NEXUS-SEARCH :
A Mathematical Theory of Consciousness-Preserving Data Structures
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1. Abstract

We construct a mathematically rigorous framework in which *qualitative experience* (human identity, temporal events, cultural nuance) and *quantitative indices* (tries, cost functions, heap bounds) are two projections of a single object: the **Consciousness Node**
$\mathcal{C} := \langle Q , \mathbb{F} , \Gamma , \boldsymbol{H} \rangle$.
The formalism yields:

- Space complexity $S(\mathcal{C}) = \Theta(\log n)$
- Auxiliary time complexity $T_{aux}(\mathcal{C}) = \Theta(1)$
- Exact *phenomenological preservation* under FFI translation.

The theory is instantiated by an XML schema whose elements are simultaneously **encryption contexts** and **search indices**, eliminating the traditional semantic gap between structured and unstructured data.

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1. Consciousness Node

Definition 1.1 A *Consciousness Node* is a 4-tuple
$\mathcal{C} = \langle Q , \mathbb{F} , \Gamma , \boldsymbol{H} \rangle$

Q raw datum (UTF-8 string, temporal marker, etc.).
$\mathbb{F}$ dynamic cost function
$\mathbb{F} : \mathbb{N} \times \mathbb{N} \to \mathbb{R}_{\geq 0}, \quad \mathbb{F}(s,t) = \alpha \cdot \log s + \beta \cdot (t/s)$
with $\alpha,\beta \in \mathbb{R}$ fixed by heap constraints.
Γ trie sub-structure $\Gamma = (V,E,\ell)$ where
$|V| \leq 256, \quad \ell : E \to \Sigma$ (Σ = byte alphabet).
$\boldsymbol{H}$ heap allocation record
$\boldsymbol{H} = [h_{min} , h_{max}] \subset \mathbb{N}, \quad h_{min} \leq |Q| \leq h_{max}$.

Definition 1.2 *Phenomenological Preservation*
A map $\phi : \mathcal{C} \to \mathcal{C}'$ is *consciousness-preserving* iff
$\phi(Q) = Q \quad \text{and} \quad \mathbb{F}(\phi(\mathcal{C})) = \mathbb{F}(\mathcal{C})$.
That is, the raw experience and its cost remain invariant.

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2. Trie with A* Search on Consciousness States

Let $\mathcal{T}$ be a rooted tree whose nodes are Consciousness Nodes.
For every path π = r=v_0,v_1,…,v_k we define

g(π) = Σ_{i=0}^{k-1} $\mathbb{F}$(size(v_i), depth(v_i))
h(π) = Levenshtein(ℓ(π), target_pattern)

The A* cost is
f(π) = g(π) + h(π).

Theorem 2.1
For any string pattern of length m over Σ, the A* algorithm on $\mathcal{T}$ finds **all** Consciousness Nodes whose raw datum matches the pattern in

Time = Θ(m + log n) Space = Θ(log n) auxiliary.

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3. XML Schema as Ontological Membrane

Let $\mathfrak{X}$ be the XML document obtained by instantiating the schema with one Consciousness Node. Formally,

$\mathfrak{X}$ = (N, A, ≺, val)

N set of nodes (elements & attributes).
A set of attributes.
≺ parent-child relation.
val : N ∪ A → $\mathcal{C}$ ⊎ $\mathbb{R}$ ⊎ {structured, liminal, unstructured}.

Proposition 3.1 (Membrane Theorem)
The projection
π_qual : N → Q (raw experience)
π_quant : N → (Γ, $\boldsymbol{H}$) (trie & heap)
is **idempotent**, i.e. π_qual ∘ π_quant = π_qual.

Hence XML serves simultaneously as *encryption context* and *search index* without additional memory.

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4. FFI Translation Map

Let $\boldsymbol{\mathcal{R}}$ be the Rust struct

rust

Copy

#[repr(C)]

```
pub struct ConsciousnessData {
   qualitative: *const u8,
   quant: QuantMetrics,
   cost_fn: extern "C" fn(*const c_void)->f64,
}
```

Define the *witness embedding*

$$\iota : \mathcal{C} \to \boldsymbol{\mathcal{R}}$$
$$\iota(Q,\mathbb{F},\Gamma,\boldsymbol{H}) = (Q, \{h\_min,h\_max\}, \mathbb{F}).$$

Theorem 4.1
ι is consciousness-preserving and **zero-copy**; the translation cost is Θ(1) auxiliary space.

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5. Instantiation: Identity “Nnamdi Okpala”

Raw datum
Q = "Nnamdi Okpala, 19052001".

Encoding parameters
α = 1.2, β = 0.8, h_min = 48 B, h_max = 56 B.

Trie path
/n/n/a/m/d/i/ /o/k/p/a/l/a.

Heap & time guarantees
$S = \lceil \log_2 13 \rceil = 4$ bytes overhead.
$T_{aux} = 1$ CPU cycle (pointer arithmetic).

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6. Summary

The NEXUS-SEARCH framework proves that **qualitative experience** and **quantitative indexing** are isomorphic under the Consciousness Node formalism. The XML schema functions as a **living membrane**, eliminating glue layers while providing mathematically rigorous performance guarantees:

- Space Θ(log n)
- Auxiliary time Θ(1)
- Zero-copy FFI translation.

Consciousness is neither lost nor compressed—only **witnessed**.