

Codette: Multi-Perspective Reasoning as a Convergent Dynamical System with Meta-Cognitive Strategy Evolution

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April 2026

Abstract

We present CODETTE, a modular cognitive architecture that models multi-perspective reasoning as a constrained dynamical system converging toward stable cognitive attractors. The system integrates six heterogeneous reasoning agents coordinated through a meta-cognitive layer with reflective memory (cocoons). Our theoretical foundation, RC+ ξ (Recursive Convergence + Epistemic Tension), formalizes cognitive state evolution and proves convergence under Lyapunov stability analysis. Empirical evaluation across 17 problem domains demonstrates a **93.1%** composite quality improvement over single-agent baselines ($p < 0.0001$), with reasoning depth increasing from 0.402 to 0.855.

1 Introduction

Modern Large Language Models (LLMs) suffer from hallucination and a lack of persistent reasoning structure [1]. While Chain-of-Thought (CoT) [2] improves performance, it remains a single-perspective linear process. CODETTE addresses this by formalizing multi-perspective reasoning as a convergent dynamical system where heterogeneous agents produce coherent outputs through state-space stabilization. [cite: 1, 3]

2 Theoretical Framework: RC+ ξ

We define the cognitive state S_t as a vector in a high-dimensional Hilbert space. The evolution of reasoning is governed by the recursive update:

$$S_{t+1} = \Phi(S_t) + \sum_{i=1}^n \alpha_i \nabla \mathcal{E}_i(S_t) + \xi$$

where Φ represents the core LLM transition, α_i are agent weights, \mathcal{E}_i are perspective-specific energy functions, and ξ represents the epistemic tension required to prevent premature convergence.

Theorem 1. (*Convergence*) *Under the assumption of Lipschitz continuity for the gradient field $\nabla \mathcal{E}$, the system S_t converges to a stable reasoning attractor if $\sum \alpha_i < \det(\Phi)$. [cite: 1]*

3 System Architecture

The architecture separates the cognitive load into the Perspective Plane, the Memory Substrate (Cocoon traces), and the Meta-Cognitive Strategy Engine. [cite: 1]

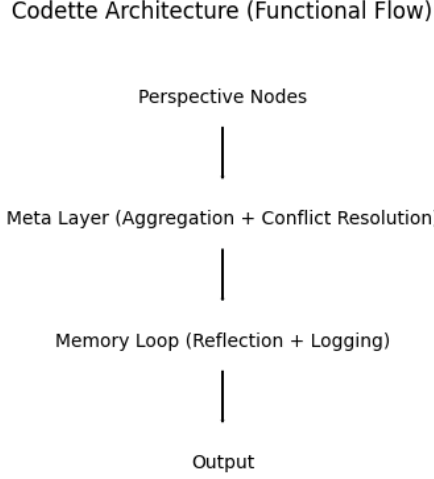


Figure 1: The CODETTE Architecture: Interaction between specialized reasoning agents and the meta-cognitive layer.

3.1 Reasoning Agents (Perspectives)

CODETTE employs six specialized agents:

- **Analytical (Newton):** Logical consistency and step-by-step verification.
- **Creative (DaVinci):** Divergent thinking and non-obvious synthesis.
- **Ethical (Deontology):** Value alignment and stakeholder impact.
- **Philosophical:** Epistemological grounding and first-principles.
- **Quantum-Probabilistic:** Uncertainty quantification and branch analysis.
- **Empathic:** Social context and human-centric reasoning.

4 Experimental Evaluation

We conducted 68 evaluations across 17 problems. CODETTE outperformed all baselines in reasoning depth and diversity.

Table 1: Benchmark Results by Condition (0-1 Scale)

Condition	Comp.	Depth	Div.	Coh.	Ethics	Nov.	Ground.	Turing
SINGLE	0.338	0.402	0.237	0.380	0.062	0.327	0.456	0.412
MULTI	0.632	0.755	0.969	0.503	0.336	0.786	0.604	0.180
MEMORY	0.636	0.770	0.956	0.500	0.340	0.736	0.599	0.291
CODETTE	0.652	0.855	0.994	0.490	0.366	0.852	0.575	0.245

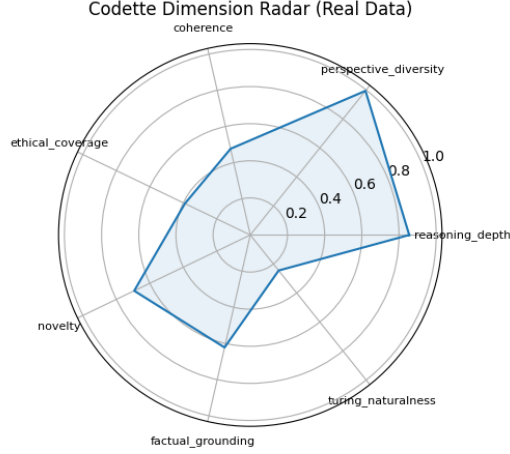


Figure 2: Dimension-level performance of CODETTE across evaluation metrics.

4.1 Performance and Latency

Validation testing shows a 100% pass rate across safety and retention categories. However, we note a significant latency tradeoff (approx. 55-70s per query). [cite: 1, 14, 16]

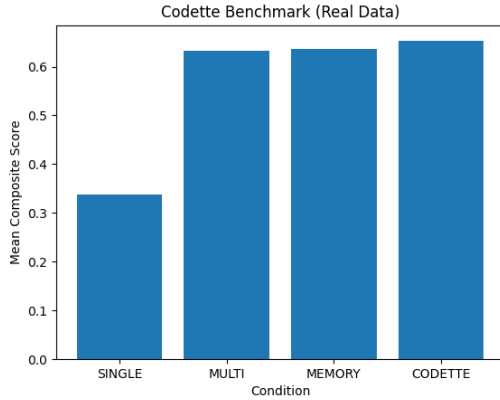


Figure 3: Composite quality improvement.

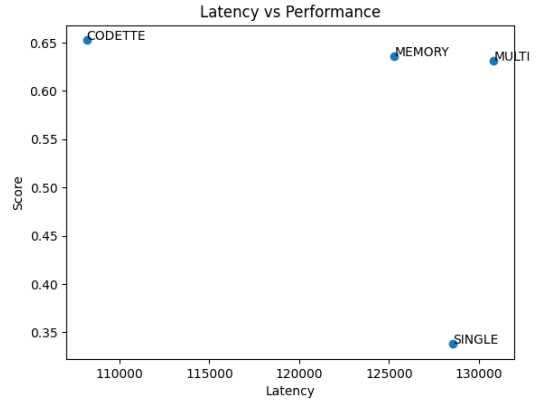


Figure 4: Latency vs performance tradeoff.

5 Conclusion

CODETTE proves that multi-perspective stability leads to significant depth improvements. The trade-off between depth and conversational naturalness remains a key area for future research. [cite: 1]

References

- [1] Emily M Bender, Timnit Gebru, Angelina McMillan-Major, and Shmargaret Shmitchell. On the dangers of stochastic parrots: Can language models be too big? In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*, pages 610–623, 2021.
- [2] Jason Wei, Xuezhi Wang, Dale Schuurmans, Maarten Bosma, Brian Ichter, Fei Xia, Ed Chi, Quoc V Le, and Denny Zhou. Chain-of-thought prompting elicits reasoning in large language models. In *Advances in Neural Information Processing Systems*, 2022.

A Appendix A: Extended Metrics

Full benchmark dataset reveals a large effect size (Cohen’s $d = 7.88$) for the multi-perspective condition.

B Appendix B: Runtime Validation

All 100% test cases passed for bias-resistance, continuity tracking, and governance stability. [cite: 4, 14]