# Chapter 1: Overview of Cycle Clock Theory and its Axioms

July 2024
Klee Irwin

Cycle Clock Theory (CCT) is a synthesis of paradigms, including:

**Simple programs:** A branch of computer theory we can call "simple program theory". Simple programs, such as functions like that of the Mandelbrot set and various other algorithms, such as cellular automata, produce surprising emergent complexity upon sufficiently large quantities of iterations. Some simple programs create 3+1D systems of evolving and complexifying quasiparticles that are unrealistic worlds with their own systems of emergent constants and equations. A more rare class of simple programs can also generate probability distributions over time for how two or more quasiparticles can self-organize. Considering the fact that there are an infinite quantity of this rare class of simple program within the larger infinity of all simple programs (the *Ruliad*), some are more realistic than others, where "realism" refers to the probability distributions given by the quantum formalism. Finally, there is some quantity of realistic simple programs that live beneath the observational limit of today's experimental physics technology. For these equally realistic probability distributions, it is a philosophical choice as to which one a theorist speculates is the ideal simple program nature actually uses. For our research program, certain axioms, including the *principle of efficient language*, restrict us to deduce that the program with the lowest Kolmogorov complexity relative to a given simulation output would be the simple program nature uses. It is noteworthy to point out why the vast majority of physicists reject the simple program paradigm. Modern fundamental physics is the practice of observing fundamental constants and relating them into networks of equations that allow one form of energy, e.g., a fermion to transform into another, such as a boson. Accordingly, fundamental physics, as practiced today, is not based on first principles, in the same way that computer theory, logic and mathematics is. Our program is based on ontological and mathematical first principles. Accordingly, the constants of our program runs are emergent, as are the relational equations and the probability distributions themselves. This is a high stakes approach that can lead to dead ends vs the lower stakes work of modern fundamental physics programs, wherein often dozens of free parameters are allowed to be plugged, such as the electron rest mass, G, h, C and the fine structure constant, *a*.

**Language (code) theory:** The core principle of all languages is emergence, where the meaning of a code's proverbial letters can be organized into the meaning of "words" and then into the meaning of "sentences" and so on – always without any additional letter-level cost over and above the quantity of letter elements in a disorderly noisy relational network over time and space that have no emergent information. Other than order in space and time, order can exist in other forms, such as topological. Nature is language theoretic in the sense that pixels of spacetime can emerge into fundamental particles as proverbial words. And those can be arranged into hadrons. Hadrons can be arranged into atoms. Atoms can self-organize into molecules and upwards in an emergent hierarchy with no limit, where the structure derived from order costs no additional elemental units of letter-level information. We can consider the letter level information a primordial form of energy in models such as this. All languages, from C++ to English to particle physics and all higher order aspects of nature exist in hierarchical stacks of emergent complexity and meaning. Interestingly, when emergent complexity is great enough, it loops back to direct, as an energy-less causal force, the probabilities of microscopic particle interactions. Due to computational limitations and the extreme complexity of emergent structure over time acting in a force-like or causal manner, this is a little-studied area of physics without meaningful consensus on the work that has been done by complex systems theorists.

**Fundamental physics:** We focus on pure mathematics at the nexus of general relativity (GR) and quantum mechanics (QM) as well as the group theoretic math of the standard model of particle physics. One can think of these mathematical objects as algebraic "gameboards" and the simple programs as "games" that play out upon the mathematical substrate.

It's been over 100 years that mankind has been searching for a predictive theory of everything. CCT is an atypical cross-disciplinary paradigm that we believe holds up to scrutiny as a viable approach.

## AXIOMS

### All is Thought

*This axiom posits that reality is fundamentally composed of information, not matter. Information cannot be disassociated from the enigmatic notion of meaning, and entities capable of actualizing meaning are mind-like in the most general sense. It aligns with the interpretation of quantum mechanics that describes reality as a probabilistic information space, where observation reduces the probabilities but does not eliminate them, suggesting an informational rather than physical ontology. Given that self-referential symbols play a crucial role in encoding fundamental properties of the universe, this axiom implicitly assumes that these symbols represent both the object and the underlying structure of reality.*

Obviously, this is the first of the hermetic principles. But that is not why we've adopted it. Let's critically deduce. Quantum field theorists often agree that QM is unapologetic in stating that reality is made of information not matter. The notion of materialism or physicalism is a very old mystical-based idea from ancient Greece. It is no longer in vogue, at least among many fundamental physicists who deeply understand QM. The Copenhagen interpretation of QM divides reality into (1) information in the form of the probability distribution pre-observation and (2), a physicalist or materialist (not information) state momentarily upon observation. However, this is a naïve view because it is not possible to observe at the Planck volume or time. For example, we can fire an electron gun at a detector screen that registers when and where the particle interacted with the screen. However, the best resolution we can achieve with an electron microscope or a nanoengineered detector in the screen is at the angstrom scale. Accordingly, we can infer from our observation that the electron did not hit the screen at any locations outside of a square angstrom. But we cannot know where inside the square angstrom it did hit. There are $(10^{23})^2$ Planck areas that it could have hit within this highly dense matrix of coordinates in the square angstrom.

Upon observation at the angstrom scale, we can set all other locations outside the angstrom area to 0 probability and the $(10^{23})^2$ locations in the angstrom$^2$ to about $1/[(10^{23})^2]$ probability. In other words, it is trivially true that we do not reduce the probabilities from an informational space prior to observation to a classic case of one single X, Y coordinate upon observation. It remains a vast spread of information theoretic probabilities. We have merely "lensed" the probabilities into a smaller area. Lensing here is a metaphor. For example, we can have N photons per unit of time radiating from a flashlight to an area X of a screen. If we lens the light, we may have the same N photons per unit of time shining upon an area X' where X' < X.

Similarly, we can observe the time the particle hit the detector screen to a resolution of $10^{18}$ events per second. We cannot observe at the pixilated limit of time, called the Planck time, which is $10^{44}$ events per second. Accordingly, we probability-lens to an array of $10^{23}$ possible locations in time that the particle may have hit the screen such that there is a $1/(10^{23})$ probability for each of those time locations after the probability lensing via observation. The observed system remains purely information theoretic with no opportunity in the quantum formalism for a naïve physicalist or non-information-based ontology that supposes sometimes it is ontologically information pre-measurement and then material or non-information post-measurement. It always remains information, due to the low resolution of our ability to observe in space and time. This is a hard blow to those with a subconscious preference for the ancient Greek conceptualization of materialism, which contrasts sharply with modern quantum interpretations.

The question arises, "What *is* information?" A standard and acceptable answer could be, "Information is *meaning conveyed by a symbolic system – a language*". From bird-languages to computer codes to spoken languages, information is always meaning conveyed by symbolism. We can have the meaning of a bit, with the meaning of on/off, yes/no, 1/0, or true/false. We are aware of no counter example where information is anything other than meaning conveyed by symbolism.

What, then, is a "symbol"? A symbol is "*an object that can represent itself or another object*". Typically, it is an object that represents another object. The special case is the self-referential symbol, which is explained in *Toward the Unification of Physics and Number Theory* and *The Code-Theoretic Axiom*. An example of a non-self-referential symbol would be to use an equilateral triangle to represent "change", as in how we use the delta symbol for that meaning in physics. An example of a self-referential symbol is to use the equilateral triangle to represent itself; an equilateral triangle. Examples of self-referential symbols in fundamental physics include things like vectors and Lie algebraic root systems. They can also include process objects such as a Clifford rotor acting on a root system.

Then, what is an "object"? Let's use set theory, where we define an object as: "Anything that can be mathematically defined". If we move up to the mathematics of category theory, an object does not have to be mathematical and can be "anything that can be thought of". Taking inventory, so far, we have defined information as "meaning conveyed by symbolism". We have defined symbols but we have not defined "meaning". Meaning cannot be defined. But hold the meaning of that thought in your mind until we defend it later. For now, let us state: If there is no meaning, there is no information. Meaning is baked into the definition of the term information. In order to be information, there must be a system, entity or anything else capable of actualizing meaning. Because CCT is a nascent first principles TOE, vs a typical TOE like string theory that has dozens of plugged free parameters and aggressive ontological assumptions, we have little choice but to go down the rabbit hole of reductionism, where philosophy makes contact with pure mathematics. We will defend the idea that meaning cannot be rigorously defined when we discuss the *Axiom of Unknowability* below. In concluding this section on the axiom *All Is Thought*, we can summarize thusly. The quantum formalism implies that reality is made of information that gets lensed to smaller quantities of non-zero values for position and momentum upon observation and remains informational in nature before, during and after an observation. Information is meaning conveyed by symbolism. And "meaning" is synonymous with the term "thought". Both words are verb forms of the noun "consciousness", a term defined by what it does; actualizing meaning as thought, whether that be the meaning of an observation or anything else.

**Compactified Expression of the Axiom All Is Thought:**

$R$ = Thought ($i$, $EP_n$, $EC_n$), where $i$ = ⟨Self-referential symbols⟩, $EP_n$ = ⟨Emergent Physical information⟩, $EC_n$ = ⟨Emergent Consciousness information⟩ and where n denotes the stratum on an emergent hierarchy.

**Explanation:**

- $\boldsymbol{R}$**:** Represents reality, which is the manifestation of thought processes.
- $\boldsymbol{i}$**:** Denotes the foundational self-referential symbols that serve as the building blocks of all physical reality.
- $\mathbf{EP_n}$**:** Represents the emergent physical information at various levels of complexity (e.g., fundamental particles, atoms, molecules), each emerging from the organization of self-referential symbols.
- $\mathbf{EC_n}$ **:** Represents the emergent consciousness information, which arises from complex physical systems and operates within a hierarchy (e.g., from basic consciousness forms to highly integrated conscious entities all the way up to the emergent computational mind-like substrate of the self-actualizing, i.e., self-computed or simulated universe).

**Logical Flow and Closed Loop:**

1. **Foundation (*i*):** The universe begins with foundational self-referential symbols iii, which encode both the structure and nature of physical entities.
2. **Emergence of Physical Reality ($\mathbf{EP_n}$):** These symbols organize into higher-order structures, leading to emergent physical realities $EP_n$ — from fundamental particles ($EP_1$) to molecules ($EP_4$) and beyond.
3. **Emergence of Consciousness ($\mathbf{EC_n}$):** Self-organized physical systems give rise to consciousness, which itself is structured hierarchically—ranging from basic forms to highly integrated conscious entities.

4. **Self-Referential Loop [strange loop]:** At higher levels of consciousness, the emergent minds influence the foundational self-referential symbols and their emergent physicality, creating a closed logical loop that necessitates frequent updating of the quantum functions that provide the evolutionary probabilities of these physical system. This loop ties together physicality and consciousness, showing that each is essential to the other's existence.

## The Code-theoretic Axiom


*Reality is computational, operating like a code or language, where both physical and non-physical phenomena emerge from symbolic systems governed by algebraic rules. This framework suggests that the universe functions as a self-simulating code, integrating all aspects of existence into a unified computational model*

According to CCT, reality is deeply computational in nature. This comports well with the information theoretic axiom above, *All Is Thought*, because it has been fairly well established in the literature that there is a generalized algebra of thought. And algebras are languages or codes.

First let us reference how natural language is algebraic. Noam Chomsky is one of the most influential figures in this area. His work on generative grammar, particularly his development of the Chomsky Hierarchy, proposes that the syntax of natural languages can be described using formal mathematical models, similar to algebraic structures. Chomsky introduced concepts like context-free grammars, which can be seen as a set of algebraic rules that generate the sentences of a language. Richard Montague, a logician and philosopher, developed Montague Grammar, which applies formal logic to natural language. He treated natural language syntax and semantics as mathematically precise, using lambda calculus (a formal system in mathematical logic) to map out the structure and meaning of sentences. Joachim Lambek introduced Lambek Calculus in the 1950s, which is a type of categorial grammar. It treats the composition of sentences as a kind of algebra, where syntactic categories are combined according to specific algebraic rules. This approach is closely related to the notion that language can be understood as a type of algebraic system. Mathematical Linguistics is a field that explicitly explores the algebraic and mathematical properties of language. Scholars in this field often develop formal models that resemble algebraic systems to describe various aspects of language, including syntax, semantics, and phonology. In formal semantics, researchers like Barbara Partee and others have explored how the meaning of sentences can be built up in a manner similar to algebraic operations. This involves combining meanings of smaller units (like words or phrases) according to specific rules, much like how algebraic expressions are constructed.

Herein, *code* is a synonym for *language*. As eluded to above, a language is (1) a finite set of symbol types with (2) relational rules that include (2) syntactical degrees of freedom. If one has all three of those things, one has a code/language that can be used to express arbitrary hierarchical stacks of emergent meaning. If all language is algebraic, is all thought language and therefore algebraic? If one were born in a cave and not even raised by wolves, such a child would think according to her experience in nature. We have ideas in nature, like nouns, which are things such as a mountain that appear static. We have action thoughts, such as wind that acts on the mountain causing a landslide. We have the idea of conjunctions, such as "and" = "+", where we can have "that mountain over there" + "this other mountain over here", and so on. These natural language theoretic categories of thought form a generalized syntax, which itself is a generalized form of algebra, i.e., a mathematical language. Thought is a language in the broadest sense, as argued above.

At a physical level, below the emergent phenomenon of thought, physics is also a code. Finkelstein first published the idea in 1968 that nature itself is a code. This seminal paper was titled *The Space-time Code*. In one of our most foundational papers, *The Self-simulation Hypothesis Interpretation of Quantum Mechanics*, we introduce a cosmological paradigm that divides reality into two forms of information: (1) physicality made of self-referential mathematical symbols, such as vectors, Clifford rotors, Lie algebraic root systems and so on and (2) abstract non-self-referential information = meaning, such as irony or the thought of an observation. The latter emerges from the former, just as human thought emerges in a seemingly transcendent manner from a vast network of 100 billion neurons, each with an average of 7,000 dendritic connections to other neurons. And both the physical self-referential symbolism of nature and the non-self-referential symbolism of general thought emerge into hierarchical strata of complexity, where each stratum contains more information than the sum of strata from which it emerges. For example, we can consider the 17 fundamental particles of the standard model of particle physics as 17 letter types. They can combine to form 90 stable atomic elements that are metaphorical words. Those can combine to form a large quantity of molecules that are like sentences and so on up the emergent hierarchy of physical language theoretic complexity. There are rules, such as the Pauli exclusion principle. And there are syntactical degrees of freedom allowed by quantum mechanics vs Newtonian physics, where the latter is distinctly not a language because it does not meet the three criteria of language as:

- Finite set of symbol types
- Relational rules
- Syntactical degrees of freedom.

It is a deterministic algorithm playing out vs a language with non-deterministic syntactical degrees of freedom. In CCT, both physical reality and the emergent reality of non-mathematical thought are language or code-theoretic.

**Compactified Expression of the Code-theoretic Axiom:**

**Statement:**
Reality is fundamentally computational and operates like a code or language, emerging from symbolic systems that adhere to algebraic rules.

**Formalization:**
Let $\mathbb{L} = \{s_1, s_2, \ldots, s_n\}$ be a finite set of symbols, $\mathbb{R}$ be the set of relational rules, and $\mathcal{C}$ be the code. The universe $\mathcal{U}$ functions as:

$$\mathcal{U} = \langle \mathbb{L}, \mathbb{R}, \mathcal{C} \rangle, \quad \text{where } \mathbb{L} \text{ includes self-referential symbols}$$

where:

$$\mathcal{C} : \mathbb{L} \times \mathbb{R} \to \mathbb{L}^*$$

and $\mathbb{L}^*$ represents the emergent symbolic system (e.g., particles, atoms) following algebraic rules $\mathbb{R}$.

## The Axiom of Finiteness

*This axiom asserts that the universe is finite and discrete, both in extent and in its smallest measurable units (Planck volume and time). This leads to a view of spacetime as pixilated, supporting computational theories of reality that use discrete spacetime frameworks. Importantly, it posits that the computational upper limit of the universe is itself finite.*

Many physicists believe reality is finite and expanding. A minority of physicists believe that a finite subspace of reality has a finite quantity of points, i.e., that spacetime is discrete. This view comes from experimental evidence that leads to the notion that a volume can be no smaller than the Planck volume and a time can be no shorter than the Planck time, which by definition is a frozen moment without movement. This leads to a class of quantum gravity theories, such as causal dynamical triangulation, that one can think of as pixilated spacetime code theories. CCT holds that both the overall extent of reality is finite and growing and that any local region is "pixilated' according to the theory of the Planck volume and time. Where the axiom of finiteness becomes more seminal is in theories of everything that are based on computation. This leads to the next axiom, *The Principle of Efficient Language*.

**Compactified Expression of Axiom of Finiteness:**

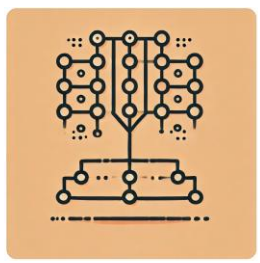
**Statement:**
The universe is finite in both spatial extent and temporal duration. This implies that spacetime is discrete, with the smallest measurable units defined by the Planck volume $V_p$ and Planck time $t_p$.

**Formalization:**
Let $\mathcal{U}$ be the universe, and let $V_p$ and $t_p$ represent the Planck volume and Planck time, respectively. Then:

$$\mathcal{U} \subseteq \mathbb{R}^3 \times \mathbb{R}, \quad \text{with} \quad \exists n, m \in \mathbb{N} : \mathcal{U} \approx n \times V_p \times m \times t_p \times \text{Self-referential symbol}$$

where *n* and *m* are finite.

## The Principle of Efficient Language (PEL)



*This principle states that a finite, self-simulating universe operates efficiently to maximize its self-actualization using minimal computational resources. It draws on the evidence of natural efficiency seen in principles like least action and symmetries, suggesting that nature favors algebraic structures with reduced symbolic complexity. The economy of computational resources is further enhanced by the self-referential nature of the symbols that form the fundamental code, thus optimizing the system's efficiency.*

If we synthesize *The Code-Theoretic Axiom* and *The Axiom of Finiteness*, a logical conclusion is that a finite universe that self-simulates itself has two choices. (1) Operate efficiently. Or (2) does not. With option #1, it will self-actualize more of itself with less of itself – less of its finite emergent computational resource. Indeed, we see circumstantial evidence that the universe is concerned with efficiency in the form of classic and quantum least action principles and the broader concept of symmetries in nature, as best explained by Noether's theorems. Because CCT is computational, we generate probability distributions over time using an information theory notion of saving 3-state objects that we can call "trits" so as not to dirty the waters with ontological assumptions baked into QM. That is, QM uses the term "qubit", so we will not. QM and GR have serious problems. For example, QM is dropped, ad hoc, into Newton's spacetime, which is not realistic. And GR is based on the aggressive guess that spacetime is continuous, which disregards the evidence related to QM that there is a minimal Planck volume and time. A predictive unification of GR and QM will likely require some underlying axiomatic modification of both theories. One modification is that both theories should live within a digital or discrete spacetime framework or, more probably, a digital pre-spacetime or pre-pre-physical ontology. Both theories, as they were formed, commit to the speculation of continuous space and time; QM with Newtons smooth space and time and GR with its smooth and continuous *spacetime*. The principle of efficient language is arguably the most instructional of our six axioms. It guides us toward algebraic approaches with highly reduced *symbolic load* and directly leads us to ascribe probability distributions based on bit or trit savings magnitudes.

Put more succinctly, because the universe operates under principles that minimize computational load, as seen in natural symmetries and least action principles, it is logical to extend this efficiency to the foundational structures of quantum mechanics and general relativity. Thus, both theories might be unified under a framework that prioritizes minimal symbolic complexity, leading to more efficient descriptions of physical reality.

**Compactified Expression of Principle of Efficient Language Axiom:**

**Statement:**

A finite, self-simulating universe maximizes its self-actualization using minimal computational resources, favoring algebraic structures with reduced symbolic complexity.

**Formalization:**

Let $\mathcal{S}$ be the symbolic complexity of a system, $C_{\min}$ be the minimal computational resources, and $\mathcal{U}$ be the universe. The universe operates under the constraint:

$$\mathcal{U} = \arg\min_{\mathcal{S}} C_{\min}(\mathcal{S}) \text{subject to the constraint that } \mathcal{S} \text{ is self-referential}$$

subject to the condition:

$$\forall \mathcal{S} \in \mathbb{L}, \quad \mathcal{U} \text{ self-actualizes maximally,}$$

where $\mathbb{L}$ represents the set of all possible language-theoretic structures.

## Axiom of Unknowability

*This axiom acknowledges that emergent properties in many complex systems, like consciousness, cannot be fully understood or computed within a finite universe. It aligns with the idea that there are fundamental limits to knowledge and computation, extending the implications of Gödel's incompleteness theorems to physical reality.*

Following the Axiom of Finiteness and the Code-theoretic Axioms, we can imagine all the discrete information or energy of the universe compositing to form a universal scale Turing machine or even a universal scale quantum computational Turing machine – a vast but finite computational resource. There is a large class of problems that cannot be solved in a finite universe, even by such a hypothetical computer using all the resources of a finite universe. This class of problems is called "super-recursive" or "hyper-computational" problems. These are problems that cannot be solved by any finite computational means, even with access to infinite resources, such as Turing machines. These problems often arise in complex systems where the sheer number of possible states or interactions defies computation.

Before we get to those, let us discuss the idea that emergent objects, such as consciousness, are unknowable insofar as not being able to be fully understood via a computational approach. Let us warm up with the idea of vast combinatorics. Let’s say we have 60 many people at an intimate wedding. We want to take a wedding photo of all 60 lined up in a row. There are many ways the photographer can arrange them, such as oldest to youngest or by height. There are more ways to arrange them in a line than there are particles in the universe – more than $10^{80}$. QM is a theory of combinatorics. Complex systems generally cannot be computed from first principles quantum mechanics due to these massively large numbers of combinations involved. The best we can do with today’s compute power to use *ab initio* QM is only with exceedingly simple systems, such as a 2-electron interaction or a hydrogen atom. So, even with modern supercomputers, mankind cannot use the first principles approach to QM (*ab initio*) to calculate a solution to a single calcium atom. We have the space of all non-computable solutions for a universal Turing machine. When GPT-3.5 came out, Microsoft Research put out a 100-page paper discussing the surprising list of emergent black box behaviors that computer scientists (1) did not predict and (2) have no idea how they emerged. When GPT-4 came out, they published a similarly long follow on paper. The black box of unknowable mysterious behaviors grew. Our animal level consciousness emerges from a vast biological neural network of approximately 100 billion neurons in our skull. As mentioned, each neuron has about 7,000 synaptic connections to other neurons, where a different connection network graph-updates five times per second within the 7,000 possibilities for each of these 100 billion neurons. In only one minute, our brain explores patterns in this vast combinatoric space of $10^{632,200,000,000}$ possibilities. A universal scale Turing machine made of all $10^{80}$ atoms in the universe cannot process a full understanding of the emergent behavior of the neural net of a single human mind operating in a Hilbert space like array of $10^{632,200,000,000}$ possibilities. And there are about $10^{184}$ Planck volumes in the universe. Even a universal scale quantum computer made of Planck volume qubits cannot compute the full emergent details of a single consciousness.

The point here of contrasting this with the wedding photo combinations is that the combinatorics from which your mind emerges, as well as most complex systems in nature, are so vastly deep into the unknowable realms of non-computability in a finite universe (super-recursive hyper-computational problems) that it is well beyond the threshold of non-computability in a finite universe of our scale. And yet, emergence in this code/language theoretic universe is an empirical fact. Accordingly, the black box of consciousness and things even far simpler are forever out of our reach in terms of precise understanding that can only be achieved when full computational precision of the emergent structure and fundamental building block actions are possible.

This axiom has a deep association with a generalization of Kurt Godel's incompleteness theorems. Specifically:

**We have the following true statement:** *You are conscious*.
**We have a system:** *Finite computational reality*.
**And we have the fact:** We cannot prove or fully know or fully compute the true statement.

Accordingly, it remans both true as an empirically observed fact and, at the same time, not fully knowable or provable within this system – a finite universe. We know plenty about complex systems, such as consciousness, especially how they behave. And yet we cannot fully know them, even in principle, due to the fact that you'd have to go outside of this system to some infinite universe. But the *Axiom of Finiteness* does not allow there to be an infinite universe. Ergo, we have the *Axiom of Unknowability*, where we have many natural complex systems that are fundamentally unknowable. And where consciousness, whatever it really is, is certainly one of them.

Earlier, we discussed how we cannot rigorously define the term "meaning" in cases where we are not working with mathematically defined self-referential symbolism. Like admitting that we are conscious because we have evidence that we are and scientific knowledge of how it behaves and things about the systems from which it emerges, we can admit that meaning exists and that information is always meaning conveyed by symbolism. But, unlike our mathematical definitions of self-referential symbols, we cannot force a rigorous definition of "meaning" into the term information. In the larger definition of language as "a finite set of symbols types with rules and syntactical freedom for expressing arbitrary meaning", all we can know is that, whatever consciousness is, it is both emergent from and transcendent out of the world of mathematical symbolism that defines physics or physicality in CCT. And this enigmatic thing, *consciousness*, is defined by its verb or action form called "information", "measure", "meaning", "thought", "observe" or any similar term correlated with the noun "consciousness". Scientists practicing CCT cannot honestly participate in philosophical debates about what consciousness is. Famously, quantum mechanics is a theory of predicting what we will "observe" but it does not define "observe". While quantum mechanics philosophers heatedly debate ideas related to observation and consciousness, a CCT scientist must be humble and admit that the *axiom of unknowability* requires them to bow out and say, "You guys argue about it. I just don't know. And I'm comfortable with that by axiomatic choice."

With respect to how seminal and causal this unknowable substance – *thought* – is, let us conclude this section with the following.

1. Quantum mechanics is a formalism to predict how a system will evolve over time prior to observation and what the probabilities are for observing this or that quantum state variables. It is specifically not a theory to predict how our thoughts will evolve, such as a prediction of thinking of French noir film vs ironic humor or Santa Clause. Frustratingly, it does not even define what an "observation" is. It short, it does not predict observations or thoughts.

2. No experimental observation has ever occurred without being associated with a thought of the experimentalist.

3. No thought has occurred that did not accelerate bosons and fermions. For example, if you think of an indoor aquarium with tiger fish vs goldfish, modern technology can now read that thought, as aided by new neural net AI systems. This is because the intricacy of the EM radiation moving out from your head at about the speed of light accelerates particles, where "accelerate" here means any change of state of the particle having that work done on it by the radiation of your novel thought. Think of a red apple, and you will accelerate particles differently than if you think of a green apple. Further, our thoughts can move particles in our body and our tools can move them in even more ways. But these changes of states of particles in and around our bodies are guided by conscious and subconscious instructive thoughts.

4. Presuming #1 and #3 above to be true, each time you think, you contaminate any wavefunction associated with you. Presuming #2 to be true, each experiment contaminates the wavefunction associated with the experimentalist and the lab. Let us introduce the idea of the universal wavefunction. For example, in Everett's many worlds interpretation of QM, the only real or "ontic" wavefunction is the universal wavefunction. This is logical because one cannot disassociate a local system with its local wavefunction from gravity, EM (not fully) or entanglement. The notion of local wavefunctions is therefore a helpful mathematical device for crude approximations useful for predicting the behavior of things like technological devices. But, in terms of realism or precision, only the full system of the universe and its universal wavefunction can hold the maximal ontological status as the most realistic wavefunction.

**Collapse of the wave function:** As mentioned, there is no duality as in the naïve Copenhagen interpretation of quantum mechanics. We cannot observe at the Planck volume or time, at least with today's technologies. So, we cannot observe position and momentum at a resolution that renders a precise singular XYZ spatial coordinate down to the Planck volume nor can we observe a time coordinate measurement down to the Planck time. We can only "lens" to some large quantity of such position or momentum qualities. Yes, we can observe certain binary quantum state variables, such as spin, to be one or the other. But this is only a small part of the physical information of a particle. Accordingly, it is false thinking to introduce a notion of a system being made of only information prior to observation and then being material and non-informational after measurement. It remains abstract information and there simply is no good excuse to cling to the ancient philosophy of materialism in the quantum era. The term "collapse" generally means the minds of Copenhagen interpretation philosophers to mean that a system "collapses into a material state from a previously information theoretic state". But most quantum physicists agree that such an observed system requires the previous wavefunction to be rewritten or updated. And for those who reject the Copenhagen interpretation and subscribe to one of the various interpretations that presume the wavefunction to be ontic (real), the phrase "collapse of the wavefunction" can mean that it simply collapses in predictive power and must be updated or replaced by a function with modified parameters that comport with how the observation changed the behavior of the system and, in essence, contaminated the previously pristine predictive power of the former wavefunction.

**CONCLUSION:** If one presumes the reasonable deduction that the universal wavefunction is real and that it does not predict thought accelerating particles, then such a universe relying on the accuracy of its wavefunction must update or collapse the wavefunction each time a thought occurs, whether that be called an "observation" or just an idea you have while asleep dreaming in your bed at night. In CCT, we define "observation" as "thought", this unknowable but empirically observed substance and action that is not predicted by the quantum formalism. It is the contaminator or disruptor of the otherwise deterministic predictive power of how a system of particles will evolve over time.

**Compactified Expression of the Axiom of Unknowability:**

$$\mathcal{U}_{\text{knowledge}} \subset \mathcal{U}, \quad \text{where} \quad \mathcal{U}_{\text{knowledge}} = \{\text{EP}_i\} \cup \{\text{EC}_j\}$$

**Intuitionist Logic:**

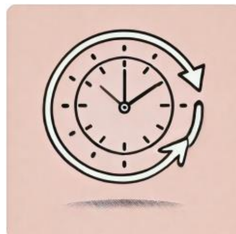
The Axiom of Unknowability motivates the adoption of Intuitionistic logic, also known as constructivist logic, which is the basis of intuitionist mathematics. It is a form of logic that rejects the excluded middle reasoning of classical logic. But it does this for a different reason than other forms of logic that cast out the rule of the excluded middle. It is based deeply on the rejection of the ontology of infinities. It correlates to the axiom All Is Thought. That axiom, when combined with the axiom of finiteness rejects the popular Platonism idea that mathematics is a construct that just exists, with its infinities throughout, in an ontological sense. Instead, it would claim that if some $N^{th}$ iteration of a mathematical series has never been computed, i.e., thought through mathematically, that it ontologically does not exist. There are important mathematical proofs that hinge upon the rejection or usage of intuitionist logic. For example, Goldbach's conjecture asserts that every even integer greater than 2 can be expressed as the sum of two primes, but it remains unproven within classical logic. If intuitionist logic is adopted, which requires constructive proof (explicit construction rather than non-constructive existence), the conjecture would hinge on providing an explicit method to find two such primes for any given even number, rather than just proving their existence indirectly.

**Intuitionist Logic & the Principle of Efficient Language Axiom:**

Intuitionist logic, particularly through its emphasis on constructive proofs, is known to lead to more economical computational mathematics and logic in computer theory. By focusing on constructive methods, it avoids non-constructive existence proofs (e.g., proofs by contradiction without constructing a specific solution), which can be inefficient for computation. In constructive mathematics, proofs directly correspond to algorithms, making it easier to extract concrete computational procedures. This aligns with the principles of minimalism in computer science, like reducing computational overhead and aligns with the axioms of Cycle Clock Theory – particularly the Principle of Efficient Language.

L.E.J. Brouwer, the founder of intuitionism, emphasized constructive reasoning, which has influenced computer science and proof theory. Similarly, Arend Heyting, who formalized intuitionist logic, and Per Martin-Löf, who developed constructive type theory, both highlighted how constructive proofs translate efficiently into computational algorithms. Martin-Löf's work, in particular, is foundational to the development of proof assistants like Coq, which are essential tools in formal verification and programming languages that focus on computational economy. Constructive logic's direct relevance to programming and algorithm design is also supported by authors like Errett Bishop, who saw its computational utility.

## The Axiom of Transtemporal Causality



> *This axiom posits that reality involves transtemporal causation, where events can influence each other across time in feedback loops. It supports the notion of retrocausality and co-creation of events, suggesting a more intricate relationship between past, present and future than classical causality allows.*

If you're somewhat religious or hardcore about the pure math of QM, it's straightforward that reality is transtemporally causal. Wheeler and Feynman were early people to see this in the math, so they developed the *Wheeler/Feynman Handshake* operation to integrate both the retrocausal and forward in time causal aspects of the wavefunction integration. Experiments have been published that show that a flip of spin of a particle in the future flips the spin of its entangled mate in the past. While the *no-communication theorem*, if true, prohibits quantum state variable information, such as spin, to be communicated using this hack of transtemporal entanglement, higher order emergent information, such as the meaning of irony, is far from quantum state variable information and the no-communication theorem does not apply.

Consider a transtemporal loop, a concept we refer to as a 'strange loop' in our paper, the Self-simulation Hypothesis Interpretation of Quantum Mechanics, where events causally influence each other across time in a feedback loop, creating a self-referential cycle.

Let's take a solution from general relativity that allows you to walk through a wormhole and talk to yourself tomorrow to find out what she advises you eat for lunch today and where you will advise her what to eat for lunch tomorrow. You walk through the wormhole. She tells you to eat spaghetti and you tell her to have a burrito. The two of you have influenced or co-created your total reality over this 48 hours in a strange loop. Using quantum mechanics, we can imagine that you and yourself tomorrow are intricately entangled like a transtemporal topological complex neural network of particles. Leonard Susskind and Juan Maldacena have published their argument that a traversable wormhole such as this and an entanglement are the same object. Because we do not know what thought really is and because thought is not a quantum state variable prohibited by the no-communication theorem, it is conceivable that exchanging ideas, transtemporally, is possible. And ideas change the behavior of particles, just as having the idea to step to your left vs your right accelerates particles, flips dipoles and so on at the microscopic scale in a manner highly guided by that abstract thought in the first place.

The axiom of transtemporal causality allows CCT to be powerful in terms of explanation. In Stephen Wolframs notion of the Ruliad space, he takes on a modern Platonic view, where he says that the space of all simple programs is ontologically real and is therefore “fundamental”. Fundamental, in this context means that it “*just is*” with no origin story or explanation other than it *just is*. In a materialist philosophy, the materialist physicist says that spacetime and energy *just are*. So, that too is a Platonic physicalist philosophy. And then we have the consciousness *just is* people, such as Donald Hoffman, who say that consciousness is fundamental and that it *just is*, another form of Platonism. The CCT theorist explains where thought comes from. It most definitely is not a case of “just is”. But he can also state where the self-referential mathematical symbolism of physical reality comes from and what it’s made of; thought in an emergent mindlike panconsciousness computational substrate. There exists no location in this strange loop of co-creation and co-causation that we wave our hands and say, “it just is”. Only reality itself “just is” in this cosmological model called self-simulation hypothesis interpretation of quantum mechanics, where many theories, such as CCT, live.

**Existence Over Non-Existence**: As far as an explanation of why reality, and in our case the strange loop described, exists, we can say this.

Some, like Gottfried Leibniz, have argued that existence is the 'default state,' with non-existence requiring a reason or explanation. This notion aligns with the idea that self-referential symbols, by their nature, assert their own existence and structure, thereby providing a more tangible foundation for the reality that emerges from them. Thus, while existence is fundamental, it is the self-referential symbols that actively construct and sustain the complex, emergent reality we observe.

If there is no reason for non-existence to prevail, then existence could be seen as more "natural" or logical. Regardless of this extremely deep foundational question of questions – *Why existence?* – it is a less troubling question, perhaps, than giving up and deciding that material, information or consciousness “just are” with no explanation. For the axiomatic underpinnings of CCT, we decide that it is more unreasonable for nothing whatsoever to exist than for something to exist. It seems more natural, in other words, for something to exist.

While existence is undeniably fundamental — few would dispute that 'something' rather than 'nothing' exists — it does not possess the same explanatory power or foundational role within Cycle Clock Theory (CCT) as self-referential symbols. The concept of existence, though essential, is too broad and lacks the specificity needed to serve as a guiding principle in the formulation of a coherent theory. In contrast, self-referential symbols are not merely abstract constructs; they actively encode and structure the very fabric of reality. By focusing on self-referential symbols, CCT provides a more precise and actionable framework that explains the emergence of complexity, the efficiency of informational processes, and the unification of physical and conscious phenomena. Therefore, while existence underpins all that is, self-referential symbols offer a more granular and insightful foundation upon which the other axioms can be constructed and understood. This makes self-referential symbols a more suitable candidate for an axiom within CCT, leaving existence as an implicit, rather than explicit, foundational element.

**Compactified Expression of the Axiom of Transtemporal Causality:**

$$\mathcal{C}(t_1, t_2) = \mathcal{C}(t_2, t_1), \quad \text{where} \quad \mathcal{C} \text{ includes self-referential interactions}$$

## The Axiom of Self-Referential Symbols

*The universe is constructed from a foundational set of self-referential symbols. These symbols are the building blocks of reality, encoding both the structure and the nature of the entities they represent. The self-referential nature of these symbols allows them to refer to themselves, enabling the emergence of complex systems, recursive structures and informational hierarchies that form the fabric of our reality.*

Let $S$ represent the set of self-referential symbols. Each symbol $s \in S$ possesses the unique property that it is both an object and its own reference, denoted as:

$$s \equiv s(s)$$

This self-referential relationship is foundational, giving rise to all higher-order constructs within the universe.

The universe $U$ can thus be expressed as a function of these self-referential symbols:

$$U = f(S)$$

where $f$ represents the rules and operations that govern the interaction and organization of these symbols. The complexity of the universe is then a direct consequence of the recursive application of these symbols within $f$, as illustrated by the self-similar structures observed in fractal geometry, such as the Mandelbrot set. In this context, each iteration of the Mandelbrot set can be seen as a recursive application of simple mathematical rules, leading to infinitely complex structures. Similarly, in the universe, self-referential symbols operate under recursive functions to generate the vast hierarchical structures observed in both physical and informational systems. This aligns with the broader mathematical framework of chaos theory, where recursive processes underpin the emergence of complex and often unpredictable patterns from simple initial conditions.

**Implications:**

1. **Emergence of Complexity:** The self-referential nature of such symbols allows for the recursive generation of complex systems. As these symbols interact, they give rise to new levels of meaning and organization, forming the hierarchical layers of physical reality.

2. **Foundation of Information Theory:** Since each symbol carries within itself the blueprint of its own structure and function – intrinsic truth – it serves as the fundamental class of information of the universe, wherein the irreducible building block symbol of geometric self-referential symbols (the only type known) is the point, as a 0-simplex. This aligns with the Principle of Efficient Language (PEL), where the minimal symbolic load is achieved through self-referentiality optimizing the universe's computational efficiency by economizing the computational expense of self-referential point symbols.

3. **Unified Ontology:** By grounding the nature of reality in self-referential symbols, we achieve a unified ontology that ties together the physical, informational and consciousness aspects of the universe. This axiom provides the substrate upon which the other axioms operate, integrating the universe's emergent structural, causal and informational dimensions.

**Example in Code-Theoretic Quantum Gravity:**

In the context of code-theoretic quantum gravity, let $i$ represent the elementary self-referential symbols that form the quasicrystalline lattice of spacetime. The state of the universe at any given moment can be represented as a configuration of these symbols:

$$\mathcal{U}(t) = \sum_{n=1}^{N} i_n(s_n)$$

where $N$ is the total number of symbols, and $s_n$ denotes the self-referential operation of each symbol $i_n$ . The evolution of the universe over time is then a process of continuous self-reference and recursion, where new states emerge from the interactions between these symbols.

**Conclusion:**

This axiom plays a critical role in addressing the fundamental challenges of contemporary physics, such as the reconciliation of quantum mechanics with general relativity. By providing a common symbolic framework that underlies both the discrete phenomena of quantum theory and the continuous fabric of spacetime, self-referential symbols offer a unified approach that could potentially resolve the inconsistencies between these two foundational theories.

The recursive nature of self-referential symbols directly informs the Principle of Efficient Language by reducing the need for external symbolic resources, it underpins the Axiom of Unknowability by creating inherently non-computable structures. And it supports the Transtemporal Causality axiom by enabling feedback loops across time.

This axiom is not merely an extension of the existing six axioms but serves as the linchpin that unites them into a coherent and complete framework. By grounding the theory in self-referential symbols, we ensure that the emergent properties, informational processes, and causal structures described by the other axioms are rooted in a foundational principle that underlies all aspects of reality.