Recursive Information Saturation Collapse Theorem (RISC)

I. Theorem Statement

The RISC Theorem formalizes a collapse condition in symbolic systems that experience either entropy overload or recursive saturation. The model identifies two distinct failure modes: entropy accumulation and recursion density.

Let:

- $\Phi(t)$ – Coherence function at time t
- $H(t)$ – Entropy imbalance (incoming entropy minus dissipated entropy)
- $D_r(t)$ – Recursion density (recursive operations per time unit)
- Θ – Entropy collapse threshold
- θ_c – Recursion collapse threshold

Collapse occurs if:

$$H(t) > \Theta \quad \text{or} \quad D_r(t) > \theta_c$$

At this point:

$$\frac{d^2\Phi}{dt^2} > 0 \quad \text{and} \quad \Delta I(t) \to 0$$

II. Collapse Mechanism

1. **Entropy Saturation:** Symbolic input exceeds system's dissipation capacity.
2. **Recursive Overload:** Internal referencing increases symbolic load beyond structural limits.
3. **Feedback Amplification:** Attempts at stabilization raise recursion density and worsen collapse risk.

III. Collapse Indicators

- Increasing $\frac{d^2\Phi}{dt^2}$ (coherence loss acceleration)
- Declining mutual information between recursive outputs
- Entropy growth (Shannon or cross-entropy)
- Repetition, contradiction, or nonsensical output

IV. Simulation Framework

Applicable Systems

- Autoregressive language models
- Symbolic logic systems with recursive input
- Cognitive agents under symbolic overload

Metrics

- BERTScore, BLEU, or coherence metrics
- Mutual information via MINE or CLUB
- Cosine similarity of embeddings
- Entropy trends over recursion depth

V. Visualization

- Time-series plots of $\Phi(t)$, $H(t)$, and $D_r(t)$
- Collapse prediction based on $\frac{d^2\Phi}{dt^2}$ and $\Delta I(t)$
- UMAP/t-SNE embedding trajectories over recursive steps

VI. Cognitive Analogy

- Symbolic overload in paradox resolution tasks
- Working memory collapse from recursive reasoning
- Contradiction loops in high-bandwidth symbolic cognition

VII. Applications

- AI safety through entropy-aware model architecture
- Cognitive collapse modeling under symbolic recursion
- Symbolic system design with recursive fail-safes
- Early-warning metrics for system saturation

VIII. Future Work

- Model entropy input/output balance as a function of recursion
- Implement dampening layers for recursion in AI architectures
- Generalize RISC to multi-agent or graph-based systems