

BALANCED TERNARY, SUCCEEDED FOR MACHINE DERIVED DECISIONS

# A Successor to Setun

*A formal result, proven in code. Setun, 1958, to the AI era.*

In 1958, at Moscow State University, Sergei Sobolev and Nikolay Brusentsov built Setun: the first modern ternary computer, balanced ternary and three valued logic where every other machine ran two. Fifty were built between 1959 and 1965. Setun's primitive, the trit, was arithmetic: a digit whose third state was the number zero. In 1958 that was correct, and it bought density against the component budget of the day.

Binary won, and it won fairly. The extra state bought density, and density got cheap. Where decisions are derived by machines, over evidence that is routinely insufficient, the third state has a job two values cannot do at all: it carries the refusal to decide. This work inverts Setun's primitive on that axis, and the trit becomes a verdict.

## What a successor must match

Setun 1958 is not a curiosity. It is four things, and a successor must answer all four: (1) one uniform balanced representation, symmetric about zero, with no sign bit; (2) a logic and arithmetic closed over it; (3) an economy argument, more work per unit of hardware, the only reason to leave binary; and (4) a machine that ran real workloads.

## The inversion

Setun's third state was arithmetic. This one is epistemic. Evidence enters through an open zero band: **quantize(x, τ)** commits to +1 above +τ and to -1 below -τ, and **[-τ, +τ]** is 0, where the system declines to commit, with τ adapted per attribute so criticality widens the refusal. Aggregation is Kleene conjunction, **min** under  $-1 < 0 < +1$ , in which the neutral absorbs from above: **min(0, +1) = 0**. Composition is not a truth table but a signed lookup into a law measured over **1,404,816 triads**. Setun assumed the third state meant nothing. This assumes it means everything, and carries it, signed, all the way to the machine.

Three valued logic is not new: Lukasiewicz 1920 and Kleene 1938 are the algebra, the SQL NULL its most deployed instance. Setun made it a digit, SQL an absence, neither a signed verdict.

## The proof

The substrate was held against Setun's four requirements and against the two axes Setun never attempted. Where it is capped, the cap is printed in the table, because a claim that hides its bound is not a claim.

| Setun requirement                      | Verdict       | How it is met                                                                                                                                                                             |
|----------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| One uniform balanced representation    | <b>HOLDS</b>  | The trit -1   0   +1, symmetric, no sign bit, reached through the open zero band. Negation is Setun's own involution.                                                                     |
| A logic closed over the representation | <b>HOLDS</b>  | Negation, presence, agreement, Kleene conjunction and disjunction, closed over three values, two agreeing implementations.                                                                |
| Economy per unit of work               | <b>EARNED</b> | Multiply free forming, signed adds and skips only. Pinned golden run: 21,528 float energy units against 3,078 ternary, a factor of 6.99, still recovering structure at ARI 0.6 or better. |
| A machine that runs real workloads     | <b>EARNED</b> | Raw signal to trit to Kleene disposition to signature gated actuation, under one offline verifiable chain.                                                                                |

|                                   |              |                                                                                                                                                                                                       |
|-----------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Beyond Setun's design             | EXCEEDS      | Composition is a signed lookup over 1,404,816 measured triads, not a designed table. The neutral is typed, survives aggregation to the actuator, and an absent record is proven rather than asserted. |
| Capability against full precision | HONEST BOUND | About 40 percent of full precision accuracy on hard continuous data. The win is energy, not capability.                                                                                               |

The five theorems, proven in code

- A. The neutral is non erasable.** Under Kleene conjunction the neutral absorbs from above:  $\min(0, +1) = 0$ . No quantity of conforming evidence raises a marginal unit to release. Two valued logic has no such element, so a marginal fact is forced to a side, silently passed or falsely failed. The gate is algebraic, not a policy a later layer can decline.
- B. The empty conjunction is not vacuously true.** Boolean conjunction over an empty set is the identity, true, so a compliance system with no applicable rule passes by construction. Here the empty aggregate is 0: a unit with no graded dimension is undetermined and routes to a human. The vacuous truth defect is closed in the algebra.
- C. Composition is measured, not assumed.** The law is ed25519 signed at  $\tau = 0.2$  over 10 corpora and 113 modules, and its nine cell counts sum to exactly 1,404,816. Two cells are states no two valued table can hold: conformance to a contested standard composes to 0 at 0.4215, indeterminate rather than passed, and failure against a standard the regulation supersedes composes to +1 at 0.7925, compliant rather than failed.
- D. The verdict reaches the actuator, or nothing does.** A directive batch actuates only if the signed chain verifies and the batch rehashes to what was signed. Tamper with one byte and the whole batch is refused, not partially applied. A held verdict is never auto actuated: the refusal survives to the physical boundary.
- E. Absence is provable, not asserted.** For an absent key the estate returns a sorted Merkle non membership proof: the two adjacent present neighbours that strictly bracket the query, their inclusion proofs, the committed root and the set size, bound under one signature against a pinned key. A third party re-derives it offline. Adjacency and strict inequality mean a present key cannot be dressed as absent, and a routing miss is typed apart from a grounded abstention, so the gate never certifies a false absence. The commitment covers the releasable corpus, so absence is proven relative to what may be exposed.

**50 tests green:** 21 in the browser port and 22 in the reference, two independent implementations of one algebra and so the check on it, plus 7 over the absence certificate. The energy result is pinned by a zero dependency golden test. Setun's third state was a digit, and the economics of 1958 did not need it. This third state is a verdict, and the economics of machine decision making do.

The claim, stated precisely

This does not replace binary where binary is optimal, which is computation over known values. It is Setun's successor for machine derived decisions: evidence is partial, the cost of a wrong commitment falls on a person, and the system must be able to decline and have that refusal survive every layer above it. Setun's third state had no job. It has one now. The claim is narrow on purpose, and stronger for it. It holds.

*Every clause above has a passing test or a signed artifact behind it.*

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