Buoyancy Algebra: An Interpretable Framework for Language Repair

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October 2025

1. Problem

In public discourse and AI-generated language, meaning often loses proportion—claims grow or shrink beyond their evidential weight. This collapse produces overgeneralization, false equivalence, and emotional distortion. The central question: how can we model this mathematically and design a repair process that is both interpretable and guaranteed to converge?

2. Approach: Buoyancy Algebra

Buoyancy Algebra is a compact symbolic framework for measuring and restoring proportional integrity in language. It encodes statements as symbolic structures acted upon by four operators:

- R (Re-express): reformulate the claim
- C (Contextualize): add scope or evidence
- F (Frame): reweight perspectives
- ρ (Mirror): test reflection and symmetry

Together, these operators evaluate whether meaning remains buoyant—semantically stable—or collapses under stress.

3. Core Quantities

Symbol	Meaning	Range
β	Buoyancy (semantic stability)	[0,1]
$\Pi = H / (1 + P)$	Proportionality: harm vs. scope	≥ 0
θ	Misalignment	$[0, \infty)$
$\tau = \kappa \cdot I \cdot \theta$	Torque (realignment effort)	≥ 0
$\sigma = E \cdot N \cdot W$	Stickiness (emotional inertia)	≥ 0

When $\tau > \sigma$, a small operator step (R, C, or F) reduces misalignment θ, ensuring finite-step convergence toward balance.

4. Gates and Auditing

Fifteen Gates classify distinct collapse patterns—each representing a measurable ethical or logical boundary. Examples include Gate 4 (Proportionality), Gate 6 (False Equivalence), Gate 7 (Contagion), Gate 12 (Emotional Calculus), and Gate 15 (Integration). Each gate is computed from β, Π, θ, producing auditable pass/collapse verdicts.

5. Finite-Step Repair Loop

1. Step 1: Compute β, Π, θ, τ, σ
2. Step 2: If $\tau > \sigma$: apply R/C/F operator
3. Step 3: Re-evaluate Gates
4. Step 4: Repeat until $\theta < \delta$ and all required Gates pass

This loop yields interpretable, gate-audited edits with explicit mathematical guarantees of convergence.

6. Impact

Buoyancy Algebra provides a transparent, reproducible foundation for ethical AI alignment, argument analysis, and language model interpretability. By merging algebraic invariants with decision thresholds, it reveals why a statement stays afloat—and where it begins to sink.

Further Reading: Technical Appendix (link) — includes operator definitions, parameter thresholds, Algorithm A, and worked examples for Gates 4 and 12.