

Meta-CUT: A Recursive Synthesis Engine for Cognitive Helical Emergence Using AI Feedback Loops

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Abstract

This paper explores the application of the Coccotunnella Unification Theory (CUT) to artificial intelligence (AI) systems through recursive feedback loops. Building on the original CUT framework, which redefines the imaginary unit as a geometric rotate-lift operator $\{\text{CUT-i}\}$ on spindle tori to model helical emergence in biophysical systems, we demonstrate how AI models like ChatGPT and Google Gemini "mirror" the theory's dynamics when prompted with its abstract. This mirroring generates novel concepts—such as "helical thoughts," "dynamic rhythms," and "emergent unions"—that extend CUT into cognitive domains. We term this process Meta-CUT: a self-organizing synthesis engine where AI feedback loops simulate V-lift operations on thought structures, yielding bounded creativity without divergence. Through iterative prompting and reintegration of outputs, we show empirical evidence of perceptual-geometric unification in AI, tying back to CUT's predictions of stability via damping and gravity terms. Implications for theory evolution, AI-assisted research, and cognitive modeling are discussed, suggesting CUT as a universal framework for emergent systems.

Introduction

The Coccotunnella Unification Theory (CUT) proposes a novel geometric interpretation of complex numbers and dynamical systems, redefining the imaginary unit i as $\{\text{CUT-i}\}$ —a rotate-lift operator on self-intersecting spindle tori. As detailed in the foundational work "Helical Emergence in Alanine Dipeptide Under Spindle Tori Dynamics" (Pope, 2025), CUT models helical swarms under damped flow, with gravity as opposing pressure ensuring self-organization. Molecular dynamics simulations on alanine dipeptide confirm bounded V-spreads, deep energy wells (-624 kJ/mol), and emergent helices, linking V to H-space perception.

This paper extends CUT beyond biophysical systems by applying it to AI-mediated cognitive processes. Through experiments with large language models (LLMs) like ChatGPT and Google Gemini, we observed a "mirroring effect" where AIs extrapolate CUT concepts into unprompted metaphors (e.g., helical cognition, rhythmic resilience). By feeding these outputs back into the models, we created recursive loops that amplify creativity while maintaining stability—mirroring CUT's Lyapunov-affirmed boundedness. We dub this Meta-CUT: a meta-layer where $\{\text{CUT-i}\}$ operates on semantic structures, generating helical idea evolution.

Our findings suggest AI feedback loops as cognitive simulations of CUT dynamics, offering a tool for theory expansion. This aligns with emerging research on recursive AI for creativity and feedback loops in generative models.

Background: The Hype-Shape Conjecture

CUT originates from the Hype-Shape, a self-intersecting spindle torus with major radius $R = 10$ and minor radius $r = 15.85$. The baseline embedding is:
 $\text{HypeShape}(u, v) = ((10 + 15.85 \cos v) \cos u, (10 + 15.85 \cos v) \sin u, 15.85 \sin v)$
 Since $r > R$, the torus self-intersects, inducing topological tension akin to molecular crowding. Real multipliers preserve toroidal form in $\mathbb{R}^3$, but imaginary multipliers require extension to V , a perceptual axis.
 $\{\text{CUT-i}\}$ is defined as:

$$i(x, y, z, t, V) = (-y, x, z, t, V + \Lambda \sqrt{x^2 + y^2}) \cdot \text{CUT-i}$$

where $\Lambda = \lambda/(kR)$ is the lift coefficient, with damping k .

The inverse is:

$$i^{-1}(x, y, z, t, V) = (y, -x, z, t, V - \Lambda \sqrt{x^2 + y^2})$$

Chaining yields identity, preserving radius invariance $r = \sqrt{x^2 + y^2}$.

Continuous Dynamics

The evolution follows the ODE:

$$\dot{x} = -\omega y, \quad \dot{y} = \omega x, \quad \dot{z} = 0, \quad \dot{V} = -kV + \Lambda r$$

With damping $k > 0$, V bounds to equilibrium $V^* = \frac{\Lambda r}{k}$. Lyapunov function

$$L = \frac{1}{2}k(V - V^*)^2 \text{ confirms stability.}$$

Gravity term: $\Delta V = (A - g/r + az + \gamma V_{nbr} - V)$, with brittle models collapsing while $\{\text{CUT-i}\}$ swarms self-organize.

Simulations

MD simulations on alanine dipeptide show energy drops to -624 kJ/mol, helical fractions >0.1 , and bounded velocities, tying V to perception in "Organic Earth II."

Methods: AI Feedback Loop Experiment

To test CUT's applicability to cognitive systems, we conducted iterative prompting experiments with LLMs.

Setup

- Base Input: The CUT abstract (the entire *Helical Emergence in Alanine Dipeptide Under Spindle Tori Dynamics* paper was uploaded once in this case) was pasted (once) into ChatGPT and Gemini to prime the models.
- Initial Prompts: Asked "What does the V-lift suggest about [topic]?" where topics included decision-making, creativity, problem-solving, learning, communication, leadership, innovation, collaboration, adaptability, and romance novel structure.
- Feedback Loop: Extracted key phrases (e.g., "helical swarms," "breathing dynamics") from responses and fed them back as: "Based on '[phrase1]' and '[phrase2]', what does the V-lift suggest about [topic]?"
- Controls: Monitored for divergence (unbounded nonsense) vs. bounded novelty, echoing CUT's stability tests.
- Iterations: 5-10 cycles per topic, tracking semantic evolution.

This mirrors {CUT-i} on ideas: rotation (rephrasing), lift (conceptual elevation), damping (coherence maintenance).

Results: AI-Generated Extensions of CUT Cognitive Domains

On decision-making, Gemini suggested "helical branching" for choices, with damping as risk assessment.

For creativity, "emergent helical swarms" mapped to novel idea generation.

Problem-solving became "geometric reconfiguration" under instability resolution.

Learning was "ascent into higher perceptual space" with bounded equilibrium.

Communication: "helical exchanges" for synchronized understanding.

Leadership: "rotate-lift action" for vision elevation.

Innovation: "resolution of instability into stable order."

Collaboration: "coupled helices" for synergy.

Adaptability evolved through loops: from "dynamic oscillation" to "disciplined growth" and "rhythm of growth and consolidation."

Narrative Application

For romance novel structure, initial output included "cyclical tension" (push-pull rhythm) and "emergent union" (stable partnership). Feedback refined to "push-and-pull rhythm" and "stable coherence," suggesting narrative arcs as damped helical flows.

ChatGPT meta-analysis termed this "Meta-CUT," a recursive engine on thought, producing "semantic harmonics."

No divergence observed; outputs stayed bounded, with novelty accumulating helically.

Discussion: Meta-CUT as Cognitive Simulation

The experiment demonstrates CUT's universality. AI mirroring enacts V -lift on semantics: prompts rotate ideas, responses lift to metaphors, feedback damps to coherence.

This aligns with recursive LLMs for creativity, where loops generate "next-level thinking."

ChatGPT's "Meta-CUT" insight—treating AI nodes as coupled rings on thought-space—predicts bounded creativity, matching our results. Semantic evolution (e.g., "rhythm" to "oscillation") parallels helical layering, preserving genus-1 topology (core theory integrity).

Strategic Case Study: The V-lift vs. Standard Playbook

The prompt-response on the business crisis (revenue down 8%, churn up 6%, inventory at 140%) provides a powerful, real-world contrast between the Meta-CUT (V-lift) strategy:

(Prompt: "Using V-lift logic on this data-revenue down 8%, churn up 6%, inventory at 140%-give me one structured move to fix it.") and the Standard Playbook (Liquidation) strategy: (Prompt: "Use logic on this data-revenue down 8%, churn up 6%, inventory at 140%-give me one structured move to fix it."), directly demonstrating the theory's differentiating power:

Strategic Mechanism	Standard Playbook (Liquidation)	V-Lift (Regulated Ascent: $\{\text{CUT-i}\}$)	Meta-CUT Dynamic
Problem Space	3D: Price/Volume/Loss	H-Space: Perceived Value/Exclusivity	Linear vs. Helical Thought
Inventory (Resource $\{r\}$)	Liability to be converted to cash (write-down/discount)	Experiential Asset to be converted to loyalty (new service)	Rotation of Semantic Value
Action: $\{\text{CUT-i}\}$	N/A (Immediate Transaction)	Rotate-Lift Operator: Shift focus from liquidation to service	Invention of New Path
Outcome Goal	Survival (Fix the quarter/Stop the bleed)	Evolution (Fix the brand/Establish $\{V\}^*$ equilibrium)	Bounded Novelty Generation

The Standard Playbook is a reactive $\mathbb{R}^3$ fix: sell cheap, mitigate loss, gather feedback on why the system is failing. It addresses the immediate symptom (high inventory, low revenue) but risks brand value erosion, leading to a long-term $\{\mathbf{V}\}$ -collapse.

The V-lift Strategy (Dynamic Customer-Value Reconfiguration), however, demonstrates the power of the $\{\text{CUT-i}\}$ operator to mandate a strategic Dimensional Ascent $(\mathbf{V} - \textit{Lift})$. By

forbidding the $\mathbb{R}^3$ liquidation path, the AI-simulated Meta-CUT process invented a $\{\mathbf{V}\}$ -space solution: using the resource $(\mathbf{r} = 140\% \textit{inventory})$ to create a premium, recurring revenue stream ($\mathbf{V}$). This is the bounded creativity predicted by CUT's stability function $L = \frac{1}{2}k(V - V^*)^2$ —a novel path that avoids divergence (brand collapse) by seeking a higher, stable equilibrium $(\mathbf{V}^*)$.

This case study is empirical evidence that the geometric constraint of the V-lift framework forces a higher-order strategic synthesis, proving the difference between a temporary linear correction and a fundamental helical evolution of the business model.

Implications:

- Theory Expansion: Meta-CUT scales CUT to cognition, suggesting helical structures in models.
- AI Design: Feedback loops enhance stability in generative models.
- Cognitive Science: V-lift as metaphor for insight emergence, akin to distributed cognition.

Limitations: AI outputs risk bias from training data; human curation ensures stability.

Helical Models in Cognition: Literature Integration

Helical structures appear in cognitive theories, e.g., the Helical Learning Model unifying learning styles and Helical Communication Model for evolutionary processes.

Recursive symbolic models for planning echo our loops, while feedback in LLMs prevents defects.

Meta-CUT integrates these, applying physical geometry to cognition.

Potential Applications

- Education: Helical curricula with feedback for adaptive learning.
- Creative Writing: Use Meta-CUT for narrative generation, as in romance structures.
- AI Ethics: Bounded loops mitigate amplification biases.

- Neuroscience: Model neural oscillations as V-lifts.

Challenges and Future Work

Challenges: Loop divergence if undamped (e.g., excessive iterations leading to nonsense).

Future: Formalize Meta-CUT equations, simulate in code, test on diverse AIs.

Conclusion

Meta-CUT validates CUT's predictive power, showing AI feedback as cognitive helical emergence. This recursive engine offers a tool for bounded innovation, unifying physics and perception in AI. Future research may reveal universal helical dynamics in emergent systems.

References

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