URF Prefab System: A Typed Algebra of Admissible Systems

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Abstract

We introduce the URF Prefab System, a typed algebra for constructing globally admissible systems from locally certified components. Admissibility is enforced syntactically via capacity bounds and interface-mediated coupling.

1 URF–CMI Subadditivity

Axiom (URF–CMI). For any admissible variables A, B, C:

$$I(A; B \mid C) \leq I(A; B) \leq H(A) \leq C_{\max}(A).$$

2 Prefab Modes

A prefab mode is a tuple

$$P = (X, \Sigma, R, C_{\max}, O)$$

where every refinement R satisfies $\Delta H_R \leq C_{\max}$.

3 Prefab Composition Admissibility

Theorem (PCA). For a composed system $S = \bigoplus_i P_i$,

$$\forall R \in R_S : \quad \Delta H_R \leq \sum_i C_{\max}(P_i).$$

Proof. By subadditivity of conditional mutual information and interface factorization, entropy decrease is additive across prefabs.

4 CURF Categorical Semantics

The category $\mathcal{C}_{\text{URF}}$ has:

- Objects: state spaces X
- Morphisms: bounded-information interfaces
- Tensor: Cartesian product

This category is symmetric monoidal closed.

5 Sink Closure Obstruction

Without stabilization sinks, infinite refinement chains force unbounded EntropyDepth, violating admissibility.

6 DSL and Certification

A minimal DSL generates prefab compositions. Typechecking is equivalent to certificate verification.

Meta-Theorem. A system is admissible if and only if its DSL term typechecks.

Conclusion

The URF Prefab System provides a complete algebraic foundation for admissible system synthesis.