Logic From Physical Cost: Deriving Consistency as the Ground State of the Recognition Potential

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Abstract

We demonstrate that the laws of logic are not axiomatic but thermodynamic. In Recognition Science, the cost functional $J(x) = \frac{1}{2}(x + x^{-1}) - 1$ is the unique potential governing reality. This function has a global minimum at $x = 1$, where $J(1) = 0$. Interpreting $x = 1$ as "Identity" or "Consistency," we show that logic emerges because consistency is the zero-cost ground state of the universe, while contradiction ($x \neq 1$) carries a positive energy penalty.

1 Introduction

In standard formulations of logic, the Law of Identity ($A = A$) is posited as an axiom. In a recognition-first setting, identity at the observable level is supplied operationally: in Recognition Geometry [**?**], a recognizer induces an equivalence relation of observational indistinguishability and an observable quotient, where identity is equality of equivalence classes. The cost functional J then acts as a selection principle that singles out self-match ($x = 1$) as the unique zero-cost fixed point.

2 Deriving Logic (T0)

2.1 Consistency as the Ground State

We have derived the unique cost function $J(x) = \frac{1}{2}(x + x^{-1}) - 1$. We observe that the global minimum of this function occurs uniquely at $x = 1$:

$$J(1) = \frac{1}{2}(1 + 1) - 1 = 0 \tag{1}$$

In this framework, the state $x = 1$ represents perfect ratio match (self-match) and therefore the operational notion of identity or consistency. The fact that $J(1) = 0$ means that self-match is "free." It is the ground state of the ontology.

2.2 The Cost of Contradiction

Consider a state of contradiction or inconsistency, represented by any deviation $x \neq 1$. Due to the strict convexity of $J(x)$ on $\mathbb{R}_+$, we have:

$$\forall x \neq 1, \quad J(x) > 0 \tag{2}$$

Any deviation from identity incurs a positive cost penalty. For small deviations $x = 1 + \epsilon$, the cost rises quadratically ($J \approx \epsilon^2/2$). For large deviations (gross contradictions), the cost grows linearly or exponentially depending on the regime.

Therefore, within this model, identity-consistent recognition corresponds to the unique zero-cost equilibrium of the cost landscape. If physical evolution is cost-minimizing, descriptions that maintain self-match ($x = 1$) are selected as stable equilibria, while inconsistent descriptions ($x \neq 1$) carry strictly positive cost and are selected against.

2.3 The Gödel Dissolution

Foundational theories are often challenged by Gödel's Incompleteness Theorems, which state that any sufficiently powerful formal system contains undecidable propositions. Does this mean a complete theory of reality is impossible?

We argue that Gödel's theorems do not obstruct the closure of Recognition Science because they apply to different domains:

- **Gödel's Domain:** The *provability* of arithmetic sentences within a formal axiomatic system.
- **RS Domain:** The *selection* of physical configurations via cost minimization.

The universe does not compute the digits of π to infinity or attempt to prove all true theorems of arithmetic. Instead, it settles into configurations that minimize the cost functional J. The process of reality is **Selection**, not **Proof**. By reframing reality as a physical selection process rather than a formal axiomatic system, RS is inoculated against logical paradoxes. Self-referential queries that lead to undecidability in logic simply correspond to high-cost or unstable configurations in physics, which are naturally filtered out by the minimization dynamic.

References

[1] Washburn, J.; Zlatanović, M.; Allahyarov, E. Recognition Geometry. *Submitted*, **2026**.