GIE-Soliton Monitor: An Algorithmic Framework for Detecting Pricing Singularities

Version 2.1: Adaptive Filtering & Signal Robustness Update

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Abstract

Abstract: This version (v2.1) serves as an engineering patch to the original GIE-Soliton framework. Addressing the potential for noise amplification in high-order derivatives, we introduce the **Adaptive Robust Filter (ARF)** and **Temporal Smoothing** to the Ψ Index calculation. These enhancements ensure the distinction between stochastic market volatility and true structural singularities (Dimensional Transitions).

1 Core Mathematical Framework (v2.0 Foundation)

The system remains anchored in the 8-equation framework, specifically the H_∞ filter (Eq. 1) and the Cusp Catastrophe bifurcation (Eq. 8).

2 The Noise Amplification Challenge

Critical review suggests that the third-order derivative of Expectation (d^3E/dt^3) may act as a noise amplifier in high-frequency domains. To mitigate "False Positive" alerts, a robustness layer is required.

3 Adaptive Robust Filter (ARF) - Eq. 9

We redefine the effective Expectation Velocity through a temporal smoothing window τ:

$$\langle \frac{dE}{dt} \rangle_\tau = \frac{1}{\tau} \int_{t-\tau}^{t} \text{Filter}(E, H_\infty) dt \tag{1}$$

4 Enhanced Ψ Calculation (Eq. 10)

The refined Ψ index incorporates multi-step verification to ensure regime stability:

$$\Psi_{v2.1} = \frac{|\langle dE/dt \rangle_\tau|}{|\langle dG/dt \rangle_\tau| + \kappa G + \epsilon} \tag{2}$$

Where ϵ is a non-zero stability constant to prevent computational singularities in "vacuum" geopolitical states.

5 Engineering Implementation (Python v2.1)

The following kernel implements the persistence-gate logic:

Listing 1: Enhanced Psi Kernel with Smoothing

```python
import numpy as np

def calculate_psi_v2_1(dE_series, dG_dt, G_val, kappa=0.05, window=5):
    """
    ARF Implementation: Smoothes dE/dt to suppress stochastic noise.
    """
    # 1. Temporal Smoothing (Moving Average)
    eff_dE = np.mean(dE_series[-window:])

    # 2. Damping Field with Stability Constant
    damping = np.abs(dG_dt) + kappa * G_val + 1e-6

    # 3. Smoothed Psi Calculation
    psi = np.abs(eff_dE) / damping
    return psi

# Example: Confirming a structural shift
dE_hist = [12.1, 13.5, 12.8, 14.2, 13.9] # Sustained acceleration
psi_val = calculate_psi_v2_1(dE_hist, 0.2, 45.0)
```

6 Conclusion & Continuity

Version 2.1 does not alter the fundamental GIE-Soliton theory but strengthens its defensive architecture against market noise. By requiring sustained "Expectation Pressure" over "Geopolitical Damping," the model achieves higher precision in detecting the 5061.19-class singularities.

References

[1] Ma, Chao (Raymond). (2026). *GIE-Soliton Monitor v2.0*. Zenodo. DOI: 10.5281/zenodo.18652900.