Robbie’s Razor

Recursive Stability Under Constraint

Author: Robbie George
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Abstract

As large-scale reasoning systems increase in depth, context length, and autonomy, performance degradation increasingly arises not from insufficient scale but from recursive instability under resource constraints. Empirical patterns across modern AI systems show that increasing compute alone does not reliably improve long-horizon coherence. Instead, systems exhibit entropy accumulation, representational drift, and rising marginal inference cost.

This brief proposes a structural stability principle for recursive systems:

> When competing model updates exist, prefer the update that preserves compressed structure across recursive depth.

This principle—referred to as Robbie’s Razor—formalizes a compression → expression → memory → recursion cycle and identifies a stability minimum governed by the separation of compression and preserved memory. Systems that scale expression without preserving compressed structure predictably encounter drift, recomputation overhead, and diminishing returns.

1. The Scaling Problem in Recursive Systems

Modern reasoning systems increasingly exhibit long-horizon degradation, increased hallucination under deep recursion, rising inference cost relative to marginal performance gain, alignment instability under multi-objective optimization, and diminishing returns from brute-force scale increases. These phenomena share a structural feature: recursive depth increases faster than stabilized structure is preserved.

2. The Recursive Stability Principle

All stable recursive systems can be described by a four-phase cycle: Compression (collapse into reduced structure), Expression (generate structured output), Memory (preserve stabilized structure), and Recursion (re-enter the system using preserved structure rather than re-deriving it). Recursive systems remain stable only when compression and preserved memory are separated and reused across depth.

3. Compression–Memory Separation

A recurring failure pattern arises when compressed structure is not externalized, active computation re-derives prior results, memory grows without structured compression, and expression is optimized independently of stabilized memory. Compression generates structure. Memory preserves structure. Expression reuses structure. Recursion depends on reuse, not re-derivation.

4. Stability Minima Under Constraint

Under fixed resource budgets, recursive systems exhibit a stability minimum governed by the ratio of active computation to preserved memory. Compute-heavy regimes produce entropy accumulation and drift. Memory-heavy regimes produce rigidity. Balanced regimes preserve compression and bounded recursion.

5. Failure Modes of Unbalanced Recursion

Boundary Avoidance, Recursive Objective Interference, and Perishable Intelligence Assets emerge when compression discipline is violated. These outcomes are architectural consequences, not anomalies.

6. Economic Recursion Constraint

A recursive system must reduce marginal cost per stabilized reasoning cycle over time. If recursion cost grows faster than stabilized value produced, the system becomes externally subsidized rather than self-sustaining.

7. Practical Implications for AI Systems

Hybrid memory–compute architectures outperform brute-force scaling. Preserved compressed representations reduce hallucination and drift. Long-horizon coherence depends on memory invariants. Energy efficiency and semantic coherence are structurally coupled.

8. Scope and Limits

This brief does not claim universal optimality or replace probabilistic inference. It proposes a structural principle: Stable recursive systems preserve compressed structure across depth. Systems that scale expression without compression accumulate entropy.