Architectural Prevention of False Reversal in Adaptive Evolution

Maksim Barziankou, Poznan 2026

In engineering and scientific literature, phenomena of hysteresis, path dependence, and irreversibility of phase transitions are widely known. However, the typical manner of their representation is reduced to switching conditions, local rules, domain-specific state machines, or parametric models in which the threshold is treated as a neutral point of comparison. The present work fixes a different architectural level: the threshold is treated as an active transition operator, and the directionality of threshold crossing is formalized as a first-class object of the system, prohibiting a class of false reversibility errors over long horizons, even when numerical values of state parameters coincide.

The key problem indicated by this approach lies not in the absence of knowledge about irreversibility, but in the absence of a minimal formal mechanism that would prevent architectural interpretation of backward movement as a return to a previous state. In many existing systems, rollback of a parameter across the same threshold is treated as restoration of the prior regime, despite the fact that structural, historical, or accumulated effects render such states non-equivalent. This error does not manifest locally and is not detected by standard correctness metrics, but accumulates over time and leads to degradation of coherence, loss of system identity, or uncontrolled regime failures.

The proposed architectural framework introduces a distinction between numerical coincidence of a state and structural equivalence. A threshold value of a parameter is no longer treated as a condition or a logical boundary, but is instead regarded as an operator whose effect depends on the direction, history, and context of system evolution. Thus, a transition "forward" and a transition "backward" across the same threshold are formally distinguished, even when observable parameters assume identical values.

It is important to emphasize that this approach is not an alternative to existing control, learning, or modeling methods and is not tied to a specific computational paradigm. It does not require the introduction of new physical quantities, statistical criteria, or domain-specific heuristics. What is introduced is an architectural layer that can be overlaid on top of existing systems and serves to prevent a class of errors associated with the false assumption of reversibility.

Accordingly, the work does not claim novelty of the irreversibility phenomenon as such, but fixes novelty at the level of formalization: the explicit introduction of an oriented threshold operator as a minimal architectural means that prohibits false regression and ensures preservation of structural coherence in the long-term evolution of adaptive systems.

DOI: https://doi.org/10.5281/zenodo.18314573