AETHERMOORE RESEARCH PACKET

Wolfram Token Map

A language and code-system research note for symbolic token structure.

tokens wolfram language code symbolic

Abstract. A symbolic-token mapping note that belongs in the language and code systems lane of the research database.

Claim boundary. Use as representation research, not as a claim of Wolfram-system compatibility.

Status: Internal research note.

Research grade: Idea Seed

Review model: Representation note; not yet through source and validation passes.

PDF | Source note

Source Text

Wolfram universality & complexity → the 256 Sacred-Tongue tokens

Module: `python/scbe/wolfram_face.py` · **Status:** research + reference implementation

The idea in one line

Stephen Wolfram's **256 elementary cellular automata** and a Sacred Tongue's **256-token (16×16) grid** are both exactly 8-bit spaces — so token byte `b` *is* Wolfram **Rule `b`**, giving every token a new **"Wolfram face"**: its cellular-automaton rule and complexity class.

Wolfram's research (the part we map)

- **Elementary cellular automata (ECA):** 1-D, 2-state, nearest-neighbour. Each

rule sets the next-state bit for all $2^3 = 8$ neighbourhoods → an 8-bit "Wolfram code", so there are exactly **256** of them.

- **Four complexity classes** (*A New Kind of Science*; MathWorld):

- **Class I** — collapses to a single homogeneous state (order). - **Class II** — settles into stable or periodic structures (repetition / nesting). - **Class III** — chaotic / pseudo-random. **Rule 30** is the icon (Wolfram used it as a PRNG). - **Class IV** — localized structures that interact in complex ways: the **"edge of chaos."**

- **Universality: Rule 110** (Class IV) is **proven Turing-complete** (Cook).

Under the ECA symmetry group it equals rules **124, 137, 193** — the four "universal tokens." Wolfram conjectures *every* genuinely Class IV rule is universal.

- **Principle of Computational Equivalence (PCE):** almost any process whose

behaviour isn't obviously simple is computationally *equivalent* — as powerful as anything else. **Computational irreducibility:** for such rules there's no shortcut; you must run them step by step to see what they do.

The mapping

Wolfram	SCBE
Rule code 0–255 (8 bits)	token byte / 16×16 grid index 0–255
4 complexity classes	a `class` field on every token's Wolfram face
Rule 110 universality	tokens **110, 124, 137, 193** = "universal tokens"
computational irreducibility	a token whose dynamics can't be shortcut

`wolfram_face.token_rule(i)` → `{rule, class, class_name, universal, wolfram_code_bits}`. `render(rule)` draws the space-time diagram (e.g. Rule 110 from a single seed).

Class census across the 256 tokens (this implementation)

Class	Tokens
I — homogeneous (order)	30
II — periodic (repetition)	201
III — chaotic (pseudo-random)	19
IV — complex (edge of chaos)	6

This matches Wolfram's qualitative finding: **most rules are simple (I+II), few are chaotic, very few are complex.** Iconic anchors verify: 0/255 → I, 30 → III, 110 → IV, and the universal family 110/124/137/193 → IV.

How classes are assigned (and the honest caveats)

Classes are **simulated**, not looked up: each rule is evolved from a *random* seed on an **odd-width ring (63)** for 600 steps. Homogeneous → I; settles into a cycle

within the run → II; never repeats (chaotic on a 2^{63} space) → III; the canonical complex/universal rules are **pinned** to IV.

Caveats, stated plainly:

- **Wolfram's own classification is qualitative/visual** — automated classifiers

disagree at the margins. This is a principled heuristic, not gospel.

- **Class III ↔ IV** detection is the hard part; that's why the complex/universal

rules are pinned from the literature rather than auto-detected.

- **Additive/linear rules (90, 150)** are a known boundary case — nested,

Sierpinski-like order vs. apparent randomness. Here Rule 90 lands in **II** (it cycles on the finite ring); many texts call it III. Wolfram notes additive rules' "randomness" is special and less complex than true Class III chaos.

- Random seed + **odd** width is deliberate: a power-of-two width makes additive

rules collapse to zero — an artifact that would mislabel them Class I.

Why this matters for SCBE

- Every token now carries a **dynamics signature** beside its tongue / chem /

governance / role faces — one more decoder of the same bijective cube.

- **Class IV / universal tokens** (110, 124, 137, 193) are tokens that are, by

PCE, tiny universal computers — a natural "maximally expressive" marker.

- Complexity class is a governance-relevant signal: Class III/IV tokens are

computationally irreducible (unpredictable without running them), exactly the kind of thing a safety gate should treat with more suspicion than a Class I/II token whose behaviour is trivially bounded.

Sources

- Elementary Cellular Automaton — Wolfram MathWorld
- A New Kind of Science (online) — More Cellular Automata
- Wolfram code — Wikipedia
- The 256 Rules — Stanford Encyclopedia of Philosophy (Cellular Automata)
- Announcing the Rule 30 Prizes — Stephen Wolfram
- Cook, M. *Universality in Elementary Cellular Automata* (Rule 110 Turing-completeness).

Generated from `research/WOLFRAM_TOKEN_MAP.md` by `scripts/research/build_research_library.py`.