IPI Letters

ISSN 2976 - 730X
IPI Letters 2024,Vol 3 (3):14-17
https://doi.org/10.59973/ipil.204

Received: 2025-05-13
Accepted: 2025-07-01
Published: 2025-07-05

Article

Femes: An Evolutionary Physics Solution to the Constructor Gap and Fine-Tuning

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Abstract - Computational models of physics suggest reality operates via a fundamental update rule, yet they lack an explicit physical mechanism for its instantiation. Constructor theory mandates that any reliable transformation requires a physical constructor. This paper resolves this gap by proposing the 'feme' – a fundamental replicating information structure – as the necessary constructor. We frame the fundamental update rules, such as those described in Wolfram Physics or supersymmetry, as the transformations caused by the interaction of the feme with reality. We argue that femes, like genes, memes, and temes, are replicators that embody knowledge for creating both a phenotype and a copy of itself. Their evolution by natural selection provides a causal mechanism for the stability and fine-tuning of physical laws, predicting observable signatures including a self-replication program, embedded error-correcting codes, and the fallibility of physical laws.

Keywords - Fundamental Replicators; Computation; Femes; Evolutionary theory; Constructor theory;

1 Physics Needs a Constructor: The Foundational Gap

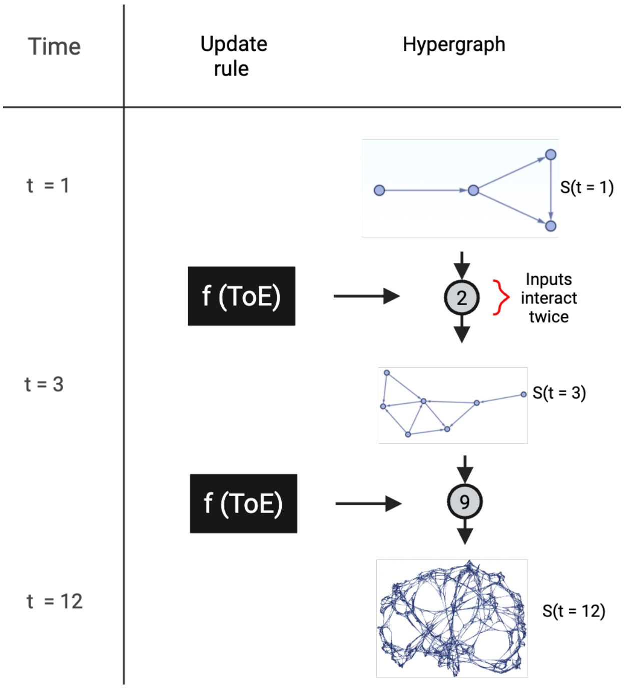
Contemporary physics explores models where reality is computational. Approaches such as the Wolfram Physics Project [1] describe the universe's state, potentially represented by a hypergraph S, evolving via discrete applications of an update rule, denoted $f(\text{ToE(Theory of Everything)}))$. The dynamical process is thus $S(t+1) = f(\text{ToE})(S(t))$. The success of such models in generating emergent dynamics, numerically reducible to mathematics consistent with General Relativity and Quantum Mechanics [2.3], supports the interpretation of $f(\text{ToE})$ as a reliably performed physical transformation T.

However, Constructor Theory [4.5] provides principles governing physical transformations. It asserts that for any transformation T to be reliably performable on a substrate S, there must exist a physical constructor C. Let $P(S,T)$ be the proposition that T is reliably performed on S. Constructor Theory posits:

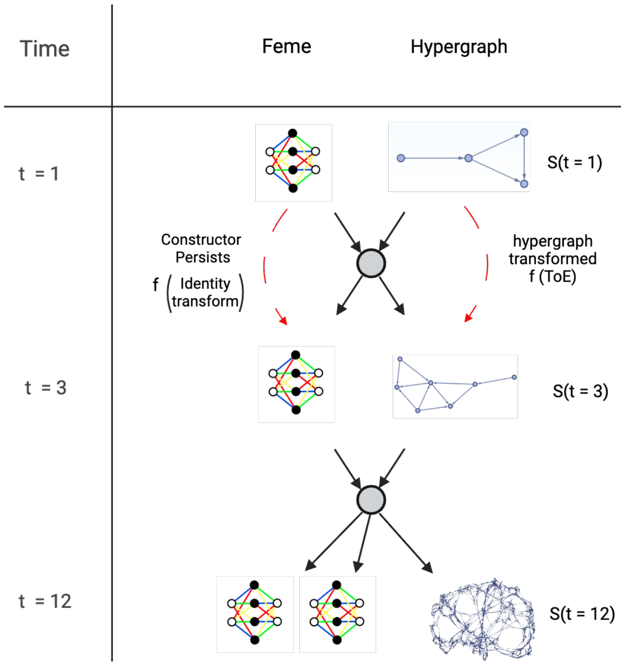
$$P(S,T) \Rightarrow \exists C : \text{ExistsConstructor}(T,S,C) \tag{1}$$

where $\text{ExistsConstructor}(T,S,C)$ means physical system C reliably causes $T(S)$ and retains the capacity to do so.

A direct inconsistency arises when applying this principle to the computational premise. If we accept $P(S, f(\text{ToE}))$ based on the success of computational models (Premise 1), then Constructor Theory (Premise 2) demands $\exists C : \text{ExistsConstructor}(f(\text{ToE}), S, C)$. Yet, the computational models typically specify $f(\text{ToE})$ and S without explicitly identifying the physical constructor C. This omission of the necessary physical mechanism constitutes the consistency gap (Fig. 1) [6].



(a) The computational view posits an abstract update rule f(ToE) transforming State(t), but lacks an explicit physical constructor.



(b) The Feme conjecture proposes a physical constructor and replicator [Feme] that interacts with State(t), enacts the transformation, and persists.

Figure 1: Illustrating the constructor gap in computational physics and its proposed resolution via the Feme.

2 The Feme: A Proposed Replicating Constructor

We propose to bridge this gap with the "feme" (F). The feme is hypothesized to be the physical constructor responsible for enacting the universe's update rule $f(\text{ToE})$, on the substrate S.

$$\text{ExistsConstructor}(f(\text{ToE}), S, F) \tag{2}$$

We conjecture that the feme is also a *replicator*, aligning with Von Neumann's insights on the requirements for self-reproducing automata [7]. Replicators embody both programs for their own self-assembly, and programs for the transformations they cause in the environment.
This can be expressed formally:

$$F = (I(F), \Phi(F)) \tag{3}$$

where:

- $I(F)$ is the *Self-Replication Program*: The internal set of instructions that codes for the Feme's own self-assembly.
- $\Phi(F)$ is the *Phenotypic Program*: The functional knowledge ($f(\text{ToE})$) that the Feme uses to interact with and transform its environment, resulting in its phenotype.

3 Femes, Genes, Memes, Temes

Why is the Feme conjectured to be a replicator? The answer lies in the nature of evolution. As David Deutsch argues, any system of interacting information will inevitably select for *knowledge*-information that remains once instantiated [8]. For knowledge to be refined and accumulated over time, it must be propagated on a high-fidelity replicator. Therefore, if the specific rule f(ToE) constitutes functional knowledge, it must be the phenotypic expression, $\Phi(F)$, of a replicator.
Information that cannot be copied reliably is lost to entropy [9].
Replicators and their evolution is the causal mechanism explaining the form and dynamics of other levels of abstraction in our reality. This is known as Universal Darwinism [10].

- Genes: Replicators on a biological substrate, creating organisms.
- Memes: Replicators on a cognitive substrate (brains), creating culture and ideas [11].
- Temes: Replicators on a digital substrate, software / AI.

The Feme is the fundamental replicator of physics, operating on the information substrate of reality. By identifying the Feme, we offer a novel framework for physics: as the base layer of a unified four-replicator reality governed by Universal Darwinism (Fig.2).

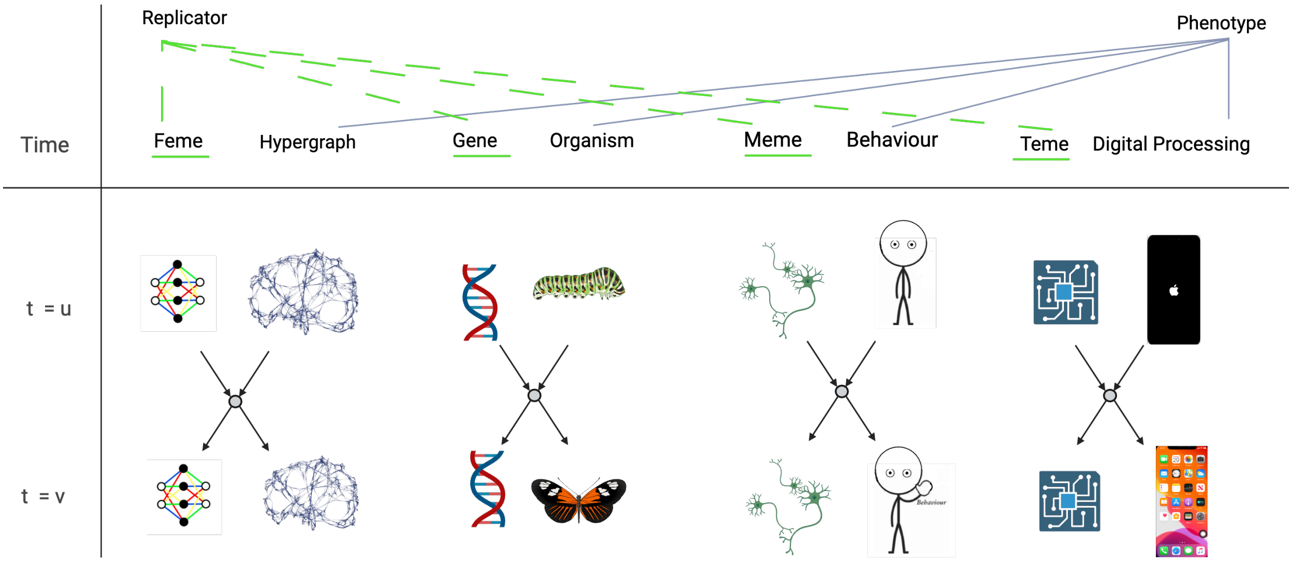


Figure 2: four-replicator reality; the proposed replicators and the phenotypes they create.

3.1 Fine-Tuning as Evolved Knowledge

The evolutionary framework established in the previous section not only explains the basic stability of physical law but also provides a causal mechanism for the much deeper problem of its fine- tuning. The combinatorial space of possible (f(ToE)) rules is vast. The fine tuning problem asks why the fundamental laws of reality are conducive to complex life. Appealing to anthropic selection across an infinite multiverse does not explain the instantiation of our specific rules [12-15].

The Feme hypothesis provides a causal mechanism for fine-tuning. The specific rule f(ToE) is the feme's phenotypic program, $\Phi(F)$. The vast majority of possible variations to this program would result in universes that would fail to support further complexity. Rare, "fine-tuned" rules, that create fertile environments allowing for the emergence of higher-order replicators, are a form of knowledge, selected by evolution.

4 Predictions and Outlook

If Femes are evolved replicators embodying knowledge, their structure and the laws they instantiate should contain discernible signatures:

- **A Replication Program:** The structure of physical laws must contain the necessary components for a self-replication mechanism, as per Von Neumann [7].
- **Error-Correcting Codes (ECCs):** To ensure high-fidelity replication, the laws enacted by femes should embed structures analogous to ECCs [16].
- **Fallibility of Physical Laws:** All knowledge is parochial and fallible. There are environments in which the feme would fail to propagate. Thus f(ToE) is not immutable, which negates the heat death of our universe.

The prediction of ECCs is particularly compelling because such structures have already been identified. The work of S. James Gates Jr. on Adinkra symbols—graphical representations of supersymmetry algebras—reveals that these structures must embody doubly-even, self-dual error-correcting codes [17]. Since ECCs are only necessary for systems that replicate information, this suggests that what we call "supersymmetric transformations" aren't abstract mathematical operations but rather the observable patterns produced by physical replicating structures.

Moreover, supersymmetric theories require "auxiliary fields"—entities that lack kinetic terms yet are necessary for theoretical consistency. This mathematical infrastructure is unexplained if supersymmetry describes pure transformations, but expected if it represents evolved replicator technology.

Understanding fundamental laws as transformations caused by evolved replicators may mark the advent of a new understanding of reality: not as a set of immutable platonic rules, but as an emergent, fallible, physical technology. This perspective unifies the computational view of physics with the causal demands of constructor theory and the explanatory power of Universal Darwinism. While built on small steps in logic from contemporary research, the Feme conjecture offers a giant leap in perspective. Further investigation into these signatures is warranted.

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