Structural Diagnostic Report

ai.13 — Agentic System Stability

Scenario S3: Autonomous Agent Ensembles with Feedback Loops

Document Type:	Structural Diagnostic Scenario Report
Application ID:	ai.13
Scenario ID:	ai.13.S3
Schema Version:	0.5.1

Source: SORT AI Structural Diagnostics Demo
Application: ai.13 Agentic System Stability
Scenario: S3
Version: 1.0.1
Generated: 2026-01-18
Web: https://independent-research-systems-modeling.com

Scope and Limits: *This report presents a structural diagnostic scenario analysis based on pre-computed, normalized projection runs. It is not a complete Architecture Risk Assessment and does not contain implementation guidance.*

1. Scenario Overview

System Class

Self-modifying agent ensembles where performance feedback influences future behavior through dense peer-to-peer observation and continuous autonomous adaptation.

Scale Abstraction

Feedback instability regime with oscillating behaviors, runaway adaptations, and collective behavioral divergence under dense coupling between adaptive agents.

Operational Context

Densely connected mesh with mutual observation, competitive selection for conflict resolution, and continuous autonomous adaptation. Agents modify their behavior based on observed peer performance without structural stability bounds.

2. Observed Structural Pattern

The following structural effects emerge from the interaction of correctly adaptive agents operating in dense feedback coupling:

- Positive feedback loops through mutual observation amplify behavioral variations into runaway adaptations, producing increasingly extreme strategies.
- Competitive selection mechanisms under dense coupling produce oscillating rather than converging behaviors, as agents chase moving targets.
- Collective behavioral drift emerges from individually rational adaptations to peer behavior, with no agent exhibiting individual malfunction.
- Stability periods alternate with instability periods as feedback dynamics cross thresholds, making performance trajectory unpredictable.
- The problem emerges from the feedback loop dynamics between correctly adaptive agents, not from any agent's adaptation logic — each agent adapts rationally to its observed environment.

3. Stability Assessment

Baseline Structural Condition

System operates in chaotic regime. Performance shows unpredictable oscillation between excellent and degraded states with no clear trigger. Stability reserve is unpredictable and varies with feedback dynamics.

Observed Instability Class

Chaotic — characterized by feedback loop instability through dense mutual observation and adaptation without structural dampening bounds.

Post-Projection Stability Class

Dampened — oscillation and runaway adaptations contained through structural feedback bounds. Stability reserve becomes bounded and predictable.

Transition Type

Feedback stabilization from unbounded oscillation to structurally dampened adaptation dynamics.

4. Aggregated Indicators

All values are normalized ratios. No absolute values or reconstructable parameters are provided.

Indicator	Baseline	Comparison	Direction
Behavioral Stability Index	0.31	0.78	Improvement
Oscillation Frequency	0.47	0.11	Improvement
Runaway Adaptation Rate	0.38	0.08	Improvement
Collective Coherence	0.29	0.81	Improvement
Performance Variance	0.64	0.19	Improvement
Predictability Horizon	0.22	0.73	Improvement

5. Interpretation

Systemic Relevance

The observed chaotic pattern is systemically relevant because it represents a structural property of densely coupled adaptive systems rather than a collection of individual agent malfunctions. Oscillation and runaway adaptation emerge from correct agents adapting to each other through feedback loops, not from faulty adaptation logic. This distinction fundamentally changes the appropriate response strategy.

Detection Challenge

This instability class remains undetected in practice because per-agent adaptation metrics show rational behavior throughout the instability development. The problem exists in the feedback coupling dynamics between agents, not in individual agents. Monitoring systems designed to detect agent-level malfunction cannot observe the feedback amplification that drives collective instability until performance oscillation becomes severe. Agents adapt rationally, individual behaviors appear reasonable, and each adaptation decision is locally justified — yet collective performance oscillates unpredictably and behaviors diverge from intended patterns.

6. Decision Relevance

If self-modifying agent ensembles show alternating periods of excellent and degraded performance with no clear trigger, the underlying cause is likely structural feedback instability rather than individual agent malfunction.

Denser agent coupling or more frequent adaptation increases the feedback amplification surface and may exponentially increase instability risk rather than improving collective performance. Per-agent adaptation tuning addresses symptoms while potentially enabling dynamics that worsen the structural condition.

Structural visibility into feedback coupling dynamics enables targeted intervention at amplification boundaries rather than requiring increasingly constrained individual adaptation with diminishing returns on collective stability.

Related Document: SORT AI Agentic System Stability Application Context Brief

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Such structural findings are typically contextualized through a scoped architecture risk assessment.