Finite-Model Experimental Verification of Fragmented Evolution Theory

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Abstract

This paper presents a reproducible finite-model experimental verification of the core structural claims of *Fragmented Evolution Theory*. Rather than assuming that evolution necessarily occurs, the experiments systematically examine the conditions under which evolution, dead loops, fragmentation, and drivenness are well-defined or fail under different scales, difference structures, and decisional thresholds. By large-scale parameter sweeping and explicit counterexample construction, we demonstrate that evolution is not an intrinsic property of a system but a scale-dependent and decision-structured relation, and that fragmentation structurally excludes absorption into terminal states.

1 Objective

The objective of this experiment is to verify the internal consistency and boundary behavior of the core structural propositions of Fragmented Evolution Theory. Specifically, we aim to:

- test whether evolution, fragmentation, and dead-loop predicates remain self-consistent across a wide class of finite models;
- identify whether structural implications admit counterexamples;
- characterize failure cases as controlled boundary conditions rather than theoretical defects.

The experiment combines parameter sweeping with explicit model checking.

2 Model and Method

2.1 State Space and Dynamics

We consider finite discrete state spaces $\mathbb{Z}_n$ with $n \geq 2$. System dynamics are defined by a translation rule:

$$x_{t+1} = x_t + \text{step} \pmod{n}, \tag{1}$$

where time indices are $t = 0, 1, \ldots, T-1$, and typically $T = n$.

2.2 Difference Functions and Decidability

Two types of difference functions are considered:

1. Modular difference:
$$\Delta(x, y) = (y - x) \bmod n; \tag{2}$$
2. Discrete difference:
$$\Delta(x, y) = \begin{cases} 0, & x = y, \\ 1, & x \neq y. \end{cases} \tag{3}$$

A decisional threshold $\varepsilon \geq 0$ is introduced, defining decidability as:

$$\text{Decidable}(\Delta) \iff \Delta > \varepsilon. \tag{4}$$

2.3 Scale Operators

Scale is modeled as a coarse-graining operator:

$$S_k : \mathbb{Z}_n \to \{0, 1, \ldots, k-1\}, \tag{5}$$

where $1 \leq k \leq n$.

Special cases include:

- $k = n$: identity scale;
- $k = 1$: total collapse scale.

Differences are evaluated after scale transformation, reflecting the assumption that scale precedes difference judgment.

2.4 Internal Transformation Families

Internal transformations are defined as affine maps:

$$F_{a,b}(x) = ax + b \pmod{n}. \tag{6}$$

Two regimes are distinguished:

- **Restricted regime**: only invertible mappings ($\gcd(a, n) = 1$);
- **Degenerate regime**: constant mappings are additionally allowed, serving as collapse controls.

3 Predicates

Under the above structure, the following predicates are defined:

- **Evolving**: there exists a time interval of length at least 2 in which all adjacent differences are decidable;

- **Dead Loop**: all future adjacent differences are undecidable;
- **Fragmented**: there exists a constant $c > \varepsilon$ such that all adjacent differences satisfy $\Delta \geq c$;
- **Driven**: for every allowed internal transformation, there exists at least one time step at which the transformed difference is decidable.

4 Experimental Design

The experiment enumerates the following parameter ranges:

- $n \in \{5, 7, 8, 9, 10, 12\}$;
- step $\in \{1, 2, 3\}$;
- scale $k \in \{1, 2, \lfloor n/2 \rfloor, n\}$;
- decisional threshold $\varepsilon \in \{0, 1\}$;
- difference type: modular / discrete;
- internal transformation family: restricted / degenerate.

In total, 828 finite model configurations are examined.

5 Results

Across all 828 configurations, the following structural implications admit no counterexamples:

$$\text{DeadLoop} \Rightarrow \neg\text{Evolving}, \tag{7}$$

$$\text{Fragmented} \Rightarrow \neg\text{DeadLoop}. \tag{8}$$

Additionally, the experiments construct explicit witnesses demonstrating:

- scale-induced zero differences;
- scale-relative evolution, where evolution holds at one scale and fails at another;
- systematic collapse of drivenness when degenerate internal transformations are permitted.

6 Conclusion

The experiments verify that the core claims of Fragmented Evolution Theory are structurally consistent across a broad class of finite models. Evolution, fragmentation, and drivenness are shown not to be intrinsic properties of systems but relational properties determined by scale, difference structure, and decisional constraints. Fragmentation emerges as a structural condition excluding absorption into terminal states.