SoulNet — An Optimizer with Behavior-Aware Dynamics (草稿初稿 · 2025.04.17)

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Abstract

SoulNet is a novel optimization framework that incorporates behavior-aware lifecycle control, enabling optimizers to sense, respond to, and self-regulate instability. Built atop Adam's momentum foundation, SoulNet introduces a five-layer behavioral cycle regulated by Jacobian dynamics, Laplacian smoothing, Lagrangian energy balance, and dual-stage Hessian analysis. A central innovation is the Instability-Behavior Energy (IBE), defined as the product of parameter momentum and Jacobian sensitivity, which governs all gate transitions. This structure transforms traditional optimizers into dynamic intelligent agents.

Core Structure

1. Meta-Hessian I — Direction Initialization
2. Laplacian Smoothing — Path Regularization
3. Jacobian Gate — Feedback Control using IBE
4. Lagrangian Constraint — Energy Balancing System
5. Meta-Hessian II — Final Directional Reassessment

Key Terms

- IBE (Instability Behavior Energy)
- LEG-4 Gate Controller
- Behavior Lifecycle in Optimizer Dynamics
- Jacobian × Momentum as Energy Signal
- Energy-Gated Transition Architecture

Licensing

Full GitHub and arXiv links coming soon.