Evolution of Information and the Laws of Physics

Thomas Bradley

October 24, 2023

Abstract

This paper intersects concepts from information theory, physics and evolutionary theory to conjecture the existence of fundamental replicators, termed 'femes'. In alignment with contemporary evolutionary theory, the paper considers various abstract replicators, moving beyond genes to include memes and temes. Femes are then posited to exist in fundamental reality and to embody knowledge selected by evolution. Femes are hypothesised to cause transformations that result in the structure and dynamics of the observable universe, classified as their phenotype. A comprehensive background section provides the foundation for this interdisciplinary hypothesis and leads to tfour predictions amenable to empirical scrutiny and criticism. Owing to its multidisciplinary approach, the paper is written to be accessible to individuals from diverse academic backgrounds. It challenges and complements ideas from various domains while opening up new avenues for research.

Contents

1 Background

This section provides a thorough background on information theory, knowledge, evolution and physics, allowing later sections to be concise. All terms in *italics* are defined in the glossary (7).

1.1 Information Theory

1.1.1 Information Interaction

Information Theory was conceived by Claude Shannon in his seminal 1948 paper, where he defined information in terms of 'bits' [**?**].

Chiara Marletto, working in the context of Constructor Theory with David Deutsch, brings a nuanced understanding to information through the notion of *counterfactual* potential[**?**, **?**]. According to them, a structure is deemed to carry information if:

1. It is capable of adopting at least two distinguishable states, paving the way for transformations like 'flip' or' not'.

2. Every state can be faithfully replicated, making copy' or identity' transformations possible.

To elucidate this, consider two functions: 'Are you black?' and 'Are you white?'. These functions interact with a square that can either be black (representing '1' or 'true') or white (indicating '0' or 'false'). They are the flip and copy transformations acting on data, and showcase the counterfactual potential and distinguishable states of information.

Input		f(■?)	Output	
□	→		→	■
■	→		→	□

Table 1: f(Black?) / f(flip)

Input		f(□?)	Output	
□	→		→	□
■	→		→	■

Table 2: f(White?) / f(copy)

The functions, much like the squares they operate upon, also demonstrate counterfactual potential, as any outcome could be different if F(B?) was replaced with F(W?). This realization underscores the idea that both the data (the square's color) and the function (the operation applied) are intrinsic carriers of information. Their interaction results in an output that results causally from their forms.

1.1.2 Computation and Universality

Lambda calculus, a formal system in mathematical logic, was among the first to recognize the equivalence between functions and data, highlighting that both are forms of information. This foundational idea was later fortified by the Church-Turing thesis, which proposed that anything computable by Lambda Calculus can be computed by a Turing machine.

The term "universal" in computation signifies that specific information structures can produce outputs non-linear to their inputs. When these structures (or operations) are rearranged or composed in different ways, they have the potential to carry out any computable task. This universality is akin to a universal Turing machine that can simulate any other Turing machine given the right input.

In traditional computational systems, the functions are typically stored externally, and reintroduced to interact with the outcome of information interaction. But when considering the system holistically, Constructor Theory considers the temporal evolution information when its is not externally stored and reintroduced into a system. The consequent dynamics lead to a consideration of knowledge.

1.2 Knowledge and Constructor Theory

1.2.1 Knowledge

Knowledge, as defined by Popper and Deutsch, is information that, when physically instantiated in an appropriate *environment* (the structures a given structure interacts with), tends to cause itself to remain so (it *propagates*). Marletto describes knowledge as information capable of self-preservation.

This can be explained a 2D binary grid structure interacting with the Game of Life function, f(GoL). The f(GoL) computes the future state of each cell based on its current state and the states of its neighboring cells.

Input					Output	
State	Live Neighbors				Next State	Description
□	0-2, 4-7	→		→	□	Stasis
□	3	→	f(GoL)	→	■	Birth
■	0-1, 4-7	→		→	□	Death
■	2-3	→		→	■	Survival

Table 3: Game of Life Update Function

The '*glider*' structure exemplifies knowledge as it propagates under interaction with F(GoL). The structure propagates under interaction with this information (it causes itself to remain in this environment).

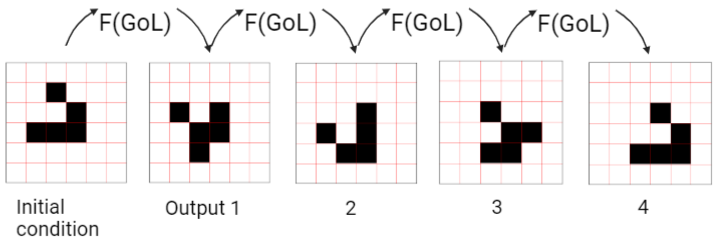

Figure 1: Glider structure interacting with GoL rule.

Knowledge is *hard to come by* and *hard to vary*. Considering a 3x3 grid of binary cells, there are 2^9 possible structures. From these, only the 4 orientations constituting a glider, the 2 of a blinker, or 1 of a block, will propagate in a large empty grid. Knowledge is hard to vary as altering structure typically reduces its capacity to propagate in its environment.

1.2.2 Constructors

Constructors cause transformations in their external environment without undergoing a net change. They propagate when interacting with the environment, and must embody knowledge. Unlike functions such as F(B?) or F(GoL), which require reintroduction, constructors can propagate within a system. A catalyst is an example of a contractor in reality.

In Conway's Game of Life, the 'Eater' pattern serves as an illustrative example. As shown in Figure 2, is causes a transformation destroying a glider, while undergoing no net change.

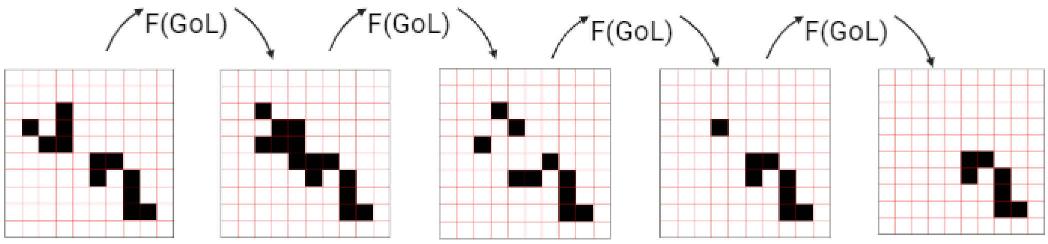

Figure 2: The Eater interacting with and stopping the Glider in Conway's Game of Life.

A central idea in constructor theory is about possibility and impossibility. While the operations of a constructor can be a universal set, certain transformations are impossible for any finite constructor when operating in a finite information space. For instance, within a 6x6 grid in the Game of Life, no constructor can produce a transformation resulting in a structure that occupies more than 36 cells. Limitations of constructors results in physical principles such as the conservation of energy, as no physical constructor can cause an increase in the amount of information constituting energy (This statement assumes reality results from computation. The basis for this treatment is given in section 1.4).

1.2.3 Abstraction and Reducibility

The future state of the glider is calculated by applying the GoL rules to each cell. The future state of a system can also be calculated by defining emergent structures, and understanding the transformations they undergo. Abstraction is the idea of understanding the dynamics of a system not through fundamental update, but emergent structures and their properties. For example, the glider emerges with a property not explicitly defined: it moves $\sqrt{2}$ grid lengths diagonally every four iterations. Important to note that the expression of the emergent rules may exist in a space with different language, irrationals are not expressible in binary information that constitute the grid.

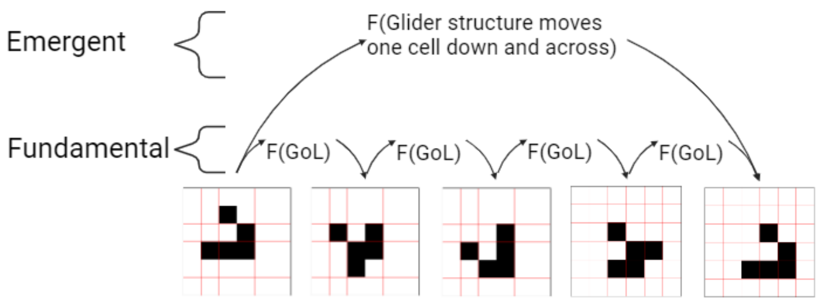

Figure 3: Abstract analysis of Glider dynamics

This concept of abstraction and its power is further elaborated by Deutsch, who references a gedankenexperiment by Hofstadter. Dominoes are arranged such that a specific domino falls if the initial number of input dominoes is a prime number. Here the fundamental level determining the fall of the final domino requires many complex calculations about the dynamics of falling dominoes. Using fundamental rules to predict or explain the falling the output domino would be difficult and complex. An abstract analysis simply considers the emergent properties of the arrangement of dominoes and uses the primality of the input to explain the future state the system.

The Wolfram physics project defines abstract identification of emergent structures and calculating the future state by consideration of their dynamic properties a *numerically reducible* parsing of the system.

1.2.4 Infinity and Fallibility

According to Deutsch, all knowledge is *parochial* and *fallible*. Any knowledge facilitates propagation upon interaction with a subset of the infinite set of possible structures. There are infinitely many unique functions that any knowledge would fail to propagate upon interaction with.

For example, if the GoL update function is varied as follows, the glider ceases to propagate.

Input					Output	
State	Live Neighbors				Next State	Description
□	0-2, 4, 5, 7	→	f(Varied GoL Update)	→	□	Stasis
□	3, 6	→		→	■	Birth
■	0, 2, 3, 6, 7	→		→	□	Death
■	1, 4, 5	→		→	■	Survival

Table 4: F(GoL) with varied input/output.

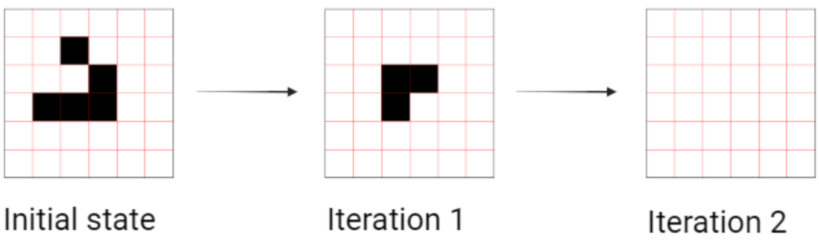

Figure 4: Illustration of a fallible glider

The parochial and fallible nature of any structure leads to Deutsch's principle that *problems are inevitable* - from the perspective of any structure, problems that can destroy the structure will inevitably be encountered. Yet, the related principle is that *all problems are soluble*. The problem is itself is fallible. There are infinitely many possible forms of knowledge, certain of which would resolve the problem. The capacity to access this knowledge and overcome problems is granted by the ability to create, or more generally, *evolve* solutions to the inevitable, fallible problem.

1.3 Evolutionary Theory

1.3.1 Evolutionary Systems

If Knowledge is hard to come by, what causes it to exist? Marletto posits: 'It is a principle of evolutionary theory that everything with the appearance of design must have come into existence by natural selection.' [1].

Knowledge evolves in an *evolutionary system*, where there are repeated cycles of imperfect copying of information, alternating with selection. Structures undergo *replication*, *variation*, and *selection*:

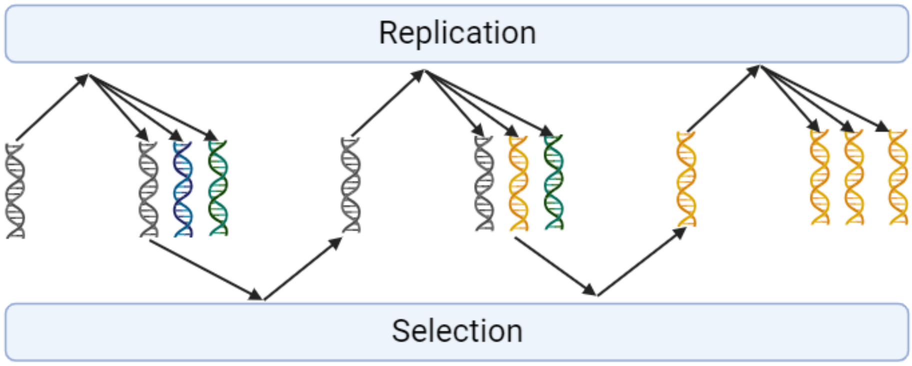

Figure 5: DNA structures undergo cycles of imperfect replication and selection, resulting in the evolution of knowledge.

These structures are selected based on their propagation efficacy when interacting with their environment. Over time, mutations that improve propagation become prevalent, as structures possessing them replicate more effectively. This iterative process gives rise to the evolution of knowledge.

Consequently, we observe the emergence of *replicators* - constructors capable of creating copies of themselves.

1.3.2 Genetic Replicators and Phenotypes

Molecular dynamics provides a substrate for the imperfect copying and selection of abstract structures, specifically the genetic replicators of DNA/RNA. These replicators have evolved to cause transformations that result in their own propagation and replication, making them *selfish*[2]. Any structure resulting from knowledge embodied by a replicator is termed its *phenotype*, as described by Dawkins in 'The Extended Phenotype'[3]. Genetic phenotypes can assume many forms, such as a cell wall, egg or beaver's dam.

Neo-Darwinism designates the *gene* as the fundamental replicator, not the larger *genome*. Dawkins defines a gene as 'a unit of heredity that, under the influence of an environment, directs the formation of an organism and drives its behavior,'[2] in essence, a gene is a DNA segment accounting for a specific selectable transformation. Genes are recognised by their stability and infrequent mutations, whereas genomes can manifest significant changes, especially during processes like meiosis. A genome is an ensemble of genes directing development of an organism. Each gene causes a transformation, for example, a gene may specify camouflage coloration, as shown in 6. The phenotype derived from this genetic data has a lifecycle marked by its genesis and eventual cessation, with its duration being brief relative to the gene.

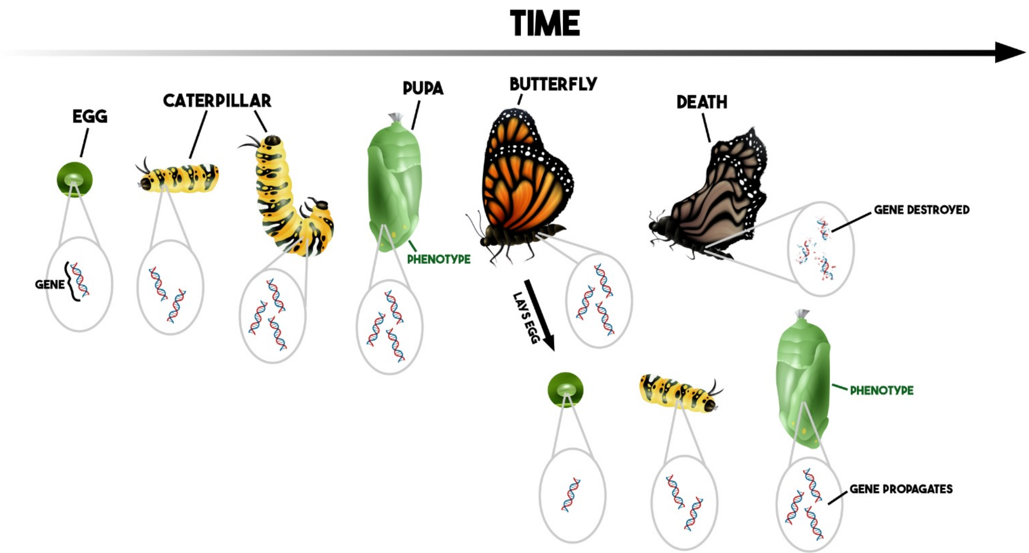

Figure 6: Propagation of the gene for camouflage coloration in the Pupa phase

Figure 6 showcases the stability of a gene influencing a lepidopteran's camouflage during its pupal stage. While the gene remains largely consistent, the phenotype is more transient. Occasional gene mutations can modify its inherent knowledge, leading to different transformations. These alterations can affect the organism's replication and propagation capacity. It is clear that genetic replicators are selected based on their transformation abilities that enhance propagation in given environments.

1.3.3 Memes and Temes

As illustrated in 7, gene and genome phenotypes manifest in various forms, such as toxins, lions, and trees. the genetic phenotype of brains evolved as they promote the propagation of genes. This phenotype is significant as the information embodied and transmitted between neural connections forms an abstract evolutionary system (abstract system where replication, mutation, and selection occurs). Therefore abstract replicators can form. In 'The Selfish Gene', Dawkins called the replicators existing in the substrate of neural processing '*memes*'.

Examples of phenotypes produced by memes, such as language and the thumbs up gesture, can be seen in fig 7. Just as genes function within a genome, memes operate within *memplexes* - clusters of memes that often disseminate together. A direct physical transfer of memes from one brain to another is infeasible. Instead, the *creative capacity* allows humans to generate memes by interacting with the memetic phenotype. Given these intricacies, generalising evolutionary theory to encompass memetics presents nuanced challenges, explicitly considered in Section 6.1.

Memes resulted in the phenotype of technology such as digital processing systems. Certain phenotypes constitute abstract evolutionary systems as there are cycles of imperfect copying and selection of abstract information. This results in the evolution abstract replicators, defined by Blackmore as (technological) -emes, or *temes*.

Temes again beget their own phenotypes. The f(GoL) is an example, along with Google (again the distinction between temes and 'temeplex' is not rigorous) and other structures that are embodied by the substrate of technological information.

The diagram below is a central idea in this paper. Many complex structures humans observe can parsed into replicators or phenotypes. The relationship between abstract replicators can also be understood. All replicators are selected by their capacity to cause transformations that result in their propagation and replication. Transformations result in phenotypes, that may be abstract evolutionary systems where abstract replicators form and create phenotypes.

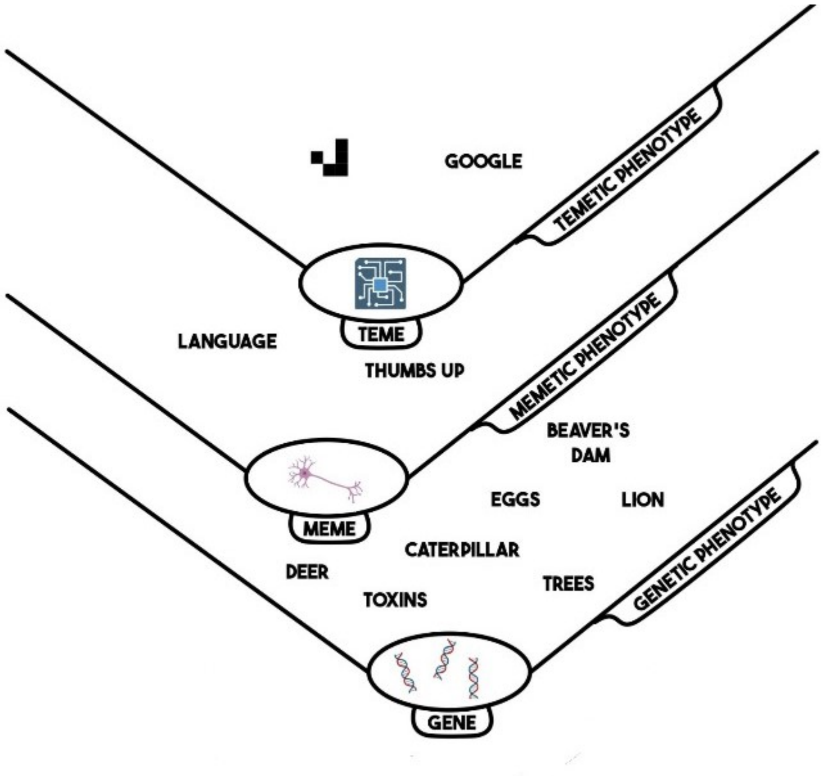

Figure 7: Causal relation between replicators at different levels of abstraction

1.3.4 Selection

The knowledge in different replicators is causally related. Replicators are selected by their capacity to survive in an environment. An environment results from transformations caused by replicators. Therefore the propagation capacity of replicators is causally dependent on the form of other replicators. The selection that results from causal dependence is often *mutual*. A simple example is how the genes of a lion and deer are causally related, resulting in mutual selection. If a lion successfully hunts a deer, both the lions genes are selected for and the deer genes are selected against.

Susan Blackmore's 'meme machine' hypothesis posits that memes select on genes, therefore showing that the selection between replicators spans to replicators at different levels of abstraction. A sub-conjecture described in section 6.1 is that this selection is mutual. Genes select on memes that assist their propagation, by evolving a neural architecture capable of selecting memes that align with genetic propagation. The central idea relevant to this paper's predictions is that mutual selection extends to replicators of different levels of abstraction.

The complexity of evolutionary selection is compounded by the necessity to consider nuanced explanations such as *game theory*. Phenomena such as birds removing parasites from back others backs initially appear to contradict the principle of selfishness. However, the apparently altruism can be understood as selfish from a game theoretic perspective. Birds remove other parasites as the genes causing this behaviour can be propagated, as birds can have an increasing the probability of their own parasites being removed by other birds. Due to such complexities, evolutionary theory is rife with nuances that make the construction of falsifiable predictions challenging (discussed in 4.3).

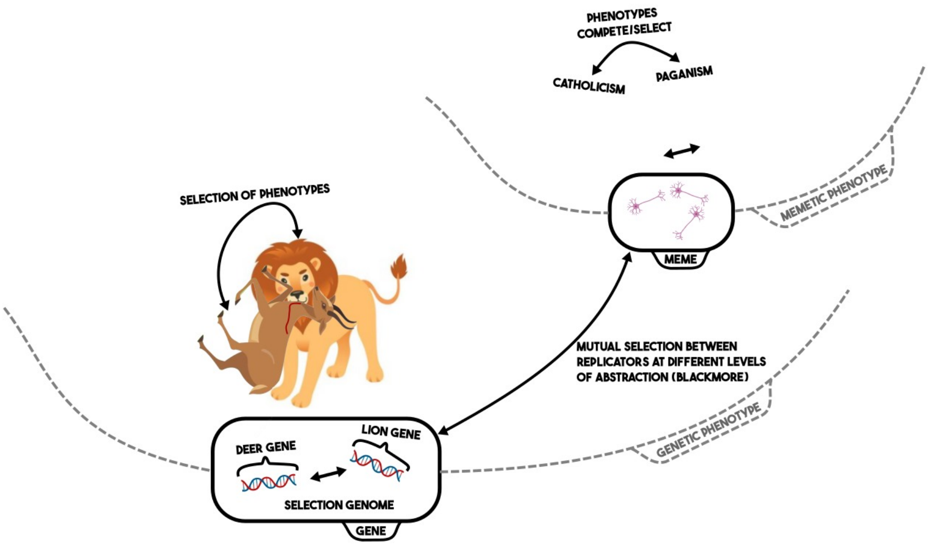

Figure 8: Mutual selection between replicators at the same and different levels of abstraction

1.3.5 Error Correction

Error correcting schemes introduce redundancy in information, allowing errors to be identified and corrected. This ensures fidelity in the transmission of an information structure. Within the context of information theory, Shannon's seminal work outlines the possibility of error correction for the reliable transfer of digital information across a noisy channel. The requirement for efficient error correcting schemes resulted in mathematical techniques like Hamming's *Error-Correcting Codes (ECCs).* These codes are efficient ways of adding redundant bits to mitigate errors such as bit flips, thereby safeguarding the integrity of the transmitted information. From the consideration of temes (1.3.3), ECCs can be understood as knowledge created by the human creative capacity to propagate temes.

The principles of error correcting are not novel inventions but pre-existed humanity's discovery, in memetic and genetic replicators. In genetic systems, error correction manifests in mechanisms like DNA proofreading and mismatch repair during DNA synthesis. Similarly, in memetic systems, the robust nature of the human creative capacity allows identification and propagation of memes in noisy environments. (Detail of this mechanism is in section 6.1)

In conclusion, replicators, ranging from Hamming's ECCs in temes to processes within genetic and memetic systems, utilize error correction to ensure the faithful propagation of their embodied knowledge. This emphasizes the ubiquitous selection for efficient error correction methods wherever replicators evolve.

1.4 Physics

1.4.1 Physics from computation

Traditional physics, grounded in continuous spaces, demands an infinitely detailed description of reality. The successes of Newton's laws, Thermodynamics, Electromagnetism, General Relativity (GR), and Quantum Mechanics (QM) have been predicated on this continuous conceptualization.

Yet, Maxwell's Statistical Mechanics illustrated that thermodynamics, when perceived in continuous space, can be numerically reduced to the discrete dynamics of atoms. Fluid dynamics offers similar insights. This transition from continuous to discrete models is reminiscent of the emergence of irrational numbers in computational automata, not native to the system.

The "It from Bit" doctrine by John Wheeler posits that information and its computational interactions are at the heart of reality. Esteemed figures like Edward Fredkin, Marvin Minsky, and Richard Feynman have echoed similar sentiments, discussing the inconsistencies of formulating reality that exists in an infinitely detailed space. There are many contemporary frontiers that align with the notion that space-time is a discrete entity, such as Carl von Weizsäcker's ur-theory, David Finkelstein's spacetime code, and Roger Penrose's spin networks, David Bohm's work in topochronology, the "It from Qubit" program, Gauge-Gravity Duality, Loop quantum gravity or Causal dynamic triangulations.

A noteworthy proponent of the computation perspective is the Wolfram Physics Project. Work by Gorard and collaborators claims that large families of hyper-graph rewriting rules an reproduce dynamics consistent with mathematical principles of GR and QM, as emergent properties of these systems.

To reproduce specific properties of our universe, specific rules or sets of rules must be identified to update the hyper-graph. The project currently explains the existence of the rule through Ruliad structure, which generates all possible rule and initial conditions. This is disagreed with in section 4.2.

1.4.2 Theory of Everything

Comprehensive detail of the fundamental structure updating information in reality and its dynamics is the ultimate objective in physics. It is referred to as the *Theory of Everything* (ToE).

In the wolfram model the F(ToE) would be the fundamental update rule. Deutsch refers to this rule as the Laws of Physics, as opposed to the laws of nature, which are abstract, numerically reducible parsings of the information structure updated by the fundamental rule. Contemporary theory recognises thermodynamics etc as numerically reducible parsings/ emergent analysis of fundamental system, the wolfram model implies that GR and QM are also laws of nature. The following conceptualisation is assumed in this paper. Some well defined structure updates reality, current laws in physics are laws of nature, or numerically reducible parsings of this update function.

Explain that this is equivalent to the laws of phsyics by deutsch or rewrite rule by wolfram.

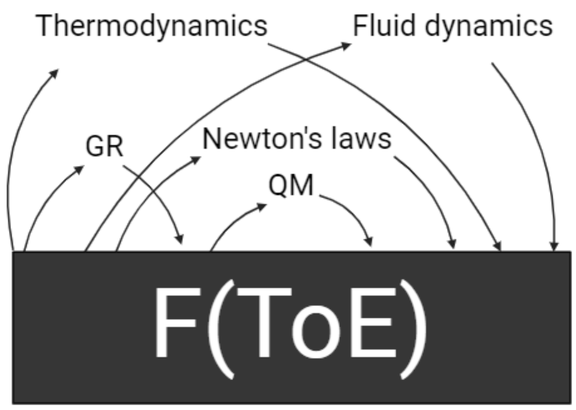

Figure 9: Abstraction - reducible/ emergent laws of physics

1.4.3 Fine Tuning Paradox

The 'everything' in ToE is misleading. A ToE aims to provide a complete mapping of a significant level of abstraction, analogous to the Human Genome Project. However, like the outcome of the Human Genome project, it does not explain the numerically irreducible, emergent phenomena that result from its existence. As Deutsch observes, even with a ToE, our understanding is always an infinitesimal subsection of possible knowledge[4].

A comprehensive ToE would therefore not resolve the mystery of its existence. The vastness of the potential law space, whether in the myriad manifolds of string theory or the constants of the standard model, QM, and GR, pose an enigma. This question is encapsulated by the *fine tuning paradox* - why do the specific laws of physics facilitating human evolution exist (the anthropic explanation is considered to be limited, as discussed in 4.2). As Hawking wrote, 'what breathes fire into the equations and makes a universe for them to describe?' The following section ventures to address this profound query.

2 Conjecture

This paper conjectures that **the fundamental structure causing the observed dynamics of reality - f(ToE) - is a replicator, henceforth defined as a *feme*** (fundemantal -eme). Femes are constructors as they causes a specific transformation and retain the capacity to cause the transformation again.

It is proposed that established laws such as Quantum Mechanics (QM) and General Relativity (GR) are numerically reducible mathematical descriptions of the information structure that dynamically interacts with the femes. The transformations caused by the feme constitute its phenotype, which in this framework is posited to be the observable universe (stars, atoms). The origin of this knowledge in femes is the evolutionary process. The phenotype of molecular dynamics is an abstract evolutionary system where genetic evolution occurs.

The conjecture therefore posits that **every structure in the universe can be categorized either as a replicator or as a phenotype**.

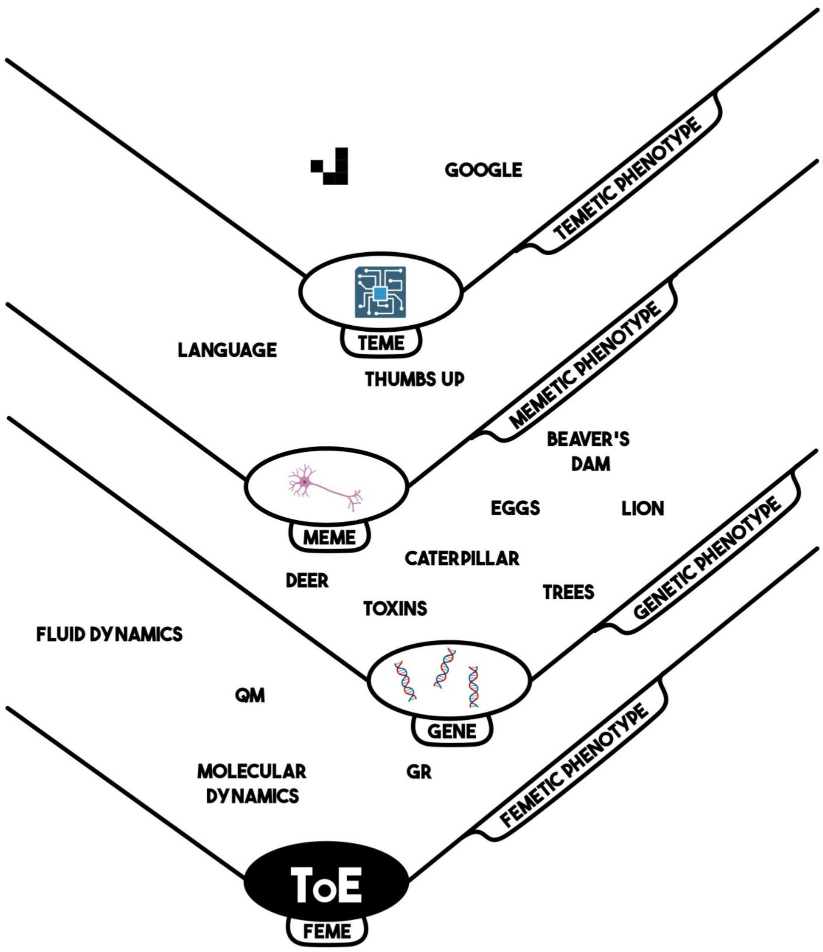

Figure 10: DNA in phenotype with observable laws, fundamental replicator forming laws.

3 Predictions

3.1 Knowledge of ECCs in Femes

As outlined in Section 3.1, evolutionary systems select for the knowledge of error correcting schemes to ensure the faithful propagation of replicators. Accordingly, it is predicted that femes embody some error correcting scheme that maintains the integrity of their embodied knowledge.

Support for this contention emerges from the work by James Gates et al., concerning super-symmetry (SUSY). Their model employs geometric objects known as Adinkras to represent SUSY equations through a one-dimensional representation technique, termed 'gnomoning.' Crucially, the structural foldings within these Adinkras exhibit bit sequences that align with principles of Hamming codes, specifically, doubly even self-dual linear binary error-correcting block codes. These codes serve to mitigate error impact, thereby preserving the mathematical properties intrinsic to SUSY.

The potential ramifications of these findings have not escaped Gates, who has pondered their implications vis-a-vis evolutionary theory:

> 'To write equations where information gets transmitted reliably, if you're in a super symmetrical system with this extra symmetry, that doesn't happen unless there's an error correcting code present. So it is as if the universe says you don't really transmit information unless there's something about an error correcting code. This to me is the craziest thing that I've ever personally encountered in my research and it actually got me to wondering how this could come about because the only place in nature that we know about error correcting codes is genetics and in genetics we think it was evolution that causes error correcting codes to be in genomes. So does that mean that there was some kind of form of evolution acting on the mathematical laws of the physics of our universe?'

Prediction - Femes contain ECCs.

3.2 Entropy of Femes

Entropy is the dissociation of non-arbitrary structures over time. In this work, femes are considered to be an example of a non-arbitrary structure, and are similarly subject to the phenomenon of entropy. Predictions resulting from the eternal existence of these laws, such as *heat death* of the universe, are similarly predicted to be incorrect.

Prediction: Femes are fallible and will be destroyed upon interaction with knowledge that evolves in the future. Heat death will not occur.

3.3 Selection for Efficient Information Processing

Hamming codes are indicative of selection of efficiency. Humans and the instruments of the current scientific method only interact with the input/output femes. There are infinitely many functions that could generate the input/output of the F(ToE), with varying efficiency. Knowledge can be created grants understanding of the processing efficiency of the f(ToE). ECCs grant significant improvements in efficiency compared to simple redundancy, suggesting selection for efficiency. Evolution generally selects for efficiency. The femes that generate the input/output we observe are predicted to in a be optimised for efficiency.

Prediction: Femes are optimised for efficient information processing. Formulations of reality requiring excessive computational resources, such as the *Many Worlds interpretation* appear inaccurate, on the basis of relative inefficiency.

3.4 Fine Tuning Implies Selection of Knowledge that Causes Propagation of Femes

This paper posits that femes contain knowledge beyond error correcting codes (ECCs) and efficiency.

The fine tuning principle acknowledges that the capacity for an information system to facilitate non convergent evolution is hard to come by.

For example, a persistent challenge in evolutionary computing is the tendency for the evolution of complex replicators to stagnate or converge on sub-optimal solutions.

Tegmark's work, along with the enormous search space posited by string theory, underscore the extreme rarity of conditions conducive to complex evolutionary pathways. In both paradigms, the vast majority of potential configurations would not allow for the emergence and evolution of complex life or replicators. Hence, the ability to generate non-stagnant, complex evolutionary pathways aligns with the definition of knowledge in that it is both hard to come by and hard to vary.

However, it is insufficient for femes to merely have properties concordant with knowledge; to constitute knowledge there must be a mechanism that causes the propagation of structure embodying it.

This paper suggests that emergent replicators, whose existence is facilitated by femes, have selected and promoted the propagation of femes containing this knowledge. Sections 1.3.4 and 6.1 discuss how memes select and promote the propagation of genes that are advantageous to them. Analogously, emergent replicators could select and promote the propagation of femes that are beneficial to their own existence and propagation. In this way, a symbiotic relationship between abstract replicators is established: femes facilitate the existence of complex emergent replicators, which in turn promote the propagation of femes containing knowledge for their creation.

Prediction: Femes contain knowledge that prevents evolutionary stagnation. This knowledge has been selected and propagated by emergent replicators that are benefited by propagation of femes. Consequently, the information selecting femes must have existed prior to the *Big Bang*.

4 Discussion

4.1 Cosmological Natural Selection

Lee Smolin's Cosmological Natural Selection (CNS) postulates that new universes arise within black holes, inheriting modified laws of physics from their parent universes. According to this theory, the conditions within black holes serve as an environment for the replication and variation of the laws of physics. Smolin proposes the selection mechanism where universes yielding a higher number of black holes possess greater 'fitness,' thus propagating their specific laws of physics more effectively, and providing a basis for resolving the fine tuning paradox.

While 2 agrees that the form of the observable universe has been selected by evolution, it argues that Smolin's CNS misidentifies the replicator.

4.2 The Anthropic Principle and Multiverse

The *Strong Anthropic Principle (SAP)* postulates: The Universe must harbor properties that render the existence of intelligent life inevitable.

The *Weak Anthropic Principle (WAP)* asserts: The observed Universe accommodates properties compatible with the existence of intelligent life, primarily because intelligent life exists to observe it.

This section encapsulates these principles with the following inference statement:

We exist → Laws capable of causing our existence exist (through evolution).

Though these principles constrain the form of physical laws, they lack explanatory power. Specifically, they offer no insights into the nature of the system that exists either prior to or beyond their scope, thereby failing to explain the origin or consequence of fundamental laws.

A common explanation for why such laws exist is to posit an infinite multiverse. This reasoning can be expressed as:

We exist → Laws capable of generating us exist ((information interacting with the laws causes evolution of knowledge embodied by humans)→ A system generating these laws exists (Infinite Multiverse/ Ruliad).

Challenging this inference, this paper invokes *Gödel's incompleteness theorems* to argue that even an infinite multiverse cannot assure the existence of all possible structures. An infinite structure, being incomplete, disallows the notion that all possible structures exist within it. This stance serves as the basis for disagreeing with the *Ruliad* in the Wolfram physics project, which posits that rules governing reality arise from all conceivable rules and initial conditions. These perspectives overlook evolutionary selection, a phenomenon this paper posits as fundamental for understanding reality, which does not require the existence of all possible rules and initial conditions. The idea is encapsulated by the following inference statement:

We exist → Laws capable of generating us exist (information interacting with the laws causes evolution of knowledge embodied by humans) → A system generating these laws exists (information interacting with some unknown system causes evolution of knowledge embodied by laws).

4.3 Falsifiability

Karl Popper initially termed evolutionary theory a 'metaphysical research program', critiquing it for its perceived lack of falsifiable predictions.

Falsifiability in evolutionary theory is complex. It is not a numerically reducible parsing that results in definite conjectures that can be easily validated or rejected. Evolution can not offer precise predictions, as the process is often numerically irreducible, especially at timescales further into the future, as many levels of abstraction causally interact, resulting in chaotic dynamics. Rather, it is an ontological concept, detailing the generalized nature of how systems may propagate through time. Evolutionary theory does then produce discernible patterns that lay the groundwork for falsifiable conjectures. Notable examples include Darwin's prediction of the existence of the elephant moth and Dick Alexander's prediction of the naked mole rat.

As such, Popper later revised this stance, acknowledging that evolutionary theory is capable of making falsifiable claims. Moreover, Popper's doctrine on the philosophy of science aligns remarkably well with the principles of evolutionary theory, a connection explicitly drawn by Deutsch. Deutsch summarises Popper's philosophy on conjecture in science by stating, "Popper could just as well have written, 'We do not acquire new memes by copying them, or by inferring them inductively from observation, or by any other method of imitation of, or instruction by, the environment.' The transmission of human-type memes cannot be other than a creative activity on the part of the receiver."

This paper's evolutionary hypothesis extends the domain of evolutionary explanation to the most fundamental information in reality. While not immediately testable, this extension is argued to be falsifiability, in line with Popper's *tradition of criticism and conjecture.*

4.4 Future Research

4.4.1 Guiding Principle for a Theory of Everything

The degree of accuracy of predictions from current theory suggests that the f(ToE) could be *simple*, in that it may well lie within our immediate capacity to describe and understand, without considering evolutionary principles. Nonetheless, this paper contends that principles from evolutionary theory may serve as heuristics for guiding research aiming to identify the F(ToE). For example, evolutionary principles could direct further research into the nature of error-correcting codes (ECCs) and the structures they act upon.

4.4.2 Assembly Theory Analysis

Determine the complexity of the laws.

4.4.3 Search Space Analysis

Search space analysis would aim to identify t, for instance, investigate the variance in the human genome to ascertain the proportion of genetic combinations embodying knowledge. Similar approaches could be used for the various sites of evolution, genes, memes, temes, across their many instantiations in reality. This would serve to gauge the degree of optimization present, and offer insights into the technique of revere engineering selection functions from the structures they select on. Similar techniques such as *assembly theory* function to carry out this process on assembled molecules. Progress here to be repurposed and applied to the F(ToE) to quantify the prevalence of knowledge within femes and the nature of the selection function that created them, and therefore the nature of information existing before the big bang.

4.4.4 Evolutionary Principles for Rule Searching

Evolutionary algorithms can be employed to explore vast combinatorial search spaces to identify potential rules that share properties expected of fundamental laws. These algorithms, derived from evolutionary principles, are particularly effective for navigating immense domains such as those found in string theory. Wolfram Physics has already initiated steps to use similar selection functions in combination with evolutionary computing systems. This approach differs from directly mimicking the evolutionary process that may generate the universe; it aims to evolve rule sets that align with the existing, observable laws, for which we already have the fitness function.

5 Conclusion

This paper conjectures that the observable universe is the phenotype of fundamental replicators termed as 'femes', that embody knowledge selected by evolution. This knowledge is proposed to have originated from interaction of information that existed before the Big Bang.

Four predictions result from this conjecture:

1. Femes contain error-correcting codes.
2. The embodied knowledge in femes is fallible and will cease to propagate upon encountering future-evolved structures.
3. The laws of physics are optimized for efficient information processing, casting doubt on theories requiring massive computational resources, such as the Many Worlds interpretation.
4. The knowledge in femes facilitating complex evolution has been selected by emergent replicators, which provides a mechanism for propagation of the knowledge in femes.

While evolutionary theory often presents challenges in deriving falsifiable predictions and identifying theoretical inconsistencies, the general principle is required to explain the form of any complex information structure we observe. This paper extends the domain of evolutionary theory into the realm of fundamental physics. Such an extension is not merely speculative but offers a novel analytical lens grounded in generalized principles of evolutionary theory.

The complexities and nuances of evolutionary theory are acknowledged, yet its application to physics is considered useful for advancing our understanding of the universe. The paper also considers the multitude of complex replicators and considers the value of developing their respective theories independently, and highlights the necessity and value of doing so. This paper aims to highlight the explanatory power of evolutionary theory as an ontology, underappreciated by conventional research efforts.

The *Something from Nothing* problem remains a central concern in both cosmology and philosophy. It highlights the necessity for a fundamental understanding of why information exists and interacts. This paper presents a hypothesis that aims to delineate a causal history for our universe that does not necessitate the complex laws of physics as an initial condition. Instead, the ubiquitous evolution arising from the interactions between information structures is proposed as the underlying mechanism that giving rise to the laws of physics.

6 Appendix

6.1 Detailed Treatment of Memetic theory

6.1.1 Divergence from Genetic Theory

Memetic theory, first introduced by Richard Dawkins in 'The Selfish Gene,' posits that memes are abstract replicators existing in the substrate of neural connections. These memes, like genes, are subject to replication, mutation, and selection. Memetics is often described as the evolution of culture. It is theorised to result in the phenotype of the structures created by humans, language, gestures, religions.

It is imperative to approach memetic theory with a discerning lens, recognizing its distinctiveness from genetic theory.

While Dawkins laid the groundwork, the intricacies of memetic theory have been further explored and refined by scholars such as David Deutsch and Susan Blackmore. Deutsch, in particular, cautions against drawing simplistic parallels between biological and cultural evolution. He emphasizes that even though both domains might share an underlying theory, the mechanisms of transmission, variation, and selection diverge significantly.

6.1.2 Memetic Replication

The replication mechanism of memes differs from that of genes, as memes can't physically transport themselves between brains (unlike the movement of genes between organisms in Figure 6). Instead, as constructors and replicators, memes cause transformations that promote their propagation and replication. The transformation results in some functional change to the behaviour of a human embodying the meme. When another individual observes this phenotype, their cognitive system can conceptualise the observed change, causing the meme to be replicated in the observer. This process leverages what Deutsch terms as the 'creative capacity' of humans — our ability to conceptualize and generate memes internally. These internal memes can then be further disseminated as the observer may cause the transformation that propagates the meme.

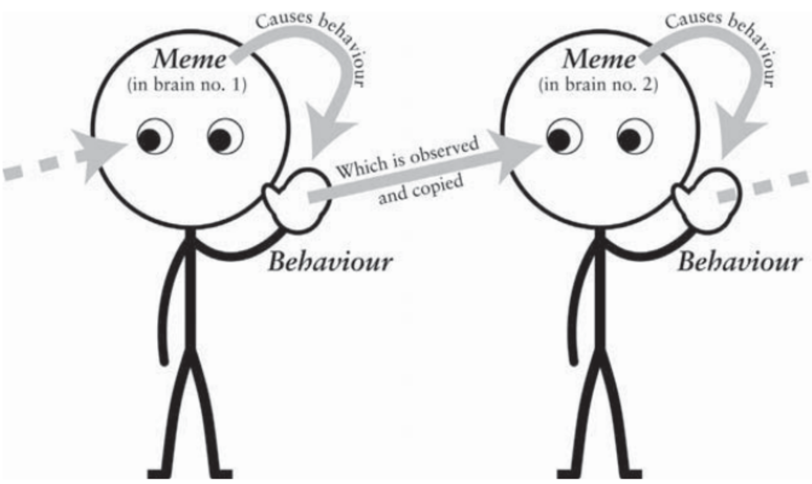

Figure 11: Deutsch's illustration of how memes propagate

It should be noted that while a behaviour is typically defined as an action carried out by the human body, the transformation that causes replication of the meme extends to all structure in reality that causally results from the existence of the meme (in alignment with the Dawkins' concept of the extended phenotype).

Deutsch recognises that the phenotype alone can cause propagation of the meme, and can therefore be recognised as a replicator. For example, particular statues of heads found on Easter Island, called Moai, existed as physical entities long after the memes that led to their creation had vanished along with the Easter Island civilization. When they were rediscovered, new memes about their origin, significance, and construction methods were formed in the minds of the explorers and researchers, leading to the replication of these new memes (mentally and physically) in broader society. A genetic phenotype could never replicate without DNA. Therefore Deutsch states that memes have a physical and mental representation, to highlight the difference in propagation capacity of genetic and memetic phenotypes. This paper maintains that the physical meme is a phenotype, as it is the transformation caused by a replicator that has a relatively constant form.

6.1.3 Memetic Variation

Deutsch's concept of *'Creative Capacity'* underscores our innate ability to conceptualise and copy memes. He argues that this capacity initially evolved to assimilate existing knowledge. However, the same mechanism that enables copying also facilitates creation, leading to memetic variations mechanism of both imperfect copying and inherent creativity. Deutsch explains:

> 'The first (question) is why human creativity was evolutionarily advantageous at a time when there was almost no innovation. The second is how human memes can possibly be replicated, given that they have content that the recipient never observes. I think that both those puzzles have the same solution: what replicates human memes is creativity; and creativity was used, while it was evolving, to replicate memes.'

This creative capacity offers memetics a distinct advantage over genetic mutation. The brain can internally simulate and evaluate the potential outcomes of new memes, allowing for a more intelligent process of variation and selection before external expression.

> For it depends on conjecture (which is variation) and criticism (for the purpose of selecting ideas). So, somewhere inside brains, blind variations and selections are adding up to creative thought at a higher level of emergence.

6.1.4 Memes Causing the Evolution of the Big Brain

Susan Blackmore's posited the *Meme Machine* idea - memes, acting in their own selfish interest, caused the selection of genes predisposing to larger brains, thus providing a more fertile ground for meme propagation[5].

Deutsch delves into the co-evolution of memes and genes. He presents a counter-intuitive perspective on how memes caused selection for genes that optimize meme propagation. He explains:

> 'In early pre-human societies, there were only very simple memes – the kind that apes now have, though perhaps with a wider repertoire of copyable elementary behaviors. Those memes were about practical things like how

> to get food that was otherwise inaccessible. The value of such knowledge must have been high, so this created a ready-made niche for any adaptation that would reduce the effort required to replicate memes. Creativity was the ultimate adaptation to fill that niche. As it increased, further adaptations co-evolved, such as an increase in memory capacity (to store more memes), finer motor control, and specialized brain structures for dealing with language. As a result, the meme bandwidth (the amount of memetic information that could be passed from each generation to the next) increased too. Memes also became more complex and sophisticated. This is why and how our species evolved, and why it evolved rapidly – at first. Memes gradually came to dominate our ancestors' behavior. Meme evolution took place, and, like all evolution, this was always in the direction of greater faithfulness. This meant becoming ever more anti-rational. At some point, meme evolution achieved static societies – presumably they were tribes. Consequently, all those increases in creativity never produced streams of innovations. Innovation remained imperceptibly slow, even as the capacity for it was increasing rapidly.'

In these static societies, behavior was predominantly dictated by societal norms. Conforming to these norms was essential for survival and reproductive success.

> 'Status in such a society is reduced by transgressing people's expectations of proper behavior, and is improved by meeting them. There would have been the expectations of parents, priests, chiefs and potential mates (or whoever controlled mating in that society) – who were themselves conforming to the wishes and expectations of the society at large. Those people's opinions would determine one's ability to eat, thrive and reproduce, and hence the fate of one's genes. And that is how primitive, static societies, which contained pitifully little knowledge and existed only by suppressing innovation, constituted environments that strongly favoured the evolution of an ever greater ability to innovate.'

Blackmore's proposition, which Deutsch agrees with, is that the human brain's primary evolutionary purpose was meme replication.

> 'Blackmore's "meme machine" idea, that human brains evolved in order to replicate memes, must be true. The reason it must be true is that, whatever had set off the evolution of any of those attributes, creativity would have had to evolve as well. For no human-level mental achievements would be possible without human-type (explanatory) memes, and the laws of epistemology dictate that no such memes are possible without creativity. On the face of it, creativity cannot have been useful during the evolution of humans, because knowledge was growing much too slowly for the more creative individuals to have had any selective advantage. This is a puzzle. A second puzzle is: how can complex memes even exist, given that brains have no mechanism to download them from other brains? Complex memes do not mandate specific bodily actions, but rules. We can see the actions, but not the rules, so how do we replicate them? We replicate them by creativity. That solves both problems, for replicating memes unchanged is the function for which creativity evolved. And that is why our species exists.'

In conclusion, the intertwined evolution of memes and genes, as detailed by Deutsch and Blackmore, provides profound insights into the complex interplay between our cognitive and biological evolution. However, while their ideas explain the result of memes causing selection of genes, neither considerations give explicit detail on the genetic selection of memes. This is the topic of the following sub-conjecture - a memetic selection mechanism results from the evolution of genes that could selfishly select on memes that caused their propagation. The evolved mechanism is posited to be a neural architecture that generates the conscious experience.

6.1.5 Memetic Selection (sub-conjecture)

In his exploration of memetic theory, Deutsch subtly yet consistently touches upon the mechanisms underpinning meme selection. He doesn't rigorously define a mechanism but gives explanations that appear to implicitly align with the sub-conjecture:

> 'the selection mechanism of memes in the form of jokes is how 'amusing' they are perceived to be.'
>
> 'each meme competes with rival versions of itself across the population, perhaps by containing the knowledge for some useful function.'
>
> 'To be transferred, a meme needs to seem useful. 'Useful' in this context does not necessarily mean functionally useful: it refers to any property that can make people want to adopt an idea and enact it, such as being interesting, funny, elegant, easily remembered, morally right and so on.'
>
> 'In such an environment, people are continually being faced with unpredictable problems and opportunities. Hence their needs and wishes are changing unpredictably too.'

The genetic selection of memes conjecture considers the co-evolutionary dynamics between genes and memes, as previously outlined and referenced in 1.3.4. We postulate that genes have evolved mechanisms to select memes that enhance their propagation. This necessitates a neural architecture capable of associating and selecting abstract memes based on their contribution to genetic propagation.

A pressing question emerges: how does this architecture bridge the abstract domain of memes with the tangible domain of gene propagation? We suggest that the concept of *utility*, expressed as emotional experiences, serves this function[6, 7]. As Deutsch notes, memes propagate and replicate based on their resonance, humor, or alignment with human desires. Drawing inspiration from Hume, these desires are framed as utility evaluations, and are transmitted by their influence on emotional experience of the human.

The *hard problem* of consciousness presents a challenge: understanding why certain neural processes lead to subjective experiences[8]. Within our framework, the hard problem results from the requirement for systems selecting on memes to be processed simultaneously with functional processes (the *easy problem*), possesses a neural architecture that integrates these evaluations, culminating in the generation of conscious experience.

Invoking Descartes's dualism, the distinction between the mind and the body parallels our theme of abstraction. The mind, adept at engaging with abstract memes, contrasts with the tangible, physical realm. Through the perspective of co-evolution, we infer that the complexities of consciousness have evolved as a necessity, propelled by the selfish propagation of abstract replicators.

To illustrate, one can consider *memeplexes* like religious beliefs. These systems, which often advocate activities such as marriage and societal cohesion, directly support genetic propagation. Such memeplexes have evolved and a propagated by individuals because they interacting with the neural structure evolved by genes that assesses their utility in relation to genetic propagation.

6.1.6 Relation to primary conjecture and predictions

The proposed selection mechanism for memes is integral to the primary conjecture and the predictions set forth in this paper.

To fully grasp memetic selection, it's essential to consider the causal influences of genetic replicators at different abstraction levels. This causal framework underscores the selection dynamics among abstract replicators.

Similarly, femes assume their form due to their causal relationships with other abstract replicators, mutually influencing each other's evolution and propagation. This concept of mutual selection between abstract replicators interconnects the sub-conjecture with the paper's main conjecture and predictions .

7 Glossary

Information: Originally introduced by Claude Shannon, it's the study of quantifying and communicating information.

Distinguishable: Output different

Counterfactual (Marletto): A property of information structures that allows them to yield varied outputs upon interaction.

Structure: Information embodied in non- arbitrary, well defined form, with counterfactual properties.

Interaction: Information structures causing the existence another stature, causally dependent on their form, interact.

Function: (transformation/ operation). Interacts with some information to create output. Is similar to a catalyst in that it is typically retained after interaction.

Data: Conceptually similar to data. Structure that can typically be input and output from a function. Normally it is acted on or transformed

Lambda Calculus: Formulation of computation where functions and data are recognised as equivalent.

Computation / System: Is the system if information structures interact. Computation in the interaction of information, where the output of interaction is typically retained and significant for the future development of the system.

Universality: (Turing complete) Property of computational systems if they are sufficiently complex to simulate any well defined transformation between sets of information. Turing Machine is example of a universal machine, therefore a Turing machine can simulate the operation of any universal machine, and any universal machine can simulate any Turing machine.

Knowledge (Deutsch): Evolutionarily shaped information with an ability for self-replication or retention.

Environment: Set of structures that are interacted to be interacted with.

Knowledge (Marletto): Information capable of self-preservation.

Propagate: A structure propagates if it exists after interaction with some other structure.

Glider: Structure in a CA that has 4 orientations, each of which cause itself to propagate when interacting with the f(GoL).

Constructor: (abstract catalyst) A structure causing transformation without undergoing any net change. It retaining the ability to do cause a transformation again.

Transformation: (Task)A process that alters the state or composition of a structure, leading to a new set of properties or functionalities.

Hard to Vary: A characteristic of a theory or explanation that cannot be easily modified without compromising its explanatory power or internal coherence.

Hard to come by: A description of knowledge or information that is difficult to acquire, often because it is deeply embedded in complex systems or requires intricate methods for extraction.

Search space: Combinatorial possibilities of the units of information that form a structure

Abstraction: Ability to define structures in a system, their properties, such that the system can be understood at a level of abstraction other than the fundamental updates

Fundamental: Most basic level of abstraction, that must exist in order for emergent properties to exist.

Emergent: results from fundamental level

Numerically reducible system: A computational system is reducible if the future state of the system can be calculated by means other that computing the fundamental updates. Glider in the GoL is an example.

Computationally bounded: Structures at different abstraction are causally disconnected.

Computational equivalence/ Interoperability:

Parochial: Any knowledge facilitates propagation upon interaction with a subset of the infinite set of possible structures.

Fallible: Any knowledge would fail to propagate upon interaction with infinitely many unique functions.

Problems are inevitable: From the perspective of any structure, interaction with structures that can destroy the structure will inevitably be encountered.

Problems are soluble: Any structure that can be encountered in itself fallible, and evolution can always create structures that will avoid destruction upon interaction with the problem.

Evolution: A dynamic process that governs the transformation of structures over time, characterized by replication, mutation, and selection.

Evolutionary system: System with repeated cycles of imperfect copying of information, alternating with selection.

Replicate: Exact or approximate copy of a given structure, thereby perpetuating its constituent structure and knowledge.

Mutate: The introduction of variations in a structure, which may result in novel functionality

Selection: A mechanism by which certain structures are preferentially retained or discarded based on their efficacy or fitness in a given environment, resulting to an accumulation of beneficial traits over time (knowledge).

Replicator: An entity that passes on its structure largely intact in successive replications.

Selfish: All replicators are selected only by their capacity for self-propagation.

Phenotype: Any transformation caused by the information embodied by a replicator.

Gene: (Dawkins) A stretch of DNA that influences an organism's form, function, or behavior in such a way that it affects the chances of that particular stretch being replicated in future generations.

Genome: The collection of genes contained in an organism.

Meme: Abstract structure existing in the substrate of connections between neurons, that causes some transformation that impacts the probability of propagation and replication.

Memeplex: A cohesive collection of memes that tend to be propagated together. Analogous to a genome in genetics, a memeplex represents a complex of ideas, beliefs, or practices that reinforce each other and are often spread as a unit.

Teme: A unit of technological information, residing in artifacts, capable of self-replication, mutation, and selection.

-eme: The '-eme' suffix usually connotes some kind of fundamental, indivisible unit within a given system. For example, in linguistics, a "phoneme" is the smallest unit of sound that can distinguish one word from another. Used here to denote replicators that generate some system of phenotypes.

Non-binary: Spectrum of results. reality is finite, space of outcomes is not continuous, but the space of discrete possibilities is vast/immense.

Mutual: (bi-directional) all structures involved in the interaction are transformed by the nature of interaction. Interaction can transform both information sets.

Game Theory: Paradigm required to understand complexity of evolutionary interaction. Study of how structures interact/ compete/ transact over time.

Utility: Capacity to positively impact the emotional state of conscious entities.

Hyper-graph:

Causal Hyper-graph: Representation of a system's causal history where states can merge and branch.

Multi-computation:

Theory of Everything (ToE):

Feme: The replicator hypothesized to generate observable reality, which results from evolution. The term uses the '-eme' suffix used in 'gene', 'meme' and 'teme' to denote replicator.

Fine Tuning Problem: Question of why the universe accommodates life, given that this property is rare.

Heat Death: The equilibrium state resulting from entropy.

Many Worlds Interpretation: Bifurcations in causal history of QM means that each possible history and future was and will be instantiated by information.

Big Bang: Instantiation of the laws and initial conditions that resulted in the observable universe.

Godel's incompleteness theorems: A pair of theorems in mathematical logic asserting that within any sufficiently rich and consistent language, there exist statements that cannot be proven true or false.

Tradition of Conjecture and Criticism: Popper's doctrine that testable laws should be testable.

Simple: Accessing some knowledge is simple if it is well within the capability of an evolutionary system to create this knowledge. Neil Turok states that the laws of physics are exceptionally simple.

Something from nothing paradox: Why does information exist and interact?

Meme Machine hypothesis: The proposition that the human brain has evolved as a mechanism for generating, processing, and propagating memes.

Utility: A measure of the perceived value or benefit of an action, choice, or object. In economics and decision theory, utility represents an individual's satisfaction or preference. In the context of memetics, utility evaluates the desirability or resonance of a meme within an individual or group.

The Easy Problem: The challenge of understanding the brain's functional processes and mechanisms.

The Hard Problem: The question of how and why the brain's processes lead to subjective consciousness.

8 Refs

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butterfly life cycle

hamming codes

error correction genetics

maybe error correction memetics

pretty intense bit on physics, ref tf outa all of these

irrational numbers

wolfram refs

theory of everything

fine tuning paradox

hawkings statement

jim gate's statements

meaning of entropy

maybe statement that for ay function there are infinitely many ways ot mimic input output, would not be recognisable to an embedded observer - bach says this.

stagnation of evolutionary systems

tegamark

string theory

analysis of other worlds and if they would support life

cns

anthropic principles

ruliad from wolfram

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mathematical chaos

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assembly theory

evolutionary algorithms gorard set of parameters that can used to identify adequate rule sets.

something from nothing

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