

Key terms Non-Markov update: a decision at a given moment that takes a short history of its own states (one-two steps back) into account, not just the present. Intermediate complexity: signals that are neither pure noise nor trivial uniformity; in practice, they remain moderately compressible and keep a recognizable structure over time. Predictive entropy: uncertainty about the next state given a short history; in “life-like” regimes this uncertainty falls. Temporal mutual information: how much information is shared between states separated in time; it rises when patterns “remember” themselves. Experiment 1 – Lattice with memory A two-dimensional grid of points with a few possible states per point. We compare four update rules: (1) purely random; (2) global majority; (3) local coherence with neighbors and one-step self-memory; (4) the same but with a short two-step memory. What we measure: pattern lifetime; similarity across time (using information-based measures); compressibility of successive “frames”; ability to re-form after we erase a patch of the grid. How to falsify: if the memory rule does not improve durability and re-formation relative to the other rules under matched conditions, the thesis loses support. Experiment 2 – Quantum walk with a history-dependent coin A photonic quantum walk in which the standard, memoryless “coin” is replaced by an operation whose settings depend on a short history of previous steps (for example via phase modulators linked to a small buffer). What we measure: the rate at which the position distribution spreads; similarity between successive distributions; persistence of hallmark interference features under controlled loss or dephasing; reappearance after a brief “mask.” How to falsify: no measurable advantage over a memoryless quantum walk. Experiment 3 – Reaction-diffusion with optical memory A Belousov-Zhabotinsky-type layer observed by camera and stimulated by a projector; the stimulus depends on a short history of recent images rather than on the current frame alone. What we measure: pattern lifetime; recovery time after a disturbance; reseeding of a cleared region. How to falsify: no improvement over a feedback loop without memory. Notes on anonymity The essay is self-contained; these endnotes only clarify metrics and falsification criteria. If references are provided, keep them to neutral reviews or textbooks, with no self-citations.