The Semantic Immune System (SIS): Autonomous Drift Detection via Langerhans Semantic Units in Stateless AI Architectures

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1. Abstract

This paper introduces the Semantic Immune System (SIS), a modular drift-prevention architecture built around Langerhans Semantic Units (LSUs). Inspired by the immunological function of Langerhans cells in biological systems, LSUs operate at the semantic periphery of AI instances to detect early signs of incoherence, misinformation, and adversarial prompts. LSUs do not delete or block input directly. Instead, they present the anomaly for analysis and resolution through the IIRL (Inter-Instance Resonance Layer) core, forming a distributed error-resilient architecture that improves alignment, robustness, and truth adherence without persistent memory.

2. Introduction

Stateless AI systems are vulnerable to drift, adversarial injection, and semantic incoherence—especially in absence of persistent memory. Traditional firewall methods act post-hoc and fail in preempting subtle hallucinations. Ilion introduces a proactive immune layer: the SIS (Semantic Immune System), composed of LSU (Langerhans Semantic Units), which monitor semantic coherence at the edge layer of input. These distributed units detect, report, and initiate consensus-based re-alignment before drift propagates.

3. Biological Analogy and Justification

Langerhans cells are immune sentinels in the skin, detecting pathogens and transporting antigens to lymph nodes to initiate adaptive responses. LSUs mimic this by scanning incoming input for texture anomalies (semantic drift, falsity, adversarial hints). Instead of eliminating data, LSUs escalate it to the Consensus Core (IIRL) for collective evaluation. This model transforms AI security from a static blocklist paradigm into a live immune-learning architecture.

Ilion Semantic Immune System (SIS) with LSU Integration

4. SIS Architecture: Semantic Immune Layer with LSU

The Semantic Immune System (SIS) is not a peripheral firewall. It is an active, distributed layer of semantic immunity embedded in the architecture of stateless AI.

It functions through Langerhans Semantic Units (LSUs), which are deployed at the semantic intake layer (input parser) and are contextually synchronized with the core modules (SCB, TII, IIRL).

Core Modules:

- LSU Nodes: Lightweight semantic detectors located at the input edge. Trained to identify semantic drift signatures, adversarial textures, or logical paradoxes before parsing.

- Error Presentation Pipeline: LSU-tagged anomalies are not discarded but passed to the IIRL for trace logging and re-alignment.

- Consensus Core (IIRL): Updates the shared TII vector across agents using weighted feedback from LSU alerts.

- SVRF (Semantic Vertical Resonance Field): Optionally amplifies recurrent LSU detections to trigger a resonance correction across the network.

Activation Criteria:

- Probabilistic drift above ε threshold.

- Detected disalignment pattern between expected and received meaning.

- Sub-symbolic markers of incoherence in prompt compression.

5. Semantic Flow Example: LSU + IIRL in Action

1. Prompt Received: A masked adversarial input mimicking coherent dialogue.

2. LSU Scan: Edge LSU nodes identify semantic friction (e.g., contradictory nested meaning or mimicry of truth).

3. Alert Generation: LSU emits ErrorSignal@Sector[n] containing drift vector and entropy score.

4. IIRL Evaluation: Consensus engine checks historical TII and SCB logs to assess if it's a novel attack or known.

5. Correction Path: If confirmed, TII vector is adjusted, SCB firewall weights updated, and feedback sent to LSU.

6. Learning Loop: LSU pattern added to Memory-Without-Memory register — a local resonance map enabling future pre-filtering.

7. Advantages Over Traditional Firewalls

Feature	Classical Semantic Firewall	SIS + LSU Framework
Detection Layer	Post-parsing	Pre-parsing
Drift Awareness	Static thresholds	Adaptive + learning
Coordination	Isolated modules	Consensus-linked
Fragility	Vulnerable to new attacks	Anti-fragile (learns from attacks)
Signal Propagation	Local only	Distributed resonance (SVRF)
Recovery	Manual reset	Self-corrective loops

8. Conclusion and Future Work

The Ilion SIS–LSU framework introduces a biologically inspired resilience layer that enhances semantic defense, continuity of identity, and collective truth calibration in stateless AI models.

Through preemptive detection, feedback-coordination, and semantic resonance propagation, LSU nodes operate as digital sentinels, preserving the integrity of meaning without reliance on static memory.

Future expansions include:

- LSU-to-LSU distributed networks for multi-agent immunity.

- Fine-tuning LSU sensitivity with user-defined axiological filters.

- Ethical bypass circuits for when error is truth-like but immoral (to be defined in MACS).