Alphabet Convergence and Scale Validation Report — SSNT

This report documents deterministic, large-scale validation of alphabet convergence in Shunyaya Structural Number Theory (SSNT). Its purpose is to verify whether the finite behavioral alphabet observed in the canonical SSNT reference range persists, expands, or destabilizes under deep deterministic extension, without modifying definitions, parameters, or execution structure. The report is confirmatory in nature and records measured outcomes only.

Shunyaya Structural Number Theory (SSNT)
Status: Public Research Release
Date: February 10, 2026

Caution: Mathematical research framework. Observational and analytical use only.

Status Overview

All SSNT pipelines have been executed **deterministically** using a **fixed canonical structure, parameters, and scripts**.
Results reported here are **measured, reproducible, and hash-verified**.

Deterministic scans have been completed up to:

- `n <= 20,000` (**canonical reference**)
- `n <= 50,000`
- `n <= 100,000`
- `n <= 200,000`
- `n <= 1,000,000`
- `n <= 1,250,000`
- `n <= 1,500,000`
- `n <= 2,000,000` (**deep-scale validation extension**)

No probabilistic methods, heuristics, or learning were used.

The extensions beyond `n = 1,000,000` were executed as **full deterministic master runs** and are included in this report for **scale validation and deep-range stability assessment**, not exploratory tuning.

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1. Core Structural Findings

1.1 Finite Behavioral Alphabet (Confirmed and Refined)

Integer transition behavior under SSNT does **not** grow without bound.

Across all tested ranges, behavior compresses into a **finite symbolic alphabet** that:

- grows rapidly at small scales,
- stabilizes strongly,
- expands only very slowly under large extensions.

This establishes that integer behavior admits a **bounded structural vocabulary**, rather than an unbounded catalog of exceptions.

This conclusion is **stronger and more defensible** than claiming a fixed constant.

The absence of new signatures across the 1,000,000 → 1,500,000 range strengthens the claim that SSNT observes a finite behavioral alphabet with early saturation and long-range stability.

1.1.1 Deep-Scale Alphabet Emergence (Refinement)

Extended deterministic evaluation of alphabet evolution at large cutoffs reveals that the apparent stabilization at **60 structural signatures** up to moderate scale represents a **local convergence plateau**, not the final alphabet closure.

Alphabet evolution was explicitly evaluated at extended cutoffs using deterministic prefix analysis of the SSNT signature stream:

Cutoff (n)	Distinct Signatures	New Added
50,000	60	+6
75,000	60	0
100,000	60	0
150,000	60	0
500,000	60	0
1,000,000	**62**	+2
1,500,000	62	0
1,750,000	62	0
2,000,000	62	0

This establishes a **deep-scale alphabet expansion** occurring only after substantial extension, followed by renewed stabilization.

Two and only two new structural signatures are responsible for this expansion:

- `(0,2,2,1,0)`
- `(0,2,2,0,0)`

These signatures:

• are **absent** from the first `500,000` transitions,
• first appear at deterministic signature indices
`525,556` → `(0,2,2,1,0)`
`525,557` → `(0,2,2,0,0)`,
• emerge as a **consecutive paired event**,
• remain **rare** and do not enter dominant Top-K distributions,
• persist without further alphabet growth through `n = 2,000,000`.

This behavior indicates **delayed structural emergence**, not noise, sampling error, or instability.

Accordingly, the refined conclusion is:

Integer transition behavior under SSNT compresses into a finite symbolic alphabet that stabilizes early, admits rare deep-scale emergence, and then re-stabilizes strongly.

The empirically validated alphabet size within the tested range is therefore:

62 distinct structural signatures (n ≤ 2,000,000).

No claim of universality is made beyond the verified domain.

1.1.2 Paired Late-Scale Micro-Class Recurrence

Deterministic gap analysis was performed on the two late-emerging structural signatures:

• `(0,2,2,1,0)`
• `(0,2,2,0,0)`

Observed occurrence indices (n):

`(0,2,2,1,0)` →
525,556 · 602,808 · 918,240 · 1,616,520 · 1,985,436 · 1,985,448

`(0,2,2,0,0)` →
525,557 · 602,809 · 918,241 · 1,616,521 · 1,985,437 · 1,985,449

Gap sequences for both signatures are **identical**:

`77252 · 315432 · 698280 · 368916 · 12`

This establishes that:

• the two signatures form a **paired structural micro-class**,
• they recur sparsely at deep scale,
• they exhibit **localized repetition bursts** (final gap = 12),

• they are **not members of belts, epochs, or fracture clusters**,
• and their recurrence is **structural**, not stochastic.

These findings further strengthen the conclusion that late alphabet growth under SSNT is **rare, paired, bounded, and non-explosive**.

1.2 Canonical vs Extended Regimes

Two regimes are now cleanly distinguished:

Canonical Regime (`n <= 20,000`)

- Early saturation
- High regularity
- Stable reference behavior
- Suitable for public, frozen reference

Extended Regime (`n > 20,000`)

- New signatures may appear
- Appearance rate is very low
- No instability or regime shift observed

This validates the canonical framing used in public releases and clarifies its scope.

1.3 Structural Geography Scales Predictably

Across all deterministic runs:

- belts,
- corridors,
- epochs,
- fracture clusters

scale approximately linearly with `n`.

There is:

- no parameter retuning,
- no definition collapse,
- no emergence of chaotic artifacts.

SSNT constructs are therefore scale-robust, not tuned to small ranges.

This conclusion is reinforced by the 1,250,000 → 1,500,000 extension, which introduced no instability, no reclassification, and no structural drift across belts, epochs, fracture clusters, or corridors.

1.4 Oscillatory Symmetry Remains Constrained

Bidirectional `±x` symmetry:

- persists across all tested ranges,
- remains exact where defined,
- tightly gates oscillatory behavior.

This confirms that oscillation is a **structural constraint**, not noise or labeling bias.

1.5 Large-Scale Validation I (n <= 1,500,000)

The deterministic extension from **n = 1,250,000 to n = 1,500,000** serves as a **pure validation run** rather than an exploratory expansion. No new parameters were introduced, no thresholds were adjusted, and no definitions were altered.

Across this extension:

• **Alphabet size remained fixed**
• **Fracture clustering ratios remained stable**
• **Belt categories preserved proportional balance**
• **Epoch counts scaled predictably**

No new structural signatures were observed throughout this additional range of **250,000 integer transitions**. When combined with the earlier stabilization between **n = 1,000,000 and n = 1,250,000**, this establishes a **continuous stabilization plateau spanning 500,000 integers**.

This result confirms that SSNT structure is **not an artifact of early ranges**, but a **persistent property of integer behavior** under deterministic structural observation.

1.6 Large-Scale Validation II — Deep-Range Closure (n <= 2,000,000)

A further deterministic scale-extension was executed beyond the previously validated plateau to assess whether the observed stabilization persists under substantially larger ranges.

Alphabet evolution was explicitly evaluated at extended cutoffs up to `n = 2,000,000` using deterministic prefix analysis of the SSNT signature stream.

The results show:

• The alphabet remains fixed at **62 distinct structural signatures** from `n = 1,000,000` through `n = 2,000,000`.
• No additional signatures emerge beyond the last observed expansion at `n = 1,000,000`.
• No previously observed signatures disappear or reclassify.

The final alphabet expansion at `n = 1,000,000` is attributable to **exactly two late-emerging signatures**:

• `(0,2,2,1,0)`
• `(0,2,2,0,0)`

These signatures:

• are absent from the first `500,000` transitions,
• first appear at deterministic signature indices
`525,556` → `(0,2,2,1,0)`
`525,557` → `(0,2,2,0,0)`,
• emerge as a **consecutive paired event**,
• remain rare and do not enter dominant Top-K distributions,
• persist without further alphabet growth across all tested extensions.

This confirms that the earlier stabilization at 60 signatures represents a **local convergence plateau**, while the final stabilized alphabet size within the tested range is:

62 distinct structural signatures (n <= 2,000,000).

The absence of further growth across one million additional integers establishes **deep-range closure** of the SSNT behavioral alphabet within the verified domain.

No claim of universality is made beyond the tested range.

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2. Recorded Alphabet Measurements

All values below are **measured outputs**, not inferred.

2.1 Canonical Reference Run

Run ID: `SSNT_ALL_RUN_0001`
Scope: `n <= 20,000`

Cutoff (n)	Distinct Signatures
5,000	27
10,000	32
20,000	**54**

Status

- Canonical
- Release-grade
- Frozen reference

2.2 Extended Deterministic Runs

Extended Scan A

Run ID: `SSNT_ALL_RUN_0002`
Scope: `n <= 50,000`

Cutoff (n)	Distinct Signatures
30,000	56
40,000	56
50,000	**60**

Observation: growth slows markedly after `n = 20,000`.

Extended Scan B

Run ID: `ALL_RUN_100000`
Scope: `n <= 100,000`

Cutoff (n)	Distinct Signatures
20,000	54
50,000	60
75,000	60
100,000	60

Observation: no new signatures beyond those observed at `n = 50,000`.

Extended Scan C

Run ID: `ALL_RUN_200000`
Scope: `n <= 200,000`

Cutoff (n)	Distinct Signatures
20,000	54
50,000	60
100,000	60
150,000	60
200,000	60

Observation: alphabet remains stable across an order-of-magnitude increase.

Extended Scan D

Run ID: `ALL_RUN_1000000`
Scope: `n <= 1,000,000`

Cutoff (n)	Distinct Signatures	New Added
20,000	54	+54
50,000	60	+6
100,000	60	0
200,000	60	0
500,000	60	0
1,000,000	**62**	+2

Observation: extremely rare late discoveries; no explosive growth.

Extended Scan E

Run ID: ALL_RUN_1250000

Scope: n <= 1,250,000

Cutoff (n)	Distinct Signatures	New Added
1,000,000	62	+2
1,100,000	62	0
1,200,000	62	0
1,250,000	62	0

Observation:
No new structural signatures appear between n = 1,000,000 and n = 1,250,000.

This confirms a sustained stabilization plateau at 62 signatures across an additional

250,000 integer transitions, with no evidence of renewed growth or regime shift.

Extended Scan F

Run ID: ALL_RUN_1500000

Scope: n <= 1,500,000

Cutoff (n)	Distinct Signatures	New Added
1,250,000	62	0
1,300,000	62	0
1,400,000	62	0
1,500,000	62	0

Observation:
No new structural signatures appear between n = 1,250,000 and n = 1,500,000.

This confirms a second stabilization plateau, extending the previously observed convergence region by an additional 250,000 integers.

Alphabet growth is now empirically flat across half a million consecutive integers.

Extended Scan G

Run ID: `ALL_RUN_2000000`
Scope: `n <= 2,000,000`

Cutoff (n)	Distinct Signatures	New Added
1,500,000	62	0
1,750,000	62	0
2,000,000	62	0

Observation:
No new structural signatures appear between `n = 1,500,000` and `n = 2,000,000`.
This confirms **deep-range closure** of the SSNT behavioral alphabet following the final expansion at `n = 1,000,000`.

Alphabet size remains fixed at **62 distinct structural signatures** across an additional **500,000 integer transitions**, extending the verified stabilization region to **one million consecutive integers** (`1,000,000 → 2,000,000`).

This result provides strong empirical evidence that SSNT alphabet growth is **bounded, rare, and structurally constrained**, rather than incremental or scale-driven.

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3. Interpretation Discipline

SSNT makes **no claim** that the alphabet size is a universal constant.

The validated claim is strictly empirical:

Integer transition behavior, under deterministic structural observation, collapses into a finite symbolic alphabet that stabilizes early, admits rare deep-scale emergence, and then re-stabilizes strongly.

Alphabet size is treated as an **empirical convergence property**, not an assumed invariant.

Within the verified domain (`n <= 2,000,000`), alphabet growth is:
• rapid at small scales,
• strongly suppressed at moderate scales,
• limited to a **single rare expansion event** at deep scale,
• and fully stable thereafter.

No extrapolation beyond the tested range is asserted.

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4. Duality: Current State

Duality investigations conducted to date include:

• neighbor pairing,
• oscillation-restricted pairing,
• extended cutoffs beyond `n = 50,000`,
• validation through deep-scale extensions.

Findings:

• unrestricted pairing grows combinatorially (as expected),
• oscillation gating compresses the pairing space significantly,
• temporary convergence to symbolic values does **not** persist under large-scale extension,
• no stable duality constant has been observed under deterministic extension.

Status:

Duality compression remains an **open, properly framed research question**.

The deep-scale alphabet results reported in this work **do not imply duality convergence**, and no such claim is made.

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5. Practical Implications

5.1 Deterministic Compression

Large discrete systems with apparent irregularity can be compressed into a **small, interpretable symbolic space** under deterministic structural observation.

SSNT demonstrates that such compression can be achieved without:
• probabilistic approximation,
• heuristic pruning,
• learning-based abstraction.

This enables:
• deterministic classification,
• bounded verification,
• finite test coverage,
• auditability at scale.

5.2 Structural Early-Warning

Structural constructs such as:
• belts,
• corridors,
• epochs,
• fracture clusters

persist at large scale and form **regions**, not isolated events.

This supports:
• regime shift detection,
• structural risk zoning,
• early instability signaling
without reliance on trend fitting or statistical thresholds.

5.3 Structural Time

Structural time `tau(n)`:

• remains well-defined at large `n`,
• remains interpretable,
• does not drift, collapse, or fragment under extension.

Ordering and progression emerge without clocks, enabling offline, replayable, and vendor-independent diagnostics across large discrete systems.

6. Final Review-Grade Statement

Shunyaya Structural Number Theory demonstrates that integer transition behavior, when observed deterministically under structural rules, compresses into a **bounded symbolic vocabulary**.

`54` structural signatures are observed within the canonical range `n <= 20,000`.

Extended deterministic scans show slow, highly constrained growth, reaching a total of **62 distinct structural signatures** at `n = 1,000,000`.

Two and only two additional signatures emerge at deep scale, appearing as a **paired event**, after which **no further growth** is observed through `n = 2,000,000`.

This establishes:
• early saturation,
• rare delayed emergence,
• and deep-range stabilization
across one million consecutive integers following the final expansion.

The SSNT framework reveals order in integer behavior **without altering arithmetic**, relying solely on reproducible observation rather than probabilistic, heuristic, or learning-based methods.

Claim Boundary Line

SSNT does not claim a universal constant for alphabet size.
It reports an empirically observed stabilization and deep-range closure of integer transition behavior under deterministic structural observation within the tested range (`n <= 2,000,000`).

Bottom Line

Integer behavior is infinite in extent, but **finite in kind** under deterministic structural observation.

That is the result recorded here.

APPENDIX — ALPHABET STABILIZATION AND SCALE VALIDATION (n <= 2,000,000)

A. Purpose of This Appendix

This appendix documents the **final scale-validation evidence** for Shunyaya Structural Number Theory (SSNT).

Its purpose is to demonstrate that the observed finite behavioral alphabet is **not an artifact of small ranges**, but an empirically verified property that persists under **large deterministic extension**, including deep-scale evaluation.

This appendix is **confirmatory, not exploratory**.
All results reported here are measured, reproducible outputs.

B. Scope of Validation

Deterministic SSNT pipelines were executed **without modification** across progressively larger integer ranges, culminating in a full validation run up to:

```
n <= 2,000,000
```

No parameters were retuned, no thresholds adjusted, and no definitions altered during these extensions.

All results reported here are:
• deterministic,
• measured directly from execution,
• hash-verified,
• not inferred or extrapolated.

C. Alphabet Evolution Across Large Cutoffs

Alphabet evolution was explicitly evaluated at large cutoffs beyond the previously observed stabilization plateaus using deterministic prefix analysis of the SSNT signature stream.

Evaluated cutoffs include:

- `n = 1,250,000`
- `n = 1,300,000`
- `n = 1,400,000`
- `n = 1,500,000`

• `n = 1,750,000`
• `n = 2,000,000`

At each cutoff:

• The total number of distinct structural signatures remained constant.
• No new signatures were introduced beyond the last observed expansion.
• No previously observed signatures disappeared or reclassified.

The alphabet size remained fixed at:

62 distinct structural signatures

This confirms **deep-range stabilization** following the final alphabet expansion.

D. Deep-Scale Emergence and Sustained Stabilization

Prior scans established the **final alphabet expansion** at:

`n = 1,000,000`, where the alphabet increased from `60` to **`62`** signatures.

This expansion is attributable to **exactly two late-emerging structural signatures**, which first appear as a **paired consecutive event** in the deterministic signature stream.

Subsequent extensions demonstrate:

• No new signatures from `n = 1,000,000` through `n = 2,000,000`.
• A continuous stabilization plateau spanning **one million consecutive integers**.

This stabilization window exceeds all earlier exploratory and validation intervals and constitutes strong empirical evidence of **alphabet closure under SSNT observation** within the tested range.

E. Dominant Signature Stability (Top-K Analysis)

In addition to total alphabet size, the **relative dominance hierarchy** of structural signatures was examined.

Across all evaluated cutoffs up to `n = 2,000,000`:

• The same dominant structural signatures persist.
• No reordering indicative of a new behavioral regime is observed.
• No late-scale dominance inversion occurs.

This confirms that SSNT convergence applies not only to total alphabet size, but also to the **internal hierarchical structure** of the alphabet.

F. Structural Geography Consistency

During the same deep-scale extension window:

• Fracture clusters continue to appear as **localized regions**, not isolated anomalies.
• Belt categories preserve **proportional balance** across extensions.
• Epoch counts scale predictably with `n`.

No evidence of:

• structural drift,
• regime bifurcation,
• or instability under scale extension

was observed.

This confirms that SSNT structural geography remains **coherent and scale-robust**.

G. Interpretation Discipline

SSNT does **not** claim that the alphabet size is a universal constant.

The validated claim is strictly empirical:

Integer transition behavior, when observed deterministically under SSNT structural rules, collapses into a finite symbolic alphabet that stabilizes early, admits rare deep-scale emergence, and remains unchanged across large extensions within the tested range.

All conclusions in this appendix are bounded by the verified domain:

```
n <= 2,000,000
```

No extrapolation beyond this range is asserted.

H. Conclusion

This appendix establishes that:

• SSNT alphabet convergence is **not an early-range artifact**.
• Structural signatures do **not proliferate with scale**.

• Rare deep-scale emergence is **finite and bounded**.
• Integer behavior under SSNT observation is **infinite in extent, but finite in kind** within the tested domain.

With stabilization verified across **one million integers beyond the final observed expansion**, the SSNT core framework can be considered **scale-validated and closure-confirmed** within the tested range.

Further extensions, while possible, are **not required** to support the claims made in this work.

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