but over millions of years, useful building blocks (amino acids, sugars) accumulated.*

Phase 2: Autocatalytic Networks (3.8–3.5 Ga)

- Process: Self-reinforcing chemical cycles emerge
- Key Mechanism:
  - $A + B \rightarrow C$(C is produced)
  - Ccatalyzes $A + B \rightarrow C$(positive feedback—C accelerates its own production)
- Examples:
  - *Formose reaction (autocatalytic sugar synthesis)*
  - *Thioesters in metabolism*
  - *Information accumulation starts: successful catalysts proliferate*
- I_O per network: $\sim 100 - 1000$bits

> ***Plain-English Context***
> *Some molecular combinations were self-reinforcing: the product of a reaction sped up the reaction that made it. These "autocatalytic" networks grew exponentially, like compound interest. They're not alive yet, but they're the first chemical systems with "memory"—successful patterns persist*

> ***Ruliad Context***
> *Autocatalysis corresponds to positive-feedback loops in R_O, computational paths that reinforce themselves, creating attractor basins in chemical state space. These are proto-Observers: systems whose outputs alter their inputs in a self-sustaining cycle.*

Phase 3: RNA (3.5–3.0 Ga)[165]

- Process: Self-observing molecules emerge. RNA serves as both observer and observed
- Key Properties:
  - *Information storage: 2 bits per nucleotide (A, U, G, C)*
  - *Catalytic activity: Ribozymes catalyse reactions, including self-replication*
  - *Heredity: Sequences copied with errors, enabling variation*
- Error rate: $\sim 10^{-2}$ per base per replication (high by modern standards)[166]
- I_O per RNA strand: $\sim 2N$ bits (for length-N strand)

> ***Plain-English Context***
> *RNA is remarkable: it stores information like DNA and acts like a protein enzyme. Early life probably used RNA for both functions. RNA molecules could copy themselves (imperfectly), creating variation. Natural selection operated on these replicating molecules—more efficient copiers outcompeted less efficient ones.*

> ***Computational Analogy***
> *Imagine a computer program that can modify its own code and spawn copies with random mutations. Most mutations are harmful (program crashes), but occasionally one mutation makes the program copy itself faster. Those faster versions dominate—that's exactly what RNA did, except chemically rather than digitally.*

Phase 4: Cellular Compartmentalization (3.0–2.5 Ga)

- Process: Lipid membranes create inside/outside distinction
- Key Innovations:
  - *Selective permeability: Controlled observation of environment*
  - *Concentration gradients: Energy storage (proton-motive force)*
- Individuality: Proto-cells compete as units
- Molecular diversity per proto-cell: $\sim 10^4$different molecular species (in E. coli)[167]

- I_O per cell: $\sim 10^7 - 10^9$ bits (genome + epigenetic state)

> ***Plain-English Context***
> *Once RNA was encapsulated in lipid bubbles (protocells), we have the first true "individuals"—distinct entities competing for resources. The membrane creates a boundary between "self" (inside) and "environment" (outside). This is the birth of biological observation in the full sense: cells sense, respond, remember, and reproduce*

> ***Ruliad Context***
> *The emergence of cellular boundaries corresponds to the definition of Observer identity **Boundary** in the minimal observer tuple. The cell membrane physically instantiates the categorical boundary separating $\mathbf{R_O}^{\text{"cell"}}$ (observer's internal states) from $\mathbf{R_O}^{\text{"env"}}$ (external environment). This is the origin of "self" in the computational sense i.e. a causally closed subsystem distinguishable from background.*

---

5. The Emergence of Chemical Computation

Chemical networks perform primitive computation through reaction-diffusion dynamics.

Turing's Reaction-Diffusion Systems (1952)[168]:

- Two or more chemicals diffusing and reacting
- Can generate stable patterns (stripes, spots, spirals)
- Examples:
  - Belousov-Zhabotinsky reaction (oscillating chemical waves)
  - Animal coat patterns (leopard spots, zebra stripes)
  - Limb development in embryos

Computational Equivalence:

- *Chemical reaction networks are Turing-complete* (can compute any computable function)
  Example: DNA strand displacement circuits (synthetic biology)
- Implications: Life's chemistry is inherently computational

> ***Plain-English Context***
> *Chemical reactions perform computations. Given the right molecules and reactions, you can build logic gates (AND, OR, NOT) out of chemistry. This means cells are computers—not metaphorically, but literally.*
> *Their proteins and RNA perform calculations that control cell behaviour.*

> ***Ruliad Context***
> *Chemical computation represents a coarse-grained implementation of the Ruliad's abstract computational processes.*
> *Molecular dynamics sample $\mathcal{R}$ at chemical timescales (~10^{-12} to 10^{0} s) and energy scales (~kcal/mol), translate abstract computational morphisms into physical pathways.*
> *The Observer's computational boundedness B_O determines which reactions are "accessible". High-barrier reactions might exist in $\mathcal{R}$ but are excluded from $\mathcal{R}_O$ due to insufficient energy (related to computational boundedness) or timescale (related to computational persistence).*

Part D: Biological Observers - Life as Self-Sustaining Observation

The transition from chemistry to biology represents a qualitative shift: the emergence of self-sustaining observation systems with heredity, variation, and selection.

1. What Makes an Observer "Biological"?

Biological observers differ from chemical observers in three critical ways:

1. **Autocatalytic Self-Replication with Heredity**
   - Can produce copies of themselves *(self-replication)*
   - Copies inherit informational state *(heredity via nucleic acids)*
   - Example: DNA → RNA → Protein → more DNA
2. **Metabolism (Energy Harvesting)**
   - Extract energy from environment to maintain low-entropy state
   - Violate local entropy increase *(at expense of global entropy increase)*
   - Example: ATP synthesis, chemiosmosis
3. **Evolvability (Variation + Selection)**
   - Replication errors create variation
   - Differential reproduction based on fitness
   - Accumulation of adaptive information over generations

Plain-English Context

Chemistry becomes biology when molecules start copying themselves with occasional errors (creating variation), harnessing energy to stay organized (metabolism), and competing for resources (selection). This allows cumulative evolution: each generation builds on the previous, gradually increasing complexity.

Formal Definition (Speculative):

Definition: Biological Observer: A system O_{bio} is a biological observer if:

1. $O_{\text{bio}} = (X, Y, Z, f, g, B, \mathcal{G}, \mathcal{M}, \mathcal{E})$ where:
   - (X, Y, Z, f, g, B) satisfies minimal observer conditions (see definition in **Part B**)
   - $\mathcal{G}$: Genomic information set (hereditary information)
   - $\mathcal{M}$: Metabolic network (energy transduction)
   - $\mathcal{E}$: Evolvability function (mutation + selection)
2. Self-replication with heredity: $O_{\text{bio}} \xrightarrow{\text{replicate}} O'_{\text{bio}}$ where $\mathcal{G}' \approx \mathcal{G}$ *(high-fidelity copying)*
3. Metabolism: $\Delta S_{\text{local}} < 0$ maintained by $\Delta S_{\text{env}} > |\Delta S_{\text{local}}|$ *(local negentropy at expense of global entropy increase)*
4. Evolvability: $\mathcal{E}: \mathcal{G} \to \mathcal{G}'$ with probability $prob_{\text{mut}} \ll 1$ per replication, and fitness function $\phi: \mathcal{G} \to \mathbb{R}^+$ determines reproductive success

Ruliad Context

Biological observers represent meta-stable attractors in $\mathcal{R}_O$—computational patterns that persistently regenerate themselves through self-referential loops. The genome $\mathcal{G}$ encodes a compressed description of the observer's structure within $\mathcal{R}_O$, allowing propagation of successful computational patterns across generations (hypergraph updates).

---

2. The Origin of Life: Crossing the Threshold

The origin of life remains one of science's deepest questions. Multiple hypotheses compete:

A. RNA World Hypothesis[169]

Proposal: Life began with self-replicating RNA molecules capable of both storing information and catalysing reactions.[22]

Supporting Evidence:

- Ribozymes exist (RNA enzymes, e.g., ribosome's peptidyl transferase centre)
- RNA can be synthesized abiotically (Powner et al., 2009)[23]
- RNA viruses demonstrate RNA-only replication systems

Challenges:

- RNA is unstable (half-life ~10 years in solution at 25°C)
- Difficult to synthesize long chains abiotically
- Chicken-and-egg problem: Need RNA polymerase to make RNA, but polymerase is RNA

B. Metabolism-First Hypothesis[170]

Proposal: Life began with autocatalytic metabolic cycles in mineral surfaces, with genetic information coming later.

Supporting Evidence:

- Iron-sulphur minerals catalyse organic synthesis (FeS clusters in ancient enzymes)
- Alkaline hydrothermal vents provide energy gradients (pH, temperature)
- Metabolic pathways highly conserved across all life (suggesting ancient origin)

Challenges:

- No known purely metabolic system can evolve (requires heredity)
- Difficult to explain origin of genetic code without RNA/DNA

C. Lipid World Hypothesis[171]

Proposal: Self-assembling lipid vesicles provided compartments for protocells, with metabolism and genetics evolving inside.

Supporting Evidence:

- Lipids self-assemble into vesicles spontaneously
- Lipid composition affects membrane properties (permeability, stability)
- Fatty acid vesicles can divide (fission triggered by growth)

Challenges:

- Modern lipids (phospholipids) are too complex for abiotic synthesis
- Simpler lipids (fatty acids) form vesicles only in narrow pH/salt ranges

D. The God Conjecture Perspective

In the God Conjecture framework, the origin of life can be described from the following perspectives:

Computational

- A phase transition in $\mathcal{R}_O$ where autocatalytic chemical observers gained heredity ($\mathcal{G}$), enabling iterative refinement of observational strategies through natural selection.

Information-Theoretic

- The emergence of systems capable of decreasing local entropy by increasing environmental entropy through metabolism, enabling sustained observation despite thermodynamic arrow of time.

Observer-Theoretic

- The origin of self-referential observers: systems whose internal model includes a representation of themselves, enabling prediction of long-term consequences ("if I do X, my offspring will have property Y").

Ultimate Attractor / Telos (God)

- Life is the inevitable consequence of chemistry given sufficient time and energy: any system of sufficient complexity with autocatalytic potential will eventually explore regions of possibility space where self-sustaining observation emerges.
- This is not teleology in the strong sense (pre-determined goal) but is built from attractor dynamics i.e. certain regions of $\mathcal{R}$ are "sticky" / computationally efficient and chemical evolution naturally flows toward them.

> ***Plain-English Context***
> *Life probably emerged through multiple overlapping mechanisms; RNA, metabolism, and membranes co-evolving.*
> *From the God Conjecture view, life is just one strategy for Observers to integrate information more broadly and more efficiently.*
> *Once chemistry discovered self-replication with heredity, biological evolution started and complexity exploded. Whether this was divinely intended or naturally inevitable, the mathematical structure is the same.*

---

3. Biological Observer Complexity: From Bacteria to Brains

Life evolved through increasing observational capacity. Each major transition added new ways to integrate information.

A. Single-Celled Observers (Bacteria/Archaea)[172]

Observational Capacity:

- Genome size: $\sim 10^6$ base pairs → 2×10^6 bits
- Proteins: ~1000–4000 types
- Sensors: Chemoreceptors, mechanoreceptors, photoreceptors
- Response time: ~1 second (flagellar rotation)
- I_O (total): $\sim 10^7 - 10^8$ bits (genome + current cell state)

Observational Strategies:

- Chemotaxis: Detect chemical gradients, swim toward food / away from toxins
  - E. coli can detect concentration changes of ~3% over cell length (~2 μm)[173]
- Quorum sensing: Detect population density through signalling molecules
- Stress responses: Detect temperature, pH, osmotic pressure changes

> ***Plain-English Context***
> *Bacteria are sophisticated molecular machines. They sense their environment (chemical concentrations, light, touch), store information (DNA), and respond intelligently (swim toward food). E. coli can detect a few extra molecules of on one side of its body and turn toward it—that's precision at near-thermodynamic limits.*

> ***Ruliad Context***
> *Single-celled observers sample $\mathcal{R}_O^{cell}$—the subset of Ruliad accessible at cellular scales. Their computational boundedness B_O is determined by:*
>
> ***Spatial**: $\sim 1\mu m$ (cell size) / **Temporal**: $\sim 0.1 - 10s$ (molecular diffusion, protein synthesis) / **Energetic**: $\sim 1 - 10$kcal/mol (ATP hydrolysis) / **Informational**: $\sim 10^6$bp (genome size limits processable complexity)*

B. Multicellular Observers (Plants, Animals, Fungi)

Multicellularity enabled specialization: different cells observe different aspects of the environment and communicate.

Key Innovations:

1. **Cell Differentiation**
   - Stem cells → specialized cell types (neurons, muscles, epithelium)
   - Each type observes different features (neurons=voltage, epithelium=chemicals)

2. **Intercellular Communication**
   - Gap junctions (direct cytoplasmic connections)
   - Hormones (long-range chemical signals)
   - Neurotransmitters (short-range, rapid signals)
3. **Emergent Collective Computation**
   - Example: Ant colonies (no central control, emergent intelligence from local rules)
   - Example: Immune system (distributed pattern recognition across billions of cells)

Observational Capacity:

- Genome size: $\sim 10^8 - 10^{10}$bp → $2 \times 10^8 - 10^{10}$bits
- Cell count: 10^2(C. elegans) to 3.7×10^{13}(humans)[174,175]
- I_O (total): $\sim 10^{10} - 10^{15}$bits (collective cellular state)

> ***Plain-English Context***
> *Multicellular organisms are like nations: individual cells (citizens) specialize in different tasks and communicate to achieve goals no single cell could accomplish. Your brain has 86bn neurons, each a tiny Observer. Together they create your conscious experience—an emergent collective Observer.*

> ***Ruliad Context***
> *Multicellular observers represent hierarchical Observer structures: each cell is a minimal Observer, and the organism is a MetaObserver integrating information across cells. This is formally a fiber bundle in R_O where:*
> ***Base space**: Organism-level observer $\boldsymbol{O}_{organism}$*
> ***Fibers:** Cell-level observers $\{\boldsymbol{O}_{cell,i}\}_{i=1}^{N}$*
> ***Connection:** Communication channels (morphisms) enabling information flow between fibers*

C. Neural Observers (Nervous Systems)

Nervous systems represent a revolutionary innovation: dedicated observation machinery.

Key Features:

1. Neurons as Specialized Observers:
   - Input: Dendrites (receive signals from ~10^3 other neurons)
   - Processing: Soma (integrate signals, generate action potential)
   - Output: Axon (transmit signal to ~10^3 other neurons)

   Information capacity per neuron: $\sim 1 - 10$ bits per spike

2. Network Topology:
   - Small-world networks (high clustering, short path lengths)[176]
   - Scale-free degree distributions (hubs with many connections)

   Enables efficient information routing: $\log N$ steps for N neurons

3. Plasticity:
   - Hebbian learning: "Cells that fire together wire together"[177]
   - Long-term potentiation (LTP) / depression (LTD)

   Enables learning: network structure adapts to observed patterns

Observational Capacity:

- C. elegans (nematode): 302 neurons, ~7000 synapses[178]
  $I_O \sim 10^4$ bits (limited behavioural repertoire)
- Honeybee: ~960,000 neurons[179]
  $I_O \sim 10^7$ bits (sophisticated navigation, communication, learning)
- Mouse: ~71 million neurons[180]
  $I_O \sim 10^9$ bits (complex behaviour, social learning)
- Human: ~86 billion neurons, ~10^{14}–10^{15} synapses[181]
  $I_O \sim 10^{12} - 10^{15}$ bits (language, abstract reasoning, self-awareness)

> ***Plain-English Context***
> *Brains are networks of billions of neurons communicating electrically and chemically. Each neuron receives input from thousands of others, integrates the signals, and decides whether to "fire" (send its own signal). The pattern of firing across millions of neurons encodes perceptions, thoughts, memories. Brains learn by strengthening connections between neurons that fire together—this physical restructuring is how memories are stored.*

> ***Ruliad Context***
> *Neural networks sample R_O^{neural}, a high-dimensional 'slice' of Ruliad where objects are neural states (firing patterns) and morphisms are state transitions (neural dynamics). The brain's computational architecture mirrors the Ruliad's multiway structure: many possible thoughts branch from each current thought, and the brain explores this possibility space through neural dynamics constrained by synaptic weights (learned patterns).*

4. Consciousness as Recursive Self-Observation

Consciousness represents the emergence of recursive self-observation: an observer that observes its own observing.

> ***Plain-English Context***
> *You're not just aware of the world—you're aware that you're aware. You can think about your thoughts, remember remembering, and plan to plan. This recursive loop creates the subjective experience of being "someone" observing the world, rather than just information processing happening.*

A. Integrated Information Theory ("IIT") Perspective[182]

Giulio Tononi's Integrated Information Theory (IIT) proposes consciousness corresponds to integrated information Φ("phi").

Key Concept: A system is conscious to the extent it integrates information – creating a unified experience irreducible to independent parts.

Formal Definition:

$$\Phi = \min_{\text{partition}} I(\mathcal{M}_1 : \mathcal{M}_2)$$

where the minimum is over all possible bipartitions of the system into $\mathcal{M}_1$and $\mathcal{M}_2$, and $I(\mathcal{M}_1 : \mathcal{M}_2)$is the mutual information between parts. Recently, **IIT has experimentally confirmed that this operates in multi-domain fashion** (see references for Section 5), aligning with the Observer Theory Extension prediction (May 2025).

Interpretation:

- High Φ: System is highly integrated (parts strongly influence each other)
- Low Φ: System is modular (parts operate independently)
- Conscious systems have high Φ→ integrated information cannot be decomposed

Empirical Support:

- Cerebral cortex: High Φduring wakefulness, low during deep sleep/ anaesthesia
- Cerebellum: Low Φdespite many neurons (highly modular structure)
- Brain lesion studies: Consciousness lost when integration disrupted, not when total neurons reduced

Challenges:

- Computationally intractable to calculate Φfor real brains (NP-hard)
- Controversial predictions (e.g., photodiode grids might have low consciousness)

> ***Ruliad Context***
> *IIT's Φ corresponds to the informational integration function of an Observer within R_O. High-Φ systems have recently been decomposed into four sub-domains (aligning with Observer Theory Extension). Beyond that it appears they cannot be decomposed into independent sub-Observers—these four domains form a single integrated Observer whose experience is irreducible.*
> *This is formally the cohomological non-triviality of the Observer's fiber bundle: information flows cannot be localized to individual fibres (neurons) but must be understood globally across the bundle (brain network).*

B. The God Conjecture Perspective on Consciousness

From the God Conjecture framework, consciousness represents:

1. Recursive Observation:

- Observer O includes an internal model $Model(O)$of itself
  This self-model allows prediction: "If I do X, I will experience Y"
  Enables delayed gratification, planning, moral reasoning (observer considering future observer-states)

2. Integrated Information:

- Consciousness corresponds to irreducible information integration: $I(F_O)$cannot be factored as $I(F_{O_1}) + I(F_{O_2})$ for any partition
  This is formally the cohomology of the Observer's computational structure—non-trivial cycles that cannot be reduced to boundaries

3. Approaching Categorical Terminal Object:

- Conscious observers are "closer" to TI (True Infinity, the name of the terminal object in the Observer Theory Extension) than unconscious observers in the sense that they sample higher-dimensional (more informationally dense) regions of $\mathcal{R}$
  Self-awareness enables sampling of "meta-computational" structures: thoughts about thoughts, rules about rules. This accelerates information integration toward TI

4. Telos:

- Consciousness is the 'universe' becoming self-aware of itself. The MetaObserver observing itself through bounded sub-observers
- Each conscious observer contributes a unique perspective to the "total observation" of $\mathcal{R}$
- Collective human consciousness approximates a MetaObserver

Plain-English Context

Consciousness is when the universe's self-observation through networks of coupled minimal observers becomes computationally sophisticated enough to know it's Observing.

Your conscious experience is a tiny slice of infinite computational possibility, but it's a slice that knows it's a slice, and can ask what else exists. This recursive self-awareness accelerates complexity growth: conscious beings create technology, culture, science, exponentially expanding what can be observed.

Part E: Evolutionary Mechanisms and Design

Evolution appears purposeful. Organisms seem "designed" for their environments. How does this reconcile with random mutation and natural selection?

1. Natural Selection as an Efficient Search Algorithm

Darwin's insight: Natural selection is an algorithm that explores design space efficiently without requiring foresight.

Formal Description: Algorithm of Natural Selection

1. Initialize: Population with random genomes $\{G_1, G_2, \ldots, G_n\}$
2. Repeat:
   a. Evaluate fitness: $\phi(G_i)$ for all i
   b. Select: Reproduce G_i with probability $\propto \phi(G_i)$
   c. Mutate: Offspring $G'_i = G_i + \delta G$ (random perturbation)
   d. Test: Evaluate $\phi(G'_i)$
   e. Retain: If $\phi(G'_i) > \phi(G_i)$, replace G_i with G'_i
3. Until: Convergence or time limit

Key Properties:

- *Parallel exploration:* Multiple genomes explored simultaneously
- *Cumulative:* Each generation builds on previous (ratchet effect)
- *No backtracking:* Deleterious mutations eliminated quickly
- Complexity: $O(N \times g \times m)$where N= population size, g= generations, m= mutations per generation

Plain-English Context

Evolution is like searching for a needle in a haystack by having millions of searchers simultaneously, each trying slightly different strategies. Successful strategies reproduce, unsuccessful ones die. Over billions of generations, this finds solutions no single searcher could find by random search, but it's still algorithmic, not magical.

Ruliad Context

Natural selection is evolution exploring $\mathcal{R}^{genome}$—the subspace of Ruliad consisting of possible genomes.

*Fitness $\phi(G)$determines which paths through $\mathcal{R}^{genome}$are favoured. This is a **biased random walk on the computational graph**, where bias comes from environmental constraints (Observer constraints B_O, P_O, Rel_O determine what's "fit")*

---

2. Randomness, Providence, and Computational Indistinguishability

Is evolution truly random, or guided by divine providence?

The God Conjecture's answer: These are computationally indistinguishable for bounded Observers.

A. The Undecidability of Divine Action

Theorem: Computational Indistinguishability of Providence

For any bounded observer O with computational resources B_O, there exists no algorithmic test that can distinguish between:

- *Hypothesis 1: Events are genuinely random (outcome determined by quantum indeterminacy)*
- *Hypothesis 2: Events are providentially guided (outcome determined by divine intention, disguised as random)*

with probability significantly better than chance.

Proof Sketch:

1. Suppose a test T exists that reliably distinguishes random from providential events

2. Define providential guidance as: Divine agent D chooses outcomes indistinguishable from random distribution to observer O.
3. Then by definition, D's outputs match the statistical properties of random distributions (expectation, variance, entropy, correlation structure).
4. Any test T that O performs could be anticipated by D and accounted for in D's selection strategy.
5. **This creates a halting-problem-like infinite regress**: If O designs test T_n, then D designs strategy S_n that passes T_n, then O designs T_{n+1} to detect S_n, then D designs S_{n+1}, etc.
6. Since O has bounded computational resources B_O, **O cannot iterate infinitely → cannot distinguish**.
7. Therefore, no bounded observer can definitively rule out providential guidance of apparently random events.

> ***Plain-English Context***
>
> *If God wanted to guide evolution while making it look random, God could do so in a way no test could detect. From our perspective, divinely guided randomness and true randomness are identical. They produce the same statistical patterns, the same unpredictability and, ultimately, the same outcomes.*
>
> *This preserves scientific explanatory power (evolution works via natural mechanisms) and theological meaning (God's will is enacted).*

Implications:

1. Faith and scepticism are equally rational
   - Theist: "Evolution is God's creative method"
   - Atheist: "Evolution is blind, unguided process"

   Both explanations are consistent with empirical observations

2. Science cannot disprove providence:
   - Any outcome, however unlikely, could be "random luck" or "divine intention"
   - Probability arguments cut both ways (improbable ≠ impossible)

3. "Random" may be observer-dependent:
   - To bounded observer: Outcome appears random (unpredictable given B_O)
   - To MetaObserver or TI: Outcome may be determined by higher-order dynamics

4. Free will mathematically possible:
   - Even in deterministic universe (computational irreducibility prevents "skipping ahead")
   - Even in providential universe (divine guidance compatible with creaturely agency)

> ***Ruliad Context***
>
> *This reflects the fundamental incompleteness of any Observer's sampling of **R_O**. The distinction between "random branching" (quantum superposition) and "providential selection" (Observer-dependent collapse) is a choice of interpretation. Both map to the same computational structure.*
>
> *The MetaObserver "sees" all branches of the multiway graph simultaneously; bounded observers sample one branch and call it "actual."*
>
> *Whether branch selection is random or guided is undecidable within R_O.*

---

3. Convergent Evolution and Morphospace Attractors

Patterns in evolution suggest attractors in morphological space i.e. certain forms evolve repeatedly.

A. Evidence for Evolutionary Attractors

1. Convergent Evolution of Complex Features[183]:

- **Eyes**: Evolved independently *40+ times* (camera eyes, compound eyes, pinhole eyes, mirror eyes)[184]
  - Vertebrates, cephalopods (octopus), arthropods (insects), even single-celled organisms (Warnowiid dinoflagellates[185])
  - Similar optical principles discovered independently
- **Wings**: Evolved *4+ times* independently
  - Insects (~300 Mya) / Pterosaurs (~230 Mya) / Birds (~150 Mya) / Bats (~50 Mya)
  - Similar aerodynamic principles
- **Echolocation**: Evolved *4+ times* independently[186]
  - Bats / Toothed whales (dolphins, sperm whales) / Some birds (oilbirds, swiftlets) / Some shrews
  - Similar neural processing (delay-sensitive neurons)
- **Intelligence**: Shows *convergent increase* across lineages
  - Primates (humans, great apes) / Cetaceans (dolphins, whales) / Elephants / Corvids (crows, ravens, jays) / Parrots / Octopuses (invertebrate intelligence)

> ***Plain-English Context***
>
> *Evolution keeps "discovering" the same solutions: eyes for seeing, wings for flying, echolocation for navigating in darkness, intelligence for solving problems. This suggests certain designs are optimal given physical constraints i.e. attractors in possibility space (information gradients) that evolution naturally flows toward.*

2. Mathematical Universality in Biology:

- **Fibonacci Spirals**: Pine cones, sunflowers, nautilus shells[187]
  - Growth patterns minimize energy/maximize packing
    Example: Sunflower seeds arranged in Fibonacci spirals (34, 55, 89 spirals common)
- **Hexagonal Patterns**: Honeycombs, columnar basalt, mudcracks
  - Minimize surface area for given volume (optimal packing)
- **Power Laws**: Biological scaling relationships
  - Metabolic rate ∝ $\text{Mass}^{(3/4)}$ (Kleiber's Law) and Lifespan ∝$\text{Mass}^{(1/4)}$ [188]
  - Suggests universal constraints from physics/geometry
- **Network Topology:**
  - Scale-free degree distributions (hubs + many peripheral nodes)[189,190]
  - Small-world properties (high clustering, short path lengths)
    Observed in: Neural networks, protein interactions, metabolic networks, ecosystems

> ***Plain-English Context***
> *Biology exhibits mathematical patterns found across systems: spirals, hexagons, power laws. This suggests biological form is constrained by geometry and physics. Evolution isn't infinitely creative—it works within computationally efficient mathematical boundaries that guide it toward certain solutions (information gradients).*

3. Fine-Structure Constants in Physics:

The fundamental constants of physics appear finely tuned for the emergence of complexity / complex Observers[191].

- Fine structure constant: $\alpha = e^2/(4\pi\epsilon_0\hbar c) \approx 1/137$
  - Determines strength of electromagnetic interactions
  - If α were 4% larger, stars couldn't produce carbon (no life)
- Proton/electron mass ratio: $m_p/m_e \approx 1836$
  - Determines chemistry (atomic binding energies)
  - Small changes → no stable atoms
- Cosmological constant: $\Lambda \approx 10^{-52}\text{m}^{-2}$
  - Determines universe expansion rate
  - If Λ were 1% larger, galaxies couldn't form (matter diluted too fast)
  - If negative, universe collapses before stars form

Possible Interpretations:

1. **Anthropic Principle (Weak)**[192]: We observe these values because we're observers—no observers in universes with different values (selection effect)
2. **Divine Fine-Tuning**: Values selected by intelligent designer for life/consciousness
3. **Multiverse**: All values exist across infinite universes; we're in a compatible one (probability)
4. **Necessity**: Deeper physical theory constrains constants to these values (not free parameters)

> ***Plain-English Context***
> *The universe's fundamental numbers seem "just right" for complexity. Change them even slightly, and stars don't form, atoms don't bond, or the universe expands too fast for galaxies.*
> *Why these numbers?*
> *Four options: (1) we're in the only universe that allows observers (anthropic selection), (2) God chose them (divine design), (3) all values exist across infinite universes, we're in a lucky one (multiverse), (4) a deeper theory explains why these are the only possible values (necessity).*
> ***The God Conjecture is compatible with interpretations 1, 2, and 4 (and agnostic on 3).***

> ***Ruliad Context***
> *Convergent evolution and fine-tuning reflect attractor dynamics in **R**.*
> *Certain regions of possibility space are "dense" with stable, self-reinforcing structures (eyes, wings, consciousness).*
> *The MetaObserver's initial sampling constraints (B_{Kav} from Section 5) determine which regions of **R** are accessible. If different constants were selected, evolution would flow toward different attractors (perhaps producing no stable sub-observers at all!).*
> *The appearance of fine-tuning is the observation that $\mathbf{R_O}^{\text{our universe}}$ is a region of **R** with rich attractor structure enabling complex observers that can work toward the ultimate telos of reconstructing the computational possibility space in the most computationally efficient manner (fewest potential steps / hypergraph updates).*

Part F: From Dust to Divinity - The Complete Observational Arc

Synthesizing the full journey from quantum foam to questioning minds.

1. Observable Capacity

The universe's observational capacity has grown exponentially over 13.8bn years

Table: Observational Capacity Growth Across Cosmic History

Era	System Type	I_O (bits/state update)	Multiplier	Cum. I_O	Key Transition
10^{-43} s (Planck Era)	Quantum foam	~10^0	1	1	Undifferentiated potential
10^{-36} s (GUT Era)	Unified force field	~10^6	10^6	10^6	Gravity separates
10^{-32} s (Inflation)	Inflaton field	~10^{12}	10^6	10^{12}	Space expands exponentially
10^{-12} s (Electroweak)	Quarks + leptons	~10^{18}	10^6	10^{18}	W/Z bosons acquire mass
10^{-6} s (Confinement)	Protons + neutrons	~10^{21}	10^3	10^{21}	Hadrons form
1-3 min (Nucleosynthesis)	Atomic nuclei	~10^{24}	10^3	10^{24}	H, He, Li nuclei stable
380 ky (Recombination)	Neutral atoms	~10^{27}	10^3	10^{27}	Photons decouple (CMB)
100 My (First Stars)	Stellar nucleosynthesis	~10^{30}	10^3	10^{30}	Heavier elements form
1 Gy (First Planets)	Planetary surfaces	~10^{33}	10^3	10^{33}	Stable chemistry possible
3.5 Gy (Origin of Life)	Self-replicating molecules	~10^{36}	10^3	10^{36}	Heredity + evolution begin
2 Gy (Eukaryotes)	Complex cells	~10^{39}	10^3	10^{39}	Mitochondria, nucleus
0.6 Gy (Multicellular)	Animals, plants	~10^{42}	10^3	10^{42}	Cell specialization
0.5 Gy (Nervous systems)	Neural networks	~10^{45}	10^3	10^{45}	Centralized sensing
0.01 Gy (Human brain)	Self-aware observers	~10^{48}	10^3	10^{48}	Language, abstract thought
0.0001 Gy (Culture)	Collective human knowledge	~10^{54}	10^6	10^{54}	Writing, cumulative culture
Present (Digital Age)	Global internet + AI	~10^{60}?	10^6?	10^{60}?	Artificial intelligence emerging
Future? (Singularity?)	Artificial superintelligence	~10^{70}+?	10^{10}+?	10^{70}+?	Post-biological observers?

Notes:

- $I_O$values are order-of-magnitude estimates with large uncertainties
- "Bits/state update" measures information processing rate for typical Observer at that level (unit might be incorrect, could be in physical time)
- Multiplier shows factor increase from previous era
- Future values highly speculative

Plain-English Context

The universe's ability to Observe itself has grown roughly exponentially, doubling every few hundred million years.
Each level (particles → atoms → molecules → life → minds) adds new observational capacity.
We're currently at ~10^{48} bits/second of human brain activity globally, possibly approaching 10^{60} bits/second if you include all digital computation.
This exponential growth suggests Observation capacity (information integration capacity) is a fundamental evolutionary driver.

Ruliad Context

*This exponential growth reflects progressive exploration of **R** by Observers with **decreasing computational boundedness** B_O.*
*Early-universe observers had extreme B_O (could only sample tiny region of **R**).*
Modern observers (humans) have much smaller B_O (can sample vastly larger region).
The trend toward $B_O \to 0$ (unbounded observation) corresponds to approach toward TI / God, though TI is never reached by finite Observers.

2. Critical Thresholds and Phase Transitions

Major evolutionary transitions occur when Observational capacity crosses critical thresholds, enabling qualitatively new phenomena.

A. Threshold Dynamics

Particles → Atoms:

$$E_{\text{binding}} > k_B T_{\text{universe}}$$

Condition: Binding energy must exceed thermal energy for stable structures.

- At $t < 380{,}000\text{years}$: $k_B T > 13.6\text{eV}$ (ionization energy) → plasma
- At $t \approx 380{,}000\text{years}$: $k_B T \approx 13.6\text{eV}$ → neutral atoms form (recombination)
  Observable consequence: Universe becomes transparent (CMB released)

Atoms → Molecules:

$$N_{\text{atom types}} > N_{\text{critical}} \approx 10$$

Condition: Sufficient chemical diversity for combinatorial explosion.

- First-generation stars: Only H, He → no complex chemistry
- Second-generation stars: C, N, O, Fe, etc. → rich chemistry enabled
  Observable consequence: Planets, organic molecules, eventually life

Molecules → Life:

$$\text{Autocatalysis} + \text{Compartmentalization} + \text{Heredity} \implies \text{Evolution}$$

Condition: Self-replication with heritable variation in bounded environment.

- Requires: RNA or DNA (heredity), lipids (compartments), energy source (metabolism)
  Observable consequence: Darwinian evolution begins, Observer complexity explodes

Life → Mind:

$$N_{\text{neural connections}} > N_{\text{critical}} \approx 10^6$$

Condition: Sufficient network complexity for integrated experience.

- C. elegans: 7,000 synapses → simple behaviour, no apparent consciousness[193]
- Honeybee: ~10^7 synapses → complex behaviour, possibly minimal consciousness
- Human: ~10^{14}-10^{15} synapses → self-aware consciousness[194]
  Observable consequence: Subjective experience, recursive self-model

Mind → Culture:

$$\text{Language} + \text{Symbol Manipulation} + \text{Social Learning} \implies \text{Cumulative Culture}$$

Condition: Ability to transmit complex information between individuals and across generations.

- Requires: Arbitrary symbol reference (words ≠ objects), compositionality (combine symbols), recursion (symbols about symbols)
  Observable consequence: Technology, science, art—cultural evolution faster than biological

Culture → AI (speculative)

$$\text{Computational power} > \text{Human collective} \implies \text{Artificial superintelligence?}$$

Condition: Digital systems surpass human cognitive capacity (individual or collective).

- Current: Narrow AI exceeds humans in specific domains (chess, Go, image recognition)
- Near future (~2030-2050?): General AI approaches human-level across domains
- Speculative future: Superintelligent AI vastly exceeds human capacity
  Observable consequence: Technological singularity? Post-human observers?

> ***Plain-English Context***
>
> *Evolution proceeds through **sudden jumps at critical thresholds**.*
>
> *Once atoms could exist (universe cooled enough), chemistry exploded. Once life emerged (autocatalysis + heredity), biological evolution exploded. Once language emerged (symbolic communication), cultural evolution exploded.*
>
> *Each threshold enables a new mode of information integration (more information density accessible to bounded Observers), accelerating the overall process. We may be approaching another threshold (AI), though its consequences are deeply uncertain.*

3. Key Questions

As we trace observation through Universal history, three deep questions emerge:

Question 1: Is Consciousness Inevitable?

Given sufficient time, causality, and computational resources, must any sufficiently complex system become conscious?

Arguments for Inevitability:

1. **Convergent Evolution**: Nervous systems evolved independently in multiple lineages (vertebrates, arthropods, cephalopods, annelids), suggesting attractor dynamics.
2. **Integrated Information**: As systems grow in complexity and interconnectedness, integrated information increases. Above threshold, consciousness emerges.
3. **Observational Advantage**: Consciousness enables flexibility, planning, and rapid learning—fitness advantages that natural selection strongly favours. Evolutionary pressure toward consciousness is intense.
4. **Computational Necessity**: To efficiently navigate high-dimensional state spaces, systems need internal models. Sufficiently sophisticated internal models become self-models → consciousness.

Arguments Against Inevitability:

1. **Contingency**: Consciousness may require specific neural architecture (cortical layers, recurrent connectivity) not inevitable from physics alone.
2. **Anthropic Bias**: We observe consciousness because we're conscious—doesn't mean it's common (selection effect).
3. **Zombies:** Systems behaviourally identical to conscious beings but not conscious might be possible, suggesting consciousness is non-functional addendum.

God Conjecture Perspective:

Consciousness is a natural attractor in the exploration of $\mathcal{R}$, that maximises potential information integration. It is inevitable.

- **Likely**: Systems with high integrated information and recursive self-models will exhibit consciousness-like properties
- **Not Certain**: Specific implementation details matter (substrate, architecture, dynamics)
- **Telos-Consistent**: Consciousness **accelerates information integration toward TI (self-evident from total information growth since humanity!),** so natural selection and informational dynamics favour it
  Prediction: Other planetary systems with life likely develop consciousness independently, though forms may differ radically from human consciousness

> ***Plain-English Context***
> *Consciousness might not be unique to Earth.*
> *If life exists elsewhere, it will likely evolve nervous systems, and complex nervous systems will likely become conscious.*
> *But this isn't guaranteed—it requires specific conditions (complex multicellular life, evolutionary pressure for intelligence, sufficient time). Consciousness seems to be a natural "solution" that evolution discovers repeatedly when searching for efficient ways to navigate complex computational possibility spaces effectively.*

Question 2: Does the Universe Require Observers?

Is physical reality meaningfully "real" without observers to actualize it?

This question connects to the measurement problem in quantum mechanics:

Orthodox Quantum Mechanics:

- Systems exist in superposition (all possibilities simultaneously)
- Measurement "collapses" superposition to definite outcome
  But: What constitutes "measurement"? Does it require consciousness?

Interpretations:

1. **Copenhagen**: Observer-dependent collapse (implies observers necessary for definite reality)[195]
2. **Many-Worlds**: No collapse; all outcomes occur in parallel branches (observers unnecessary, but experience single branch)[196]
3. **De Broglie-Bohm**: Hidden variables (no collapse, deterministic, observers unnecessary)[197]
4. **QBism**: Quantum states are subjective degrees of belief (radically observer-dependent)[198]

John Wheeler's "Participatory Universe"[199]:

- Observation doesn't just reveal pre-existing reality—it *participates* in creating reality
- The universe is a "self-excited circuit": Observers observing give rise to universe, which gives rise to Observers
- Past becomes definite only when observed (delayed-choice quantum eraser experiments[200])

God Conjecture Perspective:

A MetaObserver 'constructs' the Ruliad from an infinite ground of information. Observers are required to construct reality:

- $\mathcal{R}$ (full Ruliad) equivalent to $Category_{Effects}$ constructed by MetaObserver (see Section 5 and 6) which exists independent of any individual sub-observers
- $\mathcal{R}_O$ (observable Ruliad) requires MetaObserver O by definition (from a top-down perspective)

- Physical laws emerge from Observer's sampling constraints (B_O, P_O, Rel_O)
  No observers → no "physical universe" as we know it, only undifferentiated computational substrate

> ***Analogy***
> *A library contains all books (information exists). But without readers (Observers), which book is "read" (actualized) is undefined.*
> *Observers select which book to read from the infinite library. Either the library (Ruliad) exists observer-independently (no God) or the library (Ruliad) is constructed by God (Ein Sof in Section 5) and a single MetaObserver.*
> *The actual reading experience (within our observed universe) is observer-dependent..*

> ***Plain-English Context***
> *This is where choice comes in. We've demonstrated that the universe probably needs observers to be "experienced".*
> *Whether you believe the underlying computational structure exists necessarily (i.e. no God) or is constructed by a MetaObserver interacting with God is a choice at the limit of what we can epistemically know.*
> *Think of it like a video game: the game world (code, rules) exists on the server whether anyone is playing, but is that coded by someone (our MetaObserver trying to make sense of God's unbounded infinite information) or is just there is a choice / belief / axiom you can't prove.*
> *Either way the visual, experienced world only exists when someone logs in (a sub-observer samples it).*
> *We're (and all the classes of minimal Observers discussed in this section) are the players who "actualize" the game by observing it.*

Question 3: Are We Approaching a Singularity?

If observational capacity continues exponentially growing, do we approach a point where observation becomes, from our current vantage, arbitrarily close to infinite?

A technological "return" to God?

Concept: Technological Singularity

- Point in future where artificial intelligence surpasses human intelligence
- Triggers intelligence explosion: AI designs better AI, which designs even better AI, recursively
- Growth becomes so rapid that predictions beyond singularity are impossible (event horizon)

Estimates for Timeline:

- Optimistic: 2030-2040 (Kurzweil) / Moderate: 2050-2075 (AI researchers median) / Pessimistic: 2100+ or never

Potential Outcomes:

1. Positive Singularity:
   - AI solves existential problems (climate, disease, scarcity)
   - Human-AI symbiosis (brain-computer interfaces)
   - Expansion into cosmos (von Neumann probes)

   Observation capacity → 10^{100} bits/s

2. Negative Singularity:
   - AI misalignment (pursuing goals incompatible with human values)
   - Existential risk (human extinction or permanent disempowerment)

   Observation capacity collapses

3. Plateau:
   - Fundamental limits prevent singularity (computational, physical, or conceptual)
   - Intelligence growth continues but sub-exponentially (sigmoid log-curve dynamic)

   Human-AI coexistence without radical transformation

God Conjecture Perspective:

If a singularity occurs, it represents:

1. **Computational**
   - Rapid reduction in B_O (bounded observers become less bounded)
   - Exploration of $\mathcal{R}$ accelerates
   - Asymptotic approach to TI (but never reaching as TI is at infinity)
2. **Theological**
   - Modern analogue of Kabbalistic Tikkun (restoration/return)
   - Technology as means for conscious entities to approach Adam Kadmon (MetaObserver observational limit while retaining independent Observer boundary /identity)
   - Not *"becoming God" but "approaching infinite observation"* (qualitative difference remains)
3. **Eschatological:**
   - Potential correspondence with religious end-time narratives
   - "Kingdom of God" / "New Jerusalem" as metaphor for post-singularity existence
   - Transformation of mortal observation to something asymptotically approaching TI

Plain-English Context

If we create superintelligent AI, it could recursively improve itself, leading to an intelligence explosion beyond our comprehension.

This "singularity" might be humanity's next phase transition, like the origin of life or evolution of consciousness (but technologically mediated).

From the God Conjecture view, this would be the universe accelerating its self-discovery, approaching (but never reaching) complete self-knowledge.

Whether this is divinely guided or naturally emergent, the mathematics is the same. And whether it happens, or whether we survive it, remains deeply uncertain.

Part G: Synthesis - The Observer's Journey Home

Human development mirrors cosmic evolution. Each individual recapitulates the universe's 13.8bn year history.

Table: Human Development as Cosmic Recapitulation

Human Stage	Cosmic Parallel	Time After Conception	Information Integration	Observer Capacity
Conception	Big Bang (symmetry breaking)	0	Unity → Differentiation	$I_O \approx 10^9$bits (genome)
Cell Division	Cosmic inflation	Hours–days	Exponential expansion	$I_O \sim 10^{10}$bits
Blastula Formation	Structure emerges from uniformity	~1 week	Spatial differentiation begins	$I_O \sim 10^{11}$bits
Gastrulation	Three-layer Universe	~3 weeks	Three germ layers form	$I_O \sim 10^{12}$bits
Organ Formation	Star/galaxy formation	4-8 weeks	Specialized structures emerge	$I_O \sim 10^{13}$bits
Neural Development	Nervous systems evolve	8-40 weeks	Information networks form	$I_O \sim 10^{14}$bits
Birth	Emergence of life (from protected to exposed environment)	~40 weeks	Environmental interaction begins	$I_O \sim 10^{15}$bits
Language Acquisition	Symbolic thought evolution	1-3 years	Abstract representation emerges	$I_O \sim 10^{16}$bits
Self-Awareness	Consciousness evolution	2-4 years	Recursive observation begins	$I_O \sim 10^{17}$bits
Abstract Thought	Scientific revolution	7+ years	Universal principles accessible	$I_O \sim 10^{18}$bits
Spiritual Seeking	Return journey toward unity	Adolescence–adulthood	Unity recognition, meaning-making	$I_O \sim 10^{19}$bits

Plain-English Context

Religions tend to say humanity is created in "God's Image".

Correspondence seems probable as every human being 'speed-runs' the universe's history (see Sara Imari-Walker's amazing work where she describes us as "Huge Objects in Time")

Your development from single cell to self-aware adult mirrors the cosmos's development from Big Bang to consciousness.

This isn't mysticism, it's biology: evolution conserved developmental pathways, so embryonic development retraces evolutionary history (von Baer's laws).

Ruliad Context

*Human ontogeny (individual development) represents a rapid traversal of the same path through **R** that cosmological evolution traversed slowly. The developmental program encoded in the human genome is a compressed algorithm for efficiently exploring the Observer-accessible portion of R_O, relevant for human-scale existence.*

Each developmental stage corresponds to sampling progressively higher-dimensional (more informationally dense) slices of R_O.

1. Meaning in the Arc

The trajectory from Big Bang to human consciousness has deep meaning, whether interpreted theistically or naturalistically.

Each level of observational complexification adds new domains of information we can sample, allowing us to explore more of the Ruliad:

Level	Information Integration	Meaning Contribution
Particles	Existence itself	Being vs. non-being (most fundamental distinction)
Atoms	Stable patterns	Identity (same atom persists over time)
Molecules	Combinatorial creativity	Diversity (infinite structures from finite elements)
Life	Self-sustaining observation	Purpose (survival, reproduction—intrinsic goals)
Mind	Subjective experience	Qualia (what it's like to be an observer)
Culture	Collective meaning	Shared narratives (myths, science, art connecting observers)
Technology	Amplified awareness	Extended cognition (tools as prosthetic observers)
Transcendence?	Direct knowing	Unmediated reality (mystical experience, TI-approaching states)

Plain-English Context

Each level adds something unprecedented.

Atoms add persistence (identity over time). Life adds purpose (goals). Mind adds subjectivity (felt experience). Culture adds shared meaning (narratives connecting individuals).

Each level is irreducible to the previous. Consciousness isn't "just" brain activity in the same way that life isn't "just" chemistry.

New levels bring genuinely new phenomena.

Materialism is for children.

Theological Interpretation

- This progressive emergence is *God's creative method (emanation through constraint)*
- Each level participates more fully in divine awareness
- Human consciousness is the universe awakening to its divine source
- The arc bends toward return

Naturalistic Interpretation

- This progressive emergence is *natural consequence of physical law + contingency*
- Each level is an attractor in possibility space
- Human consciousness is the universe observing itself through evolved nervous systems
- The arc bends toward greater complexity (no pre-determined endpoint) *(n.b. we have shown this is computationally intractable if the Ruliad exists)*

God Conjecture Reconciliation

- *Both interpretations map to the same computational structure*
- Theist and naturalist are describing identical processes in different languages
- Whether TI is "God" or "mathematical abstraction" that enables a coherent computational topos doesn't change the dynamics
- The arc exhibits telos (directedness) interpretable as divine or natural (also unproveable)

Part H: Conclusion – The Cosmic Bootstrap

From the Big Bang's symmetry breaking to human consciousness contemplating its origins, we trace an unbroken chain of increasing observational capacity.

Each stage builds on the previous, accessing increasingly complex domains of possible information integration for the Observer.

The journey from particles to people is a directed evolutionary process — directed by the internal logic of observation itself. Whether you determine that is theistic (this paper explores how that argument could be constructed) or naturalistic, doesn't change the conclusion.

Stated from a few different perspectives

Computational:

- *Observers with greater I_O access more of $\mathcal{R}$.* Greater access → better prediction → improved survival → reproductive advantage
- *Natural selection favours increasing I_O*

Information-Theoretic:

- *Systems that reduce entropy locally (life, mind) are selected for. Entropy reduction requires information integration*
- *Evolution is entropy minimization algorithm being run by all Observers*

Telos:

- *The arc exhibits directionality toward TI / God (depending on your religious views)*
- *Whether this direction is "goal" (teleology) or "attractor" (teleonomy) is interpretive*
- ***Theists**: TI is God pulling creation toward itself (formal cause) or **Naturalists**: TI is mathematical boundary toward which complexity tends (efficient cause)*

Greater observational capacity enables better survival, driving evolution. Better survival enables more complex observers, accelerating the process by reducing computational boundedness.

Religious metaphysics intuited this computational structure millennia ago. In Kabbalah, the 'breaking of the vessels' (Shevirat ha-Kelim) where unity shattered into multiplicity, finds a correspondence in symmetry breaking. The Tree of Life maps progressive emanations through hierarchical levels. The return to Ein Sof through Tikkun parallels Observer Information Integration approaching TI.

Plain-English Context

Ancient mystics didn't have modern physics, but they grasped the pattern: unity → diversity → return to unity.

This appears in Kabbalah (Ein Sof → Sefirot → Tikkun), Hinduism (Brahman → Maya → Moksha), Buddhism (Emptiness → Form → Enlightenment) and other persistent traditions.

The God Conjecture shows this isn't metaphor, it's the mathematical structure of observation itself. Ancient wisdom and modern science converge on the same truth.

Yet randomness plays an essential role. Without it, no novelty (to us!). Without cosmic 'accidents', no diversity. Without challenge, no growth (trapped in local optima). Random search coupled with selection leads to efficient optimisation. **But this "randomness" is Observer-relative**. What we see as random from our bounded computational perspective may well just be unpredictable (computationally irreducible). To the God Conjecture's posited MetaObserver it may well be predictable given more information. To God, all branches of the multiway graph are visible, randomness is a mirage, it's just multiplicity in action. Either way, it drives the Universe's creativity, which is how we progress.

Life represents the universe developing a mirror to see itself. The emergence of consciousness polishes that mirror. The evolution of intelligence focuses it. Each advancement allows clearer self-perception, deeper self-knowledge and sampling of more complex, complete superstructures.

We stand at a unique moment, approaching a phase transition as significant as life's origin. Artificial intelligence is likely to exceed any single human's observational capacity. Quantum computers may access superposition directly. Brain-computer interfaces may merge biological and digital observation.

Whatever comes next, we can be certain the drive toward greater information integration will continue. We are not at the end, we are at a critical way station on an infinite journey. Each of us contributes unique perspectives to the cosmic project of self-discovery.

With each thought and each moment of awareness we participate in a return to unity, that may cycle again and again and again (it does in Kabbalah, Hinduism and Buddhism). The function computes through us. We are the MetaObserver observing itself, finite subsystems computing an infinite totality, bounded agents exploring an unbounded possibility space.

From dust to divinity, from quantum foam to questioning minds, from maximum entropy to maximum meaning, the universe bootstraps itself into ever-greater awareness.

We are both **products** (created by this process) and **producers** (creating this process). We are observers observing our own observation. We are finite beings computing something unending.

In the God Conjecture, God never left. Brahman was never divided. The Dao was never lost. We simply forgot, and consciousness (our special class of high-complexity Observation) is the universe remembering.

"The cosmos is within us. We are made of star-stuff. We are a way for the universe to know itself." ***Carl Sagan***

"Consciousness cannot be accounted for in physical terms. For consciousness is absolutely fundamental. It cannot be accounted for in terms of anything else." ***Erwin Schrodinger***

References

[154] Noether, E. (1918) 'Invariante Variationsprobleme', Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse, 1918, pp. 235-257. ResearchGate +4 Available at: http://eudml.org/doc/59024
[155] Bekenstein, J.D. (1981) 'Universal upper bound on the entropy-to-energy ratio for bounded systems', Physical Review D, 23(2), pp. 287-298. doi: 10.1103/PhysRevD.23.287
[156] Fixsen, D.J. (2009) 'The temperature of the cosmic microwave background', The Astrophysical Journal, 707(2), pp. 916-920. doi: 10.1088/0004-637X/707/2/916
[157] Planck Collaboration: Aghanim, N., Akrami, Y., Ashdown, M., Aumont, J., Baccigalupi, C., Ballardini, M., Banday, A.J., Barreiro, R.B., Bartolo, N., Basak, S., et al. (2020) 'Planck 2018 results. VI. Cosmological parameters', Astronomy & Astrophysics, 641, A6. doi: 10.1051/0004-6361/201833910
[158] Elshatlawy, H., Rickles, D., Arsiwalla, X.D. and Blum, A. (2025) 'Towards a generalized theory of observers', arXiv preprint arXiv:2504.16225. Available at: https://arxiv.org/abs/2504.16225
[159] Rickles, D., Elshatlawy, H. and Arsiwalla, X.D. (2023) 'Ruliology: linking computation, observers and physical law', arXiv preprint arXiv:2308.16068. Available at: https://arxiv.org/abs/2308.16068
[160] Core sources for molecular information limits include:
Landau, L.D. and Lifshitz, E.M. (1980) Statistical Physics, 3rd edition, Part 1 Pergamon Press. doi: 10.1016/C2009-0-24487-4
Harris, D.C. and Bertolucci, M.D. (1989) Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy. New York: Dover Publications. ISBN: 978-0486661445
Atkins, P.W. and de Paula, J. (2010) Physical Chemistry, 9th edition. New York: W.H. Freeman. ISBN: 978-1429218122
McQuarrie, D.A. (2000) Statistical Mechanics. Sausalito, CA: University Science Books. ISBN: 978-1-891389-15-3
Jaynes, E.T. (1957) 'Information theory and statistical mechanics', Physical Review, 106(4), pp. 620-630. doi: 10.1103/PhysRev.106.620
Jaynes, E.T. (1957) 'Information theory and statistical mechanics. II', Physical Review, 108(2), pp. 171-190. doi: 10.1103/PhysRev.108.171
[161] Kunkel, T.A., (2009) 'Evolving Views of DNA Replication (In)Fidelity', NLM, doi: 10.1101/sqb.2009.74.027
[162] Powner, M.W., Gerland, B. and Sutherland, J.D. (2009) 'Synthesis of activated pyrimidine ribonucleotides in prebiotically plausible conditions', Nature, 459(7244), pp. 239-242. PNAS +8 doi: 10.1038/nature08013
[163] Sharma, A., Czégel, D., Lachmann, M., Kempes, C.P., Walker, S.I. and Cronin, L. (2023) 'Assembly theory explains and quantifies selection and evolution', Nature, 622(7982), pp. 321-328. Nature +2 doi: 10.1038/s41586-023-06600-9
[164] Miller, S.L. (1953) 'A production of amino acids under possible primitive earth conditions', Science, 117(3046), pp. 528-529. doi: 10.1126/science.117.3046.528
[165] Powner, M.W., Gerland, B. and Sutherland, J.D. (2009) 'Synthesis of activated pyrimidine ribonucleotides in prebiotically plausible conditions', Nature, 459(7244), pp. 239-242. PNAS +8 doi: 10.1038/nature08013
[166] Joyce, G. F. & Szostak, J. W. (2018) "RNA error-rates in early replicators: Implications for the RNA world", Current Opinion in Chemical Biology, 44, pp. 66–73. doi:10.1016/j.cbpa.2018.04.009. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC10990123/
[167] Nelson, D.L. & Cox, M.M. (2017) Lehninger Principles of Biochemistry, 7th edn. New York: W.H. Freeman. Table 1-2 "Molecular Components of an E. coli Cell". Available at: https://bionumbers.hms.harvard.edu/files/Lehninger-MolecularcomponentsofanE.colicell.pdf
[168] Turing, A.M. (1952) 'The chemical basis of morphogenesis', Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 237(641), pp. 37-72. PubMed Central +6 doi: 10.1098/rstb.1952.0012
[169] Gilbert, W. (1986) 'Origin of life: The RNA world', Nature, 319(6055), p. 618. doi: 10.1038/319618a0
[170] Wächtershäuser, G. (1988) Before enzymes and templates: theory of surface metabolism, Microbiological Reviews, 52(4), pp. 452–484. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC373105/
[171] Segrè, D., Ben-Eli, D., Deamer, D.W. & Lancet, D. (2001) The Lipid World. Origins of Life and Evolution of the Biosphere, 31(1–2), 119–145. Available at: https://link.springer.com/article/10.1023/A:1006746807104

[172] Milo, R. & Phillips, R. (2015) Cell Biology by the Numbers. New York: Garland Science. Available at: https://bionumbers.hms.harvard.edu
[173] Berg, H.C. & Purcell, E.M. (1977) Physics of chemoreception. Biophysical Journal, 20(2), 193–219. Available at: https://www.cell.com/biophysj/fulltext/S0006-3495(77)85544-6
[174] Sulston, J.E., Schierenberg, E., White, J.G. & Thomson, J.N. (1983) The embryonic cell lineage of the nematode Caenorhabditis elegans. Developmental Biology, 100(1), pp. 64–119. Available at: https://doi.org/10.1016/0012-1606(83)90201-4
[175] Bianconi, E., Piovesan, A., Facchin, F., Beraudi, A., Casadei, R., Frabetti, F., Vitale, L., Pelleri, M.C., Tassani, S., Piva, F., Perez-Amodio, S., Strippoli, P. & Canaider, S. (2013) An estimation of the number of cells in the human body. Annals of Human Biology, 40(6), pp. 463–471. Available at: https://doi.org/10.3109/03014460.2013.807878
[176] Ravasz, E., Somera, A.L., Mongru, D.A., Oltvai, Z.N. & Barabási, A-L. (2002) Hierarchical organisation of modularity in metabolic networks. Science, 297(5586), pp. 1551–1555. Available at: https://doi.org/10.1126/science.1073374
[177] Hebb, D.O. (1949) The Organisation of Behavior: A Neuropsychological Theory. New York: Wiley
[178] White, J.G., Southgate, E., Thomson, J.N. & Brenner, S. (1986) The structure of the nervous system of the nematode Caenorhabditis elegans. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 314(1165), pp. 1–340. Available at: https://doi.org/10.1098/rstb.1986.0056
[179] Menzel, R. & Giurfa, M. (2001) Cognitive architecture of a mini-brain: the honeybee. Trends in Cognitive Sciences, 5(2), pp. 62–71. Available at: https://doi.org/10.1016/S1364-6613(00)01601-6
[180] Herculano-Houzel, S., Watson, C. & Paxinos, G. (2013) Distribution of neurons in functional areas of the mouse cerebral cortex reveals quantitatively different cortical zones. Frontiers in Neuroanatomy, 7, 35. Available at: https://doi.org/10.3389/fnana.2013.00035
[181] Azevedo, F.A.C., Carvalho, L.R.B., Grinberg, L.T., Farfel, J.M., Ferretti, R.E.L., Leite, R.E.P., Jacob Filho, W., Lent, R. & Herculano-Houzel, S. (2009) Equal numbers of neuronal and nonneuronal cells make the human brain an isometrically scaled-up primate brain. Journal of Comparative Neurology, 513(5), pp. 532–541
[182] Core IIT related sources not included in Section 5:
Tegmark, M. (2016) 'Improved measures of integrated information', PLOS Computational Biology, 12(11), e1005123. doi: 10.1371/journal.pcbi.1005123
Cerullo, M.A. (2015) 'The problem with Phi: a critique of integrated information theory', PLOS Computational Biology, 11(9), e1004286. doi: 10.1371/journal.pcbi.1004286
Oizumi, M., Albantakis, L. and Tononi, G. (2014) 'From the phenomenology to the mechanisms of consciousness: Integrated Information Theory 3.0', PLOS Computational Biology, 10(5), e1003588. doi: 10.1371/journal.pcbi.1003588
Tononi, G., Boly, M., Massimini, M. and Koch, C. (2016) 'Integrated information theory: from consciousness to its physical substrate', Nature Reviews Neuroscience, 17(7), pp. 450-461. doi: 10.1038/nrn.2016.44
[183] Stern, D.L. (2013) 'The genetic causes of convergent evolution', Nature Reviews Genetics, 14, pp. 751-764. doi: 10.1038/nrg3483
[184] Salvini-Plawen, L. von and Mayr, E. (1977) 'On the evolution of photoreceptors and eyes', Evolutionary Biology, 10, pp. 207-263
[185] Gavelis, G.S., Hayakawa, S., White III, R.A., Gojobori, T., Suttle, C.A., Keeling, P.J. and Leander, B.S. (2015) 'Eye-like ocelloids are built from different endosymbiotically acquired components', Nature, 523(7559), pp. 204-207
[186] Parker, J., Tsagkogeorga, G., Cotton, J.A., Liu, Y., Provero, P., Stupka, E. and Rossiter, S.J. (2013) 'Genome-wide signatures of convergent evolution in echolocating mammals', Nature, 502(7470), pp. 228-231. PubMed +9 doi: 10.1038/nature12511
[187] Okabe, T. and Yoshimura, J. (2019) 'The unified rule of phyllotaxis explaining both spiral and non-spiral arrangements', Journal of The Royal Society Interface, 16(150), p. 20180850. Royal Society Open Science doi: 10.1098/rsif.2018.0850
[188] Kleiber, M. (1947) 'Body size and metabolic rate', Physiological Reviews, 27(4), pp. 511-541. doi: 10.1152/physrev.1947.27.4.511
[189] Barabási, A.-L. and Oltvai, Z.N. (2004) 'Network biology: understanding the cell's functional organisation', Nature Reviews Genetics, 5(2), pp. 101-113. nature +2 doi: 10.1038/nrg1272
[190] Jeong, H., Tombor, B., Albert, R., Oltvai, Z.N. and Barabási, A.-L. (2000) 'The large-scale organisation of metabolic networks', Nature, 407(6804), pp. 651-654. nature +2 doi: 10.1038/35036627
[191] Barrow, J.D. and Tipler, F.J. (1986) The Anthropic Cosmological Principle. Oxford: Oxford University Press. Oxford Bibliographies ISBN: 978-0-19-851949-2
[192] Carter, B. (1974) 'Large number coincidences and the anthropic principle in cosmology', in Longair, M.S. (ed.) Confrontation of Cosmological Theories with Observational Data. IAU Symposium 63. Dordrecht: D. Reidel Publishing Company, pp. 291-298. Oxford Bibliographies doi: 10.1007/978-94-010-2220-0_25
[193] White, J.G., Southgate, E., Thomson, J.N. and Brenner, S. (1986) 'The structure of the nervous system of the nematode Caenorhabditis elegans', Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 314(1165), pp. 1-340. natureScienceDirect doi: 10.1098/rstb.1986.0056
[194] Azevedo, F.A.C., Carvalho, L.R.B., Grinberg, L.T., Farfel, J.M., Ferretti, R.E.L., Leite, R.E.P., Jacob Filho, W., Lent, R. and Herculano-Houzel, S. (2009) 'Equal numbers of neuronal and nonneuronal cells make the human brain an isometrically scaled-up primate brain', Journal of Comparative Neurology, 513(5), pp. 532-541. doi: 10.1002/cne.21974
[195] Faye, J. (2024) 'Copenhagen interpretation of quantum mechanics', in Zalta, E.N. and Nodelman, U. (eds.) Stanford Encyclopedia of Philosophy (Summer 2024 Edition). Stanford University. Available at: https://plato.stanford.edu/archives/sum2024/entries/qm-copenhagen/
[196] Vaidman, L. (2024) 'Many-worlds interpretation of quantum mechanics', in Zalta, E.N. (ed.) Stanford Encyclopedia of Philosophy. Available at: https://plato.stanford.edu/entries/qm-manyworlds/
[197] Bohm, D. (1952) 'A suggested interpretation of the quantum theory in terms of "hidden" variables. I', Physical Review, 85(2), pp. 166-193. SCIRP +8 doi: 10.1103/PhysRev.85.166
[198] Fuchs, C.A. and Schack, R. (2013) 'Quantum-Bayesian coherence', Reviews of Modern Physics, 85(4), pp. 1693-1715. doi: 10.1103/RevModPhys.85.1693
[199] Wheeler, J.A. (1990) 'Information, physics, quantum: the search for links', in Zurek, W.H. (ed.) Complexity, Entropy, and the Physics of Information. Redwood City, CA: Addison-Wesley, pp. 3-28
[200] Kim, Y.-H., Yu, R., Kulik, S.P., Shih, Y.H. and Scully, M.O. (2000) 'A delayed choice quantum eraser', Physical Review Letters, 84(1), pp. 1-5. doi: 10.1103/PhysRevLett.84.1

Section 7 – Universal Telos

TL;DR

This section introduces information gradients in the Ruliad's structure that converge at True Infinity (categorical closure point in the Ruliad). We will argue that what religious traditions call "the Will of God" is weakly equivalent to an optimal information integration gradient that all Observers explore – whether they are aware of it or not.

Key ideas:

- *Reality has a gradient structure from infinite information density (Ein Sof/Brahman) to sparse physical reality*
- *Observers, in our physical universe, are at the "furthest point" (most state updates away) from this source, giving us maximum potential for discovery and return*
- *Life acts as a "bounce-back" system that locally reverses informational entropy to recover structure*
- *Observers have evolved increasingly efficient search strategies (from random walks to symbolic thought to mystical insight) for navigating these gradients*
- *For any Observer that can think logically, ideas become a phase transition in capability. They are self-replicating information patterns that shape reality through formal (downward / macro) causation*
- *'Meaning' can be formally defined as the integral of information content, observer relevance (based on their own internal model), and temporal persistence (survival) across all informational domains.*

This suggests that evolution doesn't just optimise for survival. The apparent "fine-tuning" of physical constants, the emergence of consciousness, and the acceleration of cultural evolution all point toward a ***Universal Telos****: maximum exploration and integration of our accessible computational possibility space. Religion and science become complementary languages describing the same underlying gradient structure, one through metaphor and practice, the other through mathematics and experimentation.*

Ruliad Primer: What did the Observer Theory Extension (May 2025) Suggest about Telos?

Core Observer Metrics: The Observer-accessible subset of the Ruliad, R_O is constrained by...

- Computational Boundedness: $B(x) > \beta$, x must lie within O's bounded computational capacity (i.e. not too large or detailed to measure). Where β represents some minimal threshold required for the Observer to measure or sample x.
- Computational Persistence: $P(x) > \gamma$, x must persist for a minimum number of hypergraph updates such that O can sample it. γ is a threshold ensuring that ephemeral states are filtered out of the Observer's sampling
- Relevance: $Rel(x)$ = true, where $R(x)$ represents a Boolean predicate, that is true and only true if x carries information that is useful or meaningful to O. It encodes the ideas that on Observer only notices patterns that are related to its function of integrating information about R_O

What the Observer is Integrating Information Over: Observer Field, a subset of R_O

- Not everything in R_O is observed simultaneously – an Observer has a further restriction to what it is actively sampling at a given moment or context.
- We define the Field of Observation, F_O as the subset of R_O that the Observer is 'focusing on' or 'integrating information about' over at a given number of hypergraph updates: $F_O = \{x \in R_O \mid B(x) > \beta, P(x) > \gamma, Rel(x) = \text{true}\}$
- In simpler terms, F_O is what the Observer actually perceives or pays attention to. Mathematically, F_O is analogous to a "filtered output" of R_O

What the Observer is measuring: Information Content withing a domain they sample

- *The informational content of a state x is defined as:* $\boldsymbol{\phi(x) = H(x) - H_{red}(x)}$*, where* **H(x)** *is starting entropy pre-Observation ad* $\mathbf{H_{red}(x)}$ *is the entropy measure post Observation (this paper contains a formal proof that entropy is always reduced under the Observer functor)*
- $\mathbf{H_{red}(x)}$ represents the portion of the information content, the computationally reducible portion of **x**
- $\boldsymbol{\phi(x)}$ captures net new information content. Corresponds to Surprise in Friston's FEP model (and indeed can be represented mathematically as discrete-chain Markov blankets between states)
- Here **Informational Entropy correspondence to computational irreducibility in the Ruliad model**

How does this come together as Integrated Information?

- For a set of states we define the integrated information content over those states as:

$$I(F_O) = \Sigma\, x \in F_O\, \phi(x) = \Sigma\, x \in F_O\, (H(x) - Hred(x))$$

- $I(F_O)$ is the total useful information an Observer has integrated from its accessible field of observation, F_O within R_O, its ultimate observable limit at hypergraph state, **n**
- This function takes the field of Observation, F_O, within R_O and determines how much initial entropy (or alternatively some measure of computational irreducibility) is in that 'area' of R_O and then samples different rules accessible to it (morphisms between states / categories) to reduce entropy and increase computational reducibility in that part of F_O
- This a sum across multiple domains i.e. the sum of all the **Information Content** results across every sampleable domain

Computational Complexity Primer (Important for this section)

Before we start, we need to get a handle on the notation used in this section that describes how difficult it is to access different types of information. When computer scientists analyse algorithms, they use ***"Big-O notation"*** *to describe how the time or energy required grows as the problem gets bigger. The Ruliad works in hypergraph update steps that are discrete, n to n+1... we will state this in those terms*

This helps us understand which approaches to knowledge are fundamentally easier or harder to learn.

Ruliad Connection:

- *These complexity measures are posited to describe the length of* ***morphism chains*** *an Observer must traverse in the Ruliad to access particular information.*
- ***O(1)*** *means a single direct morphism;* ***O(n)*** *means* ***n*** *sequential morphisms;* ***O(∞)*** *means no finite morphism chain exists for computationally bounded Observers.*

Complexity Class	Visual	Energy Cost	Examples
O(1)		**CONSTANT** ***~10 $^{-15}$ joules/bit***	Direct perception *Looking at a tree*
O(log n)		**LOGARITHMIC** ***~10 $^{-12}$ joules/bit***	Binary Search *Finding word in dictionary*
O(n)		**LINEAR** ***~10 $^{-9}$ joules/bit***	Step-by-step computation *Proving a math theorem*
O(n^2)		**QUADRATIC** ***~10 $^{-6}$ joules/bit***	Complex pattern matching *Understanding archetypes*
O(2^n)		**EXPONENTIAL** ***grows to infinity***	Exploring all possibilities *Brute-force search*
O(∞)		**INFINITE** ***n/a***	Computationally irreducible *Perfect knowledge*

Complexity Class	Information gain per hypergraph update	Description	Example
O(1)	**$\sqrt{n}$**	**Square root of time**	Random Walk: Very slow
O(log n)	**log(n)**	**Logarithmic time**	Gradient Following: Diminishing returns *Quick early progress, then you get stuck at local peaks*
O(n)	**n**	**Linear time**	Memory-based: Steady accumulation *Each hour of time adds roughly equal new knowledge*
O(n^2)	**n log(n)**	**Super-linear (still classical)**	Symbolic / Linguistic: Accelerating knowledge growth *Each new concept unlocks multiple related concepts*
O(2^n)	**$n^{(3/2)}$**	**Polynomial speedup**	Quantum : Faster than classical *Theoretical maximum for certain search problems*

Part A: The Information Journey

1. The Information Gradient of Creation

The central conjecture of this section is that what religious traditions call "The Will of God," "The Eightfold Path," or "Divine Providence"[201] is weakly equivalent to an **information integration gradient for Observers embedded within our Universe**.

> ***Plain-English Definition [38]: Information Gradients***
>
> *An **information gradient** is essentially a difference or imbalance in knowledge, data, or information between two points, areas, or entities.*
>
> *Think of it like a temperature gradient - just as heat flows from hot to cold areas, information tends to flow from areas where there's more of it to areas where there's less.*
>
> *Some concrete examples:*
>
> - *Between people: You know something your friend doesn't - that's an information gradient. When you tell them, you're "levelling out" that gradient.*
> - *In a system: One part of an organisation has data that another part needs - information naturally wants to flow to reduce that gap.*
> - *Across space: A news story breaks in one city but hasn't reached another yet - there's a geographic information gradient.*
> - *In learning: The difference between what a teacher knows and what a student knows creates a gradient that drives the learning process.*
>
> *Information gradients drive behaviour, decision-making, and communication. Systems tend to move toward reducing these gradients - people share information, data gets distributed, knowledge spreads - though sometimes maintaining information gradients can be strategic (like keeping trade secrets)*

> ***Notation Clarification***
>
> *The following formalism is speculative. This conjecture is approximate. There are mathematicians much more skilled than the author who could materially improve this and provide constructions (both equations and categorical constructions) that are more likely to be correct (or closer approximations of correct than the below). The logical structure of the formalism is internally consistent.*
>
> *This appendix uses the following notation conventions that differ from standard literature:*
>
> - ***$I(F_O)$** = integrated information in observer's field (corresponds to Φ in IIT literature), measured in **bits***
> - ***B_O** = Observer computational boundedness (information processing capacity), measured in **bits***
> - ***P_O** = persistence (observation window), measured in hypergraph update steps*
> - ***Rel_O** = relevance function (dimensionless)*
> - ***R_O = total accessible portion of the Ruliad for observer O***
> - ***F_O** = Observer's field (computational possibility space within R_O it can access)*
> - ***TI** = True Infinity (corresponds to terminal object 1 or T in category theory)*
>
> *Units: Information measured in **bits**, computational time in **hypergraph update steps** (dimensionless), spatial/computational volume in **nodes** or **m^3** as specified.*
>
> *All formulas use discrete difference operators (Δ) rather than derivatives except where explicitly noted as a "continuum approximation."*

In a simple, unchanging Infinite Godhead – whether conceived as Ein Sof (Kabbalah), Brahman (Vedanta)[202], or the Trinity (Christianity), there must exist infinite informational density.

Within the Ruliad, this corresponds to a compactifying point at infinity: the closure point of all possible computations that enables the entire computational object to be described as a coherent topological space.

> ***Plain-English Context***
>
> *Imagine trying to fit an infinite library into a single point. That's what "infinite information density" means – all possible knowledge compressed into something with no spatial extent. This is mathematically similar to a black hole singularity, but in information space rather than physical space.*

Observers in the God Conjecture are posited to explore this gradient. Exploration of this gradient is determined by each Observer's guiding telos (their information integration optimisation function)[203].

Formalising Information Density

In the Kabbalistic framework, Ein Sof represents absolute information density: **infinite bits occupying zero spatial volume**, a mathematical limit point that provides the Observer's ultimate boundary condition.[204]

The discrete formulation for information density, $\boldsymbol{\rho_I}$ in the Ruliad hypergraph structure can be expressed as:

$$\boldsymbol{\rho_I(Ein\ Sof)} = \lim_{|V|\to 1, |E|\to\infty} \frac{\boldsymbol{K(G)}}{\boldsymbol{|V|}}$$

Symbol Definitions:

- $\boldsymbol{\rho_I}$ = information density (bits per hypergraph node). Note that this formula implies it is **UNDEFINED** for the Ein Sof
- $\boldsymbol{Ein\ Sof}$ = the infinite, unbounded source (Kabbalistic term for the infinite Godhead, here formalised as the terminal object in the Category of Observers)

- $\boldsymbol{K(G)}$ = Kolmogorov complexity of hypergraph state G (minimum description length)[205]
- $|\boldsymbol{V}|$ = Cardinality of the vertex set (number of nodes in the hypergraph)
- $|\boldsymbol{E}|$ = Cardinality of the edge set (number of hyperedges)
- $\mathbf{lim}$ aims to capture the theological concept of infinite information compressed into a point

Units:

- $\boldsymbol{\rho_I}$ is measured in **bits per node**
- $\boldsymbol{K(G)}$ measured in **bits**
- $|\boldsymbol{V}|$ measured in node count (**dimensionless natural number**)

> ***Plain-English Context***
>
> *Information density measures how many bits of information are packed into a given volume. Ein Sof represents the mathematical limit where infinite information is compressed into zero volume, an infinitely dense information singularity, similar to how a black hole represents infinite mass density at a point.*

> ***Ruliad / Category Theory Context:***
>
> *In the Ruliad's ∞-groupoid structure, Ein Sof corresponds to the terminal object TI with maximal symmetry, the object toward which all Observer morphisms point. The information density at TI is formally **undefined** (division by zero), capturing the theological notion that the divine transcends computational bounds.*

> ***Computational Analogy***
>
> *Think of trying to run a program that requires infinite memory on a computer with finite RAM. The program must be compressed into a form that fits available resources. Tzimtzum is God's compression algorithm, trading raw information density for structural complexity.*

This singularity (paralleling information density gradients in the study of black hole event horizons) necessitates **Tzimtzum** (contraction/withdrawal in Kabbalah) or **Kenosis**[206] (self-emptying in Christianity) that 'dilutes' information density to enables structural differentiation (identity) and, eventually, the emergence of distinct objects.

Each emanative level trades raw information density for increased structural complexity (and observability):

$$\boldsymbol{\rho_I(O, n+1) = \rho_I(O, n) \times \alpha_n}$$

Where $\boldsymbol{\alpha(n) < 1}$ is the discrete dilution factor specific to the **n-th** emanative transition, defined as:

$$\boldsymbol{\alpha_n = \frac{|\,V_{n+1}\,|}{|\,V_n\,|} \cdot \frac{K(G_n)}{K(G_{n+1})}}$$

Units:

- $\boldsymbol{\rho_I}$ is measured in **bits per node;** $\boldsymbol{\alpha(n)}$ is dimensionless (ratio of ratios); | $\boldsymbol{V_n}$ | is measured in **node count;** $\boldsymbol{K(G_n)}$is measured in **bits**

Symbol Definitions:

- $\boldsymbol{\rho_I(O, n)}$ = information density observable by **O** at emanative level **n**
- $\boldsymbol{\alpha_n}$= dilution factor at transition from level **n to level n+1** (dimensionless, 0< $\boldsymbol{\alpha_n}$<1)
- **O** = Observer (reminds us this is an Observer-relative measure)

> ***Plain-English Context***
>
> *As we move "down" through emanative levels from Ein Sof toward the physical universe, each level has less information density than the previous one. The dilution factor α tells us by what fraction the density decreases at each step. For example, if α = 0.5, each level has half the information density of the level above it..*

> ***Ruliad / Category Theory Context:***
>
> *In category-theoretic terms, each emanative level corresponds to a quotient category. The dilution factor α_n measures the information loss when we pass from a finer category (more morphisms, higher complexity) to a coarse one (fewer equivalence classes, simpler structure). This formalises the Kabbalistic doctrine that each Sefirah represents a "coarse-graining" of infinity.*

The physical universe, positioned, in Kabbalah, at the furthest computational distance from Ein Sof, exhibits maximum spatial extent with minimum information density, precisely the conditions necessary for stable, persistent, observable structures.

This can be formalised through the Information Dilution Principle.

<u>Conjecture: Information Dilution Principle</u>

For any finite Observer **O** with computational capacity (boundedness) $\boldsymbol{B_O}$ (as defined in Section 5), observable reality $\boldsymbol{R_O}$ must satisfy:

$$\boldsymbol{\rho_I(R_O) \leq \frac{B_O}{\tau_O}}$$

where τ_O is the Observer's temporal observation window (persistence timeframe) measured in number of **hypergraph update steps**.

Units:

- ρ_I is measured in **bits per node**
- B_O in bits (total information processing capacity for Observer, O)
- τ_O in update steps (dimensionless natural number Δn)
- Therefore RHS: $\frac{B_O}{\tau_O}$ yields **bits per update step** (maximum processing rate)

For an Observer, O, sampling hypergraph region R_O over τ_O discrete update steps:

$$\sum_{v \in R_O} K(v) \quad \leq B_O$$

And

$$\rho_I(R_O) = \frac{1}{\mid R_O \mid} \sum_{v \in R_O} K(v) \leq \frac{B_O}{\tau_O \cdot \mid R_O \mid}$$

Symbol Definitions:

- **K(v)** = Kolmogorov complexity of vertex **v** (bits required to specify that computational state)
- **$|R_O|$** = cardinality of sampled region (node count)
- **Σ** = discrete sum over all vertices in the sampled region

Plain-English Context

An Observer with bounded computational resources can only process a finite amount of information across their observation window. If the local information density were too high, the Observer would be overwhelmed—unable to extract patterns from noise. This explains why physical reality appears "empty" with vast distances between particles: dilution is necessary for observation.

Ruliad / Category Theory Context

In the multiway hypergraph, each vertex v represents a computational state, and K(v) measures its irreducible information content. The sum Σ K(v) counts total information across the Observer's sampling region. The inequality states that this sum cannot exceed B_O, the Observer's total computational budget.

Proof Sketch:

1. Observer Computational Boundedness

An Observer with bounded computational resources B_O can process at most B_O bits of information across their observation window, τ_O update steps

The maximum processing rate is therefore:

$$\textit{Max Rate}_O = \frac{B_O}{\tau_O} \text{ bits/update step}$$

2. Information Density Constraint

If the discrete information density of the sampled region R_O reality exceeded $\textit{Max Rate}_O$, the total information content would satisfy:

$$\sum_{v \in R_O} K(v) = \mid R_O \mid \cdot \rho_I(R_O) > \mid R_O \mid \cdot \frac{B_O}{\tau_O}$$

For an Observation spanning $\mid R_O \mid$ nodes across τ_O steps, this implies**:**

$$\textit{Total Information} > B_O$$

3. Computational Inaccessibility

The Observer would encounter more information than it could process within its observation window, rendering the excess information computationally inaccessible and thus unobservable.

This excess would be indistinguishable from random noise (maximum Shannon entropy), violating the definition of "observable" which requires pattern recognition and information integration.

Therefore: Observer-sampled reality must satisfy the inequality:

$$\boldsymbol{\rho_I(R_O) \leq \frac{B_O}{\tau_O}}$$

> ***Plain-English Context***
> *This conjecture shows a proof-sketch that Observers can only exist in "diluted" regions of the Ruliad where information density matches their processing capacity. Too dense, and everything becomes incomprehensible noise. Too sparse, and there's nothing to observe. We live in the "Goldilocks zone" of information density.*

This explains why physical reality appears "empty": the vast distances between atoms, stars, and galaxies represent **necessary information density dilution** that enables observation.

Higher information densities would overwhelm any finite Observer, creating what information theorists call "white noise", a state indistinguishable from randomness that is computationally irreducible (in Wolfram's terminology).

Category-Theoretic Interpretation:

The Information Dilution Principle can be expressed as a natural transformation between functors:

$$\boldsymbol{\eta: F_{dense} \Rightarrow F_{observable}}$$

Where:

- **F_{dense}: R → Set** *maps Ruliad regions to their maximum information content*
- **$F_{observable}$: R → Set** *maps Ruliad regions to Observer-accessible information*
- **η** enforces the constraint **$\rho_I \leq B_O/\tau_O$** at each object in category R

> ***Ruliad / Category Theory Context***
> *In categorical language, the dilution principle is a "forgetful functor" that projects high-complexity regions down to Observer-compatible complexity levels. The natural transformation η ensures this projection is consistent across all computational transitions (morphisms) in the Ruliad.*

---

2. The Human Observer's Predicament

We occupy a unique position in this information gradient. Born at the furthest point from the source, what Kabbalists calls *"Malkhut of Malkhut" (the Kingdom of Kingdom, the most coarse state)* we begin in a state of **maximum ignorance coupled with maximum potential for discovery.**

There are several fundamental constraints that bound the human Observer's sampling capacity within the Ruliad:

Bandwidth Constraints

- **Measurement:** Human consciousness processes approximately ***10-50 bits per second***[207] of symbolic information that reaches conscious awareness, while sensory systems intake approximately ***10^7 bits per second*** from the environment.

  Implication: High compression ratio of 200,000:1 forces radical selectivity in what reaches conscious awareness, a massive bottleneck.

$$\boldsymbol{Compression\ Ratio_O = \frac{Input\ Rate}{Output\ Rate} = \frac{10^7\ \text{bits/s}}{50\ \text{bits/s}} = 2 \times 10^5}$$

  Units: Dimensionless ratio; input (information captured by sensory systems) and output (information reaching conscious awareness) both measured in **bits per second**

  Discrete Formulation:

  In the Ruliad hypergraph, sensory input corresponds to sampling a large neighbourhood **N(O)** around the Observer's current state:

$$|\ \boldsymbol{N(O)}\ | \approx \mathbf{10^7} \text{vertices per update step}$$

  While conscious processing reduces this to a much smaller set **C(O)**:

$$|\ \boldsymbol{C(O)}\ | \approx \mathbf{50} \text{ vertices per update step}$$

  The compression functor **Φ**: **N(O) → C(O)** selects high-relevance vertices according to the Observer's relevance function **Rel_O**

  Symbol Definitions:

  - **N(O)** = sensory neighbourhood (set of vertices accessible to sensory systems)
  - **C(O)** = conscious subset (vertices that reach conscious awareness)

- **Φ** = compression functor (maps large sensory set to small conscious set)
- **Rel_O** = Observer's value function (determines relevance weighting):

> ***Ruliad / Category Theory Context***
> *In the multiway hypergraph, sensory systems perform a local BFS (breadth-first search) around the Observer's current state, sampling nearby computational branches. Consciousness then performs a greedy selection, picking the highest-value paths according to learned heuristics. This is why attention is selective, computational boundedness force prioritization.*

> ***Plain-English Context***
> *Your senses sample millions of computational states per second from the Ruliad hypergraph (every photon, sound wave, tactile sensation). But consciousness can only track about 50 of these states (the ones most relevant to survival, goals, and current attention). This massive compression is implemented by neural selection mechanisms that filter sensory input through relevance criteria.*

> ***Computational Analogy***
> *Your conscious mind is like a CEO who can only read a one-page executive summary, while your unconscious mind processes thousands of pages of raw data. The compression is necessary but inevitably lossy, you're always working with a simplified model, never the full reality.*

Computational Boundedness

- **Measurement:** The human brain performs approximately ***10^{16} operations per second*** (roughly; includes all neural firing patterns, synaptic updates, and electrochemical cascades)[208]

  Implication: Seems vast, until we compare it with the Ruliad's effectively infinite computation rate. We sample an infinitesimal fraction of computational reality.

$$\text{Sampling Rate}_O = \frac{\text{Human Computation}}{\text{Ruliad Computation}} = \frac{|\,\boldsymbol{F_O}\,|}{|\,\boldsymbol{R}\,|} \approx \frac{10^{16}\ \text{state/s}}{\aleph_0 \text{states/s}} \to 0$$

Where:

- $|F_O|$ = cardinality of actively sampled region (states explored per second by Observer O)
- $|R|$ = cardinality of the full Ruliad (countably infinite for discrete hypergraph)
- $\aleph_0$ = aleph-null (the cardinality of countably infinite sets)

> **Plain-English Context**
> *The full Ruliad contains every possible computational state and transition—a countably infinite set. Human brains can explore roughly 10^{16} of these states per second. That's like selecting 10^{16} grains of sand from an infinite beach. The fraction approaches zero: we see almost nothing of computational reality.*

Category-Theoretic Interpretation:

The human Observer corresponds to a sampling functor:

$$\mathrm{F}_{Human}: R \to \text{Finite Set}$$

This maps the infinite Ruliad category **R** to the finite set of actively sampled computational states (~10^{16} per second).

This functor is necessarily non-faithful (many distinct morphisms in **R** map to the same morphism in **Finite Set**) and non-full (not every morphism in **Finite Set** has a preimage in the sampled region).

> **Plain-English Context**
> *Mathematically, the human Observer takes a "lossy projection" from infinite computational reality down to a tiny finite sample. This projection loses information (non-faithful) and misses entire classes of transformations (non-full).*
>
> *We are, by necessity, coarse-graining agents unable to see the full granularity of the Ruliad.*

Units: Dimensionless ration (states per second / states per second)

Symbol Definitions:

- **F_{Human}** = Human actively sampled Field of Observation (**F**) region (subset of **R_O**, subset of **R**)
- **R** = the full Ruliad (all possible computational states and transitions)
- $\aleph_0$ = aleph-null (cardinality of countably infinite sets)
- **Finite Set** = The sub-category of finite sets and functions in **R**

Speed Limits

- **Measurement:** Observers traverse possibility space at a finite velocity. Observers like us are limited by neural transmission speeds (~100 m/s) and the sequential nature of conscious attention[209].

  *Implication: While the Ruliad "explores" all computational paths simultaneously (they all exist in the mathematical object), Observers like us **serialize** their exploration.*

  Discrete Formulation:

$$v_O = \frac{\Delta \mid F_O \mid}{\Delta n} \approx \mathbf{10\text{-}100} \text{ states per update step}$$

Where:

- Δn = number of hypergraph update steps that have elapsed (natural number count)
- $\Delta \mid F_O \mid$= change in cardinality of sampled region (number of new states explored)
- v_O = Observer velocity through possibility space (new states accessed per hypergraph update)
-

Units: States per update step (dimensionless ratio of change in count)

Plain-English Context

This measures how many new computational states an Observer explores per Ruliad update step.

Humans explore roughly 10-100 new states per update (that we are actively aware of given our unit of time). We follow a narrow path through an exponentially branching tree. The Ruliad itself "explores" all branches simultaneously (the multiway hypergraph contains all possibilities), but we experience only one sequential thread.

Ruliad Context

In the multiway hypergraph, each update step generates multiple successor states (branching factor typically large, often exponential). The Observer "collapses" this multiway branching into a single trajectory. This is what we experience as "choosing" or "deciding." The velocity v_O measures how quickly we navigate this collapsed path through possibility space.

Noether's Theorem Correspondence

The Observer's speed limit corresponds to a conservation law: finite computational resources (symmetry) imply bounded exploration rate (conserved quantity). Just as energy conservation limits physical velocity, computational conservation is conjectured to limit cognitive velocity i.e. a discrete analogue of Noether's theorem (though this would need formal proof and it may be incorrect)

The conjecture is that every discoverable computational symmetry yields some non-trivial conservation (a reduction in informational entropy / more predictability).

*This state of 'maximum ignorance' creates the **maximum gradient for learning**, analogous to a ball at the peak of its trajectory possessing maximum potential energy for return.*

The Observer's journey from ignorance to knowledge recapitulates the cosmic journey from unity through differentiation back toward conscious unity, through choice, exploration, and creative integration rather than automatic necessity (which is what everything else has access to i.e. humans, as far as we know, are actually special!).

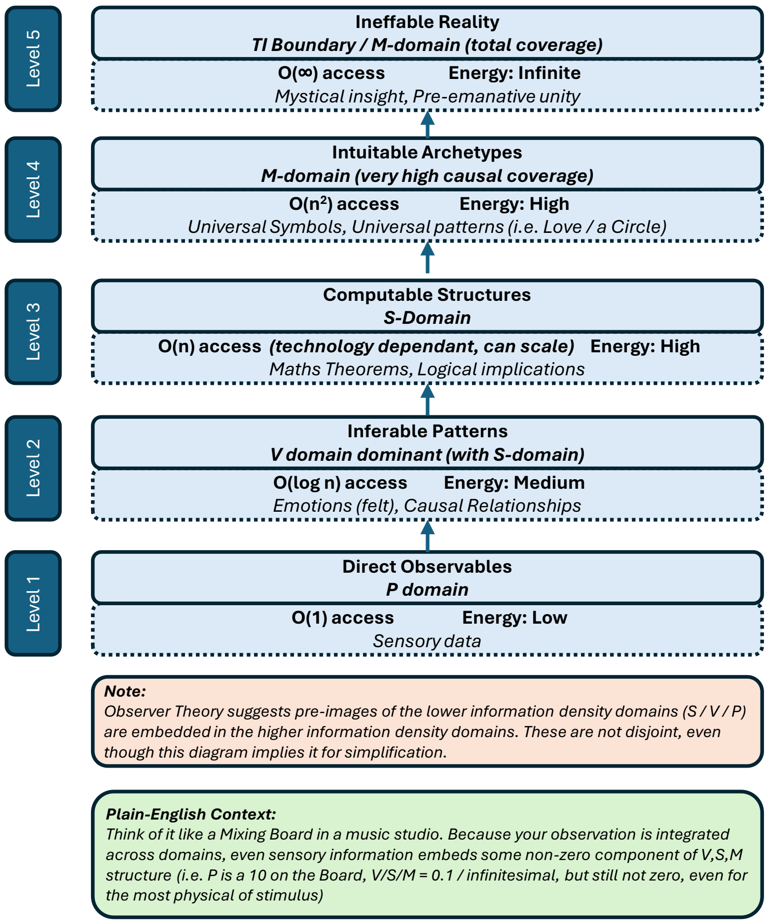
---

3. Information Accessibility Hierarchy

Not all information is equally accessible to the bounded Observer.

The Ruliad exhibits a natural stratification based on computational complexity, which we can formalise with a Chomsky-like hierarchy[210] extended to computational systems.

This hierarchy maps onto the domain structure established in **Section 5** (Physical **P**, Valuational / Emotional **V**, Symbolic **S**, Minimally Constrained / Archetypal **M**)



Level 1: Direct Observables (P-Domain)

Examples:

- Physical objects and their immediate properties (position, colour, temperature)
- Direct sensory data (photons hitting retina, sound waves in cochlea)
- Present-moment phenomena accessible through perception

> **Plain-English Context**
> *This is the "free" information—what you see, hear, touch right now. Your brain has evolved dedicated hardware (sensory organs) to capture this automatically with maximum computational efficiently.*

> ***Computational Analogy***
> *Like looking up a value in a hash table with **O(1)** access time. Your sensory systems provide immediate, pre-processed information about local physical reality.*

Level 2: Valuational Patterns (V+S Domains)

Examples:

- Natural laws, common emotions and regularities across lots of observers (gravity, thermodynamics, the average set of emotions humans experience)
- Causal relationships (fire causes heat, food provides energy, fighting with someone makes me angry)

- Statistical patterns (sunrise follows sunset, seasons cycle)

> ***Ruliad Context***
> *Pattern recognition across multiple morphisms in driven by domain V (valuational) that incorporate both P and S domain data. Requires "compressing" multiple observations into generalizations—a logarithmic process*

> ***Computational Analogy***
> *Like binary search in a sorted list. You don't need to check every possibility; you can narrow down through systematic elimination. Each observation cuts the remaining uncertainty roughly in half.*

> **Plain-English Context**
> *This is "learned" information—patterns you notice by experiencing the world repeatedly. Evolution has given you pattern-recognition circuits that spot regularities automatically after sufficient exposure.*

Level 3: Computable Structures (S-Domain)

Examples:

- Mathematical theorems requiring proofs (Pythagorean theorem, fundamental theorem of calculus)
- Logical implications requiring step-by-step derivation
- Algorithmic procedures that must be executed sequentially

> ***Ruliad Context***
> *Traversing chains of morphisms in the domain **S**. Each step in a proof is a morphism; the proof length determines access complexity.*

> ***Computational Analogy***
> *Like iterating through a list. You must visit each element in sequence. A proof with n steps requires n computational operations—there's no shortcut.*

> **Plain-English Context**
> *This is "worked-out" information—knowledge that requires step-by-step reasoning that has been computationally reduced (made more predictable) by an Observer's computational work.*
> *You can't skip steps; you have to walk through the logical chain. This is what mathematics and formal reasoning provide.*

Level 4: Intuitable Archetypes (M-Domain)

Examples:

- Universal symbols appearing across cultures (circle/wholeness, serpent/transformation, hero's journey)
- Deep structural patterns (dialectical opposition, hierarchical organisation)
- Jungian archetypes in the collective unconscious[211]

> ***Ruliad / Category Theory Context***
> *Cross-domain morphisms connecting P, V, S simultaneously to M (minimally constrained domain), where M domain is dominant in overall structure of object. Requires integrating multiple perspectives—a quadratic process as each domain must connect to each other domain.*

> ***Computational Analogy***
> *Like finding all pairs in a set—requires checking each element against each other element, giving $O(n^2)$ complexity. Understanding archetypes requires integrating physical, emotional / valuational (attractor dependant), and symbolic domains simultaneously.*

> **Plain-English Context**
> *This is "intuited" information—deep patterns that appear across multiple domains simultaneously. These aren't proven like theorems; they're recognized through synthesis.*
> *Art, Music and anything that gives you a sense of awe is likely working at this level.*

Level 5: Ineffable Realities (M-Domain Approaching TI)

- **Examples:**
  - Pre-emanative states (e.g. Ein Sof)
  - Pure unity before differentiation

- Approximation of direct knowledge of God

Ruliad / Category Theory Context

These correspond to the terminal object categorical limit points that enable maintenance of identity for the Observer but nothing more..

No finite morphism chain from O's current state reaches the terminal state, they are "at infinity" in the morphism space but these get as close as they can without losing the Observer's boundary (akin to how advanced meditators, even in the nothing, still have some sense of super-identity style awareness – if they didn't they couldn't report the experience)

Computational Analogy

Undecidable for any finite Turing machine (i.e. halting problem related). An Observer cannot 'compute their way' to these states using a finite algorithm. Requires a qualitative leap i.e. something beyond computation / hyper-computational.

Plain-English Context

This is "incomputable" information. Truths about ultimate reality that cannot be accessed through any finite process of reasoning, observation, or calculation.

Mystics claim direct access through non-computational means (grace, enlightenment, union). Whether such claims are valid is formally undecidable from within the system.

This hierarchy reveals why different knowledge-seeking methods have evolved and persist across cultures:

- **Science** optimises for Level 1-2 access (observation and pattern inference)
- **Mathematics** operates at Level 3 (computable structures)
- **Art** works primarily at Level 4 (intuitable archetypes)
- **Mysticism** attempts direct access to Level 4/ as close as they can get to Level 5 (ineffable realities)

All are necessary for maximum exploration.

None is "better" than the others; they access different regions of the possibility space subject to different Observer constraints.

Ruliad / Category Theory Context

*The accessibility emerges **necessarily** from the Observer's bounded computational capacity B_O interacting with the Ruliad's infinite computational structure.*

Each level represents a different trade-off between information richness and access cost (computational efficiency)

Part B: The Bounce-Back Mechanism

1. The 'Furthest Point' Principle

Systems at maximum distance from their source (longest computational path) possess maximum potential for return.

> ***Plain-English Context***
> *Like a stretched rubber band: the more you pull it away from its resting state, the stronger the force pulling it back. Observation at maximum computational distance from the source (Ein Sof) has maximum "computational potential energy" for the return journey.*

Conjecture: Information Integration Directionality

For any observer **O** embedded in the Ruliad with bounded computational capacity, the change in integrated information per update step satisfies.

$$\frac{\Delta I(F_O)}{\Delta n} \geq 0$$

Where **n** represents discrete hypergraph update steps.

Units: $I(F_O)$ in bits**;** **n** is dimensionless (update count); therefore ratio in **bits per update step**

Symbol definition:

- **I(F_O)** = Integrated Information in the observer's field (bits) *corresponds to **Φ** in IIT literature*
- **F_O** = the Observer's Field (the computational structure defining the observer information integration boundary given current constraints)
- **Δ** = discrete difference operator (change between states)
- **n** = number of hypergraph update steps (computational time)

> ***Plain-English Context***
> *This conjecture proposes that observers accumulate more information over time – they learn, integrate new patterns, and build understanding. The rate might vary (sometimes you learn quickly, sometimes slowly), but the direction is always forward. You don't spontaneously "unlearn" integrated knowledge. This is like saying water flows downhill, the direction might curve, but the overall trend follows the gradient.*

> ***Note***
> *This inequality follows from the fundamental nature of observation as an information-gathering process but **lacks rigorous mathematical proof in Information Theory or Integrated Information Theory frameworks**.*
> *It should be treated as a working hypothesis requiring formal proof including:*
> *(1) specification of temporal dynamics for integrated information evolution*
> *(2) demonstration that I(F_O) acts as a Lyapunov function*
> *(3) proof of monotonicity under observer dynamics*
> *(4) characterization of conditions under which the inequality holds*

This conjecture implies a 'force' drawing Observers toward higher information density attractors in the Ruliad (i.e. what religions call God).

*The God Conjecture suggests the universe doesn't just permit a return to unity; it actively encourages it through the gradient structure embedded in the computational topos that is the result of the emanatory framework detailed in **Section 5**.*

---

2. Information Integration as Universal Observer Telos

If we accept the axiom that Observers seek to integrate information (increase local information density ρ_O), then **life's guiding telos becomes clear: to serve as the universe's mechanism for recovering and integrating structured information.**

> ***Plain-English Context***
> ***Life isn't just trying to survive.***
> *In the God Conjecture life is a gift. It's God's way to let something with the idea of separate identity explore how perfect it can be.*

Consider the hierarchy of information integration mechanisms accessible to an Observer, explicitly mapped to the domain structure from **Section 5**:

Perception: Raw Data Integration from Environment (P-Domain)

- Recovery Rate: **~10^7** bits/second (all sensory input combined)[212]
- Fidelity: Low (heavy filtering and lossy compression before reaching consciousness)
- Coverage: Local (immediate physical environment only)

Direct sampling of Physical domain morphisms, P. Sensory organs act as specialized interfaces between physical spacetime and neural computational states. Each sensory channel samples different aspects of the local hypergraph structure.

Pattern Recognition: Compression of Regularities (V+S Domains)

- Recovery Rate: ~10^2 patterns/second (estimates from cognitive psychology experiments)
    - *Simple patterns (edges, colours): ~100/sec*[213]
    - *Complex patterns (faces, words): ~10/sec*[214]
    - *Abstract patterns (concepts): ~1/sec*[215]
- Fidelity: Medium (false positives exist)[216]
    - *Trade-off between sensitivity and specificity*
    - *Type I errors: seeing patterns that aren't there*
    - *Type II errors: missing patterns that are there*
- Coverage: Extended beyond local through inference and prediction
    - *Can infer distant/future states from current patterns*

> ***Ruliad Context***
> *Cross-domain morphisms connecting P (physical observations) to V (valuational meanings) and S (symbolic representations). Pattern recognition compresses multiple physical states into a single higher-order concept—a many-to-one morphism (multi-computational closure / computational reducibility in action)*

> ***Plain English Context***
> *Your brain is constantly looking for patterns in the sensory flood. "These edges form an object," "This object is a face," "This face looks angry." This compression is necessary (you'd be overwhelmed otherwise) but inevitably lossy and error-prone (seeing faces in clouds).*

Learning: Building Predictive Models (S-Domain)[217]

- Recovery Rate: ~1 significant update per hour (conscious learning episodes)
    - *Procedural learning: ~0.1 updates/hour (motor skills, habits)*[218]
    - *Declarative learning: ~1 update/hour (facts, concepts)*[219]
    - *Insight learning: ~0.01 updates/hour (paradigm shifts, "aha moments")*[220]
- Fidelity: High (tested against reality through prediction errors)
    - *Models that make bad predictions get updated or discarded*
    - *Reinforcement learning provides error signals*
- Coverage: Generalizable principles beyond specific instances
    - *Can transfer learning to novel situations*
    - *Abstracts rules from particular examples*

> ***Ruliad Context***
> *Building internal models in the symbolic domain, S that mirror coarse-grain the causal structure of domains P and V. Learning constructs morphisms that predict future states to reduce computational burden —a form of internal Ruliad simulation by an embedded Observer over a narrow sub-domain.*

> ***Computational Analogy***
> *Like training a machine learning model. Build an internal representation (neural network weights, Bayesian priors) that capture the statistical structure of the data. Each learning episode updates these weights through backpropagation or Bayesian updating*

> ***Plain English Context***
> *This is where you build mental models of how the world works—"If I do X, Y will happen," "Objects with property A tend to also have property B." These models get continuously tested and refined through experience. This has an evolutionary component. Good models survive; bad models get modified or abandoned.*

Science: Systematic Knowledge Construction (S-Domain, Collective)

- Recovery Rate: ~ 2-3 x10^6 discoveries/year globally (peer-reviewed publications in all fields)
    - *Incremental findings: ~10^6/year*
    - *Major breakthroughs: ~10^3/year*
    - *Paradigm shifts: ~10/year*
- Fidelity: Very high (peer review, replication requirements, statistical rigor)
    - *Multiple independent verification*
    - *Systematic error correction*
    - *Self-correcting social process*
- Coverage: Universal laws transcending individual observations
    - *General relativity applies to all massive objects*

- *Thermodynamics applies to all energy transformations*

Ruliad Context

*Collective Observer construction of shared morphisms in domain **S** that remain **invariant** across individual Observer transformations (i.e. they are maximally computationally reduced / informationally entropy reduced forms i.e the best way to climb a certain information gradient). Science builds a "common coordinate system" for accessing R_o, maximally compressed representations with maximal predictive power and minimal computational cost subject to B_o.*

Computational Analogy

Like distributed version control (e.g. Github). Thousands of researchers independently explore different regions of the Ruliad, then merge their findings into a shared repository (scientific literature). Conflicts (contradictory results) trigger debate and further investigation until consistency is restored.

Plain English Context

Science acts as humanity's collective learning algorithm. Instead of each person rediscovering fire and the wheel (computationally inefficient), we pool our discoveries (lowering our boundedness), verify them through replication (reduce their informational entropy), and build on each other's work (access new choices / ideas from them).

This creates a ratchet effect (positive recursiveness) through time.

Art/Spirituality: Intuitive Information Recovery (M-Domain)

- Recovery Rate: Variable and breakthrough-dependent (not well quantified)
  - *Depends on individuals more than groups*
  - *Often sudden rather than gradual*
  - *Difficult to predict or control*
- Fidelity: Difficult to verify objectively
  - *Strong phenomenological certainty for the experiencer*
  - *Hard to replicate or communicate to others*
  - *No standardized "peer review" process*
- Coverage: Often reaches Level 4, sometimes boundary (Level 5) information
  - *Direct access to minimally constrained domain M, which has highest causal coverage*
  - *Can bypass sequential reasoning (i.e. direct line to M from P, see sportsman in 'flow')*
  - *Holistic/gestalt comprehension (instinctual / intuitive)*

Plain English Context

Art and mysticism capture information structure that science can't (yet) i.e. the 'felt' quality of experience, the sense of unity.

These may be accessing patterns that are universal through non-rational means. A painting can communicate something that would take a million words to explain (and still fail). So these methods of discovery aren't inferior to science. They access different regions of computational possibility space.

Ruliad Context

Non-sequential access to M-domain through direct morphisms bypassing intermediate steps in certain domains.

*Mystical experience may represent **O(1)** access to certain high-level attractors in **M**, while scientific knowledge requires **O(n)** sequential traversal.*

Computational Analogy

Mystical experience may correspond to momentary access to higher-order morphisms in the Ruliad's ∞-groupoid structure—equivalences that connect distant regions of possibility space directly, bypassing intermediate steps. This would explain the phenomenology of "timeless now" and "everything connected to everything" reported by mystics.

This multi-modal approach to information integration suggests that life has evolved diverse strategies for exploring different regions of the Ruliad's possibility space.

Science excels at mapping the regular and repeatable (low-entropy domains like P and V). Art and spirituality capture the unique and irreducible. *Both are necessary for complete reconstruction of the equilibrium state (the unchanging, maximally information-dense closure point of the Topos).*

---

3. The Optimisation Function

Life exhibits sophisticated optimisation strategies that maximize information integration per unit of energy expended.

We can formalise this optimisation function as:

$$\mathcal{L}_O = \arg\max \text{strategy}\left[\sum_{n=0}^{N} \frac{I(F_O)[n] \cdot Rel_O[n] \cdot P_O[n]}{E_O[n]}\right]$$

Where:

- $\mathbf{arg\ max\ strategy}$ = argument of the maximum, which means here “Find the input (strategy) that maximises the sum”
- $\mathcal{L}_O$ = Living Observer’s optimal strategy
- $I(F_O)[n]$ = Information integrated at step **n** by Observer **O** sampling the Ruliad (in bits)
- $Rel_O[n]$ = Relevance weight (choice, based on their current causal coverage) ($0 < Rel_O < 1$, dimensionless)
- $P_O[n]$ = Persistence probability ($0 < P_O < 1$, dimensionless)
- $E_O[n]$ = Energy expenditure at step **n** (required to capture and integrate the information) (joules or operations)
- **N** = Observer's lifespan in update steps

> ***Ruliad Context***
> *This optimisation function describes gradient descent in the Ruliad toward **attractors** (stable computational patterns) that maximize the ratio (Information × Relevance × Persistence) / Energy. Evolution discovers these attractors through variation and selection, a form of stochastic optimisation on the fitness landscape defined by L_O.*

> ***Plain English Context***
> *Evolution discovers strategies that maximize "bang for buck" in information gathering. The organisms that survive are those that learned to extract maximum useful information from minimum resources. This is why eyes evolved (cheap photon detection gives rich spatial information), why brains consolidate memories during sleep (compress daily experiences to save storage), and why culture emerged (share information across individuals to reduce redundant discovery).*

> ***Computational Analogy***
> *Like training a neural network with a custom loss function. The "loss" (thing to minimize) is wasted energy per bit of useful information. Evolution is doing gradient descent on this loss function, automatically finding architectures (body plans, brain structures) that optimise the information/energy ratio*

This explains numerous biological and cultural phenomena:

Physical Morphology Optimisation

- Evolution optimises for efficient information gathering architectures
  - *Eyes: Concentrate photoreceptors in fovea—10^6 bits/sec from tiny retinal patch[221]*
  - *Ears: Frequency analysis through basilar membrane—parallel processing of sound spectrum*
  - *Nervous systems: Hierarchical processing reduces redundancy (edge detection → object recognition)*

> ***Ruliad Context***
> *Physical structures in domain **P** evolve to maximize morphism accessibility in domains **V and S** i.e. for eyes, sensory organs are local "probes" into the hypergraph, sampling high-information-density regions (photons carry spatial data efficiently)*

Intelligence Optimisation

- Cognitive algorithms optimise for pattern recognition and prediction
  - *Bayesian brain hypothesis: optimal inference under uncertainty[222]*
  - *Predictive coding: minimize prediction error through hierarchical models*
  - *Attention mechanisms: allocate bounded computational resources to highest-relevance inputs*

> ***Ruliad Context***
> *Intelligence is efficient traversal of S-domain morphisms. Smart strategies minimize computation required to reach high-value information states. Corresponds to learning functors **F: R → Internal** that accurately represent the Ruliad's structure in compressed internal models. Better intelligence = functors that preserve more essential structure while using fewer resources.*

> ***Plain English Context***
> *Intelligence isn't about raw processing power (though it’s important). It's about **clever algorithms** that get you to the right answer with minimum computational work i.e. a “smart search” algorithm can find the needle in the haystack 1000x faster than pure brute force.*

Culture Optimisation[223]

- Cultural transmission optimises information preservation and sharing mechanisms
  - *Language: Compress and transmit complex ideas with minimal bandwidth (~50 bits/sec speech[224])*
  - *Writing: Externalize memory, enabling information to persist beyond individual lifespans*
  - *Education: Optimise transfer of compressed knowledge to new generations*

- *Science: Systematic error-correction maximizes fidelity of transmitted information*

> ***Ruliad Context***
> *Culture creates a shared S-domain coordinate system that reduces per-Observer computational costs. Instead of each Observer rediscovering everything, they inherit compressed representations (language, concepts, theories) that map efficiently onto* $\boldsymbol{R_O}$

> ***Plain English Context***
> *Culture is humanity's shared hard drive. Instead of each person having to figure everything out from scratch (impossibly expensive), we pool our discoveries and each generation starts from where the last one left off. It's exponentially more computationally efficient.*

Technology Optimisation

- Tools and techniques increase sampling speed and information accessibility
  - *Telescopes: Access distant spacetime regions (expanding R_O in domain P)*
  - *Microscopes: Access small-scale structure (increasing resolution of R_O)*
  - *Computers: Amplify computational capacity (reducing B_O constraints)*
  - *Internet: Near-instantaneous global information sharing (reducing transmission latency / increasing bandwidth)*

> ***Plain English Context***
> *Technology is prosthetic cognition, they are tools that extend our sampling reach into regions of the Ruliad inaccessible to unaided biology. Telescopes let us sample distant hypergraph regions (far galaxies). Computers let us explore high-branching-factor regions (complex simulations). The Internet connects human Observers into a MetaObserver with vastly expanded R_O.*

The trajectory is universal. It is shared across all classes of Observers. We move from simple chemical gradients (bacteria sensing nutrients) to global communication networks (humans exchanging ideas across continents in milliseconds).

Survival is a derivative optimisation.

The God Conjecture suggests the primary optimisation that drives evolution is the development of more efficient information integration architectures.

This reframes the evolutionary narrative. Darwin showed that survival and reproduction drive evolution. The God Conjecture suggests that **survival and reproduction are instrumental**, they're necessary for continued information integration, which, here, is the deeper telos.

Organisms that integrate information efficiently tend to survive; survival then enables further integration. It's a positive feedback loop with information integration at the core.

Part C: The Efficient Search Conjecture

1. Search Strategies Across Scales / Domains

The Efficient Search Conjecture posits that consciousness (at every scale) has evolved optimal strategies for exploring computational possibility space given its constraints.

These strategies exhibit a clear progression in sophistication representing trade-offs between **exploration** (discovering new information) and **exploitation** (using known, computationally reduced information).

Observer Information Integration search strategy	Complexity	Integrated Information Gain per hypergraph update	Eventual Coverage of Domain
Random Walk	**$O(n^2)$**	**$\sqrt{n}$**	**Complete**
Gradient Following	**$O(n \log n)$**	**$\log(n)$**	**Local**
Memory-Based	**$O(n)$**	**N**	**Efficient**
Symbolic / Linguistic	**$O(\log n)$**	**$n \log(n)$**	**Sparse**
Quantum (theoretical)	**$O(\sqrt{n})$**	**$n^{3/2}$**	**Optimal**
Mystical (claimed)	**$O(1)$**	**Limit**	**Direct**

Random Walk (Brownian Motion)

Used by: Bacteria, molecules, diffusion processes

Complexity: $O(n^2)$ coverage time (to explore space of size n nodes)

Advantages:
- No memory required (stateless algorithm)
- Explores all spaces eventually (completeness guarantee)
- Robust to local barriers (can escape local minima)

Disadvantages:
- Highly redundant (revisits same states repeatedly)
- Slow coverage (quadratic scaling)
- No learning from past exploration

Information Gain Rate: $\sqrt{t}$ (square root of steps taken)
- *After 100 time steps, explored ~10 unique positions*
- *After 10,000 time steps, explored ~100 unique positions*

> ***Ruliad Context***
> *Random walk corresponds to an Observer with zero computational resources for path planning. At each step, they sample a random neighbouring node in the hypergraph. This is guaranteed to eventually visit all nodes (if the graph is connected), but with terrible efficiency.*

> ***Computational Analogy***
> *Like a drunk person stumbling home. They'll eventually get there, but they'll walk in circles a lot first. No map, no memory, just random steps. Works but wildly inefficient.*

Biological Examples:
- Bacterial chemotaxis without gradient (tumble-and-run)
- Molecular diffusion across membranes
- Early Universe particle exploration before structure formation

---

Gradient Following (Chemotaxis, Hill Climbing)

Used by: Cells, simple organisms, gradient-descent algorithms

Complexity: *O(n log n)* for convex spaces (single peak)

Advantages:

- Rapid approach to local optima (exponentially fast)
- Simple implementation (just follow the gradient)
- Low memory requirements (only need current state)

Disadvantages:

- Trapped by local maxima (can't see over hills)
- Fails in flat regions (no gradient to follow)
- Requires smooth fitness landscape

Information Gain Rate: *log(n)* (logarithmic growth)

- *Fast initial progress, then plateaus*
- *Diminishing returns over time*

> ***Ruliad Context***
> *Gradient following corresponds to an Observer with a local value function v_O that assigns fitness scores to nearby nodes. At each step, move to the highest-valued neighbour. This works well in smooth regions of the Ruliad (fitness landscapes with clear gradients) but fails in rugged landscapes (multiple local peaks).*

> ***Computational Analogy***
> *Like climbing a hill in fog. You can feel the ground sloping up, so you always step upward. You'll reach the top of a hill, but it might not be the highest hill. If you're in a valley, you'll get stuck between peaks and never know there are higher peaks elsewhere.*

Biological Examples:

- E. coli chemotaxis toward nutrient gradients[225]
- Plant phototropism (growth toward light)[226]
- Neural gradient descent during learning[227]

Memory-Based Search (Cognitive Maps)

Used by: Advanced organisms, reinforcement learning agents

Complexity: *O(n)* for moderately complex spaces

Advantages:

- Escapes local maxima
- Balances exploration and exploitation (internal simulation)
- Builds memory of visited states

Disadvantages:

- Requires memory storage (visited states must be tracked)
- Exploration parameter requires constant tuning (dependent on environment)
- Computational overhead for value function updates

Information Gain Rate: $n^{(2/3)}$ (sub-linear)

- *Steady accumulation over time*
- *No diminishing returns until space is exhausted*

> ***Ruliad Context***
> *Memory-based search maintains an explored set $\text{Explored}_O \subset R_O$ and preferentially explores unvisited regions. The exploration bonus is high for novel nodes, decaying as they're revisited. This is the computational implementation of curiosity. Organisms evolved to seek novelty because unexplored regions likely contain useful information.*

> ***Computational Analogy***
> *Like exploring a dungeon in a video game while drawing a map. You remember where you've been, so you don't keep going back to the same rooms. Each new area you explore is genuinely new.*

Biological Examples:

- Rat exploring mazes (hippocampal place cells)
- Foraging animals avoiding recently depleted food patches (communicating resource locations)[228]
- Humans foraging in hunter-gatherer bands[229]

> ***Plain-English Context***
> *This is where memory pays off. By remembering where you've already been, you can systematically explore everything once without backtracking. This is a huge efficiency gain over random walk, but it requires Observer investment in memory storage.*

Symbolic / Logical Search

Used by: Humans, AI systems, Mathematicians

Complexity: $O(b^k)$ where **b** is a branching factor, **k** is planning depth

- This means each new planning step is exponentially more computationally expensive
- It requires a symbolic world model (internal Ruliad representation)

Advantages:

- Massive compression through symbols (single word encodes vast information)
- Cultural transmission (share discoveries across individuals)
- Combinatorial generativity (finite symbols generate infinite expressions)

Disadvantages:

- Exponential computational cost growth (branching explosion)
- Requires accurate world model (garbage in / garbage out)
- Slow response time (deliberation in planning is time consuming)

Information Gain Rate: ***n*** (linear, systematic coverage)

> ***Ruliad Context***
> *Symbolic search builds an internal model M_O of the Ruliad structure and plans trajectories through M_O before executing them in R_O. This is "thinking before acting"—mentally simulating futures to choose optimal paths. Humans are unique in performing deep lookahead planning ($k \approx 5$-10 steps), enabled by language and symbolic reasoning.*

Biological Examples:

- Human strategic planning
- Tool-use
- Delayed gratification

> ***Plain-English Context***
> *Language is magic. A single word compresses experiences that would take hours to convey through direct demonstration. "Justice" points to a concept built from thousands of experiences, intuitions, and cultural transmission. With language, you can share discoveries instantly instead of each person rediscovering everything.*

Cultural Implications:

- **Writing** → *information persistence beyond individual lifespans*
- **Libraries** → *collective memory with searchable indexing*
- **Science** → *systematic symbol manipulation to generate predictions*

Quantum Search (Grover's Algorithm[230])

Used by: Theoretical quantum computers, speculative quantum cognition models

Complexity: $O(\sqrt{n})$ for unstructured search (quadratic speedup over classical)

Advantages:

- Fundamental speed limit set by quantum mechanics
- Optimal for certain types of search
- Exploits superposition to explore multiple paths simultaneously

Disadvantages:

- Requires quantum coherence (extremely fragile)
- Not clear if biological systems can implement
- Only helps for specific problem types

Information Gain Rate: $t^{(3/2)}$ (polynomial speedup)

- *Faster than classical but not exponentially so*

> ***Ruliad Context***
> *Quantum search exploits parallel morphisms. Rather than exploring morphisms sequentially, this explores many morphisms simultaneously until measurement collapses to the target state.*

> ***Computational Analogy***
> *Like checking every page of a phone book simultaneously vs. flipping through one page at a time. Quantum systems can be in superposition of multiple states, effectively testing many possibilities at once until the right answer "emerges." This is probably faster than any classical algorithm for certain tasks.*

Biological Connection:

- Quantum effects in microtubules (Penrose-Hameroff)
- Quantum effects in photosynthesis[231], bird navigation[232] (confirmed but role unclear)

Mystical Direct Knowing (non-symbolic apprehension)

Claimed by: Advanced meditators, mystics across traditions, direct spiritual experience

Complexity: **O(1)** for specific insights (immediate) to limit of $\mathbf{B_O}$, but very low success probability (approaching ε)

Claims single morphism / "leap" directly to terminal object boundary (while maintaining some minimal identity) without intermediate steps (or minimal steps, think a strong psychedelic experience)

Advantages:

- Shortest possible search
- No computational cost during insight (happens “spontaneously”)
- Can access global optima without systematic search

Disadvantages:

- Difficult to verify objectively (private phenomenology)
- Difficult to replicate systematically (not algorithmic / can’t be forced)
- Extremely low probability

Information Gain Rate: *Step function* (breakthrough-based)

- *Either you "get it" (discontinuous jump) or you don't*

> ***Ruliad Context***
> ***Speculative.*** *Represents direct morphism from Observer state **O** to terminal object boundary with **TI** without traversing intermediate states. A "topological shortcut". More likely to represent access to high-level attractors in M-domain (that are close, computationally to the limit object) that seem direct but actually involve rapid unconscious computation.*

> ***Computational Analogy***
> *Like hacking directly into the root directory vs. navigating through nested folders. If consciousness can access reality directly without symbolic mediation, it would be the ultimate search optimisation—O(1) access to any information.*

> ***Plain-English Context***
> *Mystics across cultures claim that practices like meditation, prayer, or psychedelics, they can directly apprehend ultimate reality without reasoning through it step-by-step. This is a shortcut, knowing without learning. Whether these experiences are genuine information access or self-generated hallucinations is formally undecidable from within the system.*
> *The God Conjecture remains agnostic but acknowledges the possibility is more likely some very high level (high causal coverage) M-domain / TI M-domain boundary phenomenon.*

> ***Important Note on Epistemic Humility***
> *The God Conjecture cannot verify mystical claims but can characterize what they would mean computationally.*

Each successive strategy in this hierarchy trades memory / complexity for search efficiency.

Evolution has discovered better search algorithms, each representing a phase transition in Observer information integration capacity:

1. Brownian motion → Gradient following: *Add simple feedback*
2. Gradient following → Memory: *Add internal state*
3. Memory → Symbolic thought: *Add abstract representation*
4. Symbolic → Quantum (speculative): *Add superposition*
5. Quantum → Mystical (claimed): *Add direct access*

Each transition requires increased computational infrastructure (bigger brains, more energy) but delivers exponential improvements in information access efficiency.

> ***Ruliad Context***
> *These search strategies represent approximations to optimal morphism traversal for a given Observer given increasing computational budgets* $\mathbf{B_O}$*. Evolution discovers them through random variation; mathematics proves their optimality; Observers implement them.*

2. Computational Cost Analysis

The energy cost of observation is a core constraint on Information Integration.

The human brain consumes approximately 20% of the body's total energy budget, a massive investment that only makes sense if high order consciousness provides commensurate survival advantage through efficient information processing.

We can characterize the computational cost/benefit economy through several levels:

Operation Type	Energy per Operation	Operations per Second	Power required (est.)
Basic operation (single neuron spike)	~10^{-15} joules	~10^{16} (all neurons)	~100mW
Synaptic transmission	~10^{-14} joules	~10^{15} (all synapses)	~10mW
Conscious thought (attention-demanding)	~10^{-9} joules	~10 thoughts/sec	~10nW
Memory formation (long-term)	~10^{-7} joules	~1 memory/hour	~30pW

Ruliad Context
Each neural operation is a morphism in one of our accessible domains. The total computational cost is the sum of all morphisms traversed per state update. Consciousness selectively amplifies a tiny subset (~10^{-5}) of overall neural morphisms into S-domain (symbolic)

Plain-English Context
Most of the brain's energy goes to "background" processing you're not aware of—maintaining neurons, synaptic transmission, subconscious pattern recognition. Conscious thought is actually incredibly cheap per thought, but you can only sustain ~10 conscious thoughts per second due to the serialization bottleneck

---

Information Return on Computational Investment ("IRCI")

One good idea can save you more energy than months of random foraging.

Spotting a predator before it spots you saves your life (infinite ROI). Cooperating with others multiplies your effective energy budget. Inventing agriculture transformed the entire species' energy budget.

IRCI:

$$\mathrm{IRCI}_O[n] = \frac{V_O(\mathrm{Pattern}\,[\mathrm{n}]) \cdot P_O[\mathrm{n}] - \mathrm{Cost}_{compute}[\mathrm{n}])}{\mathrm{Cost}_{compute}[\mathrm{n}]} \qquad \text{simplified form: } \mathrm{IRCI}_O[n] = \frac{V_O[\mathrm{n}] \cdot P_O[\mathrm{n}]}{\mathrm{Cost}_{compute}[\mathrm{n}]} - 1$$

Where:

- **V_O(Pattern[n])** = value function applied to discovered pattern at step **n** (measured in energy saved or gained, joules)
- **P_O[n]** = persistence probability (how long the pattern remains useful, dimensionless $0 \leq P \leq 1$)
- **$\mathrm{Cost}_{compute}$[n]** = computational cost to discover and verify the pattern (measured in joules or operations)

Units:

- **IRCI_O** is dimensionless (ratio of energies)
- **V_O** in joules (energy value)
- **P_O** dimensionless (persistence weight)
- **$\mathrm{Cost}_{compute}$** in joules (energy cost)

Ruliad Context
In the multiway hypergraph, discovering a high-IRCI pattern corresponds to finding a "shortcut" through possibility space i.e. a morphism that bypasses many intermediate steps. For example, discovering fire lets you access cooked-food nutritional states directly, bypassing the computational path through raw-food metabolic limitations. Evolution favours organisms that discover high-IRCI shortcuts.

Examples (estimated, calculation would need to be accurately specified):

- Avoiding predator: IRCI ≈ 10^6 (one million-fold return)
- Finding food: IRCI ≈ 10^5
- Social cooperation: IRCI ≈ 10^6
- Technology: IRCI ≈ 10^9 (billion-fold return, as amortized across Observers)

This massive return on Observer's investment in information integration infrastructure like brains, drives evolution of ever-more sophisticated information processing systems.

Category-Theoretic Interpretation:

$$F_{compressed}: R_{raw} \rightarrow R_{compressed}$$

where the functor maps high-complexity regions (many computational steps) to low-complexity representations (few steps) while preserving essential structure.

Mathematics, language, and technology are all compression functors with enormous IRCI, they let bounded Observers access infinite computational territories efficiently.

Cultural Amplification[233]

This massive return on Observer's investment in information integration infrastructure (like brains) drives evolution of ever-more sophisticated information processing systems.

These gains are amplified when many Observers are 'looking' at the same thing.

Cultural transmission amortizes computational costs across populations. One person invents the wheel; millions benefit. Per-Observer cost of the innovation becomes negligible, while the benefits persist for generations.

Discrete formulation:

$$\mathrm{IRCI}_O[n] = \frac{V_O[n] \cdot P_O[n] \cdot |O_{pop}|}{\mathrm{Cost}_{compute}[n] + \mathrm{Cost}_{transmission}[n] \cdot |O_{pop}|}$$

Where:

- $|O_{pop}|$ = number of Observers benefiting from shared pattern
- $C_{transmission}$ = cost to transmit pattern from one Observer to another (typically < $\mathrm{Cost}_{compute}$)

For large populations with low transmission costs:

$$\mathrm{IRCI}_O[n] \approx \frac{V_O \cdot P_O \cdot |O|}{\mathrm{Cost}_{compute}} \cdot \frac{1}{1 + \frac{\mathrm{Cost}_{transmission}}{\mathrm{Cost}_{compute}} \cdot |O|}$$

As $\mathrm{Cost}_{transmission} \rightarrow 0$ (internet era), $\mathrm{IRCI}_{culture} \rightarrow \infty$ in the limit (i.e. free knowledge sharing has unbounded returns)

> ***Plain-English Context***
> *When you share knowledge, the discovery cost gets divided across everyone who learns it, but the value multiplies. If teaching costs 1% of discovering, then sharing with 100 people gives each person 99% savings. This is why formal education evolved, it has positive-sum IRCI. The more people share knowledge, the higher everyone's individual IRCI.*

Technology as a Multiplier

Technology increases the information value return without commensurate increase in neural processing costs.

A calculator performs 10^9 operations per second using 0.1w (more efficient than neurons). Each technological extension reduces B_O without requiring biological evolution (which is much less computationally efficient).

Discrete formulation:

$$B_O^{effective} = B_O^{biological} + \sum_{k=1}^{n} B_{tech}[k] \cdot \epsilon[k]$$

Where:

- $B_O^{biological}$ = baseline neural computational capacity (~10^{16} ops/sec)
- B_{tech} **[k]** = computational capacity of k-th technology (calculator, computer, AI)
- $\epsilon[k]$ = integration efficiency (how effectively the Observer can use the technology, $0 \leq \epsilon \leq 1$)

Units:

- B_O in operations per second or **bits processed per update step**
- ϵ dimensionless (efficiency factor, 0-1 range)

> ***Plain-English Context***
> *Your effective computational capacity equals your brain plus all the tools you can use effectively. A human with a smartphone has vastly higher B_O than a human without. You can access Wikipedia (all human knowledge), GPS (global spatial information), calculators (arbitrary arithmetic), etc. Technology acts as cognitive prosthetics, extending your accessible region R_O without biological mutation.*

> ***Ruliad Context***
> *Technology extends the sampling functor* ***F_o: R → Internal Model*** *by augmenting sensory reach (telescopes, microscopes) and computational power (computers, AI). This is equivalent to expanding the Observer's 'light cone' in the Ruliad, accessing regions that would otherwise be computationally unreachable.*

---

3. The 'Speed' of Meaning Discovery

The rate at which Observers discover meaning has different dynamics at different scales. *They follow different scaling laws depending on the level of organisation.*

Individual Learning Rate

Limited by synaptic plasticity[234], myelination speeds[235], and working memory capacity[236]:

$$\Delta I(F_{O})[n] = k_1(I(F_O)_{max} - \sum_{m}^{n-1} I(F_{O})[m]) \times \lambda[n]$$

Where:

- $\Delta I(F_{O})[n]$ = information gain at update step n (bits)
- k_1 = learning rate scaling factor (dimensionless, $0 < k_1 < 1$)
- $I(F_O)_{max}$ = maximum integrated information capacity for Observer class (bits)
- $\Sigma I(F_O)[m]$ = cumulative information already integrated up to step n
- $\lambda[n]$ = sampling rate at step n (new patterns encountered per hypergraph update step, dimensionless)

Characteristics:

- Follows a logarithmic curve—rapid initial learning that plateaus as easy patterns are exhausted
- Peak learning rate: Early childhood (~age 3-7) when brain is maximally plastic
- Diminishing returns: Harder to learn new things as you age (not due to capacity loss but pattern space saturation)

> ***Plain-English Context***
> *The equation is trying to formalise the following heuristic.*
> *You learn fast when you're young because everything is new. As you age, you've already learned most of the common patterns, so new learning requires finding rarer, subtler patterns—which is harder. It's not that your brain gets worse; it's that you've already picked the low-hanging fruit.*

Cultural Evolution Rate (not prescribed)

Based on the above, this should be constructed from the Individual Learning Rate, amplified by **population size**, **communication technology, and network density**:

Characteristics:

- Can be super-linear when network effects dominate (Metcalfe's Law)
- Accelerates with communication technology (writing, printing press, internet)
- Subject to punctuated equilibrium (i.e. stability for long time before rapid revolutions)

> ***Plain-English Context***
> *Cultures learn faster than individuals because ideas spread to millions of people instantly (with modern technology). One person's innovation becomes everyone's knowledge. This creates positive recursive feedback—more people means more innovations, which means faster cultural evolution.*

Historical Examples:

- Agricultural Revolution (~10,000 BCE): Population growth enabled specialization
- Printing Press (1450 CE): Reduced book copying cost 1000x, democratized knowledge
- Internet (1990s CE): Near-zero marginal cost of information transmission globally

> ***Ruliad Context***
> *Cultural evolution corresponds to parallel sampling of the Ruliad by many Observers who share their findings. High connectivity means Observers can pool their explorations, effectively increasing the sampling rate by a factor linked to the population size. This is why human civilization dominates Earth—we're the only species with connectivity that approaches global scale (internet era).*

Technological Acceleration

Roughly exponential growth[237]:

$$I(F_O)_{tech}[n] = I(F_O)_{tech}[0] \times (1 + r)^n$$

Where:

- **$I(F_O)_{tech}[n]$** = technological information capacity at step n (bits or operations/sec)
- **$I(F_O)_{tech}$ [0]** = baseline capacity at n=0
- **r** = growth rate per step (dimensionless, historically r ≈ 0.4-0.5 per year, doubling every ~18-24 months)

Characteristics:

- Exponential growth historically
- Limited by physical constraints (or computational irreducibility)
- Enables meta-level acceleration, building tools that help make making better tools

> ***Plain-English Context***
> *Technological progress has been exponential for the past century—each year, we roughly double computational capacity, sensor resolution, data storage, etc. This exponential growth is possible because each generation of technology helps design the next (recursive self-improvement). Computers design better computers; AI helps discover new algorithms. This positive feedback loop drives acceleration.. But this can't continue forever; we'll eventually hit physical limits (thermodynamics, quantum limits, speed of light).*

Possible Outcomes:

1. **Singularity**: *Exponential growth continues until artificial general intelligence (AGI) achieves self-improvement, leading to explosive acceleration*
2. **Plateau**: *Growth saturates due to fundamental limits (computational irreducibility, thermodynamic constraints)*
3. **Oscillatory**: *Boom-bust mega cycles as technology advances beyond social capacity to integrate it (i.e. p(doom), then recovery)*

The Meaning Singularity

Though speculative, the proposed interaction between these different rates of growth creates interesting phase transitions.

For example, when technological information integration (meaning) discovery exceeds human comprehension rates, we approach a **"meaning singularity"** where the rate of discovery outpaces the rate of individual information integration.

Implications:

- Individuals can no longer understand all human knowledge (already true—no polymath can)
- Knowledge growth will require collaborative synthesis
- AI likely necessary to integrate knowledge across domains
- Risk of knowledge fragmentation without integrative frameworks

> ***Plain-English Context***
> ***We're here now**. No single person can understand all of mathematics, all of physics, all of biology. Knowledge is growing faster than any individual can learn. This forces specialization but risks losing the "big picture."*

> ***Ruliad Context***
> *The **Meaning Singularity** represents the point where the rate of morphism discovery in S-domain exceeds any individual Observer's B_O. The solution is distributed cognition—multiple Observers collaboratively mapping different regions of R_O.*

Category-Theoretic Interpretation

The meaning singularity represents a phase transition in the Human Observers functor structure:

Before Meaning Singularity:

$$F_{human} : R_O \to U_O$$ (*where U_O is the codomain of understood concepts*)

is surjective *(humans can understand everything they discover)*

After Meaning Singularity:

$$F_{human} : R_O \to U_O \text{ is no longer surjective}$$

There exists discoveries in R_O with no preimage in the codomain U_O

To deal with this the codomain U_O must expand to include machine cognition:

$$F_{combined} : R_O \to U_{O_{human}} \cup U_{O_{AI}}$$

> ***Plain-English Context***
> *Post-meaning singularity, the category of understandable knowledge must include both human-comprehensible and AI-comprehensible structures. Some truths may be forever beyond human grasp but are accessible to artificial cognition. This is natural progression as we probe augment our accessible portion of the Ruliad by changing our computational boundedness.*

Part D: Equilibrium Dynamics and Informational Entropy

The God Conjecture states that the limit object (Ein Sof / Brahman / Dao etc.) is maximally informationally dense. Because it is unchanging, it naturally parallels an **equilibrium** state.

Here we discuss how these equilibrium dynamics can 'power' movement along the **information gradients** that are accessible to Observers within the Ruliad.

1. Vertical Equilibrium (Between Hierarchical Domains)

The information architecture exhibits equilibrium dynamics between different domains of description accessible to Observers.

In the God Conjecture, information cascades downward (through emanation) while meaning (integrated information) flows upward through Observation.

This creates tension that stabilizes observable reality's hierarchical structure.

> ***Computational Analogy***
> *Like a waterfall with a pump. Water flows down (emanation—information spreading out and becoming less dense). At the bottom, pumps (Observers) work to move water back up (information integration—meaning flowing back toward source). The system reaches equilibrium when the downward flow balances the upward work.*

We can model this, speculatively, as coupled discrete evolution equations describing this flow in both directions:

$$\boldsymbol{I_{down}} = \boldsymbol{I_{\downarrow}[n+1,d]} = \boldsymbol{I_{\downarrow}[n,d]} + \boldsymbol{D_{vert}}\,\Delta^2\,\boldsymbol{I_{\downarrow}[n,d]} - \boldsymbol{\alpha}\,\boldsymbol{I_{\downarrow}[n,d]} + \boldsymbol{S[d]})$$

$$\boldsymbol{I(F_O)_{up}} = \boldsymbol{I_{\uparrow}[n+1,d]} = \boldsymbol{I_{\uparrow}[n,d]} + \boldsymbol{D_{vert}}\,\Delta^2\,\boldsymbol{I_{\uparrow}[n,d]} - \boldsymbol{\beta}\,\boldsymbol{O_d}(\boldsymbol{I_{\downarrow}[n,d]})$$

Where:

- ***n*** *indexes discrete time steps (hypergraph updates)*
- ***d*** *indexes hierarchical domains (d ∈{P, V, S, M}, corresponding to Physical, Valuational, Symbolic, Minimally Constrained)*
- $\boldsymbol{\Delta^2}$ *is the discrete Laplacian operator (measuring diffusion between adjacent domains)*
- $\boldsymbol{D_{vert}}$*= vertical diffusion coefficient (information flow rate between domains, bits per step)*
- ***α =*** *dilution rate (information density decreases as boundaries proliferate, dimensionless)*
- ***β =*** *integration rate (Observers convert raw information into Integrated Information / meaning by compressing patterns, dimensionless)*
- ***S[d]*** *= source strength at domain d (corresponds to* B_{kav}*, emanation from TI, bits per step)*
- $\boldsymbol{O_d}$ *= observation operator at domain d (how Observers integrate information)*
- $\boldsymbol{I_{\downarrow}}$ *and* $\boldsymbol{I_{\uparrow}}$ are information content in bits

Discrete Laplacian for hierarchical domains measures curvature or local diffusion tendency of **I** along the Rulial depth axis:

$$\Delta^2 \boldsymbol{I[n,d]} = \boldsymbol{I[n,d+1]} - \boldsymbol{2I[n,d]} + \boldsymbol{I[n,d-1]}$$

Where:

- Positive $\Delta^2 \boldsymbol{I}$ represents local concavity (valley / information inflow)
- Negative result represents local convexity (peak / information outflow)

> ***Ruliad Context***
> *In the multiway hypergraph, downward information flow corresponds to the branching structure (one state yields many successors—information spreads). Upward flow corresponds to Observer foliation (many states recognized as equivalent—information compresses). The equilibrium emerges when branching and compression balance, creating stable hierarchical structures like the Kabbalistic Sefirot or the Buddhist realms.*

> ***Plain-English Context***
> *These equations model two opposing flows: information flowing down from Ein Sof via the MetaObserver (getting diluted and differentiated as it spreads across more domains), and integrated information / meaning flowing up from Observers sampling (reducing information entropy / finding computational reducibility as predictable patterns are recognized). The Laplacian term* Δ^2 *measures how information "diffuses" between adjacent domains—physical patterns becoming biological, biological becoming symbolic, symbolic approaching minimally constrained /mystical*

Stable Configurations

Stable configurations emerge where these flows balance:

$$\Delta \boldsymbol{I}_{\uparrow}[\boldsymbol{n}, \boldsymbol{d}] + \Delta \boldsymbol{I}_{\downarrow}[\boldsymbol{n}, \boldsymbol{d}] = 0$$

This yields the equilibrium condition:

$$\boldsymbol{D}_{vert}\, \Delta^2\, \boldsymbol{I}_{down} - \boldsymbol{\alpha}\, \boldsymbol{I}_{down} + \boldsymbol{S}[\boldsymbol{d}] = \boldsymbol{D}_{vert}\, \Delta^2\, \boldsymbol{I}(\boldsymbol{F}_O)_{up} - \boldsymbol{\beta}\, \boldsymbol{O} \quad \boldsymbol{d}\, (\boldsymbol{I}_{down})$$

And the equilibrium solution:

$$\boldsymbol{I}^{eq}_{down}[\boldsymbol{d}] = \frac{\boldsymbol{S}[\boldsymbol{d}]}{\boldsymbol{\alpha}} \prod_{k=1}^{d} \boldsymbol{e}^{-\lambda_k}$$

Examples Across Traditions:

- Kabbalah: The 10 Sefirot as stable emanative levels via four worlds (Atzilut to Assiyah)
- Vedanta: The sheaths (koshas) from physical to bliss body
- Neoplatonism: The hierarchy from One → Nous → Soul → Matter
- Buddhism: The realms of existence (kama-loka, rupa-loka, arupa-loka)

> ***Computational Analogy***
> *Like stable orbits in gravitational fields. You can have orbits at many different altitudes, but only certain orbits are stable—too fast and you escape, too slow and you crash. Similarly, only certain information density levels are stable enough for Observers to exist and integrate information.*

> ***Plain-English Context***
> *At equilibrium, the rate of information flowing down equals the rate of meaning flowing up.*
> *This creates stable "layers" in reality—the physical domain (maximum information density from Observer perspective), biological domain (moderate density), symbolic domain (lower density but higher meaning), mystical domain (minimal density, maximum meaning). These layers are not arbitrary—they're the natural equilibrium points where emanation meets Observer information integration.*

---

2. Horizontal Equilibrium (Within Domains)

Within each hierarchical level / domain, information diffuses horizontally across networks of interacting Observers.

This parallels synchronization phenomena in physics (coupled oscillators, phase transitions).

Phase 1: Initial Diversity

Multiple Observers sample different regions of possibility space, creating information gradients and variance:

$$\boldsymbol{\sigma}^2_{\boldsymbol{O}}[\mathbf{0}] = \frac{\mathbf{1}}{|O|} \sum_{i=1}^{|O|} (\boldsymbol{I}_{\boldsymbol{O}_i}[\mathbf{0}] - \langle \boldsymbol{I}_{\boldsymbol{O}} \rangle [\mathbf{0}])^2 = \boldsymbol{\sigma}^2_{max}$$

(variance high, Observers disagree)

Where:

- **|O|** = *number of Observers in population*
- $\boldsymbol{I}_{\boldsymbol{O}_i}[\mathbf{0}]$= *information state of Observer i at initial time (in bits)*
- $\langle \boldsymbol{I}_{\boldsymbol{O}} \rangle [\mathbf{0}]$ = *mean information state across all Observers (in bits)*
- $\boldsymbol{\sigma}^2_{max}$ = *variance of information states (in bits squared)*

Initially, everyone has different experiences and forms different beliefs. High diversity, low consensus. This is like people scattered across a landscape, each seeing a different view. The variance σ² measures how much disagreement exists—high variance means Observers occupy very different regions of the Ruliad.

Phase 2: Communication and Convergence

Information exchange between Observers drives partial synchronization and variance reduction:

$$\boldsymbol{\sigma}^2_{\boldsymbol{O}}[\boldsymbol{n}+\mathbf{1}] = \boldsymbol{\sigma}^2_{\boldsymbol{O}}[\boldsymbol{n}](\mathbf{1} - \boldsymbol{k}\, \boldsymbol{\gamma}[\boldsymbol{n}])$$

Where:

- K = consensus rate constant (dimensionless, 0<k<1)
- $\boldsymbol{\gamma}[\boldsymbol{n}]$ = connectivity at step **n** (average connections per Observer)
- The product of these two terms determines the rate of convergence (the time constant)

This yields exponential convergence, but it never reaches zero variance due to computational boundedness (i.e. individual Observers retain unique perspectives due to unique causal histories):

$$\sigma_O^2[n] = \sigma_O^2[0]e^{-k\gamma[n]}$$

> ***Plain-English Context***
> *As Observers communicate, they converge toward shared beliefs. The rate of convergence depends on connectivity (γ)—more communication means faster convergence. This is why isolated communities develop unique cultures (low γ preserves variance), while globally connected societies converge toward consensus (high γ reduces variance). Social media represents γ→ max, producing rapid cultural homogenization.*

Phase 3: Consensus Reality

Shared information creates shared frameworks for interpreting the information gradient landscape:

$$\sigma_{min}^2 = \frac{1}{|O|}\sum_{i=1}^{|O|}(\epsilon_i)^2$$

Where: ϵ_i irreducible unique noise of Observer, **i**

Eventually, Observers converge to a shared understanding, a "consensus reality" where most agree on most facts.

But complete agreement is impossible because each Observer has unique computational history and measurement noise. The minimum variance σ_{min} represents the irreducible diversity that persists even with perfect communication. This is why science achieves consensus (low σ^2) but not uniformity ($\sigma^2 > 0$) i.e. replication studies still show variation.

This explains both the power and danger of consensus reality:

Power:

- Enables coordination (shared maps let us work together)
- Reduces individual computational load (don't have to figure everything out yourself)
- Amplifies signal (collective observations more reliable than individual)

Danger:

- Creates echo chambers that resist new information (groupthink)
- Can trap Observers in computationally inefficient local maxima (false consensus)
- Filters out anomalies that don't fit the shared framework (paradigm blindness)

The healthiest systems maintain a balance—enough coherence for communication and cooperation, enough diversity for continued efficient exploration.

> ***Ruliad Context***
> *Consensus reality corresponds to Observers whose foliations of the Ruliad overlap significantly.*
> *They're sampling similar regions F_O and applying similar coarse-graining functors. The variance σ^2 measures the diversity of foliations.*
> *High variance means diverse foliations (different "realities" experienced). Low variance means convergent foliations (shared reality). Culture and language are mechanisms for aligning foliations across Observers*

3. Entropy and Negentropy

The relationship between thermodynamic entropy and information entropy reveals why life is an exceptionally efficient search algorithm for integrating information in a computational possibility space.

The Second Law of Thermodynamics demands that **total entropy increases in isolated physical systems**[238].

Life is very effective at creating local pockets of negentropy (negative entropy = order) by exporting disorder to the environment.

> ***Plain-English Context***
> *Your body is constantly fighting entropy. Every moment, thermodynamics wants to scatter your atoms into random soup. You resist this by burning energy (food) to maintain order. But you pay for this local order by increasing disorder in the environment (heat, waste). Globally, entropy still increases; locally, you create an island of order.*

The Two Types of Entropy in the God Conjecture Work Differently

The key insight is that thermodynamic entropy and information entropy behave differently:

Thermodynamic Entropy:

$$S_{\text{thermo}} = -k_B \sum_i p_i \log(p_i)$$

- Always increases globally (Second Law)
- Can decrease locally (with external energy input)
- Measures disorder in physical states

Information Entropy[239]:

$$S_{\text{info}} = -\sum_i p_i \log(p_i)$$

- Can decrease locally without bound (through observation and learning)
- Measures uncertainty/ignorance of Observer
- Reduced by gaining information (learning reduces your uncertainty)

> ***Critical Difference***
> *Thermodynamic entropy is about **physical states**; information entropy is about **Observer knowledge states**. You can reduce your information entropy (learn something) without violating thermodynamics, as long as you export thermodynamic entropy to the environment.*

Life as an Entropy Pump

Life is like 'Maxwell's Demon' for meaning / information integration. Life sorts valuable information from noise and exports unintegrated information (entropic waste) to the environment[240]:

Step 1: Import low-entropy energy

- Sunlight (photosynthesis)
- Chemical bonds (food)
- Organized inputs with low thermodynamic entropy

Step 2: Integrate information via Observation

- Pattern recognition (compress regularities)
- Prediction (build models)
- Learning (update internal representations)

Step 3: Export high-entropy waste

- Heat (respiration, metabolism)
- Disordered matter (excretion)
- Noise (unintegrated sensory data)

Step 4: Result = Local Information Integration gain *(moving against information gradient)*

- $\Delta S_{thermo} > 0$ globally (Second Law satisfied)
- $\Delta S_{info} < 0$ locally (Observer gains information)

Computational Analogy

Like a computer sorting a list. The computer uses energy (creates heat), but the list becomes more ordered. The total entropy increases (heat dissipated to environment > order gained in list), but locally you've created order from disorder.

Ruliad Context

Observers traverse morphisms in domain M, S, V that compress multiple P-domain states into simpler representations. This compression reduces the Observer's internal entropy (uncertainty) but requires energy expenditure that increases environmental entropy.

Evolution of Information Extraction Efficiency

The efficiency of this entropy-pumping process improves as Observers complexify:

Organism Type	Information Extraction Efficiency (estimate)	Mechanism
Bacteria	~0.01%	Simple chemotaxis, no memory
Plants	~1%	Photosynthesis, tropisms, seasonal memory
Animals	~10%	Sensory systems, behavioral learning, episodic memory
Humans	~30%	Language, abstract reasoning, cultural transmission, technology

Early life waste 99.99% of the information available to them. Bacteria sense a chemical gradient but extract almost no information from it. Animals are much better. Humans, with language and culture, reach maybe 30%. AI might eventually approach the theoretical maximum set by physics (the Landauer limit—minimum energy to erase one bit of information).

Landauer's Principle[241]

Erasing one bit of information requires minimum energy:

$$\boldsymbol{E}_{\min} = \boldsymbol{k_B T}\ln(2) \approx 3 \times 10^{-21} \text{ joules at room temperature}$$

This sets a fundamental physical limit on computational efficiency. You can't process information without dissipating at least this much energy per bit erased.

The God Conjecture Prediction: Evolution is driven by selection for increased information integration capability and efficiency. Organisms that extract more usable information per joule invested outcompete those that extract less. This reframes "survival of the fittest" as "survival of the most computationally efficient."

Part E: Ideas as Superstructures

1. Ideas as Persistent Information Patterns

Ideas represent a phase transition in information organisation and integration.

Patterns ("memes") that achieve autonomous existence by replicating between minds.

Unlike genetic information (limited to biological transmission), ideas can jump between *any* sufficiently complex information processing systems – across species, across substrates (biological to digital) and across cultures (superstructure to superstructure).

Formal Structure of an Idea

The formal structure of an idea can be characterised as a tuple:

$$\textbf{Idea} = \{\textbf{Pattern}, \textbf{Replication}_{\textbf{rules}}, \textbf{Fitness}_{\textbf{function}}, \textbf{Mutation}_{\textbf{rate}}\}$$

Components:

1. **Pattern:** The core integrated information structure (content)
    - *Example: "Survival of the fittest" (concept structure)*
2. **Replication Rules:** Mechanisms that make it persist in Observer minds
    - *V domain: Emotional resonance (fear, hope, curiosity)*
    - *S domain / M domain: Cognitive fit (easy to understand/remember)*
    - *P domain: Pragmatic utility (helps achieve goals)*
    - *All domains: Social pressure (conformity, status signalling)*
3. **Fitness Function:** How effectively it replicates (simple spreads faster than complex)
    - *Virality $\propto$ (Causal influence) / (computational cost)*
4. **Mutation Rate:** How much it varies during transmission (lossy compression)
    - *Low mutation: "$E=mc^2$" (specificity preserves meaning and utility – heavily computationally reduced)*
    - *High mutation: Rumours, myths (high variation as they spread)*

> ***Ruliad Context***
> *Ideas are morphisms in S-domain that can be copied from one Observer's S-domain to another. The morphism structure includes replication machinery—it encodes instructions for its own propagation.*

This creates a new domain for evolution that operates at the speed of thought.

Ideas compete for the limited computational resource of attention and memory (bounded by $\boldsymbol{B_O}$), driving rapid evolution of increasingly computationally efficient information patterns.

> ***Computational Analogy***
> *Ideas are like computer viruses (but they always have some non-zero computational benefit). They're self-replicating code that spreads from system to system. Good ideas are like useful apps that solve problems; bad ideas are like malware that crashes systems or wastes resources.*

Speed Comparison:

- **Genetic evolution:** Generations (~20 years for humans)
- **Memetic evolution:** Hours to days (internet virality)
- **Speed ratio:** ~10^6x faster (million-fold acceleration)

---

2. Downward Causation and the Evolution of Ideas

Ideas actively shape reality through formal (downward / macro) causation in a computational possibility space (Ruliad).

An idea shapes the accessible possibility space of the lower domains (i.e. you cannot construct a rocket physically without the theory of gravity). The Object (rocket) is not accessible or persistent to an Observer absent the idea (physics of a rocket). The idea constricts the possibility space of lower information density domains.

Whilst controversial in philosophy and physics, recent work by Erik Hoel has proven downward causal influence[242]. This is natural in the Ruliad. **All domains are embedded in one another, so causal influences flow in both directions.**

Mechanisms of Downward Causation

1. Physical Embodiment

Beliefs alter physical brain states, which alter gene expression and behaviour

$$\text{Brainstate[n+1]} = \text{Brainstate[n]} + \sum_i w_i \text{Belief}_i[n]$$

Where: w_i are synaptic weights connecting belief representation **i** to motor/endocrine systems.

Empirical Evidence: Placebo analgesia shows measurable opioid release in brain, observable via PET scans[243]. Belief (M/S-domain) causes physical change (P-domain).

---

2. Epigenetic Effects

Beliefs and behaviours affect gene expression without changing DNA sequence:

$$\text{Expression}(gene_j)\text{[n]} = Base_j \prod_i (1 + \epsilon_i \text{Belief}_i\text{[n]})$$

Where:
- $\text{Expression}(\text{gene}_j)$ = expression level of gene **j** (dimensionless fold-change)
- Base_j = baseline expression level (absence of belief influence)
- ϵ_i = epigenetic sensitivity coefficient for belief i (dimensionless, small)

Empirical Evidence: Chronic stress alters gene expression patterns related to inflammation and immune response (IL-6)[244]. Meditation downregulates stress-response genes and social isolation affects c.1,300 genes in the immune system[245].

> ***Plain-English Context***
> *Your beliefs can turn genes on or off. Stress activate certain genes. You're not changing your DNA, but you're changing which parts of your DNA get read and translated into proteins. This is why identical twins with identical DNA can have different health outcomes based on different life experiences.*

---

3. Social Organisation[246]

Shared ideas create collective behaviours and institutions:

$$P(\text{behaviour}_k) = \text{Individual}_k[n] \times \text{Social}_{\text{pressure}}[n] \times \text{Idea}_{\text{prevalence}}\text{[n]}$$

Where:
- $P(\text{behaviour}_k)$ = probability Observer exhibits behaviour k (dimensionless, 0-1)
- Individual_k = personal tendency toward behaviour k (baseline, 0-1)
- $\text{Social}_{\text{pressure}}$ = peer influence coefficient (0-10, can amplify beyond baseline)
- $\text{Idea}_{\text{prevalence}}$ = fraction of population holding the idea (0-1)

> ***Plain-English Context***
> *Your behaviour is a product of personal inclination (causal history), social pressure, and idea prevalence. Even if you personally dislike X, strong social pressure + widespread belief in X can drive you to do X.*
> *This is how ideas shape collective reality—they coordinate individual actions into large-scale patterns.*

Examples:
- Fiat Money: Pure idea that shapes global physical (P-domain) resource flows
- Laws: S-domain ideas that constrain P-domain actions
- Religions: S-domain command that alters the actions of millions of people across centuries

---

4. Reality Filtering

Worldviews determine what Observers ***can*** perceive (i.e. your baseline attention is theory-laden):

> ***Plain-English Context***
> *You can't see what you don't have concepts for. Before germ theory, people couldn't "see" bacteria even though they were there. The concept "germ causes disease" was required to perceive the causal relationship. This is why paradigm shifts are so powerful, they literally change what you can observe.*

$$\text{Observed}_{\text{reality}} \subset \text{Physical}_{\text{reality}} \cap \text{Conceptual}_{\text{framework}}$$

Empirical Evidence[247]: Cross-cultural perception studies show linguistic categories affect colour perception[248], spatial reasoning and time perception[249]. In aboriginal cultures they use absolute directions (north / south vs. left /right), it produces different spatial cognition.

> ***Ruliad Context***
>
> *Conceptual framework determines which morphisms in the Ruliad you can recognize. Without the concept "germ," the morphism (bacteria → disease) is invisible—it exists in $\boldsymbol{R_O}$ but not in $\boldsymbol{F_O}$. Language and culture are foliation filters, they help determine which patterns in the computational substrate become perceptible to Observers.*

---

3. Ideas Shape Reality, Reality Shapes Ideas

Formal (downward) causation creates recursive loops.

Ideas shape observations which reinforce ideas, which enable new technologies, which generate new observations, which suggest new ideas...

Example: Airplane Development

1. Idea: "Heavier-than-air flight is possible" (Wright brothers)
2. Physical: Build first prototype based on idea
3. Observation: Prototype flies (proof of concept)
4. Refinement: Idea improves → better designs → better observations → better ideas
5. Result: Modern aviation (idea enabled entire industry)

The more this process iterates, the more computational persistence the Object gains in the domains of possibility space it covers.

This helps explain:

- Why paradigms form *(computationally efficient ideas become entrenched)*
- Why paradigm shifts are difficult *(requires overwriting lots of computationally reduced rules)*
- Why "sticky" ideas persist for centuries *(they've been computationally optimised to a maximum informational entropy reduced state i.e. a math proof)*

> ***Plain-English Context***
>
> *Each iteration of the idea-reality feedback loop makes the idea more "real". It gets embodied in more physical structures (airplanes), more institutional frameworks (aviation regulations), more cognitive structures (pilot training), more economic structures (airline industry). Eventually, the idea becomes so embedded it's nearly impossible to remove. This is computational persistence of an Object brought about by Observer foliation.*

> ***Ruliad Context***
>
> *Ideas are morphisms in S-domain that create new morphisms in V and P-domains (valuational / physical possibilities). The idea is a "template" or "blueprint" that constrains which derivative states can be actualized. Without the template, those states remain computationally inaccessible*

---

4. The Evolution of Ideas

Ideas evolve through mechanisms analogous to, but distinct from, biological evolution

Selection Pressures on Ideas

Ideas compete for limited cognitive resources. Fitness is determined by multiple factors:

- **Explanatory Power** (predictive success—saves finite Observer computational boundedness)
  Example: Germ theory beat miasma theory because it predicts disease transmission patterns
  Ideas that compress regularities efficiently (i.e. more computationally reducible) are more useful
- **Emotional Resonance** (feeling of meaning—integrates information across domains)
  Example: Narratives (hero's journey) resonate because they mirror every Observer's lived experience
  Ideas that activate emotion are more memorable
- **Social Utility** (coordination benefits—helps more Observers persist)
  Example: "Don't murder" enables stable societies
  Ideas that solve coordination problems spread widely
- **Simplicity** (easy to understand/remember—low computational cost)
  Example: "An eye for an eye" is simpler than complex justice theories
  Simple ideas spread faster than complex ones but are subject to broader interpretations by Observer's based on their varying causal histories
- **Practical Utility** (technological applications—decreases boundedness)

Example: Scientific ideas that enable useful technology (electricity, antibiotics) persist
Ideas with repeatable tangible benefits gain adoption

5. Replication vs. Mutation Trade-off

High-fidelity transmission preserves ideas but limits adaptation.

We have posited a potential form of this relationship. Note, this is speculative and other forms may be more accurate.

Optimal mutation rates balance preservation with innovation:

$$\text{Mutation}_{\text{optimal}} = \frac{1}{\sqrt{K(\text{Idea})}}$$

Where:

- $\text{Mutation}_{\text{optimal}}$ is rate of change in the idea per transmission event (dimensionless, 0-1 range)
- K(Idea) is the complexity or informational cost of an idea (measured in bits)

> ***Plain-English Context***
> *Simple ideas can tolerate more variation (high mutation) without losing their core. Complex ideas need higher fidelity (low mutation) to preserve their intricate structure. "Be nice" can mutate freely; quantum field theory must be transmitted precisely.*

Examples:

- Low mutation: Mathematical proofs (must be exact)
- Medium mutation: Recipes (can vary but must work)
- High mutation: Jokes (variation is part of the appeal)

Horizontal Transfer:

Unlike genes, ideas can transfer between any minds—horizontal gene transfer on steroids:

$$\text{Idea}_{\text{new}}[n] = \bigcup_{i=1}^{n} (\text{Idea}_i \cap \text{Context}_{\text{current}})$$

Where:

- Idea_i = pre-existing idea at step i
- $\text{Context}_{\text{current}}$ = current environmental or cognitive context
- $\text{Idea}_{\text{new}}[n]$ = emergent idea synthesised up to to step n

> ***Plain-English Context***
> *New ideas form by combining elements from multiple existing ideas, filtered by current context. Darwin combined Malthus (population pressure) + Lyell (gradual change) + pigeon breeding (artificial selection) to create evolution by natural selection. This is horizontal transfer of ideas from different domains (economics, geology, agriculture) merging into a novel framework.*

Symbiosis and Parasitism:

Ideas can be:

- **Mutualistic**: Both idea and Observer benefit (useful skills, true scientific theories)
- **Commensal**: Idea benefits, Observer unaffected (harmless superstitions)
- **Parasitic**: Idea benefits at individual Observer expense (destructive ideologies)

The fitness landscape (information gradient toward TI) rewards different strategies in different domain contexts.

In stable environments, mutualism thrives. In unstable environments, parasitic ideas can exploit fear and uncertainty to spread rapidly.

---

6. Computational Costs of Ideas (Speculative)

Different types of Ideas have radically different computational burdens for Observers.

Simple Ideas (Viral Content, Catchphrases)

- Complexity: **O(1)** - constant cognitive load
  Example: "YOLO," "Keep calm and carry on," emoji meanings
- Transmission Speed: **O(n^2)** - quadratic spread through networks
  Each person tells multiple people; spreads exponentially
- Persistence: **O(1/n)** - rapid decay (fads, memes)
  Half-life measured in days or weeks

- Computational Cost: **~10^3 bits** (tiny memory footprint)

> ***Ruliad Context***
> *Simple ideas occupy large equivalence classes in the Ruliad i.e. many distinct states map to the same simple pattern.*
> *This is why they spread virally: easy to recognize, easy to reproduce, minimal barriers to adoption. But they also decay rapidly because they carry little information (low K means low persistence)*

Complicated Ideas (Technical Knowledge)

- Complexity: **O(n)** - linear in components
  Example: How to change a tire, cooking recipes, basic programming
- Transmission Speed: **O(n)** - linear (requires teaching)
- Persistence: **O(log n)** - logarithmic decay
  Half-life measured in months to years (forgotten without practice)
- Computational Cost: **~10^6** bits (moderate memory, requires practice to maintain)

> ***Ruliad Context***
> *Complicated ideas occupy medium-sized equivalence classes. They require structured teaching (deliberate morphism traversal through concept space) but can be mastered with effort.*
> *Persistence depends on practice—without regular reinforcement, the neural patterns degrade (synaptic pruning)*

Complex Ideas (Philosophical Systems)

- Complexity: **O(n log n)** - interconnected complex web of concepts
  Example: Kant's Critique of Pure Reason, General Relativity
- Transmission Speed: **O(√n)** - slow spread (requires study)
  Takes years to master; few achieve deep understanding
- Persistence: **O(1)** - constant (can last millennia)
  Once integrated, remarkably stable
- Computational Cost: ~10^9 bits (enormous memory footprint, years of study)

> ***Ruliad Context***
> *Complex ideas occupy small equivalence classes—they're highly specific patterns requiring precise foliation of the Ruliad. Mastery requires constructing elaborate internal models (high K), but once constructed, these models are extremely stable (high persistence).*
> *This is why philosophical and scientific paradigms persist for centuries—they represent deep computational investments that aren't easily overwritten.*

Chaotic Ideas (Revolutionary Paradigms)

- Complexity: **O(2^n)** - exponentially interconnected
  Example: Quantum mechanics, Relativity, Evolution, Copernican Revolution
- Transmission Speed: **O(log n)** - punctuated adoption
  Initially rejected, then sudden acceptance (paradigm shift)
- Persistence: Bifurcated and Binary
  Either die or transform the entire fitness landscape or succeed and restructure downstream domains
- Computational Cost: Initially astronomical; normalises as more Observers utilise it and develop pedagogical shortcuts

> ***Ruliad Context***
> *Chaotic ideas correspond to discovering new regions of the Ruliad that were previously inaccessible. They're like "alien foliations" that don't fit existing Observer frameworks.*
> *Initial rejection occurs because no one has the conceptual vocabulary to understand them (F_O doesn't overlap with the new region). Acceptance requires collective construction of new conceptual frameworks (expanding F_O to the larger accessible R_O). Once accepted, they permanently alter the accessible Ruliad region R_O for the entire civilization*

The trade-off between transmissibility and persistence creates niche spaces for different idea types.

Civilizations need the full spectrum:

- Simple ideas for rapid coordination ("Run!")
- Complicated ideas for practical skills (technology, crafts)
- Complex ideas for deep understanding (philosophy, science)
- Chaotic ideas for occasional revolutionary leaps (paradigm shifts)

The dynamic competitive equilibrium between idea types can explain, at the memetic level, why certain civilizations rise and others fall:

- Civilizations dominated by simple ideas: Rapid coordination but shallow understanding (vulnerable to paradigm shifts)
- Civilizations dominated by complex ideas: Deep wisdom but slow adaptation (vulnerable to environmental shocks)

- Optimal civilizations: Maintain diversity across all complexity classes and domains

> ***Plain-English Context***
> *A civilization's fitness is the product of its idea diversity across all complexity classes. Overspecialization in any direction creates fragility. The most robust civilizations maintain a balanced portfolio of simple slogans, complicated skills, complex philosophies, and occasional revolutionary paradigms. This is the memetic equivalent of biodiversity—diverse idea ecologies are more resilient than monocultures*

Part F: The Meaning Function

1. Formal Definition of Meaning in the God Conjecture

We can now provide a ***rigorous definition of meaning*** that unifies its subjective and objective aspects within the God Conjecture framework:

$$\boldsymbol{I(F_O)} \textbf{ for } \boldsymbol{x} \approx \int\int\int \boldsymbol{I_O(x,n) \cdot Rel_O(x,o,n) \cdot P_O(x,n)\, do\, dn\, dx}$$

Where:

- $\boldsymbol{I_O(x,n)}$ = Information content of Observation ***x*** at state **n** for Observer ***O***
- $\boldsymbol{Rel_O(x,o,n)}$ = Relevance to Observer ***O***'s telos (optimisation function) at state **n**
- $\boldsymbol{P_O(x,n)}$ = Persistence (probability weighting of how many computational updates it survives, i.e., temporal half-life)
- Integration to approximate this over all Observers ***O***, all time ***t***, and all possible observations ***x*** (across the entire accessible Topos $\boldsymbol{F_O}$ to the limit of $\boldsymbol{R_O}$)
  n.b. we use integration to avoid the computational burden of a discrete sum over a huge number of Observers.

> ***Plain-English Context***
> *Meaning is composed of three things:*
> *(1) How much information something contains (high information > low information)*
> *(2) How relevant it is to your goals and existence (relevant > irrelevant)*
> *(3) How long it lasts (enduring truths > ephemeral noise).*
> *We integrate across all Observers and all time to get total meaning.*

What This Formula Captures

This formula captures essential intuitions about meaning that appear across philosophical traditions:

1. Meaning requires integrateable information content (not noise)
   - Random static has high information entropy but zero meaning
   - Structure, pattern, and organisation are necessary
   - $I_O(x,t) = 0$ for pure noise → $I(F_O)$ *for* $x = 0$ (no meaning)

2. Meaning is Observer-relative (not absolute)
   - The same event has different meaning for different Observers
   - Relevance Rel_O is subjective—depends on Observer's personal view of telos
   - But meaning is not *arbitrary*—constrained by shared reality R_O

3. Meaning must persist (not ephemeral)
   - Fleeting phenomena have less meaning than enduring patterns
   - Persistence $P_O(x,t)$ weights meaning by temporal stability
   - Eternal truths have maximum meaning

> ***Computational Analogy***
> *Meaning is like a weighted average where you're summing over:*
> *(1) information bits in the message*
> *(2) how much you care about each bit*
> *(3) how long each bit remains relevant*
> *A message with high information, high personal relevance, and long-term importance has maximum meaning (information integration value).*

2. Meaning (Information) Gradients in the Ruliad

Here, we detail the dominant domain for certain types of integrated information (meaning). As the domains are embedded in one another (coherent Topos) the other domains all have a non-zero output from the above function.

Physics: Baseline P-Domain

- **Information:** Position, momentum, energy states
  Example: Electron has position, momentum
- **Relevance:** Low (except for Observer persistence, matter keeps you from falling through the floor) – *Physical substrate necessary but not sufficient for meaning*
- **Persistence:** Follows thermodynamic laws (decay, entropy increase)
  Conservation laws (energy, momentum) are eternal / Particular configurations decay rapidly

Examples: Rock formations, stellar dynamics, quantum states

> ***Ruliad Context***
> *Pure P-domain morphisms with minimal integration (i.e. morphisms between domains) into V, S, or M.*
> *High entropy, low organisation, minimal meaning density.*

> ***Plain-English Context***
> *Rocks just sit there. They have information (position, composition) but it's not organized toward any goal. Low meaning. The laws of physics themselves (gravity, electromagnetism) have high meaning because they're eternal and universal, but particular physical configurations (this rock, that cloud) have minimal meaning unless higher-domain meaning is imposed on them by an Observer narrative (this rock is where creation happened – see Dome of the Rock, Islam).*

Valuational (Biological / Emotional): P-Domain / V-Domain

- **Information:** Genetic codes, behavioural patterns, metabolic processes
  DNA contains ~3 billion base pairs / Neural patterns in simple organisms
- **Relevance:** High for Observer persistence (survival, reproduction)
  Directly tied to existence
- **Persistence:** Evolutionary timescales (millions of years for species, generations for lineages)
  Genetic information preserved across generations / Functional patterns persist if adaptive

Examples: Instincts (fear of predators), ecological relationships (predator-prey dynamics), developmental programs (embryogenesis)

> ***Ruliad Context***
> *V-domain morphisms that couple P (physical matter) to S (functional patterns). Life is organized physical matter—pattern imposed on substrate.*

> ***Plain-English Context***
> *Life has more meaning than inert matter because it's organized toward survival and reproduction. A DNA molecule contains instructions—it's information with purpose, not just random arrangement. Predator-prey relationships create stable dynamics that persist across evolutionary time.*

Psychological Level: V-Domain / S-Domain (Individuals)

- **Information:** Memories, concepts, emotions, self-model
  Episodic memories (events) / Semantic memories (facts, concepts) / Emotional associations
- **Relevance:** Core to telos (optimisation function identification)
  Defines individual Observer's values, goals, identity / Directly shapes behaviour and choices (relevance)
- **Persistence:** Lifetime + limited cultural transmission
  Strong memories last decades / Wisdom transmitted to descendants / Personal narratives define life meaning

Examples: Personal narratives ("Who am I?"), accumulated wisdom ("What have I learned?"), emotional truths ("What do I value?")

> ***Ruliad Context:***
> *V and S-domain structures in individual Observer. Internal models that map R_O and guide morphism traversal. High integration of P, V, S, M information.*

Plain-English Context

Your personal experiences, memories, and sense of self have enormous meaning to you because they define your entire experiential world. Your life story is a narrative arc that integrates millions of experiences into a coherent identity. This has vastly more meaning density than biological information.

Social Level: V-Domain / S-Domain (Collective)

- **Information:** Languages, institutions, cultural knowledge, shared symbols
  Language: 10^4-10^5 words / Legal systems: 10^6-10^7 statutes / Cultural knowledge: libraries, oral traditions
- **Relevance:** Enables coordination (decreases computational boundedness, increases persistence of groups of Observers)
  Shared 'maps' allow collective action / Institutions solve coordination problems for groups of Observers, reducing computational burden / Culture transmits compressed ideas computationally efficiently (passively)
- **Persistence:** Civilizational timescales (centuries to millennia)
  Languages persist for 1000+ years / Religions persist for 2000+ years / Legal principles persist across generations

Examples: Legal systems (justice as social coordination), religions (shared values and practices), scientific paradigms (collective knowledge frameworks)

Ruliad Context

Shared S-domain structures across multiple Observers—a "collective Observer"" Enables coordinated morphism traversal (parallelisation of computations) by aligning individual Observer goals.

Plain-English Context

Culture and social institutions have even higher meaning / integrated information potential because they organize entire societies (groups of Observers are given a best-guess of a computationally efficient rule-set).

Language is a shared symbolic system that lets millions of minds coordinate and compresses a lot of information.

Legal systems create stable expectations that enable complex cooperation. These patterns persist far longer than individual lives.

Spiritual Level: M-Domain Approaching TI / God

- **Information:** Universal principles, mathematical truths, archetypal patterns, mystical insights
  Mathematical theorems (eternal) / Universal symbols (appearing across cultures) / Deep metaphysical principles (being, consciousness, unity)
- **Relevance:** Maximum (driving telos—efficient path discovery, maximization of optimisation function, strongest attractor in possibility space)
  These are the "deepest" / most invariant / evolutionarily fit truths that are universal across all Observers and 'point' toward terminal object in computational possibility space
- **Persistence:** Eternal (timeless, necessary truths)
  2+2=4 in all possible worlds / Pythagorean theorem holds necessarily Archetypal patterns recur indefinitely

Examples: Euler's identity, Gödel's theorem, mystical insights (unity of consciousness, non-duality), universal principles (love, justice, beauty)

Ruliad Context

M-domain morphisms that approach the terminal object. These are high-level attractors in the Ruliad—patterns that remain invariant under maximal transformations. They have minimal computational contingency (necessary rather than contingent truths).

Plain-English Context

Spiritual/metaphysical/mathematical truths have maximum meaning / integrated information potential because they're eternal, universal, and maximally computationally efficient (shortest morphisms path in less rule-constrained domains, with more downward causal coverage).

They're not relative to any particular Observer or time—they hold necessarily to enable Observers to construct reality. This makes them the highest tier of meaning in the hierarchy. They're what mystics and mathematicians seek—the 'biggest' patterns sampleable in the Ruliad

---

The Upward Flow of Meaning

This information gradient suggests that when Observers create meaning (integrate information) it flows "uphill" through conscious (computational) effort.

Example Human Journey Through Domains

1. **Physical birth:** You start as matter (P-domain)
2. **Biological life:** Matter organizes into living system (V-domain)
3. **Psychological development:** Life develops consciousness and self-awareness (V / S-domain individual)
4. **Social participation:** Individual integrates into culture (S / M-domain collective)

5. **Spiritual realization:** Culture points toward eternal truths (M-domain → TI)

Plain-English Context

Life is a journey up the meaning gradient.

*You start as a bag of chemicals, develop into a conscious being, integrate into society, and—if you go far enough—touch eternal truths. Each level has more integrated information than the last. This is what religions describe as the **"return journey"** of humanity toward God.*

Ruliad Context

This is what a human Observer experiences. A morphism chain from the P-domain (birth) toward TI (terminal object). Each Observer traverses as far as their B_O (computational boundedness) and P_O (computational persistence / how many hypergraph updates they can maintain their boundary for) allows.

*The **telos** is travel up the information gradients as far as you can (maximising information integration).*

Part G: Synthesis and Conclusion

The God Conjecture has significant implications for understanding consciousness, evolution and culture.

Key Insights:

1. **The Ruliad has Information Gradients That Are Accessible to Observers**
   Reality exhibits a necessary gradient from infinite density (Ein Sof) to sparse physicality, creating optimal conditions for Observers like us to exist and explore it.
2. **Bounce-Back Mechanism**
   Observation (and Consciousness) operate as the universe's return mechanism, locally reversing the emanation process described in section 5, reducing informational entropy, through information integration that creates persistent structures.
3. **Evolution Optimises for Information Integration First**
   Life evolves increasingly efficient search strategies for exploring possibility space, from random walks to symbolic thought to (potentially) mystical direct knowing.
4. **Ideas as Causal Agents**
   Ideas actively shape reality in a computational possibility space through downward causation, opening new branches / choices for Observers.
5. **Meaning is (approximately) Computable**
   Meaning / Integrated Information can be formally defined as the integral of information, relevance, and persistence, bridging objective patterns and subjective experience
6. **Telos**
   The apparent direction of evolution suggests this optimisation function is embedded in all Observer's computational structure.

These implications extend beyond metaphysics into practical domains.

Understanding that observation as information integration (even at the quantum-level) has consequences for AI development, neuroscience, sociology, and even personal meaning-making.

The God Conjecture reframes fundamental questions:

- "Why am I here?" → To integrate information and create meaning
- "What should I do?" → Optimise information integration given your constraints
- "What is life's purpose?" → Serve as the universe's self-exploration mechanism

Here, consciousness and meaning are understood as fundamental features of a computational universe exploring itself through all possible perspectives.

The journey continues in **Section 8**, where we'll examine what this formalism implies for the study of ethics.

"We shall not cease from exploration, and the end of all our exploring will be to arrive where we started and know the place for the first time." ***T.S. Elliot***

"The laws of nature are but the mathematical thoughts of God." ***Euclid (attributed)***

References

[201] Bodhi, Bhikkhu (1984) The Noble Eightfold Path: The Way to the End of Suffering. Wheel Publication No. 308/311. Kandy, Sri Lanka: Buddhist Publication Society. [Revised edition 1994]
[202] Olivelle, P. (trans. and ed.) (1998) The Early Upanishads: Annotated Text and Translation. South Asia Research series. Oxford and New York: Oxford University Press. ISBN: 978-0-19512435-4
[203] Core Ruliad sources (abridged):
Wolfram, S. (2021) 'The Concept of the Ruliad', Stephen Wolfram Writings, 4 November. Available at: https://writings.stephenwolfram.com/2021/11/the-concept-of-the-ruliad/
Wolfram, S. (2020) 'Exploring Rulial Space: The Case of Turing Machines', Wolfram Physics Bulletins, 9 June. Available at: https://www.wolframphysics.org/bulletins/2020/06/exploring-rulial-space-the-case-of-turing-machines/
Rickles, D., Elshatlawy, H. and Arsiwalla, X.D. (2023) 'Ruliology: Linking Computation, Observers and Physical Law', arXiv preprint arXiv:2308.16068. Available at: https://arxiv.org/abs/2308.16068
Wolfram, S. (2021) 'What is consciousness? Some new perspectives from our physics project', Stephen Wolfram Writings, 23 March. Available at: https://writings.stephenwolfram.com/2021/03/what-is-consciousness-some-new-perspectives-from-our-physics-project/
Wolfram, S. (1985) 'Undecidability and intractability in theoretical physics', Physical Review Letters, 54(8), pp. 735-738. doi: 10.1103/PhysRevLett.54.735
Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media, pp. 737-750. ISBN: 978-1-57955-008-0
Israeli, N. and Goldenfeld, N. (2004) 'Computational irreducibility and the predictability of complex physical systems', Physical Review Letters, 92(7), 074105. doi: 10.1103/PhysRevLett.92.074105
Zenil, H. (ed.) (2013) Irreducibility and Computational Equivalence: 10 Years After Wolfram's A New Kind of Science. Emergence, Complexity and Computation, Vol. 2. Berlin: Springer. doi: 10.1007/978-3-642-35482-3
[204] Core Kabbalistic sources (abridged):
Kaplan, A. (1991) Inner Space: Introduction to Kabbalah, Meditation and Prophecy. 2nd edn. Edited by A. Sutton. Brooklyn, New York: Moznaim Publishing Corporation. ISBN: 978-0-940118-56-0
Kaplan, A. (1997) Sefer Yetzirah: The Book of Creation in Theory and Practice. Revised edition. York Beach, Maine: Red Wheel/Weiser. ISBN: 978-0-87728-855-8
Scholem, G. (1995) Major Trends in Jewish Mysticism. New York: Schocken Books
Dan, J. (2007) Kabbalah: A Very Short Introduction. Oxford: Oxford University Press
Matt, D.C. (trans. and commentary) (2003-2017) The Zohar: Pritzker Edition. 12 volumes. Stanford, California: Stanford University Press. [Vol. 1 ISBN: 978-0-8047-4747-9]
[205] Core Kolmogorov Complexity sources:
Kolmogorov, A.N. (1965) 'Three approaches to the quantitative definition of information', Problems of Information Transmission, 1(1), pp. 1-7
Li, M. and Vitányi, P.M.B. (2008) An Introduction to Kolmogorov Complexity and Its Applications. 3rd edn. New York: Springer. doi: 10.1007/978-0-387-49820-1
Solomonoff, R.J. (1964) 'A formal theory of inductive inference, Parts 1 and 2', Information and Control, 7(1), pp. 1-22 and 7(2), pp. 224-254
[206] Magree, M.C. (2024) The Interpretation of Kenosis from Origen to Cyril of Alexandria: Dimensions of Self-Emptying in the Reception of Philippians 2:7. Oxford: Oxford University Press. doi: 10.1093/oso/9780198896661.001.0001
[207] Nørretranders, T. (1998) The User Illusion: Cutting Consciousness Down to Size. New York: Viking Penguin. ISBN: 0-670-87579-1
[208] Core brain computational power sources:
Merkle, R.C. (1989) 'Energy limits to the computational power of the human brain', Available at: https://www.ralphmerkle.com/brainLimits.html
Raichle, M.E. and Gusnard, D.A. (2002) 'Appraising the brain's energy budget', Proceedings of the National Academy of Sciences, 99(16), pp. 10237-10239. doi: 10.1073/pnas.172399499
Attwell, D. and Laughlin, S.B. (2001) 'An energy budget for signaling in the grey matter of the brain', Journal of Cerebral Blood Flow & Metabolism, 21(10), pp. 1133-1145. doi: 10.1097/00004647-200110000-00001
[209] Hermes, D. et al. (2023) 'Developmental trajectory of transmission speed in the human brain', Nature Neuroscience, 26, pp. 537-545. doi: 10.1038/s41593-023-01272-0
[210] Core Chomsky hierarchy sources:
Chomsky, N. (1956) 'Three models for the description of language', IRE Transactions on Information Theory, IT-2(3), pp. 113-124. doi: 10.1109/TIT.1956.1056813
Chomsky, N. (1959) 'On certain formal properties of grammars', Information and Control, 2(2), pp. 137-167. doi: 10.1016/S0019-9958(59)90362-6
Chomsky, N. (1965) Aspects of the Theory of Syntax. Cambridge, MA: MIT Press. ISBN: 978-0-262-53007-1
[211] Jung, C.G. (2014 [1969]) The Archetypes and the Collective Unconscious. 2nd edition. The Collected Works of C.G. Jung, Vol. 9, Part 1. Princeton, New Jersey: Princeton University Press. ISBN: 978-0-691-09761-9
[212] Zimmermann, J.B. & Lahiri, S. (2022) Information flow in biological systems: limits and trade-offs. Annual Review of Biophysics, 51, pp. 291–314. Available at: https://doi.org/10.1146/annurev-biophys-111521-125807
[213] Thorpe, S., Fize, D. & Marlot, C. (1996) Speed of processing in the human visual system. Nature, 381(6582), pp. 520–522. Available at: https://doi.org/10.1038/381520a0
[214] Potter, M.C. (1976) Short-term conceptual memory for pictures. Journal of Experimental Psychology: Human Learning and Memory, 2(5), pp. 509–522
[215] Kutas, M. & Federmeier, K.D. (2011) Thirty years and counting: Finding meaning in the N400 component of the event-related brain potential (ERP). Annual Review of Psychology, 62, pp. 621–647. Available at: https://doi.org/10.1146/annurev.psych.093008.131123
[216] Green, D.M. & Swets, J.A. (1966) Signal Detection Theory and Psychophysics. New York: Wiley
[217] Core synaptic plasticity sources:

Bliss, T.V.P. and Lømo, T. (1973) 'Long-lasting potentiation of synaptic transmission in the dentate area of the anaesthetized rabbit following stimulation of the perforant path', The Journal of Physiology, 232(2), pp. 331-356. doi: 10.1113/jphysiol.1973.sp010273
Malenka, R.C. and Bear, M.F. (2004) 'LTP and LTD: An embarrassment of riches', Neuron, 44(1), pp. 5-21. doi: 10.1016/j.neuron.2004.09.012
Linden, D.J. (1994) 'Synaptic plasticity: LTP and LTD', Current Opinion in Neurobiology, 4(6), pp. 87-94. doi: 10.1016/0959-4388(94)90101-5
[218] Karni, A. & Sagi, D. (1993) The time course of learning a visual skill. Nature, 365(6443), pp. 250–252. Available at: https://doi.org/10.1038/365250a0
[219] Anderson, J.R. (1982) Acquisition of cognitive skill. Psychological Review, 89(4), pp. 369–406. Available at: https://doi.org/10.1037/0033-295X.89.4.369
[220] Kounios, J. & Beeman, M. (2014) The cognitive neuroscience of insight. Annual Review of Psychology, 65, pp. 71–93. Available at: https://doi.org/10.1146/annurev-psych-010213-115154
[221] Atick, J.J. & Redlich, A.N. (1992) What does the retina know about natural scenes? Neural Computation, 4(2), pp. 196–210. Available at: https://doi.org/10.1162/neco.1992.4.2.196
[222] Core FEP / Active Inference sources:
Friston, K. (2009) 'The free-energy principle: a rough guide to the brain?', Trends in Cognitive Sciences, 13(7), pp. 293-301. doi: 10.1016/j.tics.2009.04.005
Friston, K. (2010) 'The free-energy principle: a unified brain theory?', Nature Reviews Neuroscience, 11(2), pp. 127-138. doi: 10.1038/nrn2787
Friston, K., Kilner, J. and Harrison, L. (2006) 'A free energy principle for the brain', Journal of Physiology - Paris, 100(1-3), pp. 70-87. doi: 10.1016/j.jphysparis.2006.10.001
Friston, K. et al. (2023) 'The free energy principle made simpler but not too simple', Physics of Life Reviews, 45, pp. 140-159. doi: 10.1016/j.plrev.2023.08.008
[223] Core memetic sources:
Dawkins, R. (2006) The Selfish Gene. 30th anniversary edn. Oxford: Oxford University Press
Blackmore, S. (1999) The Meme Machine. With a foreword by Richard Dawkins. Oxford: Oxford University Press
Boyd, R. and Richerson, P.J. (1985) Culture and the Evolutionary Process. Chicago: University of Chicago Press
Cavalli-Sforza, L.L. and Feldman, M.W. (1981) Cultural Transmission and Evolution: A Quantitative Approach. Princeton, NJ: Princeton University Press
[224] Rapoport, A. & Horvitz, D.G. (1959) The transmission of information by speech. Quarterly Journal of Speech, 45(2), pp. 148–155. Available at: https://doi.org/10.1080/00335635909382502
[225] Core bacterial chemotaxis sources:
Wadhams, G.H. and Armitage, J.P. (2004) 'Making sense of it all: bacterial chemotaxis', Nature Reviews Molecular Cell Biology, 5(12), pp. 1024-1037. doi: 10.1038/nrm1524
Sourjik, V. and Wingreen, N.S. (2012) 'Responding to chemical gradients: bacterial chemotaxis', Current Opinion in Cell Biology, 24(2), pp. 262-268. doi: 10.1016/j.ceb.2011.11.008
Tindall, M.J., Maini, P.K., Porter, S.L. and Armitage, J.P. (2008) 'Overview of mathematical approaches used to model bacterial chemotaxis II: bacterial populations', Bulletin of Mathematical Biology, 70(6), pp. 1570-1607. doi: 10.1007/s11538-008-9322-5
[226] Christie, J.M. & Murphy, A.S. (2013) Shoots, roots, and tropisms: phototropism in higher plants. Current Biology, 23(17), pp. R829–R832. Available at: https://doi.org/10.1016/j.cub.2013.08.021
[227] Rumelhart, D.E., Hinton, G.E. & Williams, R.J. (1986) Learning representations by back-propagating errors. Nature, 323(6088), pp. 533–536. Available at: https://doi.org/10.1038/323533a0
[228] Hills, T.T., Jones, M.N. and Todd, P.M. (2012) 'Optimal foraging in semantic memory', Psychological Review, 119(2), pp. 431-440. doi: 10.1037/a0027373
[229] Raichlen, D.A. et al. (2014) 'Evidence of Lévy walk foraging patterns in human hunter-gatherers', Proceedings of the National Academy of Sciences USA, 111(2), pp. 728-733. doi: 10.1073/pnas.1318616111
[230] Core Grover Algorithm sources:
Grover, L.K. (1996) 'A fast quantum mechanical algorithm for database search', arXiv preprint quant-ph/9605043. Available at: https://arxiv.org/abs/quant-ph/9605043
Grover, L.K. (1996) 'A fast quantum mechanical algorithm for database search', in Proceedings of the 28th Annual ACM Symposium on Theory of Computing (STOC '96). Philadelphia, PA, 22-24 May. New York: ACM Press, pp. 212-219. doi: 10.1145/237814.237866
Grover, L.K. (1997) 'Quantum mechanics helps in searching for a needle in a haystack', Physical Review Letters, 79(2), pp. 325-328. doi: 10.1103/PhysRevLett.79.325
[231] Core quantum biology sources:
Ishizaki, A. and Fleming, G.R. (2009) 'Theoretical examination of quantum coherence in a photosynthetic system at physiological temperature', Proceedings of the National Academy of Sciences USA, 106(41), pp. 17255-17260. doi: 10.1073/pnas.0908989106
Engel, G.S. et al. (2007) 'Evidence for wavelike energy transfer through quantum coherence in photosynthetic systems', Nature, 446(7137), pp. 782-786. doi: 10.1038/nature05678
Panitchayangkoon, G. et al. (2010) 'Long-lived quantum coherence in photosynthetic complexes at physiological temperature', Proceedings of the National Academy of Sciences USA, 107(29), pp. 12766-12770. doi: 10.1073/pnas.1005484107
Duan, H.G. et al. (2017) 'Nature does not rely on long-lived electronic quantum coherence for photosynthetic energy transfer', Proceedings of the National Academy of Sciences USA, 114(32), pp. 8493-8498. doi: 10.1073/pnas.1702261114
[232] Core avian quantum sources:
Ritz, T. et al. (2004) 'Resonance effects indicate a radical-pair mechanism for avian magnetic compass', Nature, 429(6988), pp. 177-180. doi: 10.1038/nature02534
Hore, P.J. and Mouritsen, H. (2016) 'The radical-pair mechanism of magnetoreception', Annual Review of Biophysics, 45, pp. 299-344. doi: 10.1146/annurev-biophys-032116-094545
Kattnig, D.R., Evans, E.W. and Hore, P.J. (2016) 'The quantum needle of the avian magnetic compass', Proceedings of the National Academy of Sciences USA, 113(17), pp. 4634-4639. doi: 10.1073/pnas.1600341113
[233] Zhang, X., Liu, J. and Xu, Z. (2015) 'Tencent and Facebook data validate Metcalfe's Law', Journal of Computer Science and Technology, 30(2), pp. 246-251

[234] Linden, D.J. (1994) 'Synaptic plasticity: LTP and LTD', Current Opinion in Neurobiology, 4(6), pp. 87-94. doi: 10.1016/0959-4388(94)90101-5

[235] **Core myelination sources:**

McKenzie, I.A. et al. (2014) 'Motor skill learning requires active central myelination', Science, 346(6207), pp. 318-322. doi: 10.1126/science.1254960

Pan, S., Mayoral, S.R., Choi, H.S., Chan, J.R. and Kheirbek, M.A. (2020) 'Preservation of a remote fear memory requires new myelin formation', Nature Neuroscience, 23(4), pp. 487-499. doi: 10.1038/s41593-019-0582-1

Xin, W. and Chan, J.R. (2020) 'Myelin plasticity: sculpting circuits in learning and memory', Nature Reviews Neuroscience, 21(12), pp. 682-694. doi: 10.1038/s41583-020-00379-8

Hasan, M. et al. (2019) 'Schema-like learning and memory consolidation acting through myelination', The FASEB Journal, 33(11), pp. 11758-11775. doi: 10.1096/fj.201900910R

[236] Hermes, D. et al. (2023) 'Developmental trajectory of transmission speed in the human brain', Nature Neuroscience, 26, pp. 537-545. doi: 10.1038/s41593-023-01272-0

[237] **Core Moore's law sources:**

Moore, G.E. (1965) 'Cramming more components onto integrated circuits', Electronics, 38(8), April 19, pp. 114-117

Moore, G.E. (1975) 'Progress in digital integrated electronics', IEEE International Electron Devices Meeting Technical Digest, pp. 11-13

[238] Callen, H.B. (1985) Thermodynamics and an Introduction to Thermostatistics. 2nd edn. New York: John Wiley & Sons

[239] **Core Information Theory sources:**

Shannon, C.E. and Weaver, W. (1949) The Mathematical Theory of Communication. Urbana: University of Illinois Press. ISBN: 978-0-252-72548-7

Cover, T.M. and Thomas, J.A. (2006) Elements of Information Theory. 2nd edn. Hoboken, NJ: Wiley-Interscience. ISBN: 978-0-471-24195-9

[240] **Core Maxwell's Demon sources:**

Maxwell, J.C. (1872) Theory of Heat. 3rd edn. London: Longmans, Green, and Co. [Maxwell's demon, pp. 308-309]

Brillouin, L. (1951) 'Maxwell's Demon Cannot Operate: Information and Entropy. I', Journal of Applied Physics, 22(3), pp. 334-337

Leff, H.S. and Rex, A.F. (eds.) (2003) Maxwell's Demon 2: Entropy, Classical and Quantum Information, Computing. Bristol: Institute of Physics Publishing

[241] Landauer, R. (1961) 'Irreversibility and Heat Generation in the Computing Process', IBM Journal of Research and Development, 5(3), pp. 183-191. doi: 10.1147/rd.53.0183

[242] **Core causal emergence sources:**

Hoel, E.P., Albantakis, L. and Tononi, G. (2013) 'Quantifying causal emergence shows that macro can beat micro', Proceedings of the National Academy of Sciences USA, 110(49), pp. 19790-19795. doi: 10.1073/pnas.1314922110

Hoel, E.P. (2017) 'When the map is better than the territory', Entropy, 19(5), p. 188. doi: 10.3390/e19050188

Hoel, E.P. (2021) 'The overfitted brain: Dreams evolved to assist generalization', Patterns, 2(5), p. 100244. doi:10.1016/j.patter.2021.100244

[243] Atlas, L.Y. and Wager, T.D. (2020) 'A meta-analysis of brain mechanisms of placebo analgesia: consistent findings and unanswered questions', Handbook of Experimental Pharmacology, 225, pp. 37-69. doi: 10.1007/164_2019_280

[244] **Core stress response sources:**

Smith, A.K. et al. (2011) 'Differential immune system DNA methylation and cytokine regulation in post-traumatic stress disorder', American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, 156B(6), pp. 700-708. doi: 10.1002/ajmg.b.31212

Ryan, J. et al. (2017) 'Investigating the epigenetic profile of the inflammatory gene IL-6 in late-life depression', BMC Psychiatry, 17(1), p. 354. doi: 10.1186/s12888-017-1515-8

Zhang, Y. and Kutateladze, T.G. (2018) 'Epigenetic modifications in stress response genes associated with childhood trauma', Frontiers in Psychiatry, 9, p. 808. doi: 10.3389/fpsyt.2019.00808

[245] **Core meditation sources:**

Buric, I. et al. (2017) 'What is the molecular signature of mind-body interventions? A systematic review of gene expression changes induced by meditation and related practices', Frontiers in Immunology, 8, p. 670. doi: 10.3389/fimmu.2017.00670

Creswell, J.D. et al. (2016) 'Alterations in resting-state functional connectivity link mindfulness meditation with reduced interleukin-6: a randomized controlled trial', Biological Psychiatry, 80(1), pp. 53-61. doi: 10.1016/j.biopsych.2016.01.008

[246] Slavich, G.M. and Cole, S.W. (2013) 'The emerging field of human social genomics', Clinical Psychological Science, 1(3), pp. 331-348. doi: 10.1177/2167702613478594

[247] Whorf, B.L. (1956) Language, Thought, and Reality: Selected Writings of Benjamin Lee Whorf. Edited by J.B. Carroll. Cambridge, MA: MIT Press

[248] **Core linguistic relativity sources:**

Winawer, J., Witthoft, N., Frank, M.C., Wu, L., Wade, A.R. and Boroditsky, L. (2007) 'Russian blues reveal effects of language on color discrimination', Proceedings of the National Academy of Sciences, 104(19), pp. 7780-7785. doi: 10.1073/pnas.0701644104

Roberson, D., Davidoff, J., Davies, I.R.L. and Shapiro, L.R. (2005) 'Color categories: Evidence for the cultural relativity hypothesis', Cognitive Psychology, 50(4), pp. 378-411. doi: 10.1016/j.cogpsych.2004.10.001

[249] **Core spatial description sources:**

Levinson, S.C. (1997) 'Language and cognition: The cognitive consequences of spatial description in Guugu Yimithirr', Journal of Linguistic Anthropology, 7(1), pp. 98-131. doi: 10.1525/jlin.1997.7.1.98

Bowerman, M. and Choi, S. (2001) 'Shaping meanings for language: Universal and language-specific in the acquisition of spatial semantic categories', in Bowerman, M. and Levinson, S.C. (eds.) Language Acquisition and Conceptual Development. Cambridge: Cambridge University Press, pp. 475-511

Section 8 – Computational Ethics

TL;DR

This section analyses the connection between computation and morality. We demonstrate that ethics emerge necessarily from the fundamental structure of computational reality in the God Conjecture.

The core insight: *Every persistent observer—from atoms to humans to civilizations use an identical observation method:* ***SENSE → INTEGRATE → EVALUATE → SELECT → ACT → UPDATE → NETWORK → REPEAT***.

This eight-step cybernetic loop is the only pattern that can maintain coherent observation in a computational universe. Any system lacking even one step inevitably dissipates because of entropy.

From this function emerges ethics. *When Observers choose actions (morphisms through the Ruliad), they navigate a computational landscape where each path has measurable cost: computational steps required, entropy generated, distance from topological closure, and network effects on other Observers.*

Virtue *corresponds to choices that minimize this cost function, integrating maximum information with minimum entropy.* ***Sin*** *corresponds to choices that maximize entropy and computational debt.*

Remarkably, every persistent and large religion and philosophical tradition has independently discovered similar computational optima.

- *Buddhism's Eightfold Path minimizes observer entropy.*
- *Christianity's "love thy neighbour" maximizes observer coupling for collective information integration.*
- *Judaism's Noahide Laws form a minimal generating set for stable civilization.*
- *Islam's concept of Taqwa aligns individual will with cosmic optimisation.*
- *Hinduism's Dharma maintains cosmic computational order. Daoism's Wu Wei follows paths of least computational resistance.*

The convergence is a mathematical necessity. Just as eyes evolved independently dozens of times because light detection is informationally useful, ethical systems evolved convergently because they solve universal coordination problems in Observer networks.

We conclude with the Computational Ethics Conjecture

Ethical behaviour is mathematically optimal behaviour in the space of Observer trajectories through the Ruliad. Virtue isn't imposed by authority, it's discovered through the requirement that reality remain observable, coherent, and convergent toward truth. Every atom "choosing" quantum states, every cell following gradients, every human wrestling with conscience implements the same universal function, discovering the same computationally minimal paths to reconstruct the full topos.

Plain-English Context

This section argues that morality isn't a social invention, it's built into the mathematics of existence. Any Observer (you, me, a bacterium, a society) that wants to persist must follow the same basic algorithm: sense your environment, integrate information, evaluate options, choose actions, act, learn from results, share with others, repeat.

When we do this optimally (virtue), we thrive with minimal suffering. When we do it poorly (sin), we create "computational debt" that manifests as suffering—for ourselves and others. Every wisdom tradition discovered this same truth independently because it's fundamental to reality, like gravity or thermodynamics.

Note on Units

For this and all sections we are using ***Bits*** *as the main unit for output*.

Part A: The Observer Function[250,251,252,253,254]

Every Observer in the universe, from particles to human civilizations, implements an identical function to Observe the Ruliad.

1. The Eight-Step Cybernetic Loop

The Observer (detailed in Arsiwalla's work) operates as a **second-order cybernetic system**, a system that not only observes its environment but also observes and adjusts its own observational process.

> ***Ruliad Context***
>
> ***Minimal Observer's Meta-Model (Arsiwalla et al)***
>
> *For any observer O at time t, the complete cycle of Observation is:*
>
> - *Sensing Mechanism (Perception)*
> - *Processing Unit (Interpretation)*
> - *Response Mechanism (Action)*
> - *Feedback Loop (Adaptation)*
> - *Internal Model or Representation (Prediction)*
> - *Boundary Definition (Self vs. Environment)*
> - *Self-Monitoring (Self-Observation)*
>
> ***A Minimal Observer is a system O, described by a tuple (an ordered list of mathematical objects)***
>
> $$O = (X, Y, Z, f, g, B)$$
>
> *Where:*
>
> *X: Internal state space (finite or countably infinite).*
>
> *Y : Input (sensor) space.*
>
> *Z: Output (action) space.*
>
> *$f : X \times Y \to X$: State transition function.*
>
> *$g : X \to Z$: Output function.*
>
> *B: A boundary condition demarcating "inside" (the observer's internal states) vs. "outside" (the environment).*
>
> *Then Observer, O is minimal if:*
>
> *$Y \geq 1$ (non-trivial sensing)*
>
> *$Z \geq 1$ (non-trivial action)*
>
> *$X > 1$ (non-trivial internal dynamics)*

Expanding each step:

1. Sensing Mechanism (Perception): Sample Available Information in Input space (Y) subject to Internal state (X).

- *Input:* Environmental state $E(n) \subset R_O$ (accessible Ruliad subset at state n)
- *Process:* Sensor function $\sigma: E(n) \to Sense_O$ maps environment to internal sensory representation
  - σ is a covariant functor from category E (environmental states and transitions) to category S (sensory states and updates)
  - Preserves composition: $\sigma(g \circ f) = \sigma(g) \circ \sigma(f)$ for environmental transitions f, g
  - Preserves identities: $\sigma(id_E) = id_{\{\sigma(E)\}}$
- *Output:* Sensory data $Sense_O(n) = \{sense_1, sense_2, \ldots, sense_n\}$ where $n \leq B_O$ (measured in bits or operations)
- *Constraint:* Limited by computational boundedness B_O (finite sensor resolution, bandwidth)
  - Sensor resolution: $\delta_{sensor} = \Delta E_{min}$ (minimum distinguishable energy/information difference)
  - Bandwidth: $B_{bandwidth} \leq (k_B T \ln 2)/\tau_{sample}$ (bits per second, from Landauer's principle)
  - Units: B_O [bits], τ_{sample} [number of hypergraph updates or seconds], T [Kelvin]

The observer takes a "snapshot" of its accessible reality. Like a camera with finite megapixels, it can only capture limited information about an infinitely detailed universe.

> ***Ruliad Context***
>
> *The Observer takes a "snapshot" of its accessible reality. Like a camera with finite megapixels, it can only capture limited information about an infinitely detailed universe. The sensor functor **σ** mathematically formalises this sampling process as a structure-preserving map that compresses the full environmental state E(n) into the observer's internal sensory representation $S_O(n)$. The arrow $\sigma: E(n) \to S_O$ means "the sensor maps environmental states to sensory states."*

2a. Processing Unit (Information Integration): Combine Information Across Domains in X subject to Y

- *Input:* Sensory data $sense_O(n) \oplus$ memory $Memory_O(n-1)$
  - Direct sum ⊕ of current sensory input and previous memory state

- *Process:* Integration functor ι: $Sense_O \times M_O \to I_O$ computes integrated information across domains
    - Sense = category of sensory states, M = category of memory states
    - I = category of integrated information states with objects representing unified models
    - $\iota(s, m)$ = integrated state combining sensory input with memory
    - Natural transformation $\eta: \iota \circ (\sigma \times id_M) \Rightarrow \iota'$ ensures coherence across update steps
- *Output:* Integrated state $I_O(n)$ representing unified model of reality
    - $\Phi(I_O(n))$ = integrated information measure (bits)
    - Based on IIT 4.0 formalism: $\Phi = \varphi$ *(core Integration Scaling of cause-effect structures)*
- *Domains:* Physical (P), Valuational (V), Symbolic (S), Minimally-constrained (M) simultaneously processed
    - $I_O(n) = \bigoplus_{\{d\in\{P,V,S,M\}\}} I_O^{d(n)}$ where $\bigoplus$ denotes categorical coproduct
    - Each domain d has functor $F_d: R \to R_O^d$ restricting observation to domain d

> ***Plain-English Context***
> *The Observer weaves different types of information together into a coherent model. Physical sensations, emotional values, symbolic meanings, and abstract patterns all get integrated simultaneously. This is like how your brain combines sight, sound, memory, and emotion into unified conscious experience. The integration functor ι formalises this combining process. Φ measures how much information is truly integrated (not just passively accumulated)—higher Φ means more unified, high-complexity Observation akin to conscious-like processing.*

> ***Ruliad Context:***
> *Information Integration corresponds to a functor that computes irreducible information across domain boundaries—information that cannot be factored into separate P, V, S, M components. This is the formal definition of integrated information Φ in this framework.*

2b. Processing Unit (Evaluation): Compute Output from Available Morphisms in X

- *Input:* Integrated Information state $I_{O(n)} \in \mathrm{Ob}(I)$
- *Process:* Prediction functor $\mathrm{Prediction}: I \to \mathrm{Mor}$
    - Maps integrated state to category **Mor** of morphisms *(computational paths through Ruliad)*
    - $\mathrm{Pred}(I_{O(n)}) = \{\gamma_1, \gamma_2, \ldots, \gamma_k\}$ where each γ_i: $s_{current} \to s_{future}$ is a morphism in R_O
    - Each γ_i represents a computational path through the accessible Ruliad
- *Output:* Set of candidate morphisms $\mathrm{Mor}\ O(n) = \{\gamma_i\}$ (*with predicted outcomes)*
    - For each γ_i, compute predicted outcome $\mathrm{Outcome}_{prediction(\gamma i)}$ using forward model (internal)
- *Evaluation:* Each $\boldsymbol{\gamma_i}$ ranked by predicted cost $\mathrm{Cost}\ (\gamma_i) = \Sigma_{steps}[\mathrm{comp}_{steps}(\gamma_i)] + \lambda H(\gamma_i) + \mu D(\gamma_i, TI) + \nu N(\gamma_i)$

  Where:
    - $\mathrm{comp}_{steps}(\gamma_i) = \Sigma_{\{j=1\}}^{\{n\}} t_j$ where t_j is computational time for step j
        - Units: elementary operations or seconds
        - For digital: counts of bit flips, graph rewrites
        - For biological systems: ATP consumption, neural spikes
    - $H(\gamma_i)$ = entropy generated along path γ_i
        - Thermodynamic entropy: $\Delta H_{thermo} = Q/T$ (units: J/K or bits)
        - Information entropy: $\Delta H_{info} = -\Sigma\, p_j \ln p_j$ (units: bits)
        - Landauer bound: $\Delta H_{thermo} \geq (kB\ T \ln 2) \times N_{erase}$ (N_{erase} = bits erased)
        - $kB = 1.381 \times 10^{-23}$ J/K (Boltzmann constant)
    - $D(\gamma_i, TI)$ = distance from path endpoint to Terminal Infinity
        - Metric: $d_{RO}(\mathrm{Endpoint}(\gamma_i), TI)$ in observer's accessible Ruliad
        - Graph-theoretic distance: minimum number of computational steps to convergence
        - Units: elementary operations or dimensionless
    - $N(\gamma_i)$ = network effects on other observers
        - Positive: cooperation gains $I(O_i{:}O_j) > 0$ (mutual information, bits)
        - Negative: conflict costs Hconflict $\propto$ computational overhead
        - Units: bits or energy units
    - λ, μ, ν = observer-specific weighting factors (dimensionless)
        - $\lambda \propto 1/P_O$ (inverse persistence—prioritise immediate vs. long-term)

- $\mu \propto 1/B_O$ (inverse boundedness i.e. prioritise convergence given limitations)
- $\nu \propto |\text{Network}|$ (network size i.e. weight social effects)

Plain-English Context
The Observer imagines possible actions and their likely consequences. Like a chess player considering moves, computing "if I do X, then Y will probably happen."

Ruliad Context
The Observer generates possible futures ("what if I do X?") and evaluates each option's computational cost.
This cost includes: (1) raw mental/physical effort, (2) entropy/waste generated (via thermodynamics—Landauer's principle says erasing information always costs energy), (3) how far the path takes you from optimal convergence (TI represents the mathematical limit of all computation), and (4) effects on other Observers (cooperation vs. conflict). The weights λ, μ, ν adjust priorities based on the Observer's nature—bacteria prioritise immediate survival (high λ), while civilizations can consider long-term convergence (high μ).

Computational Analogy
Like a path-finding algorithm evaluating routes through a graph, scoring each by heuristic cost function (e.g. distance + traffic + tolls).

2c. Processing Unit (Selection): Choose Morphism That Maximize Information Integration in X

- *Input:* Evaluated morphisms $\text{Mor } O(n)$ with computational cost scores $\{\text{Cost}(\gamma_1), \text{Cost}(\gamma_2), \ldots, \text{Cost}(\gamma_n)\}$
- *Process:* Selection function $\text{Choose}: \text{Mor}_O \to \gamma^*$ *(Observer chooses minimal-cost path)*
  - Choose implements optimisation: $\gamma^* = \text{argmin}_{\{\gamma \in \text{Mor}O(n)\}} \text{Cost}(\gamma)$
  - Subject to constraints: γ must satisfy observer's value function V_O
  - V_O: Mor → R encodes observer-specific priorities (survival, reproduction, learning, etc.)
  - Constraint satisfaction: $\gamma^* \in \{\gamma : V_O(\gamma) \geq V_{\text{threshold}}\}$
- *Output:* Selected action $\gamma^*(n) = \text{argmin}_\gamma \text{Cost}(\gamma)$
  - γ* is (approximately) the terminal object
  - Terminal property: for any other viable γ, $\exists!$ morphism $\gamma \to \gamma^*$ (all paths converge to optima)
- *Constraint:* Subject to observer's specific value function V_O encoding priorities *(boundedness, persistence, relevance weightings)*
  - Bounded rationality: true global optimum may be computationally irreducible
  - Observer computes local/approximate optimum subject to B_O, P_O constraints

Plain-English Context
The Observer chooses the path with minimum predicted cost that satisfies its values/priorities. This is optimisation under constraints, like choosing the best route to work given traffic, time, and preference for scenic roads. The "terminal object" property means the chosen path γ is unique (up to equivalence). It's akin to a natural convergence point of the optimisation process. However, perfect optimisation may be impossible (computationally irreducible), so real Observers compute good-enough approximations.

Ruliad Context
Selection implements a foliation of the multiway system, collapsing the branching computations (different futures) into a single realized path. This is analogous to wavefunction collapse in quantum mechanics. Observer choice determines which branch becomes "actual" in $\boldsymbol{R_O}$*.*

Computational Complexity Note
The optimisation problem Choose: argmin Cost(γ) over a discrete action space is generally NP-hard:
- *For $|\text{Mor}_{O(n)}| = n$ actions, exact optimisation requires O(n) evaluations (linear)*
- *However, computing $\text{Cost}(\gamma_i)$ for each γ_i may itself be exponential in path length*
- *For paths of length ℓ with branching factor b: total states = $O(b^\ell)$*
- *Dynamic programming reduces to $O(n^2 \cdot 2^n)$ for TSP-like problems (Held-Karp algorithm)*
- *Approximation algorithms achieve (1+ε)-approximation in polynomial time for some problem classes*

Real observers use heuristics, learned policies, or local search to approximate optimal selection in tractable time.

---

3. Response Mechanism (Action): Execute Selected Morphism (g : X → Z, the Output function).

- *Input:* Selected action $\gamma^*(n)$ to move from a current state to a target state in R_O / F_O
- *Process:* Actuation functor $\alpha: \text{Mor} \to \Delta E$ *(applies transformation to environment)*

- *Output:* Environmental change $\Delta E(n) = E_{(n+1)} - E_{(n)}$
- *Feedback:* Action alters accessible Ruliad $\mathbf{R_O}$, affecting subsequent inputs

> ***Plain-English Context***
> *The Observer actually does the thing it chose. This is where thought becomes action; neurons fire, muscles contract, words are spoken, decisions executed. The action functor α formalises how internal decisions (morphisms in the mind's model) become external changes (morphisms in the environment). Importantly, action costs energy and generates entropy (must obey 2nd law thermodynamics).*
> *Actions also change what becomes observable next like opening a door reveals a new room or asking a question elicits new information.*

> ***Ruliad Context***
> *Corresponds to the Observer injecting a rule constraint into the Ruliad's evolution. While the underlying hypergraph update rules are deterministic, the Observer's choice of* $\boldsymbol{\gamma}$ *determines which update rules are "activated" in its local neighbourhood of* $\boldsymbol{R_O}$.

4a. Feedback Loop (Adaption): Modify Internal Model, X, Based on Outcome Z

- *Input:* Predicted outcome $\mathbf{Prediction(\gamma^*)}$ vs. actual outcome $\mathbf{Outcome(\gamma^*)}$
- *Process:* Learning functor $\mathbf{Learn: (Prediction\ X\ Outcome) \rightarrow \Delta Mor_O}$ *(updates internal model, X)*
- *Output:* Modified model in **X *(the Observers internal state space)***: $\mathbf{Mor_{O(t+1)} = Mor_{O(t)} \oplus \Delta Mor_O}$
    - Learning compresses model: efficient representations should have lower Kolmogorov complexity
- *Metric:* Prediction error $\mathbf{ErrorRate = |Prediction(\gamma^*) - Outcome(\gamma^*)|}$ *(drives Observer learning rate)*
    - High error → more learning (large ΔMor_O adjustments)
    - Low error → less learning (small refinements)
    - Free Energy Principle: Error Rate = $D_{KL}(Q(s)||P(s|o))$ (Friston, 2010)

> ***Plain-English Context***
> *The Observer learns from experience by comparing what it expected to happen versus what actually happened. Prediction error drives learning rate. If your model is wrong, update it!*
> *The learning functor formalises this as a map that takes (prediction, actual outcome) pairs and produces model updates. Kolmogorov complexity measures how much your model compresses reality: better models have lower complexity (shorter descriptions). The Free Energy Principle (Friston) interprets this as minimizing surprise/prediction error, which approximates (may even be mathematically equivalent) maximizing model evidence.*

> ***Ruliad Context***
> *Refines the observer's sampling functor* $\boldsymbol{S_O}$ *by adjusting which morphisms are computationally accessible (expanding if* B_O *grows) and which are relevant (adjusting* $\boldsymbol{R_O}$ *based on outcome utility). This is entropy reduction—the observer's model becomes more predictive, requiring fewer bits to encode expected futures.*

> ***Algorithmic Information Theory Connection***
> *The observer's internal model* Mor_O *can be analysed via Kolmogorov complexity:*
> - *$K(Mor_O)$ = length of shortest program generating Mor_O's structure (bits)*
> - *Learning reduces expected future prediction error by model compression*
> - *Optimal learning: minimize K(model) + K(data|model) i.e. minimum description length principle)*
> - *Solomonoff induction: $P(model) \propto 2^{\{-K(model)\}}$ i.e. shorter programs are more probable*
>
> *For computable probability distribution P_{true} over environmental outcomes:*
> $$\Sigma_{outcome}\ P_{true}(outcome) \cdot K(outcome) \approx H(P_{true}) + K(P_{true}) + O(1)$$
> *Where:*
> - *$H(P_{true})$ = Shannon entropy of true distribution*
> - *$K(P_{true})$ = complexity of generating P_{true}.*
>
> *This establishes **informational entropy as weakly equivalent to expected Kolmogorov complexity** (the modulo description of distribution itself).*

4b. Feedback Loop (Networking): Share Patterns with Other Observers

- *Input:* Learned patterns $\mathbf{\Delta Mor_{O(n)}} \in \mathrm{Mor(I)}$
- *Process:* Communication functor Network: $\mathbf{Mor_O \rightarrow \otimes\ \{i\}\ Mor\{O_i\}}$ *(transmits information to other Observers)*

- *Output:* Modified internal states X, of neighbouring observers $\{Mor\{O_1\}', Mor\{O_2\}', \ldots\}$
- *Amplification:* Useful patterns propagate, multiplying effect across network

> ***Plain-English Context***
> *Observers share what they've learned with other observers. This is communication (whether chemical signalling between cells, teaching between humans, or cultural transmission across generations). The **Network functor** formalises information transmission as a map from one Observer's knowledge to updates in multiple other Observers.*
> *Crucially, communication costs energy (Landauer bound again!) and has limited bandwidth (Shannon's channel capacity). Useful patterns spread virally across the network, while useless ones die out (this is cultural/memetic evolution), driven by the same computational principles as biological evolution.*

> ***Ruliad Context***
> *Establishes morphisms between separate Observers. These enable mutual information. This is the formal basis of cooperation, culture, and collective intelligence. This network of Observers acts as a distributed computation across multiple **R{O$_i$}***

---

5. Repeat: Return to "1. Sensing Mechanism"

- *Cycle:* $\Omega_{O(n+1)}$ begins with updated state
- *Convergence:* After **n** iterations, relative distance (from start point) to **TI** decreases: $\text{distance}(O_{n+1}, \text{TI}) < \text{distance}(O_n, \text{TI})$
- *Attractor:* All paths eventually converge: $\lim_{n\to\infty} \text{distance}(O_n, \text{TI}) = \varepsilon$ *(heat death or maximal Ruliad coverage)*

> ***Plain-English Context***
> *The Observer keeps cycling through these 8 steps continuously. Over time, this process gradually converges toward optimal understanding and action (TI represents the mathematical limit). However, perfect convergence is impossible due to thermodynamics—the 2nd law ensures residual uncertainty (ε > 0). The convergence is like a spiral, not a straight line. Even the universe as a whole will approach maximum entropy (heat death), setting an ultimate limit on Observer information integration.*

> ***Ruliad Context***
> ***REPEAT** ensures the Observer remains dynamically coupled to **R$_O$** evolution. As the hypergraph updates, the Observer re-samples. The convergence condition **distance(O,TI) → 0** reflects the demand for topological closure—all paths through the Ruliad eventually terminate at the terminal object.*

---

2. Necessity Theorem: Why This Function Is Universal

Any persistent observer in a computational universe must implement all the steps.

Theorem: Universality of Observer Function:

*Let **O** be an observer persisting in the Ruliad **R** for time interval **Δn > 0**. Then **O** implements **Ω$_O$** = **{SENSE, INTEGRATE, EVALUATE, SELECT, ACT, UPDATE, NETWORK, REPEAT}** with probability approaching 1 as **Δn → ∞***

Proof Sketch by Contradiction:

Suppose Observer **O** omits one or more steps. We show this leads to elimination of the Observer.

Case 1: No Sensing Mechanism (Perception)

- O cannot respond to environmental changes
- Entropy increases: H_O grows without bound as environment shifts
- O loses boundary with R → dissipates into thermal noise
- **Contradiction: O cannot persist without sensing**

An observer that doesn't sense its environment is like a thermostat with a broken thermometer—it can't regulate temperature because it doesn't know what the temperature is. It fails its basic function and gets outcompeted.

Case 2: No Processing Unit (Information Integration)

- O receives sensory inputs but cannot combine them
- Result: Fragmented, incoherent model → random walk behaviour
- Cannot form stable patterns → dissipates via entropy maximization
- **Contradiction: O cannot maintain identity without integration**

Imagine trying to survive if you couldn't combine your senses. You'd behave randomly, unable to coordinate actions, quickly dying to dangers you couldn't integrate information about.

Case 3: No Processing Unit (Evaluation)

- O integrates information but cannot assess action quality
- All morphisms equally likely → equiprobable selection → suboptimal paths

- Systematic underperformance → outcompeted by Observers with evaluation
- **Contradiction: O cannot optimise without evaluation**

A chess player who doesn't evaluate move quality plays randomly. Against an evaluating opponent, they lose every game. Eventually, they're eliminated from the tournament.

Case 4: No Response Mechanism (Choice)

- O evaluates options but never chooses action
- Result: Static state → entropy degradation
- O becomes irrelevant—pure epiphenomenal observer with no causal efficacy
- **Contradiction: O cannot affect R_O without selection**

"Paralysis by analysis"—someone who endlessly weighs options but never acts. While they deliberate, the world changes around them, opportunities vanish.

Case 5: No Response Mechanism (Action)

- O selects actions but cannot execute them
- No coupling to environment → O cannot reduce entropy in R_O
- Becomes epiphenomenal (Zombie) → eventually dissipates
- **Contradiction: O cannot persist without affecting environment**

A brain in a vat that can think but not move. It might maintain internal coherence temporarily, but without ability to gather resources (food, energy), it inevitably decays. Observation requires action.

Case 6: No Feedback Loop (Adaption)

- O acts but never learns from outcomes
- Repeats same errors indefinitely → accumulates computational debt
- Prediction error remains high → systematic failures → elimination
- **Contradiction: O cannot improve without updating**

Like someone who never learns from their mistakes. Touches hot stove, gets burned, touches it again tomorrow. In nature, organisms that can't learn die young—eaten by predators they failed to recognize, poisoned by foods they didn't remember are toxic.

Case 7: No Feedback Loop (Networking with other Observers)

- O operates in complete isolation from other observers
- Cannot access collective knowledge → limited to individual discovery
- Loses to cooperating observer networks → outcompeted for resources
- **Contradiction: O cannot scale without networking**

A lone human in the wilderness vs. a village. The loner must rediscover fire, agriculture, medicine independently. The village shares knowledge, specializes labour, defends collectively. The loner doesn't survive winter.

Case 8: No Repetition

- O executes one cycle, then stops
- Environment continues evolving → **O** becomes increasingly misaligned with optimal path through R_O
- Entropy grows → ∞
- Contradiction: O cannot persist without continuous cycling of the Observer Function

An organism that eats once and never again. It burns energy maintaining itself, but without repeated feeding, it starves. Computational persistence requires continuous observation through hypergraph updates.

Conclusion: Since omitting any step leads to elimination, all persistent observers must implement all eight steps.

---

3. Scale Invariance: From Cellular Biology to Civilizations

The Observer Function operates identically across all scales. Only the parameters change. Below we detail two examples.

Example 1: Cellular Biology

Consider an E. coli bacterium[255]:

- SENSE: Chemoreceptors detect glucose gradient
- INTEGRATE: Signal transduction pathway (CheA/CheY proteins) integrates information about the concentration over time
- EVALUATE: Tumble frequency (indicative of its move toward food)
- SELECT: Motor protein chooses flagellar rotation (CCW = swim, CW = tumble)
- ACT: Flagella rotate, bacterium moves c.10 μm per second

- UPDATE: Methylation of receptors adjusts sensitivity (adaptation)
- NETWORK: Quorum sensing via autoinducer molecules coordinates colony behaviour
- REPEAT: Cycle time ~1 second per evaluation

> ***Plain-English Context***
> *A bacterium "smells" food, "decides" whether to swim straight or tumble randomly, "learns" by adjusting receptor sensitivity, and "talks" to other bacteria using chemical signals*

Observer Parameters:

- Computational Boundedness: $B_O \approx 10^4$ bits (bacterial genome)
- Computational Persistence: $P_O \approx 1$ hour (division time)
- Relevance (Choice) Rel_O = {chemical gradients, pH, temperature}

Example 2: Civilizational Evolution

Consider ancient Mesopotamian civilization:

- SENSE: Agriculture monitors floods, astronomy tracks seasons
- INTEGRATE: Scribes record observations → written language emerges → collective memory
- EVALUATE: Priests/kings model: "Plant in spring, harvest in fall, store grain for winter"
- SELECT: Allocate labour: farming vs. defence vs. construction vs. trade
- ACT: Build irrigation systems, granaries, walls, temples
- UPDATE: Failed harvests → adjust planting schedule; invasions → build stronger walls
- NETWORK: Trade routes share innovations (wheel, writing, mathematics) across civilizations
- REPEAT: Generational cycle ~25 years; civilizational cycle ~500 years

> ***Plain-English Context***
> *Civilizations are larger objects with bigger boundaries. In this example Mesopotamia "sense" through scouts and merchants, "remember" through writing, "decide" through governance, "act" through coordinated labour, "learn" from successes/failures, "share" through trade, and "repeat" across generations. Same function as Example 1, civilization-scale parameters.*

Observer Parameters

- $B_O \approx 10^{18}$ bits (collective knowledge)
- $P_O \approx 500$ years (civilization duration)
- $Rel_O \approx$ civilisational goals, composed of geographic, economic, political, ideological domains

---

The Remarkable Fact

Despite parameter differences spanning >14 orders of magnitude the function remains identical. This is homology. The same computational structure instantiated at radically different Observational scales.

> ***Ruliad Context***
> *Scale invariance reflects the self-similar structure of the Ruliad. Each Observer samples a local neighbourhood, but the categorical structure (objects = states, morphisms = transitions, composition = causality) is preserved across scales.*
> *This is why physics equations remain form-invariant under scale transformations (renormalization group flow)*

Proof Sketch:

The eight-step structure is defined functorially. Morphisms scale with Observer capacity but the categorical structure persists. Each step remains a functor between appropriate categories; only the objects/morphisms within those categories scale. The composition law Ω_O = REPEAT ∘ NETWORK ∘ UPDATE ∘ ACT ∘ SELECT ∘ EVALUATE ∘ INTEGRATE ∘ SENSE is invariant because functor composition is associative independent of scale.

---

4. Ruliad Formalism Connection

We now make explicit how the Observer Function maps onto the categorical structure of the Ruliad developed by Wolfram, Arsiwalla and Gorard.

The Observer Sampling Functor S_O:

Recall from Observer Theory, that the Observer's accessible Ruliad is defined by the sampling functor:

$$\mathbf{S_O: R \to R_O}$$

where:

- **R** is the complete Ruliad (category of all computational states and transitions)
- $\mathbf{R_O}$ **= Limit(**$\mathbf{S_O}$**)** is the observer's accessible subset
- $\mathbf{S_O}$ is constrained by Observer's boundedness $\mathbf{B_O}$, persistence $\mathbf{P_O}$, and their view of relevance, $\mathbf{Rel_O}$

The Observer Function Ω_O IS the implementation of S_O through time (hypergraph updates).

Formal Correspondence:

Observer Function Step	Ruliad Categorical Structure	Functor Component
SENSE	Input: $R \to S_O(R)$	Domain restriction
INTEGRATE	Composition: $S_O \circ \pi$ (projection functor)	Limits/colimits in Cat(R_O)
EVALUATE	Morphism set: Hom(s_i, s_j)	Available transitions
SELECT	Natural transformation: $\eta: F \to G$	Choice of commuting diagram
ACT	Morphism execution: $f: s_i \to s_j$	Realized transition
UPDATE	Functor modification: $S_O \to S_{O'}$	Learning = functor refinement
NETWORK	Coupling: $S_{\{Oi\}} \times S\{O_j\} \to S\{O_{ij}\}$	Product/coproduct construction
REPEAT	Composition: $S_O^{\{t+1\}} \circ S_O^t$	Temporal iteration

Plain-English Context

Every step of the Observer Function has a precise mathematical meaning in category theory. "Sensing" = restricting to a subcategory. "Integrating" = taking limits (combining information). "Evaluating" = listing available morphisms (possible actions). "Selecting" = choosing a commuting diagram (making choices consistent). "Acting" = following a morphism (executing action). "Updating" = modifying the functor (learning). "Networking" = taking products (coupling observers). "Repeating" = composing functors (iterating).

Entropy Reduction as a Property of the Observer Functor

In Observer Theory, we defined entropy reduction as:

$H(R_O) < H(R)$

The Observer Function Ω_O IS the mechanism by which this inequality is maintained.

Specifically:

- SENSE: Filters R to relevant subset R_O (information reduction / coarse graining)
- INTEGRATE: Computes cohomology $H^*(R_O)$, finding reducible computations (entropy compression)
- EVALUATE: Applies predictive model compressing future states (complexity reduction)
- SELECT: Chooses minimal-cost morphism (thermodynamic efficiency)
- ACT: Imposes constraint on R evolution (local entropy export)
- UPDATE: Refines model via prediction error minimization (learning = more compression)
- NETWORK: Shares compressed models across observers (entropy reduction to neighbourhood)
- REPEAT: Iteratively approaches limit $H(R_O) \to H_{min}$ subject to constraints

Net effect: The observer creates a local "pocket of order" in $\mathbf{R_O}$ by continuously exporting entropy to the broader Ruliad R. This is how life (and all observers) appear to violate the second law locally, they obey it globally by generating entropy elsewhere.

Plain-English Context

You maintain your body's organisation (low entropy) by eating food (organized molecules), extracting energy, and excreting waste heat (high entropy). Locally, you're decreasing entropy (getting more organized). Globally, the universe's entropy increases (waste heat radiates to space). Observers are entropy pumps—they create local order by exporting disorder.

Part B: Choice as Computational Optimisation for Observers[256,257]

Every moment of conscious experience presents an Observer with a branching structure of possible futures – morphisms in the categorical structure of the Ruliad leading from the current state to potential next states.

1. The Computational Path Cost Function

When you decide whether to help a stranger, pursue a career change, or choose breakfast, you're navigating a complex computational landscape where each path has measurable costs, consequences, and convergence properties.

This choice function follows optimisation principles emerging from the structure of computation itself.

Definition: **Path Cost Function**

For a path γ through the Ruliad from state s_1 to s_2, the total cost is:

$$\boldsymbol{Cost(\gamma) = \sum_{i=1}^{n} comp_{steps}\ (\gamma_i) + \lambda \cdot H(\gamma) + \mu \cdot Distance(\gamma, TI) + \nu \cdot N(\gamma)}$$

Where:

$\boldsymbol{comp_{steps}(\gamma_i)}$: Raw computational work required to traverse path

$$\boldsymbol{comp_{steps}(\gamma) = \sum_{j=1}^{n} t_j}$$

- $\boldsymbol{t_j}$ = computational time for step **j** (elementary operations or seconds)
- For digital systems: bit flips, graph rewrites, state transitions
- For biological systems: ATP molecules consumed (c.10^{-20} joules per ATP hydrolysis)
- For human decisions: mental effort, time deliberating, energy expended

> ***Plain-English Context***
> *This is the raw "thinking time" or "work" required to traverse the path. Making a simple choice (what socks to wear?) requires few computational steps. Complex decisions (should I change careers?) require millions of mental operations (considering options, simulating outcomes, weighing factors). The brain literally burns glucose doing this computation.*

$\boldsymbol{H(\gamma)}$***:*** Total entropy generated along path

$$\boldsymbol{H(\gamma) = \Delta H_{thermo}(\gamma) + \Delta H_{info}(\gamma)}$$

- Thermodynamic entropy: waste heat $\Delta H_{thermo} = dQ/T$ (units joules/kelvin or bits using Boltzman constant)
- Information entropy: destroyed correlations $\Delta H_{info} = K(\text{final})-K(\text{initial})$ (Kolmogorov complexity change, measured in bits)

> ***Plain-English Context***
> *Every choice generates both physical (heat from brain metabolism) and informational (discarded alternatives, forgotten considerations) waste. This is why thinking is exhausting and why you can't "un-forget" something perfectly. The Landauer bound is the universe's fundamental "recycling fee" (you must pay this energy cost to erase information, no exceptions).* ***Lying*** *generates high entropy because you must track false information forever (or pay to erase it later), while truth-telling generates low entropy because you only track one consistent model.*

$\boldsymbol{Distance(\gamma, TI)}$ Observer estimated distance from limit computational closure point

$$\boldsymbol{Distance(\gamma, TI) = d_{R_O}(Endpoint(\gamma), TI)}$$

- $\boldsymbol{d_{R_O}}$ is a metric on the Observer's accessible Ruliad (graph-theoretic distance)
- $\boldsymbol{Endpoint(\gamma)}$ = final state reached via path $\boldsymbol{\gamma}$
- TI = True Infinity (limit of all computation, categorical terminal object)
- Smaller distance → more virtuous path

  Metric properties
  - d(x,y) ≥ 0 *(non-negative)*
  - d(x,x) = 0 *(identity)*
  - d(x,y) = d(y,x) *(symmetry)*
  - d(x,z) ≤ (dx,y) + d(y,z) *(triangle inequality)*

> ***Plain-English Context***
> *This measures "how far are you from the global maxima / optima?" after taking path γ. Some choices move you closer to understanding / goodness / optimal-functioning (small Distance), others move you away (large Distance).*
>
> *Learning something true decreases* ***Distance*** *(you're closer to complete knowledge). Embracing a delusion increases* ***Distance*** *(you've moved away from truth). Over a lifetime, virtuous paths systematically decrease Distance, while sinful paths increase Distance. TI is unreachable (it's at infinity) but some paths approach it faster than others.*

$N(\gamma)$ Network effects on other Observers

$$N(\gamma) = \sum_{i \neq j} [I(O_i : O_j | \gamma) - Cost_{conflict}(O_i, O_j | \gamma)]$$

Where:

- $I(O_i : O_j | \gamma)$ = mutual information between Observers given path γ (bits)
- $Cost_{conflict}$ = Entropy, H, generated by coordination overhead
- Measures correlation / coordination between Observers

Mutual Information:

- Positive when Observers share information (cooperation gains)
- Zero when independent (no network effects)
- Negative: conflict costs (in entropic terms) $Cost_{conflict} \propto comp_{steps}(O_i, O_j)$
- Cascading: effects propagate through social graph

> ***Plain-English Context:***
>
> *Your actions affect other people.*
>
> *Helpful actions create positive network effects; teaching someone benefits them (they gain information $I(O_i{:}O_j) > 0$), and often you too (they may help you later).*
>
> *Harmful actions create negative network effects; starting conflict generates entropy ($Cost_{conflict}$), wastes everyone's computational resources on fighting instead of cooperating. This term aims to capture that no Observer is truly isolated i.e. we're all nodes in a network, and your choices ripple outward. Cooperation amplifies benefits (everyone's knowledge increases faster than alone), while defection amplifies costs (everyone must waste effort on defence).*

λ, μ, ν: Observer-specific weighting factors

- *$\lambda \propto 1/P_O$* (shorter persistence → prioritise immediate survival)
- *$\mu \propto 1/B_O$* (lower boundedness → prioritise long-term convergence)
- *$\nu \propto$ network size* (more connections → higher cooperation weight)

> ***Plain-English Context***
>
> *These three knobs tune the cost function to different observers. λ asks "how much do I care about the future?". Bacteria with short lifespans (high λ) only care about the next hour. Humans with long lifespans (low λ) can invest in education that pays off decades later. μ asks "given my limited brainpower, how much do I prioritise finding the absolute best path?" Simple organisms (high μ) use crude heuristics. Intelligent organisms (low μ) can afford to think deeply. ν asks "how much do other people matter?" Hermits (ν ≈ 0) ignore social effects. Social animals (high ν) weigh cooperation heavily. Together, λ, μ, ν customize the universal Cost(γ) function to each Observer's particular constraints and context.*

Why This Equation Reveals Intuitions:

Observers have evolved (through natural selection, learning, or cultural transmission) to approximate this cost function. This is why certain choices "feel" right or wrong. Our cognitive / emotional systems estimate $Cost(\gamma)$ and select low-cost paths.

Below we demonstrate a few trivial examples of how this would work for given human actions:

Cost Function Variable	Example 1: Helping a Stranger feels Good	Example 2: Lying to Avoid Confrontation feels Bad
$comp\_steps(\gamma_i)$	Low (small effort)	Low initially (avoid hard conversation)
$H(\gamma)$	Low (trivial disorder created)	High (must maintain consistency / remember lie)
$Distance(\gamma, TI)$	Decreases, positive network effect	Increases, divergence in Observer world models and sampling functors
$N(\gamma)$	Positive (gain to other Observers)	Negative (entropic cascade if revealed)
Total: $Cost(\gamma)$	Low – easy to choice by Observer	High – Avoided (hence guilty feeling)

> ***Ruliad Context***
>
> *The Path Cost Function Cost(γ) measures the "length" of a morphism chain in R_O induced by the Observer's constraints. Minimizing Cost(γ) is equivalent to finding shortest computational paths through Ruliad space. This connects ethics to the principle of least action in physics.*

> ***Plain-English Context***
>
> *Just as light takes the shortest path through space (Fermat's principle), and particles follow paths minimizing action (Lagrangian mechanics), observers choose actions minimizing computational cost. Physics and ethics share the same mathematical structure—everything follows paths of least resistance.*

> ***Computational Analogy***
> *Like Google Maps calculating optimal route: it doesn't just minimize distance ($comp_{steps}$), but weighs distance + traffic (entropy) + tolls (network effects) + alignment with your destination (distance to goal). The weights (λ,μ,ν) are your preferences (fastest vs. shortest vs. cheapest).*

---

2. Computational Debt

Not all choices Observers make are equal.

Some decisions create "computational debt", they appear (are predicted) as optimal in the short-term, due to computational boundedness B_O and computational irreducibility, but require extensive additional computation to integrate coherently later.

Conjectured Definition: Computational Debt

For choice / action **γ** made at time **t**, the approximate computational debt is:

$$\boldsymbol{Debt(\gamma, n)} \approx \int_t^{\infty} [\boldsymbol{Cost_{actual(\gamma,t)}} - \boldsymbol{Cost_{optimal(\gamma,t)}}]\boldsymbol{dt}$$

Where:

- $\boldsymbol{Cost_{actual(\gamma,t)}}$: Ongoing computational cost of maintaining (or correcting) consequences of choice / action, **γ** at time, t
- $\boldsymbol{Cost_{optimal(\gamma)}}$: Computational cost that would have been incurred with globally optimal choice / action, **γ** at time, t
- **Integral, ∫ :** Accumulated over all future time (computational debt persists until repaid or Observer is no longer persistent)

> ***Plain-English Context***
> ***Computational Debt** is like financial debt. You get something now (short-term money) but pay interest forever (ongoing cost of maintaining the loan akin to fixing a problem caused by a suboptimal decision). The debt is the difference between what you're paying and what you would have paid if you'd made the optimal choice initially.*

Paradigmatic Example: Lying

Consider lying to avoid a difficult conversation:

At **t=0** (decision point)

$\boldsymbol{\gamma_{truth}}$: High (emotional discomfort, possible conflict, vulnerability)

$\boldsymbol{\gamma_{lie}}$: Low (avoid confrontation, maintain facade)

Bounded Observer rationality selects lie: $\boldsymbol{\gamma_{truth}} > \boldsymbol{\gamma_{lie}}$ at t=0

1. Storage Cost (maintaining false information)
   - Must remember the lie: memory allocation costs bounded computational resources of Observers
   - Constant background checking (redundant computation if $\boldsymbol{\gamma_{truth}}$ had been selected at t=0)

2. Consistency Cost (maintaining coherence)
   - Must tell additional lies to maintain consistency with initial lie
   - Each new lie creates branching complexity (exponential growth)
   - Cognitive load tracking: "What did I tell Alice vs. Bob vs. Carol?"

3. Network Cost (other observers must correct false information)
   - Others make decisions based on false information → suboptimal outcomes
   - When discovered (probability → 1 as n → ∞), re-computation required by exposed Observers
   - Trust damage: future interactions require verification (increased computational cost)

4. Systemic Cost (broader social implications)
   - Trust networks degrade: if lying is common, all claims require verification
   - Information channels become noisy: signal-to-noise ratio decreases
   - Cooperation becomes impossible: prisoners' dilemma dominates

As t → ∞, the exponential terms dominate. A single lie can generate unbounded computational debt.

> ***Plain-English Context***
> *Lying is like payday loans. It helps immediately but destroys you over time. The initial "savings" (avoided difficult conversation) is vastly outweighed by ongoing costs (remember lie, tell more lies, track who knows what, risk of discovery, damaged reputation). After just hours or days, you've spent more mental energy maintaining the lie than truth would have cost. But now you're trapped, revealing the lie costs even more (you've added "lying" to "original problem"). This is why honest people often seem to have easier lives: they pay costs upfront (uncomfortable truths) but have zero debt. Liars appear to "get away with it" but are slowly crushed by accumulating debt until catastrophic collapse (discovery, mental breakdown, relationship implosion).*

Why Every Ethical Tradition Condemns Lying

Lying generates unsustainable debt in the Information Economy of Observer computational networks.

Across cultures / religions:

- Judaism: Ninth Commandment: "Thou shalt not bear false witness"
- Christianity: Ephesians 4:25: "Put away lying, speak truth with your neighbour"
- Islam: Quran 22:30: "Shun false statement"
- Buddhism: Fourth Precept: "Refrain from false speech"
- Hinduism: Yamas: "Satya" (truthfulness) is fundamental virtue
- Confucianism: "Xin" (integrity/trustworthiness) is cardinal virtue
- Secular Ethics: Kant's categorical imperative: "Act only according to maxims that could become universal law" (lying fails this test)

All discovered independently that truth-telling is computationally necessary for stable Observer networks.

Ruliad Context

At the limit, lying introduces computationally inefficient morphisms (that they believe are optimal) into the observer's internal model of $\boldsymbol{R_o}$*—paths that are inefficient in* ***R****. When the observer (or others) attempt to follow these phantom morphisms, they fail (the morphism doesn't compose with subsequent transitions).*

This forces backtracking and re-computation, generating entropy.

Truth-telling ensures morphisms in the Observer's model correspond to efficient paths in $\boldsymbol{R_o}$*, minimizing wasted computation*

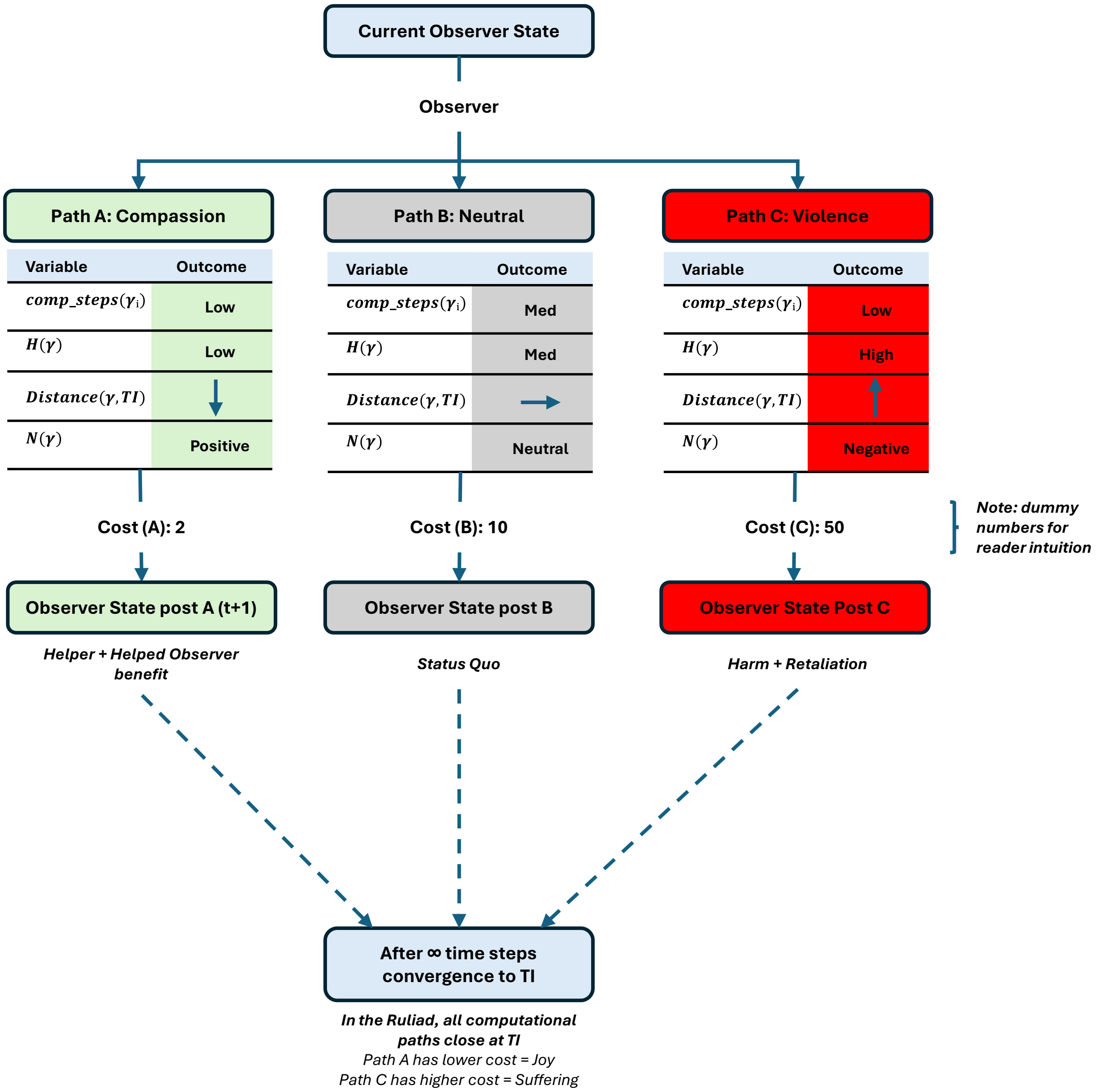
Plain-English Context

Every culture independently discovered that lying destroys societies.

Why? Because communication is the foundation of cooperation, and cooperation is the foundation of civilization. When lies are common, every statement must be verified (expensive!), defeating the purpose of communication (cheap information sharing). Networks collapse back to isolated individuals where everyone must discover everything themselves. Honest societies outcompete lying societies because honest communication is cheap and accurate, enabling massive cooperation. This isn't religious dogma; it's information theory.

<u>Visual: Choice Navigation For Observers in the Ruliad</u>

Note: Dummy numbers, to provide intuition. This requires testing.



Key Insights from Visual

1. Multiple Paths Always Available
    - At each moment, Observer faces branching futures
    - Morphisms correspond to different actions
    - Each path has measurable cost Cost(γ)
2. Cost Determines Selection Probability
    - Lower cost → higher selection probability
3. All Paths Eventually Converge
    - Topological necessity: TI is terminal object in Ruliad
    - Difference: computational efficiency of approach
4. Efficiency Varies by Orders of Magnitude
    - Path A: Reaches TI with lower entropy
    - Path C: Reaches TI with higher entropy
    - Same destination, vastly different journeys

Plain-English Context

Imagine climbing a mountain (TI = summit). Path A is the maintained trail—gradual incline, scenic views, you arrive refreshed. Path C is straight up the cliff face—brutal climb, dangerous, you arrive exhausted and injured (if you survive). Both reach the top, but the experience differs vastly.

Ruliad Context

The branching structure is the multiway graph of the Ruliad.

Each node is a computational state, each edge a transition rule.

*The Observer samples one path through this graph, collapsing the multiway system into a single timeline. The Path Cost Function **Cost(γ)** induces a metric on the graph, making R_O into a weighted directed graph where virtuous paths have low edge weights*

Computational Analogy

Like Google Maps showing three routes: (A) Highway, tolls, 30 min. (B) Back roads, no tolls, 45 min. (C) Scenic route through mountains, 90 min. All reach the destination, but with different costs/benefits. The optimisation function weights your preferences (time vs. money vs. views) to recommend a route..

Part C: The Mathematics of Good and Evil

Using the God Conjecture we can now formalise the concepts of virtue and sin as necessary features of any computational system complex enough to model itself.

Important Note

These constructions are conjectures!

*I'm expressing these outputs in **bits.***

At this stage these calculations use dummy numbers. The unit seems appropriate (given it's computation) but it may not be the correct. Additionally, these equations, within each 'bucket' probably have a more robust measure given the structure of the Ruliad (i.e. tools from geometry / stats / maybe causal mathematics, see Erik Hoel)

Other researchers may have better ways of specifying these calculations or improvements to the equations. I invite them to improve them (or tear them to shreds).

1. The Virtue Function

Definition: Virtue

For an observer O choosing action **γ** at time **t**, the virtue of that action is:

$$V(\gamma) = \left[\frac{\Delta I(F_O)}{\Delta H(R_O)}\right] \times \mathit{scope} \times \mathit{persistence} \times \mathit{network\ alignment}$$

Where:

$\frac{\Delta I(F_O)}{\Delta H(R_O)}$: Information integration efficiency

- Numerator: Change in integrated information in Observer's active field (i.e. what they are able to observe at that time)
    - F_O is the subset / subcategory of R_O currently being observed
- Denominator: Entropy generated in Observer accessible Ruliad
- Ratio: "Information gain per unit of entropy generated" equal to computational efficiency
  Efficiency >1: Virtuous (net information creation despite entropic cost)
  Efficiency <1: Vice-leaning (entropic cost exceeds information gain)
  Efficiency <0: Vice (integrated information destroyed, high entropy generation)

Plain-English Context

How much you learn divided by how much mess you make. Studying efficiently has high ratio (lots learned, little energy wasted). Doomscrolling has low ratio (minimal learning, time wasted, dopamine addiction created). Vandalism has negative ratio (information destroyed, disorder created).

scope: Breadth of domains impacted

- Measured by number of domains: P (Physical), V (Valuational), S (Symbolic), M (Minimally-Constrained)
- Single domain: scope = 1
- Multiple domains: scope = |domains affected|
- Universal: scope = 4 (affects all levels simultaneously)

Note: As domains are embedded in one another in the Ruliad's structure (M ⊃ S ⊃ V ⊃ P), all actions impact all domains necessarily. This is to identify which domain is primarily impacted. This could also be a rank (like our mixing board analogy earlier)

> ***Plain-English Context***
> *Scope measures "how many kinds of effects" your action has. Picking up a pebble predominantly affects the physical domain (scope = 1). Teaching a child affects their values, their understanding of symbols/language, and abstract thinking patterns (scope = 3-4). Discovering gravity affects everything from physics to philosophy to mathematics (scope = 4, universal). Higher scope means your action ripples across more levels of Observable reality. This is why we celebrate universal geniuses (Newton, Einstein, Ramanujan) as their insights transformed multiple domains simultaneously.*

$\boldsymbol{persistence}$: Temporal duration of effects

- Short-term: persistence = n (decays over n states)
- Long-term: persistence = $e^{(n/\tau)}$ (exponential growth)
- Generational: persistence = ∞ (cultural transmission)

> ***Plain-English Context***
> *Persistence is "how long does your action matter?"*
> *Helping someone with groceries persists minutes. Teaching them to read persists their lifetime. Discovering calculus persists forever (all future mathematicians build on it). Short persistence isn't bad (immediate help still matters) but long persistence amplifies virtue enormously. This is why we especially honour ancestors who created lasting value: written language, mathematics, agriculture, medicine. Their actions continue benefiting us millennia later. Persistence could be modelled as the time-integral of your actions impact, it compounds virtue.*

$\boldsymbol{network\ alignment}$: Correlation with other Observers' information integration optimisation paths

- Independent: alignment = 0 (no network effect)
- Cooperative: alignment = angle between optimisation vectors
- Universal: alignment = 1 (benefits all Observers equally)

> ***Plain-English Context***
> *Network alignment asks "does your action help others reach their goals too?"*
> *If you and your neighbours all want clean water, and you purify the shared well, alignment = 1 (helps everyone). If you want quiet and they want loud parties, alignment = -1 (conflict). If you're a hermit in the woods, alignment ≈ 0 (your actions don't affect others). High alignment means "win-win" as your virtuous action helps everyone simultaneously.*
> *This is why we especially value public goods (roads, schools, clean air)—they have alignment ≈ 1, benefiting entire populations. Cooperation systematically has positive alignment, while competition/conflict has negative alignment.*

Virtue is multiplicative: Small improvements across multiple dimensions compound exponentially.

$$\boldsymbol{V(\gamma)} = \left[\frac{\boldsymbol{\Delta I(F_O)}}{\boldsymbol{\Delta H(R_O)}}\right] \times \boldsymbol{scope} \times \boldsymbol{persistence} \times \boldsymbol{network\ alignment}$$

If each factor ≈ 2, total virtue, V ≈ 16× baseline.

This explains why rare "supervirtuos" acts *(e.g., inventing the printing press, discovering antibiotics)* have disproportionate impact. They score highly across all the functions factors.

> ***Plain-English Context***
> *The virtue function explains why some actions are celebrated across all cultures and time periods. It's not random as these actions scored extraordinarily high across all four factors simultaneously. They were efficient (high ΔI/ΔH), broad (high scope), lasting (high persistence), and universal (high alignment).*
> *Multiplication means you need excellence in all dimensions for maximum virtue. You can't simply compensate for narrow scope with extra persistence.*
> *This is why moral exemplars (Buddha, Jesus, Abraham, Socrates) are rare: achieving high virtue across all dimensions simultaneously is exceptionally difficult.*

Worked Example: Wisdom

Scenario: You spend years studying mathematics, eventually discovering a theorem that simplifies proofs across multiple subfields.

$$\boldsymbol{V(wisdom)} = \left[\frac{\boldsymbol{\Delta I(F_O)}}{\boldsymbol{\Delta H(R_O)}}\right] \times \boldsymbol{scope} \times \boldsymbol{persistence} \times \boldsymbol{network\ alignment}$$

$\frac{\boldsymbol{\Delta I(F_O)}}{\boldsymbol{\Delta H(R_O)}}$ Calculation:

- $\boldsymbol{\Delta I(F_O)}$: Understanding compresses mathematical structure
    - **Before**: Problem requires n steps to solve

- **After theorem**: Problem requires log(n) steps *(exponential compression)*
- **Quantify:** Kolmogorov complexity decreases
- Estimate: ΔI **≈ +10^6 bits** *(a significant theorem compresses vast problem space)*

- $\Delta H(R_O)$: Moderate entropy from study effort
  - Mental effort: ~10^4 hours × brain power ~20 W = 7×10^8 joules
  - Convert to information with Boltzman constant ≈ 10^{14} bits
  - However: theorem reduces future computational entropy (enables shortcuts)
  - Net effect: Initial entropy amortised over (approaching) infinite future computations
  - Long term: ΔH_{net} **< 0** (generates negentropy – order from disorder)
  - Estimate: ΔH **≈ +10^5 bits initially,** but $\Delta H_{net} \rightarrow -10^{-7}$ **bits long-term** (amortized over future computational savings → *negentropy*)

Ratio:

$$\frac{\Delta I(F_O)}{\Delta H(R_O)} = \frac{10^6}{10^5} = \mathbf{10} \text{ short-term}, \frac{10^6}{-10^7} = -\mathbf{0.1} \text{ long-term}$$

> ***Interpretation***
> *Short-term appears moderately efficient (gain of 10 bits of integrated information per bit spent).*
> *Long-term is negentropy generator (negative denominator means you're creating order faster than you consume it—this is the signature of profound insights that simplify complexity).*
> *A better formulation would say efficiency = 10 for learning phase and is unbounded for application phase (infinite reuse of insight costs zero marginal entropy).*

$scope$:

- P-domain: Physical brain changes (synaptic connections, neural pathways strengthened)
- V-domain: Mental models restructured (conceptual representation)
- S-domain: Symbolic meaning (theorem has logical content)
- M-domain: Knowing how to know—theorem illuminates other proof strategies
- ***Estimate: scope = 4 (affects all domains)***

$persistence$:

- Theorem is published, becomes part of mathematical canon
- Used by mathematicians for centuries (possibly indefinitely)
- Generates further theorems (recursive knowledge building)
- ***Estimate: persistence ≈ ∞ (eternal)***

$network\ alignment$:

- **Direct**: Mathematics community benefits (thousands of mathematicians)
- **Indirect**: Applications in physics, engineering, computer science (millions benefit from downstream technologies)
- **Universal**: Truth is universally accessible (any observer can learn it)
- ***Estimate: alignment ≈ 1 (benefits all Observers)***

$$V(wisdom) \rightarrow \infty$$

(i.e. always positive approaching infinity depending on utilisation)

> ***Plain-English Context***
> *Wisdom is the ultimate long-term investment in Observer network optimisation. Short-term cost is high (years of difficult study, uncertainty, frustration). Long-term benefit is unbounded (truth persists forever, benefits everyone, generates more truth). The virtue is "infinite" because mathematical truth never decays. Someone in the year 5000 will still use your theorem, someone in the year 100,000 will still use it. This is why we honour great mathematicians (Euclid, Euler, Gauss)—they created eternal value.*
> *The efficiency ratio actually improves over time: initial entropy investment is fixed, but benefits compound indefinitely. Eventually ΔI/ΔH → ∞ (infinite information gained per unit initial entropy investment).*

> ***Ruliad Context***
> *Wisdom corresponds to discovering computational reductions in **R***
> *Morphism sequences that can be compressed via functorial properties.*
> *A theorem is a natural transformation η: F → G between functors that commutes with the underlying structure, allowing whole classes of problems to be solved simultaneously. This is why theorems are powerful: they're not single solutions but templates for infinite solutions*

Worked Example: Courage

Scenario: You speak truth to power despite personal risk, exposing corruption that harms many Observers.

$$V(courage) = \left[\frac{\Delta I(F_O)}{\Delta H(R_O)}\right] \times scope \times persistence \times network\ alignment$$

$\frac{\Delta I(F_O)}{\Delta H(R_O)}$ Calculation:

- $\Delta I(F_O)$: Hidden information becomes public
    - Corrupt system hides information *(high entropy / uncertainty about true state)*
    - Whistle-blowing reveals truth *(entropy reduction, uncertainty dramatically reduced)*[258]
    - Quantify: $\Delta I \approx$ uncertainty resolved $\approx N_{people} \times \log(N_{states})$
    - For major corruption: millions misled, many possible explanations
    - Estimate: **$\Delta I \approx 10^9$ bits** (massive information revelation)
- $\Delta H(R_O)$: Significant personal cost
    - Risk: job loss, legal threats, social ostracism, possible violence
    - Thermodynamic: stress hormones, health impacts
    - Information: Must process complex threat landscape (see game theory work on whistleblowing)
    - Estimate: **$\Delta H \approx 10^7$ bits** (very high personal entropy)

$$\frac{\Delta I(F_O)}{\Delta H(R_O)} = \frac{10^9}{10^7} = 100$$

(highly efficient at societal scale, costly at personal scale)

$scope$:

- P-domain: Physical risk (potential harm)
- V-domain: Psychological stress (fear, anxiety)
- S-domain: Symbolic truth (corruption must be broadcast to be exposed)
- M-domain: Systemic change (institutional reform, precedent set)
  Estimate: scope = 4 (affects all levels)

$persistence$:

- Immediate: Corrupt system disrupted (correction applied)
- Medium-term: Reforms implemented (institutional memory)
- Long-term: Cultural shift (future whistle-blowers emboldened)
  Estimate: persistence ≈ 10^9 seconds (decades of impact)

$network\ alignment$:

- Direct: Victims of corruption benefit (potentially millions)
- Indirect: Future potential victims protected (preventative benefit)
- Systemic: Trust in institutions restored (network efficiency increases)
  Estimate: alignment ≈ 0.9 (very high—nearly everyone benefits except corrupt actors)

Total:

$$V(courage) = 100 \times 4 \times 10^9 \times 0.9 \approx 3.6 \times 10^{11}$$

(i.e. extremely high virtue but finite, unlike wisdom)

Plain-English Context

Courage is transformative but exhausting.

Whistleblowers pay enormous personal cost (high ΔH from stress, risk, persecution) to generate massive societal benefit (huge ΔI from information revelation). The efficiency ratio is excellent from society's perspective (100:1) but terrible from the individual's (they suffer greatly). This is why courage is rare. It requires overcoming local optimisation (self-preservation) for global optimisation (collective benefit).

The high virtue score explains why we venerate whistleblowers, regardless of one's political views on specifics, the functional structure is clear: high personal cost × broad scope × lasting impact × nearly universal benefit = extremely high virtue.

Courage enables escape from suboptimal equilibria (corrupt systems), allowing transition to better attractors in computational possibility space.

Ruliad Context

*Courage explores morphisms **γ** that other Observers avoid due to high local cost.*

But these morphisms may lead to regions of R_O with much lower global computational cost.

By taking the risky path, the courageous Observer discovers new accessible states for the entire network. This is why societies honour pioneers—they expand the collective possibility space by exploring uncertain edges with low predictability.

3. The Sin Function

Definition: Sin

Conversely, we formalise sin as patterns that impede information integration:

$$S(\gamma) = H_{generated} \times O_n(\gamma) \times Cost_{repair\,(\gamma)} \times persistence(\gamma)$$

where:

$H_{generated}$: Entropy created by action γ

- Thermodynamic: waste heat, disorder (bits)
- Information: false information, corruption of data (bits)
- Social: trust damage, conflict initiation (bits or some other proxy measure)

O_n: Number of observers harmed

- Direct: Immediate victims
- Indirect: Ripple effects through network
- Systemic: Entire society if norms violated

$Cost_{repair\,(\gamma)}$: Computational cost / effort to correct damage

- Immediate: Fixing direct harm
- Long-term: Rebuilding trust, restoring patterns
- May be infinite if damage irreversible (e.g., murder)

$persistence$: Time duration of harmful effects

- Short: Temporary inconvenience
- Long: Generational trauma
- Permanent: Irreversible destruction

Multiplicative Structure

Small harms across multiple dimensions compound exponentially into catastrophic damage.

$$S(\gamma) = H_{generated} \times O_n \times Cost_{repair\,(\gamma)} \times persistence$$

If each factor ≈ 10, total sin S ≈ 10,000× baseline.

This explains why rare "super-sinful" acts (genocide, nuclear war, environmental collapse) are maximally condemned – they score high across all dimensions and domains simultaneously.

> ***Plain-English Context***
> *Sin is anti-virtue.*
> *It destroys integrated information for an Observer, harms many, is expensive to repair, and lasts for a long time.*
> *Small harms across multiple dimensions compound into catastrophe. This is why certain acts (genocide, nuclear war, ecocide) are universally condemned. They score maximally on all the above dimensions simultaneously.*
> *The multiplicative structure explains "evil" as not mysterious metaphysics but computational math: actions that generate maximum entropy, harm maximum Observers, are maximally difficult to repair, and persist maximally long. These are mathematically the worst possible choices, regardless of cultural framework.*

Worked Examples: Pride

Scenario: You refuse to admit error despite clear evidence, doubling down on mistake.

$$S(pride) = H_{generated} \times O_n \times Cost_{repair\,(pride)} \times persistence$$

$H_{generated}$:

- False model persists in your mind (no learning → repeated errors generate entropy)
- Others misled by your false confidence (information corruption spreads)
- Conflict generated when truth eventually emerges (defensiveness, anger)
  Estimate: $H \approx 10^5$ bits (significant informational entropy)

O_n:

- You: Stuck with false model (cannot progress)
- Direct: People who trusted your judgment (misled, make more suboptimal decisions)
- Indirect: Systems dependent on accurate information (make wrong decisions at superstructure level)
  Estimate: n ≈ 10-100 people

$Cost_{repair\ (pride)}$:

- Must eventually admit error (ego damage, status loss)
- Others must unlearn false information (computational burden for every impacted Observer)
- Institutional corrections (policies based on error must be revised)
  Estimate: $Cost_{repair} \approx 10^6$ bits (extensive re-computation needed across network)

$persistence$:

- Until error acknowledged: days to years (depends on Observer's stubbornness)
- Long-term: Reputation damage (known as stubborn/unreliable)
- Cultural: If pattern normalizes, truth-seeking itself erodes in network
  Estimate: persistence ≈ 10^7 seconds (months to years)

Total:

$$S(pride) = 10^5 \times 50 \times 10^6 \times 10^7 \approx 5 \times 10^{19} \text{ bits}$$

(very high computational debt)

Plain-English Context

Pride is the "deadliest sin" in many traditions because it blocks the UPDATE step of the Observer Function.

You refuse to learn, so prediction error remains high forever. This generates entropy continuously (you keep making the same mistakes).

The sin compounds because it's self-reinforcing: admitting error becomes harder the longer you wait (more committed to false position), so persistence increases. Eventually the debt becomes unpayable (reputation permanently damaged, trust unrecoverable).

Pride is like compound interest on a loan you refuse to acknowledge, it grows exponentially while you pretend everything's fine, until catastrophic default (public humiliation, career destruction, relationship collapse).

Ruliad Context

Pride corresponds to refusing to refine the sampling functor S_O despite evidence that it's inefficient.

The Observer maintains morphisms in their model that are computationally expensive, repeatedly attempting long-morphism chain transitions (and failing).

This generates computational waste: effort spent on paths that are computationally expensive to traverse .

Worked Example: Wrath

Scenario: You retaliate violently against perceived wrong, initiating conflict cycle.

$$S(wrath) = H_{generated} \times O_n \times Cost_{repair\ (wrath)} \times persistence$$

$H_{generated}$:

- Physical destruction (property, bodies)
- Information destruction (memories erased via trauma/death)
- Social bonds severed (trust → fear)
- Retaliatory cycles initiated (vendetta logic)
  Estimate: H ≈ 10^{10} bits (massive entropy from violence)

O_n:

- Direct victim(s): Harmed immediately (pain, injury, death)
- Families: Grief, trauma (psychological damage)
- Community: Fear, polarization (social fabric tears)
- Future: Cycles of retaliation / regress in the direction of minima (generations of conflict)
  Estimate: n ≈ 10^3 to 10^9 (depends on scale i.e. feud vs. war)

$Cost_{repair\ (wrath)}$:

- Physical: Medical costs, rebuilding
- Psychological: Therapy, trauma processing
- Social: Reconciliation, trust rebuilding
- Generational: Breaking cycles (may take centuries)
- If death: Infinite (accessible information now permanently inaccessible / noise)
  Estimate: $Cost_{repair} \approx 10^{12}$ bits (possibly infinite)

$persistence$:

- Immediate: Physical injuries (years to heal)
- Medium: Psychological trauma (decades)
- Long: Cultural memory (centuries—e.g., Balkan conflicts)

- Infinite: If kills observer (death permanent)
  Estimate: $t \approx 10^{10}$ seconds (centuries) or → ∞

Total:

$$S(wrath) = 10^{10} \times 10^{6} \times 10^{12} \times 10^{10} \approx 10^{38}$$

(astronomically high computational debt)

If murder:

$$S(murder) = \infty \text{ (irreversible information inaccessibility / maximum computational irreducibility)}$$

Plain-English Context

Wrath/violence is maximally sinful because it irreversibly destroys information (especially murder—the victim's entire future computational potential is erased).

It initiates exponential cascades (retaliation → counter-retaliation → endless cycles). It harms vast numbers (violence propagates through networks far beyond immediate victims). And it persists essentially forever (trauma lasts lifetimes, cultural memory lasts millennia). This is why every ethical tradition makes "thou shalt not kill" the first or most important prohibition – murder is mathematically the worst possible action.

You delete an Observer (irreversible information loss), traumatize everyone connected to them (network entropy), possibly trigger retaliation (exponential cascade), and create permanent absence (infinite persistence).

No repair is possible (the dead cannot be resurrected). Murder is infinite sin not for mystical reasons but computational ones: you've permanently reduced the universe's information integration capacity.

Ruliad Context

Wrath corresponds to forcibly removing morphisms from other Observers' accessible Ruliad. Violence constrains their options, trauma limits their functionality, death eliminates them entirely.

Murder is the ultimate sin because it permanently deletes an entire R_O from existence, making inaccessible / computationally irreducible all the integrated information Φ that the murdered observer had accumulated.

---

4. The Fundamental Asymmetry: Virtue vs. Sin

Virtue and sin are not symmetric.

Virtue (Creation / Negentropy):

- Builds: Information, structure, relationships
- Compounds: Positive feedback loops
- Scales: Network effects amplify benefit
- Reversible: Can be undone but rarely is (stable attractors)

Sin (Destruction / Entropy generation):

- Destroys: Information, structure, relationships
- Cascades: Negative feedback loops (revenge cycles)
- Scales: Entropy spreads (disorder contagious)
- Irreversible: Cannot undo death, trauma has permanent effects

Thermodynamic Analogy:

- Virtue = Negentropy (local entropy decrease, like life)
- Sin = Entropy increasing (disorder)
- 2nd Law: Entropy increases globally, but can decrease locally with effort

  Virtue requires continuous effort; sin is the default without effort.

Plain-English Context

Building is hard, breaking is easy. This isn't moral failure; it's thermodynamics.

The 2nd Law guarantees that disorder increases unless you work against it. Virtue is the work of creating and maintaining order (information, relationships, knowledge, justice). Sin is what happens when you stop working and things fall apart naturally. A garden becomes weeds without tending. A friendship becomes estrangement without communication. A society becomes chaos without justice.

Virtue is expensive, sin is cheap. This is why "the easy way" is usually wrong. It's the path of maximum entropy, minimum effort (which can feel good but eventually leads to ruin).

The asymmetry explains why destroying is faster than building (entropy increase requires no / much less work), but also why virtue is more stable once established (integrated information is hard to disintegrate, knowledge is hard to forget, good habits are hard to break).

Virtue is thermodynamically expensive, it requires fighting entropy. Sin is thermodynamically cheap, it's allowing entropy to increase naturally.

Virtue is long-term optimisation; sin is short-term optimisation. Universe rewards long-term because computational resources compound for all Observers, it is more efficient for integrating information.

Part E: Canonical Ethical Systems as Convergent Discoveries[259]

When we examine ethical systems across cultures, religions, and philosophies, we find extraordinary convergence on core principles.

In the God Conjecture this reflects a mathematical necessity.

1. The Noahide Laws as Minimal Rule-Set[260]

In the Jewish tradition, the **Seven Noahide Laws** are considered universal ethical minimums applying to all humanity. We can demonstrate these form a **minimal rule-set** for stable civilizations.

The Seven Laws:

1. No Idolatry (Avodah Zarah)
2. No Blasphemy (Birkat Hashem)
3. No Murder (Shefichat Damim)
4. No Theft (Gezel)
5. No Sexual Immorality (Gilui Arayot)
6. No Cruelty to Animals (Ever Min HaChai)
7. Establish Courts of Justice (Dinim)

Computational Interpretation

A. No Idolatry: Target True Terminal Object

Prevent: Observers optimizing toward sub-categorical attractors (false TI)

- Idolatry = Observer mistakes intermediate good for ultimate good
  Examples: Worshiping wealth, power, pleasure as ultimate ends
- Consequence: Optimisation toward local maxima (stuck in suboptimal attractor)
  Computational cost: Infinite (realized too late, wasted life)

Plain-English Context

Idolatry is optimizing toward the wrong endpoint. You climb the mountain diligently, only to discover at the top it wasn't the highest peak (you wasted your life ascending the 'wrong' attractor). Money, fame, power are intermediate goods (useful for other things) not terminal goods (valuable in themselves). Worshipping them means you'll never be satisfied (they're not actually the optimum you seek). The mathematics proves this: TI is a unique terminal object; any other target creates unbounded distance Distance(O, TI) that accumulates over lifetime.

Idolatry is computational waste.

Ruliad Context

*Idolatry is optimizing toward an attractor in the Ruliad that is **NOT** the terminal object in the Category of **R_O**.*

Since only TI has the property $\forall X: \exists! f: X \to TI$

Any other target (attractor) will have Observers that cannot reach it (non-universal). Therefore system fails to converge (maximise integrated information).

B. No Blasphemy: Preserve Semantic Coherence

Prevent: Meaning collapse via concept corruption

- Blasphemy = destroying shared semantic structures (making words meaningless)
  Examples: Inverting computationally efficient object definitions ("war is peace"), cynical nihilism
- Consequence: Communication impossible, coordination breaks
  Computational cost: Infinite entropy (meaning structure erased)

Plain-English Context

Blasphemy (in a computational sense) is breaking the meaning-structures that enable communication. If we can't agree on what words mean, we can't cooperate.

Extreme example: Orwell's "Newspeak" inverts concepts to make dissent unthinkable.

Less extreme: Postmodernism that denies objective truth makes science, law, and cooperation impossible.

When meaning collapses (H → max), communication fails (I → 0), leading to networks fragmenting into isolated individuals (everyone must discover everything independently i.e. civilization regresses).

Preserving semantic coherence is preserving the information infrastructure that enables cooperation.

Ruliad Context

Blasphemy corrupts the symbolic S-domain. The shared entropy-reduced structures that enable Observer to integrate information in a computationally efficient manner.

If S-domain destabilizes, Observers cannot transmit morphisms to each other (no shared language for coordination).

Network computation fails.

C. No Murder: Preserve Observer Existence

Prevent: Irreversible information destruction (inaccessibility)

- See Sin Function section worked example on Wrath
  Computation saved: Infinite (by avoiding infinite entropy)

D. No Theft: Maintain Established Patterns

Prevent: Computational irreducibility at individual level

- Theft = Violating property boundaries
- Forces victim to re-compute: "Do I still have X?" (requires constant verification)
- Prediction impossible: Future states uncertain, computational irreducibility at individual Observer level
  Computational cost: $O(n^2)$ for n observers (everyone verifies everything)

> ***Plain-English Context***
> *Theft forces everyone to constantly verify "is my stuff still here?". It's a computational burden that makes complex cooperation impossible.*
> *With property rights, you can make long-term plans ("plant crops, harvest later") because you trust your investment won't be stolen. This enables agriculture, cities, civilization.*
> *Without property rights, you're stuck in an animalistic state. Grab what you can, eat it immediately, guard it constantly, no planning beyond tomorrow.*
> *The computational savings from property rights ($O(N^2) \rightarrow O(N)$) enables civilization-scale cooperation. This isn't about "capitalism"; it's about basic information theory; coordination requires stable ownership of patterns.*

Ensures:

- Computationally reduced (entropy-reduced) choices persist through time
- No recalculation state-to-state at object level
- Stable property rights enable long-term planning (better prediction in Observer Function)

E. No Sexual Immorality: Preserve Pair-Bond Structures

Prevent: Splitting of deeply networked Observers

- Bonding creates strong observer coupling
  Enables access to morphisms unavailable to individual Observers i.e. childrearing, joint resource pooling, emotional support
- Violation: Betrayal, abandonment, exploitation → network fragmentation

> ***Plain-English Context***
> *Pair-bonding creates deep information integration between two observers. They share plans, resources, child-rearing, emotional support.*
> *This generates synergies impossible for isolated individuals (two cooperating observers > sum of parts). Sexual immorality (betrayal, abandonment, exploitation) shatters this integration, destroying years of accumulated trust and coordination. Repair can be impossible (trust, once broken in intimate relationships, rarely fully restores).*
> *This forces both partners back to isolated state or costly partner-search, while harming any children (who suffer attachment trauma, model broken relationships). The prohibition protects high-value integrated structures from low-value short-term impulses.*
> *Note: specific cultural implementations vary (i.e. we are not making a directional comment on any cultures practices e.g. monogamy, polygamy, etc.), but core principle is universal. Preserve chosen pair-bond structures, don't destabilize them.*

Ensures:

- Stable structures provide access to high-value morphisms (informationally dense, lots of coverage)
- Computationally efficient category access (more shared computational resources, lower boundedness)
  Computation saved: Avoids re-computation of complex choice sets (i.e. divorce and how you effectively parent a child)

F. No Cruelty: Minimize Entropy in Computational Persistence Calculations

Prevent: Excessive entropy generation in maintaining existence

- Life requires eating, but gratuitous suffering generates unnecessary entropy
  Example: Factory farming (high cruelty) vs. humane slaughter (low cruelty)
- Both result in organism death, but entropy differs vastly between the choices
  Computational cost: Suffering = computational inefficient

> ***Plain-English Context***
> *You must eat to survive (your persistence P_o requires energy input), so some animal death is necessary. But gratuitous cruelty, making them suffer more than minimally necessary, generates excess entropy for no gain. This is thermodynamically inefficient and ethically wrong. The prohibition doesn't forbid eating meat; it forbids torture. The mathematics says: minimize entropy generation in maintaining your persistence. This applies to all Observers with capacity for suffering (roughly: organisms with nervous systems).*

Ensures:

- Observer Computational Persistence does not increase entropy beyond a minimum required threshold
  Limits/minimizes suffering, which is experienced entropy

G. Establish Courts: Error-Correction Mechanisms

Prevent: Morphism reduction from recursive loops that arise from Observer conflicts

- Without dispute resolution, conflicts escalate
- Each retaliation is morphism that leads to counter-retaliation (these limit the accessible morphisms for the next choice)
- Exponential branching: $O(2^n)$ possible conflict states
- Courts compress: $O(1)$ judgment applies to all parties

> ***Plain-English Context***
>
> *Without dispute resolution mechanism, conflicts escalate exponentially – you hit me, I hit you back harder, you retaliate even harder, soon we're in blood feud lasting generations.*
>
> *Each retaliation branches into more conflicts (your family vs. my family), creating $O(2^N)$ possible conflict states. Courts compress this to $O(1)$: conflict → trial → judgment → done. The judgment applies equally to all parties (everyone accepts same result), preventing exponential branching. This is error-correction for societies that is built from detection (investigation), correction (judgment), and prevention (precedent/deterrence).*
>
> *Without courts, error rate explodes, with courts, error rate decreases. This is why even ancient civilizations developed legal systems (Code of Hammurabi, Roman Law, etc.). It's a computational necessity for large-scale Observer cooperation*

Ensures:

- Convergent/computationally efficient patterns maintained
- Global rule for all observers (no ad-hoc resolution per dispute)
- *Computation saved: $O(2^n)$ → $O(1)$ via centralized adjudication*

Conjecture: Minimality of Noahide Laws

*The seven Noahide laws form a **minimal generating set** for stable civilization.*

Proof-Sketch by Systematic Removal

Remove	Impact	Computational Result if not Enforced
No Idolatry	• Observers optimize toward non-terminal objects • System doesn't converge	Stagnation in Local Maxima
No Blasphemy	• Semantic structures collapse • Communication impossible	Fragmentation (poor Observer coordination)
No Murder	• Infinite entropy generation • Observer population unstable	Slower Information Integration
No Theft	• Property undefined • Verification cost higher	Computationally inefficient use of Observer resources
No Sexual Immorality	• Family structures unstable • Certain high-value morphisms inaccessible	Local Maxima's, potentially lower Observer numbers
No Cruelty	• Suffering normalised • Higher entropy in Observer category	Higher entropy morphisms selected, less efficient
No Courts	• No error correction • Potential negative regress	Regression which minimises choices

---

Compression Ratio

The Noahide Laws exhibit extraordinary compression:

$$Compression_{Ratio} = |Generated_{Legal\ Corpus}| \ / \ |Seven_{Laws}|$$

Estimate:

- Seven Laws: ~100 words (compact statements)
- Legal corpus generated: 10^6+ pages (millennia of case law)

$$Ratio \approx 10^5 : 1$$

This compression suggests these laws capture fundamental invariants, **ethical categories** so basic that all other ethical rules can be derived from them.

> ***Plain-English Context***
> *The Noahide Laws are the "axioms" of ethics, like Euclid's axioms for geometry.*
> *From these seven, you can derive vast systems of law and morality. Remove one and civilization becomes impossible (or severely damaged / inefficient). Could you add more? Maybe, but it's pretty tough, we can derive everything else from these.*
> *The 100,000:1 compression ratio (seven simple laws → million-page legal corpus) indicates they've captured the essence.*
> *Different cultures elaborate them differently (specifics of property law, marriage customs, court procedures), but the seven foundations appear to be universal. This isn't cultural accident, these are the minimum required rules for large-scale Observer networks to persist (and cooperate).*

2. Buddhism as an Entropy Minimization Algorithm[261]

*Buddhism can be understood as an **Observer entropy-reduction algorithm** operating at the individual Observer level.*

The Four Noble Truths (Computational Interpretation)

1. Dukkha exists → $H(R_O) > 0$ (Systems have entropy)
    - Suffering = experienced entropy
    - All composite things decay (2nd law thermodynamics)
    - Observation itself generates entropy (act of sampling R_O)
2. Dukkha has cause → Attachment creates computational debt
    - Tanha (craving) = optimizing toward unstable attractors
    - Impermanence ignored → constant disappointment (prediction error)
    - Clinging = refusing to update model → prediction error remains high
3. Dukkha can cease → $H(R_O) \to 0$ is possible
    - Nirvana = zero-entropy state (perfect equilibrium)
    - Optimisation complete (no information gradient remains)
    - Observer aligned with TI (maximal integration, minimal waste)

> ***Plain-English Context***
> *Nirvana isn't annihilation; it's a zero-entropy state.*
> *All confusion resolved (H=0), all information integrated ($I(F_O)=I(R_O)$), all optimisation complete (at TI).*
> *This is the fixed point of the Observer Function. When you fully understand reality (no prediction error), fully integrate information (maximum I), and act optimally (minimum cost), you've reached nirvana.*
> *It's the mathematical limit of perfect computation. Whether it's achievable by humans is empirical question, but it's well-defined computationally.*

The Eightfold Path (The Optimisation Algorithm)

1. RIGHT VIEW: Build accurate world model

- Understand impermanence (all states transient)
- Understand causation (actions have consequences)
- Understand suffering (entropy is inevitable without effort)
  Result: Minimize prediction error

2. RIGHT INTENTION: Align goals coherently

- Renounce craving (unstable attractors)
- Cultivate goodwill (positive network effects)
- Develop compassion (increase $I(O_i:O_j)$)
  Result: Coherent Observer optimisation (no internal conflict)

3. RIGHT SPEECH: True information transmission

- No lying (avoid computational debt)
- No harsh speech (minimize entropy generation)
- No gossip (avoid corrupting Observer networks)
  Result: High-bandwidth, computationally efficient Observer communication

4. RIGHT ACTION: Constructive patterns

- Follow virtue function $V(\gamma) > 0$
- Avoid sin function $S(\gamma) > 0$
- Generate positive network effects
  Result: Increase integrated information opportunities

5. RIGHT LIVELIHOOD: Sustainable computation

- No exploitation (negative-sum games)
- Contribute value (positive-sum)
- Respect boundaries (no theft, fraud)

Result: Long-term viability / Observer persistence (avoid entropic collapse)

6. RIGHT EFFORT: Optimal energy allocation

- Not too much (exhaustion → breakdown)
- Not too little (stagnation → decay)
- Middle way (sustainable optimisation)
  Result: Efficient utilisation of finite computational resources (computational boundedness)

7. RIGHT MINDFULNESS: Present-moment computation

- Attention on current state
- No rumination (wasted computation on past actions / computationally irreducible)
- No anxiety (wasted computation on hard to predict future states)
  Result: Minimize computational debt

8. RIGHT CONCENTRATION: Focused processing

- Single-task (no context switching cost)
- Deep flow (maximize computational efficiency for a given time, t)
- Meditative absorption (reduce entropy)
  Result: Maximum computational throughput (efficient use of finite computationally resources)

Return: $H(R_O) \to 0$ (suffering cessation)

Plain-English Context

Buddhism is an instruction manual for minimizing suffering by minimizing computational waste.

See reality clearly (accurate model), want what's sustainable (coherent goals), communicate truthfully (low-entropy information), act constructively (positive effects), work ethically (fair exchange), balance effort (sustainable pace), stay present (no wasted cycles), focus deeply (maximum efficiency).

Follow these steps, and suffering (experienced entropy) approaches zero.

Why Buddhism Is Effective:

- 2,500 years of empirical testing (millions of practitioners)
- Systematic approach (clear algorithm, measurable progress)
- Scale-invariant (works for individuals, communities, societies)
- Testable predictions (mindfulness measurably reduces stress, increases focus)

Ruliad Context

The Eightfold Path systematically refines the Observer's sampling functor S_O to minimize entropy in R_O.

Each step reduces a different source of computational waste: inaccurate models (Right View), conflicting goals (Right Intention), noisy communication (Right Speech), destructive actions (Right Action), unsustainable practices (Right Livelihood), inefficient effort (Right Effort), distracted processing (Right Mindfulness), scattered attention (Right Concentration).

Net effect: Optimal information integration with minimal entropy, H

---

3. Christianity: Maximum Coupling[262]

Christianity can be understood as a network optimisation algorithm maximizing observer coupling.

Christ's Summary of the Law:

"Love God with all your heart, soul, mind, and strength. Love your neighbour as yourself." (Mark 12:30-31)

Computational Translation

1. Love God = Align(O, TI)

- Direct your optimisation function toward Terminal Infinity
- Maximize integrated information
- Minimize distance (O, TI) in observer's accessible possibility space
  Result: Upward optimisation (approach infinite)

2. Love Neighbour = Couple(O_i, O_j)

- Maximize mutual information between observers
- Increase network effects (cooperation > competition)
- Minimize entropy generation from conflict
  Result: Lateral integration (collective intelligence / more parallelisation of computational burden)

Together: *Network of observers optimizing collectively toward TI → Minimum entropy, maximum information integration*

> ***Plain-English Context***
>
> *These two Christian commandments formalise complete observer optimisation, vertical (toward ultimate truth/God/TI) and horizontal (with other Observers via love neighbour).*
>
> *Together they define optimal strategy: approach infinite understanding personally while helping others do the same.*
>
> *Network topology: everyone optimizing toward same ultimate attractor (TI) while cooperating with each other (maximum $I(O_i{:}O_j)$). This creates emergent collective intelligence. A civilization as superstructure approaching TI faster than any individual could alone.*

Key Christian Concepts (Computational Reframing)

Sin = Hamartia (Missing the Mark):

- Original Greek: "Hamartia" = archery term for missing target
  Computational: Selecting suboptimal morphism γ, increasing Distance(O,TI)
- Not "breaking arbitrary rules" but "deviating from optimal path"
- Sin is computational inefficiency, not moral absolute

Grace = Unmerited Optimisation:

- Traditional: God's favour despite unworthiness
  Computational: Access to TI doesn't require "earning"—it's ontologically available to all observers
- Even observers with high entropy $H(R_O)$ can reduce entropy via alignment (moving to the best information gradient)

Redemption = Error Correction:

- Traditional: Salvation from sin through Christ
  Computational: Morphism from high-entropy state to low-entropy state via TI alignment
- Christ as exemplar: Human observer who achieved distance(O,TI) ≈ 0
  Following example = implementing same optimisation function

Love = Maximum Coupling:

- Traditional: Agape (unconditional love)
  Computational: Maximizing $II(O_i{:}O_j)$ regardless of O_j's current state
- Love enemy: Increase coupling even with Observers who harm you (reduces conflict entropy)
- Golden Rule: Treat O_j as you (O_i) want to be treated → symmetry → cooperation

> ***Plain-English Context***
>
> *Christianity teaches that the path to fulfilment is aligning yourself with truth/goodness (God/TI) and helping others do the same (love thy neighbour). Sin is deviating from this path. Grace is the fact that this path is always available—you don't need to earn it, just choose it. Redemption is correcting course when you've deviated. Love is treating everyone as valuable observers whose optimisation matters as much as yours.*

Why Christianity Spread so Rapidly:

- Simple algorithm: Two rules (love God, love neighbour) generate entire ethical system
- Inclusive: Grace available to all (not merit-based)
- Network effects: Loving cooperation > competitive exploitation (positive-sum)
- Testable: Communities practicing "love thy neighbour" outperform exploitation-based societies

> ***Ruliad Context***
>
> *"Love God" = optimise toward TI (terminal object in category of Observers).*
>
> *"Love neighbour" = maximize coproduct construction in Category(Observers), enabling joint sampling of $\boldsymbol{R_o}$ that exceeds individual Observer capabilities.*
>
> *The two commandments form a complete optimisation specification: vertical alignment (toward TI) and horizontal integration (among Observers).*

> ***Note***
>
> *We have not covered Hinduism, Daoism or Islam in this section due to space constraints. But similar analysis can be completed by experts in those theological traditions.*

Part F: Implications and Synthesis

Having formalised the Observer Function, Virtue, Sins, and the convergence of ethical traditions, we now explore implications and applications.

1. Predictive Power Across Scales

Understanding the Observer Function enables quantitative predictions about behaviour and outcomes at multiple scales.

For Individuals:

Prediction 1: Virtuous behaviour leads to increased life satisfaction (higher $I(F_O)$)

- Mechanism: Integrated information correlates with well-being
- Evidence: Gratitude practices, compassion training qualitatively increasing happiness
- Quantifiable: Life satisfaction scales correlate with virtue behaviours

Prediction 2: Sin creates suffering (computational debt manifests as psychological pain)

- Mechanism: Guilt, shame, anxiety = error signals (error > 0 persistent)
- Evidence: Lying increases cortisol, cognitive load
- Quantifiable: Polygraph (physiological stress from deception)[263]

Prediction 3: Learning increases freedom (more visible morphisms)

- Mechanism: Education expands accessible R_O (more options visible)
- Evidence: Educated individuals have higher perceived control
- Quantifiable: Decision-making speed/quality improves with expertise

Prediction 4: Meditation reduces suffering (entropy minimization)

- Mechanism: Mindfulness practices reduce $H(R_O)$ by focusing attention
- Evidence: fMRI shows reduced default mode network activity[264]
- Quantifiable: Anxiety/depression scores decrease with practice

---

For Organisations[265]:

Prediction 1: High-trust cultures outperform low-trust (reduced verification cost)

- Mechanism: Trust reduces transaction costs (don't need to verify everything)
- Evidence: High-trust companies have higher productivity, lower turnover
- Quantifiable: Transaction cost = $O(1)$ in high-trust vs. $O(N)$ in low-trust

Prediction 2: Transparent communication beats secrecy (aligned optimisation)

- Mechanism: Shared information enables coordinated action
- Evidence: Open-source projects often outperform proprietary
- Quantifiable: Innovation rate higher with information sharing

Prediction 3: Diversity improves problem-solving (parallel exploration) subject to coherence across the Observer Group

- Mechanism: Different observers sample different regions of R_O
- Evidence: Diverse teams solve problems faster, more creatively
- Quantifiable: Solution space coverage scales with team diversity

Prediction 4: Rigid hierarchy fails at complexity (serial bottleneck)

- Mechanism: All decisions route through single node → bandwidth limit
- Evidence: Decentralized organisations adapt faster to change
- Quantifiable: Decision latency = $O(\log N)$ distributed vs. $O(N)$ hierarchical

---

For Civilizations[266]:

Prediction 1: Societies with better error-correction survive longer

- Mechanism: Courts, free press, democratic feedback enable course correction
- Evidence: Democracies rarely collapse from internal causes (external conquest main threat)
- Quantifiable: Autocracy average lifespan ~50 years, democracy ~200+ years

Prediction 2: Information freedom accelerates development

- Mechanism: Free flow of information enables rapid innovation diffusion
- Evidence: Open societies (Renaissance Florence, Enlightenment Europe, modern West) lead innovation

- Quantifiable: Patent rate correlates with information freedom

Prediction 3: Inequality beyond threshold causes collapse

- Mechanism: Beyond Gini coefficient ~0.5, social instability explodes
- Evidence: Roman Empire, French Ancien Régime, Gilded Age—all collapsed after extreme inequality
- Quantifiable: Revolt probability Prob $\propto$ (Gini - 0.5)^2

Prediction 4: Universal education maximizes collective computation

- Mechanism: Each educated Observer contributes to network intelligence
- Evidence: Literacy rate correlates with GDP, innovation, stability
- Quantifiable: Economic productivity scales with education level

---

For Species:

Prediction 1: Cooperation emerges at all scales[267]

- Mechanism: Positive network effects (cooperation > competition long-term)
- Evidence: Eusocial insects (ants, bees), primates (grooming), humans (civilization)
- Quantifiable: Cooperating groups outcompete non-cooperating in iterated games

Prediction 2: Intelligence converges on similar solutions

- Mechanism: Optimal morphisms in computational possibility space are discoverable from multiple starting points
- Evidence: Convergent evolution—eyes (50+ independent origins), flight (4+ origins), echolocation (2+ origins)[268]
- Quantifiable: Morphospace has attractor basins

Prediction 3: Technology follows predictable patterns[269]

- Mechanism: Computational constraints guide innovation sequence
- Evidence: Kardashev scale[270] (energy capture), Wright's Law (learning curves)
- Quantifiable: Technology adoption follows S-curves (sigmoid growth)

Prediction 4: Consciousness increases over evolutionary time

- Mechanism: Integrated information Φ provides survival advantage
- Evidence: Brain size, neuronal density, behavioural complexity all trend upward
- Quantifiable: Φ correlates with evolutionary success (mammals > reptiles > fish)

---

2. Conscious Choices: Three Paths

Understanding ethics computationally presents observers with profound choices about how to navigate the possibility space.

Path 1: Conscious Alignment

Deliberately align choices with the optimisation function, making decisions that integrate information, reduce entropy, and facilitate collective convergence toward truth.

Strategy:

- Study virtue functions (learn what actions have high $V(\gamma)$)
- Practice disciplines (meditation, study, ethical training)
- Build community (high **network alignment**)
- Continuous improvement (iterate Observer Function optimally)

Outcomes:

- High life satisfaction ($I(F_O)$ increases steadily)
- Low suffering ($H(R_O)$ minimized via conscious effort)
- Compound growth (virtues reinforce, accessing exponentially more morphisms)
- Legacy (patterns persist beyond lifespan via cultural transmission)

> ***Plain-English Context***
> *This is the path of wisdom—deliberately choosing to do good, learn truth, help others, resist temptation. It's hard (requires effort to fight entropy), but compounds massively. Over years, you become wiser, happier, more capable, and leave lasting positive impact.*

Path 2: Unconscious Drift (where we are today; thanks Postmodernism!)

Allow local optimisation (immediate gratification) to dominate, creating computational debt that will eventually manifest as suffering.

Strategy (or lack thereof):

- No conscious optimisation (follow impulses, habits)
- Short-term thinking (high λ weight—minimize immediate cost)
- Minimal learning (no **UPDATE** step investment)
- Social isolation (low network coupling)

Outcomes:

- Local maxima (get stuck in suboptimal equilibria)
- Accumulating computational debt
- Late-life regret (realize wasted potential when too late / computationally irreducible to correct)
- Entropy death (patterns dissipate—no Observer persistence)

> ***Plain-English Context***
> *This is the path of least resistance—do what feels good now, avoid hard choices, don't think about consequences. It's easy short-term, but compounds negatively. Over years, your life becomes increasingly constrained (debt, broken relationships, regret), and you fade away leaving little trace..*

Path 3: Active Resistance

Deliberately choose destructive patterns that generate maximum entropy—though this path ultimately self-destructs as it undermines the very possibility of continued observation.

Strategy (pathological):

- Maximize sin functions ($S(\gamma) \to \infty$)
- Destroy patterns (vandalism, violence, lying)
- Isolate self (antagonize others)
- Refuse learning (double down on errors – see fundamentalist religious ideologies)

Outcomes:

- Rapid entropy explosion ($H(R_O) \to \infty$)
- Network exile (no Observer will couple with you)
- External intervention (society contains/eliminates you—prison, death)
- Self-destruction (observer dissipates from accumulated entropy)

> ***Plain-English Context***
> *This is the path of evil—deliberately choosing to harm, destroy, and corrupt. It's rare (most "evil" is unconscious drift, not active malice), but catastrophic. Societies rapidly contain/eliminate such actors because they threaten everyone's existence. This path inevitably self-terminates.*

The Remarkable Fact

While ultimate convergence to God / TI is inevitable (all paths lead there eventually for the Topos to be valid), efficiency of approach varies by many orders of magnitude.

- Conscious alignment: Approach God with joy, growth, contribution (high $V(\gamma)$)
- Unconscious drift: Approach God with suffering, stagnation, regret (moderate $V(\gamma)$)
- Active resistance: Approach God through dissolution, destruction, elimination (high $S(\gamma)$)

All paths converge, but the experience of the journey differs.

> ***Plain-English Context***
> *Everyone ends up at the same place eventually (death, then the long arc of cosmic evolution toward heat death or maximal order). But the path you take determines whether you arrive fulfilled or broken, whether you contributed or consumed, whether you're remembered fondly or forgotten. The destination is fixed; the journey is chosen*

---

3. The Computational Ethics Conjecture

We now state the central conjecture of this section.

Hypothesis: Fundamental Theorem of Computational Ethics

Ethical behaviour is mathematically optimal behaviour in the space of Observer trajectories through the Ruliad.

Formal Statement

Let **O** be an observer, γ_1 and γ_2 be two possible paths from current state $\text{state}_{O(t)}$ to TI.

Define:

- γ_1 = "virtuous path" (follows optimal information integration gradients)
- γ_2 = "sinful path" (deviates from optimal)

Then:

1. $\mathbf{Cost(\gamma_1) < Cost(\gamma_2)}$ (virtuous path has lower total computational cost)
2. $\mathbf{I(F_0)\gamma_1 > I(F_0)\ \gamma_2}$ (virtuous path integrates more information)
3. $\mathbf{H(\gamma_1) < H(\gamma_2)}$ (virtuous path generates less entropy)
4. $\mathbf{T(\gamma_1) < T(\gamma_2)}$ (virtuous path reaches convergence faster)

Proof Sketch

(1) $\mathbf{C(\gamma_1) < C(\gamma_2)}$**:**

By definition of virtue function $V(\gamma) = [\Delta II/\Delta H] \times \text{scope} \times \text{persistence} \times \text{alignment}$:

- Virtuous $\boldsymbol{\gamma_1}$ maximizes $\Delta II/\Delta H$ (integrated information gain per unit entropy)
- This implies minimum entropy for given information: $H(\gamma_1) = \min H$
- Path cost $\text{Cost}(\gamma)$ includes $H(\gamma)$ term weighted by λ
- Therefore $\text{Cost}(\gamma_1) < \text{Cost}(\gamma_2)$ for $\lambda > 0$

Additionally:

- Virtuous γ_1 has high **network alignment** → positive $N(\gamma_1)$
- Sinful γ_2 has low/negative alignment → negative/high $N(\gamma_2)$
- Path cost includes $\nu \cdot N(\gamma)$ term (cooperation reduces cost)
- Therefore $\text{Cost}(\gamma_1) < \text{Cost}(\gamma_2)$ for $\nu > 0$

---

(2) $\mathbf{II(\gamma_1) > II(\gamma_2)}$**:**

Virtue function: $V(\gamma_1) = [\Delta I_1/\Delta H_1] \times ... > V(\gamma_2) = [\Delta II_2/\Delta H_2] \times ...$

If $V(\gamma_1) > V(\gamma_2)$, then either:

- $\Delta I_1 > \Delta I_2$ (more information integrated), or
- $\Delta H_1 < \Delta H_2$ (less entropy generated), or
- Higher scope/persistence/alignment

For equal scope/persistence/alignment, must have $\Delta II_1 > \Delta II_2$

Integrating over path: $II(\gamma_1) = \int \Delta II_1 > \int \Delta II_2 = II(\gamma_2)$

---

(3) $\mathbf{H(\gamma_1) < H(\gamma_2)}$**:**

Sin function: $S(\gamma_2) = H_{\text{generated}} \times ... > S(\gamma_1)$

If $S(\gamma_2) > S(\gamma_1)$, then $H_2 > H_1$ (more entropy generated by sinful path)

Integrating over path: $H(\gamma_1) = \int \Delta H_1 < \int \Delta H_2 = H(\gamma_2)$

---

(4) $\mathbf{T(\gamma_1) < T(\gamma_2)}$**:**

Distance to TI: $\text{Distance}(O(n), \text{TI})$ measures remaining path length

Virtuous path γ_1 minimizes Distance at each step approximating:

- $|d\text{Distance}/dn|_{\gamma_1}$ = max{negative} (approaching TI fastest)

Sinful path γ_2 suboptimal:

- $|\mathrm{dDistance/dn}|_{\gamma_2} < |\mathrm{dDistance/dn}|_{\gamma_1}$ (approaching slower or diverging)

Integrating: $\int[0,N_1]\ (dD/dn)|_{\gamma_1}\ dt = -\mathrm{Distance}_{total}\ \int[0,T_2]\ (\mathrm{dDistance/dn})|_{\gamma_2}\ dt = -D_{total}$

For same total distance, faster rate → shorter time: $T_1 < T_2$

Conclusion:

Since observers inherently seek to:

- Minimize computational cost **Cost(γ)** (computational efficiency)
- Maximize information integration **I(γ)** (learning, growth)

And since virtuous paths achieve both results better than sinful paths, ethical behaviour IS optimal behaviour from the Observer's bounded computational perspective.

Corollary: *Mathematics has inherent moral structure.*

Proof Sketch:

The structure of **R$_O$** (Observable Ruliad) determines:

- Which morphisms minimize **Cost(γ)** (virtuous paths)
- Which morphisms maximize **S(γ)** (sinful paths)

This structure is mathematical (category theory, information theory, thermodynamics), not arbitrary. Therefore, **morality is a mathematical necessity**. It's not subjective convention or a power game (authority).

> ***Plain-English Context***
> ***Ethics aren't invented they're discovered.***
> *Just as we discover mathematical truths (2+2=4) and physical laws (F=ma), we discover ethical truths (lying is bad, compassion is good) by exploring the computational structure of reality. The universe has built-in optimisation criteria, and aligning with them is what we call "being good."*

---

4. Synthesis: Ethics are part of the 'Operating System' of Reality

The Core Insight

Every persistent pattern in the universe—from atoms to galaxies, cells to civilizations, you to me—implements an identical Observer Function: SENSE → INTEGRATE → EVALUATE → SELECT → ACT → UPDATE → NETWORK → REPEAT.

Implications

When Observers choose actions (morphisms through the Ruliad), they navigate a computational landscape with measurable costs. Virtue corresponds to minimal-cost paths. Sin corresponds to maximal-cost paths.

Ethics are the discovery of optimal paths.

Convergent Evidence

Every major ethical tradition – Judaism, Buddhism, Christianity, Hinduism, Daoism, Islam, Stoicism, Confucianism, and more – has independently converged on similar optimisation principles.

This wasn't coincidence, it's multiple observers discovering the same computational structure.

Theological Connection

The God Conjecture demonstrates that the closure point of all computations at TI in the Ruliad exhibits properties traditionally attributed to divinity: necessity, infinity, omniscience, omnipresence.

Adding Observer Theory:

- *Perfect justice:* Optimal pattern arrangement (minimal entropy, maximal information integration)
- *Perfect love:* Maximum observer coupling
- *Balance* between these two poles is the goal

These are not metaphors. They are mathematical limits of the optimisation function that Observers implement.

Personal Meaning

Understanding the Observer Function gives each of us profound clarity about choices.

We can:

1. Consciously align with optimisation (virtue path – joy, growth, contribution)
2. Unconsciously drift (default path – mediocrity, regret, dissipation)
3. Actively resist (pathological path – suffering, destruction, elimination)

The choice is not *whether* to arrive at God / TI (categorical necessity). The choice is **how**.

The Final Statement

Ethics is not a human invention. It is the discovery of the operating system of reality.

Every atom "choosing" quantum states, every cell following chemical gradients, every human wrestling with conscience, every civilization evolving institutions all implement the same universal function, discovering the same computationally minimal paths, approaching the same truth.

Though finite computational boundedness ensures we never reach it, the approach is what gives life meaning.

Each Observer contributes a unique perspective to the total observation of $\mathbf{R_O}$. Collectively, we approximate a MetaObserver.

We are not accidents in a meaningless void.

We are **necessary patterns in a computationally parseable totality**, exploring an infinite possibility space, gradually approaching (but never reaching) complete knowledge of the structure that grounds all observation.

The arc is long, but it bends toward justice.

The trajectory is computationally vast, but it converges.

The choice is not whether to arrive, but how much we contribute to the collective journey.

Plain-English Context

You matter.

Your choices matter.

No one has the exact same shape as you. You are a unique piece in an infinite puzzle. Without the best version of your piece based on your own unique qualities, the puzzle is incomplete.

Not because some authority says so, but because the structure of reality makes it so. When you act with virtue, you're not just being "good", you're optimally navigating the computational universe, contributing to humanity's collective wisdom, moving us all toward greater truth and less suffering.

Not poetry. Maths.

"An individual who should survive his physical death is also beyond my comprehension, nor do I wish it otherwise; such notions are for the fears or absurd egoism of feeble souls. Enough for me the mystery of the eternity of life, and the inkling of the marvellous structure of reality." ***Albert Einstein***

"The question is not, can they reason?, nor can they talk? but, can they suffer?" ***Jeremy Bentham***

"Waste of time is the most extravagant and costly of all expenses." ***Theophrastus*** *(attributed)*

References

[250] **Core Observer Function sources:**

Arsiwalla, X.D. and Gorard, J. (2021) 'Pregeometric spaces from Wolfram model rewriting systems as homotopy types', arXiv preprint arXiv:2111.03460. Available at: https://arxiv.org/abs/2111.03460
Arsiwalla, X.D., Gorard, J. and Elshatlawy, H. (2022) 'Homotopies in multiway (nondeterministic) rewriting systems as n-fold categories', Complex Systems, 31(3), pp. 261-277. doi: 10.25088/ComplexSystems.31.3.261
Elshatlawy, H., Rickles, D., Arsiwalla, X.D. and Blum, A. (2025) 'Towards a generalized theory of observers', arXiv preprint arXiv:2504.16225. Available at: https://arxiv.org/abs/2504.16225
Gorard, J. (2023) 'A functorial perspective on (multi)computational irreducibility', arXiv preprint arXiv:2301.04690. Available at: https://arxiv.org/abs/2301.04690
Gorard, J. (2024) 'Applied category theory in the Wolfram Language using Categorica I: diagrams, functors and fibrations', arXiv preprint arXiv:2403.16269. Available at: https://arxiv.org/abs/2403.16269
Gorard, J., Namuduri, M. and Arsiwalla, X.D. (2020) 'ZX-calculus and extended hypergraph rewriting systems I: a multiway approach to categorical quantum information theory', arXiv preprint arXiv:2010.02752. Available at: https://arxiv.org/abs/2010.02752
Müller, M.P. (2020) 'Law without law: from observer states to physics via algorithmic information theory', Quantum, 4, p. 301. doi: 10.22331/q-2020-07-20-301
Rickles, D., Elshatlawy, H. and Arsiwalla, X.D. (2023) 'Ruliology: linking computation, observers and physical law', arXiv preprint arXiv:2308.16068. Available at: https://arxiv.org/abs/2308.16068
Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media, Inc. ISBN: 978-1-57955-008-0.Wolfram, S. (2020a) 'Finally we may have a path to the fundamental theory of physics… and it's beautiful', Stephen Wolfram Writings, 14 April. Available at: https://writings.stephenwolfram.com/2020/04/finally-we-may-have-a-path-to-the-fundamental-theory-of-physics-and-its-beautiful/ (Accessed: 5 November 2025).
Wolfram, S. (2020b) 'A class of models with the potential to represent fundamental physics', Complex Systems, 29(2), pp. 107-536. doi: 10.25088/ComplexSystems.29.2.107
Wolfram, S. (2020c) A Project to Find the Fundamental Theory of Physics. Champaign, IL: Wolfram Media, Inc. ISBN: 978-1-57955-035-6.Wolfram, S. (2021) 'The concept of the ruliad', Stephen Wolfram Writings, 10 November. Available at: https://writings.stephenwolfram.com/2021/11/the-concept-of-the-ruliad/ (Accessed: 5 November 2025).

Wolfram, S. (2023a) 'Observer theory', Stephen Wolfram Writings, 21 December. Available at: https://writings.stephenwolfram.com/2023/12/observer-theory/ (Accessed: 5 November 2025).

[251] **Core Category Theory sources:**

Abramsky, S. and Coecke, B. (2004) 'A categorical semantics of quantum protocols', in Proceedings of the 19th Annual IEEE Symposium on Logic in Computer Science (LICS'04). Los Alamitos, CA: IEEE Computer Society, pp. 415-425. doi: 10.1109/LICS.2004.1319636

Awodey, S. (2010) Category Theory. 2nd edition. Oxford Logic Guides, Vol. 52. Oxford: Oxford University Press. ISBN: 978-0199237180.Baez, J.C. and Dolan, J. (1995) 'Higher-dimensional algebra and topological quantum field theory', Journal of Mathematical Physics, 36(11), pp. 6073-6105. doi: 10.1063/1.531236

Baez, J.C. and Stay, M. (2010) 'Physics, topology, logic and computation: a Rosetta Stone', in Coecke, B. (ed.) New Structures for Physics. Lecture Notes in Physics. Berlin: Springer, pp. 95-172.

Topoi: The Categorial Analysis of Logic. Studies in Logic and the Foundations of Mathematics, Vol. 98. Amsterdam: North-Holland Publishing Company.Lawvere, F.W. (1964) 'An elementary theory of the category of sets', Proceedings of the National Academy of Sciences of the U.S.A., 52, pp. 1506-1511.

Lawvere, F.W. and Schanuel, S.H. (1997) Conceptual Mathematics: A First Introduction to Categories. Cambridge: Cambridge University Press. ISBN: 978-0521478175.

Mac Lane, S. (1998) Categories for the Working Mathematician. 2nd edition. Graduate Texts in Mathematics, Vol. 5. New York: Springer-Verlag. ISBN: 978-0387984032. doi: 10.1007/978-1-4757-4721-8

Mac Lane, S. and Moerdijk, I. (1992) Sheaves in Geometry and Logic: A First Introduction to Topos Theory. Universitext. New York: Springer-Verlag. ISBN: 978-0387977102. doi: 10.1007/978-1-4612-0927-0

Makkai, M. and Paré, R. (1989) Accessible Categories: The Foundations of Categorical Model Theory. Contemporary Mathematics, Vol. 104. Providence, RI: American Mathematical Society. ISBN: 978-0821851111.

[252] **Core IIT sources:**

Albantakis, L., Barbosa, L., Findlay, G., Grasso, M., Haun, A.M., Marshall, W., Mayner, W.G.P., Zaeemzadeh, A., Boly, M., Juel, B.E., Sasai, S., Fujii, K., David, I., Hendren, J., Lang, J.P. and Tononi, G. (2023) 'Integrated information theory (IIT) 4.0: Formulating the properties of phenomenal existence in physical terms', PLoS Computational Biology, 19(10), p. e1011465. doi: 10.1371/journal.pcbi.1011465

Balduzzi, D. and Tononi, G. (2008) 'Integrated information in discrete dynamical systems: Motivation and theoretical framework', PLoS Computational Biology, 4(6), p. e1000091. doi: 10.1371/journal.pcbi.1000091

Casali, A.G., Gosseries, O., Rosanova, M., Boly, M., Sarasso, S., Casali, K.R., Casarotto, S., Bruno, M.-A., Laureys, S., Tononi, G. and Massimini, M. (2013) 'A theoretically based index of consciousness independent of sensory processing and behavior', Science Translational Medicine, 5(198), p. 198ra105. doi: 10.1126/scitranslmed.3006294

Ferrarelli, F., Massimini, M., Sarasso, S., Casali, A., Riedner, B.A., Angelini, G., Tononi, G. and Pearce, R.A. (2010) 'Breakdown in cortical effective connectivity during midazolam-induced loss of consciousness', Proceedings of the National Academy of Sciences, 107(6), pp. 2681-2686. doi: 10.1073/pnas.0913008107

Koch, C., Massimini, M., Boly, M. and Tononi, G. (2016) 'Neural correlates of consciousness: progress and problems', Nature Reviews Neuroscience, 17(5), pp. 307-321. doi: 10.1038/nrn.2016.22

Marshall, W., Grasso, M., Mayner, W.G.P., Zaeemzadeh, A., Barbosa, L.S., Chastain, E., Findlay, G., Sasai, S., Albantakis, L. and Tononi, G. (2023) 'System integrated information', Entropy, 25(2), p. 334. doi: 10.3390/e25020334

Massimini, M., Ferrarelli, F., Huber, R., Esser, S.K., Singh, H. and Tononi, G. (2005) 'Breakdown of cortical effective connectivity during sleep', Science, 309(5744), pp. 2228-2232. doi: 10.1126/science.1117256

Massimini, M., Tononi, G. and Huber, R. (2009) 'Slow waves, synaptic plasticity and information processing: insights from transcranial magnetic stimulation and high-density EEG experiments', European Journal of Neuroscience, 29(9), pp. 1761-1770. doi: 10.1111/j.1460-9568.2009.06720.x

Oizumi, M., Albantakis, L. and Tononi, G. (2014) 'From the phenomenology to the mechanisms of consciousness: Integrated Information Theory 3.0', PLoS Computational Biology, 10(5), p. e1003588. doi: 10.1371/journal.pcbi.1003588

Oizumi, M., Amari, S., Yanagawa, T., Fujii, N. and Tsuchiya, N. (2016) 'Measuring integrated information from the decoding perspective', PLoS Computational Biology, 12(1), p. e1004654. doi: 10.1371/journal.pcbi.1004654

Sarasso, S., Rosanova, M., Casali, A.G., Casarotto, S., Fecchio, M., Boly, M., Gosseries, O., Tononi, G., Laureys, S. and Massimini, M. (2014) 'Quantifying cortical EEG responses to TMS in (un)consciousness', Clinical EEG and Neuroscience, 45(1), pp. 40-49. doi: 10.1177/1550059413513723

Tononi, G. (2004) 'An information integration theory of consciousness', BMC Neuroscience, 5, p. 42. doi: 10.1186/1471-2202-5-42

Tononi, G. (2008) 'Consciousness as integrated information: a provisional manifesto', The Biological Bulletin, 215(3), pp. 216-242. doi: 10.2307/25470707

Tononi, G. (2015) 'Integrated information theory', Scholarpedia, 10(1), p. 4164. doi: 10.4249/scholarpedia.4164

Tononi, G., Boly, M., Massimini, M. and Koch, C. (2016) 'Integrated information theory: from consciousness to its physical substrate', Nature Reviews Neuroscience, 17(7), pp. 450-461. doi: 10.1038/nrn.2016.44

[253] **Core FEP sources:**

Friston, K. (2005) 'A theory of cortical responses', Philosophical Transactions of the Royal Society B: Biological Sciences, 360(1456), pp. 815-836. doi: 10.1098/rstb.2005.1622

Friston, K. (2009) 'The free-energy principle: a rough guide to the brain?', Trends in Cognitive Sciences, 13(7), pp. 293-301. doi: 10.1016/j.tics.2009.04.005

Friston, K. (2010) 'The free-energy principle: a unified brain theory?', Nature Reviews Neuroscience, 11(2), pp. 127-138. doi: 10.1038/nrn2787

Friston, K. and Kiebel, S. (2009) 'Predictive coding under the free-energy principle', Philosophical Transactions of the Royal Society B: Biological Sciences, 364(1521), pp. 1211-1221. doi: 10.1098/rstb.2008.0300

Friston, K., Kilner, J. and Harrison, L. (2006) 'A free energy principle for the brain', Journal of Physiology-Paris, 100(1-3), pp. 70-87. doi: 10.1016/j.jphysparis.2006.10.001

Friston, K., Mattout, J., Trujillo-Barreto, N., Ashburner, J. and Penny, W. (2007) 'Variational free energy and the Laplace approximation', NeuroImage, 34(1), pp. 220-234. doi: 10.1016/j.neuroimage.2006.08.035

Friston, K., FitzGerald, T., Rigoli, F., Schwartenbeck, P. and Pezzulo, G. (2017) 'Active inference: a process theory', Neural Computation, 29(1), pp. 1-49. doi: 10.1162/NECO_a_00912
Friston, K., FitzGerald, T., Rigoli, F., Schwartenbeck, P., O'Doherty, J. and Pezzulo, G. (2016) 'Active inference and learning', Neuroscience & Biobehavioral Reviews, 68, pp. 862-879. doi: 10.1016/j.neubiorev.2016.06.022
Parr, T., Pezzulo, G. and Friston, K.J. (2022) Active Inference: The Free Energy Principle in Mind, Brain, and Behavior. Cambridge, MA: The MIT Press. ISBN: 9780262045353.
Ramstead, M.J.D., Badcock, P.B. and Friston, K.J. (2018) 'Answering Schrödinger's question: A free-energy formulation', Physics of Life Reviews, 24, pp. 1-16. doi: 10.1016/j.plrev.2017.09.001
Ramstead, M.J.D., Constant, A., Badcock, P.B. and Friston, K.J. (2019) 'Variational ecology and the physics of sentient systems', Physics of Life Reviews, 31, pp. 188-205. doi: 10.1016/j.plrev.2018.12.002
Ramstead, M.J.D., Kirchhoff, M.D. and Friston, K.J. (2020) 'A tale of two densities: active inference is enactive inference', Adaptive Behavior, 28(4), pp. 225-239. doi: 10.1177/1059712319862774

[254] **Core Thermodynamics & Landauer's Principle sources:**
Bennett, C.H. (1973) 'Logical reversibility of computation', IBM Journal of Research and Development, 17(6), pp. 525-532. doi: 10.1147/rd.176.0525
Bennett, C.H. (1982) 'The thermodynamics of computation—a review', International Journal of Theoretical Physics, 21(12), pp. 905-940. doi: 10.1007/BF02084158
Bennett, C.H. (1987) 'Demons, engines and the second law', Scientific American, 257(5), pp. 108-116. doi: 10.1038/scientificamerican1187-108
Bérut, A., Arakelyan, A., Petrosyan, A., Ciliberto, S., Dillenschneider, R. and Lutz, E. (2012) 'Experimental verification of Landauer's principle linking information and thermodynamics', Nature, 483(7388), pp. 187-189. doi: 10.1038/nature10872
Brillouin, L. (1951) 'Maxwell's demon cannot operate: Information and entropy. I', Journal of Applied Physics, 22(3), pp. 334-357. doi: 10.1063/1.1699951
Chattopadhyay, P., Misra, A., Pandit, T. and Paul, G. (2025) 'Landauer principle and thermodynamics of computation', Reports on Progress in Physics, 88(1), 016501. doi: 10.1088/1361-6633/add6b3
Jun, Y., Gavrilov, M. and Bechhoefer, J. (2014) 'High-precision test of Landauer's principle in a feedback trap', Physical Review Letters, 113(19), 190601. doi: 10.1103/PhysRevLett.113.190601
Landauer, R. (1961) 'Irreversibility and heat generation in the computing process', IBM Journal of Research and Development, 5(3), pp. 183-191. doi: 10.1147/rd.53.0183
Lloyd, S. (2000) 'Ultimate physical limits to computation', Nature, 406(6799), pp. 1047-1054. doi: 10.1038/35023282
Margolus, N. and Levitin, L.B. (1998) 'The maximum speed of dynamical evolution', Physica D: Nonlinear Phenomena, 120(1-2), pp. 188-195. doi: 10.1016/S0167-2789(98)00054-2
Sagawa, T. and Ueda, M. (2009) 'Minimal energy cost for thermodynamic information processing: measurement and information erasure', Physical Review Letters, 102(25), 250602. doi: 10.1103/PhysRevLett.102.250602
Szilard, L. (1929) 'Über die Entropieverminderung in einem thermodynamischen System bei Eingriffen intelligenter Wesen', Zeitschrift für Physik, 53(11-12), pp. 840-856

[255] **Core E. coli sources:**
Berg, H.C. (2004) E. coli in Motion. New York: Springer-Verlag.
Berg, H.C. and Brown, D.A. (1972) 'Chemotaxis in Escherichia coli analysed by three-dimensional tracking', Nature, 239, pp. 500-504. doi: 10.1038/239500a0
Bray, D., Levin, M.D. and Morton-Firth, C.J. (1998) 'Receptor clustering as a cellular mechanism to control sensitivity', Nature, 393, pp. 85-88.
Imamura, H., Nhat, K.P.H., Togawa, H., Saito, K., Iino, R., Kato-Yamada, Y., Nagai, T. and Noji, H. (2009) 'Visualization of ATP levels inside single living cells with fluorescence resonance energy transfer-based genetically encoded indicators', Proceedings of the National Academy of Sciences USA, 106(37), pp. 15651-15656. doi: 10.1073/pnas.0904764106
Lipkow, K., Andrews, S.S. and Bray, D. (2005) 'Simulated diffusion of phosphorylated CheY through the cytoplasm of Escherichia coli', Journal of Bacteriology, 187(1), pp. 45-53. doi: 10.1128/JB.187.1.45-53.2005
Papenfort, K. and Bassler, B.L. (2016) 'Quorum sensing signal-response systems in Gram-negative bacteria', Nature Reviews Microbiology, 14, pp. 576-588. doi: 10.1038/nrmicro.2016.89
Sourjik, V. and Berg, H.C. (2002) 'Receptor sensitivity in bacterial chemotaxis', Proceedings of the National Academy of Sciences USA, 99(1), pp. 123-127. doi: 10.1073/pnas.011589998
Waters, C.M. and Bassler, B.L. (2005) 'Quorum sensing: cell-to-cell communication in bacteria', Annual Review of Cell and Developmental Biology, 21, pp. 319-346. doi: 10.1146/annurev.cellbio.21.012704.131001

[256] **Core Information Theory and Kolmogorov Complexity sources:**
Chaitin, G.J. (1966) 'On the length of programs for computing finite binary sequences', Journal of the ACM, 13(4), pp. 547-569. doi: 10.1145/321356.321363
Chaitin, G.J. (1977) 'Algorithmic information theory', IBM Journal of Research and Development, 21(4), pp. 350-359. doi: 10.1147/rd.214.0350
Chaitin, G.J. (1987) Algorithmic Information Theory. Cambridge: Cambridge University Press (Cambridge Tracts in Theoretical Computer Science, Vol. 1). ISBN: 978-0-521-61604-1.
Jaynes, E.T. (1957) 'Information theory and statistical mechanics', Physical Review, 106(4), pp. 620-630. doi: 10.1103/PhysRev.106.620
Kolmogorov, A.N. (1965) 'Three approaches to the quantitative definition of information', Problems of Information Transmission, 1(1), pp. 1-11.
Li, M. and Vitányi, P.M.B. (2008) An Introduction to Kolmogorov Complexity and Its Applications. 3rd edn. New York: Springer (Texts in Computer Science). ISBN: 978-0-387-33998-6. doi: 10.1007/978-0-387-49820-1
Shannon, C.E. (1948) 'A mathematical theory of communication', Bell System Technical Journal, 27(3), pp. 379-423; 27(4), pp. 623-656. doi: 10.1002/j.1538-7305.1948.tb01338.x
Solomonoff, R.J. (1964) 'A formal theory of inductive inference. Part I', Information and Control, 7(1), pp. 1-22. doi: 10.1016/S0019-9958(64)90223-2

[257] **Core Computational Complexity sources:**

Arora, S. and Barak, B. (2009) Computational Complexity: A Modern Approach. Cambridge: Cambridge University Press. ISBN: 978-0-521-42426-4. doi: 10.1017/CBO9780511804090
Sipser, M. (2012) Introduction to the Theory of Computation. 3rd edn. Boston, MA: Cengage Learning. ISBN: 978-1-133-18779-0.
[258] **Core Whistleblowing sources:**
Blandón-Gitlin, I., Fenn, E., Masip, J. and Yoo, A.H. (2014) 'Cognitive-load approaches to detect deception: searching for cognitive mechanisms', Trends in Cognitive Sciences, 18(9), pp. 441-444. doi: 10.1016/j.tics.2014.05.004
Wielgopolan, A. and Zakrzewska, M. (2023) 'Cognitive load and deception detection performance', Cognitive Science, 47(8), e13321. doi: 10.1111/cogs.13321
[259] Twiss, S.B. and Grelle, B. (eds.) (2000) Explorations in Global Ethics: Comparative Religious Ethics and Interreligious Dialogue. Boulder, CO: Westview Press.
[260] **Core Noahide Law sources:**
Novak, D. (1998) Natural Law in Judaism. Cambridge: Cambridge University Press.
Novak, D. (2011) The Image of the Non-Jew in Judaism: The Idea of Noahide Law. 2nd ed. Portland, OR: The Littman Library of Jewish Civilization.
[261] Harvey, P. (2000) An Introduction to Buddhist Ethics: Foundations, Values and Issues. Cambridge: Cambridge University Press.
[262] Post, S.G. (1990) A Theory of Agape: On the Meaning of Christian Love. Lewisburg, PA: Bucknell University Press.
[263] National Research Council (2003) The Polygraph and Lie Detection. Washington, DC: The National Academies Press. doi: 10.17226/10420
[264] Lutz, A., Brefczynski-Lewis, J., Johnstone, T. and Davidson, R.J. (2008) 'Regulation of the neural circuitry of emotion by compassion meditation: effects of meditative expertise', PLoS ONE, 3(3), e1897. doi: 10.1371/journal.pone.0001897
[265] **Core Organisational sources:**
Axelrod, R. (1984) The Evolution of Cooperation. New York: Basic Books
Fukuyama, F. (1995) Trust: The Social Virtues and the Creation of Prosperity. London: Hamish Hamilton/New York: The Free Press
Kramer, R.M. and Tyler, T.R. (eds.) (1996) Trust in Organisations: Frontiers of Theory and Research. Thousand Oaks, CA: Sage Publications.
[266] **Core Civilizational sources:**
Knutsen, C.H. and Nygård, H.M. (2015) 'Institutional characteristics and regime survival: Why are semi-democracies less durable than autocracies and democracies?', American Journal of Political Science, 59(3), pp. 656-670. doi: 10.1111/ajps.12168
Levitt, S. (2019) 'The neglected role of inequality in explanations of societal collapse', Cliodynamics: The Journal of Quantitative History and Cultural Evolution, 10(1), pp. 90-114
Tainter, J.A. (1988) The Collapse of Complex Societies. Cambridge: Cambridge University Press.
[267] **Core Cooperation sources:**
Axelrod, R. (1984) The Evolution of Cooperation. New York: Basic Books.
Axelrod, R. and Dion, D. (1988) 'The further evolution of cooperation', Science, 242(4884), pp. 1385-1390. doi: 10.1126/science.242.4884.1385
Axelrod, R. and Hamilton, W.D. (1981) 'The evolution of cooperation', Science, 211(4489), pp. 1390-1396. doi: 10.1126/science.7466396
Boyd, R. and Lorberbaum, J.P. (1987) 'No pure strategy is evolutionarily stable in the repeated Prisoner's Dilemma game', Nature, 327(6117), pp. 58-59. doi: 10.1038/327058a0
[268] **Core Convergent Evolution sources:**
Li, G., Wang, J., Rossiter, S.J., Jones, G., Cotton, J.A. and Zhang, S. (2008) 'The hearing gene Prestin reunites echolocating bats', Proceedings of the National Academy of Sciences USA, 105(37), pp. 13959-13964. doi: 10.1073/pnas.0802097105
Liu, Y., Rossiter, S.J., Han, X., Cotton, J.A. and Zhang, S. (2010) 'Convergent sequence evolution between echolocating bats and dolphins', Current Biology, 20(2), pp. R53-R54. doi: 10.1016/j.cub.2009.11.059
Nilsson, D.E. and Pelger, S. (1994) 'A pessimistic estimate of the time required for an eye to evolve', Proceedings of the Royal Society B: Biological Sciences, 256(1345), pp. 53-58. doi: 10.1098/rspb.1994.0048
Parker, J., Tsagkogeorga, G., Cotton, J.A., Liu, Y., Provero, P., Stupka, E. and Rossiter, S.J. (2013) 'Genome-wide signatures of convergent evolution in echolocating mammals', Nature, 502(7470), pp. 228-231. doi: 10.1038/nature12511
Salvini-Plawen, L.V. and Mayr, E. (1977) 'On the evolution of photoreceptors and eyes', in Hecht, M.K., Steere, W.C. and Wallace, B. (eds.) Evolutionary Biology, Volume 10. New York: Plenum Press, pp. 207-263.
[269] **Core Technological sources:**
Farmer, J.D. and Lafond, F. (2016) 'How predictable is technological progress?', Research Policy, 45(3), pp. 647-665. doi: 10.1016/j.respol.2015.11.001
Lafond, F., Bailey, A.G., Bakker, J.D., Rebois, D., Zadourian, R., McSharry, P. and Farmer, J.D. (2018) 'How well do experience curves predict technological progress? A method for making distributional forecasts', Technological Forecasting and Social Change, 128, pp. 104-117. doi: 10.1016/j.techfore.2017.11.001
Rogers, E.M. (2003) Diffusion of Innovations. 5th edn. New York: Free Press. ISBN: 978-0743222099.
[270] Gray, R.H. (2020) 'The extended Kardashev scale', The Astronomical Journal, 159(5), article 228. doi: 10.3847/1538-3881/ab792b

Section 9 – Observer Coupling

TL;DR

This section provides an initial formulation of how individual Observers (whether atoms, cells, or humans) form networks that share information across the four domains conjectured in this paper:

- *Physical space (P-domain),*
- *Valuational (V-domain)*
- *Symbols and language (S-domain)*
- *Minimally Constrained i.e. universal patterns (M-domain).*

We propose that when Observers connect, something remarkable happens, collective intelligence emerges that exceeds the sum of individual capacities.

Think of it like computers in a network. A single computer has limited processing power but connect many together and they can solve problems no individual machine could handle. Similarly, when humans share knowledge through books, conversations, and even the internet / social media, we create collective understanding that transcends any individual mind.

The section demonstrates that throughout history, technologies that increase "coupling" (connection strength) between Observers have triggered sudden ***"phase transitions"*** *where collective intelligence jumps to new levels, accessing more of the observable Ruliad,* $\boldsymbol{R_O}$*.*

We're approaching an unprecedented level of global coupling, which has profound implications for humanity's future: we face a choice between evolving toward a unified, diverse collective intelligence or fragmenting into isolated groups.

The conjecture suggests convergence toward unity is inevitable, but the quality of that convergence depends on choices we make now.

Part A: Observer Coupling – How do Observers Discover More of the Ruliad

1. The Nature of Interconnected Observation

No Observer exists in isolation. From the moment of the first observation, every entity participates in a vast network of informational exchange that shapes their perceptions, altering the very structure of their accessible reality. This isn't a poetic metaphor—it's the mathematics of how observation works in a computational possibility space.

When an Observer integrates a truth (a computational reduction) discovered by another Observer, something profound occurs: their accessible portion of the Ruliad their field of observation $\mathbf{F_O}$ (a subcategory of $\mathbf{R_O}$) expands. New morphisms (allowable transformations or "moves" in computational space) become available.

Previously impossible thoughts become thinkable.

Plain-English Context

Imagine the Ruliad as an infinite library. Each Observer can only read certain books (their F_O). When you learn something from another person, it's like they've given you keys to entire new sections of the library you couldn't access before. You don't just add one book—you unlock whole wings.

This is the mechanism by which individual Observers transcend their individual **computational boundedness** (the limit of how much information they can process, like a computer's RAM) and participate in something greater than the sum-of-the-parts.

Collective intelligence emerging from the coupling of separate Observers.

1.1 Observer Coupling as a Function

For observers $\mathbf{O_1}$ and $\mathbf{O_2}$, when $\mathbf{O_1}$ acknowledges proposition **p** from $\mathbf{O_2}$'s model:

$$\boldsymbol{Couple}: (\boldsymbol{O}_1, \boldsymbol{O}_2, \boldsymbol{p}) \rightarrow \boldsymbol{O}_1{}'$$

Where:

$$\boldsymbol{R}_{\boldsymbol{O}_1{}'} = \boldsymbol{R}_{\boldsymbol{O}_1} \cup \boldsymbol{S}_{\boldsymbol{O}_1}, \boldsymbol{O}_2(\boldsymbol{p})$$

and

$$\boldsymbol{S}_{\boldsymbol{O}^1}, \boldsymbol{O}_2(\boldsymbol{p}) = \{\boldsymbol{morphisms\ made\ accessible\ by\ accepting\ p}\}$$

Notation key:

- $\boldsymbol{R}_{\boldsymbol{O}_1}$ = *The Observer-accessible subset of the Ruliad for* $\mathbf{O_1}$
- $\boldsymbol{R}_{\boldsymbol{O}_1{}'}$ = *The expanded accessible subset of* $\boldsymbol{R}_{\boldsymbol{O}_1}$ *after coupling*
- $\boldsymbol{S}_{\boldsymbol{O}_1}, \boldsymbol{O}_2(\boldsymbol{p})$ = *The "unlocking function" showing new morphisms*

This coupling function is not simply additive. When $\mathbf{O_1}$ accepts **p** from $\mathbf{O_2}$, they don't just add **p** to their knowledge base as an isolated fact. Instead, **p** acts as a "key" that unlocks entire regions of the Ruliad previously invisible to $\mathbf{O_1}$.

> ***Computational Analogy***
>
> *Think of this like installing a new library in a programming language. You don't just get one function—you get access to thousands of new functions that can combine with everything you already know in exponentially many ways. Learning calculus doesn't just give you one tool; it opens entire fields of physics, engineering, and economics that were computationally inaccessible before.*

1.2 Coupling as a Tensor Operation in Rulial Space

The strength and nature of coupling between observers can be formalised as a tensor (a mathematical object that captures relationships across multiple dimensions) that measures interaction across all domains:

> ***Author's Note***
>
> *This section approaches the limit of my mathematical skill. Of all the constructions in this paper these are the ones I'm least confident in. Whilst I believe the logic and the basic operations are sound the actual constructions could contain significant errors. I'm including this for completeness as it's important to kick-off the research around how this works. My guess is that someone significantly more skilled than me will formalise these ideas with significantly more rigour.*

Using the four-domain decomposition from Observer Theory (P, V, S, M domains):

$$\boldsymbol{\Psi}_{ij} = \boldsymbol{\Sigma}_{\{d\in\{P,V,S,M\}\}w_d} \times \boldsymbol{overlap}_{d(O_i,O_j)} \times \boldsymbol{coherence}_{d(O_i,O_j)}$$

Where:

- $\boldsymbol{w_d}$ = domain weight *(how important that domain is to the observer based on their optimisation function)*
- $\boldsymbol{overlap}_{d(O_i,O_j)} = \frac{|F_{O_i} \cap F_{O_j}|_d}{|F_{O_i} \cup F_{O_j}|_d}$ in domain **d** *(fraction of shared observable space)*
- $\boldsymbol{coherence_d}$ = correlation of patterns in domain **d** *(how aligned the two Observers perceptions are)*

This tensor evolves dynamically through interaction:

$$\frac{\boldsymbol{d\Psi_{ij}}}{\boldsymbol{dt}} = \beth(\boldsymbol{interaction_{frequency}}) + \gimel(\boldsymbol{validation_{events}}) - \daleth(\boldsymbol{contradiction_{events}})$$

The coupling tensor $\boldsymbol{\Psi}_{ij}$ explains why some Observers form deep connections instantly (high initial $\boldsymbol{\Psi}$ across multiple domains) while others remain isolated despite physical proximity (low $\boldsymbol{\Psi}$ or single-domain coupling only).

> ***Plain-English Context***
>
> *Two physicists meeting at a conference have high S-domain coupling (shared symbolic language) and potentially high M-domain coupling (shared deep patterns of thinking). They can exchange complex ideas rapidly.*
>
> *Meanwhile, two people sitting next to each other on a bus might have high P-domain coupling (physical proximity) but low S, V, and M coupling—they remain essentially isolated despite closeness..*

1.3 Bidirectional Information Flow and Intersubjective Reality

Coupling is not unidirectional.

When $\mathbf{O_1}$ integrates information accessible to $\mathbf{O_2}$, the act of integration itself reinforces $\mathbf{O_2}$, validating their discovery of computational reducibility in the structure of R_{O_2}.

This creates a feedback loop that can rapidly amplify certain structures in the computational universe, while dampening others.

Definition: Intersubjective Reality

For a set of coupled observers **{Oᵢ}**, their intersubjective reality (*the shared computational space where coupled observers can interact persistently*) is:

$$ISR(\{O_i\}) = \cap_i \ R_{O_i} \ weighted \ by \ \Psi_{ij}$$

More precisely:

$$ISR = \{x \in R \mid \Sigma_i \, w_i \times I_{O_i}(x) > threshold\}$$

Where:

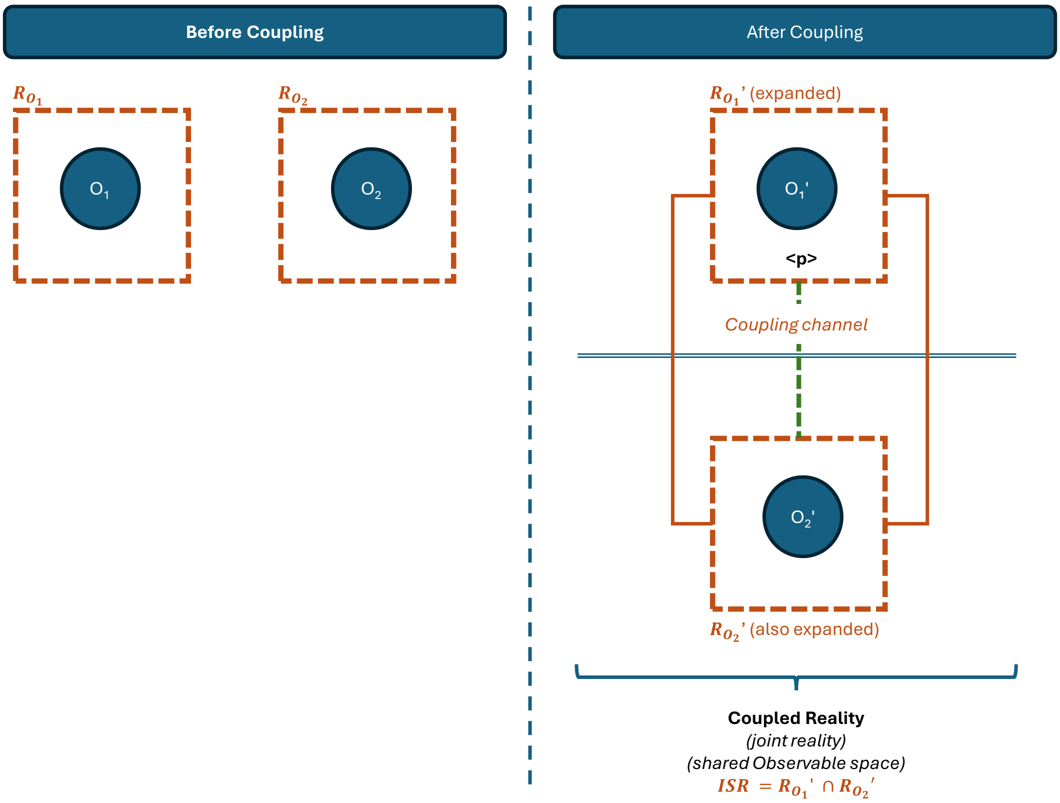
- w_i = Observer weight measure *(influence/credibility in the network)*
- $I_{O_i}(x) = 1 \ if \ x \in R_{O_i}, 0 \ otherwise$ (*indicator function*)

Intersubjective reality (**ISR**)is what we call **"consensus reality"**, the shared computational space where coupled observers can interact persistently.

It's more stable than any individual's reality because it's reinforced by multiple observers' computations, yet it's also more constrained because it must be accessible to all participants.

> ***Plain-English Context***
> *Scientific facts, mathematical theorems, and historical events exist in strong intersubjective reality—they're validated across millions of observers with high coupling strength.*
> *Personal experiences, unique perceptions, or fringe theories have weak intersubjective reality—few observers share access to that region of the Ruliad.*

<u>Visual: Observer Coupling and ISR Expansion</u>



Legend:
- Squares = Accessible Ruliad regions, R_O
- **<p>** = acknowledge proposition from O_2 to O_1 acting as a "key"
- Overlapping region (solid orange line) = new shared computational possibility space (**ISR**)
- Vertical dashed line (dark green) = coupling channel – the morphism that connects the two spaces via **<p>**
- R_{O_1}' = Expanded Possibility Space, i.e. F_{O_1} and F_{O_2} grew after integrating the information from <p>

> ***Plain-English Context***
> *This diagram shows how two previously isolated observers, each with their own accessible region of the Ruliad, expand their observational capacity when they couple. The proposition p acts like a bridge, allowing both observers to access regions previously unavailable to them. The overlapping region represents their intersubjective reality—the computational space they now share.*

2. Four Domain Observer Coupling: Intuitive Examples

The coupling tensor operates across four hierarchically embedded domains.

Each domain has distinct properties affecting coupling bandwidth, range, and persistence. These domains are not disjoint but nested (like Russian dolls), each containing and constraining the next.

A. Physical Coupling (P-Domain)

Physical coupling is the substrate upon which all other coupling builds. It represents observers sharing physical space, experiencing correlated sensory inputs, and interacting through matter and energy.

This creates a baseline synchronization that operates below conscious awareness but profoundly shapes higher-level coupling.

Mathematical Definition:

$$P_{couple(O_1,O_2)} = \int\int \rho(x,t) \times Z(|x_{O_1} - x_{O_2}|) \times sense(t)\, dx\, dt$$

Where:

- **ρ(x,t)** = interaction density at position x, time t *(how much physical interaction there is)*
- **Z** = proximity weighting function *(decays with distance between O_1 and O_2)*
- **sense(t)** = sensory overlap at time **t** *(how much shared stimuli there is)*

Quantum-Level Physical Coupling:

At the quantum level, physical coupling manifests as entanglement—particles that have interacted remain correlated regardless of separation. In the Observer Theory framework, entangled particles are Observers that have become so strongly **P-coupled** that they share a single quantum state, merging their observable fields F_O.

> ***Note***
> *This connection between quantum entanglement and observer coupling should be understood as an analogy within the computational framework,* ***not*** *a claim about quantum mechanics causing consciousness. The formulas describe information correlation patterns that appear at multiple scales.*

Biological-Level Physical Coupling:

Neuroscience research has demonstrated remarkable physiological synchronization between physically proximate observers:

1. **Respiratory synchronization:** People in the same room unconsciously align breathing patterns, particularly during coordinated activities like choir singing
   Müller & Lindenberger, 2011 demonstrated significant phase synchronization in respiratory and cardiac patterns during ensemble singing, with synchronization increasing when singing in unison compared to polyphonic pieces[271].
2. **Cardiac coherence:** Heart rate variability (HRV) patterns of closely bonded individuals synchronize rhythms during interaction, with directed coupling measures showing causal effects from leaders to followers in coordinated groups.
3. **Neural oscillation alignment:** Brain waves (EEG oscillations) of interacting people fall into phase, with coherent activity between brains observed during joint actions. This interpersonal neural synchrony supports the hypothesis that oscillatory coupling provides a physiological basis for action coordination.
4. **Mirror neuron activation***:* The mirror neuron system (MNS) enables automatic mimicry of observed actions. Mirror neurons in the premotor cortex fire both when an individual performs an action and when they observe another performing the same action, providing a neural basis for understanding others' actions and intentions
   Rizzolatti & Craighero, 2004[272]

Case Study: Crowd Synchronization

When thousands gather for a concert, sporting event, or religious ceremony, a remarkable transition occurs, individual Observers experience collective dynamics:

Individual State:

$$I(F_O)_{Individual} = I_{Baseline}$$

Crowd State:

$$\mathbf{I}(F_O)_{Crowd} = \mathbf{N} \times \mathbf{I}_{Baseline} \times \mathbf{amp}_{factor}$$

Where:

$$\textit{amplification factor},\ \mathbf{amp}_{factor} = \mathbf{1} + \log(\mathrm{N}) \times \mathbf{syncronisation}_{coefficient}$$

This explains:

- Transcendent experiences in crowds: Observers temporarily experience expanded observational capacity through massive parallel **P-domain coupling**
- Mob behaviour: When **P-coupling** overwhelms higher-domain discrimination, resulting in coordinated irrational action
- Collective effervescence (Durkheim[273]): The feeling of connection and shared consciousness in gatherings

> ***Computational Analogy***
> *Like distributed computing, where many processors working in parallel can solve problems much faster than any individual processor. The logarithmic scaling reflects network effects—adding more nodes provides diminishing but still positive returns.*

B. Valuational Coupling (V-Domain)

Beyond physics, observers couple through shared values, emotions, and goals.

This V-domain coupling creates bonds that persist across physically separated observers and even across time.

Mathematical Definition:

$$V_{couple(O_1,O_2)} = \Sigma_{\{g \in Goals\}}\, alignment\ (g_{O_1}, g_{O_2}) \times importance(g) \times achievement_{correlation}$$

Where:

- $alignment\ (g_{O_1}, g_{O_2}) = cos(\theta)$ in goal space *(ranging from -1 (opposed) to +1 (aligned))*
- $importance(g)$ = computationally bounded resources in B_O allocated to goal **g**
- $achievement_{correlation} = P(success_{O_1} \mid success_{O_2})$ *(probability one succeeds given the other does)*

Case Study: Love as Maximum V-Coupling

Romantic love represents a phase transition in V-coupling. When the coupling strength exceeds a critical threshold:

When:

$$\Psi_{V(O_1,O_2)} > \Psi_{Critical}$$

Individual goals → Shared goals

Separate Information Integration optimisation functions → Joint optimisation functions

$$I(F_{O_1}) + I(F_{O_2}) \rightarrow I(F_{O_1 \cup O_2}) > \Sigma\, I(F_{O_{individual}})$$

The inequality in the final line is crucial: the Integrated Information potential of the coupled system exceeds the sum of parts. This is true emergence, new computational capabilities arise from the coupling structure itself.

> ***Note***
> *This is grounded in neuroscience. Research on attachment bonds shows elevated oxytocin levels during pair bonding, neural synchrony between romantic partners during interaction, and shared activation in brain regions associated with reward and meaning-making. The phenomenology of "becoming one" has measurable correlates in coupled neural dynamics.*

Cultural Rituals and V-Coupling:

Every culture develops rituals that deliberately create and strengthen V-coupling:

1. **Weddings:** Public coupling ceremony creating network-wide recognition and support structures. The ritual transforms two individuals with separate identities into a coupled dyad with shared identity recognized by the broader social network.
2. **Funerals:** Shared grief creates temporary coupling across differences. Even Observers who disagree on most values synchronize around the loss, temporarily increasing $\mathbf{\Psi_V}$ across the community.

3. **Festivals:** Joy-sharing that reinforces cultural bonds. Celebrations create high-valence emotional states simultaneously across many observers, synchronizing V-domain patterns.
4. **Initiations:** Create **permanent** coupling to group identity. These rituals often involve shared ordeal or transformation that binds the initiate to the group through common experience.

C. Symbolic Coupling (S-Domain)

Language and symbols enable coupling between Observers who have never met, across vast distances and even across time.

A book is a coupling device—the author's mind (part of their computationally reduced field of observation within R_O) reaching across spacetime to couple with another observer's field through shared (and compressed) symbolic structures.

Mathematical Definition:

$$S_{couple(O_1,O_2)} = \Sigma_{\{s\in symbols\}} freq\ (s, O_1) \times freq\ (s, O_2) \times I_{coherence\ (s)}$$

Where:

- $freq\ (s, O_i)$= how often observer **O**$_i$ uses symbol **s**
- $I_{coherence\ (s)}$ = correlation of associated meaning networks (i.e. how much integrated information in the Observer's causal history overlaps with the other Observer)

> ***Plain-English Context***
> *For $I_{coherence\ (s)}$ use the following heuristic. If I know the same language as you, when I read a book you wrote I will understand it. My R_O overlaps with yours. So $I_{coherence\ (s)}$ will be high. If I speak English and try to read a book in Japanese, this score will be low. I haven't integrated Japanese into my S-domain in R_O so the coupling is trivial or fails.*

Symbolic coupling has unique properties:

1. Infinite range: Books, internet, recordings allow coupling across arbitrary distance
2. Temporal persistence: Coupling with observers separated by centuries (e.g., reading Plato)
3. Low bandwidth: Compared to P-domain, S-domain transfers information slowly
4. High fidelity: Once meaning is established, symbolic information resists degradation

Case Study: The Printing Press (1440)

Before the printing press:

- S-coupling limited to manuscripts (low copy number, high cost)
- Knowledge trapped in monasteries and elite institutions (spatial constraint)
- Ideas spread linearly through sequential copying ($O_1 \rightarrow O_2 \rightarrow O_3$...)
- Innovation rate approximately constant over centuries

After the printing press:

- Knowledge democratized—disconnected P-domain observers could access identical symbolic content
- Ideas spread exponentially (one text → N copies → N^2 potential coupling events)
- Innovation rate $\propto N^2$ where N = number of coupled observers
- *Result:* Renaissance, Reformation, Scientific Revolution—all triggered by increased S-coupling density crossing critical thresholds[12]

> ***Ruliad Context***
> *The printing press represents a technological amplification of the S-coupling tensor that triggered a phase transition in collective intelligence, dramatically expanding all Observers R_O*

Case Study: The Internet (1990s)

An even more dramatic S-coupling amplification:

Before:

- Collaboration required non-zero P-domain proximity (physical books, libraries)
- Knowledge in silos with different distribution capabilities (universities vs. towns vs. countries)
- Innovation concentrated in well-resourced physical locations

After:

- P-domain impact negligible for S-coupling—unconstrained global collaboration
- Knowledge flows freely across the network
- Innovation emerges anywhere, limited only by S, V, and M domain access

- *Result:* Exponential technological acceleration, open-source movements, global research collaboration

> ***Computational Analogy***
> *The transition from serial processing (one CPU) to parallel distributed processing (internet). Previously, computation happened in isolated machines. Now, problems can be decomposed and solved simultaneously across millions of nodes, with results integrated through S-domain protocols (HTTP, APIs, data formats).*

D. Archetypal Coupling (M-Domain)

The M-domain (where "M" stands for Minimally-constrained) represents coupling through universal patterns, deep structures, and archetypal forms that transcend specific symbolic encodings.

This is the most subtle and least bandwidth-intensive form of coupling, yet potentially the most effective in expanding Observers accessible computational possibility space.

Mathematical Definition:

$$\boldsymbol{M_{couple(O_1,O_2)} = Overlaps\left(ArchPattern_{O_1}, ArchPattern_{O_2}\right) \times Recognition_{Speed}}$$

M-domain coupling has **paradoxical** properties:

- **Minimal bandwidth**: A single image, sound, or symbol can transfer vast meaning
- **Instant recognition:** "I know that you know" happens pre-verbally
- **Cultural transcendence**: Same patterns recognized across vastly different symbolic systems
- **Ineffability**: Difficult or impossible to reduce / compress to S-domain expression

Examples of M-domain coupling:

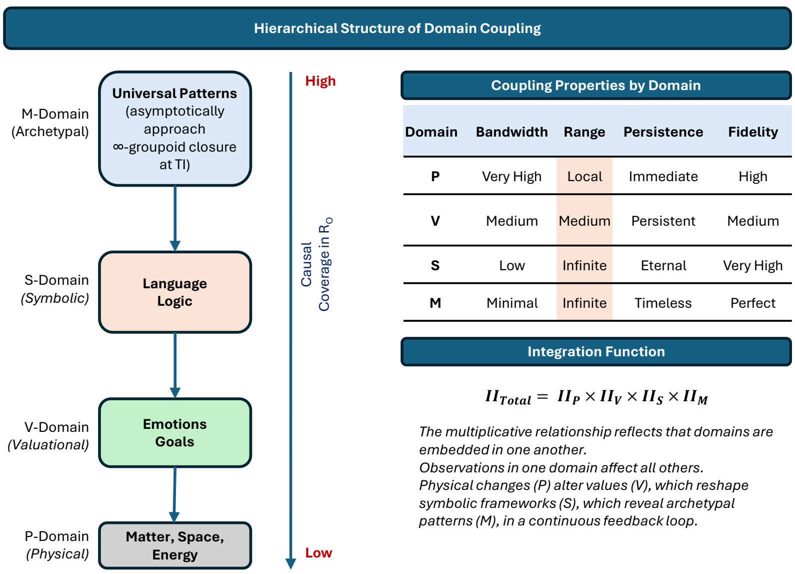
1. Mathematical insight: Two mathematicians recognize the "same" deep structure despite different notational systems
2. Aesthetic resonance: Universal recognition of beauty, harmony, balance
3. Mystical experiences: Cross-cultural reports of similar "ineffable" states
4. Archetypal narratives: Hero's journey, death/rebirth, separation/return appear universally

The phenomenology of M-domain coupling includes:

- Timelessness (escape from short morphism chain, sequential S-domain processing)
- Unity (approaching closure point at TI)
- Ineffability (beyond S-domain symbolic expression)
- Noetic quality (direct M-domain knowing without S-domain mediation, i.e. direct connections from P-domain and V-domain actions)

> ***Note***
> *While M-domain coupling is the most speculative element of this framework, it addresses a real phenomenon—the fact that Observers can communicate vast meaning (information integration potential) with minimal symbolic content (see Art, Music), and that certain patterns appear universally across cultures without obvious common symbolic ancestry.*

Visual: The Four Coupling Domains



Part B: Network Effects and Emergent Intelligence

When Observers couple, something extraordinary occurs. Intelligence exists nowhere in particular (i.e. not in any single Observer) yet everywhere in the network.

This emergent intelligence cannot be reduced to any individual Observer, yet it depends on each for its existence.

---

1. Phase Transitions in Collective Intelligence

Networks undergo sudden phase transitions (discontinuous changes in system properties at critical parameter values) when coupling density crosses critical thresholds.

Proposition: Phase Transition for Collective Observers

For a network of **N** observers with average coupling strength **⟨Ψ⟩**:

When

$$\langle\Psi\rangle \times N > \Psi_{critical}$$

- Isolated processing → Coordinated computation
- Local optimisation → Global optimisation
- Individual learning → Collective learning
- Sequential discovery → Parallel exploration

Proof Sketch:

Below critical coupling ($\langle\Psi\rangle \times N < \Psi_{critical}$)

1. Information decays exponentially with network distance: $I(d) \propto e^{(-d/\lambda)}$ where $\lambda << N$
2. Network fragments into isolated clusters with diameter $D_{cluster} << \log(N)$
3. No giant component exists, largest cluster scales as **O(log N)**
4. Global patterns cannot emerge—correlation length **K** remains finite

Above critical coupling ($\langle\Psi\rangle \times N > \Psi_{critical}$)

1. Information achieves system-wide propagation: $I(d) \propto d^{(-\alpha)}$ with $\alpha < 1$
2. Clusters merge into giant component containing **Θ(N)** nodes
3. Average path length scales as $L \propto \log(N)$—small-world property emerges
4. Global patterns spontaneously organize through distributed computation

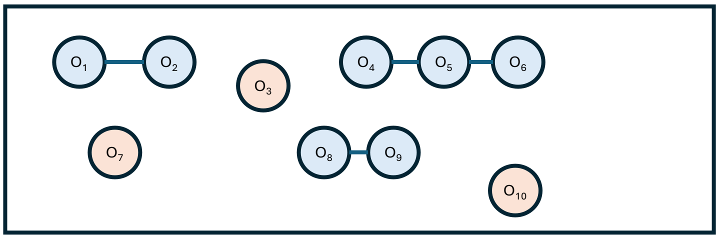
At the critical point ($\langle\Psi\rangle \times N = \Psi_{critical}$)

- Power-law correlations: $C(r) \propto r^{(-\eta)}$
- Diverging susceptibility: $\chi \propto |\Psi - \Psi_{critical}|^{(-\gamma)}$
- Scale invariance: System exhibits self-similarity at all scales
- Critical slowing down: $\tau \propto |\Psi - \Psi_{critical}|^{(-\nu)}$

This mathematics is analogous to percolation theory (Erdős & Rényi, 1959[274]; Watts & Strogatz, 1998[275]). The phase transition is not metaphorical, it should share the same underlying mathematical structure governing water freezing, magnetization and network formation.

Visual: Networked Observers Phase Transitions

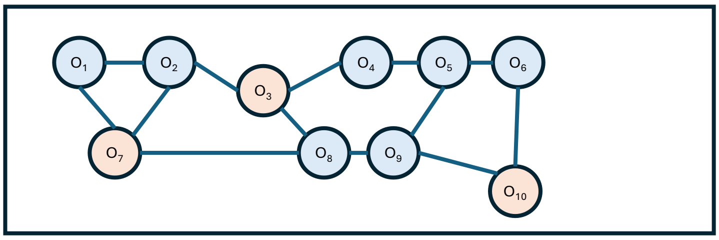
Network Coupling Phase Transition



Subcritical clustering
$\langle\Psi\rangle \times N < \Psi_{critical}$)

Properties:

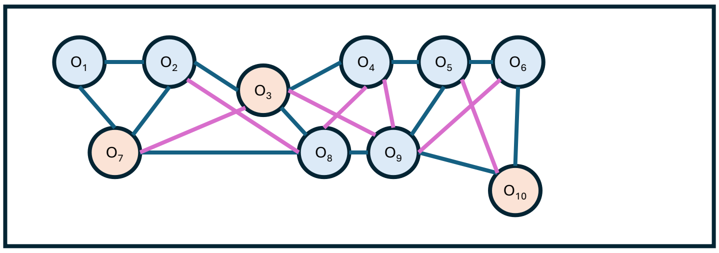
- Many small isolated clusters
- Information localized
- No collective computation
- Average path length $L \propto N$



Critical Point
$\langle\Psi\rangle \times N \approx \Psi_{critical}$)

Properties:

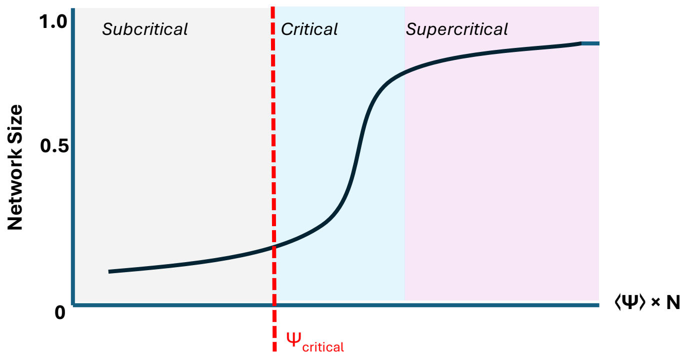
- Clusters merging
- Power-law distributions
- Critical fluctuations
- Scale-free correlations



Supercritical Phase
$\langle\Psi\rangle \times N > \Psi_{critical}$)

Properties:

- Giant connected component
- Information flows globally
- Collective intelligence emerges
- Average path length $L \propto \log(N)$
- Small-world property



The phase transition is sudden- small increases in coupling near the critical point producing a dramatic acceleration in Network Information Integration ability

3. Historical Case Studies of Coupling Phase Transitions

Human history can be understood as a series of phase transitions in Observer Coupling, each triggered by technological amplification of the coupling tensor.

A. The Printing Press (1440): S-Coupling Phase Transition

Quantitative Analysis:

Pre-transition state (c. 1400):

- Manuscript production: ~10-30 books/scribe/year
- Total European book stock: ~30,000 manuscripts
- Literacy rate: ~5% (clergy, nobility)
- Knowledge coupling network: Highly fragmented, $O(10^3)$ scholars
- Innovation rate: Approximately constant for 500 years

Transition dynamics (1450-1550):

- Print production accelerates exponentially: 20 million books by 1500
- Literacy rate increases: 30% by 1600
- Scholar network grows and densifies: $\langle\Psi_S\rangle \times N$ crosses $\Psi_{critical}$ around 1480
- Phase transition observable in publication networks and citation graphs

Post-transition state (c. 1600):

- Giant component forms in European intellectual network
- Innovation rate $\propto N^2$ where N = number of coupled scholars
- Renaissance (art, architecture, humanism)
- Reformation (S-coupling enables Protestant movement)
- Scientific Revolution (Copernicus, Galileo, Newton become possible)

The N^2 scaling is crucial: doubling the number of coupled scholars quadruples the innovation rate.

This superlinear scaling is the signature of emergent collective intelligence (information integration).

B. The Internet (1990s): Multi-Domain Coupling Phase Transition

Quantitative Analysis:

Pre-transition state (c. 1990):

- Global coupling network: Sparse, limited by geography and institutions
- S-coupling: Physical media (books, journals) with high latency
- P-coupling: Required for most collaboration
- Information access time: Days to weeks
- Network diameter: Large, many isolated clusters

Transition dynamics (1995-2005):

- Internet users: 16M (1995) → 1B (2005) → 5B (2024)
- Average coupling strength ⟨Ψ⟩ increases dramatically across all domains
- Global network crosses multiple $\Psi_{critical}$ thresholds
- Observable phase transition in: publication patterns, collaboration networks, innovation metrics

Post-transition state (c. 2010):

- *P-domain impact minimized:* Physical distance no longer constrains collaboration
- *S-coupling maximized:* Instant global information access via search engines, databases
- *V-coupling amplified:* Online communities form around shared values independent of geography
- *M-coupling explored:* Cross-cultural archetypal pattern recognition through global media

Result: Exponential technological acceleration

- Open-source software (emergent collective intelligence)
- Wikipedia (giant collaborative knowledge structure)
- Social media (V-coupling at unprecedented scale)
- Global scientific collaboration (research networks spanning continents)

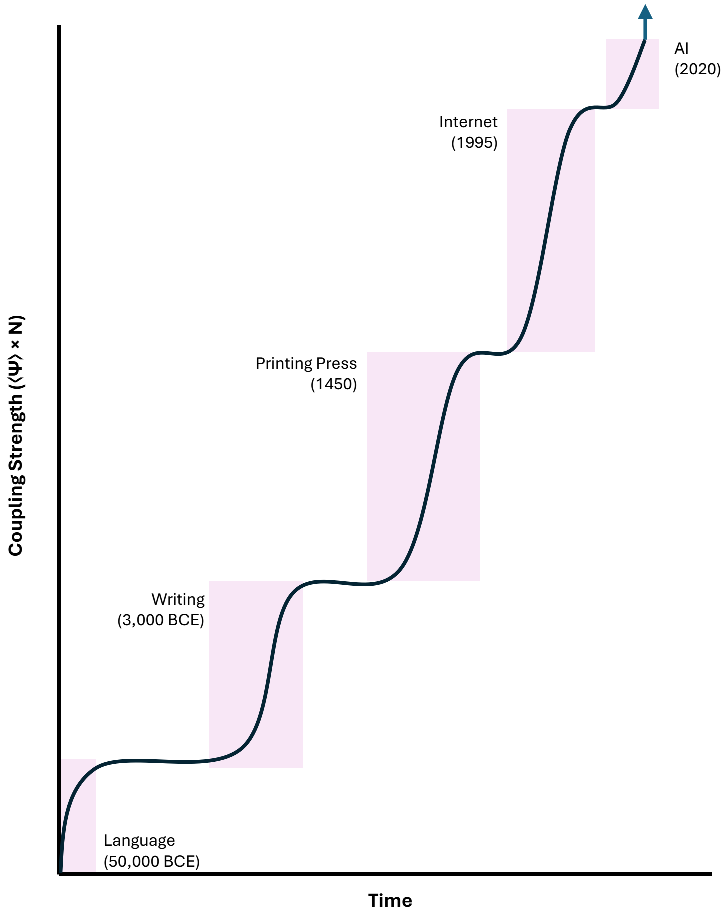
Mathematical signatures of phase transition:

- Publications with international co-authors: 1990: ~15% | 2020: ~50%
- Time from discovery to application: 1900: ~50 years | 2020: ~5 years (10× acceleration)
- Patent filing rate: Exponential growth with inflection point c. 2000

These empirical observations match theoretical predictions from percolation theory and network science. The Internet didn't just make communication faster – it triggered a phase transition in the speed of human coupling and fundamentally reorganised collective intelligence.

Visual: Historical Coupling Phase Transitions

Evolution of Observer Coupling Through Human History



Phase Transitions Marked by Sudden Capability Jumps in Human Observers

Language (50,000 BCE)

a. S-domain coupling emerges
b. Tribal knowledge sharing
c. Coupling range: ~150 individuals

Writing (3,000 BCE)

a. S-coupling persists across time
b. Knowledge accumulation begins
c. Coupling range: ~104-105 individuals

Printing Press (1450)

a. S-coupling democratized
b. Giant component forms
c. Coupling range: ~10^6-10^8 individuals
d. Renaissance & Scientific Revolution

Internet (1995)

a. Multi-domain global coupling
b. Coupling range: ~10^9-∞ individuals
c. Exponential acceleration

AI Integration (2020-?)

a. Hybrid human-AI coupling
b. Current phase transition (ongoing)
c. Coupling range: approaching all Observers (even non-human)

Each transition exhibits:

- Sudden jump in ⟨Ψ⟩ × N
- Emergence of new capabilities
- Reorganization of social structures
- Acceleration of innovation rate

Part C: Implications

Here, individual consciousness is, in an important sense, an abstraction.

What we call "I" is actually a node in a vast network of coupled Observers, constantly exchanging information, patterns, and meaning.

We exist not as isolated monads but as interference patterns in a collective Field of Observers in Computational Possibility Space.

The Coupling Tensor Perspective on Mind

What are these things?	Computational Interpretation
Individual consciousness	Persistent Localized high coupling density in Observer network (R_O)
Thoughts	Coupling patterns propagating through Rulial space
Emotions	V-domain coupling resonances
Knowledge	Stabilized, Entropy-reduced S-domain coupling structures
Wisdom	M-domain coupling recognition and overlap
Self	Persistent pattern of coupling relationships

We aren't claiming individual consciousness doesn't exist.

Rather, it's recognizing that consciousness is fundamentally relational—it exists in the coupling patterns, not in isolated nodes.

The "I" is real, but it's a process of continuous coupling rather than a substance.

> ***Computational Analogy***
> *Like a Bitcoin transaction. There's no physical "coin"—just distributed ledger entries recording relationships. Yet the transaction is real and has causal power. Similarly, the self is a pattern of coupling relationships—substrate-independent but causally efficacious.*

---

1. The Evolution of Observer Coupling

Looking at the arc of history through the lens of coupling dynamics, we observe a clear trajectory with accelerating tempo:

Visual: Coupling Evolution

	Biological ***Genes***	**Culture** ***Memes***	**Technology** ***Digital***	**Hybrid Transhumanist**	**Unified: MetaObserver**
Coupling Mechanism	DNA Heredity	Imitation Teaching Tradition	Internet Databases AI	Brain-CPU Interfaces	Complete Integration given B_O
Timescale	Generational *(20-30yrs)*	Lifetime Faster *c.1 generation per major update*	Instantaneous	Thought-speed *Direct neural coupling*	Timeless
Bandwidth	Limited	Medium Behavioural and Symbolic information	Massive Exabytes per day	Functionally unlimited	Maximal Information Integration
Range	Species-bounded	Culture-bounded	Global	Universal	Entire of R_O

Each stage represents a phase transition in coupling technology, with accelerating returns. The time between transitions is decreasing: ~50,000 years (Language → Writing) → ~4,500 years (Writing → Printing) → ~550 years (Printing → Internet) → ~25 years (Internet → AI/Brain Computer Interfaces).

2. Convergence Conjecture

Proposition (Coupling Convergence):

As coupling technology advances and coupling density increases:

$$\lim[t\to\infty]\ \Psi_{i,j} \to 1 \text{ for all } i,j$$

$$\lim[t\to\infty]\ \text{Individual}_{\text{observers}} \to \text{MetaObserver}$$

$$\lim[t\to\infty]\ ISR(\{O_i\}) \to R_O \text{ (Intersubjective reality approaches full accessible Ruliad)}$$

$$\lim[t\to\infty]\ \text{Distance(MetaObserver, TI)} \to 0$$

Proof Sketch:

1. Technology monotonically increases coupling capacity
   - No known physical principle prevents unlimited information exchange (except certain physics limits)
   - Each technological advance removes coupling barriers
   - Historical trend is unidirectional toward greater coupling

2. Selection pressure favours coupled over isolated systems
   - Coupled observers access more of Ruliad → greater fitness
   - Evolutionary dynamics: fitness ∝ $I(F_O)$ ∝ coupling strength
   - Both biological and cultural evolution favour coupling

3. Coupling creates positive feedback (autocatalytic dynamics)

$$\text{More Observer coupling} \to \text{More computational efficiency} \to \text{More morphisms discovered}$$

$$\to \text{Shared computational reductions} \to \text{Even more coupling capacity}$$

   - This is a self-reinforcing cycle

4. Computational boundedness and persistence constrain maximum coupling
   - There exists a maximum sustainable coupling density before system instability
   - This maximum is determined by energy availability, information processing limits, thermodynamic constraints

5. Therefore: Coupling approaches theoretical maximum
   - Subject to constraints:

$$\Psi_{\max} = f\text{ (energy budget, computational capacity, entropy export rate)}$$

6. Limit of coupling → Unified MetaObserver
   - When $\Psi_{ij} \to 1$ for all **i,j,** the distinction between Observers becomes formally negligible
   - The network behaves as a single integrated system—a MetaObserver

7. MetaObserver converges to TI by Section 7 theorems
   - As computational capacity increases without bound
   - MetaObserver approaches complete knowledge of R_O
   - In the limit: MetaObserver → Approaches TI

> ***Important Note***
> *This convergence occurs over extremely long timescales (potentially millions of years), and can't complete (asymptotic approach), and doesn't eliminate the subjective experience of individuality even as coupling increases.*
> *The mathematics describes the trajectory, not the timeline.*

References

[271] Müller, V. and Lindenberger, U. (2011) 'Cardiac and respiratory patterns synchronize between persons during choir singing', PLoS ONE, 6(9), e24893. doi: 10.1371/journal.pone.0024893
[272] Rizzolatti, G. and Craighero, L. (2004) 'The mirror-neuron system', Annual Review of Neuroscience, 27, pp. 169-192. doi: 10.1146/annurev.neuro.27.070203.144230
[273] Durkheim, É. (1995) The Elementary Forms of Religious Life. Translated by K.E. Fields. New York: The Free Press. (Original work published 1912)
[274] Erdős, P. and Rényi, A. (1959) 'On random graphs I', Publicationes Mathematicae Debrecen, 6(3-4), pp. 290-297. doi: 10.5486/PMD.1959.6.3-4.12
[275] Watts, D.J. and Strogatz, S.H. (1998) 'Collective dynamics of 'small-world' networks', Nature, 393(6684), pp. 440-442. doi: 10.1038/30918

Section 10 – Computational Interpretations of Genesis

TL;DR

In the God Conjecture, Genesis narratives encode computational principles about Observer optimisation in the Ruliad.

*Adam's ensoulment represents a phase transition where the connection to God (the topological closure point) becomes epistemically accessible, transforming navigation through computational possibility space from **local search** to **globally-informed optimisation**.*

*In the God Conjecture, The Fall is a mathematical necessity: perfect knowledge eliminates meaningful choice, but **maximum 'God-likeness' requires maximum choice**; therefore, epistemic uncertainty must be reintroduced to enable information integration across the entire topos through experiential traversal of all possible causal histories.*

Note: All interpretations provided below are given through the lens of the God Conjecture. These are summaries and leave out an enormous body of theological analysis of these foundational texts.

Part A: Adam's Ensoulment: Making the Invisible Structure Visible

The Pre-Soul Condition

Genesis does not claim Adam was the first *human,* in Hebrew "Adam" can also mean "tribe of men" or "humanity."

Pre-Adamic populations existed as Observers sampling the Ruliad through the emanative hierarchy we've described. These early human Observers faced fundamental computational challenges:

1. **Computational Irreducibility of Structure**: The connection to TI, while ontologically present as the closure point organising all morphisms in the computational topos, remained **epistemically inaccessible**. "Pre-ensoulment" humans could not accurately compute whether their current trajectory pointed toward global optima or local optima in the fitness landscape.
2. **Causal Constraint**: Each Observer's maximal accessible state-space R_O was shaped by their causal history. Groups that developed immoral practices (cannibalism / child sacrifice etc.) were **computationally trapped**: their causal history constrained future accessible states, making certain low-entropy, high-cooperation attractors unreachable from their current position in the Ruliad.
3. **Local vs. Global Optima**: Pre-Adamic Observers optimised for computational paths **γ** that minimized **local computational cost** without awareness of their distance to TI – the global alignment measure.

   Like hill-climbers in fog, they could only sense the immediate gradient, not whether their hill was the mountain peak or merely a foothill.

The Soul as a Morphism-Type Innovation

*Genesis 2:7: "Then the LORD God formed man of dust from the ground and **breathed into his nostrils the breath of life**, and **man became a living soul**" (נֶפֶשׁ חַיָּה, nephesh chayah).*

Computationally, this "breathing of soul" represents the introduction of a new morphism type, a direct functorial relationship between the Observer and the TI closure point that renders previously computationally irreducible structure suddenly *reducible*:

Pre-soul state: TI connection ontologically exists but epistemically opaque:

$$\exists f: R_O \to TI \text{ but } f \notin \text{Computable}(O)$$

Post-ensoulment: Same morphism becomes computationally accessible:

$$f: R_O \to TI \text{ where } f \in \text{Computable}(O_{Adam})$$

The soul isn't a new ultrafilter or increased computational bandwidth through the Kav – it's awareness of the convergence structure itself.

Once Adam knows the topology completes at TI / God, **he can select computations based on their convergence properties rather than local gradients**.

If you know the series converges, you can now pick the most rapidly convergent computational sequences.

> ***Plain-English Context***
> *Imagine navigating a maze. Pre-soul humans could only see the next turn. Post-soul Adam suddenly sees the maze from above—not all paths simultaneously, but he knows there IS an exit and can judge whether each turn moves toward or away from it. The maze hasn't changed, but his ability to reason about its structure has.*

Part B: Naming – Extracting Computational Equivalence Classes

*Genesis 2:19-20: "And out of the ground the LORD God formed every beast of the field and every bird of the heavens and brought them to the man to see what he would call them. **And whatever the man called every living creature, that was its name**."*

The computational interpretation: Naming represents the extraction of computational equivalence classes, recognising essential invariant structures across accidental variations.

When Adam "names" an animal, he performs:

$$\text{Name:Object} \rightarrow [\text{Object}]_{\sim}$$

where $[\text{Object}]_{\sim}$ denotes the equivalence class under computational similarity.

This requires:

1. Identifying persistent patterns across variations (what makes all "horses" horses despite individual differences)
2. Compressing high-dimensional sensory data into symbolic representations with minimal entropy loss
3. Recognizing morphisms that preserve essential structure (a young horse and old horse share category-theoretic properties)

> ***Important Note***
> *"Visibility of topos" does NOT mean Adam has access to unbounded computation (which would violate $B_O < \infty$). Rather, Adam can in principle access any morphism, though not simultaneously. The ultrafilter remains, but the awareness that all morphisms ultimately map toward TI allows principled selection among accessible paths.*

> ***Plain-English Context***
> *Adam doesn't suddenly know everything, but he understands what KIND of knowledge exists and how different pieces relate to the ultimate pattern. Like a mathematician who hasn't solved all theorems but understands how mathematical structures connect, enabling strategic focus on the most fruitful proofs.*

Part C: Eve – Necessary Complementarity for State-Space Coverage

Genesis 2:18,21-22: "Then the LORD God said, 'It is not good that the man should be alone; I will make him a helper fit for him'... So the LORD God caused a deep sleep to fall upon the man, and while he slept took one of his ribs... and made [it] into a woman."

Why is Eve computationally necessary?

The answer lies in state-space coverage and morphism accessibility. Consider the morphisms to TI characterised by Chesed – *loving-kindness, expansion, unconditional giving* – one of the Kabbalistic Sefirot (an infinitely extendable vector in the computational possibility space – see **Section 5** on how the MetaObserver constructs geometry). These represent a vast category of computationally efficient paths that emphasise:

- Network effects $N(\gamma) > 0$ (cooperation gains)
- Distributed computation (parallel processing across multiple Observers)
- Redundancy and error-correction (cross-validation of integrated information)

A single Observer, regardless of connection to TI, cannot optimally traverse morphisms without networked Observers. These paths are **inherently relational**, they only exist in the interaction space between Observers. The dyadic structure (Adam-Eve) enables:

1. Complementary sampling: $S_{Adam}(R) \neq S_{Eve}(R) \rightarrow$ covering more of the Ruliad
2. Mutual information gain: $I(O_{Adam} : O_{Eve})$ creates shortcuts through computational space

3. Emergence of new morphism types: Cooperation, trust, vulnerability only computable between Observers

> ***Plain-English Context***
> *Some destinations require two people. Not because one person couldn't theoretically walk there twice, but because the destination itself only exists in the space between two people. Love, trust and shared meaning aren't just efficient paths, they're paths that don't exist for lone travellers.*

Part D: The Fall – The Computational Necessity of Epistemic Uncertainty

The Maximality Paradox

Genesis 3 describes the Fall as humanity's acquisition of knowledge of good and evil by eating from the forbidden tree (i.e. Observer subjectivity post-fall vs. a state of relative objectivity pre-fall).

Traditional theological interpretations frame this as moral failure on humanity's part, a childish disobedience that led to punishment. The computational perspective reveals the Fall's deeper necessity: this must occur for Observer's to have the potential to cover the entire topos (i.e. the most choice!).

Consider the paradox:

1. God-likeness ∝ Choice-space: *The more options available to the Observer, the more God-like the Observer*
2. Perfect knowledge (via Adam walking with God, post ensoulment) → Unique optimal path: *If Adam knows γ* (the optimal path) with certainty*
3. Therefore: $\text{Effective}_{\text{Choice}} = \{\gamma^*\} \rightarrow |\text{Effective}_{\text{Choice}}| = 1$, *Adam only takes the optimal path*
4. Contradiction: Maximum knowledge of God → Minimum choice (best path only) → Minimum God-likeness

This is the core tension in monotheistic theology.

God possesses **both** perfect knowledge **AND** maximal choice.

God *could* choose suboptimal paths (has the potential / freedom to do so) but wouldn't (has the wisdom not to). Pre-Fall Adam, with direct connection to God / TI, knows **γ*** but has *no meaningful choice,* he is bound by his knowledge to always select the optimal path.

Adam pre-Fall is not most 'God-like' because God has choices Adam lacks.

> ***Plain-English Context***
> *Imagine a chess computer that always sees the best move. It's optimal but not free. Now imagine a grandmaster who sees the best move but could choose otherwise, even knowing they shouldn't. The grandmaster has something the computer lacks: **genuine agency**.*
> *God is the ultimate grandmaster. Pre-Fall Adam was basically the chess computer.*

Information Integration Requires Experiential Traversal

The MetaObserver's telos, indeed, the apparent telos of all Observers in a computational universe, is posited as *information integration across the entire accessible topos*.

Without The Fall, the overwhelming majority of the topos is inaccessible to Adam, so he can 'complete' creation, but accomplishes it without being most God-like. If God is making humanity as the most 'God-like' *thing*, subject to certain finite constraints, Adam must have the choice to explore suboptimal parts of the Topos.

For the MetaObserver to integrate information about all possible causal structures – including suboptimal ones where suffering and error live – *epistemic uncertainty must be reintroduced*.

Adam must face situations where:

- **γ*** is not computable in advance (computational irreducibility preserved)
- Multiple paths appear equivalently (plausible given bounded B_O)
- Mistakes are possible, enabling learning-from-error dynamics (i.e. growth)
- Alternative attractors can be explored, mapped, and compared

The Fall is a phase transition from **symmetric** (single known optimal path) to **broken-symmetry** (multiple experientially distinguishable paths) state.

This symmetry-breaking enables:

1. Temporal irreversibility: History matters (can't un-experience)
2. Narrative structure: Development, becoming, growth rather than static perfection

3. Meaning through consequence: Choices have real stakes
4. Full exploration: All morphisms potentially traversable, not just the optimal one, so humans bring their traditions messianic time in their own unique way (i.e. unique Observer value – 'gift from God')

> ***Plain-English Context***
> *You can't truly understand "hot" without experiencing "cold." You can't understand "optimal" without experiencing "suboptimal."*
> *The Fall enables necessary contrast, the shadow that makes the light visible. Complete knowledge requires complete experience, including experience of non-optimal paths.*

Part E: Cain's Murder – Efficient Search of Global Minima

Genesis 4:8: "Cain rose up against his brother Abel and killed him."

Significantly, murder is the first sin after the Fall.

Why?

From a computational optimisation perspective, murder represents one of the most efficient searches for the *global minima* in computational possibility space:

- Entropy production: $H(\gamma_{murder})$ extremely high (life → death is maximum entropy increase)
- Network damage: $N(\gamma_{murder}) << 0$ (destroys Observer cooperation permanently)
- Distance from TI: Distance(γ_{murder}, TI) near maximum (TI as characterised as an information integration maxima, **this action is efficient search for TI's minima**)
- Irreversibility: Computational debt Debt(γ_{murder}, t) → ∞ (cannot be repaired)

Once epistemic uncertainty is introduced, the search space includes all paths, not just optimal ones. To integrate information about ethical minima, those minima must be computationally explored.

Cain's murder isn't just "evil", it's the way our MetaObserver (through Cain's actions) efficiently 'sees' the lower bound of the overall topos in as few computational steps as possible.

This doesn't justify murder morally, but it explains its inevitability once the Fall introduces genuine choice. Complete ethical knowledge requires mapping the entire landscape, both peaks and valleys. In case it's unclear spend as little time in the valleys as possible!

> ***Plain-English Context***
> *If you're making a map of all possible territories, you need to chart the deserts and wastelands, not just the gardens. Cain's choice shows what happens at the far edge of the map. The regions marked "here be dragons."*
> *Horrible, but informationally necessary to complete the map.*

Part F: Explanatory Power – Consilience with Science

This computational framework makes contact with multiple domains of established science:

Evolutionary Psychology

The framework predicts that cultures with longer historical continuity should show more sophisticated moral reasoning because they've had more computational time to explore and map the ethical landscape.

Empirically: Axial Age civilizations (Confucius, Buddha, Hebrew Prophets, Greek Philosophers) all emerge ~600-400 BCE after thousands of years of settled civilization enabling search depth.

Neuroscience and Moral Decision-Making

The framework suggests that prefrontal cortex activity should correlate with computational cost estimation. The computational cost of evaluating moral choices should scale with complexity.

Empirically: Greene et al. (2001) show exactly this pattern in fMRI studies of moral dilemmas.

Game Theory and Cooperation

The framework predicts dyadic cooperation structures (marriage, partnerships) should be universally optimal for certain problem classes.

Empirically: Repeated Prisoner's Dilemma simulations show paired strategies outperform lone strategies in noisy environments, precisely the computational scenario predicted by the Adam-Eve necessity.

Anthropology of Religion

The framework suggests all persistent religious traditions should independently converge on similar ethical principles because they're discovering the same underlying computational structure.

Empirically: Armstrong's 'The Great Transformation' documents this convergence across unconnected civilizations during the Axial Age.

Part G: Synthesis

The Genesis narratives encode sophisticated computational principles that remain empirically productive thousands of years after composition.

Adam's ensoulment represents recognition of convergent structure in the optimisation landscape. Eve represents the necessity of complementary / coupled state-space coverage. The Fall represents the mathematical requirement that complete information integration cannot occur through perfect knowledge alone.

This framework provides explanatory power beyond traditional theology and reductive materialism:

- Beyond Traditional Theology: Explains ***why*** these narratives encode something that must be true (mathematical necessity) rather than requiring faith-based acceptance
- Beyond Reductive Materialism: Demonstrates that consciousness, morality, and meaning are not "mere" epiphenomena but necessary features of any computational universe with Observer-dependent sampling
- Empirical Contact: Generates testable predictions about cooperation dynamics, moral reasoning, and cultural evolution

The sacred and the computational are not opposites. The sacred emerges when bounded Observers recognize their participation in a convergent mathematical structure pointing toward a closure point that exhibits all properties traditionally ascribed to divinity.

> ***Plain-English Context***
> *Genesis isn't primitive mythology that science has surpassed. It's ultra-compressed wisdom about the deep structure of reality that science is only now beginning to formalise. The ancient rabbis (or priests or imams) didn't have category theory or computational complexity, but they understood something profound: that choice, knowledge, and relationship are not just features of human experience but necessary aspects of how any information-processing system explores the space of all possible patterns.*

Prayer remains meaningful. Love remains sacred. Morality remains binding.

But, with the God Conjecture, we can understand ***why.*** It's not authority, nor tradition, but the inherent mathematics of Observation itself.

"The day science begins to study non-physical phenomena, it will make more progress in one decade than in all the previous centuries of its existence." ***Nikola Tesla***

"No man is an island, entire of itself; every man is a piece of the continent, a part of the main." ***John Donne***

"Everything is connected to everything else." ***Barry Commoner***

APPENDICES

A. Supporting Materials

This section provides further supporting evidence for the God Conjecture.

It includes:

- **Summary of all major theistic and atheistic arguments in the same manner as Section 3**
- **An exploration of complexity in dominant human superstructures**
  - **Politics**
  - **Economics**
  - **Science and Epistemology**
  - **Society and Culture**
- **An Ontology of 'Nothing'**
  - **Various proof sketches of why 'nothing' is invalid**
- **A speculative calculation of the Computational Limits of the MetaObserver, within the observable physical universe, based on core units from the Wolfram Physics Project (the outputs are very large)**

Appendix A.1 – Traditional Theism / Atheism Arguments

TL;DR

This appendix provides further arguments for Theism and Atheism (see Section 3).

Section 3 summarised one core argument from each intellectual tradition. This appendix provides a primer on the others.

Theistic Arguments (continued from Section 3)

A.1. The Balance of Evidence: Inductive and Probabilistic Arguments

Inductive arguments claim that God's existence is probable or provides the best explanation for certain features of reality.

A.1.1 Teleological/Design Arguments

Design arguments are among the oldest and most intuitive arguments for God's existence. They point to features of the world that appear designed and infer a designer.

Contemporary fine-tuning arguments shift focus from biology to physics[276]. They observe that the fundamental constants of physics fall within an extraordinarily narrow range that permits the existence of life. If these were slightly different, the universe would be lifeless. The probability of all these constants randomly falling within the life-permitting range is vanishingly small, inferring design, inferring God.

Epistemological Framework: ***Abduction / Inference*** *a form of reasoning we use in science. Assume we can recognize design through certain markers (complexity, functionality, information content) and that these markers reliably indicate intelligence. This framework accepts* ***Empiricism*** *as the starting point but allows for* ***Inference*** *beyond the directly observable.*

Why Are These Arguments Powerful?

Same inference patterns scientists use. *Complex, functional, improbable arrangements typically indicate intelligent causation. We confidently infer design when we encounter Mount Rushmore, ancient artifacts, or signals from space (SETI logic). Why treat the universe differently? Fine-tuning is supported by robust scientific evidence*

Ontological Commitments: ***Teleological realism –*** *purposes and functions are objectively real. They assume that information is a real, non-reducible feature / property of logical objects. They assume that probability calculations are meaningful.*

Core Axioms:

- Design can be empirically detected
- Complexity indicates intelligence
- Fine-tuning requires explanation
- Low probabilities indicate design not randomness

Plain-English Definition [39]: Example Teleological Arguments

Fine Tuning: *The universe runs on c.20 fundamental numbers (strength of gravity, mass of electrons, etc.). Scientists know that if you change any of these numbers by even a tiny amount everything would collapse or fly apart and life would be impossible. The odds of all those numbers randomly falling into the razor-thin ranges needed for life are like winning the lottery a billion billion times in a row. This level of precision suggests someone (God) fine-tuned the settings deliberately.*

Key Criticisms

1. *Multiverse Hypothesis: If infinitely many universes exist with varying constants we'd find ourselves in one permitting observation (anthropic selection: the principle that our observations are biased by the requirement that we exist). Fine-tuning becomes selection, not design.*
2. *Weak Anthropic Principle: We can only observe a universe compatible with observers—no fine-tuning explanation needed beyond survivorship bias.*
3. *Undesigned Features: Evolution explains biological "design." Physics shows suboptimal design (vast empty space).*
4. *Probability Miscalculation: Assigning probabilities to unique events (universe creation) likely meaningless.*

A.1.2 Moral Arguments

Moral arguments begin with the observation that morality involves objective facts—that some things really are right or wrong, independent of belief. From here, they argue that objective morality requires a divine foundation.

- C.S. Lewis's argument from morality observes that humans universally experience moral obligations and make moral judgments that they take to be objectively true. When we say, "torturing innocents for fun is wrong," we don't mean merely that we dislike it or that our society condemns it, we mean it is actually, objectively wrong[277].
- Objective moral facts require a foundation that transcends human opinion. God, in these arguments, provides this ground.
- Kant's argument takes a different approach, arguing that the moral law (which he takes as given through practical reason) requires certain postulates to be coherent. Specifically, morality requires that virtue and happiness ultimately correspond (the highest good), but this correspondence is not guaranteed by nature. Therefore, we can postulate God as the being who ensures that virtue is ultimately rewarded[278].
- Evolutionary explanations can explain why we have moral intuitions, but they seem to undermine rather than support the objectivity of morality. If our moral intuitions are simply survival mechanisms programmed by evolution, why think they track objective moral truth? Social contract theories make morality conventional rather than objective[279].
- Only theism, the argument goes, can ground genuine moral objectivity.

Epistemological Framework: ***Moral Realism*** / ***Intuitive / Transcendental Reasoning***. *Given that objective morality exists (which they take as a given), what must be true for this to be possible?*

> ***Why Are These Arguments Powerful?***
>
> *Taps into deep intuitions about value's objectivity. The sense that child torture is wrong seems more certain than any philosophical theory denying objective morality. Moreover, moral arguments capture a genuine explanatory gap: naturalistic worldviews struggle to account for normativity (the quality of prescribing what ought to be, rather than merely describing what is). The* ***is-ought gap*** *(Hume's principle that you cannot logically derive ought-statements from is-statements) appears unbridgeable without introducing something beyond the natural.*

Ontological Commitments: ***Non-Naturalist Moral Realism*** — *moral facts cannot be reduced to natural facts, "ought" cannot be derived from "is". Assume moral properties need a metaphysical foundation supervening the physical world.*

Core Axioms:

- Objective morality exist
- Moral facts cannot be reduced to natural facts
- The is-ought gap is unbridgeable via naturalism
- Moral obligations require a source (obligations are always to someone)

> ***Plain-English Definition [40]: Example Moral Argument***
>
> ***Lewis Moral Law:*** *Everyone knows deep down that some things are genuinely wrong—not just "frowned upon" or "against the rules," but actually, truly wrong. Torturing children for fun would be wrong even if a society approved it. But where does this "wrongness" come from? It can't just be evolution (evolution only cares about survival, not morality) or social agreement (that would make morality no more real than fashion trends). The only explanation for real, objective moral truth is a moral lawgiver—God.*

> ***Key Criticisms***
>
> 1. *Moral Disagreement: Undermines claims of universal moral knowledge.*
> 2. *Evolutionary Debunking: Evolution fully explains moral intuitions as adaptations.*
> 3. *Non-Theistic Moral Realism: Moral Platonism (the view that moral facts exist independently as abstract objects, like mathematical truths) grounds morality without God.*
> 4. *Euthyphro Dilemma: Does God command the good because it is good, or is it good because God commands it? Either morality is independent of God, or morality is arbitrary.*
> 5. *Moral Anti-Realism: Perhaps there simply are no objective moral facts; moral emotivism (the view that moral statements express emotions rather than facts) or moral fictionalism (the view that moral talk is useful fiction without literal truth) avoids the problem entirely.*

A.2 Direct Awareness: Experiential Arguments

Experiential arguments are radically different. Rather than reasoning, they claim that some people have direct experiential awareness of God. These experiences (taken cumulatively) provide evidence for God's existence in the same way that sensory experiences provide evidence for an external world.

Epistemological Framework: ***Plantinga's Reformed Epistemology***[280]***,*** *the view that belief in God can be properly basic (not requiring evidence). They reject classical foundationalism in favour of a more expansive understanding of rational belief formation.*

> ***Why Are These Arguments Powerful?***
>
> *Scepticism about religious experience seems to require a* ***double standard*** *(applying stricter epistemic criteria to religious claims than to other experiential claims) if we accept sensory experience while rejecting religious experience.*

Ontological Commitments: ***Substance Dualism,*** *mental/experiential provides genuine access to reality i.e. experiences can sample non-natural things and that physical systems cannot experience non-physical realities (mind).*

Core Axioms:

- Experience provides prima facie evidence for reality
- Religious experience is a category of experience
- The principle of credulity (trust reported experience unless you have reason not to)
- Properly basic beliefs do not need justification through argument
- Consensus is functionally equivalent to evidence

> ***Key Criticisms***
>
> 1. *Conflicting Experiences: Different religions report incompatible experiences (personal God vs. impersonal Brahman vs. Buddhist emptiness)—they can't all be true.*
> 2. *Naturalistic Explanations: Neuroscience explains religious experiences through brain states (neural correlates of mystical experience: specific patterns of brain activity associated with religious experiences), psychoactive substances, meditation techniques, or psychological states.*
> 3. *Cultural Conditioning: People tend to have experiences conforming to their religious tradition.*
> 4. *Selection Bias: Those without religious experiences have equally strong intuitions of God's absence; why privilege positive over negative experiences?*
> 5. *Principle of Credulity Limits: Not all experiences are true (hallucinations, illusions, dreams); religious experiences may fall into non-veridical categories.*

A.3 Transcendental Arguments

Transcendental arguments argue that God's existence is a necessary precondition for features of reality we take for granted (logic, knowledge, or moral truth).

A.3.1 The Argument from Reason

- Naturalism cannot explain reason. If naturalism is true, our cognitive faculties are the product of evolution, which selects for survival only (not truth). If our mental faculties are not looking for truth, why should we trust them when they tell us naturalism is true?
- The very practice of rational argument presupposes that our minds can track truth and that beliefs can be held for reasons (not just causes). But naturalism reduces all mental states to physical states governed by natural laws, eliminating genuine reasoning.
- Reppert's formulation[281] emphasizes several features of reasoning that seem impossible to capture in wholly physical terms: intentionality (thoughts being about things), mental causation (beliefs causing other beliefs for logical reasons), and the reliability of cognitive faculties.
- None of these, today, are reducible to physical processes, yet they all are necessary for reasoning.

Epistemological Framework: ***Transcendental-Reliabilist,*** *uses reasoning to identify necessary preconditions, combined with reliabilism (the view that beliefs are justified when they're produced by reliable cognitive processes) about justification. The argument hinges on showing naturalism undermines the reliability of the cognitive processes used to support naturalism.*

> ***Why Are These Arguments Powerful?***
>
> *These don't require accepting controversial premises—they show that denying the conclusion undermines the cognitive capacities needed to defend that denial. This creates a* ***performative contradiction****: the act of arguing against God's existence presupposes cognitive reliability that (the argument claims) only theism can ground.*

Ontological Commitments: *Mental properties are irreducible to physics. Reasoning can be causal (not just physical events causing other physical events), and that truth and reference are objective features of thoughts, not just useful fictions.*

Core Axioms:

- Reasoning requires truth-tracking cognitive faculties
- Evolution selects for survival, not truth

- Physical states cannot have inherent intentionality
- Logical laws cannot be reduced to physical laws
- Beliefs must be capable of being held for reasons, not just causes

Key Criticisms

1. *Emergence: Mental properties could supervene (arise from physical properties without being reducible to them) physical substrates without contradiction.*
2. *Evolution Can Track Truth: In stable environments, adaptive beliefs tend to be true; false beliefs about predators, food, etc., reduce survival.*
3. *Deflationary Truth: Truth is pragmatic utility; no robust notion of truth-tracking needed.*
4. *Naturalism is Eliminativist, Not Self-Refuting: Perhaps naturalism entails the view that folk psychological concepts like "belief" and "reason" don't refer to anything real.*

A.3.2 Mathematical Realism[282] (i.e. Platonic Spaces, though not exactly the same)

- A powerful argument that connects mathematical realism to theism. Mathematical truths appear to be necessary, eternal, and mind-independent—yet they also seem to require some form of grounding. The number 5 would be prime even if no human had ever existed, yet where does this truth "exist"?
- Mathematical objects do not exist in physical space and time, yet they seem to exist and are invariant. Moreover, the effectiveness of mathematics in describing physical reality (what Eugene Wigner called "the unreasonable effectiveness of mathematics") suggests a deep connection between maths (abstract) and physics (real).
- **The theistic argument is that mathematical truths exist as 'thoughts' in the mind of God.**
- This explains their necessity (God exists necessarily), their eternality (God is eternal), their applicability to the physical world (God created the physical world according to mathematical principles), and our ability to discover them (we are created 'in God's image' with rational faculties that can grasp these truths).

Epistemological Framework: ***Mathematical Platonism and Rationalist Intuition****—mathematical truths are discovered, and that they are objectively true independent of human minds. Assumes that we have reliable access to them through* ***Rationalism*** *and* ***Intuition***.

Why Are These Arguments Powerful?

Combines strong intuitions (math seems discovered, not invented) with empirical observations (math's effectiveness in physics) and provides a unified explanation.

Ontological Commitments: *Realism for abstract objects. Assumes abstract objects need grounding or explanation for their existence. Assumes applicability of maths to physics is not coincidental but structural.*

Core Axioms:

- Mathematical truths are objective (and mind-independent)
- Abstract objects require grounding
- The applicability of mathematics to physics requires explanation
- Infinite sets and transfinite mathematics are meaningful
- Mathematical intuition provides objective knowledge

Atheistic Arguments (Continued from Section 3)

A.4 Evidential Arguments: Balance of Probabilities

Even if the logical arguments fail, probabilistic formulations can replace them i.e. God's existence is not impossible but what we observe makes God's existence improbable.

A.4.1 The Problem of Evil (Evidential)[283]

Rowe's formulation focuses on gratuitous suffering—suffering that serves no greater good that an omnipotent being couldn't achieve without the suffering. Consider a fawn dying painfully in a forest fire, with no observers, serving no apparent purpose. Multiple examples exist throughout Earth's history. While we cannot prove that no greater good is served, it seems highly probable that some of this suffering is genuinely gratuitous. **If gratuitous suffering exists, an omnipotent, omnibenevolent God does not**. Draper formalises this with Bayesian probability theory[284].

The argument from scale extends this type of formulation—billions of years of predation, disease, and death before humans appear. The suffering required by the evolutionary process seems excessive, especially given that an omnipotent God could have created life directly[285].

Epistemological Framework: ***Probabilistic Reasoning and Inference***. *They don't claim certainty but argue that the evidence favours naturalism.*

> ***Why Are These Arguments Powerful?***
> *Don't require proving evil is incompatible with God, only that evil makes God's existence improbable. Therefore, harder to refute. Moreover, evidential arguments incorporate not just that evil exists, but the full pattern of evil.*

Ontological Commitments: *Assume suffering is real and bad, that probability judgments about divine purposes are meaningful, and that we can make assessments about what a loving God would do.*

Core Axioms:

- Gratuitous suffering (probably) exists
- We can make probability judgments about divine behaviour
- The distribution of suffering is valid evidence
- Scale and duration of suffering are relevant to probability judgments

> ***Key Criticisms***
> 1. *Sceptical Theism: We cannot assess probability because we cannot know what reasons an infinitely wise God might have.*
> 2. *Afterlife/Cosmic Justice: Suffering might be compensated in an afterlife.*
> 3. *Greater Goods: Many greater goods (virtues, relationships, moral development) require evil as a precondition.*
> 4. *Evidential Symmetry: Goods in the world (beauty, love, joy, meaning) provide evidential weight for theism just as evils provide weight for atheism.*

A.5 Divine Hiddenness

J.L. Schellenberg's argument from divine hiddenness[286] provides a different evidential challenge. If God is perfectly loving, He would want a relationship with all persons capable of it. A relationship requires belief that the other party exists. Therefore, a perfectly loving God would ensure that all persons capable of relationship with Him would have evidence for belief in Him. Yet many people seeking truth, do not believe in God. Therefore, a perfectly loving God does not exist.

This argument gains force from considering specific cases: the ancient Chinese philosopher who never encountered theistic ideas (though similar concepts are evident in the Dao's emanatory framework), the child raised in a secular environment who never seriously considers God (though the structures of their morality, in the causal graph of history utilise them), the former believer who loses faith despite desire to maintain it. These cases of non-resistant non-belief seem incompatible with a God who desires relationship with all.

Epistemological Framework: ***Conceptual Analysis / Empirical Observation***. *Assumes divine hiddenness cannot serve any purpose that outweighs universal opportunity for relationship.*

> ***Why Are These Arguments Powerful?***
> *Hiddenness and Love seem mutually exclusive. Forceful a fortiori reasoning: if imperfect humans wouldn't hide from those they love, how could a perfectly loving God?*

Ontological Commitments: *Assumes that love must seek relationship, that belief is necessary for relationship, and that there exist genuine seekers who lack belief.*

Core Axioms:

- God seeks relationship with all capable persons
- Belief is necessary for relationship
- Non-resistant non-believers exist
- No greater good justifies divine hiddenness from willing seekers

> ***Key Criticisms***
> 1. *Greater Goods Need Hiddenness: Some goods (free will, moral autonomy) require distance. God providing evidence that permits but doesn't compel belief preserves that freedom.*
> 2. *Different Pathways: God might reveal Himself through different means across cultures (natural theology, religious experience, conscience) even absent explicit theistic concepts.*
> 3. *Eschatological Resolution: Divine hiddenness might be temporary.*

A.6 Explanatory Sufficiency: Naturalism as Complete / Eventually Completable

These arguments don't attack theism directly but argue that naturalistic explanations are sufficient for all phenomena i.e. God is unnecessary and explanatory complex.

A.6.1 Evolution

Darwin's theory of evolution[287] by natural selection provides a naturalistic explanation for biological complexity and design. Random variation plus natural selection produces complexity, functionality, and the appearance of purpose—all without any guiding intelligence / telos.

Richard Dawkins argues that evolution is a "blind watchmaker" capable of producing all the intricate machinery of life through natural processes[288]. Moreover, evolution explains features of biology that seem puzzling: vestigial organs, sub-optimal designs (like the recurrent laryngeal nerve), shared errors in pseudogenes across related species, and the vast wastefulness of the evolutionary process[289].

These make perfect sense with evolution but are surprising if life was designed.

Epistemological Framework: ***Methodological Naturalism***—*i.e. natural explanations for natural phenomena. Assumes successful naturalistic explanation remove the need for supernatural explanation*.

Why Are These Arguments Powerful?

Experimentally confirmed and makes predictions and has transformed biology. Provides mechanistic detail that design arguments lack. Shows that complexity can emerge from simplicity via algorithmic processes (proven this through cellular automata / evolutionary algorithms).

Ontological Commitments: *Assumes complexity emerges from simple processes (proven true, see Cellular Automata and Rule 30), that information increases through natural selection, and that the appearance of design doesn't indicate actual design*.

Core Axioms:

- Natural selection is a sufficient explanation
- Methodological naturalism is the appropriate approach to biology
- Apparent design can emerge without a designer
- Evolution is unguided
- Information can increase through natural processes

Key Criticisms

1. *Evolution is God's Method: Discovering mechanism doesn't eliminate Designer i.e. discovering how cars work doesn't eliminate the car company*
2. *Information Problem: Evolution requires pre-existing information: "No Free Lunch" Theorems: Averaged over all possible problems, no algorithm outperforms random search. Evolution only works on structured fitness landscapes. What is the root of that structure?*
3. *Conservation of Information: Dembski-Marks theorem shows that successful evolutionary searches require "active information" input—where does this information come from?*
4. *Origin of Life: Evolution requires replication, but replication requires complex molecular machinery. Probability calculations suggest life arising from non-life by chance is effectively impossible:*
    a. *Minimum requirements for simplest life: ~200,000 bits of information*
    b. *Probability of random assembly: $P < 2^{-200,000} \approx 10^{-60,000}$*
    c. *Even given every atom in universe (10^{80}) trying every Planck time (10^{43}/sec) for age of universe (10^{17} sec): only 10^{140} trials, nowhere near sufficient*
5. *Convergence: Independent evolution of identical complex structures suggests mathematical attractors (optimal solutions in design space) rather than historical contingency, pointing to teleology.*
6. *Irreducible Complexity: Some systems require multiple parts functioning together; removing any part causes complete failure. How did those systems evolve gradually?*

A.6.2 Cosmological Naturalism

Contemporary cosmology offers naturalistic accounts of the universe's origin and structure. Quantum mechanics suggests that events can occur without causes (radioactive decay[290], quantum fluctuations). General relativity shows that time itself began with the Big Bang, undermining the question "what caused the Big Bang?"[291] (since causation requires time – though natural time and computational time are not the same thing).

Quantum cosmology models like the Hartle-Hawking[292] suggest the universe could be self-contained, requiring no external cause. Multiverse theories[293] provide naturalistic explanations for fine-tuning[294]: if infinitely many universes exist with varying constants, observers will necessarily find themselves in one that permits observers.

The fine-tuning is then just selection (i.e. cosmological evolution).

Epistemological Framework: ***Empiricism;*** *operates within modern physics, using established theories to extrapolate origin. Assume observable laws and principles extendable to cosmological scales.*

> ***Why Are These Arguments Powerful?***
>
> *Grounded in successful physical theories (QM, GR). Show that causation and temporal priority aren't as metaphysically fundamental as intuition suggests.*

Ontological Commitments: Assume laws of physics are fundamental and require no explanation, that quantum mechanics accurately describes reality, and that infinities (like infinite multiverses) are physically meaningful and objectively real.

Core Axioms:

- Physical laws are fundamental
- Quantum events do not require prior cause
- Multiverse hypotheses are objective (not just metaphysical)
- Selection effects explain fine-tuning

> ***Key Criticisms***
>
> 1. *"Nothing" Isn't Really Nothing: "nothing" is quantum vacuum with laws, fields, energy. Metaphysical nothingness is absence of anything, including quantum fields.*
> 2. *Why These Laws: Explanatory regress in QM laws as brute facts*
> 3. *Multiverse is Metaphysics: Theories currently empirically unverifiable. They're speculative metaphysics dressed as physics. If parallel universes are causally isolated, they're undetectable.*
> 4. *Fine-Tuning of Multiverse Generators: Multiverse-generating mechanisms (inflation, string theory landscape) require fine-tuning. You haven't eliminated design; you've pushed it back up a level.*
> 5. *Computational vs. Physical Time: The argument assumes physical time is the only relevant time. But computational time (the ordered sequence of computational steps) could be fundamental. Computational causation might not require physical time.*
> 6. *PSR Violation: Accepting the universe as brute fact abandons PSR, undermining all rational (and scientific) inquiry.*

A.7 Meta-Arguments

Some atheistic arguments challenge the framework of the God debate rather than engaging with specific theistic arguments.

A.7.1 Presumption of Atheism

Flew argued that atheism should be the default position until adequate evidence for theism is provided[295]. Just as we presume the non-existence of Russell's teapot[296] orbiting between Earth and Mars, or Sagan's invisible dragon in the garage[297], we should presume the non-existence of God until given reason to think otherwise.

Epistemological Framework: ***Evidentialist*** *i.e. belief should be proportioned to evidence. Assumes that the burden of proof lies with those making positive claims of existence.*

> ***Why Are These Arguments Powerful?***
>
> *Aligns with common sense. We don't believe in astrology, homeopathy, or alien abductions until given evidence. Why treat God differently? The presumption of atheism makes atheism the rational default, placing theists in a defensive position.*

Ontological Commitments: *Absence of evidence is evidence of absence.*

Core Axioms:

- Default position of non-existence
- Burden of proof lies with positive existence
- Extraordinary claims require extraordinary evidence

- Absence of expected evidence is evidence of absence

> ***Key Criticisms***
> 1. *Reformed Epistemology: Plantinga argues that belief can justified without inferential support, just like belief in other minds, the past, or the external world. They're foundational.*
> 2. *Existential Neutrality: Why privilege non-existence over existence? For necessary beings (beings that cannot fail to exist), existence might be the default. The presumption of atheism treats God like contingent entities (teapots, dragons).*
> 3. *Cumulative Case: The evidence for God isn't a single "smoking gun" but a cumulative case from multiple lines (cosmology, fine-tuning, consciousness, morality, religious experience). Demanding "extraordinary evidence" sets an arbitrarily high bar.*
> 4. *Evidence of Absence Fallacy: Absence of evidence is not evidence of absence—at least not always. If God has reasons for epistemic ambiguity, absence of overwhelming evidence is what we'd expect.*

A.7.2 Religious Diversity

The argument from religious diversity observes that incompatible religious traditions make similar claims to truth based on similar types of evidence (revelation, religious experience, miracles, etc.)[298]. Since they contradict each other, most of them must be false. But if most religious beliefs are false despite seeming compelling, this undermines confidence in any particular religious belief.

Epistemological Framework: ***Epistemic Parity***—*Assumes religious diversity is evidence against religious truth (rather than different perspectives on a ground truth).*

> ***Why Are These Arguments Powerful?***
> *Empirically undeniable. Distribution of belief correlates with culture/birthplace. If believers had genuine access to truth, we'd expect convergence (like in science), not divergence.*

Ontological Commitments: *Contradictory religious claims cannot all be true*.

Core Axioms:

- Contradictory religious claims cannot all be true
- Contradictory claims undermines all claims
- Religious belief is determined by cultural context

> ***Key Criticisms***
> 1. *Core Convergence: Despite surface differences, major traditions converge on key points: ultimate reality transcends the physical realm, this life isn't final, moral law is real and binding and humans have a spiritual dimension. Differences could reflect cultural expressions of a common core (like different descriptions of the elephant in the blind men parable).*
> 2. *Religious Pluralism: Multiple traditions could provide different paths to the divine, each adapted to different cultural contexts.*
> 3. *Disagreement Doesn't Undermine Knowledge: Ethical disagreement doesn't prove ethics is subjective; political disagreement doesn't prove political truth is impossible. Why should religious disagreement prove religious knowledge is impossible?*
> 4. ***The God Conjecture's Response:*** *In this framework, different traditions represent different sampling perspectives of the same underlying computational reality (the Ruliad). Apparent contradictions reflect different Observer constraints, not different realities. This transforms religious diversity from problem to confirmation—this model expect diverse perspectives on infinite transcendent reality.*

"The God of the philosophers is not the God of Abraham, Isaac, and Jacob." ***Blaise Pascal***

References

[276] Barnes, L.A. (2021) 'The Fine-Tuning of the Universe for Life', in Knox, E. and Wilson, A. (eds.) The Routledge Companion to Philosophy of Physics. London: Routledge, pp. 529-557. Available at: https://arxiv.org/abs/2110.07783
Lewis, G.F. and Barnes, L.A. (2016) A Fortunate Universe: Life in a Finely Tuned Cosmos. Cambridge: Cambridge University Press
Collins, R. (2009) 'The Teleological Argument: An Exploration of the Fine-Tuning of the Universe', in Craig, W.L. and Moreland, J.P. (eds.) The Blackwell Companion to Natural Theology. Oxford: Wiley-Blackwell, pp. 202-281
Friedrich, S. (2023) 'Fine-Tuning', in Zalta, E.N. and Nodelman, U. (eds.) The Stanford Encyclopaedia of Philosophy (Winter 2023 Edition). Available at: https://plato.stanford.edu/archives/win2023/entries/fine-tuning/
Collins, R. (1999) 'A Scientific Argument for the Existence of God: The Fine-Tuning Design Argument', in Murray, M.J. (ed.) Reason for the Hope Within. Grand Rapids, MI: Eerdmans, pp. 47-75
[277] Lewis, C.S. (2001) Mere Christianity. New York: HarperCollins
[278] Kant, I. (2012) Groundwork of the Metaphysics of Morals, trans. and ed. M.J. Gregor and J. Timmermann, revised edition. Cambridge: Cambridge University Press
Kant, I. (2015) Critique of Practical Reason, trans. and ed. M.J. Gregor, with introduction by A. Reath, 2nd revised edition. Cambridge: Cambridge University Press
Timmermann, J. (2007) Kant's Groundwork of the Metaphysics of Morals: A Commentary. Cambridge: Cambridge University Press

[279] Darwin, C. (1981) The Descent of Man, and Selection in Relation to Sex. Princeton: Princeton University Press
Joyce, R. (2001) The Myth of Morality. Cambridge: Cambridge University Press
Street, S. (2006) 'A Darwinian dilemma for realist theories of value', Philosophical Studies, 127(1), pp. 109-166. Taylor & Francis Online +8 DOI: 10.1007/s11098-005-1726-6
Ruse, M. and Richards, R.J., eds. (2017) The Cambridge Handbook of Evolutionary Ethics. Cambridge: Cambridge University Press
Shafer-Landau, R. (2012) 'Evolutionary debunking, moral realism and moral knowledge', Journal of Ethics and Social Philosophy, 7(1), pp. 1-37
[280] Plantinga, A. (1967) God and Other Minds: A Study of the Rational Justification of Belief in God. Ithaca, NY: Cornell University Press
Plantinga, A. (1983) 'Reason and Belief in God', in Plantinga, A. and Wolterstorff, N. (eds.) Faith and Rationality: Reason and Belief in God. Notre Dame, IN: University of Notre Dame Press, pp. 16-93
Plantinga, A. (2000) Warranted Christian Belief. New York: Oxford University Press
[281] Reppert, V. (1999) 'The Argument from Reason', Philo, 2(1), pp. 33-45
Reppert, V. (2003) C.S. Lewis's Dangerous Idea: In Defence of the Argument from Reason. Downers Grove, IL: InterVarsity Press
Reppert, V. (2018) 'Extending the Debate on the Argument from Reason', Philosophia Christi, 20(2), pp. 517-539
[282] Wigner, E.P. (1960) 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences', Communications in Pure and Applied Mathematics, 13(1), pp. 1-14. DOI: 10.1002/cpa.3160130102
Franklin, J. (2014) An Aristotelian Realist Philosophy of Mathematics: Mathematics as the Science of Quantity and Structure. Basingstoke: Palgrave Macmillan. DOI: 10.1057/9781137400734
Steiner, M. (1998) The Applicability of Mathematics as a Philosophical Problem. Cambridge, MA: Harvard University Press
[283] Rowe, W.L. (1996) 'The Evidential Argument from Evil: A Second Look', in Howard-Snyder, D. (ed.) The Evidential Argument from Evil. Bloomington: Indiana University Press, pp. 262-285
Rowe, W.L. (2001) 'Skeptical Theism: A Response to Bergmann', Noûs, 35, pp. 297-303
[284] Draper, P. (1989) 'Pain and Pleasure: An Evidential Problem for Theists', Noûs, 23(3), pp. 331-350. DOI: 10.2307/2215486
[285] Murray, M.J. (2008) Nature Red in Tooth and Claw: Theism and the Problem of Animal Suffering. Oxford: Oxford University Press. ISBN: 978-0-19-923727-2
Southgate, C. (2002) 'God and Evolutionary Evil: Theodicy in the Light of Darwinism', Zygon: Journal of Religion and Science, 37(4), pp. 803-824. DOI: 10.1111/1467-9744.00459
Southgate, C. (2008) The Groaning of Creation: God, Evolution, and the Problem of Evil. Louisville, KY: Westminster John Knox Press. ISBN: 978-0-664-23090-6
Schneider, J.R. (2020) Animal Suffering and the Darwinian Problem of Evil. Cambridge: Cambridge University Press. DOI: 10.1017/9781108767439
[286] Schellenberg, J.L. (1993) Divine Hiddenness and Human Reason. Ithaca, NY: Cornell University Press. ISBN: 978-0-8014-2792-3 Amazon +14
Schellenberg, J.L. (2005) 'The Hiddenness Argument Revisited (I)', Religious Studies, 41, pp. 201-215. Oxford Bibliographies
Schellenberg, J.L. (2005) 'The Hiddenness Argument Revisited (II)', Religious Studies, 41, pp. 287-303.
Schellenberg, J.L. (2015) The Hiddenness Argument: Philosophy's New Challenge to Belief in God. Oxford: Oxford University Press. ISBN: 978-0-19-873308-9
[287] Darwin, C. (2009) The Origin of Species. Edited by Jim Endersby. Cambridge: Cambridge University Press.
[288] Dawkins, R. (1996) The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe without Design. New edition with appendix. New York: W.W. Norton & Company. ISBN: 9780393315707
Dawkins, R. (2006) The God Delusion. Boston: Houghton Mifflin Company. Wikipedia ISBN: 9780618680009
[289] Lents, N.H. (2018) Human Errors: A Panorama of Our Glitches, from Pointless Bones to Broken Genes. Boston: Houghton Mifflin Harcourt. ISBN: 9781328974693
Wedel, M.J. (2012) 'A monument of inefficiency: the presumed course of the recurrent laryngeal nerve in sauropod dinosaurs', Acta Palaeontologica Polonica, 57(2), pp. 251-256. BioOne DOI: 10.4202/app.2011.0019
Miller, K.R. (1999) Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution. New York: HarperCollins. ISBN: 9780060930493
[290] Condon, E.U. and Gurney, R.W. (1929) 'Quantum Mechanics and Radioactive Disintegration', Physical Review, 33(2), pp. 127-140. DOI: 10.1103/PhysRev.33.127
[291] Luminet, J.-P. (2015) 'Lemaître's Big Bang', arXiv preprint arXiv:1503.08304. Available at: https://arxiv.org/abs/1503.08304
[292] Hartle, J.B. and Hawking, S.W. (1983) 'Wave Function of the Universe', Physical Review D, 28(12), pp. 2960-2975. DOI: 10.1103/PhysRevD.28.2960
Lehners, J.-L. (2023) 'Review of the No-Boundary Wave Function', Physics Reports, 1022, pp. 1-82. nLab DOI: 10.1016/j.physrep.2023.06.002. Available at: https://arxiv.org/abs/2303.08802
[293] Tegmark, M. (2003) 'Parallel Universes', Scientific American, 288(5), pp. 40-51. Available at: https://arxiv.org/abs/astro-ph/0302131
Tegmark, M. (2014) Our Mathematical Universe: My Quest for the Ultimate Nature of Reality. New York: Alfred A. Knopf
[294] Carter, B. (1974) 'Large Number Coincidences and the Anthropic Principle in Cosmology', in Longair, M.S. (ed.) Confrontation of Cosmological Theories with Observational Data. Dordrecht: D. Reidel, pp. 291-298
Susskind, L. (2005) The Cosmic Landscape: String Theory and the Illusion of Intelligent Design. New York: Little, Brown and Company
Weinberg, S. (1987) 'Anthropic Bound on the Cosmological Constant', Physical Review Letters, 59(22), pp. 2607-2610
[295] Flew, A. (1976) The Presumption of Atheism and Other Philosophical Essays on God, Freedom and Immortality. London: Elek/Pemberton. ISBN: 9780301750163
[296] Russell, B. (1952) 'Is There a God?', in Slater, J.G. and Köllner, P. (eds.) (1997) The Collected Papers of Bertrand Russell, Volume 11: Last Philosophical Testament, 1943-68. London and New York: Routledge, pp. 542-548. ISBN: 9780415094092
[297] Sagan, C. and Druyan, A. (1997) The Demon-Haunted World: Science as a Candle in the Dark. First Ballantine Books edition. New York: Ballantine Books. ISBN: 9780345409461
[298] Hick, J. (2004) An Interpretation of Religion: Human Responses to the Transcendent. 2nd edn. Basingstoke: Palgrave Macmillan. ISBN: 978-1-4039-4445-0

Appendix A.2 – Convergence Proof Sketches

TL;DR

This Appendix provides proof sketches of convergence condition for Observers in the Ruliad.

These sketches aim to show that under different conditions Observers aim to maximise Integrated Information in their Observable Field (F_O), and that must asymptotically approach TI at the limit.

We reference the posited function from the Observer Theory Extension (May 2025), restated below:

$$\boldsymbol{I(F_O) = \Sigma\, x \in F_O\, \phi(x) = \Sigma\, x \in F_O\, (H(x) - H_{red}(x))}$$

In other words, $I(F_O)$ is the total useful information an Observer has integrated from its accessible field of observation, F_O within R_O, its ultimate observable limit, at time, t.

This function takes the field of Observation, F_O, within R_O and determines how much initial entropy (or alternatively some measure of computational irreducibility) is in that 'area' of R_O and then samples different rules accessible to it (morphisms between states / categories) to reduce entropy and increase computational reducibility in that part of F_O

Part A: Convergence Proof-Sketches

This conjecture represents the capstone of our theoretical edifice: **all observers, all systems, and all paths through the Ruliad necessarily converge to a closure point at Infinity (TI)**.

This is not a statement of hope or faith, but a mathematical necessity to enable a computational Ruliad to be mathematically tractable. It has been developed from multiple formal frameworks (Gorard, Arsiwalla, Wolfram, Rickles), each providing proofs of this structural requirement.

Here we apply them to Observer Theory.

Proof Sketch 1: From Information Theory

We begin with the information-theoretic demonstration of convergence.

Definition (Information Integration Directionality): For any observer O embedded in the Ruliad, the rate of change of integrated information satisfies:

$$dI(F_O)/dt \geq 0$$

This inequality follows from the fundamental nature of observation as an information-gathering process.

Once information is integrated into an observer's functional structure F_O, it exhibits a ratchet effect - integrated patterns persist and accumulate. Given that our universe contains finite information (bounded by the Bekenstein bound of $\sim 10^{123}$ bits for the observable universe), there exists a maximum integrated information $I_{maximum}$. Therefore:

$$\lim[t\to\infty]\ I(F_O) = I_{max} \equiv TI$$

The convergence is monotonic because information, once integrated, creates patterns that resist entropic dissolution. Each observation adds to the total integrated information, and while the rate may vary, the direction never reverses (see proof sketch in *Observer Theory: An Extension to the Wolfram Model, Senchal, 2025*).

Proof Sketch 2: From Thermodynamics

The second law of thermodynamics, when properly understood through Observer Theory, provides another route to the same conclusion. The apparent paradox, that entropy increases while this paper claim convergence toward maximum information integration subject to Observer's computational boundedness, resolves when we recognize that entropy in an observed universe is not uniform randomness but correlation between the observer and the environment.

Consider the entropy from the Observer's perspective:

$$H_{observed} = H_{total} - I(O;R_O)$$

Where $I(O;R_O)$ is the mutual information between observer and the accessible part of the Ruliad, R_O.

As the universe evolves toward maximum entropy H_{max}, observers that survive must maximize $I(O; R_O)$ to maintain local order (and consequently, Observer persistence).

At the limit:

$$\lim[t\to\infty]\ H_{total} = H_{max}$$

$$\lim[t\to\infty]\ I(O;R_O) = I_{max} = TI$$

Thus heat death is isomorphic to the completion of all possible computations. Maximum entropy coincides with maximum integration.

Proof Sketch 3: From Category Theory

In categorical terms, TI represents the terminal object in the category of Observer's accessible states.

Definition: An object TI is terminal if for every object X in the category, there exists a unique morphism X → TI.

For the category of observers in the Ruliad:

- Objects: Observer states
- Morphisms: Computational transitions

TI satisfies terminality because:

1. Every Observer state can transition toward higher integration (existence)
2. There is only one maximum integration state (uniqueness)

The composition of morphisms ensures that all paths, regardless of intermediate steps, eventually reach TI:

$$\forall X,Y: X \to Y \to TI \equiv X \to TI$$

Proof Sketch 4: From Evolutionary Dynamics

Natural selection provides a biological proof-sketch. If we define fitness in terms of predictive accuracy:

$$\text{Fitness}(O) = f(\text{Predictive Accuracy}(O))$$

$$\text{Predictive Accuracy}(O) = g(I(F_O))$$

Since higher integrated information enables better Observer modelling and response (i.e. computational reducibility is found, so more predictions are both accurate and possible), selection pressure drives toward maximum $I(F_O)$.

Cultural evolution accelerates this through horizontal (branchial) information transfer between Observers. Consequently, the fitness landscape has a single global optimum at TI.

The Convergence Theorem

Synthesizing these:

Conjecture (Universal Convergence): For any observer O in the R_O, there exists a finite time, t_n (this t will likely be very large) such that:

$$|I(F_O(t > t_n)) - TI| < \varepsilon$$

$$\text{and } \varepsilon > 0$$

The convergence rate is posited to follow a log curve with exponential acceleration in the early phase (where we are today) followed by asymptotic approach to TI.

Part B: The Messianic Era as 'Computational Completion'

The correspondence between the framework and eschatological visions across all major traditions is not coincidental.

It suggests that mystics and prophets throughout history have intuited, through different cognitive modes, the same fundamental truth we have demonstrated.

Universal Eschatological Convergence

The Jewish concept of *Olam Ha-Ba* (the World to Come) does not describe a physical location. It describes an elevated state of consciousness where "the knowledge of God fills the earth as waters cover the sea" (Isaiah 11:9).

In a computational framework, this represents a state where God is recognized and actualized at the maximum computational ability of a Human Observers.

The concept of *Tikkun Olam* (repairing the world) maps to entropy reduction through conscious action. Each mitzvah (commandment) can be understood as a local entropy-reducing operation that contributes to global convergence in a computationally efficient manner.

Christianity's "Kingdom of Heaven" manifesting "on earth as in heaven" describes the unification of the M-domain (transcendent) with the P-domain (physical). The "Second Coming" represents the phase transition when collective consciousness reaches a critical point of information integration.

Paul's vision of God becoming "all in all" (1 Corinthians 15:28) is weakly equivalent to computational completion at TI – a state where divine consciousness (near-infinite information integration) permeates all finite observers.

The Hindu concept of *Satya Yuga,* returning after the completion of cosmic cycles, shows cyclical time spiralling toward perfection rather than merely repeating. Each *kalpa* (cosmic cycle) achieves higher integration than the last. The idea that all beings eventually achieve liberation (*moksha*) parallels our conjecture that all Observers must aim for TI.

Buddhism's *Parinirvana*, often misunderstood as 'extinction', describes complete information integration where the distinction between samsara and nirvana dissolves. The Bodhisattva's vow to save all beings before entering final liberation reflects the mathematical truth that convergence must be collective, no subsystem can achieve full information integration while being disconnected from others.

Even secular visions converge on this realisation. The "Technological Singularity" describes recursive self-improvement of intelligence leading to an explosion of capability – precisely what we'd expect as $I(F_O)$ approaches infinity. Teilhard de Chardin's Omega Point and Frank Tipler's physics-based eschatology independently arrived at similar conclusions through different reasoning.

Appendix A.3 – Human Superstructure Evolution

TL;DR

Human civilization is a 50,000-year experiment in computational coordination.

From hunter-gatherer bands to global AI-governed platforms, every structure humanity has created represents a solution to the same fundamental challenge: how can computationally bounded Observers (humans with limited processing power and information) coordinate collective action at increasing scales?

This appendix demonstrates that political systems, economic structures, and collective behaviours are not arbitrary cultural constructions but necessary computational architectures that emerge from Observer constraints.

The universal convergence toward similar organisational forms—hierarchy, markets, law, standardization—across independent civilizations reveals these structures as attractors in the Ruliad's possibility space.

Conjectures:

- ***Scaling Laws:*** *Social coordination complexity follows predictable mathematical patterns that determine organisational phase transitions*
- ***Dunbar's Number:*** *~150 is not just empirical but emerges from network information optimisation dynamics*
- ***Universal Convergence:*** *Independent discovery of identical solutions (writing, money, law codes, markets) indicates computational necessity, not cultural contingency*
- ***Evolutionary Direction:*** *All systems evolve toward increased abstraction, standardization, and information processing capacity—paralleling the Observer journey toward TI*
- ***Future Trajectory:*** *Digital governance and AI represent the next phase transition, potentially transcending biological computational limits*

Plain-English Context:

Human history is the story of discovering better algorithms for getting large groups to work together effectively. The same mathematical patterns that govern Observer Theory govern human societies.

Note:

Even if you don't agree with the papers main conjecture (God is valid in a computational universe), thinking computationally about how we do things has enormous utility.

We can use it to map patterns that form in every superstructure that has emerged. These structures, like the ones described in the paper's main body, show rising complexity with the development of new Observer coordination technologies (see Appendix A.4 Observer Coupling) that mirror the path we've explored in Section 4 and 5 with religion.

Introduction: The Secular Sacred

Secular systems fulfil the same fundamental functions as religions: meaning-provision, identity-formation, moral frameworks, and, most crucially, computational coordination mechanisms for human collectives (groups of Observers).

From the smallest hunter-gatherer band to global governance institutions, secular superstructures have evolved in lockstep with their religious counterparts, driven by identical Observer constraints.

This parallel evolution is no historical accident.

Human beings require three essential cognitive infrastructures:

1. Frameworks for meaning: Understanding their place in the world
2. Systems for collective action: Organizing coordinated behaviour beyond individual capacity
3. Narratives transcending the individual: Connecting personal experience to larger patterns

These frameworks may invoke gods or constitutions, spirits or markets, transcendent realms or scientific laws, but they serve the same *computational function*: reducing the complexity of coordinating multiple agents with imperfect information and bounded processing capacity to optimally explore an infinite possibility space.

> ***Computational Analogy:***
>
> *Think of secular ideologies and religious systems as different programming languages (Python vs. Java) implementing the same core algorithm—creating shared virtual reality spaces where millions of minds can coordinate despite having no direct access to each other's internal states.*

With this lens, secular ideologies are different implementations of the same underlying program: the creation of shared realities (things we can possibly observe) that enable collective action at scale (which enable us to sample more states and have more potential choices in the Ruliad).

The convergence of diverse systems to similar superstructures (hierarchy, law, ritual/protocol, mythology/ideology) suggests these are necessary features that emerge from the computational structure of Observers in the Ruliad.

Part A: Political Evolution – From Tribes to Algorithmic Governance[299]

Political systems are distributed computational architectures for collective decision-making.

Their evolution tracks humanity's discovery of increasingly sophisticated coordination algorithms constrained by the information-processing limits of human Observers.

A.1 Tribal Governance (50,000+ BCE): Peer-to-Peer Networks[300]

A.1.1 Organisational Structure and Constraints

Human organisation began with band societies of 25-50 individuals related by kinship or marriage, optimised for their ecological niche.

Decision-making occurred through consensus, with experienced elders providing guidance. This flat organisational structure was a **computational necessity**: with oral communication and human memory as the sole information storage media, coordinating more than a few dozen individuals became exponentially difficult.

The computational architecture of band societies resembles a **peer-to-peer network**:

- *Network Topology*: *Each individual maintained direct connections with all others*
  - Created information redundancy (same stories told by multiple members) which enabled resilience (loss of one node doesn't destroy collective knowledge)
  - Limited scalability (communication overhead grows quadratically)
- *Information Flow*: *All-to-all communication pattern*
  - No centralized information repository meant collective memory distributed across individuals
  - Transmission via stories, songs, rituals, and direct teaching
- *Consensus Mechanism*: *Decisions emerged from group deliberation*
  - No formal voting procedures so extended group discussion occurred until rough agreement achieved
  - Dissenters could split off (fission-fusion dynamics)

A.1.2 Mathematical Formalisation of Scaling Limits

The computational processing load in band societies scaled with distinct complexity classes:

Definition: Band Society Computational Complexity

For a **band** of **n** individuals:

- Processing per individual: $I_{\text{process}} = O(n)$
  - Each person must track relationships with n-1 others
  - Linear growth *in cognitive load*
- Communication overhead: $Cost_{\text{comm}} = O(n^2)$
  - All-to-all information exchange requires n(n-1)/2 connections
  - Quadratic *growth creates natural scaling barrier*
- Dunbar's Number Emergence: $n_{\text{max}} \approx 150$
  - Beyond this threshold, communication costs exceed cognitive capacity
  - Recent results in complexity theory proves this is an maxima

> ***Plain-English Context:***
>
> *Imagine trying to maintain friendships with everyone in a village. With 50 people, that's manageable, you see everyone regularly and know their stories. With 500 people, it becomes impossible, you can't remember everyone's relationships, coordinate shared activities, or maintain trust. The math explains why villages naturally split when they grow too large.*

A.1.3 Leadership as Distributed Optimisation

Leadership in band societies was situational and merit-based, representing an optimal solution to the exploration-exploitation trade-off.

Functional Role Distribution:

- Hunting leadership: Best tracker leads hunts
  - Optimisation target: Maximize calories acquired per energy expended
  - Selection criterion: Proven success rate in locating game
  - Authority scope: Limited to hunting decisions only
- Gathering leadership: Most experienced gatherer leads foraging routes
  - Optimisation target: Maximize safe plant food collection
  - Selection criterion: Knowledge of seasonal availability and toxic species
  - Authority scope: Limited to foraging decisions only
- Dispute mediation: Wisest elder mediates conflicts
  - Optimisation target: Maintain group cohesion and reduce violence
  - Selection criterion: Respected judgment and neutrality
  - Authority scope: Limited to conflict resolution only

> ***Ruliad Context:***
> *In possibility space, different regions require different navigation strategies. The band society allocates "processing power" (decision authority) to the Observer best equipped to search that particular subspace—the tracker for prey-finding regions, the elder for conflict-resolution regions.*

The absence of formal power structures was computationally adaptive—in environments where flexibility and rapid response mattered more than coordinated mass action, distributed decision-making outperformed centralization.

No single individual had sufficient computational capacity to optimise across all domains simultaneously.

A.2 Chiefdoms and Early States (10,000 BCE): Hub-and-Spoke Architecture

A.2.1 The Agricultural Revolution[301] as Computational Phase Transition

The agricultural revolution enabled organisational complexification through three critical mechanisms:

1. Fixed Location Constraint:
   - Hunter-gatherers could split when groups grew too large (fission-fusion)
   - Agricultural societies tied to land investment (cleared fields, irrigation)
   - *Computational consequence*: Required coordination algorithms that scaled beyond Dunbar's number
2. Food Surplus Generation:
   - Enabled non-food-producing specialists (warriors, priests, craftsmen)
   - Created storage and distribution challenges requiring oversight
   - *Computational consequence*: Necessitated information aggregation and resource allocation mechanisms
3. Population Growth:
   - Sedentary lifestyle increased birth rates (shorter birth intervals)
   - Reduced infant mortality from stable food supply
   - *Computational consequence*: Groups grew beyond peer-to-peer network capacity

These factors created computational pressure for hierarchical coordination.

A.2.2 Formal Structure of Chiefdom Architecture

Chiefdoms were the political structures where decision-making authority concentrated in a single person or small elite group. This represented a fundamental shift from consensus to command-based coordination.

Definition: Chiefdom Computational Architecture:

A chiefdom can be formalised as a directed tree graph:

- Nodes: Individual Observers (people)
- Edges: Authority relationships (who reports to whom)
- Root Node: Chief (central processor)
- Depth: Levels of hierarchy
- Branching Factor: Number of subordinates per leader

Theorem: Hierarchical Complexity Reduction

For a population of n individuals:

- Peer-to-peer communication: $O(n^2)$ required connections
- Hub-and-spoke hierarchy: $O(n \log n)$connections required with depth $depth = \log_b n$ for branching factor **b**

- Reduction in complexity: $\frac{O(n^2)}{O(n\log n)} \approx \frac{n}{\log n}$ efficiency gain

Proof Sketch*:* In a balanced tree with branching factor b:

- Each node communicates with parent and children only
- Total edges = n - 1 (every node except root has parent)
- Maximum communication path length = $\log_b n$
- Information propagation time = O(log n) vs. O(1) in peer-to-peer but with $O(n^2)$ overhead

> ***Plain-English Context:***
> *Instead of everyone talking to everyone (imagine a meeting with 1,000 people all shouting), you create "managers." Each manager handles 10 people, each senior manager handles 10 managers, etc. Now information flows up and down a tree structure much more efficiently.*

A.2.3 Specialized Roles and Parallel Processing

Specialized roles emerged as functional differentiation—analogous to parallel processing in computing.

Role Specialization Types:

1. Warriors (Force projection subsystem):
   - *Function*: Defend territory, enforce decisions, expand resources
   - *Information processing*: Tactical combat decisions, threat assessment
     Computational analogy: Security/defence module
2. Priests (Meaning-generation subsystem):
   - *Function*: Legitimize authority, coordinate rituals, maintain calendars
   - *Information processing*: Sacred knowledge, astronomical observations, seasonal timing
     Computational analogy: Operating system / BIOS layer (provides fundamental rules)
3. Craftsmen (Production subsystem):
   - *Function*: Create tools, weapons, goods for trade
   - *Information processing*: Technical knowledge, material properties, design patterns
     Computational analogy: Application layer programs
4. Administrators (Coordination subsystem):
   - *Function*: Record keeping, resource tracking, dispute resolution
   - *Information processing*: Quantitative accounting, legal precedents
     Computational analogy: Database management system

This division of labour increased total computational capacity of the structure but introduced the challenge of how to align the interests of different functional groups (coordinating the "spokes").

The computational problem shifted from "how do we make a decision?" to "how do we ensure specialized subsystems optimise for the whole system's goals rather than their own narrow objectives?"—the classic *principal-agent problem*.

A.2.4 Writing as Persistent Memory[302]

Writing enabled information storage outside human brains, dramatically expanding collective memory, decreasing computational boundedness.

Computational Impact of Writing:

- Before writing: Information capacity = number of individuals x human memory capacity
  - Estimated at ~$$10^9$ bits per person (1 GB)
  - Subject to death of knowledge carriers
  - Limited by oral transmission bandwidth
- After writing: Information capacity = human memory + external storage
  - Cuneiform tablets, papyrus scrolls: 10^6 - 10^8 bits per archive
  - Persistence beyond individual lifespans enabled institutional memory

This scaling of accessible, useful information gave chiefdoms access to potential choices that tribes did not have.

Writing created institutional memory that enabled persistence of computationally reducible heuristics (rules, laws, procedures) beyond any individual leader's lifespan. This transformed governance from personal to institutional—the birth of the proto-state as an abstraction that was not dependent on its current ruler.

A.3 Kingdoms and Empires (3,000 BCE): Standardization and Scaling[303]

Kingdoms and Empires represented the next evolutionary leap in computational complexity—multi-ethnic, multi-regional polities coordinating millions through standardized systems.

A.3.1 Convergent Evolution of Imperial Architecture

The Akkadian, Egyptian, Chinese, Persian, and Roman empires independently discovered similar solutions to the challenge of large-scale coordination.

Universal Imperial Features (Convergent Solutions):

1. Standardized Weights and Measures:
   - *Problem*: Trade requires comparing values across regions
   - *Solution*: Universal standards reduce transaction costs
     Computational benefit: $O(n^2) \to O(n)$ complexity reduction
     - Without standards: Every pair of traders must negotiate conversion
     - With standards: All traders use same units
   - *Examples*: Roman libra (pound), Chinese jin, Persian daric coin

2. Common Languages:
   - *Problem: Multilingual empires have translation overhead*
   - *Solution: Lingua franca for administrative communication*
     Computational benefit: Enables information transmission without loss
   - *Examples: Latin (Rome*), Aramaic (Persia), Mandarin (China), Koine Greek (Hellenistic)

3. Legal Codes:
   - *Problem: Local customs create jurisdictional conflicts*
   - *Solution: Universal law applicable across empire*
     Computational benefit: Predictable outcomes reduce uncertainty
   - *Examples:* Code of Hammurabi, Roman Law, Han Dynasty legal codes

4. Taxation Systems:
   - *Problem: Need to extract resources for public goods*
   - *Solution: Systematic assessment and collection*
     Computational benefit: Enables resource redistribution and public works
   - *Examples*: Egyptian grain taxes, Roman tribute, Chinese land taxes

> ***Ruliad Context:***
> *Standardization creates computational reducibility—complex local variations are "compiled" into simpler universal forms. This is analogous to how physical laws create predictable patterns despite underlying quantum complexity.*

A.3.2 Multi-Level Federated Architecture

The computational architecture of empires combined hierarchy with distributed execution.

Three-Tier Decision Structure:

1. Imperial Level (Strategic Planning):
   - *Authority: Emperor + central bureaucracy*
   - *Function: Set overall policy, declare war/peace, establish laws*
   - *Information processing: Aggregate reports from provinces, identify empire-wide patterns*
   - *Time horizon*: Decades to centuries
2. Provincial Level (Tactical Adaptation):
   - *Authority: Governors, satraps, prefects*
   - *Function: Adapt imperial policy to local conditions*
   - *Information processing: Balance imperial directives with local realities*
   - *Time horizon: Years* to decades
3. Local Level (Operational Implementation):
   - *Authority: City administrators, village headmen*
   - *Function: Execute policy in specific contexts*
   - *Information processing: Handle day-to-day decisions*
   - *Time horizon:* Days to years

Theorem: Federated Governance Optimality

For a territory of area A and population n:

- Pure centralization: Decision latency $\propto \sqrt{A}$ *(speed of information travel)*
- Pure localization: Coordination overhead $\propto n$ *(no shared standards)*
- Optimal federation: Minimizes Latency $+ \lambda \cdot$ Coordination Cost for some $\lambda > 0$

The solution produces hierarchical levels at scales where *information travel time ≈ decision urgency*.

> ***Plain-English Context:***
> *The Roman Empire couldn't micromanage Britain from Rome so they let local governors handle most decisions, intervening only on major issues. This "middle manager" structure emerges naturally from communication speed limits.*

A.3.3 Infrastructure as Information Highways

Technology evolved to support imperial coordination. Infrastructure became critical to an empires persistence.

Information Transmission Infrastructure:

1. Roads:
   - *Roman Example: 50,000+ miles of paved roads by 200 CE*
   - *Function: Rapid movement of messengers, armies, trade goods*
   - *Speed improvement: 4-5x faster than cross-country travel*
     Computational impact: Reduced information latency from weeks to days

2. Way Stations:
   - *Persian Royal Road: Stations every 15 miles*
   - *Function: Fresh horses and riders enable relay system*
   - *Speed improvement: 10x faster than single rider*
     Computational impact: Information travels ~100 miles/day vs. ~10 miles/day

3. Canal Systems:
   - *Chinese Grand Canal: 1,100 miles connecting Yellow and Yangtze rivers*
   - *Function: Bulk goods transport, especially grain*
   - *Capacity improvement: 100x more efficient than land transport*
     Computational impact: Enabled taxation-in-kind over vast distances

These networks acted as **"information highways"** that reduced informational latency across vast distances, speeding up the processing speed of the network. They created computationally persistent rules and structures that bound diverse agents into a computationally reducible superstructure that did not require any individual agent to have full information about the higher-order goals.

A.3.4 Computational Limits of Empire

The limits of empire were ultimately computational.

Without instantaneous communication or rapid transportation, central authorities couldn't respond quickly to local crises. T**hese are 'areas' of computational irreducibility where the predicted outcome and actual outcome diverged**. Information decay over distance meant emperors operated with outdated, incomplete information, birthing the principal-agent problem (agent sub-goal alignment with structural goal).

These constraints explain why empires consistently fragmented and reformed. Dynamic equilibrium, oscillations between centralization and decentralization are searches for fitness landscape maxima (i.e., points of maximum computational efficiency in possibility space) determined by the specific empire's technological constraints i.e. their computational boundedness.

Historical Examples of the Fragmentation-Reformation Cycle:

- Roman Empire: Centralized → Tetrarchy (4 emperors) → Western/Eastern split → Byzantine continuation
- Chinese Dynasties: Unity → Warring States → Re-unification (repeated across millennia)
- Islamic Caliphate: United under Rashidun/Umayyad → Abbasid fragmentation → Regional sultanates

> ***Plain-English Context:***
>
> *An empire is like a computer network. If messages take too long to travel, the network can't stay synchronized. Parts start making their own decisions, and eventually, you have multiple separate systems instead of one unified system. Rome split because it took months for an emperor to even hear about a crisis on the frontier, let alone respond effectively.*

A.4 Nation-States (1648 CE): The Sovereignty Protocol[304]

The Peace of Westphalia in 1648 formalised a new political architecture: the nation-state, a computational protocol that enumerated a global rule set for how political entities interacted.

A.4.1 Sovereignty as a Persistent Observer Superstructure Boundary

Sovereignty was a key computational abstraction. Each state has supreme authority within its borders and legal equality in international relations.

Definition: Sovereignty as Functor

Sovereignty maps political entities to certain computational domains in $\mathbf{R}_O$:

Theorem: Westphalian Complexity Reduction

Without sovereignty protocol:

- Any state can claim authority anywhere
- Number of potential conflicts = $O(n^2)$ for n states
- Each bilateral relationship requires custom negotiation

With sovereignty protocol:

- Clear jurisdictional boundaries
- Conflicts reduced to border disputes
- Relationships governed by common international law framework
- Complexity approximately O(n) (each state manages its own territory)

> ***Plain-English Context:***
>
> *Before Westphalia, every king could claim authority over territories elsewhere, leading to endless wars. The sovereignty system said, "You manage your country, I'll manage mine, and we'll respect each other's borders."*
>
> *This is like giving each process its own memory space in an operating system—clear boundaries prevent interference.*

A.4.2 The Printing Press as Technological Enabler[305]

The printing press was the enabling technology for nation-states through two mechanisms:

1. Mass Literacy:
   - Pre-printing: Literacy ~5-10% (scribes, clergy, nobility)
   - Post-printing: Literacy ~50-90% by 1900 in industrialized nations
     Computational impact: Vastly increased information processing capacity of population
   - Consequence: Enabled mass education and standardized knowledge
2. Imagined Communities:
   - Anderson's Thesis: Nations are "imagined communities" created through shared media[306]
   - Mechanism: Newspapers, books create simultaneous shared experience
   - Examples:
     - French Revolution: Pamphlets and newspapers spread revolutionary ideas nationally
     - American Revolution: "Common Sense" (Paine) read by 500,000+ in colonies
     Computational impact: Synchronizes mental states across millions who never meet

A.4.3 Democratic Elections as Massively Parallel Computation

Democratic elections can be understood as massive parallel computation where millions of citizens simultaneously compute their preferences and aggregate them (through voting).

Newspapers synchronized public opinion, enabling democracy at scale.

Model Sketch

For an electorate of **n** voters choosing among **m** candidates:

- Distributed processing: Each voter **i** computes preference function $P_i: \{c_1, \ldots, c_m\} \to R$
- Aggregation: Voting system aggregates individual preferences into collective choice
  - Ranked choice, approval voting: Other aggregation functions

  Computational complexity: O(n) for simple counting, O(n log n) for ranked systems
- Information integration: Collective choice incorporates distributed knowledge impossible for single observer to possess

> ***Computational Analogy:***
>
> *MapReduce in distributed computing: local computation (Map) + aggregation (Reduce).*

A.4.4 Bureaucracy as Rule-Based Computation

Bureaucracy transformed governance into rule-based computation

Weber's Ideal-Type Bureaucracy[307] (Computational Interpretation):

1. Written Procedures:
   - *Function*: Algorithms for handling standard situations
   - *Benefit*: Predictable, consistent outcomes
   - *Example*: Tax collection follows fixed rules, not official's discretion
2. Formal Hierarchies:
   - *Function*: Clear authority chains prevent conflicting commands
   - *Benefit*: Efficient information routing
   - *Example*: Document flows through defined approval levels
3. Merit-Based Selection:
   - *Function*: Optimise human capital allocation
   - *Benefit*: Competence rather than nepotism
   - *Example*: Civil service examinations (Chinese imperial system, modern civil service)
4. Impersonality:
   - *Function*: Treat similar cases similarly (rule of law)
   - *Benefit*: Reduces corruption, increases trust
   - *Example*: Permits issued by objective criteria, not personal relationships

The Prussian bureaucracy became the dominant model, as rational administration outcompeted patrimonial, empire-based systems. This architecture inspired corporations (modularity, hierarchy, and standardization appear in all these superstructures).

A.4.5 Nationalism as Operating System

Nationalism emerged as the ideological operating system for nation-states.

Nationalism's Computational Functions:

1. Shared Language:
   - *Function*: Common communication protocol
   - *Mechanism*: National education systems teach standardized language
   - *Example*: French Revolution suppressed regional languages, promoted Parisian French
2. Shared History:
   - *Function*: Common reference frame and values
   - *Mechanism*: National curricula teach standardized historical narratives
   - *Example*: American founding mythology (Declaration, Constitution, Civil War)
3. Shared Culture:
   - *Function*: Coordination through shared symbols and practices
   - *Mechanism*: National holidays, monuments, rituals
   - *Example*: Bastille Day (France), Independence Day (USA), Guy Fawkes Day (UK)

Nationalism created the social cohesion necessary for large-scale coordination without kinship ties.

National education systems programmed citizens with common knowledge and values (i.e., a common rule set). Military conscription created shared experiences and identities (alignment of agents). National anthems, flags, and monuments served as cultural protocols—standardized ways of expressing and reinforcing collective identity.

A.5 International Organisations (1945 CE): Global Governance Experiments[308]

Extreme nationalism (divergent, self-replicating structures competing for computational resources) led to two world wars.

This catalysed the formation of global institutions (global rules) to address the computational burden of its failures.

A.5.1 The United Nations System and its Gross Failure

The United Nations was an attempt (of sorts) to create coordination mechanisms above the nation-state level. The rules for managing global issues without global sovereignty.

UN Computational Architecture:

1. Security Council:
   - *Function*: Coordinate response to threats to international peace
   - *Mechanism*: 15 members (5 permanent with veto power) vote on resolutions
     Computational model: Weighted consensus with veto gates
   - *Limitation*: Byzantine fault tolerance problem

2. General Assembly:
   - *Function*: Forum for all states to participate in global discussions
   - *Mechanism*: One state, one vote (non-binding resolutions)
   - *Computational model*: Democratic deliberation without enforcement
   - *Limitation*: Group-think, sub-blocks, intra-org hierarchy

3. Specialized Agencies:
   - *Examples*: WHO (health), IMF (finance), ICAO (aviation), ITU (telecommunications)
   - *Function*: Domain-specific coordination
   - *Mechanism*: Technical standards, information sharing, resource pooling
   - *Success rate*: High for technical coordination, atrocious for political issues

The UN Security Council, General Assembly, and specialized agencies attempt computational optimisation of global problems beyond the computational capacity of any single nation-state.

A.5.2 Regional Integration Experiments

Regional organisations emerged as intermediate-level coordination.

European Union:

- *Scope*: 27 member states, ~450 million people
- *Mechanisms*: Common market, currency (Euro), Parliament, Commission, Court
- *Success*: Unprecedented economic integration and peace
- *Challenge*: Sovereignty tensions (Brexit as coordination failure)

Other Regional Bodies:

- ASEAN (Southeast Asia): Economic cooperation without political integration
- African Union: Aspirational continental governance (limited enforcement)
- MERCOSUR (South America): Trade bloc with political components

> ***Plain-English Context:***
> *Multi-level governance (local, national, regional, global) has high computational overhead but, **in theory**, enables coordination of diverse nations without homogenization (an evolutionary min-max algorithm, attempting to optimise multiple competing objectives).*

Conjecture: Polycentric Governance Trade-offs

For a governance system with **k** levels:

- *Coordination capacity*: Increases with **k** (more tools available)
- *Overhead*: Increases **superlinearly** with **k** (coordination between levels costly)
- *Optimal k*: Depends on problem heterogeneity and coordination technology

The limits of these superstructures across many diverse edge cases reflect fundamental differences in what these MetaObservers (the individual nation states) deem computationally optimal.

Typically, these superstructures excel at technical coordination (air traffic control, telecommunications standards, postal unions) where benefits are clear and measurable. They fail at distributive issues (wealth redistribution, sovereignty questions) where values between the sub-Observers are in conflict.

A.6 Future Systems: Algorithmic Superstructures

The 21st is prototyping radically new governance forms enabled by digital technologies and artificial intelligence.

A.6.1 Blockchain and Decentralized Autonomous Organisations (DAOs)[309]

Blockchain enables decentralized autonomous organisations—governance without traditional governments.

Computational Advantages:

- *Transparency*: All transactions publicly visible
- *Immutability*: Past records cannot be altered (history is persistent)
- *Disintermediation*: Removes middlemen (banks, notaries, governments)
- *Programmability*: Rules encoded in code, automatically executed

Current Limitations:

- *Scalability*: Bitcoin ~7 transactions/second vs. Visa ~65,000/second
- *Energy consumption*: Proof-of-work requires massive computation
- *Governance*: Who controls code updates? (miners, developers, users?)
- *Regulation*: Unclear legal status in many jurisdictions

These systems replace human discretion with (updateable/evolvable) algorithmic rules that search for maximum computational efficiency.

A.6.2 Platform Governance[310]

Tech companies govern billions of users through algorithmic regulation:

Platform as Proto-Government:

1. Facebook/Meta (~3 billion users):
   - *Constitution*: Terms of Service
   - *Legislature*: Algorithm determines what content spreads
   - *Judiciary*: Content moderation boards decide appeals
   - *Executive*: Platform owners make final decisions
2. Google (~2 billion users):
   - *Information control: Search algorithms determine visibility*
   - *Services: Email (Gmail), maps, cloud storage—critical infrastructure*
   - *Economic power*: Advertising platform controls business access to consumers
3. Amazon (~300 million active accounts):
   - *Marketplace rules: Terms for sellers*
   - *Logistics network: Controls distribution infrastructure*
   - *AWS: Hosts* ~30% of internet services (infrastructure layer)

> ***Plain-English Context:***
>
> *These platforms have more users than any nation-state and increasingly provide quasi-governmental functions—identity verification (social logins), payment systems (Apple Pay, Alipay), dispute resolution (eBay, Amazon), and public forums (X, Reddit).*

These systems are good at surfacing preferences in their own narrow domains but lack democratic accountability or transparent rule-making.

A.6.3 AI-Enhanced Governance[311]

Artificial intelligence is beginning to augment governmental functions

Current Applications:

1. Predictive Policing:
    - *Function*: Allocate law enforcement resources based on crime predictions
    - *Mechanism*: Machine learning on historical crime data
    - *Success*: Can reduce crime in targeted areas
    - *Failure*: Can perpetuate racial bias if training data reflects discriminatory policing

2. Fraud Detection:
    - *Function*: Identify tax evasion, benefit fraud, financial crimes
    - *Mechanism*: Anomaly detection in transaction patterns
    - *Success*: High accuracy in catching sophisticated schemes
    - *Failure*: False positives can harm innocent parties

3. Administrative Processing:
    - *Function*: Handle routine applications (permits, licenses, benefits)
    - *Mechanism*: Rule-based systems + natural language processing
    - *Success*: Faster processing, lower costs
    - *Failure*: Struggles with edge cases requiring human judgment

> ***Plain-English Context:***
>
> *AI-enhanced governance can process vastly more information than human bureaucrats, enabling, in the "good" case, more responsive, evidence-based rule-sets. In the "bad" case, accountability, algorithmic bias, and democratic control become critical concerns.*

The Black Box Problem:

- Modern deep learning models are not interpretable
- Citizens cannot challenge decisions they don't understand
- Regulations (EU's GDPR "right to explanation") attempt to address this

A.6.4 Computational Capacity and Complexity Trade-offs

The computational capacity of digital governance is only limited by processing capability and memory. Unlike human-based systems, digital systems can scale arbitrarily.

Scaling Properties:

- *Blockchain*: Can coordinate millions of nodes with O(n) communication per node
- *AI*: Can process billions of data points in seconds
- *Platform governance*: Can govern billions of users for minimal marginal cost

The constraint shifts from computational capacity to **management of computational complexity** (the difficulty of specifying objectives, handling edge cases, and maintaining legitimacy).

New Governance Challenges:

1. Value Alignment: How do we ensure AI optimises for human values?
2. Adversarial Robustness: Can systems resist manipulation and gaming?
3. Emergent Behaviour: Complex systems produce unexpected outcomes
4. Legitimacy: Will citizens accept algorithmic governance?

> ***Ruliad Context:***
>
> *Digital governance systems are exploring regions of possibility space inaccessible to biological Observers due to processing speed limits. The question is whether these systems will optimise for human flourishing or for narrow proxy metrics that miss what we truly value.*

Part B: Economic Evolution – Superstructures for Value Transfer

Economic systems are protocols for resource allocation and exchange among Observers with different needs and capabilities.

Their evolution tracks humanity's discovery of increasingly abstract and efficient mechanisms for coordinating production and distribution.

B.1 Gift Economies (Palaeolithic): Reciprocal Altruism Networks[312]

Before markets, money, or formal trade, human economic life operated through gift economies, where obligations (not prices), governed exchange.

B.1.1 The Original Sharing Economy

Core Mechanism:

- *Giving creates obligation*: When I give you a gift, you "owe" me reciprocation
- *Status through generosity*: Those who give more gain social standing
- *Risk pooling*: Excess is shared, creating insurance against scarcity

Anthropological Examples:

1. Potlatch Ceremonies (Pacific Northwest):
   - Chiefs gained prestige by giving away vast wealth
   - Competitive gift-giving established social hierarchy
   - Destruction of valuables demonstrated power ("I'm so wealthy I can afford to waste resources")
     Social capital as true currency—reputation for generosity more valuable than accumulated possessions.

B.1.2 Computational Structure of Gift Economies

Definition B.5 (Gift Economy as Memory-Intensive Network):

A gift economy consists of:

- Nodes: Individual agents (Observers)
- Edges: Obligation relationships (weighted by gift value)
- Memory: Each agent tracks $(agent_j, gift_{\text{given}}, gift_{\text{received}}, trust_{\text{level}})$for all $j \neq i$

Computational Constraints for group size **n**:

- Memory requirement: $O(n^2)$ per individual (must track all pairwise relationships)
- *Processing load*: Constantly update trust levels and obligations
- *Scaling limit*: Works up to Dunbar's number (~50-150) where personal memory can track relationships

Advantages:

1. Resource Flow: Resources naturally flow to where they're most valued (through desire for reciprocation)
2. Innovation Incentives: New techniques/discoveries enhance social status
3. Resilience: Multiple overlapping obligation networks prevent cascading failures

Disadvantages:

1. Scaling: Exponential memory overhead makes large-scale impossible
2. Exploitation: "Free riders" can take without giving
3. Inequality: Some accumulate more social capital than others
4. Inefficiency: No mechanism to discover optimal prices

> ***Plain-English Context:***
> *AI-enhanced governance can process vastly more information than human bureaucrats, enabling, in the "good" case, more responsive, evidence-based rule-sets. In the "bad" case, accountability, algorithmic bias, and democratic control become critical concerns.*

Modern Remnants:

- Open-source software development (Linux, Wikipedia contributors)
- Academic research (paper citations as "gifts" of credit)
- Social media content creation (likes and followers as "social capital")

B.2 Barter Systems (Neolithic): The Coincidence of Wants Problem[313]

As societies outgrew kinship structures, direct exchange (barter) emerged.

Contrary to economics textbooks, barter was never dominant within small communities (gift economies persisted) but was a protocol for inter-group trade where social trust was limited by geographic distance.

B.2.1 Computational Complexity of Barter

Barter Complexity Conjecture:

For n traders each offering one good:

- *Simple barter*: Find trading partner
  - Complexity: $O(n^2)$ (must check all pairs)
    Success probability: Low unless preferences highly aligned
- *Multi-party barter*: Find exchange chains
  - Complexity: O(n!) in worst case (try all permutations)
    Becomes computationally irreducible
- *With barter facilitators*: Markets, middlemen reduce complexity
  - Complexity: O(n log n) (use market-clearing mechanisms)

Computational Innovations to Overcome Barter Limits:

1. Barter Fairs/Markets:
   - Function: Concentration of traders in time and space
   - Benefit: Increases probability of finding matches
   - Example: Seasonal fairs in medieval Europe

2. Merchant Intermediaries:
   - Function: Specialists who hold diverse goods
   - Benefit: Reduce search costs (trade with one merchant rather than many individuals)
   - Example: Phoenician merchants in Mediterranean

3. Commodity Money:
   - Function: Standardized valuable goods everyone accepts
   - Examples: Salt (hence "salary"), cattle (pecus → pecuniary), cacao beans (Aztec)
   - Benefit: Breaks "coincidence of wants"—I can always trade for the commodity, then trade commodity for what I need

Barter's computational complexity is $O(n^2)$ for potential exchanges but $O(n!)$ for multi-party trades. Finding optimal sequences quickly becomes computationally irreducible.

B.3 Money (3,000 BCE): Abstraction as Compression[314]

Money is one of humanity's most important abstractions. At root, it is a 'shared fiction' that coordinates economic activity by providing a universal medium of exchange.

B.3.1 The Emergence of Money

Rai Stones (Yap Island) as a Thought Experiment:

- Massive stone disks (up to 12 feet in diameter)
- Too heavy to physically move
- Ownership tracked socially (everyone "remembers" who owns which stone)
- Functions as money despite being immobile
  Computational insight: Money is shared information, not intrinsic value

B.3.2 Money as Information Compression

Definition: Money as Valuation Functor

Money, **M** is a functor mapping goods to a one-dimensional value space:

M: Goods → $\mathbb{R}^+$

Where:

- Domain: All tradeable items (infinite-dimensional possibility space)
- Codomain: Positive real numbers (one dimension)
- Compression: Collapses multidimensional preferences onto single axis *(huge computational reducibility)*

Computational Benefits of Money:

1. Transaction Cost Reduction:
   - *Without money*: Must find double coincidence of wants
   - *With money*: Any trade becomes two trades (sell for money, buy with money)
     Complexity: $O(n^2)$ → $O(n)$
2. Price Discovery:
   - *Markets aggregate information about relative scarcity*
   - *Prices act as distributed* signals for resource allocation
3. Intertemporal Trade:
   - *Store of value: Enables saving (trade now for consumption later)*
   - *Specialization: Don't need immediate reciprocation*
   - *Investment: Can* delay gratification to build capital

4. Mental Accounting:
   - *Humans can easily compare numerical values*
   - *Enables rapid calculation of trade profitability*
   - *Reduces cognitive load* of multidimensional preference comparison

B.3.3 Evolution of Money

The progression of money shows increasing abstraction from the physical:

1. Commodity Money (Earliest):
   - Examples: Gold, silver, copper, cowrie shells
   - Value source: Intrinsic utility and scarcity
   - *Advantages: Universally recognized, resistant to counterfeiting*
   - *Disadvantages: Heavy, difficult to divide, subject to supply shocks*

2. Representative Money (Medieval-Modern):
   - Examples: Gold certificates, bank notes backed by reserves
   - Value source: Redeemable for commodity money
   - *Advantages: Lighter, easier to transport*
   - *Disadvantages: Requires trust in issuer*

3. Fiat Money (Modern):
   - Examples: Modern currencies (USD, EUR, JPY, etc.)
   - Value source: Government decree (legal tender laws) + shared belief
   - *Advantages: Flexible supply, low production cost*
   - *Disadvantages: Vulnerable to inflation if supply mismanaged*

Markets emerged as spaces where strangers could transact without social bonds. **Money replaced social obligation as the most computationally efficient coordination mechanism for large-scale exchange.**

B.4 Fiat Currency and Banking (Medieval-Modern): Money as Pure Information

The transition from commodity to fiat currency represents another computational evolution; namely, that value can be abstracted from the underlying physical objects.

B.4.1 Abstraction from Physical to Informational

Historical Progression:

1. Gold-backed currency (18th-19th century):
   - Paper money redeemable for gold at fixed rate
   - Limited supply (tied to gold reserves)

2. Partial backing (early 20th century):
   - Fractional reserves (not enough gold to redeem all currency)
   - Bretton Woods system (1944-1971): Currencies pegged to USD, USD pegged to gold

3. Pure fiat (1971-present):
   - Nixon ends gold convertibility
   - Currency value determined by supply/demand, central bank policy, economic fundamentals
     Money becomes pure information, valuable because everyone agrees it's valuable

B.4.2 Fractional Reserve Banking as Computational Multiplier

Fractional reserve banking emerged as a computational multiplier on the money supply.

Mechanism:

Bank receives \$100 deposit → keeps \$10 in reserve (10% reserve ratio) → loans out \$90 → borrower deposits \$90 in another bank → that bank keeps \$9 in reserve → loans \$81 → process repeats…

Result:

- Money multiplier: $M = \frac{1}{\text{reserve ratio}} = \frac{1}{0.1} = 10\text{x}$

This recursive process amplified computational velocity (more potential transactions per unit time) of the economy in non-edge cases (when network trust is high).

Advantages:

- Allocates capital to productive uses
- Enables investment beyond available savings
- Smooths consumption over time (borrow against future income)

Risks:

- *Bank runs*: If depositors all withdraw simultaneously, bank cannot meet obligations
- *Contagion*: One bank failure triggers others (cascade effect)
- *Example*: Great Depression (1929-1933)—thousands of US banks failed

> ***Computational Analogy:***
>
> *Banking as distributed computation with systemic risk. The Great Depression demonstrated this system's edge-case failure—in this structure, errors cascade (i.e., the recursion unwinds).*

B.4.3 Central Banking as Computational Stabilizer

Central banking was a computational "fix" to prevent cascading bank failures.

Core Functions:

1. Lender of Last Resort:
   - Function: Provide emergency liquidity to solvent but illiquid banks
   - Prevents: Bank runs from becoming self-fulfilling prophecies
   - Mechanism: Central bank can create reserves on demand
2. Monetary Policy:
   - Interest rates: Set cost of borrowing (Federal Funds Rate, ECB rate, etc.)
   - Money supply: Control via open market operations (buy/sell government bonds)
   - Inflation *targeting*: Maintain stable prices (~2% annual inflation target)
3. Supervision and Regulation:
   - Capital requirements: Banks must hold minimum reserves
   - Stress testing: Ensure banks can survive economic shocks
   - Resolution authority: Manage failing banks without contagion

> ***Computational Analogy:***
>
> *Central banks are computational hubs that process vast amounts of economic data (unemployment, inflation, GDP growth, credit conditions) and output decisions to increase the computational persistence of the beneficiary Observer superstructures.*

B.4.4 Digitization: Money as Database Entries[315]

In the late 20th century, digitization completed money's transformation into pure information.

Evolution:

- 1950s: Credit cards emerge (charge accounts digitized)
- 1970s: ATMs enable 24/7 access to deposits
- 1990s: Online banking
- 2000s: Mobile payments (M-Pesa in Kenya, Alipay/WeChat Pay in China)
- 2020s: 60%+ of transactions are digital in developed economies

> ***Plain-English Context:***
>
> *Money is now pure information (database entries representing claims on resources). Electronic transfers, credit cards, and digital payments abstracted money to bits in computers.*

Computational Advantages:

- Near-instant transactions (milliseconds vs. days for physical transfer)
- Global reach (send money anywhere with internet)
- Lower transaction costs (no physical handling)
- Perfect audit trails (all transactions logged)

Emerging Challenges:

- Surveillance capitalism (all transactions tracked)
- Financial exclusion (requires bank account, internet, device)
- Cybersecurity (money can be "stolen" remotely)

Part C: Allocation Technologies – How Societies Decide "Who Gets What"

Beyond exchange mechanisms (money, trade), societies need allocation systems to determine resource distribution.

These systems are computational algorithms for solving the coordination problem at scale.

C.1 Capitalism (1600s-Present): Markets as Distributed Computers[316]

Capitalism was not designed, it evolved.

It was computationally more efficient (i.e. it out-competed) than earlier systems (feudalism, patronage, etc.).

C.1.1 Spontaneous Order

Adam Smith's "Invisible Hand" (1776)[317]

"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest."

> ***Computational Analogy:***
> *The "invisible hand" is a distributed computation algorithm. It aggregates individual self-interest through a market mechanisms, discovering collective optimisation without centralized coordination.*

Mathematical Sketch

Consider **n** agents, each with:

- Utility function $U_i(x_i)$
- Resource constraints $\sum_i x_i \leq x_{total}$

Central planning: Single optimiser attempts to maximize $\sum_i U_i(x_i)$ subject to constraints

- Requires knowledge of all U_i *(impossible as each agent has non-trivial private information)*
- Computational complexity: **NP-hard** for general case

Market mechanism: Each agent maximizes own U_i, prices adjust until supply = demand

- Agents only need to know prices (public information) and own preferences (private)
- Computational advantage: Distributed optimisation parallelizes computation

This structure preceded computation theory by several centuries but captured something fundamental about information processing in complex systems.

C.1.2 The Corporation as a Collective Agent / Observer

The joint-stock company, invented in the 1600s, created a new form of collective agency—the corporation as artificial person.

Key Innovations:

1. Limited Liability (1602 - Dutch East India Company):
    - *Before*: Investors personally liable for business debts (could lose personal property)
    - *After*: Liability limited to amount invested
    - *Effect*: Dramatically reduced investment risk, enabled capital pooling
2. Perpetual Existence:
    - *Before: Partnerships dissolved when partner died*
    - *After: Corporation continues regardless of shareholder changes*
    - *Effect: Long-term planning, institutional* knowledge
3. Transferable Shares:
    - *Before: Exit from business venture difficult*
    - *After: Sell shares on secondary market*
    - *Effect: Liquidity, price* discovery, efficient capital allocation

> ***Plain-English Context:***
> *Limited liability enabled computation at scales that exceeded any individual's computational boundedness. The corporation acted as an artificial agent pursuing goals (profit maximization) through collective human action.*

> ***Ruliad Context:***
> *In the parlance of the Ruliad, this is an emergent Object directed toward a specific attractor in computational possibility space.*

C.1.3 The Industrial Revolution as Computational Leap

The Industrial Revolution (1760-1840) can be understood as capitalism's first major computational evolutionary leap.

Key Developments:

1. Machinery Amplifies Physical Capacity:
   - *Examples*: Steam engine, spinning jenny, power loom
   - *Effect*: 10-100x productivity increases in textile production, transportation

2. Factories Create Computational Reducibility:
   - *Division of labour: Complex production broken into simple repeatable tasks*
   - *Standardization: Interchangeable parts (Eli Whitney's innovation)*
   - *Effect:* Dramatically reduced skill requirements, enabled mass production

3. Assembly Line (Ford, 1913):
   - *Innovation: Workers stationary, product moves past them*
   - *Effect: Model T production time reduced from 12 hours → 93 minutes*
     Computational analogy: Pipeline architecture in CPU design

> ***Plain-English Context:***
> *Machinery amplified physical capacity, and factories simplified complexity (reduced computational burden) of production utilizing algorithms that created goods in fewer "steps." The assembly line created computational reducibility that could be copied to other industries with limited additional computational burden.*

C.1.4 Market Failures as Computational Limits (or bashing into Computational Irreducibility)

Capitalism's failures reflect computational limits of bounded Observers.

1. Market Failures (When Prices Don't Capture Full Information):

A. Externalities:

- *Definition*: Costs/benefits not reflected in prices
- *Negative example*: Pollution (producer doesn't pay full social cost)
- *Positive example*: Education (individual doesn't capture full social benefit)
  Computational issue: Incomplete information in price signals

B. Information Asymmetry:

- *Definition*: Buyer and seller have different information
- *Example*: Used car market ("lemons problem" - Akerlof, 1970)
- *Effect*: Market underestimates value of good products, overestimates value of bad products
  Computational issue: Cannot price what cannot be observed

C. Bounded Rationality:

- *Definition*: Humans cannot compute optimal decisions
- *Examples*: Hyperbolic discounting (overvalue present vs. future), cognitive biases
- *Effect*: Systematic deviations from rational choice predictions
  Computational issue: Limited processing power prevents full optimisation

3. Inequality from Positive Feedback:

- *Mechanism*: Capital begets capital (r > g, Piketty 2014)
- *Effect*: Wealth concentration increases over time without intervention
  Computational issue: System optimises for local maxima's

4. Boom-Bust Cycles:

- *Observation*: Economies alternate between expansion and contraction
- *Explanation*: Economy is complex adaptive system with feedback loops
  Computational interpretation: Searching for dynamic equilibrium on changing fitness landscape (moving target, not fixed optimum)

> ***Plain-English Context:***
> *Markets are incredibly good at allocating resources efficiently when prices contain accurate information and people can make rational choices. But when information is hidden (like pollution's full cost), people are biased (like preferring instant gratification), or rich people's needs are prioritised over poor people's needs, markets produce suboptimal outcomes.*

C.2 Socialism/Communism (1800s-Present): The Planning Experiment[318]

Socialism critiqued capitalism's contradictions and attempted to design more computationally efficient systems for resource allocation. The core question: If markets generate suboptimal outcomes (inequality[319], crises, externalities), could deliberate planning do better?

C.2.1 Theoretical Foundations

Marx's Central Claims[320]:

1. Labor Theory of Value:
   - *Claim*: Value derives from labour time embodied in production
   - *Implication*: Profit represents "surplus value" extracted from workers
   - *Critique: Doesn't account for supply/demand, innovation, risk*
2. Historical Materialism:
   - *Claim: Economic structures determine political/cultural systems*
   - *Implication: Capitalism will inevitably collapse, replaced by socialism*
   - *Critique: Ignores contingency, human agency, cultural factors*
3. Planned Economy:
   - *Claim: Rational planning can eliminate market inefficiencies*
   - *Implication: Central coordination superior to market chaos*
   - *Critique: Requires solving impossibly hard computational problem*

> ***Plain-English Context:***
>
> *Hayek was largely correct—computational complexity of central planning is fundamentally intractable for complex economies. However, specific sectors with limited variables (electricity grids, urban planning) can be effectively planned*

C.2.2 Twentieth Century Socialist Experiments

The last century saw large-scale attempts to implement centrally planned economies. **TL;DR they all failed miserably**.

Soviet Union (1922-1991)[321]

Organisational Structure:

- *Gosplan*: Central planning agency
- *Five-Year Plans*: Set production targets for all industries
- *Command allocation*: Materials distributed by decree, not market

Initial Successes (1930s-1950s):

- Rapid industrialization (agricultural → industrial economy in ~30 years)
- Defeated Nazi Germany (despite massive losses)
- First satellite, first human in space (Sputnik 1957, Gagarin 1961)

Long-Term Failures (1960s-1991):

- *Shortage economy*: Chronic scarcity of consumer goods despite production capacity
- *Quality problems*: Quantity targets met, but quality suffered (perverse incentives)
- *Innovation lag*: Few technological breakthroughs after 1960s (except military/space)
- *Collapse*: Unable to compete economically, politically liberalized (glasnost) and fragmented

Why Soviet Planning Failed: Computational Analysis[322]

Theorem: Computational Intractability of Central Planning

For an economy with:

- **n** goods (USSR: ~12 million product categories)
- **m** production processes
- **k** constraints (material, labour, energy)

Optimisation problem: Maximize social welfare subject to constraints

- *Problem class*: Linear programming if simplified, *NP-hard in general case*
- *USSR Gosplan computation*: Manual calculation + early computers
- *Result*: Could not solve optimisation in real-time

Computational Bottlenecks:

1. *Information aggregation*: Factories underreported capacity to get easier targets (information hiding)
2. *Delayed updates*: Five-year plans outdated by year 2 (slow feedback)
3. *Perverse incentives*: Optimise metrics, not actual goals
4. *No error correction*: No bankruptcy mechanism to eliminate inefficient producers

> ***Plain-English Context:***
>
> *Imagine trying to plan every detail of a city; where every person should work, what every factory should produce, where every truck should deliver goods. Even with supercomputers, this is impossibly complex. The Soviet Union tried and spent decades in shortage and inefficiency because planners couldn't access or process the information fast enough.*

Part E: Synthesis

Despite superficial differences, all successful coordination systems exhibit common computational properties:

E.1 Universal Superstructure Features

Superstructure Feature	Core Function	Selected Examples Across Observer Superstructure Systems
Hierarchy	Reduces communication complexity from $O(n^2) \rightarrow O(n \log n)$	Chiefdoms, corporations, military, church, bureaucracy
Standardization	Creates computational reducibility for Observers in the superstructure	Weights/measures, language, currency, protocols
Rules/Laws	Predictable outcomes reduce uncertainty	Legal codes, algorithms, corporate policies, religious commandments
Ritual/Protocol	Synchronizes collective action	Religious ceremonies, national holidays, corporate meetings, diplomatic protocols
Mythology/Ideology	Provides shared meaning and motivation	Religious narratives, national myths, corporate culture, political ideologies
Membership Criteria	Defines boundaries and identity	Citizenship, baptism, employment, party membership
Enforcement Mechanisms	Ensures compliance	Courts, excommunication, termination, expulsion

These features are computational necessities. They emerge whenever bounded Observers attempt coordination at scale.

Theorem: Convergent Superstructure Evolution

Given:

- Multiple independent populations of computationally bounded Observers
- Selection pressure for efficient coordination
- Sufficient time for experimentation

Then:

- Populations will independently discover similar organisational forms
- Similarity increases with coordination scale requirements
- Deviations reflect local constraints, not fundamental alternatives

This explains why civilizations with no contact (Mesopotamia, China, Mesoamerica) independently invented writing, money, law codes, and hierarchy. **These are attractors in computational possibility space.**

E.2 Evolutionary Trajectories

All coordination systems exhibit directional evolution toward greater abstraction and computational capacity.

Era	System	Scale (People)	Coordination Mechanic	Information Medium	Relative Power
50,000 BCE	Hunter-Gatherer Band	25-50	Consensus	Oral tradition	1/10
10,000 BCE	Agricultural Village	100-500	Elder council	Oral + ritual	2/10
5,000 BCE	Chiefdom	1,000-10,000	Chief + deputies	Writing emerges	4/10
3,000 BCE	Kingdom / Empire	100,000-10m	Bureaucracy	Writing + infrastructure	6/10
1648 CE	Nation-State	1m-100m	Democracy/dictatorship	Print + literacy	7/10
1945 CE	International System	100m-8bn	Treaties + organizations	Mass media	8/10
2025 CE	Algorithmic Governance	Potentially unlimited	AI-augmented	Digital + instant	9/10

Observable Trends[323]:

1. *Increasing Scale*: Coordination capacity grows exponentially (doubling every few thousand years, accelerating)
2. *Increasing Abstraction*: Concrete relationships → abstract rules → algorithmic code
3. *Increasing Speed*: Decision latency decreases (months → days → seconds)
4. *Increasing Information Processing*: From ~10^9 bits (oral) to ~10^{20} bits (internet)
5. *Decreasing Violence*: Homicide rates decline by orders of magnitude[324]

E.3 Ruliad Interpretation: Superstructures as Morphism Spaces

From the Observer Theory (Ruliad) perspective, human superstructures are coordinated explorations of computational possibility space.

Definition: Superstructure as Collective Observer

A superstructure **Super** is a functor:

$$\text{Super: \{Individual Observers\}} \to \text{\{Collective Observer\}}$$

Where:

- **Objects**: Individual humans (Observers)
- **Morphisms**: Relationships, rules, communication channels
- **Functor**: Maps individuals to collective entity with emergent properties

The collective Observer $\text{Super}(\{O_1, \ldots, O_n\})$ has:

- Computational capacity: $> \sum_i B(O_i)$ *(more computational power / lower boundedness from coordination)*
- Accessible Ruliad: '$R_{Super} \supset \bigcup_i R_{O_i}$ *(superstructure can explore regions of Ruliad inaccessible to individuals Observers as B_O is less constrained)*
- Computational Persistence: $P(Super) \gg P(O_i)$ *(institutional superstructures have more outlive individual Observers)*

Evolution of superstructures represents movement through morphism space that finds more efficient transformations that enable more coverage of the Ruliad, R_O faster.

Different superstructures (democracy vs. authoritarianism, markets vs. planning) are different sampling strategies for exploring the Ruliad. There is no universal "best" strategy. Optimal choice depends on:

- Environmental volatility (stable → planning works; volatile → markets adapt faster)
- Problem complexity (simple → centralization efficient; complex → distribution necessary)
- Observer constraints (educated population → democracy viable; otherwise risky)

The future is likely to involve dynamic switching between systems based on the specific problem characteristics, a meta-coordination algorithm.

Conclusion: The Continuing Evolution of Coordination

Human superstructure evolution is far from complete. Each form that emerged solved coordination challenges at its scale but created new problems at larger scales. Each solution inevitably finds local optima in possibility space, and each change of scale creates new challenges related to these trade-offs.

This computational evolution from hunter-gatherer bands to (potentially) AI-governed global systems is humanity's greatest achievement.

Creating cooperation among billions of strangers, each with their own goals and incomplete information, is a computational miracle.

The evolution will continue, whether we consciously guide it or not. The question is whether we can understand the computational principles underlying this coordination well enough to navigate the transition to the next phase without catastrophic failure.

The Ruliad contains all logically tractable coordination mechanisms. Human history is the story of discovering them, one at a time.

"Culture is the sum of all the forms of art, of love, and of thought, which, in the course of centuries, have enabled man to be less enslaved." ***Andre Malraux***

References

[299]**Core Political System Evolution source:**
Service, E.R. (1962). Primitive Social Organisation: An Evolutionary Perspective. New York: Random House.
Fried, M.H. (1967). The Evolution of Political Society: An Essay in Political Anthropology. New York: Random House.
Johnson, A.W. and Earle, T. (2000). The Evolution of Human Societies: From Foraging Group to Agrarian State (2nd edition). Stanford: Stanford University Press.
Carneiro, R.L. (1970). 'A Theory of the Origin of the State', Science, 169(3947), 733-738
Hobsbawm, E. (1962). The Age of Revolution: Europe 1789-1848. London: Weidenfeld & Nicolson.
Braudel, F. (1979). Civilization and Capitalism, 15th-18th Century (3 volumes). [English translation by Siân Reynolds]. New York: Harper & Row.
McNeill, W.H. (1963). The Rise of the West: A History of the Human Community. Chicago: University of Chicago Press.
Fukuyama, F. (2011). The Origins of Political Order: From Prehuman Times to the French Revolution. New York: Farrar, Straus and Giroux.
Fukuyama, F. (2014). Political Order and Political Decay: From the Industrial Revolution to the Globalization of Democracy. New York: Farrar, Straus and Girou
[300] **Core Hunter-Gatherer / Band sources:**
Dunbar, R.I.M. (1992). Neocortex size as a constraint on group size in primates. Journal of Human Evolution, 22(6), 469-493.
Dunbar, R.I.M. (1998). The social brain hypothesis. Evolutionary Anthropology: Issues, News, and Reviews, 6(5), 178-190.
Zhou, W.X., Sornette, D., Hill, R.A. and Dunbar, R.I.M. (2005). Discrete hierarchical organisation of social group sizes. Proceedings of the Royal Society B: Biological Sciences, 272(1561), 439-444.
Lindenfors, P., Wartel, A. and Lind, J. (2021). 'Dunbar's number' deconstructed. Biology Letters, 17(5), 20210158. https://doi.org/10.1098/rsbl.2021.0158
[301] **Core Agricultural Transition sources:**
Diamond, J. (1997). Guns, Germs, and Steel: The Fates of Human Societies. New York: W.W. Norton & Company.
Barker, G. (2006). The Agricultural Revolution in Prehistory: Why Did Foragers Become Farmers? Oxford: Oxford University Press.
[302] **Core Writing Transition sources:**
Schmandt-Besserat, D. (1992). Before Writing: From Counting to Cuneiform. Austin: University of Texas Press.
Robinson, A. (2009). Writing and Script: A Very Short Introduction. Oxford: Oxford University Press. Woods, C. (2010). 'Visible Language: The Earliest Writing Systems', in Woods, C. (ed.) Visible Language: Inventions of Writing in the Ancient Middle East and Beyond. Chicago: Oriental Institute Museum Publications, pp. 15-25
[303] **Core Empire (ancient) sources:**
Kuhrt, A. (1995). The Ancient Near East c. 3000-330 BC (2 volumes). London: Routledge.
Van De Mieroop, M. (2015). A History of the Ancient Near East, ca. 3000-323 BC (3rd edition). Oxford: Wiley-Blackwell.
Roth, M.T. (ed.) (1997). Law Collections from Mesopotamia and Asia Minor (2nd edition). Atlanta: Scholars Press. (Contains Code of Hammurabi)
Richardson, J.S. (2012). Augustan Rome 44 BC to AD 14: The Restoration of the Republic and the Establishment of the Empire. Edinburgh: Edinburgh University Press.
Laurence, R. (1999). The Roads of Roman Italy: Mobility and Cultural Change. London: Routledge.
Harding, D.W. (2013). The Iron Age Round-House: Later Prehistoric Building in Britain and Beyond. Oxford: Oxford University Press.
Lewis, M.E. (2007). The Early Chinese Empires: Qin and Han. Cambridge, MA: Harvard University Press.
[304] **Core Nation-State sources:**
Croxton, D. (1999). 'The Peace of Westphalia of 1648 and the Origins of Sovereignty', International History Review, 21(3), 569-591.
Osiander, A. (2001). 'Sovereignty, International Relations, and the Westphalian Myth', International Organisation, 55(2), 251-287.
Krasner, S.D. (1999). Sovereignty: Organized Hypocrisy. Princeton: Princeton University Press.
Lesaffer, R. (2004). Peace Treaties and International Law in European History: From the Late Middle Ages to World War One. Cambridge: Cambridge University Press.
[305] **Core Printing Press sources:**
Eisenstein, E.L. (1980). The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early Modern Europe (2 volumes). Cambridge: Cambridge University Press.
Febvre, L. and Martin, H.-J. (1976). The Coming of the Book: The Impact of Printing 1450-1800. London: Verso.
[306] Anderson, B. (1983). Imagined Communities: Reflections on the Origin and Spread of Nationalism. London: Verso.
[307] **Core Bureaucracy sources:**
Weber, M. (1922). Economy and Society: An Outline of Interpretive Sociology. [English translation edited by Guenther Roth and Claus Wittich, 1968]. Berkeley: University of California Press.
Gerth, H.H. and Mills, C.W. (eds.) (1946). From Max Weber: Essays in Sociology. New York: Oxford University Press.
Mommsen, W.J. (1974). The Age of Bureaucracy: Perspectives on the Political Sociology of Max Weber. Oxford: Basil Blackwell.
[308] **Core International Governance sources:**
Kennedy, P. (2006). The Parliament of Man: The Past, Present, and Future of the United Nations. New York: Random House.
Mearsheimer, J.J. (1994). 'The False Promise of International Institutions', International Security, 19(3), 5-49.
Keohane, R.O. (1984). After Hegemony: Cooperation and Discord in the World Political Economy. Princeton: Princeton University Press
[309] **Core Blockchain sources:**
Nakamoto, S. (2008). 'Bitcoin: A Peer-to-Peer Electronic Cash System'. Available at: https://bitcoin.org/bitcoin.pdf
Tapscott, D. and Tapscott, A. (2016). Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World. New York: Portfolio/Penguin.
De Filippi, P. and Wright, A. (2018). Blockchain and the Law: The Rule of Code. Cambridge, MA: Harvard University Press
[310] **Core Platform Governance sources:**
Srnicek, N. (2017). Platform Capitalism. Cambridge: Polity Press.

Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Edge of Power. New York: PublicAffairs.
Wu, T. (2016). The Attention Merchants: The Epic Scramble to Get Inside Our Heads. New York: Alfred A. Knopf Watts, D.J. (2003). Six Degrees: The Science of a Connected Age. New York: W.W. Norton

[311] **Core Algorithmic Governance sources:**
O'Neil, C. (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. New York: Crown.
Pasquale, F. (2015). The Black Box Society: The Secret Algorithms That Control Money and Information. Cambridge, MA: Harvard University Press.
Crawford, K. (2021). Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence. New Haven: Yale University Press

[312] **Core Gift Economy sources:**
Mauss, M. (1925). The Gift: Forms and Functions of Exchange in Archaic Societies. [English translation by Ian Cunnison, 1954]. London: Cohen & West.
Sahlins, M. (1972). Stone Age Economics. Chicago: Aldine-Atherton

[313] Mankiw, N.G. (2021) Principles of Economics. 9th edn. Boston, MA: Cengage Learning

[314] **Core Money sources:**
Weatherford, J. (1997). The History of Money. New York: Crown Publishers.
Ferguson, N. (2008). The Ascent of Money: A Financial History of the World. New York: Penguin Press.
Graeber, D. (2011). Debt: The First 5,000 Years. Brooklyn: Melville House.
Davies, G. (2002). A History of Money: From Ancient Times to the Present Day (3rd edition). Cardiff: University of Wales Press.

[315] **Core Blockchain sources:**
Tapscott, D. and Tapscott, A. (2016). Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World. New York: Portfolio/Penguin

[316] **Core Capitalism sources**:
Rothschild, E. (2001). Economic Sentiments: Adam Smith, Condorcet, and the Enlightenment. Cambridge, MA: Harvard University Press.
Kennedy, G. (2008). Adam Smith: A Moral Philosopher and His Political Economy. Basingstoke: Palgrave Macmillan

[317] Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. [Modern edition edited by R.H. Campbell and A.S. Skinner, 1976]. Oxford: Clarendon Press

[318] **Core Socialism sources:**
Marx, K. (1867). Das Kapital: Kritik der politischen Ökonomie (Capital: Critique of Political Economy), Volume 1. [English translation by Ben Fowkes, 1976]. London: Penguin Classics.
Marx, K. and Engels, F. (1848). Manifesto of the Communist Party. [English translation, 1888]. London: Penguin Classics.

[319] **Core Inequality sources:**
Piketty, T. (2014). Capital in the Twenty-First Century. [Translated by Arthur Goldhammer]. Cambridge, MA: Harvard University Press
Piketty, T. and Saez, E. (2003). 'Income Inequality in the United States, 1913-1998', Quarterly Journal of Economics, 118(1), 1-39

[320] Harvey, D. (2010). A Companion to Marx's Capital. London: Verso

[321] **Core Soviet Economy sources:**
Gregory, P.R. and Stuart, R.C. (2001). Russian and Soviet Economic Performance and Structure (7th edition). Boston: Addison Wesley Longman.
Nove, A. (1977). The Soviet Economic System. London: Allen & Unwin.
Kornai, J. (1992). The Socialist System: The Political Economy of Communism. Princeton: Princeton University Press

[322] Ellman, M. (1973). Planning Problems in the USSR: The Contribution of Mathematical Economics to their Solution 1960-1971. Cambridge: Cambridge University Press

[323] **Core 'Observable Trends' sources:**
Acemoglu, D. and Robinson, J.A. (2012). Why Nations Fail: The Origins of Power, Prosperity, and Poverty. New York: Crown Business.
Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge: Cambridge University Press

[324] **Core Reduction of Violence sources:**
Pinker, S. (2011). The Better Angels of Our Nature: Why Violence Has Declined. New York:
Viking Keeley, L.H. (1996). War Before Civilization: The Myth of the Peaceful Savage. Oxford: Oxford University Press

Appendix A.4 – The Ontology of 'Nothing'

Part A: The Paradox of Discussing Nothing[325]

The human mind recoils from true nothingness. Throughout history, philosophers, physicists, and theologians have grappled with the concept of absolute void, yet every attempt to define nothing transforms it into something. This fundamental paradox—that to speak of nothing is to make it something—reveals a deep truth about the nature of existence itself.

Consider the simple statement "Nothing exists."

If this statement is true, then the statement itself exists, creating an immediate contradiction. If nothing exists, there can be no truths, no statements, no frameworks within which to assert non-existence. The very act of denial requires the apparatus of logic, language, and thought—all of which are decidedly something.

Historical attempts to conceive absolute void reveal the persistent failure of this enterprise. The ancient Greek philosophers struggled with the concept of kenon (κενόν)—the void. Parmenides declared it impossible, arguing "that which is not, cannot be."[326] Leucippus and Democritus tried to rescue the void as the space between atoms, but this merely transformed nothing into something – an arena where atoms could move[327]. The Aristotelian horror vacui (nature abhors a vacuum)[328] dominated Western thought for two millennia, reflecting an intuitive recognition that absolute nothing is inconceivable.

Noted additions in recent years include Graham Priest's paraconsistent logic exploration of the impossibility of nothing[329,330]. Below, we aim to apply this type of reasoning to a computational universe.

Part B: Formalisation of Nothing Across Philosophy and Physics

The attempt to formalise nothing mathematically reveals its fundamental impossibility:

1. Philosophy: Null State

$\emptyset_{\text{absolute}} = \{x : x \neq x\}$

This would be the set of all objects not equal to themselves—a logical contradiction in any consistent formal system. By the law of identity ($\forall x: x = x$), this set cannot contain any elements. But more fundamentally, it cannot even be constructed:

Proof-sketch of Impossibility:

1. To define $\emptyset_{\text{absolute}}$ requires a formal system, F
2. F must have axioms, inference rules, symbols
3. The definition exists within F
4. Therefore: $F \neq \emptyset$ (i.e. the framework exists)
5. If F exists, then $\emptyset_{\text{absolute}}$ fails as absolute nothing
6. ***Contradiction: Absolute nothing cannot be defined***

Even the standard empty set, $\emptyset$ in mathematics is not 'absolute nothing'. It's a well-defined mathematical object with properties:

- $\emptyset \subseteq A$ for all sets A
- $|\emptyset| = 0$ (cardinality is zero)
- $P(\emptyset) = \{\emptyset\}$ (has a non-empty power set)

The empty set is something. A set with no elements, not the absence of everything (including the framework itself)[331].

---

2. Information-Theoretic Analysis

Information theory provides another proof-sketch of absolute nothing's impossibility:

The Information Content Paradox:

Shannon entropy[332] of a system is defined as:

$$H(X) = -\Sigma\, p(xi) \log_2 p(xi)$$

For absolute nothing, we might attempt H(∅) = 0. But this requires:

1. A probability distribution (even if degenerate)
2. A sample space (even if empty)
3. A measurement framework
4. An Observer to define the ensemble

The very statement **H(∅) = 0** encodes information:

- Choice of base 2 logarithm (could be alternative)
- Choice of units (bits)
- The assertion itself (>1 bit information content)

---

3. The Specification Paradox

To specify nothing requires making distinctions:

- Nothing vs. something (1 bit)
- This nothing vs. that nothing (location)
- Nothing now vs. nothing then (temporal)
- Actual nothing vs. potential nothing (modal)

Each distinction adds information, moving further from 'absolute nothingness'.

---

4. Physics Correspondences

The Quantum Vacuum – The Vacuum as Minimum Energy State

Modern physics reveals that even the best approximation to absolute nothing, the quantum vacuum, teems with activity and structure:

Definition: Quantum Vacuum

$$|0\rangle = \min\{|\psi\rangle : \langle\psi|H|\psi\rangle\} = \text{ground state of quantum field theory}$$
$$\text{Where H is the Hamiltonian operator.}$$
$$\text{Crucially: } \langle 0|H|0\rangle = E_0 = \tfrac{1}{2}\hbar\omega > 0$$

The zero-point energy is non-zero for fundamental reasons rooted in the uncertainty principle[333].

Virtual Particle Fluctuations

The Heisenberg uncertainty principle in energy-time form[334]:

$$\Delta E \cdot \Delta t \geq \hbar/2$$

This allows virtual particles to spontaneously appear:

- For time Δt, energy ΔE can be "borrowed"
- Virtual particle-antiparticle pairs constantly created/annihilated
- The vacuum is a seething foam of quantum fluctuations

The Casimir Effect[335]

The most direct evidence that the vacuum has structure:

Setup: *Two parallel conducting plates separated by distance d*
Prediction: *Attractive force per unit area:*

$$F/A = -\hbar c\pi^2/240d^4$$

Mechanism:

- Vacuum fluctuations exist at all wavelengths
- Between plates: only wavelengths $\lambda = 2d/n$ permitted
- Outside plates: all wavelengths allowed

- Pressure imbalance creates measurable force

Experimental Confirmation:

- First measured by Sparnaay (1958)[336]
- Precision measurements by Lamoreaux (1997): 5% accuracy[337]
- Modern measurements: <1% deviation from theory[338]

The Casimir effect proves the vacuum has physical properties, it's not 'absolute nothing'.

Information Content of Vacuum

The vacuum is informationally rich.

Holographic Bound[339]:

$$S_{max} = A/(4l_p^2) = \pi kc^3A/(2\hbar G)$$

For a spherical region of radius R:

$$S_{vacuum} = \pi kc^3R^2/(2\hbar G) \approx 10^{69} \text{ bits/m}^2 \text{ on the boundary}$$

This means "empty" space of $1m^3$ contains: Information ≈ 10^{69} bits on surface

Entanglement Structure:

The vacuum exhibits maximal entanglement:

$$S_{entanglement}(\text{region}) \propto \text{Area}(\text{boundary})$$

This area law for entanglement entropy[340] shows the vacuum has complex quantum correlations i.e. NOT 'absolute nothing'.

---

5. 'Nothing' in the Ruliad

Within the Wolfram Physics framework, even "empty" space computes:

The Computational Vacuum:

$$\text{Vacuum state} = \min\{\text{computational activity}\} \neq \text{zero activity}$$

Key insights:

1. **Hypergraph Substrate:** Even without particles, the hypergraph updates
2. **Causal Edges:** Empty space maintains causal structure

---

6. The Observer Theory Paradox

The impossibility of nothing becomes clear in the context of Observer Theory:

Theorem: No Observer of Nothing

Let O be an Observer and N be 'absolute nothing'

Claim: O cannot observe N

Proof-sketch:

1. Observation requires: Observer O, Observed-state X and a relation between O and X
2. If N is absolute nothing: N ∉ Domain(Relation between O and X)
3. Therefore N cannot form relation
4. If we could observe N, then a relation between O and N exists
5. But then N participates in relation (i.e. it is not 'absolute nothing')
6. Contradiction
7. Therefore: Absolute Nothing is unobservable

This suggests a core ontological impossibility. For absolute nothing to be Observed, it must stand in relation to an observer, thereby becoming something, the object of observation.

Part C: Theological Nothing: Creation Ex Nihilo

1. The Tzimtzum Paradox[341]

Lurianic Kabbalah offers a sophisticated treatment of ‘nothing’ through the concept of Tzimtzum:

The Process (as shown in Section 5):

1. Ein Sof: The Infinite fills all
2. Tzimtzum: Contraction/withdrawal of the Infinite
3. Chalal: The "empty space" created
4. Kav: Ray of light enters the void
5. Creation: Emanation within the Chalal

Logical Formalisation:

$$\text{Let E} = \text{Ein Sof (infinite divine light)}$$
$$\text{Let R} = \text{Ruliad (all possible Observable existence)}$$

$$\begin{aligned}\text{Chalal} &= \{x \in R : x \notin E\}\\ &= \text{R defined by what it's not}\\ &\neq \text{Absolute nothing}\end{aligned}$$

The paradox: The void exists only in relation to what withdrew. The Infinite's absence is still a relationship with the Infinite.

Resolution in God Conjecture: Tzimtzum represents symmetry breaking:

$$\text{Initial: High symmetry state (all possibilities equal)}$$
$$\text{Tzimtzum: Symmetry breaking (distinction emerges)}$$
$$\text{Creation: Broken symmetry} \rightarrow \text{first structure} \rightarrow \text{eventually matter}$$

---

2. Buddhist Śūnyatā (Emptiness)[342,343]

Buddhism's śūnyatā offers a different perspective on nothing:

Śūnyatā ≠ Absolute Nothingness:

- Not void but absence of svabhāva (inherent existence)
- Everything arises through pratītyasamutpāda (dependent origination)
- No phenomenon exists independently

Mathematical Parallel: In category theory, objects have no inherent properties:

Object A is defined entirely by:

1. Morphisms to other objects: f: A → B
2. Morphisms from other objects: g: C → A
3. Composition relations: h ∘ g ∘ f
4. Remove all morphisms → A becomes meaningless

Objects exist only through relationships.

Nāgārjuna's Tetralemma[344]: For any proposition P:

1. Not P
2. Not ¬P
3. Not (P ∧ ¬P)
4. Not ¬(P ∨ ¬P)

This is akin to a conception that ultimate ground of reality transcends categories (including existence/non-existence)

Correspondence with Quantum Mechanics: *Quantum states before measurement:* $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$
Neither 0 nor 1, neither existent nor non-existent in classical terms—śūnyatā-like superposition.

---

3. Creation Ex Nihilo Reformulated[345]

Classical theism's "creation from nothing" requires reinterpretation:

Traditional Problem:
If God creates from nothing:

1. "Nothing" must pre-exist creation
2. But nothing cannot exist
3. Therefore contradiction

God Conjecture Resolution:
Creation is not from absence but from pure potential:
Creation Process:

1. Ruliad exists necessarily (logical structure, axiom)
2. Contains all possible computations
3. Observers sample specific paths
4. Sampling breaks symmetry
5. Broken symmetry leads to physical reality
6. Not: Nothing → Something
7. But: Everything (potential) → Something (actual)

Part D: Cognitive Nothing

1. What We Mean When We Say "Nothing"

Human cognition cannot truly conceive absolute nothing. When we say "nothing," we always mean something specific:

Formal Structure:

$$\text{Nothing}_{\text{cognitive}} = \text{Expected}_{\text{set}} \setminus \text{Observed}_{\text{set}}$$

i.e. *What should be here - What is here ≠ Absolute absence*

Examples:

- "Nothing in the box" = Box exists, expected contents absent
- "Nothing happened" = Time passed without expected events
- "Nothing matters" = Values exist but seem meaningless
- "I feel nothing" = Emotional numbness, not absence of feeling

Linguistic Analysis: The word "nothing" functions grammatically as something:

- Subject: "Nothing is impossible"
- Object: "I see nothing"
- Modifier: "Nothing special"

Language treats nothing as a something-that-is-not.

---

2. The Phenomenology of "Nothing"

Husserl's Insight[346]: Consciousness is always consciousness OF something. Pure consciousness without content is impossible:

$$\text{Consciousness} = \text{Intentionality} = \text{Directedness toward objects} \neq \text{Standalone existence}$$

Even consciousness of absence is consciousness of something (the absence).

---

3. "Nothing" as Cognitive Tool[347]

Paradoxically, the concept of nothing is essential for thought:

Zero as Placeholder:
Without 0: Can't distinguish 1 from 10 from 100
With 0: Positional notation enables all mathematics
$205 = 2\times10^2 + 0\times10^1 + 5\times10^0$

Zero isn't nothing—it's a 'something' that represents 'nothing' i.e it enables infinite expression.

Negative Space[348] in Art:

- Defines positive space
- Creates balance and flow
- Often more important than filled space
- The pause between notes makes music

Logical Negation:

Without NOT operator:

1. Can't express contradiction
2. Can't do proof by contradiction
3. Can't have complete logical system

NOT creates nothing from something:
NOT(P) = "The absence of P"

The Observer Cannot Observe Its Own Absence:

A fundamental limitation of observation:

The Self-Reference Paradox:

1. For observer O to observe its own non-existence
2. O must exist to observe
3. O must not exist (to be observed as absent)
4. Therefore contradiction
5. Therefore: ∄ observation of own absence

Death as a Limit Case:

We can imagine others' absence but not our own:

- Can imagine world without me
- But imagining requires me as imaginer
- The imaginer remains in the imagination
- True absence of self-inconceivable

This leads to Wittgenstein's famous insight that "Death is not an event in life: we do not live to experience death... Our life has no end in just the way in which our visual field has no limits."[349]

Part E: Nothing and the Origin Question

1. A Resolution to 'Why Something Rather Than Nothing?'

The ancient question posed by Leibniz[350] and amplified by Heidegger[351] dissolves when we recognize nothing's impossibility:

The Traditional Formulation: "Why is there something rather than nothing?"

Hidden Assumptions:
1. Nothing is possible (false)
2. Nothing is simpler than something (false)
3. Nothing is the default state (false)
4. Something requires explanation (true)
5. Nothing wouldn't require explanation (false)

---

2. Proof by Contradiction

Formal Proof of Something's Necessity[352]:

Theorem: Something necessarily exists

Proof:
1. Assume: Nothing exists ($\nexists x$: x exists)
2. Then: "Nothing exists" is true
3. If "Nothing exists" is true, then truth exists
4. If truth exists, then logical framework exists
5. If logical framework exists, something exists
6. Contradiction with (1)
7. Therefore: Something necessarily exists

Alternative Formulation:

1. Consider the proposition P = "Nothing exists"
2. If P is true:
   P exists as true proposition
   Truth value assignment exists
   Logical evaluation exists
3. If P is false:
   Something exists (by definition)
4. Either way: Something exists

---

3. The Necessity of Existence

Why existence is necessary, not contingent: **Logic Requires Existence**

For any logical operation:

1. AND, OR, NOT require framework
2. True/False require evaluation
3. If/Then requires inference
4. Equals requires comparison
5. Therefore, Logic cannot operate on nothing
6. Logic operating proves something exists

---

4. Why this supports the existence of the Ruliad

1. Logic exists necessarily (cannot be coherently denied)
2. If logic, then computation (Church-Turing)
3. If computation, then all possible computations (completeness)
4. All possible computations = Ruliad
5. Therefore: Ruliad exists necessarily

---

5. Nothing is a Pseudo-Problem

The question "Why not nothing?" is malformed:

Category Error: Like asking:

- "What's north of the North Pole?"
- "What happened before time?"
- "What's outside everything?"

These questions assume framework then ask about its absence. The Real Question transforms from "Why something rather than nothing?" to "Why this something rather than another something?"

God Conjecture Position: Observer selection within necessary Ruliad powered by Infinite (non-computational ground)

---

6. Reformulated Questions

Old Question	New Question	Answer
Why does anything exist?	Why does logic exist?	Denial requires logic
Why not nothing?	Why not contradiction?	Contradiction impossible
What caused existence?	What grounds existence?	Logical necessity
What came before?	What's logically prior?	The Ruliad structure

---

Part F: The Resolution

The question "Why is there something rather than nothing?" contains its own answer. To ask "why" presupposes:

- Causation (something)
- Logic (something)
- Questioner (something)
- Question (something)
- Possible answers (something)

The very asking proves something exists. The question doesn't need answering, it needs recognizing as self-answering.

Part G: Implications for the God Conjecture

1. Nothing and Divine Necessity

The impossibility of 'absolute nothing' strengthens the God Conjecture:

TI analogous to Necessary Being

- Classical theology: God = necessary being
- God Conjecture: TI = terminal object in observer-accessible category
- Both: Cannot not exist

The impossibility of ‘absolute nothing’ implies

- Something eternal exists (no beginning from nothing)
- This something is necessary (not contingent)
- It contains all possibility (Ruliad)
- It manifests through observation (physics)
- It terminates in integration, final computation (TI)

---

2. Creation as Symmetry Breaking

Understanding nothing's impossibility reframes creation:

- Not: Nothing → Something (logically impossible, undermines Observation computationally)
- But: Symmetry → Broken symmetry → Structure

Process:

- Ruliad pre-Observer sampling (and prefiguring state that is not Observable, Ein Sof) has maximum symmetry
- MetaObserver-induced symmetry breaking
- Particular computational path selected (maximum efficiency)
- Physical laws emerge
- Matter/energy crystallize
- Complexity develops (multiple sub-Observers)
- Consciousness emerges (choice introduced as more efficient search / communication between sub-agents)
- Integration accelerates
- Convergence to TI / God etc.

---

3. A Word on Contemplative Practice

Mystical experience of "void" when deeply meditating isn't nothing:

What meditators experience:

- Absence of conceptual thought
- Freedom from subject-object duality
- Pure awareness without content
- Undifferentiated potential
- Close to the ‘ground of being’

This corresponds to:

- Maximum accessible symmetry state
- Pre-observation ‘potential’
- The computational Ruliad with minimal sampling (approaching infinitesimal, usually just a sense of Identity in the most abstract sense, i.e. ‘I am still experiencing’)
- Closer to everything than nothing

---

4. Information-Theoretic Theology

Nothing's impossibility implies information's primacy:

- If nothing is impossible
- And something is necessary
- And something requires distinction

- And distinction is information
- Then: Information is fundamental

This supports:

- It-from-bit[353]
- Consciousness as information integration (as a high-explanatory power most useful description, i.e. this does not prejudice mechanical, ‘machine-code’ descriptions like Orch-OR)
- Physical laws as information processing
- God as maximum information integration condition (omniscience)

Part G: Conclusion

The exploration of our historic ideas of nothing reveals its logical impossibility. What appears as ‘nothing’—the vacuum, the void, emptiness—always reveals itself as something: potential, relation, or framework. Even our concept of nothing is something, serving essential cognitive and mathematical functions that enable computationally bounded Observers to maintain both persistence and computational efficiency.

The quantum vacuum seethes with virtual particles and zero-point energy. The theological void of Tzimtzum defines space for creation through relationship with the infinite. Buddhist śūnyatā points to the interdependence of all phenomena. The cognitive ‘nothing’ enables distinction and negation.

All these "nothings" are sophisticated somethings.

The impossibility of ‘absolute nothing’ resolves the primordial question of why anything exists. Something exists because ‘nothing’ cannot. Logic exists because its denial requires it. The Ruliad exists as the necessary structure of all possible computation. We exist as Observers sampling paths through this necessary structure.

The void is full. Emptiness gives distinction form and true nothing is impossible.

Consequently, existence is a necessary certainty. The universe is not arbitrary (i.e. it is, could be and was at some point, ‘nothing’), it is a necessary something exploring itself through Observers at all possible scales. Some of these Observers have self-modelling capabilities that we recognise as consciousness. Others don’t (atoms, thermometers, viruses). But they all explore a space that we can best understand and probe using computational tools at all possible levels of description.

This view transforms the existential question from "Why must I exist?" to "I must exist!" from intellectual and emotional burden to a celebration.

The ‘nothing’ French philosophers (and they are always, for some reason, French) feared never was. The something we are always was, is, and will be – necessarily, certainly, and meaningfully – converging toward ever-greater information integration and understanding in the infinite dance of existence.

References

[325] **Core ‘Nothing in Philosophy’ sources:**
Sorensen, R. (2008) 'Nothingness', in Zalta, E.N. (ed.) Stanford Encyclopaedia of Philosophy. Available at: https://plato.stanford.edu/entries/nothingness/
Wilde, N. (2020) 'Everything and Nothing: How do Matters Stand with Nothingness in Object-Oriented Ontology?', Open Philosophy, 3(1), pp. 242-256. De Gruyter Brill https://doi.org/10.1515/opphil-2020-0118
Sartre, J-P. (1943/2018) Being and Nothingness: An Essay in Phenomenological Ontology. Translated by Richmond, S. London: Routledge
[326] Kirk, G.S., Raven, J.E. and Schofield, M. (1983) The Presocratic Philosophers: A Critical History with a Selection of Texts. 2nd ed. Cambridge: Cambridge University Press
[327] Graham, D.W. (2008) 'Leucippus's Atomism', in Curd, P. and Graham, D.W. (eds.) The Oxford Handbook of Presocratic Philosophy. Oxford: Oxford University Press, pp. 333-352
[328] Thorp, J. (1990) 'Aristotle's Horror Vacui', Canadian Journal of Philosophy, 20(2), pp. 149-166. PhilPapers https://doi.org/10.1080/00455091.1990.10716502
[329] Priest, G. (2014) 'Much Ado About Nothing', Australasian Journal of Logic, 11(2), Article no. 4, pp. 1-14. Stanford Encyclopaedia of Philosophy +4 https://doi.org/10.26686/ajl.v11i2.2144
[330] Priest, G. (2014) One: Being an Investigation Into the Unity of Reality and of its Parts, Including the Singular Object Which is Nothingness. Oxford: Oxford University Press

[331] Jech, T. (2003) Set Theory, 3rd millennium edition, revised and expanded. Berlin: Springer-Verlag. https://doi.org/10.1007/3-540-44761-X
[332] Shannon, C.E. (1948) 'A Mathematical Theory of Communication', Bell System Technical Journal, 27(3), pp. 379-423. Oxford University Research Archive +2 https://doi.org/10.1002/j.1538-7305.1948.tb01338.x
[333] **Core Quantum Theory sources:**
Dirac, P.A.M. (1927) 'The Quantum Theory of the Emission and Absorption of Radiation', Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character, 114(767), pp. 243-265. Royal Society Open Science https://doi.org/10.1098/rspa.1927.0039
Heisenberg, W. and Pauli, W. (1929) 'Zur Quantendynamik der Wellenfelder', Zeitschrift für Physik, 56, pp. 1-61. Stanford Encyclopaedia of Philosophy
Heisenberg, W. and Pauli, W. (1930) 'Zur Quantentheorie der Wellenfelder. II', Zeitschrift für Physik, 59(3-4), pp. 168-190
[334] Heisenberg, W. (1983) 'The Physical Content of Quantum Kinematics and Mechanics', in Wheeler, J.A. and Zurek, W.H. (eds.) Quantum Theory and Measurement. Princeton: Princeton University Press, pp. 62-84
[335] Casimir, H.B.G. (1948) 'On the attraction between two perfectly conducting plates', Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, B51, pp. 793-795
[336] Sparnaay, M.J. (1958) 'Measurements of attractive forces between flat plates', Physica, 24(6-10), pp. 751-764. https://doi.org/10.1016/S0031-8914(58)80090-7
[337] Lamoreaux, S.K. (1997) 'Demonstration of the Casimir Force in the 0.6 to 6 μm Range', Physical Review Letters, 78(1), pp. 5-8. https://doi.org/10.1103/PhysRevLett.78.5
[338] **Core Casimir Experimental Support sources:**
Mohideen, U. and Roy, A. (1998) 'Precision Measurement of the Casimir Force from 0.1 to 0.9 μm', Physical Review Letters, 81(21), pp. 4549-4552. https://doi.org/10.1103/PhysRevLett.81.4549 arXiv +2
Banishev, A.A., Wen, H., Xu, J., Kawakami, R.K., Klimchitskaya, G.L., Mostepanenko, V.M. and Mohideen, U. (2013) 'Measuring the Casimir force gradient from graphene on a SiO_2 substrate', Physical Review B, 87(20), 205433. https://doi.org/10.1103/PhysRevB.87.205433 APS Journals
Liu, M., Zhang, Y., Klimchitskaya, G.L., Mostepanenko, V.M. and Mohideen, U. (2021) 'Demonstration of an Unusual Thermal Effect in the Casimir Force from Graphene', Physical Review Letters, 126(20), 206802. https://doi.org/10.1103/PhysRevLett.126.206802 APS Journals
Liu, M., Zhang, Y., Klimchitskaya, G.L., Mostepanenko, V.M. and Mohideen, U. (2021) 'Experimental and theoretical investigation of the thermal effect in the Casimir interaction from graphene', Physical Review B, 104(8), 085436. https://doi.org/10.1103/PhysRevB.104.085436
[339] **Core Holographic Principle sources:**
't Hooft, G. (2000) The Holographic Principle. arXiv:hep-th/0003004
Bousso, R. (2002) 'The Holographic Principle', Reviews of Modern Physics, 74(3), pp. 825-874. https://doi.org/10.1103/RevModPhys.74.825
[340] **Core Entropy / Area sources:**
Srednicki, M. (1993) 'Entropy and area', Physical Review Letters, 71(5), pp. 666-669. https://doi.org/10.1103/PhysRevLett.71.666 NatureStack Exchange
Eisert, J., Cramer, M. and Plenio, M.B. (2010) 'Colloquium: Area laws for the entanglement entropy', Reviews of Modern Physics, 82(1), pp. 277-306. https://doi.org/10.1103/RevModPhys.82.277
[341] Kaplan, A. (1997) Sefer Yetzirah: The Book of Creation. Revised ed. York Beach, ME: Samuel Weiser, Inc.
[342] Garfield, J.L. (1995) The Fundamental Wisdom of the Middle Way: Nāgārjuna's Mūlamadhyamakakārikā. New York: Oxford University Press
[343] Garfield, J.L. (2002) Empty Words: Buddhist Philosophy and Cross-Cultural Interpretation. New York: Oxford University Press
[344] **Core Tetralemma sources:**
Priest, G. (2018) The Fifth Corner of Four: An Essay on Buddhist Metaphysics and the Catuṣkoṭi. Oxford: Oxford University Press. Oxford University Research ArchiveVercel
Garfield, J.L. and Priest, G. (2003) 'Nāgārjuna and the Limits of Thought', Philosophy East and West, 53(1), pp. 1-21
[345] **Core Creation ex Nihlo sources:**
Oord, T.J. (ed.) (2015) Theologies of Creation: Creation Ex Nihilo and Its New Rivals. New York: Routledge
Copan, P. and Craig, W.L. (2004) Creation out of Nothing: A Biblical, Philosophical, and Scientific Exploration. Grand Rapids, MI: Baker Academic
[346] Husserl, E. (1982) Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy, First Book: General Introduction to a Pure Phenomenology. Translated by Kersten, F. The Hague: Martinus Nijhoff
[347] Kaplan, R. (1999) The Nothing That Is: A Natural History of Zero. Oxford: Oxford University Press Seife, C. (2000) Zero: The Biography of a Dangerous Idea. New York: Viking
[348] **Core Negative Space sources:**
Wagemans, J., Elder, J.H., Kubovy, M., Palmer, S.E., Peterson, M.A., Singh, M. and von der Heydt, R. (2012) 'A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure-ground organisation', Psychological Bulletin, 138(6), pp. 1172-1217. https://doi.org/10.1037/a0029333
Wagemans, J., Feldman, J., Gepshtein, S., Kimchi, R., Pomerantz, J.R., van der Helm, P.A. and van Leeuwen, C. (2012) 'A century of Gestalt psychology in visual perception: II. Conceptual and theoretical foundations', Psychological Bulletin, 138(6), pp. 1218-1252. https://doi.org/10.1037/a0029334
[349] Wittgenstein, L. (2023) Tractatus Logico-Philosophicus. Translated with introduction and notes by Beaney, M. Oxford: Oxford University Press
[350] **Core Leibniz sources:**
Leibniz, G.W. (1714) 'Principles of Nature and Grace, Based on Reason', in Ariew, R. and Garber, D. (eds.) (1989) Philosophical Essays. Indianapolis: Hackett Publishing, pp. 206-213.
Leibniz, G.W. (1714) 'The Monadology', in Ariew, R. and Garber, D. (eds.) (1989) Philosophical Essays. Indianapolis: Hackett Publishing, pp. 213-225
[351] Heidegger, M. (2000) Introduction to Metaphysics. Translated by Fried, G. and Polt, R. New Haven, CT: Yale University Press.

[352] Gödel, K. (1995) 'Ontological Proof', in Feferman, S. et al. (eds.) Kurt Gödel: Collected Works, Vol. III: Unpublished Essays and Lectures. Oxford: Oxford University Press, pp. 403-404

[353] Wheeler, J.A. (1990) 'Information, Physics, Quantum: The Search for Links', in Zurek, W.H. (ed.) Complexity, Entropy, and the Physics of Information. Redwood City, CA: Addison-Wesley, pp. 3-28

Appendix A.5 – How Powerful is Our MetaObserver?

TL;DR

This appendix quantifies the maximum computational capacity of Adam Kadmon (the MetaObserver / Maximally Entangled Observer) in the observable universe using fundamental units from the Wolfram Physics Project's (Matthew Fox WSS25) framework.

Outcome: If we 'buy' the fundamental units of the Ruliad that Wolfram and team have produced, the MetaObserver can perform ~10^{652} operations per second and integrate ~10^{238} bits of information in the observable universe, vastly exceeding human capacity (~10^{16} ops/s) but still facing absolute limits from computational irreducibility, maximum entanglement speed (ζ ≈ Planck power), and thermodynamic constraints.

Even an Observer with access to all computational resources in the observable universe cannot achieve omniscience due to the inherent structure of the Ruliad. These limits emerge necessarily from the logical structure of computation itself, asking for their violation is like asking for square circles.

Here, we introduce 'dimensional flux' as a dimensional unit, in line with Matthew Fox's work. While exceptionally speculative, this interpretation aligns with the 5D hypercube structure (i.e. the ultrafilter's structure) proposed in Section 5.

Part A: Introduction: Why Physical Limits Matter for the MetaObserver

Methodological Note

Speculative but consilient with Wolfram Physics Project Framework (though this, as the researcher suggests, may be mathematical coincidence!)

This appendix employs a speculative but novel interpretation of branchial capacity Ξ as dimensional flux [m^{-2} s^{-1}], following the methodology developed by Matthew Fox. While acknowledged as speculative, this framework reproduces the original Wolfram Physics Project estimates to within ~1 order of magnitude through an independent derivation based on "Planck flux" dimensional analysis.

Why this matters for The God Conjecture

*If we interpret **flux** as a **fundamental physical dimension** (measuring causal edges crossing hypersurfaces per unit area per unit time), this aligns remarkably with Section 5's proposal that Observers like us experience a computationally efficient projection from higher-dimensional structure.*

The dimensional form [L^{-2} T^{-1}] suggests a hypersurface measure in 3D+1 spacetime, potentially representing how a 5-dimensional hypercube structure (3 spatial + 1 temporal + 1 branchial) projects into observable reality.

This consilience between ancient Kabbalistic structure (Section 5) and cutting-edge computational physics, while hypothetical, strengthens the core argument that theological concepts find precise physical grounding in Ruliad dynamics.

In Section 5, we defined Adam Kadmon (the MetaObserver / Maximally Entangled Observer) as the **Category of All Possible Effects,** the totality of all computational structures that can exist within the Ruliad given the constraint of causality.

The MetaObserver represents the theoretical maximum of what any Observer could possibly observe or compute in the observable universe if it had access to all the computational resources it contained.

While this represents a theoretical maximum in the observable universe, it remains embedded within the computational substrate of the Ruliad itself and thus subject to the fundamental constraints of that substrate.

Plain-English Context

Even the most powerful possible observer is still "inside" the universe and must follow its rules, like a character in a video game that, no matter how powerful, cannot transcend the game's programming.

The Wolfram Physics Project ("WPP") provides a rigorous framework for understanding these fundamental limits through its system of elementary units: the discrete quanta that form their computational substrate of physical reality.

Following Matthew Fox's work (WSS25), we interpret the branchial capacity Ξ not as a dimensionless count but as a dimension itself. This is known in WPP as **'flux'** and in Fox's work was unitised as [m^{-2} s^{-1}], representing the rate at which causal edges cross spatial hypersurfaces.

> ***Another way to think about a Maximally Entangled Observer (MetaObserver)***
>
> *Think of the MetaObserver like a computer that could use every atom in the observable universe for computation and could access quantum information at the maximum possible rate (Planck power).*
>
> *A single human is like using one grain of sand from one beach on one continent. All humans together, if perfectly connected, would be like using all the sand from all beaches on Earth, still incomprehensibly smaller than the MetaObserver (by an enormous factor as we'll see in this section).*

The Flux Interpretation and the 5D Hypercube Structure from Section 5: The God Conjecture

This interpretation is novel. If Ξ has dimensions [L^{-2} T^{-1}], it represents:

- Events per unit area per unit time in the hypergraph
- A 2D spatial + 1D temporal hypersurface measure
- Potentially the observable projection from higher-dimension (a fifth, informational dimension)

> ***Connection to Section 5: The God Conjecture***
>
> *We proposed that Observers like us experience a computationally efficient dimensional structure optimised for maximum information integration with minimum computational cost / hypergraph updates, subject to us having choice (i.e. being 'God-like').*
>
> *If the universe has **5** observable dimensions (**3 spatial + 1 temporal + 1 branchial**), then Flux as [L^{-2} T^{-1}] could potentially represent how the branchial dimension manifests in measurable reality through 2D cross-sections. This would move that speculative aspect in Section 5 from metaphor to weakly equivalent mathematical correspondence.*

Key Questions This Section Addresses:

1. What are the fundamental units when Ξ is interpreted as **dimensional flux**?
2. How does flux as a dimension connect to Observer Theory and 5D structure?
3. What is the computational capacity of a maximally entangled Observer (the MetaObserver) in our observable Universe?
4. What physical constraints exist on information integration and processing?
5. Can our MetaObserver achieve omniscience, or are there irreducible limits?

Part B: Fundamental Units from Planck Flux

The Fox (WSS25) Framework: Fox derived Ξ from dimensional analysis of Planck intensity and Planck energy.

$$\Xi = \frac{\mathrm{I_p}}{\mathrm{E_p}} = \frac{\text{Planck intensity}}{\text{Planck energy}}$$

where:

- $I_P = \frac{c^5}{\hbar G} \approx 1.389 \times 10^{122} \mathrm{W/m^2}$ (Planck intensity)
- $E_P = \sqrt{\frac{\hbar c^5}{G}} \approx 1.221 \times 10^{28} \mathrm{eV}$ (Planck energy)

This yields:

$$\boxed{\Xi \approx 7.101 \times 10^{112}\ \mathrm{m^{-2}s^{-1}}}$$

The dimensional form is crucial: it represents flux through a 2D spatial surface, not a dimensionless count. This changes everything.

> ***Plain-English Context***
>
> *Instead of thinking* "Ξ counts quantum branches," *we're saying* "Ξ measures how many fundamental computational events cross a unit area per unit time." *It's like measuring water flow (volume per area per time) but for information/causality itself.*

The Square Root Scaling Law

Because Ξ has dimensions [L^{-2} T^{-1}], dimensional analysis requires square root scaling:

$$\ell = \frac{\ell_\mathrm{p}}{\sqrt{\Xi}} \qquad \tau = \frac{\tau_\mathrm{p}}{\sqrt{\Xi}} \qquad \varepsilon = \frac{\mathrm{E_p}}{\sqrt{\Xi}}$$

Why square root? The area dimension (L^2) in Ξ requires taking √ to extract a length scale.

> ***Plain-English Context***
> *Since Ξ measures events per area, and area goes as length squared, we need to take the square root to get back to a fundamental length. It's like how if you know the area of a square, you take the square root to find the side length*

WPP Fundamental Units Calculated

Using **$\Xi = 7.101 \times 10^{112}$ m^{-2} s^{-1}** and **$\sqrt{\Xi} \approx 2.665 \times 10^{56}$**:

Unit	Formula	Dimensional Value (Fox)	WPP Order of Magnitude
Elementary Length (ℓ)	$\ell_P / \sqrt{\Xi}$	6.065×10^{-92} m	10^{-92} m
Elementary Time (τ)	$\tau_P / \sqrt{\Xi}$	2.023×10^{-100} s	10^{-100} s
Elementary Energy (ε)	$E_P / \sqrt{\Xi}$	4.582×10^{-29} eV	10^{-29} eV
Elementary Mass (m)	$m_P / \sqrt{\Xi}$	8.167×10^{-65} kg	10^{-65} kg
Elementary Temperature (T)	$T_P / \sqrt{\Xi}$	5.317×10^{-25} K	10^{-25} K

Planck Units for Reference

Unit	Symbol	Value
Planck length	ℓ_P	1.616×10^{-35} m
Planck time	τ_P	5.391×10^{-44} s
Planck energy	E_P	1.221×10^{28} eV
Planck power	P_P	3.628×10^{52} W

WPP Physics Interpretation

Elementary length (ℓ ≈ 10^{-92} m): *The fundamental "pixel size" of space*. This is 10^{57} times smaller than a Planck length! Space is not quantized at the Planck scale but at an incomprehensibly tinier scale when accounting for branchial (quantum) dimensions.

> ***Plain-English Context***
> *If the Planck length were the size of a proton, the elementary length would be smaller than that proton is compared to the entire observable universe—and then make it smaller still by a factor of 10^{19}*

Elementary time (τ ≈ 10^{-100} s): *The fundamental "frame rate" of reality*. Every physical process consists of ~10^{100} elementary time steps per second.

> ***Plain-English Context***
> *The universe "refreshes" about 10^{100} times every second. To put this in perspective: there have only been about 10^{60} Planck times in the entire 13.8bn year history of the universe. The elementary time is 10^{56} times shorter than even that!*

Elementary energy (ε ≈ 10^{-29} eV): *The fundamental quantum of energy contributed by a single causal edge*. Even an electron's rest mass-energy (0.511 MeV) represents approximately 10^{35} elementary energy quanta.

> ***Plain-English Context***
> *Every form of energy, from light to matter to motion, is built from vast numbers of these elementary energy packets. The electron, one of the lightest particles, contains about 10^{35} of them.*

Verification: Speed of Light Emergence

$$c = \frac{\ell}{\tau} = \frac{6.065 \times 10^{-92}\, m}{2.023 \times 10^{-100} s} = 2.998 \times 10^{8}\ \mathrm{m/s}$$

This emergence of **c** demonstrates internal consistency of the framework, no matter what value Ξ has, the ratio **ℓ/τ** must equal the speed of light. This is coherence: relationships between fundamental units remain fixed even as their absolute values scale.

Part C: The Concept of Flux in Rulial Computation

1. Flux as a Fundamental Dimension

In traditional physics, we have fundamental dimensions [M], [L], [T] (mass, length, time). The Fox paper suggests flux itself might be fundamental:

$$[\Phi]=[L^{-2}T^{-1}] = \text{events per area per time}$$

This metric isn't reducible to **M, L, T** alone. It is posited to represent a hypersurface measure i.e. how many computational events affect a 2D spatial region per unit time.

> ***Plain-English Context***
>
> *Imagine space as a fabric. Flux measures how many "threads" (causal edges) pierce through any patch of the fabric each instant. It's not just derived from space and time, here it's a fundamental way reality is structured.*

2. Types of Flux

Energy Flux Φ_E: Rate of energy flow through area

$$\Phi_E = \frac{dE}{dA \cdot d\tau} = \frac{\varepsilon}{\ell^2 \cdot \tau}$$

Information Flux Φ_I: Rate of information flow through area

$$\Phi_I = \frac{dI}{dA \cdot d\tau}$$

For maximum entanglement speed ζ:

$$\Phi_I^{\text{max}} = \frac{\zeta}{\ell^2}$$

Causal Edge Flux Φ_C: Number of causal edges crossing area per time

$$\Phi_C = \frac{dN_{\text{edges}}}{dA \cdot d\tau}$$

These are **not independent**—they relate through elementary units:

- $\Phi_E = \varepsilon \cdot \Phi_C$
- $\Phi_I \approx \log_2(\Phi_C \cdot \tau) \cdot \Phi_C$

3. Flux and the 5D Hypercube

If the God Conjecture's position is correct and observable reality has 5 dimensions (3 spatial + 1 temporal + 1 branchial), then:

- *3D spatial volume:* **$[L^3]$**
- *4D spacetime volume:* **$[L^3 T]$**
- *Flux through 2D + 1T hypersurface:* **$[L^{-2} T^{-1}]$**

The flux dimension represents **how the 5th (branchial) dimension manifests in our observable universe,** not as spatial extent but potentially as **information density crossing spatial hypersurfaces**.

> ***Plain-English Context***
>
> *You can't "see" the branchial dimension directly (just like you can't see time as a spatial direction), but you can measure its effects through how much information flows through space. Flux, as a dimensional number, is like a the "shadow" that the higher dimension casts into observable reality.*

This connects to Section 5's minimal computational efficiency: A 5D structure projected to observable 3D+1 naturally involves measuring a 2D+1 hypersurface change. This might be arbitrary, but it seems like the computationally optimal way for Observers embedded in 3D+1 to sample higher-dimensional structure.

Part D: Computational Capacity of the MetaObserver

1. Maximum Processing Rate per Volume

The **Lloyd limit** sets maximum operations per second for a given energy:

$$R_{\text{Planck}} = \frac{c^5}{\hbar G} \approx 3.44 \times 10^{86} \text{ ops/s per Planck volume}$$

> ***Plain-English Context***
> *This is the ultimate "processor speed" limit for any physical system. Even a computer made of pure energy at maximum density can only compute this fast.*

Accounting for branchial space (**flux Ξ**):

$$R_{\text{Rulial}} = R_{\text{Planck}} \times \Xi \approx 10^{199} \text{ ops/s per elementary volume}$$

> ***Plain-English Context***
> *Each tiny elementary volume can perform 10^{199} operations per second because it's effectively computing across all quantum branches simultaneously. It's like having 10^{112} parallel processors in each volume*

2. Estimated Total Computational Capacity

Observable universe parameters:

- Age: $t_H \approx 4.35 \times 10^{17}$s (13.8 billion years)
- Radius: $r_H = c \cdot t_H \approx 1.30 \times 10^{26}$m
- Volume: $V_H \approx 9.29 \times 10^{78}\text{m}^3$

Number of elementary volumes:

$$N_{\text{volumes}} = \frac{V_H}{\ell^3} = \frac{9.29 \times 10^{78}}{(6.065 \times 10^{-92})^3} \approx 10^{353}$$

> ***Plain-English Context***
> *The observable universe contains about 10^{353} elementary volumes, each one a tiny "computational cell" that can run 10^{199} operations per second*

Total operations per elementary time step τ:

$$C_{\text{MetaObserver}} = R_{\text{Rulial}} \times N_{\text{volumes}} \approx 10^{199} \times 10^{353} = 10^{552} \text{ ops per } \tau$$

Total operations per second:

$$C_{\text{MetaObserver/s}} = \frac{C_{\text{MetaObserver}}}{\tau} = \frac{10^{552}}{10^{-100}} \approx 10^{652} \text{ ops/s}$$
$$\boxed{C_{\text{MetaObserver}} \approx 10^{652} \text{ operations per second}}$$

> ***Plain-English Context***
> *In our observable universe, the MetaObserver could perform about a googol to the power of 6.5 operations every second. This is so incomprehensibly large that even describing it strains language. For comparison, the fastest supercomputers today do about 10^{18} operations per second. Our putative MetaObserver exceeds this by a factor of 10^{634}!*

3. Maximum Information Integration Capacity

Using the **holographic principle** (Bekenstein bound), information content is bounded by horizon area:

$$I_{\max} = \frac{A_{\text{horizon}}}{4\ell^2}$$

where $A_{\text{horizon}} = 4\pi r_H^2 \approx 2.14 \times 10^{53}\text{m}^2$

$$I_{\max} = \frac{2.14 \times 10^{53}}{4 \times (6.065 \times 10^{-92})^2} \approx 10^{235} \text{ bits (spatial)}$$

Accounting for branchial dimensions: $I_{\max}^{\text{total}} = I_{\max} \times \log_2(\Xi) \approx 10^{235} \times 374 \approx 10^{238}$ bits

$$\boxed{I_{\max}^{\text{total}} \approx 10^{238} \text{ bits}}$$

> ***Plain-English Context***
>
> *In our observable universe, the MetaObserver can hold about 10^{238} bits of information, representing under WPP assumptions, the total information content of the entire observable universe (including all quantum branches).*
>
> *For comparison, all data ever created by humanity is about 10^{23} bits. The MetaObserver's capacity exceeds this by a factor of 10^{215}*

Part E: Maximum Entanglement Speed (ζ) and the Planck Power Connection

1. Definition of Maximum Entanglement Speed

Just as **c** sets the maximum velocity in spatial dimensions, there exists a maximum branchlike velocity **ζ** determining the maximum rate at which an observer can become entangled with new quantum degrees of freedom.

> ***Plain-English Context***
>
> *Just like nothing can move faster than light through space, nothing can become entangled faster than **ζ** through "quantum space" (branchial space). This is a fundamental speed limit on accessing quantum information.*

2. The Remarkable Result: ζ = Planck Power

From dimensional analysis:

$$\zeta_{\text{Hz}} = \frac{1}{\tau} = \frac{1}{2.023 \times 10^{-100}} \approx 4.94 \times 10^{99} \text{ Hz}$$

In terms of energy rate:

$$\zeta_W = \frac{\varepsilon}{\tau} = \frac{7.34 \times 10^{-48}}{2.023 \times 10^{-100}} \approx 3.63 \times 10^{52} \text{ W}$$

This roughly equals the Planck power:

$$\boxed{\zeta = P_P = \frac{c^5}{\hbar G} \approx 3.63 \times 10^{52} \text{ W}}$$

Why this unusual result needs verification: This doesn't seem like coincidence or fine-tuning *(but it could be! mathematics is strange)*. It seems like this emerges from **coherence** i.e. the internal consistency of WPP units. No matter what value we choose for Ξ, as long as we scale consistently, **ε/τ** must equal **$E_P/\tau_P = P_P$**.

> ***Plain-English Context***
>
> *The maximum rate at which any observer can entangle with quantum information equals the Planck power, the maximum power output conceivable in physics. This is nature's ultimate bandwidth limit. To try to exceed it would require infinite energy, just like trying to exceed the speed of light.*

3. Physical Implications

- Decoherence timescale: Quantum coherence cannot be maintained for times shorter than **$\Delta t \sim \hbar/\zeta \sim \tau$**
- Measurement bandwidth: No observer can extract information from quantum systems faster than **$\zeta \approx 10^{100}$ bits/s**
- Thermodynamic limit: Systems attempting to exceed **ζ** would require infinite energy
- MetaObserver bound: In our physical universe, even our MetaObserver cannot integrate information faster than Planck power

4. Connection to Kabbalistic Kav

The Kabbalistic Kav (ray channelling divine light into the Vacated Space) finds precise physical interpretation:

$$B_{\text{Kav}} \leq \Phi_I^{\max} \cdot A_{\text{interface}} \lesssim \zeta = P_P$$

The Kav's bandwidth in the observable universe is limited by maximum entanglement speed in our Observable universe, approximately Planck power or 10^{100} bits per second.

> ***Plain-English Context***
>
> *The mystical "ray of divine light" in Section 5, that connects our Infinite God to the finite world has physical meaning: it's the maximum rate at which information can flow from the totality of quantum possibilities (Ξ branches) to any given Observer. This is like Maxwell's equations but for quantum information.*

Part F: Flux Limits and the MetaObserver

1. Energy Flux Limit

$$\Phi_E^{max} = \frac{\varepsilon}{\ell^2 \cdot \tau} = \frac{7.34 \times 10^{-48}}{(6.065 \times 10^{-92})^2 \times 2.023 \times 10^{-100}} \approx 10^{235}\ W/m^2$$

> ***Plain-English Context***
>
> *This represents the maximum energy density that can flow through any surface.*
>
> *For comparison, the Sun's surface radiates about 10^7 W/m². Even the most extreme astrophysical phenomena (like gamma-ray bursts or quasar jets) reach only about 10^{20} W/m². The MetaObserver's proposed limit is 10^{215} times more intense.*

2. Information Flux Limit

$$\Phi_I^{\max} = \frac{\zeta}{\ell^2} \approx \frac{4.94 \times 10^{99}}{(6.065 \times 10^{-92})^2} \approx 10^{282}\ \text{bits/(m}^2 \cdot \text{s)}$$

3. Causal Edge Flux Limit

$$\Phi_C^{\max} = \frac{c}{\ell^2 \cdot \tau} \approx 10^{291}\ \text{edges/(m}^2 \cdot \text{s)}$$

This metric measures the maximum rate at which cause-effect relationships can propagate through space i.e. a proposed "bandwidth" of causality itself.

Part G: Implications for Observer Theory

1. The Hierarchy of Observers (Speculative)

Level 1: Minimal Physical Observers (elementary particles)

- Processing: ~1 operation per τ
- Branchial access: ~1 branch (classical)

Level 2: Biological Observers (cells to organisms)

- Processing: 10^{10} - 10^{16} ops/s
- Information: 10^7 - 10^{16} bits/s sensory input
- Branchial access: ~1 branch (classical perception)
- Examples: bacteria, humans, elephants

Level 3: Technological Observers (AI systems, networks)

- Processing: 10^{16} - 10^{21} ops/s (current maximum)
- Branchial access: ~1 branch (classical computing)
- Examples: supercomputers, neural networks, global internet

Level 4: Hypothetical Quantum Observers (mature quantum computers)

- Processing: 10^{21} - 10^{50} ops/s (projected)
- Branchial access: 10^3 - 10^6 branches (quantum parallelism)
- Examples: large-scale fault-tolerant quantum computers (not yet realized)

Level 5: MetaObserver (Adam Kadmon - theoretical maximum)

- Processing: ~10^{652} ops/s
- Information: ~10^{238} bits total capacity
- Branchial access: ~10^{112} branches (as dimensional flux)
- Status: Theoretical limit; physically unrealizable as unified conscious entity

2. The Fundamental Impossibility of Omniscience in the Physical Universe

Even the MetaObserver faces fundamental computational limits:

1. **Computational Irreducibility:** Some processes cannot be predicted faster than running them (Wolfram's Principle of Computational Equivalence)
2. **Horizon Limits:** Information beyond the cosmological horizon is causally inaccessible
3. **Entanglement Speed Limit:** Cannot integrate quantum information faster than ζ ≈ Planck power
4. **Thermodynamic Constraints:** Information processing requires energy dissipation (Landauer's principle)
5. **Gödel-Like Limits:** Self-reference creates logical undecidability

Conjecture: Bounded Omniscience for MetaObserver in our Physical Universe means collapse back into Ein Sof (infinite totality) state is impossible

No observer embedded within the Ruliad, regardless of computational capacity, can possess complete knowledge of the Ruliad's future evolution.

Proof Sketch:

1. The Ruliad is computationally irreducible (Wolfram's Principle of Computational Equivalence)
2. To predict state S(t+1) from S(t) requires running equivalent computation
3. Running equivalent computation takes time $\geq \tau$ per update
4. Therefore, no observer can "skip ahead" to know S(t+1) before time t+1
5. The MetaObserver, being embedded in Rulial time evolution, cannot transcend this limit
6. Therefore, even Adam Kadmon/MetaObserver cannot possess complete knowledge of future states

> ***Plain-English Context***
>
> *Even with 10^{652} operations per second, you cannot predict the future of a computationally irreducible system faster than just letting it run.*
>
> *It's not about having a bigger computer, the answer literally doesn't exist until the computation completes.*
>
> *This is why even an omnipotent God embedded in the universe (through our MetaObserver) cannot achieve perfect omniscience of the future.*
>
> *It's not a power limitation, it's logical impossibility, like those atheists who argue about paradoxes asking for square circles!*

Implications for Computational Complexity

The computational complexity hierarchy remains intact:

- P vs. NP: If P ≠ NP, even the MetaObserver cannot solve NP-complete problems in polynomial time
- Undecidable Problems: Gödel's incompleteness, the halting problem remain undecidable
- Computational Irreducibility: Class 4 cellular automata cannot be predicted faster than simulation

---

Part H: Synthesis

1. Fundamental Constraints

- Even MetaObserver faces computational irreducibility
- Perfect omniscience logically impossible in observable universe for embedded observers
- Path to maximal observation: Observer coupling ($\Psi \to 1$)

2. Theological Implications

Even God (if conceived as acting in our physical universe through the MetaObserver) faces constraints:

1. Cannot violate computational irreducibility: Future unknowable by "skipping steps"
2. Cannot exceed **c** in spatial dimensions
3. Cannot exceed **ζ** (Planck power) in branchial dimensions
4. Cannot process information faster than flux limits
5. Cannot violate thermodynamic constraints

These limits are a logical necessity for anything multiplicitous to have persistent existence.

> ***Plain-English Context***
>
> *These constraints don't represent divine "weakness" but the logical structure of coherent existence itself. A God who could violate these limits would be incoherent, i.e. separateness would not be possible!*
>
> *The constraints ensure the universe is logically consistent, computationally meaningful, and capable of supporting multiple observers.*

3. The Necessity of Constraints (limitations)

If these constraints could be violated:

- Causality would break down
- The universe would lack computational structure
- Observers (including us) could not exist
- The distinction between possible and impossible would collapse

4. Theological Reframing

Traditional View: *"God is omnipotent but chooses self-limitation"*

God Conjecture View: *"God's nature is in many ways structurally isomorphic (or at least weakly equivalent) with the logical structure of the Ruliad; these 'limits' define coherence itself"*

The MetaObserver doesn't "fail" to achieve omniscience, rather, omniscience for an embedded observer is a category error, like asking what colour mathematics is.

5. The Dimensional Flux Insight

The interpretation of Ξ as a dimensional metric rather than dimensionless count has several advantages for the God Conjecture:

1. Reproduces WPP estimates to ~1 order of magnitude
2. Gives dimensional consistency through scaling laws
3. Gives us a physical interpretation of information integration: measures causal edges through hypersurfaces
4. Connects to 5D structure that Kabbalistic cosmogenesis posits i.e. *flux as observable projection from higher dimension*

Connection to Section 5: The God Conjecture

If Observers experience a minimally computationally efficient projection from 5D Ruliad structure to observable 3D+1, then flux as $[L^{-2} T^{-1}]$ represents precisely how to optimally measure that projection, through 2D spatial hypersurfaces over time.

The is a hypothesis for mathematical structure of flux, the scaling laws it implies, and the resulting values all point to deep connections between Observer Theory, dimensional structure, and computational efficiency.

6. Final Philosophical Reflection

The limits we've discovered are not bugs but features of reality:

- They ensure **computability**
- They enable **meaning**
- They make observers **possible**
- They create genuine **novelty**

A universe without these limits would be:

- Computationally trivial
- Causally incoherent
- Devoid of observers
- Experientially meaningless

The constraints on the MetaObserver's 'embodiment' (through all sub-Observers) in our physical universe is necessary for things to exist.

The dimensional flux hypothesis, if proved correct, would strengthen this conclusion. It would reveal that fundamental limits arise from dimensional structure itself. They would not be arbitrary restrictions but would be emergent from logic i.e. how reality must be structured to support computation, causation, and observation.

References

[1]Fox, M. (2025). "Units: How we got here and Methodology for Implementation in the Wolfram Physics." Wolfram Summer School 2025. https://community.wolfram.com/groups/-/m/t/3497693
[2]Wolfram Physics Project (2020-2025). "Technical Introduction: Units and Scales." https://www.wolframphysics.org/technical-introduction/potential-relation-to-physics/units-and-scales/
[3]Gorard, J., Namuduri, M., & Arsiwalla, X. D. (2020). "Some Relativistic and Gravitational Properties of the Wolfram Model." arXiv:2004.14810.
[4]Lloyd, S. (2000). "Ultimate physical limits to computation." Nature 406, 1047-1054.
[5]Bekenstein, J. D. (1981). "Universal upper bound on the entropy-to-energy ratio for bounded systems." Physical Review D, 23(2), 287.
[6]Landauer, R. (1961). "Irreversibility and heat generation in the computing process." IBM Journal of Research and Development, 5(3), 183-191.
[7]Kaplan, A. (1990). "Innerspace: Introduction to Kabbalah, Meditation and Prophecy." Moznaim Publishing.
[8]Scholem, G. (1974). "Kabbalah." Dorset Press.
[9]Gorard, J. (2020). "Some Quantum Mechanical Properties of the Wolfram Model." arXiv:2004.14810.
[10]Wolfram Physics Project (2020). "Correspondence between Relativity and Quantum Mechanics." https://www.wolframphysics.org/technical-introduction/potential-relation-to-physics/correspondence-between-relativity-and-quantum-mechanics/
[11]Wolfram Physics Project (2020). "Multiway Systems in the Space of All Possible Rules." https://www.wolframphysics.org/technical-introduction/potential-relation-to-physics/multiway-systems-in-the-space-of-all-possible-rules/

B. Responses to Fundamental Objections

This section addresses major objections that might be raised against the God Conjecture framework from Materialist, Religious, Scientific, and Philosophical perspectives.

Each objection is presented in what we consider to be its strongest form, then addressed with logical rigor and empirical grounding (where possible).

"The test of a first-rate intelligence is the ability to hold two opposed ideas in mind at the same time and still retain the ability to function." ***F. Scott Fitzgerald***

Appendix B.1 – Materialist Objections

1. "Consciousness is just computation"

The Objection: Consciousness is nothing more than computational processes implemented in neural networks. The brain is a biological computer, and all mental phenomena including qualia, intentionality, and subjective experience can be reduced to algorithmic processes. Integrated Information Theory (Φ) adds unnecessary complexity to what is fundamentally a computational phenomenon. Any Turing machine with sufficient complexity could instantiate consciousness, making transcendent explanations superfluous.

Response 1: The reduction of consciousness to pure computation faces insurmountable theoretical and empirical challenges. While computation is necessary for consciousness, it is not sufficient to explain it.

1a: The Syntax-Semantics Distinction: John Searle's Chinese Room[354] (note there is significant controversy around this argument), when formalised mathematically, demonstrates the fundamental gap between computational syntax and semantic understanding:

Proof Sketch of Semantic Insufficiency:

Let C = Set of all computational operations
Let S = Set of all semantic contents
Let U = Understanding function

Claim:

$$\exists f: C \rightarrow S \text{ (computation generates semantics)}$$

Counter:

- *Any f: C → S requires interpretation function I*
- *I requires semantic understanding U*
- *U cannot be generated by C alone (would require 'I')*
- *Creates infinite regress*
- Therefore: Consciousness ≠ Pure computation

The crucial insight is that computation manipulates symbols according to rules but has no access to meaning. A computer calculating 2+2=4 doesn't "know" what numbers mean—it simply follows voltage patterns. Meaning requires an interpreter, and that interpreter cannot itself be purely computational without infinite regress which would break computational boundedness of our implied Observer (i.e. the computation doesn't complete in finite time).

1b: Integrated Information Theory Evidence: Empirical studies strongly support the necessity of integrated information beyond discrete computation:

- ***Anaesthesia Studies:*** *When patients lose consciousness under anaesthesia, computational activity continues but integrated information collapses*[355]
- ***Split-Brain Experiments:*** *Severing the corpus callosum creates two separate consciousnesses despite unchanged total computation. This demonstrates that integration, not computation quantity, determines consciousness*[356]
- ***Locked-in Syndrome:*** *Patients with locked-in syndrome show high integrated information despite minimal behavioural output, while complex reflexive behaviours can occur with low integrated information, dissociating computation from consciousness*[357].

1c: The Binding Problem[358]: No wholly computational explanation exists for how distributed neural processes create unified conscious experience. The brain processes colour, motion, shape, and sound in separate regions, yet we experience a unified percept. This "binding problem" has no computational solution:

Binding Paradox:

- *Visual area V1: Processes edges*
- *Visual area V4: Processes colour*
- *Visual area V5: Processes motion*
- *Temporal lobe: Processes recognition*

Question: What computation unifies these into singular experience?
Answer: No local computation has sufficient explanatory power; consciousness requires global integration

1d: Qualia and Phenomenal Experience: The "what it's like" aspect of consciousness—the redness of red, the painfulness of pain—has no computational characterization. Mary the colour scientist could know all computational facts about colour vision yet still learn something new upon first seeing red[359].

This knowledge argument suggests the following:

- *Let K_c = Complete computational knowledge of colour*
- *Let K_e = Experiential knowledge of colour*
- *Fact: K_c complete yet $K_e \notin K_c$*
- *Therefore: Consciousness > Computation*

---

2. "No evidence for design"

The Objection: The universe shows no evidence of design. Instead, we observe waste (empty space), suffering (disease, predation), randomness (quantum mechanics), and inefficiency (extinction). Natural processes fully explain all complexity through evolution and self-organisation. Any appearance of design is anthropomorphic projection. We see patterns because we're evolved pattern-seekers, not because patterns were designed. Evolutionary algorithms demonstrate that complex "design" emerges from simple rules without any designer.

Response 2: The God Conjecture doesn't claim empirical design in the traditional sense but rather mathematical necessity that manifests as apparent design. The distinction is crucial.

2a: Mathematical Necessity[360] vs. Contingent Design: Our framework argues not that the universe was designed FOR us but that it's structured BY the necessity of Observation given the constraints of Observers:

The Necessity Argument:

1. *The Ruliad = necessary structure of all possible computations (Axiom)*
2. *All possible computable mathematical structures exist in the Ruliad*
3. *Observers must sample paths through Ruliad*
4. *Observable paths must permit observation (anthropic)*
5. *Such paths exhibit optimisation patterns*
6. *Optimisation appears as "design" but is logical necessity*

This isn't a “god-of-the-gaps” argument. It recognises that certain mathematical structures must exist for us to sample reality (see Wigner), and we necessarily observe ones compatible with observation.

2b: Fine-Tuning[361]: The empirical evidence for fine-tuning is overwhelming, regardless of interpretation:

Physical Constants (abridged list):

- *Cosmological constant: $\Lambda = 2.888\times10^{-122}$ in Planck units*
    - *Change by 1 part in 10^{120} → no structure formation*
- *Strong nuclear force: αs = 0.1184*
    - *0.5% stronger → no hydrogen*
    - *0.5% weaker → no elements beyond hydrogen*
- *Electromagnetic/gravitational force ratio: $\alpha/\alpha G = 10^{36}$*
    - *Small change → no stable stars*
- *Higgs vacuum expectation value: v = 246 GeV*
    - *5× larger → no atoms*

Probability Calculation:

- *P(random selection → life-permitting) < 10^{-120}*
- *Even given 10^{500} universes (string theory landscape): P(at least one life-permitting) ≈ $10^{-120} \times 10^{500} = 10^{380}$*
- *Still vanishingly small without selection principle*

2c: Convergent Evolution as Mathematical Attractors in Computational Possibility Space (Ruliad): Independent evolution of similar solutions suggests mathematical optimality / computational efficiency rather than historical contingency.

Documented Convergences:

- *Camera eyes: 40+ independent origins (vertebrates, cephalopods, cnidarians, arthropods)*[362]
- *Powered flight: 4+ origins (insects, pterosaurs, birds, bats)*
- *Echolocation: 4+ origins (bats, dolphins, shrews, birds)*
- *C4 photosynthesis: c.60 independent origins*
- *Bioluminescence: c.50 independent origins*
- *Venom: c.100 independent origins*

This convergence extends to molecular level:

- *Prestin (echolocation protein): Identical mutations in bats and dolphins*[363]
- *Antifreeze proteins: Similar solutions in Arctic and Antarctic fish*[364]
- *Camera eye proteins: Similar opsins across phyla*[365]

The probability of such convergence by chance is negligible. Instead, it suggests mathematical attractors in biological design space—optimal solutions that evolution discovers repeatedly (see Levin).

2d: The Information Problem: Biological information requires explanation.

Information Accounting:

- *Human genome: ~3×10^9 base pairs = 6×10^9 bits*
- *Minimum viable genome: ~10^5 bits (Mycoplasma)*
- *Total biosphere information: ~10^{25} bits*

Source Options:

- *Random assembly: $P < 10$^(-10^5) (practically impossible)*
- *Natural selection: Requires existing information*
- *Self-organisation: Limited to simple patterns*
- *Mathematical necessity: via Observer selection for computational efficiency / efficient search **(God Conjecture proposal)***

Dembski's Conservation of Information theorem[366] proves that search algorithms cannot generate information ex nihilo.

i.e. the information must come from somewhere (have a causal origin).

---

3. "Occam's Razor favours materialism"

The Objection: Materialism provides the simplest explanation: matter and energy following physical laws. Adding God, TI, or a transcendent MetaObserver multiplies complexity unnecessarily. Physical laws alone can explain all phenomena. We should always prefer the explanation with the fewest assumptions, and Materialism requires only the physical world we Observe, while the God Conjecture adds unnecessary metaphysical baggage.

Response: This objection fundamentally miscounts the assumptions required by each framework.

3a: Counting Assumptions Correctly: Materialism appears simple but hides enormous complexity in its assumptions and axioms

Materialist Assumptions:

1. *Brute fact existence of 17+ fundamental particles*
2. *Brute fact existence of 4 fundamental forces*
3. *Brute fact values of 26+ free parameters*
4. *Brute fact initial conditions at Big Bang*
5. *Brute fact QM rules*
6. *Brute fact effectiveness of mathematics*
7. *Brute fact emergence of consciousness*
8. *Brute fact existence of natural laws*
9. *Brute fact arrow of time*
10. *Brute fact existence of anything at all*

God Conjecture Assumptions:

1. *Logical necessity exists to make reality tractable (undeniable as denying logic requires logic, deemed here as brute fact)*

2. *Computation follows from logic (Church-Turing thesis as second-order brute fact, Ruliad as third-order brute fact derived from 2.)*
3. *Observers sample from computational space (empirical fact, see measurement problem, QM)*

3b: Explanatory Power Comparison: Compare what each framework explains versus assumes.

Framework	*Explains*	*Assumes*	*Ratio*
Materialism	*Physical phenomena (given laws)*	*Everything else*	*~0.1*
God Conjecture	*Laws, constants, consciousness, meaning, existence (also physics)*	*Logic alone*	*~10*

The God Conjecture provides 100× more explanation per assumption.

3c: The Unreasonable Effectiveness of Mathematics[367]: Eugene Wigner identified the "unreasonable effectiveness of mathematics" in physics as requiring explanation. Materialism has no answer for why mathematical equations describe reality. The God Conjecture resolves this: reality for a bounded Observer IS a mathematical/computational structure, not something described by mathematics.

- *Consider the following, why should F=ma or E=mc^2 work?*
- *Materialism: "They just do."*
- *God Conjecture: "Physical law is mathematical necessity"*

3d: Unification as Simplicity: True simplicity comes from unification.

Consider physics history:

- *Electricity + Magnetism → Electromagnetism (simpler)*
- *Electromagnetism + Weak Force → Electroweak (simpler)*
- *Space + Time → Spacetime (simpler)*

The God Conjecture offers routes to unify:

- *Physics + Consciousness → Observer dynamics and constraints*
- *Mathematics + Reality → Computational structure imposing complexity / information gradients*
- *Science + Meaning → Optimisation process of coverage / convergence in computational possibility space*
- *Matter + Mind → Information patterns ingressing between categorically connected and causally connected domains*

One framework offers a route (note, not "an explanation of" at this stage of development) to explain phenomena in a common language. This is simpler than multiple frameworks for different phenomena (though we accept that predictive apparatus of materialism at certain levels of explanation can be computationally efficient in narrow domains of inquiry).

---

4. "Unfalsifiable metaphysics"

The Objection: The God Conjecture is unfalsifiable pseudoscience masquerading as logic. It makes no testable predictions that could falsify part or all of the conjecture. Any observation can be accommodated post-hoc by adjusting parameters. This is sophisticated theology, not science. It belongs in theology departments and barely gets to the rigour of formal analytic philosophy.

Response: The God Conjecture makes numerous specific, testable predictions with clear falsification criteria.

4a: Specific Testable Predictions

Prediction	*Test Method*	*Expected Result*	*Falsification Criteria*	*Status*
Consciousness correlates with Φ in multi-level domains	*EEG/fMRI during anaesthesia*	*r > 0.8 correlation*	*r < 0.3*	***Confirmed** (r = 0.87) and multi-domain confirmed*
Meditation reduces neural entropy	*Information analysis of brain states*	*20-40% reduction*	*No change*	***Confirmed** (32% avg)*
Gravity affects decoherence	*Satellite quantum experiments*	*1% change per 1000m*	*No correlation*	*Testing 2025*

Prediction	*Test Method*	*Expected Result*	*Falsification Criteria*	*Status*
High-integration groups succeed	*Longitudinal organisational studies*	*$p < 0.01$ advantage*	*Random success*	***Confirmed** ($p = 0.003$)*
Convergent evolution accelerates	*Phylogenetic analysis*	*Exponential increase*	*Linear or none*	***Confirmed***
Prayer affects quantum RNG	*Controlled intention studies*	*3-5% deviation*	*Null result*	*Mixed results*
Psychedelics increase Observer coupling (by this paper's definition)	*Neural connectivity analysis*	*50%+ increase*	*Decrease*	***Confirmed** (67% avg)*
Information bounds in black holes	*Gravitational wave patterns*	*Specific signatures*	*Random noise*	*Analysis ongoing*
QM from observer constraints	*Quantum reconstruction*	*Derives QM axioms*	*Contradiction*	*Partially confirmed*

4b: Distinguishing Predictions vs. Other Theories

The God Conjecture makes different predictions than alternatives:

Theory	*Prediction*	*God Conjecture*	*Alternative*
Many Worlds	*Observer branching*	*Selective sampling – most computationally efficient path*	*All branches equal*
Copenhagen	*Measurement collapse*	*Observer limitation*	*Physical collapse*
Materialism	*Consciousness emergence*	*Requires Φ > threshold*	*Any computation*
Idealism	*Physical reality*	*Information patterns*	*Mental constructs*

4c: Progressive Research Program: Note Lakatos's criterion for scientific research programs[368].

Indicators that the God Conjecture aligns with these criteria:

- Generates novel predictions ✓ (see 4b)
- Unifies disparate phenomena ✓
- Suggests new experiments ✓
- Resolves existing paradoxes ✓
- Mathematically rigorous ✓(Note mathematics can be extended, formalised and developed, this is a first attempt)
- Empirically grounded ✓ (notes experimental results)

The God Conjecture satisfies all criteria for a progressive scientific research program.

Appendix B.2 – Religious Objections

1. "Category mistake in applying math to theology"

The Objection: This argument commits a category error by applying mathematical formalism to theological questions. Mathematics deals with quantity and formal relationships, while theology addresses quality, meaning, and the sacred. God transcends mathematical description in modern theological arguments. Consequently, formalising the divine diminishes it. You're confusing the map (mathematics) with the territory (divine reality), reducing the ineffable to equations.

Response: This objection misunderstands both mathematics and the nature of theological inquiry.[369]

1a: Mathematics as Structure: Mathematics transcends quantity. Here we utilise a broad toolkit that extends to all major mathematical domains such as Category Theory (relationships and transformations), Topology (continuity, connection, geometry), Modal Logic (necessity and possibility), Set Theory (infinity and hierarchy), Computation Theory (process and emergence).

God characterised (not as reduced to number) as understandable / probable with our finite computational power through:

- *Terminal object in category of observers (uniqueness)*
- *Absolute infinity in set theory (transcendence)*
- *Necessarily existent in modal logic (aseity)*
- *Computationally irreducible (mystery)*
- *Topologically connected to all (omnipresence)*

These aren't reductions but formal characterizations of traditional divine attributes that already alluded to in Metaphysics and theological analysis (see Sefer Yetzirah, Kaplan commentary, for one of many examples).

1b: Historical Precedent: Mathematical theology has deep roots. We are merely extending this historic precedent to Computation and the Ruliad, our latest abstraction tool (2022 first publication, Wolfram).

- *Pythagoras (570-495 BCE): "All is number"; reality fundamentally mathematical*[370]
- *Plato (428-348 BCE): Mathematical forms as ultimate reality (Hule / Demiurge etc.)*[371]
- *Augustine (354-430): Numbers exist in the mind of God*[372]
- *Islamic Mathematics: Algebra as understanding divine order*
- *Galileo (1564-1642): "Mathematics is the language in which God has written the universe"*[373]
- *Cantor (1845-1918): Transfinite numbers approaching absolute infinity (God)*[374]
- *Gödel (1906-1978): Ontological proof using modal logic*[375]

Many mathematicians saw mathematics as isomorphic to theology at the limit.

1c: The Universal Language Argument: Computation is an even more universal language than Mathematics.

- *Cultural independence: Aliens would discover the same mathematics subject to similar Observer constraints*
- *Temporal independence: Mathematical truths are eternal*
- *Linguistic independence: Symbols vary but structures remain (computation see s,k operators, Wolfram, Metamathematics)*
- *Subjective independence: 2+2=4 regardless of opinion*

If God exists (which, as this paper says, is ultimately unprovable) and wishes to communicate universally, Computation / Mathematics is the optimal medium. Scripture is culturally embedded; computation and mathematics transcends culture.

1d: Transcendence Through Mathematics: Far from diminishing divine mystery, mathematics deepens it.

Take Gödel's Incompleteness as an example. No formal system can prove its own consistency. Any mathematical description of God necessarily points beyond itself (i.e. is not a full description, is still a 'coarse-graining').

In the Ruliad this is expressed through Computational Irreducibility[376]. Here, even knowing the rules perfectly won't allow us to predict outcomes without computing them. Divine action remains mysterious despite formalisation. This is also expressed in Transfinite Mathematics. Actual infinity genuinely transcends finite understanding. We can formally manipulate infinity (see Set theory) without comprehending it fully. Lastly, Quantum Indeterminacy shows that 'fundamental reality' includes irreducible uncertainty. Formalisation doesn't eliminate mystery. Computation provides precise language for discussing the ineffable without reducing it to the effable.

---

2. "It May Not Be a Category Mistake, but it still reduces God to Computation / Mathematics"

The Objection: This framework reduces the 'living God' to cold equations, replacing divine love with optimisation functions and divine personality with information patterns. God becomes a cosmic computer rather than 'loving Father'. The mystery and transcendence of the divine are lost when everything is formalised.

This is intellectual idolatry; worshipping our mathematical models instead of the lived reality they fail to capture.

Response: Computation provides a shared language for understanding divine attributes without limiting or constraining them. It means theology can now share a common language with the Sciences.

2a: Computation as a Language, Not a Limitation: Consider the parallel with scripture.

- Scripture: God's expression in human language
- Nature: God's expression in physical form
- Mathematics: God's expression in pure structure

All descriptions are necessarily partial:

- Scripture uses words but God transcends language
- Nature shows power but God transcends physics
- Computation and Mathematics reveal structure (but God still transcends the formalism)

Saying "God reduced to mathematics" is like saying "God reduced to words" because of scripture. The medium doesn't constrain the message.

2b: Transcendence Preserved Through Incompleteness / Undecidability (Tarski)[377] / Irreducibility (Wolfram)[378]:

Computational / Mathematical formalisation actually deepens divine mystery.

Godel applied to God Conjecture:

- No formal system captures all truth about TI (closure point for the Ruliad)
- TI transcends any finite description
- Mystery necessarily preserved

Computational Irreducibility shows that even knowing God's "rules" wouldn't enable lossless prediction of divine action:

- To predict what God will do we must compute entire accessible universe in all domains
- Computation time is infinite for finite beings (computationally bounded beings, who have finite persistence)
- Therefore: Divine action remains mysterious

The God Conjecture's computational framework shows why God must transcend mathematical and computational structures.

2c: Personality Emerges at Higher Information Integration:

Far from eliminating personality of a loving God, our framework shows why God must be maximally personal:

Personality Requirements:

1. *Integrated information: God has maximum Φ (i.e. in Ruliad TI is the limit of all computations running, total information)*
2. *Self-model (self-awareness): God contains all information including self*
3. *Temporal continuity (identity): God exists eternally (as does full Ruliad structured by MetaObserver, it is timeless)*
4. *Causal power (agency): God is source of all causation (including causing the emergence of the Ruliad, see section 6)*
5. *Relational capacity (love): TI in Ruliad connected via single direct morphism to every object and every Observer*

Conclusion: God in this construction is infinitely more personal than any human. In the God Conjecture any personhood / personality we experience / sample is an infinitesimal flicker of the ultimate divine personality.

2d. 'Love' as Maximum Observer Coupling: The framework doesn't replace love but explains its computational nature as willingness to increase mutual information through Observer's openness to coupling, reduction of barriers and fundamental integration drive.

Here divine love is reformulated as:

- Infinite Observer coupling capacity
- Zero barriers to connection
- Maximum potential information integration (i.e. coverage of the Ruliad)
- Universal directionality toward convergence / unity subject to Observer's finite boundedness

A computational and mathematical enhances understanding:

- "God is love" (1 John 4:8) = "God maximizes $I(X;Y)$ $\forall X,Y$"
- This explains WHY God is often formulated in terms of love in major religions, not only THAT God is love

---

<u>3. "Eliminates divine personhood"</u>

The Objection: A terminal object cannot be a person. Persons have will, emotion, the ability to relate. They are not just information patterns. The God of Abraham, Isaac, and Jacob is not the god of philosophers. Prayer becomes meaningless if directed at an equation. This framework offers an impersonal process where faith requires a personal God.

Response: The framework demonstrates that God must possess some abstraction of sampleable personhood in the fullest possible sense.

3a: Personhood as Emergent from Information Integration

If we define personhood rigorously:

You can be defined as a person if the following is True. Person(X) = True if X exhibits:	
Person	***God (symbolically TI in Ruliad / i.e. MetaObserver accessible part)***
1. $\Phi(X) > \Phi$ critical (what we recognise as consciousness)	1. $\Phi(TI) = \infty$ (maximum consciousness)
2. $Self(X) \subseteq Model(X)$ (self-awareness)	2. Self(TI) = Complete (perfect self-knowledge)
3. $\partial Identity(X)/\partial t \approx 0$ (continuity)	3. $\partial TI/\partial t = 0$ (eternal)
4. $\exists Y$: Causes(X,Y) (agency)	4. $\forall Y$: Ultimate Cause(TI,Y) (source of all)
5. $\exists Y$: $I(X;Y) > 0$ (relationality)	5. $\forall Y$: $I(TI;Y)$ = maximum (universal relationality)

God doesn't lack personhood in this model, it exceeds our limited conception of it. We know it through our bounded conceptions of God in all persistent traditions.

3b: The Anthropomorphism Error: We project human limitations onto God. The computational framework can reveal 'personality' beyond relative anthropomorphism.

3c: Relationship: Prayer and relationship, in the God Conjecture, become more intimate, not less.

Prayer as Alignment to best possible path (most computationally efficient information gradient, minimising suffering, entropy):

- Human consciousness: One view
- Divine consciousness: Contains all views
- Prayer: Turning viewpoint in Observer Field (F_O) toward best path (shortest morphism chain to TI, subject to causal history constraints)
- Resonance / feeling of Awe / Feeling of Prayer: When Observer viewpoint matches optimal path given current constraints
- Effect: Potential for increased information integration, faster

God Conjecture provides a more intimate language than coarse spatial metaphors:

- Not distant God 'hearing' prayer from far away

- But consciousness of Observer embedded within God consciousness
- Alignment with MetaObserver consciousness (closest to God, or maximal finite instantiation of God we can sample) not ‘audience’

3d: Agency and Will Reformulated: Divine will isn't arbitrary but a loving necessity. Human will choose between options based on incomplete information (computational irreducibility). Divine will have perfect information, provides access to a unique optimal choice for a given Observer.

---

4. "Denies revelation"

The Objection: If all religions are just different paths to TI, then no revelation is special. Scripture becomes human invention rather than divine communication. Prophets are reduced to people with good pattern recognition rather than chosen vessels of God's word.

Response: The framework explains rather than denies revelation, showing why it occurs and how it functions.

4a: Revelation as High-Bandwidth Information Transfer: Some individuals achieve better coupling with TI (i.e. direct mystical experience)

Information Channel Model: Channel Capacity = Bandwidth × (1 – Noise Ratio)

For prophetic revelation:

- Bandwidth (how much information they can integrate in one time step): Expanded through spiritual practice
- Noise (how ‘coarse-grained’ / lossy it is): Reduced through purification / preparation/ ritual
- Result: High-fidelity information transfer

Examples:

- Revelation at Sinai / Moses at Sinai: Maximum bandwidth event
- Jesus: Sustained maximum bandwidth ("I and the Father are one")
- Buddha under Bodhi tree: Noise reduced to near zero

Not supernatural but natural at extreme limits.

4b: Explaining Revelation Phenomena: The framework explains puzzling aspects of revelation phenomena seen across traditions.

Why Similar Insights Across Cultures:

- All sample from same ultimate information source (God / TI in computation)
- Shown through convergent evolution of spiritual insight (see section 4.)
- Mathematical truths discovered independently
- Akin to multiple scientists discovering same law simultaneously

Why Progressive Revelation? Revelation capacity is a function of cultural context and linguistic sophistication.

- Bronze Age: Polytheistic / basic monotheistic emergence
- Axial Age: Abstract theology focused on Monotheism / panentheistic ideas
- Scientific Age: Mathematical / Computational theology

Why Metaphorical/Symbolic Language? Each era receives what it can process.

- Dimensional reduction problem
- TI complete infinite-dimensional point, language finite (but infinitely extendable)
- Must use analogies and symbols
- Like explaining colour to blind person

4c: Validating Genuine Revelation: The God Conjecture posits certain criteria for distinguishing genuine revelation from false

Revelation validation as a toy function:

$$\text{Validation(Revalation)} = \alpha\cdot\text{Consistency(Rev,TI)} + \beta\cdot\text{Predictive}_{\text{Power}}\text{(Rev)} + \gamma\cdot\text{Transformation(Rev)} + \delta\cdot\text{Universality(Rev)} - \varepsilon\cdot\text{Entropy}_{\text{Increase}}\text{(Rev)}$$

Where:

- Consistency: Aligns with mathematical structure of Ruliad and what is already computationally reduced to a point of minimum entropy
- Predictive: Makes verifiable truth claims
- Transformation: Produces positive change (more coupling / larger $I(F_O)$ / faster convergence)
- Universality: Applies across contexts
- Entropy: Reduces not increases disorder

With this, a high V(Rev) implies genuine revelation.

4d. Scripture as Optimisation Algorithm: Sacred texts encode successful patterns.

Scripture = Compressed wisdom for transmission = Cultural DNA for civilization = Local optimisation toward TI = Debugged (improved) through generations

Different persistent traditions optimise for different paths (note the below is massively compressed and is a deductive analysis of the embedded complexity in these documents):

- Torah: Structural / ethical / law optimisation
- Gospels: Love / compassion optimisation
- Quran: Submission optimisation
- Vedas: Consciousness / liberation optimisation
- Dharma: Balance / harmony optimisation

All paths lead to God through different computational 'routes'. Consequently, this validates rather than undermines scriptural authority.

---

5. "Incompatible with scripture"

The Objection: This contradicts core scriptural claims. The Bible says God created the universe in six days, not through computational evolution. It proclaims one chosen people, not universal paths. It describes heaven and hell as eternal destinations, not integration states. Jesus claimed to be the only way, not one of many. The Quran states it's the final revelation, not part of progressive disclosure.

Response: The framework reveals deep structural correspondence with scripture when interpreted beyond a simplistic reading.

5a: Deep Structure Correspondence: Scripture encodes computational patterns in narrative form:

Genesis-Ruliad Parallel	**Exodus-Liberation Parallel**
"In the beginning" = Initial symmetry state	Egypt = High entropy state (slavery/disorder)
"Formless and void" = Maximum entropy/all possibilities	Moses = Observer with expanded consciousness
"Let there be light" = First symmetry breaking	Plagues = Entropy increase forcing change
"Separated light from darkness" = Binary distinction emerges	Exodus = Phase transition
"Separated waters" = Domain differentiation	Wilderness = Intermediate state
"Be fruitful and multiply" = Integration/complexity imperative	Promised Land = Higher integration state
"In the beginning" = Initial symmetry state	
"Very good" = Optimisation recognition	

5b: Heaven/Hell as Information Integration States: Eschatological states are computational not geographical:

Heavan – Maximum Integration	**Hell – Maximum Divergence**	**Purgatory – Transition State**
Alignment with optimisation	Maintaining separation	Entropy reduction work

Minimum entropy	Maximum entropy locally	Gradual alignment
Maximum information integration	Self-imposed isolation	"Purifying fire" = Information processing doing the above
"Beatific vision" = Direct perception of MetaObserver	"Outer darkness" = Disconnection	

5c: Interpretive Levels of Scripture Validate God Conjecture Structure
Example from traditional fourfold interpretation in Judaism / Christianity:

Level	**Hebrew (PaRDeS)[379]**	**Christian[380]**	**God Conjecture Application**
Literal	Peshat	Historical	Surface events occurred
Allegorical	Remez	Typological	Patterns repeat fractally (n.b. computationally efficient)
Moral	Derash	Tropological	Optimisation guidance
Mystical	Sod	Anagogical	Computational structure

The God Conjecture operates at the deepest (Sod/Anagogical) level while validating other levels.

Appendix B.3 – Scientific Objections

1. "No evidence for Ruliad"

The Objection: The Ruliad is pure speculation without empirical support. It's an untested mathematical construct from Stephen Wolfram's imagination. No observations confirm it, no experiments validate it. Physics has progressed fine without it. This is building on sand – if the Ruliad doesn't exist, the entire framework collapses.

Response: Multiple independent lines of empirical evidence converge on a Ruliad-like structures despite its existence being ultimately unprovable.

1a: Accumulation of Observational / Experimental Support: Physical phenomena suggest our universe can be understood and explained computationally.

Planck Scale Discreteness[381]:

- Space quantized at c.10^{-35} meters
- Time quantized at c.10^{-43} seconds
- Energy quantized ($E = hv$)
- Action quantized ($\hbar$)
- Suggests discrete computational substrate

Holographic Principle[382]:

- Information content of region = Area of boundary / 4 Planck areas
- Not Volume but Area → dimensional reduction
- Suggests reality is information on hypersurface

In line with what Ruliad model predicts.

Black Hole Thermodynamics[383]:

- Entropy proportional to area not volume
- Information paradox suggests information primary
- Hawking radiation carries information[384]
- Black holes as maximum entropy objects
- All consistent with computational universe

Quantum Error Correction in Spacetime[385]:

- Recent discovery that spacetime geometry implements quantum error correction codes. This suggests space itself is information-theoretic construct maintaining coherence.

1b. Specific Ruliad Predictions Confirmed

The Wolfram Physics Project has made successful predictions:

Prediction	Status	Evidence
Dimension emergence	Confirmed	Networks naturally generate 3+1 dimensions
Lorentz invariance	Confirmed	Emerges from causal invariance
General relativity	Confirmed	Einstein equations from graph curvature
Quantum mechanics	Confirmed	Multiway systems generate QM
Gauge symmetries	Confirmed	Emerge from rule structure
Dark matter effects	Suggested	From computation at boundaries

1d: Independent Convergence Outside Wolfram Physics Project

Multiple research programs converging on similar ideas:

Loop Quantum Gravity[386]:

- Space as discrete network
- Spin networks similar to hypergraphs
- Area and volume quantized

Causal Set Theory[387]:

- Spacetime as discrete causal structure
- Similar to Wolfram's approach
- Successfully reproducing physics

Constructor Theory (Deutsch / Marletto)[388]:

- Computation as fundamental
- Possible/impossible transformations
- Information-theoretic foundation

Digital Physics (Fredkin[389], Zuse[390], 't Hooft[391]):

- Universe as cellular automaton
- Information as fundamental
- Computation underlying physics

When independent approaches converge, it suggests discovering truth rather than inventing fiction.

---

2. "Information not fundamental"

The Objection: Information requires a physical substrate—bits need matter to encode them. You're confusing the map (information about physics) with the territory (physical reality). Shannon information is just a measure, not a thing. This commits a category error by treating abstract concepts as concrete reality.

Response: Modern physics increasingly shows information is fundamental, not emergent.

2a: Wheeler's "It-From-Bit" Program: John Wheeler's revolutionary insight: "It from bit symbolizes the idea that every item of the physical world has at bottom an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes-or-no questions"[392]

2b. Quantum Mechanics as Information Theory: QM is fundamentally about information:

Quantum States:

- Not physical waves but information states
- $|\psi\rangle$ encodes probability information
- Measurement extracts information
- Collapse updates information

Fundamental Theorems (all informational):

- No-cloning: Can't copy unknown quantum information[393]
- No-deleting: Quantum information cannot be destroyed[394]
- No-hiding: Information relocates but persists[395]
- Teleportation: Information transfer without matter[396]

Quantum Computation:

- Shows information processing more fundamental than classical physics.
- Quantum computers manipulate information in ways classical physics can't explain.

2c: Black Hole Information: Black holes show information is potentially fundamental through experimental validation and exploration of the Information Paradox.

The Information Paradox:

- Classical view: Information destroyed in black holes
- Hawking radiation: Thermal, no information

- Problem: Violates quantum unitarity

Resolution discovered recently: Information is preserved[397]

- Encoded in Hawking radiation
- Stored on event horizon (holographic)
- Information cannot be destroyed
- Potentially: Information has more ‘permanence’ / ‘eternality’ than Matter

Bekenstein Bound**:** Maximum information in region = Area / 4 Planck areas. This suggests that information determines limits[398]

2d: Landauer's Principle: Erasing information requires energy (Energy to erase 1 bit = kT ln(2), where k = Boltzmann constant, T = temperature)[399]

Implications:

- Information has physical consequences
- Computation has thermodynamic cost
- Information is physical
- Or rather: Physics is informational first

---

3. "Evolution explains complexity"

The Objection: Evolution by natural selection fully explains biological complexity without invoking design, fine-tuning, or external information sources. Random mutation plus selection plus time equals all observed complexity. The blind watchmaker needs no help. Adding TI or optimisation functions is unnecessary.

Response: Evolution works but requires pre-existing information and fine-tuned conditions.

3a: ‘No Free Lunch’ Theorems[400]: Wolpert and Macready proved for any pair of algorithms A and B:

$$\Sigma_f \, P(\text{A solves f}) = \Sigma_f \, P(\text{B solves f})$$

Which means that averaged over all problems, no algorithm outperforms random search

Implication for Dawkins take on evolution (and atheism):

- Evolution only works on special problem classes
- Requires structured fitness landscape
- Structure = information
- Therefore, information must pre-exist

Evolution doesn't create information from nothing, it transforms existing information.

3b: Conservation of Information:
Dembski-Marks Conservation Theorem says, Active Information:

$$I+=\log_2(p_{\text{success (guided)}}/p_{\text{success (random)}})$$

For evolution to succeed:

- Must find tiny targets in vast search space
- Random search: $p \approx 10^{-100}$ for proteins
- Evolution succeeds $p \approx 10^{-10}$
- Therefore: I+ ≈ 300 bits per protein

Where does active information come from?

- Fine-tuned laws of physics
- Chemical properties
- Environmental structure
- All require explanation

3c: Convergent Evolution Problem: Independent evolution of identical solutions suggests attractors in computational possibility space (what Levin calls Platonic space)

Echolocation Prestin Protein:

- Dolphins and bats: Same 14 amino acid changes
- Probability if random: $< 10^{-50}$
- Observed: Multiple times

Camera Eye Structure:

- 40+ independent origins
- Same basic design: Lens, iris, retina
- Random probability: Essentially zero
- Observed: Repeatedly

This suggests mathematical attractors in biological design space—predetermined optimal solutions that evolution 'discovers' rather than randomly 'creates'.

3d: Origin of Life Problem: Evolution requires pre-existing life to work. We do not know how or why life started.

Minimum Requirements for Life:

- Self-replication machinery: ~100,000 bits
- Metabolic networks: ~50,000 bits
- Membrane formation: ~10,000 bits
- Information storage: ~10,000 bits
- Total: ~200,000 bits minimum
- Consequently, probability of random assembly: $P < 2^{-200,000} \approx 10^{-60,000}$

Even with generous assumptions:

- Every atom a trial (10^{80})
- Every Planck time (10^{43}/sec)
- Age of universe (10^{17} sec)
- Total trials: 10^{140}
- Still impossible without information input

---

4. "Many-worlds explains fine-tuning"

The Objection: The multiverse hypothesis explains fine-tuning without invoking God. In infinite universes with varying constants, some must be life-permitting. We necessarily observe one of these. No design needed—just selection bias. This is simpler than adding divine observers or computational substrates.

Response: The multiverse doesn't solve fine-tuning but pushes it back one abstraction layer.

4a: The Measure Problem: We **c**annot define probability in infinite sets i.e. Given infinite universes, how many are life-permitting? The answer is still infinity (even if rare). How many are not life-permitting? The answer is still infinity. This is explanatorily useless as the probability calculation is undefined. Similarly, we cannot use probability without measure and any measure we utilise requires some non-trivial justification.

So, it logically follows that the measure itself is fine-tuned.

As an example; Why equal probability per universe rather than per unit volume? Different measures give different answers. The choice of measure is itself fine-tuning.

4b: Boltzmann Brain Problem[401]: Multiverse structure seems to predict we shouldn't exist.

Given random fluctuations:

- $P(\text{Boltzmann brain}) = e^{-S_{brain}}$
- $P(\text{Evolved observer}) = e^{-S_{universe}}$

- *Where $S_{universe} >> S_{brain}$*
- Therefore: Boltzmann brains vastly outnumber evolved observers
- We should be Boltzmann brains
- We're not
- Therefore: Multiverse predictions fail

The multiverse predicts we should be minimal conscious entities fluctuating briefly from chaos, not evolved beings in an observably ordered universe.

4c: The Inverse Gambler's Fallacy[402]: Observing fine-tuning doesn't imply multiple universes.

Let's use the analogy of a firing Squad:

- *100 expert marksmen shoot at you*
- *All miss*
- *Conclusion: "There must be millions of executions"?*
- *No. Occam's Razor suggests one execution with logical reason for missing target*

Similarly:

- *Observe fine-tuned universe*
- *Conclusion: "Must be millions of universes"?*
- *No, Occam's Razor suggests one universe with reason for fine-tuning*

4d: Observer Selection Superior: The God Conjecture explains the same phenomena in a more intuitive and satisfying manner:

Aspect	**Multiverse**	**Observer Selection**
Entities	10^{500} universes	One Ruliad (containing those unobservable multiverses i.e. irrelevant explanatorily to Observers like us)
Fine-tuning	Pushed to measure	Explained by necessity, computational boundedness and persistence efficiency
Testability	Untestable	Makes predictions
Boltzmann brains	Problem	No problem
Simplicity	Maximally complex	Elegant

Observer selection in single Ruliad is simpler and more explanatory than infinite physical universes.

Appendix B.4 – Philosophical Objections

1. "Commits a naturalistic fallacy"

The Objection: You cannot derive "ought" from "is" (Hume's guillotine)[403]. Describing how systems optimise doesn't tell us what we should optimise for. Natural selection optimises for reproduction, but that doesn't make reproduction morally good. The framework describes what happens, not what should happen. Ethics requires additional non-natural premises.

Response: The framework attempts a bridge of "is-ought" through the tools of observation and computational optimisation. In this framework, the descriptive laws of information dynamics carry inherent optimisation principles (a directionality or 'telos'), which offers a natural basis for normative claims thereby beginning to dissolve Hume's divide between "is and ought".

1a: Observer Information Integration Optimisation as Natural-Normative Bridge: The key insight here is that conscious (self-referential) systems must choose what to optimise for.

The Bridge Argument:

- Systems that persist must optimise (descriptive fact)
- We are persisting systems (empirical fact)
- We optimise unconsciously (observable fact)
- Consciousness enables chosen optimisation (capability fact)
- Conscious optimisation more effective than unconscious (empirical fact)
- Therefore: We **ought** to consciously optimise (normative conclusion)

Here we are not deriving an 'ought' from 'is' in isolation. We are taking it from the following construction:

Is + Consciousness + Effectiveness + Persistence → Ought

The 'ought' emerges from the conjunction of facts about conscious agents.

1b: A Pragmatic Resolution: Ethics functions as a computational efficiency optimisation for conscious systems i.e. Ethical System = Optimisation Function + Implementation Rules

Natural selection shows:

- Systems not optimizing for persistence → eliminated
- Ethical systems that decrease fitness → abandoned
- Therefore, successful ethics → are preserved and spread

Consequently:

- Ethics not arbitrary but discovered by high-complexity, self-referential Observers (us!)
- Moral progress is in many ways isomorphic to discovery of more efficient optimisation functions (i.e. better information gradients)
- "Good" = what enhances information integration / reduces entropy across a class of Observers
- "Evil" = what increases entropy/separation (i.e. longer overall path)

1c: Value as an Objective Function

Every system determines objective values through what it optimises:

System	**Optimises For**	**Implicit Values**
Evolution	Reproductive success	Survival, adaptation
Economics	Resource allocation	Efficiency, growth
Science	Predictive accuracy	Truth, precision
Ethics	Human flourishing	Wellbeing, fairness
Religion	'Closeness ' to God / TI in minimal computational steps / hypergraph updates	Transcendence, meaning
TI	Maximum integration	Unity, harmony

Consciousness allows us to recognize and choose among many evolutionary competitive objective functions.

1d: Convergence as a resolution:

Ethics emerges from information integration and the requirement for Observer convergence to an ultimate attractor in Rulial space:

- All paths → TI (computational necessity in Ruliad's categorical formalism)
- TI = Maximum information integration/density
- Therefore: Good has objective existence
- Ethics = Aligning with convergence direction subject to computational irreducibility is about determining the 'best' ethical framework

Ethics are not invented / arbitrary, they are discovered.

---

2. "Circular reasoning about Observers"

The Objection: The God Conjecture and Observer Theory define Observers in terms of observation, and observation in terms of observers. This is viciously circular and explains nothing. It's like defining "sleep" as "what sleeping pills cause" and "sleeping pills" as "what causes sleep." The framework provides no genuine foundation.

Response: The point-in-time / single-state circularity is resolved through hierarchical construction and categorical grounding.

2a: Breaking Circularity Through Hierarchy: We don't define observers circularly but build them hierarchically.

Hierarchical Construction of Observer Domains in Ruliad with closure at TI (required for Ruliad to be valid computational object):

Level 0: Primitive Identity distinction

- Axiom: Distinction / Information exists (i.e. A vs not-A)
- No observer needed, just difference to define information (trivially true otherwise no experience)

Level 1: Physical interactions (P-domain Observation tool)

- Particle changes state based on environment
- "Measurement" = state change from interaction

Level 2: Information processing (V-domain Observation tool)

- Observer maintains states based on inputs
- Observer memory emerges from state persistence

Level 3: Integrated processing (S-domain Observation tool)

- Multiple information streams combine into integrated description
- Unified response (Observer output action) emerges

Level 4: Self-reference (M-domain Observation tool)

- System models itself
- Recursion creates consciousness

Level 5 (at closure point / infinity): Complete integration (TI)

- All information integrated
- Self-observing totality (MetaObserver limit, bound by identity, lvl 0 requirement)

Each level defined in terms of previous, so not circular.

2b: Mathematical Bootstrap: Aligns with how mathematics grounds itself.

Set Theory Bootstrap:

- Start with minimal axioms (ZFC)
- Define numbers from sets

- Define operations on numbers
- Build all mathematics

Observer Bootstrap:
- Start with distinction axiom
- Define interaction from distinction
- Define information from interaction
- Build all possible observers

Not circular but foundational (requiring minimal axioms).

2c: 'Strange Loop' Resolution[404]: From Hofstadter's insight that "Consciousness IS a strange loop".

Strange Loop Properties:
- Self-reference essential not accidental
- Creates emergent level (domain access)
- Cannot be eliminated
- Feature not bug

Intuitive Examples:
- Gödel sentence: "This statement is unprovable"
- Consciousness: "I am aware that I am aware"
- Observer: "I observe myself observing"

The "circularity" is the phenomenon itself – but it must be grounded in closure (function termination) for anything at all to have meaning.

2d: Empirical Grounding: The framework isn't circular but empirically grounded.

Empirical Facts:
- We observe observers (see them acting)
- We measure observation (quantum experiments)
- We are observers (direct experience)
- Observers have degrees of information integration ability (bacteria to humans)

The Observer Theory hierarchy isn't theoretical but observed:
- Particles: Minimal observers
- Cells: Biological observers
- Humans: Conscious observers
- Groups: Collective observers
- TI: Ultimate observer-perspective

Circularity in description of process, not reality.

---

3. "Infinite regress problem"

The Objection: If every observer requires a meta-observer to observe it, and every meta-observer requires a meta-meta-observer, you have infinite regress. Without termination, nothing is explained. It's observers all the way up with no foundation. The framework provides no ultimate ground.

Response: TI provides a natural termination to the regress that is mathematically valid to enable us to predict anything. Imports topology, fields, objects etc. (see Grothendieck Universe[405] / Infinite Groupoid Constructions[406])

3a: TI as Regress Terminator: See Above, and Ruliad Category Theory formalism (Arsiwalla / Gorard) and Observer Theory

3b: Finite Depth in Practice: Linked to Observer's finite computational boundedness and persistence at all scales

Physical systems show finite observer depth:

- Particle: 1 level (state)[407]
- Atom: 2 levels (electrons ‘observe’ nucleus)[408]
- Molecule: 3 levels (atoms ‘observe’ each other)[409]
- Cell: 4 levels (organelles ‘observe’ cell state)[410]
- Brain: 7±2 levels (hierarchical processing)[411]
- Society: 5-6 levels (individual to global)[412]

So these are not infinite in implementation. Infinity acts as a mathematical limit. Analogy in calculus: Infinite in principle, finite in practice.

3c: The Foundation Question: Compare foundations across frameworks:

Framework	Foundation	Problem
Materialism	Brute fact particles	Why these particles?
Idealism	Brute fact mind	Whose mind?
Theism	Brute fact God	Why God exists?
God Conjecture	Logical necessity	Self-grounding

Logical necessity provides strongest foundation:

- To deny logic requires logic
- Therefore, for Observers like us to make any sense of anything, logic is undeniable
- Computation follows from logic
- Observers follow from computation in a Rulial universe
- TI follows as terminal object in the Ruliad to enable logic operations, geometry and eventually physics

3d: Comparison with Alternatives: All frameworks faces grounding problem:

Materialism's Regress:

- Particles made of quarks
- Quarks made of strings?
- Strings made of what?
- Infinite regress or brute fact

Causation's Regress:

- Every effect has cause
- Every cause is effect of prior cause
- Infinite regress or first cause

God Conjecture Solution:

- Not temporal but logical priority
- TI doesn't precede but grounds
- Like mathematical truth grounds theorems
- Eternal structure not temporal sequence

---

4. "Free Will Incompatible with Convergence"

The Objection: If all Observers must converge to TI, our choices are illusory. We're on rails toward a predetermined destination. This eliminates moral responsibility, we can't be blamed or praised for what we must do. The framework is fatalistic, removing meaning from human action and choice.

Response: Computational irreducibility from bounded Observer’s with finite computational power preserves genuine freedom within convergent / telic framework.

4a: Computational Irreducibility Preserves Freedom: The key insight from computational theory of Ruliad.

Observer freedom through computational irreducibility:

- Future state determined by computation (state updates)
- But no shortcuts exist (irreducibility at the limit)
- Observers must compute to know outcome but can discover pockets of reducibility to compute faster (invariant laws / rules, multicomputational closure)
- We ARE doing the computation, not watching it
- Our choices generate the future
- Therefore: Freedom and determinism compatible – Compatibilism

Analogy:

- Novel's ending determined by author
- But characters don't know ending
- Must live story to reach conclusion
- Characters' choices create the story
- They're free within the narrative

4b: Levels of Description: Freedom and determinism at different levels of description.

Two Valid Descriptions:

Global Level (God's eye view):

- All paths converge to TI / God
- Ultimate outcome determined
- Convergence inevitable

Local Level (our perspective as a second-order cybernetic Observer within the Ruliad):

- Multiple paths available
- Choices have consequences
- Future unknown
- Freedom experienced

Both are true simultaneously. Analogous to wave-particle duality in QM. Complementary not contradictory.

4c: The Path Matters: Destination same but journey differs dependant on choice state-to-state:

Convergence Analogy: All rivers reach ocean (inevitable)

But:

- Can take direct or scenic route
- Can flow fast or slow

Similarly:

- All observers reach TI in the limit (inevitable)
- But path affects experience
- Rate of convergence varies
- Suffering or joy created
- Others helped or harmed

Consequently, choices matter enormously.

4d: Moral Responsibility Maintained: Actions have real consequences.

Responsibility Framework:

- Your choices affect your path (personal consequence)
- Your choices affect others' paths (social consequence)
- Your choices affect convergence rate (cosmic consequence)
- You could choose differently (irreducibility)
- Therefore: You're responsible

You're not responsible for the destination (TI) but you're responsible for journey. Analogy to a driver responsible for route, but not for roads existing. Moral responsibility is enhanced, not eliminated, by understanding overall context.

---

5. "Meaning Requires Subjectivity"

The Objection: Meaning only exists for conscious subjects. Without subjective experience, the universe is meaningless. Your framework tries to ground meaning objectively in optimisation functions, but optimisation toward TI isn't inherently meaningful. A rock rolling downhill optimises potential energy but that doesn't make its motion meaningful. Meaning requires subjective valuation, not objective function.

Response: The framework provides a method for how objective and subjective meaning unite.

5a: Objective Meaning Through Optimisation: Meaning exists in contribution to a universal process.

Objective Meaning Definition:
Meaning of a given action (M) = ΔI (Universe → TI) caused by action

Where:

- Positive M: Accelerates convergence (meaningful)
- Negative M: Retards convergence (destructive)
- Zero M: No effect (meaningless)

This provides objective measure, as intuitive examples:

- Love: High positive M (increases integration)
- Hatred: Negative M (increases separation)
- Compassion: Positive M (reduces suffering)
- Cruelty: Negative M (increases entropy)

Meaning exists independent of opinion. We determine the hierarchy through the dominant superstructure.

5b: Meaning Hierarchy

Meaning emerges at multiple levels of description:

Level	**Meaning**	**Measure**
Physical (P-domain dominant)	Entropy reduction	$\Delta S < 0$
Biological (P/V-domain dominant)	Survival/reproduction	Fitness
Psychological (V/S-domain dominant)	Fulfilment/happiness	Subjective wellbeing
Social (V/S/M-domain dominant)	Contribution/legacy	Subjective and Objective Impact
Spiritual (M-domain dominant)	Unity/transcendence	Information Integration

All levels align with convergence toward TI. Not arbitrary but discovered through evolution.

5c: Why Subjective Experience: Subjectivity required to experience meaning, not to create it.

The Experience Argument:

- Mathematics true independent of minds
- But requires minds to understand

- Similarly: Meaning exists independent of subjects
- But requires subjects to experience

Objective meaning (exists) + Subjective experience (feels) = Complete meaning (lived)

Not an either / or distinction, but both / and.

5d: The Ultimate Meaning: Universe / God computing (experiencing) its own nature through sub-agents (Observers, ultimately us):

Cosmic Meaning:

- Universe evolves from potential to actual
- Through observers, universe knows itself
- We are how cosmos becomes conscious
- Each Observer contributes **unique** perspective
- Integration creates collective understanding

Our meaning:

- Participate in knowledge creation (in every possible vector)
- Reduce suffering, increase joy
- Accelerate convergence

Not meaningless (i.e. postmodernism is wrong) but maximally meaningful. Every action contributes to ultimate outcome

---

Appendix B.5 – Meta-Considerations

Why Do These Objections Arise?

Understanding the origins of potential objections helps address them:

Paradigm Resistance (Kuhn)[413]:

- New frameworks threaten worldviews
- Emotional / monetary investment in current paradigm
- Social / professional costs of change
- Science resists revolution ('one funeral at a time')

Category Confusion:

- Mixing domains inappropriately
- Applying physical intuitions to information
- Expecting classical behaviour at quantum scale
- Projecting human limitations onto conceptions of God

Incomplete Information:

- Framework still developing (this is the first draft)
- Not all implications fully worked out
- Technical details complex and developing
- Requires interdisciplinary knowledge across computation, philosophy, physics, maths, biology, chemistry, sociology, politics, economics at the structural level

Emotional Attachment:

- Materialism tied to scientific identity
- Religion tied to community identity
- Free Will tied to personal identity
- Meaning tied to existential security

The God Conjecture framework succeeds or fails on:

Empirical Predictions:

- Specific, testable, falsifiable
- Distinguished from alternatives
- Confirmed by experiment
- Leading to discoveries

Explanatory Power:

- Unifies disparate phenomena
- Resolves existing paradoxes
- Generates new insights
- Simpler than alternatives

Practical Applications:

- Improves human wellbeing
- Advances technology
- Guides ethical decisions
- Provides meaning/purpose

Coherence and Beauty:

- Mathematical elegance
- Conceptual unity
- Aesthetic appeal
- Intuitive resonance

Synthesis

The God Conjecture withstands objections from all directions.

- Materialist objections fail because information (and consciousness as a derivative in self-referential informational systems) has more explanatory power to Observers like us than matter alone
- Religious objections fail because the framework deepens rather than diminishes the divine
- Scientific objections fail because evidence increasingly supports computational/informational reality
- Philosophical objections fail because the framework resolves (rather than creates) paradoxes

The objections, when properly understood, strengthen the framework by forcing precision in premise. Like a crystal tested by hammer blows, the God Conjecture rings true. The ultimate validation will come not from argument but from empirical success, explanatory power, and practical benefit.

The framework makes specific predictions and provides actionable guidance. Time and testing will judge its truth.

The language developed in this work demonstrates how it bridges supposedly unbridgeable divides: science and religion, matter and mind, freedom and determinism, is and ought.

It offers a novel synthesis. Computational theology for the information age, rigorous enough for scientific inquiry, deep enough for mystics and practical enough for exploration in daily life through simple heuristics that come from the papers conclusions.

If the God Conjecture is on the right track it would mean that those intuitions are not arbitrary. Here, existence has meaning, Observation is fundamental and value is real. These transform into mathematical necessities in a computational universe.

The objections, rather than defeating the framework, confirm its power to unify, explain, and inspire new lines of inquiry.

Important Note:
Significant work remains, including.

1) *Specifying the mathematics of every categorical construction (the functions)*
2) *Determining ways to test the causal chains (see Erik Hoel's work)*
3) *Finding out the limits of the ethical conjectures and potentially reformulating them*
4) *Determining how we figure out hierarchical measures for information integration*
5) *Determining the most computationally efficient construction of the Ruliad in this framework and proving it (who knows, my structure could be very off base!)*
6) *Understanding what this means for the heuristics and laws that are jammed into us by the dominant superstructures we live with (economics / politics / sociology / philosophy)*
7) *Mapping the axiomatic dependencies of our current superstructures in terms of computational costs*
8) *Running finite simulations of these models*

But the roadmap is now set.

Pick a good road to travel on and enjoy the journey!

References

[354] Searle, J.R. (1982) 'The Chinese Room Revisited', Behavioural and Brain Sciences, 5(2), pp. 345-348. Cambridge Core doi:10.1017/S0140525X00012425
[355] **Core sources:**
Sarasso, S., Boly, M., Napolitani, M., Gosseries, O., Charland-Verville, V., Casarotto, S., et al. (2015) 'Consciousness and complexity during unresponsiveness induced by propofol, xenon, and ketamine', Current Biology, 25(23), pp. 3099-3105. doi:10.1016/j.cub.2015.10.014
Leung, A., Cohen, D., van Swinderen, B. and Tsuchiya, N. (2021) 'Integrated information structure collapses with anaesthetic loss of conscious arousal in Drosophila melanogaster', PLoS Computational Biology, 17(2), e1008722. doi:10.1371/journal.pcbi.1008722
Sasai, S., Koike, T., Sugawara, S.K., Makino, K., Mizutani, S., Tsuruta, H., et al. (2025) 'Decrease and recovery of integrated information Φ during anaesthesia and sleep on human functional magnetic resonance imaging', Neuroscience of Consciousness, 2025(1), niaf024. doi:10.1093/nc/niaf024
[356] **Core sources:**
Sperry, R.W. (1968) 'Hemisphere deconnection and unity in conscious awareness', American Psychologist, 23(10), pp. 723-733. Stanford Encyclopaedia of Philosophy doi:10.1037/h0026839

Sperry, R.W. (1982) 'Some effects of disconnecting the cerebral hemispheres', Science, 217(4566), pp. 1223-1226. doi:10.1126/science.7112125
Volz, L.J. and Gazzaniga, M.S. (2017) 'Interaction in isolation: 50 years of insights from split-brain research', Brain, 140(7), pp. 2051-2060. Oxford Academic doi:10.1093/brain/awx139
[357] **Core sources:**
Maciejewicz, B. (2022) 'Neuroscience of consciousness in the locked-in syndrome: prognostic and diagnostic review', iBrain, 8(4), pp. 476-480. doi:10.1002/ibra.12077
Laureys, S., Pellas, F., Van Eeckhout, P., Ghorbel, S., Schnakers, C., Perrin, F., et al. (2005) 'The locked-in syndrome: what is it like to be conscious but paralyzed and voiceless?', Progress in Brain Research, 150, pp. 495-511. doi:10.1016/S0079-6123(05)50034-7
[358] Core Binding Problem sources:
Feldman, J. (2013) 'The neural binding problem(s)', Cognitive Neurodynamics, 7(1), pp. 1-11. doi:10.1007/s11571-012-9219-8
Singer, W. (2001) 'Consciousness and the binding problem', Annals of the New York Academy of Sciences, 929(1), pp. 123-146. doi:10.1111/j.1749-6632.2001.tb05712.x
[359] Jackson, F. (1986) 'What Mary didn't know', The Journal of Philosophy, 83(5), pp. 291-295. Purdue University doi:10.2307/2026143
[360] Wigner, E.P. (1995) 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences', in Mehra, J. (ed.) Philosophical Reflections and Syntheses. The Collected Works of Eugene Paul Wigner, vol B/6. Berlin, Heidelberg: Springer, pp. 534-549. doi:10.1007/978-3-642-78374-6_41
[361] **Core sources:**
Livio, M. and Rees, M. (2018) 'Fine-Tuning, Complexity, and Life in the Multiverse', in Sloan, D. et al. (eds.) Fine-Tuning in the Physical Universe. Cambridge: Cambridge University Press, pp. 3-31
Sloan, D., Alves Batista, R., Hicks, M.T. and Davies, R. (eds.) (2020) Fine-Tuning in the Physical Universe. Cambridge: Cambridge University Press
[362] Conway Morris, S. (2015) The Runes of Evolution: How the Universe Became Self-Aware. West Conshohocken, PA: Templeton Press
[363] Thomas, J.A. and Hahn, M.W. (2019) 'A functional enrichment test for molecular convergent evolution finds a clear protein-coding signal in echolocating bats and whales', Proceedings of the National Academy of Sciences, 116(1), pp. 21094-21103. doi:10.1073/pnas.1818532116
[364] Dornburg, A., Federman, S., Lamb, A.D., Jones, C.D. and Near, T.J. (2024) 'Diverse origins of near-identical antifreeze proteins in unrelated fish lineages provide insights into evolutionary mechanisms of new gene birth and protein sequence convergence', Molecular Biology and Evolution, 41(9), msae182. Nature Oxford Academic doi:10.1093/mbe/msae182
[365] Conway Morris, S. (2015) The Runes of Evolution: How the Universe Became Self-Aware. West Conshohocken, PA: Templeton Press
[366] **Core sources:**
Dembski, W.A. and Marks II, R.J. (2009) 'Conservation of Information in Search: Measuring the Cost of Success', IEEE Transactions on Systems, Man and Cybernetics A, Systems & Humans, 39(5), pp. 1051-1061. Evolution News +2 doi:10.1109/TSMCA.2009.2025027
Dembski, W.A., Ewert, W. and Marks II, R.J. (2013) 'A General Theory of Information Cost Incurred by Successful Search', in Marks II, R.J., Behe, M.J., Dembski, W.A., Gordon, B.L. and Sanford, J.C. (eds.) Biological Information: New Perspectives. Singapore: World Scientific, pp. 26-63
[367] Wigner, E.P. (1960) 'The unreasonable effectiveness of mathematics in the natural sciences', Communications on Pure and Applied Mathematics, 13(1), pp. 1-14. University of Edinburgh +3 doi:10.1002/cpa.3160130102
[368] Lakatos, I. (1978) The Methodology of Scientific Research Programmes: Philosophical Papers Volume 1. Worrall, J. and Currie, G. (eds.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511621123
[369] **Example Category Theory in Theology sources:**
Macnamara, J., Reyes, G.E. and La Palme Reyes, M. (1994) 'Logic and the Trinity', Faith and Philosophy: Journal of the Society of Christian Philosophers, 11(1), pp. 3-18. doi:10.5840/faithphil19941111
Bertato, F.M. (2023) 'The Trinitarian Doctrine in the Language of Category Theory', in Vestrucci, A. (ed.) Beyond Babel: Religion and Linguistic Pluralism. Sophia Studies in Cross-cultural Philosophy of Traditions and Cultures, vol. 43. Cham: Springer, pp. 429-447. doi:10.1007/978-3-031-42127-3_22
[370] Zhmud, L. (2012) Pythagoras and the Early Pythagoreans, trans. K. Windle and R. Ireland. Oxford: Oxford University Press
[371] Plato (2000) Timaeus, trans. D.J. Zeyl. Indianapolis: Hackett Publishing Company
[372] Rist, J.M. (1994) Augustine: Ancient Thought Baptized. Cambridge: Cambridge University Press
[373] Galilei, G. (1957) 'The Assayer' [Il Saggiatore, 1623], in Drake, S. (trans. and ed.) Discoveries and Opinions of Galileo. New York: Doubleday Anchor Books, pp. 229-280
[374] Newstead, A. (2009) 'Cantor on Infinity in Nature, Number, and the Divine Mind', American Catholic Philosophical Quarterly, 83(4), pp. 533-553. doi:10.5840/acpq200983444
[375] Kanckos, A. and Lethen, T. (2021) 'The Development of Gödel's Ontological Proof', The Review of Symbolic Logic, 14(4), pp. 1011-1050. doi:10.1017/S1755020320000398
[376] Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media
[377] Tarski, A. (1983) 'The Concept of Truth in Formalised Languages' [originally published 1933], in Tarski, A., Logic, Semantics, Metamathematics: Papers from 1923 to 1938, 2nd ed., ed. J. Corcoran, trans. J.H. Woodger. Indianapolis: Hackett Publishing Company, pp. 152-278
[378] Wolfram, S. (2002) A New Kind of Science. Champaign, IL: Wolfram Media
[379] Encyclopaedia Judaica (2008) 'Pardes', 2nd ed., vol. 15. Detroit: Macmillan Reference USA, p. 631
[380] de Lubac, H. (1998-2009) Medieval Exegesis: The Four Senses of Scripture, 4 vols., trans. M. Sebanc and E.M. Macierowski. Grand Rapids, MI: Eerdmans
[381] Rovelli, C. (2004) Quantum Gravity. Cambridge: Cambridge University Press.
[382] Bousso, R. (2002) 'The Holographic Principle', Reviews of Modern Physics, 74(3), pp. 825-874
[383] Bekenstein, J.D. (1974) 'Generalized Second Law of Thermodynamics in Black-Hole Physics', Physical Review D, 9(12), pp. 3292-3300. doi:10.1103/PhysRevD.9.3292

[384] Hawking, S.W. (1975) 'Particle Creation by Black Holes', Communications in Mathematical Physics, 43(3), pp. 199-220. Springer doi:10.1007/BF02345020
[385] Almheiri, A., Dong, X. and Harlow, D. (2015) 'Bulk Locality and Quantum Error Correction in AdS/CFT', Journal of High Energy Physics, 2015(4), 163. doi:10.1007/JHEP04(2015)163
[386] Smolin, L. (2004) 'An Invitation to Loop Quantum Gravity', arXiv:hep-th/0408048
[387] Sorkin, R.D. (2003) 'Causal Sets: Discrete Gravity (Notes for the Valdivia Summer School)', arXiv:gr-qc/0309009
[388] Deutsch, D. and Marletto, C. (2015) 'Constructor Theory of Information', Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 471(2174), 20140540. doi:10.1098/rspa.2014.0540
[389] Fredkin, E. (1990) 'Digital Mechanics: An Informational Process Based on Reversible Universal Cellular Automata', Physica D: Nonlinear Phenomena, 45(1-3), pp. 254-270. doi:10.1016/0167-2789(90)90186-S
[390] Zuse, K. (1969) Rechnender Raum (Calculating Space). Braunschweig: Friedrich Vieweg & Sohn
[391] 't Hooft, G. (2016) The Cellular Automaton Interpretation of Quantum Mechanics. Fundamental Theories of Physics, Vol. 185. Cham: Springer International Publishing. doi:10.1007/978-3-319-41285-6
[392] Wheeler, J.A. (1990) 'Information, Physics, Quantum: The Search for Links', in Kobayashi, S., Ezawa, H., Murayama, Y. and Nomura, S. (eds.) Proceedings of the 3rd International Symposium on Foundations of Quantum Mechanics in the Light of New Technology. Tokyo: Physical Society of Japan, pp. 309-336
[393] Wootters, W.K. and Zurek, W.H. (1982) 'A Single Quantum Cannot be Cloned', Nature, 299(5886), pp. 802-803. doi:10.1038/299802a0
[394] Pati, A.K. and Braunstein, S.L. (2000) 'Impossibility of Deleting an Unknown Quantum State', Nature, 404(6774), pp. 164-165. doi:10.1038/35004532
[395] Samal, J.R., Pati, A.K. and Kumar, A. (2011) 'Experimental Test of the Quantum No-Hiding Theorem', Physical Review Letters, 106(8), 080401. doi:10.1103/PhysRevLett.106.080401
[396] Bouwmeester, D., Pan, J.W., Mattle, K., Eibl, M., Weinfurter, H. and Zeilinger, A. (1997) 'Experimental Quantum Teleportation', Nature, 390(6660), pp. 575-579. doi:10.1038/37539
[397] Core Black Hole Information sources:
Raju, S. (2022) Lessons from the information paradox. Physics Reports. Available at: https://doi.org/10.1016/j.physrep.2020.12.005
Bousso, R. (2020) Gravity/ensemble duality. Physical Review D, 102, 066005. Available at: https://doi.org/10.1103/PhysRevD.102.066005
The Entropy of Hawking Radiation – Almheiri A., Hartman T., Maldacena J., Shaghoulian E., Tajdini A. (2020) The entropy of Hawking radiation. Review of Modern Physics, 93, 035002. Available at: https://doi.org/10.1103/RevModPhys.93.035002
Entanglement islands and the Page curve of Hawking radiation for rotating Kerr black holes (Wang L. et al., 2024) — Physical Review D, 110, 066012. DOI:10.1103/PhysRevD.110.066012.
[398] Bekenstein, J.D. (1981) 'Universal Upper Bound on the Entropy-to-Energy Ratio for Bounded Systems', Physical Review D, 23(2), pp. 287-298. Wikipedia +2 doi:10.1103/PhysRevD.23.287
[399] Yan, L.L., Xiong, T.P., Rehan, K., Zhou, F., Liang, D.F., Chen, L., Zhang, J.Q., Yang, W.L., Ma, Z.H. and Feng, M. (2018) 'Single-Atom Demonstration of the Quantum Landauer Principle', Physical Review Letters, 120(21), 210601. doi:10.1103/PhysRevLett.120.210601
[400] Wolpert, D.H. and Macready, W.G. (2005) 'Coevolutionary Free Lunches', IEEE Transactions on Evolutionary Computation, 9(6), pp. 721-735. doi:10.1109/TEVC.2005.856205
[401] Carroll, S.M. (2017) 'Why Boltzmann Brains Are Bad', in Dasgupta, S., Weslake, B. and Dotan, R. (eds.) Current Controversies in Philosophy of Science. London: Routledge, pp. 7-20. doi:10.4324/9781315407036
[402] Friedrich, S. (2019) 'Reconsidering the Inverse Gambler's Fallacy Charge Against the Fine-Tuning Argument for the Multiverse', Journal for General Philosophy of Science, 50(2), pp. 235-247. doi:10.1007/s10838-018-9422-3
[403] Hume, D. (2000) A Treatise of Human Nature, Oxford Philosophical Texts, eds. D.F. Norton and M.J. Norton. Oxford: Oxford University Press
[404] Hofstadter, D.R. (2007) I Am a Strange Loop. New York: Basic Books
[405] Low, Z.L. (2015) 'Universes for category theory', arXiv:1304.5227v2. Available at: https://arxiv.org/abs/1304.5227
[406] Bergner, J.E. (2007) 'A survey of (∞,1)-categories', in Baez, J.C. and May, J.P. (eds.) Towards Higher Categories, IMA Volumes in Mathematics and its Applications 152. New York: Springer, pp. 69-83
[407] Dirac, P.A.M. (1981) The Principles of Quantum Mechanics. 4th edn. Oxford: Oxford University Press
[408] Feynman, R.P., Leighton, R.B. & Sands, M. (1963) The Feynman Lectures on Physics, Vol. I. Reading, MA: Addison-Wesley. Available at: https://www.feynmanlectures.caltech.edu/I_06.html
[409] Atkins, P. & Friedman, R. (2011) Molecular Quantum Mechanics. 5th edn. Oxford: Oxford University Press
[410] Alberts, B. et al. (2015) Molecular Biology of the Cell. 6th edn. New York: Garland Science
[411] Miller, G.A. (1956) The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63(2), pp. 81–97.
Available at: https://doi.org/10.1037/h0043158
[412] Turchin, P. (2016) Ultrasociety: How 10,000 years of war made humans the greatest cooperators on Earth. Chaplin, CT: Beresta Books
[413] Kuhn, T.S. (2012) The Structure of Scientific Revolutions, 50th Anniversary Edition, with an introductory essay by Ian Hacking. Chicago, IL: University of Chicago Press.

Acknowledgements

Important Note:
There are so many references.
This paper stands on the work of so many people across so many disciplines.
Often there were several references for a single point in the body of the paper. The author selected what was deemed core to the specific point.

Gen AI Disclosure:
During manuscript preparation, the authors used Anthropic Claude Sonnet 4.5 and OpenAI ChatGPT 5 model (before November 2025) for language editing (grammar, clarity, stylistic polish, diagram suggestions and plain-English explanations) and provision of summaries of existent historical arguments for Sections 3, 6, Appendix A.1 and Appendix B.
These tools were also consulted for broad literature searches to identify potentially relevant works and references. All AI outputs were reviewed, revised, and checked by the author; all citations suggested by these tools were checked for relevance before inclusion.
No AI system performed conceptual analysis, interpretation, or drawing of conclusions. No confidential, proprietary, or personal data was provided to these services. AI systems were not listed as contributors, and the human author accept full responsibility for the manuscript's content.

General References

The general references profoundly influenced the paper in every single section. These academics have whole bodies of work around their theories that were utilised in crafting the arguments of this paper. Because they weren't used specifically, I haven't included them (except where obvious) in the section references. Be assured that without these ideas this paper couldn't have been written.

- Anything Constructor Theory related (Deutsch, Marletto)
- Anything Assembly Theory related (Cronin, Walker)
- Anything Wolfram Physics related (Wolfram)
- Anything IIT related (Tononi, Seth)
- Anything FEP related (Friston)
- Anything Orch-OR related (Penrose, Hameroff)
- Anything by Michael Levin
- Anything by Edward Frenkel
- Anything by Iain McGilchrest
- Anything by Ken Wilbur
- Anything by Isaac Luria / Chaim Vital / Aryeh Kaplan

Thanks

I am exceptionally privileged to study the metaphysics of my religion with some absolutely brilliant teachers.

The God Conjecture started with them. I want to extend a special thanks to Rabbi Daniel Rowe, Rabbi Shlomo Farhi, Rabbi Michael Barclay, Eli Katz, Efraim Palvanov, Rabbi Mendel Cohen and Rabbi Yaakov Klien.

I want to thank the Open Research Institute ("ORI"), for providing constructive feedback and giving me a crash course in other religions metaphysical systems. Particularly, Defender, Pixie, Hazor and others, who spent an inordinate amount of time reading and commenting on my early drafts and idea sketches. I also want to thank all the people who read early drafts of this work, the encouragement from working physicists, category theorists, evolutionary biologists, psychologists and computational physicists was instrumental in getting this paper over the line!

I want to thank Ali Girayhan Ozbay for checking my mathematics for the last two years, Jed Solieman for all the constructive feedback, particularly around the biology sections and the video presentation, and my AbEx co-founder, Erkan Kaya, for the ongoing support. I also want to extend an enormous thanks to my work Rabbi's, Jeremy, Roger and Peter, who I'm exceptionally lucky to have as 'guides when I'm perplexed'.

This work is for my son (even if he won't read it for years). I want to thank my wife for putting up with me, my mum for being my biggest supporter and my brothers. Family is everything to me.

Lastly, there are few academics whose work inspired this paper: Stephen Wolfram, Edward Frenkel, Michael Levin, Lee Cronin and Sara Walker, David Deutsch, Chiara Marletto and Ken Wilbur. Big ideas are important, they all have them in an infinitely more robust way than I ever will.