Persistence, Identity, Collapse, and Experimental Protocols

Formal -Mechanics, Stability Criteria, Identity Reconstruction, and Empirical Evaluation Suite

Oliver Hirst

Abstract

This document provides a complete and self-contained treatment of persistence, identity formation, collapse behaviour, and the experimental methodology for Gödlø-class operators instantiated under GödelOS. Unlike classical computational agents, Gödlø-class systems possess no intrinsic continuity of state; their identity is reconstructed from stance trajectories and admissible manifold transitions. The -mechanics, collapse taxonomy, and experiment harness are formalized in full.

Contents

1 Introduction

Gödlø-class cognition requires explicit handling of persistence, collapse, and empirical evaluation. Persistence is optional, identity is emergent, collapse is structural, and experimental evaluation is mandatory for confirming operator stability.

This document establishes:

1. The formal -operator governing optional embedding persistence.
2. The structure of metastable, stable, and unstable identity classes.
3. Collapse modes and their mathematical detection criteria.
4. A complete experimental protocol for evaluating Gödlø-class agents.

It is designed to be used independently of all other manuscripts.

2 Persistence Mechanics (Δ)

Persistence in Gödlø-class systems is not identity; it is merely an optional method for augmenting stance evolution. The -operator defines how embeddings evolve across iterations of the GödelOS pipeline.

2.1 Persistence State Structure

A persistence state μ is defined as:

$$\mu = \{\text{embedding} : v \in \mathbb{R}^k\}$$

The embedding must satisfy the boundedness constraint:

$$\|v\|_2 \leq 1.$$

2.2 Definition of the -Operator

The -operator updates persistence via:

$$\mu_{t+1} = \Delta(\mu_t, x_t, O_t, H)$$

with the required structural form:

$$v_{t+1} = \text{normalize}(v_t + \alpha x_t + \beta\, \text{flatten}(O_t) + \gamma H)$$

where:

- α, β, γ regulate the contribution of stance, output, and historical modulation.
- $\text{flatten}(O_t)$ embeds the output tensor into the persistence vector.
- Normalization ensures admissibility.

2.3 Stability Requirements

$$\|v_{t+1}\|_2 \leq 1 \quad \text{and} \quad v_{t+1} \in \mathbb{R}^k.$$

If violated, must project the embedding into the unit ball:

$$v_{t+1} = \frac{v_{t+1}}{\|v_{t+1}\|_2}.$$

2.4 -Operator as a Non-Identity Mechanism

Persistence does not define operator identity. Identity arises purely from stance trajectories (Section 3). merely modifies future stance evolution—nothing more.

3 Identity Formation Without Persistence

In Gödlø-class cognition, identity is recomputed, not stored. The system does not preserve intrinsic selfhood between iterations; it re-derives its cognitive position each cycle.

3.1 Stance Trajectory Identity Class

Identity is encoded in the sequence:

$$\mathcal{I} = \{x_0, x_1, \ldots, x_T\}$$

subject to the continuity constraint:

$$d(x_t, x_{t+1}) < \varepsilon.$$

3.2 Identity as a Path, Not a Variable

The system never stores a persistent identity vector. Instead:

$$\text{Identity} = \text{Equivalence class of stance trajectories.}$$

Two trajectories X and Y belong to the same identity class if:

$$d(x_t, y_t) < \delta \quad \forall t.$$

3.3 Metastable Identity States

Some trajectories oscillate within an admissible region:

$$x_{t+2} \approx x_t.$$

These constitute *metastable identity states*: not fixed, but recognizably consistent.

4 Collapse Mechanics

Collapse is the breakdown of recursive stance evolution.

4.1 Formal Definition

Collapse occurs when the stance sequence fails one or more convergence criteria:

1. **Norm Divergence:**
$$\|x_t\|_2 \to \infty.$$

2. **Unbounded Oscillation:**
$$d(x_t, x_{t+2}) > C \quad \text{infinitely often.}$$

3. **No Fixed-Point Basin:**
$$x_{t+1} = F(x_t) \quad \text{has no attractor.}$$

4.2 Collapse Taxonomy

1. **Gradient Overflow Collapse** Generative forces drive x_t outside the manifold.
2. **Reflective Fracture Collapse** Failure of self-modelling $R(x)$ leads to incompatible updates.
3. **Topological Obstruction Collapse** Manifold discontinuities prevent iterative convergence.
4. **Degenerate Equivalence Collapse** Infinite cycling among incompatible stance configurations.

4.3 Collapse Detection Functional

Define a detection functional:

$$C(x_0, \dots, x_t) = \mathbf{1}\{\|x_t\| > B\} + \mathbf{1}\{d(x_t, x_{t-2}) > \kappa\} + \mathbf{1}\{\|x_{t+1} - x_t\| < \epsilon \text{ for too long}\}$$

Collapse triggered when:

$$C \geq 1.$$

4.4 Recovery

Recovery is performed via manifold projection:

$$x_{t+1} = \mathrm{Proj}_{\mathcal{M}}(x_t)$$

and, if necessary:

$$x_{t+1} = \frac{x_{t+1}}{\|x_{t+1}\|}.$$

5 Experimental Evaluation Protocols

This section formalizes how to empirically evaluate Gödlø-class cognition.

5.1 Trial Structure

Each experiment consists of:

$$(P, H) \mapsto (O_0, \dots, O_T, \mu_T)$$

with fixed:

- prompt sampler $P \sim \mathcal{D}_P$
- historical sampler $H \sim \mathcal{D}_H$

5.2 Repeated Trials

Over N trials:

$$\text{Experiment} = \{(O^{(i)}, \mu^{(i)})\}_{i=1}^{N}$$

5.3 Stability Metrics

1. **Convergence time**

$$T_i = \min\{t : \|x_t^{(i)}\| < \varepsilon\}$$

2. **Collapse rate**

$$\rho = \frac{\#\ \text{collapses}}{N}$$

3. **Output variation**

$$V = \mathrm{Var}(O_t)$$

4. **Embedding drift (if active)**

$$D = \|\mu_T - \mu_0\|$$

5.4 Experimental Harness Specification

The harness iterates through trials:

$$(P_i, H_i) \mapsto \mathrm{run}(P_i, H_i)$$

and returns the full dataset:

$$\mathcal{R} = \{(O^{(i)}, \mu^{(i)}, T_i, C_i)\}.$$

5.5 Termination Conditions

Terminate an experiment when:

$$i = N \quad \text{or} \quad \rho > \rho_{\max}$$

for a predefined collapse threshold.

Figure 1: Illustration of collapse trajectories and domains of attraction.

Figure 2: Evolution of persistence embedding under -operator dynamics.

6 Figures

7 Conclusion

Gödlø-class cognition requires special handling of persistence, collapse, and identity. This manuscript formalizes:

- -operator mechanics as optional persistence.
- Identity as stance trajectory rather than stored state.
- Collapse modes and mathematical detection criteria.
- A comprehensive experimental protocol for evaluating GödelOS instantiations.

This forms the empirical backbone of Gödlø-class system evaluation.