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Distinction-Lattice Framework: Eigenforms, Bisimulation, and the Realizability Boundary of Self-Reference

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ABSTRACT

A conservative formal version of DLF: stable entities are bisimulation classes of observational behaviour, certified coinductively, with realizability separated from fixed-point existence. v0.2.0 narrows novelty claims and corrects the JPCUB/Landauer bridge. Published at papers.qnfo.org (<https://papers.qnfo.org/papers/distinction-lattice-framework/>).

KEYWORDS distinction lattice, eigenform, coalgebra, bisimulation, coinduction, Lawvere, Landauer, JPCUB

SUBJECTS DLF · coalgebra · bisimulation · self-reference · JPCUB

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1. Scope and Status

This document is the formal statement of the Distinction-Lattice Framework (DLF), and it is deliberately conservative. It makes one structural proposal, one definitional commitment, and one conjecture with explicit falsification conditions. It does not claim a solved theorem where a conjecture stands, and it does not bridge to physical claims beyond what the referenced programs independently support.

The central proposal is this: **distinction precedes number, behavior precedes proof, and the Lawvere diagonal is the invariant boundary of all self-referential notation.** The framework's technical content is the formalization of that sentence.

2. The Substrate: Distinctions and the Realizability Filter

Let the primitive act be not the element $x \in S$ but the **distinction** $\delta = (A \mid A^c)$: a partition of a state space S into what an observer can tell apart and what it cannot.

Definition (Distinction). Let S be a state space. A distinction on S is an equivalence relation $\sim$ on S ; the class of A under $\sim$ is what the distinction counts as *the same*, and its complement is what the distinction counts as *other*.

Definition (Realizability filter). Let $R \subseteq \mathcal{P}(S)$ be a family of subsets that is closed upward (if $A \in R$ and $A \subseteq B$ then $B \in R$) and closed under finite intersection (if $A, B \in R$ then $A \cap B \in R$). Call R a **realizability filter**. A distinction δ is R -realized when its realized side lies in R .

The filter is the framework's definitional commitment (axiom D5 in the program's internal numbering): *a distinction is real if it can be the output of an observation.* Closure under finite intersection is the formal shape of "observations compose"; upward closure is the shape of "if something is observable, anything it entails is at least as observable."

3. Stable Entities as Bisimulation Classes

The DLF identifies *entity* with *stable observational behavior*.

Definition (Behavioral functor). Let F be an endofunctor on a category of states and observations, with the intended reading that an F -coalgebra $\delta \rightarrow F\delta$ is one step of observed behavior from a distinction.

Definition (Realizability as behavioral fixed point). A distinction δ is realized, written $R(\delta)$, if and only if δ is a fixed point of the behavioral functor F **up to bisimulation**:

$$R(\delta) \iff \delta \text{ is } F\text{-bisimilar to } F\delta.$$

Proposition (Lambek). If F admits a final coalgebra, then the final coalgebra Ω satisfies $\Omega \cong F\Omega$ (Lambek's lemma). The space Ω is then the space of all observable behaviors; every realized distinction is, up to bisimulation, a point of Ω .

Consequently, a stable entity is a **bisimulation class** of observational behavior — an equivalence class of states that no observation within the filter can separate. The framework's structural claim is that this is what "being the same thing" means operationally, and that set-theoretic identity is the special case in which the filter is total.

4. Eigenforms: Objects as Fixed Points of Their Own Observation

Kauffman's eigenform formulation reads an object as a solution of

$$x = F(x),$$

where F is the operation of the object's own observation (Kauffman, arXiv:1102.2048). The DLF adopts this reading and places it in the coalgebraic setting of Section 3: an eigenform is a fixed point of the behavioral functor, and the final coalgebra $\Omega \cong F\Omega$ is the universal eigenform.

The framework does not claim priority over the eigenform concept; it claims only the specific reading that *bisimulation up to the realizability filter* is the correct notion of solution for self-referential equations. The novelty statement is correspondingly narrow: the contribution is the filter, not the fixed-point equation.

5. The Self-Reference Boundary: The Lawvere Diagonal

Lawvere's diagonal argument shows, in categorical form, that a cartesian closed category with an object A admitting a fixed point for every endomap of A cannot contain a surjective map $A \rightarrow Y^A$ (Lawvere, "Diagonal arguments and cartesian closed categories"). Every self-referential construction — from Cantor's theorem to Goedel-type incompleteness to fixed-point combinators — is a special case of this diagonal.

The DLF's reading: self-referential notation always asks for a fixed point of an endomap built from the notation itself. The diagonal is therefore the **invariant boundary of self-referential notation**: where a notation can name itself, the Lawvere diagonal delimits what that naming can achieve.

6. The Central Separation: Realizability Is Not Fixed-Point Existence

The framework's central conjecture separates two notions that are routinely conflated:

Conjecture (Realizability boundary). Fixed-point existence does not imply realizability. There exist distinctions δ such that the equation $\delta \cong F\delta$ has solutions in the ambient category, yet no solution lies in the realizability filter R — and, conversely, there exist filters for which every realizable fixed point is a bisimulation class of the final

coalgebra.

Falsification conditions (any one of these refutes the conjecture):

1. Exhibit a realizability filter R , a behavioral functor F with a final coalgebra, and a fixed point $\delta \cong F\delta$ such that $\delta \in R$ but δ is not a bisimulation class of Ω .

1. Show that for every filter closed upward and under finite intersection, every fixed point is realized — i.e., that the filter never cuts.

1. Show that the diagonal boundary collapses: construct a notation that names itself through the Lawvere diagonal without leaving R .

The conjecture is falsifiable, and the author does not currently know whether it holds in full generality; the framework's value is that it forces the question into a form where the answer is checkable.

7. The JPCUB/Landauer Bridge (Corrected)

The program's thermodynamic bridge (internal reference QNFO.JPC.003) states a falsifiable connection between the realizability filter and the Landauer bound: *the minimal cost of realizing a distinction is bounded below by the information the filter must discard*. Version v0.1.1 corrected this bridge: it is **not** established that the filter's cost saturates the Landauer bound, and the bridge is a conjecture to be tested against the JPCUB program's measurements, not a derived result of this framework.

8. Open Problems

1. Find a natural class of categories and functors for which Conjecture 6 holds with proof (the author's current candidate: accessible categories with finitary behavioral functors).

1. Characterize the realizability filters that correspond to physical observations (which upward-closed, intersection-closed families arise from actual measurement apparatus?).

1. Sharpen the JPCUB/Landauer bridge into an inequality with explicit constants.

2. Determine whether the realizability boundary is computable: given F , R , and δ , is $R(\delta)$ decidable?

9. References

- Kauffman, L. H. *Eigenform*. arXiv:1102.2048.
- Lambek, J. *A fixpoint theorem for complete categories*. Mathematische Zeitschrift 103 (1968) 151–161.
- Lawvere, F. W. *Diagonal arguments and cartesian closed categories*. In: Category Theory, Homology Theory and their Applications II, Lecture Notes in Mathematics 92 (1969), Springer, 134–145.
- QNFO.JPC.003 — internal program reference for the Landauer-bound bridge

(conjectural, per Section 7).