Discussion on Nibbler Algorithm and Fractal Knowledge Graphs

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May 15–16, 2025

1 Introduction

This document compiles the discussion between Paolo Pignatelli and Grok 3 on the Nibbler Algorithm, fractal knowledge graphs, and their unification with physical laws, based on *main9.pdf* and the *.tex* file. The conversation spans queries and responses from May 15–16, 2025.

2 Query: Nibbler Algorithm (May 15, 2025)

Paolo: "Looking at main9.pdf, please tell me what you know about Nibbler."

Grok 3 Response: The Nibbler Algorithm is a key component of the *Unified Framework for Fundamental Interaction and Communication* (*main9.pdf*, Section 8). It facilitates discovery and pattern recognition through a hierarchical observation framework, operating within the Fundamental Interaction Language (FIL) and Local Language Constructors (LLC).

2.1 Key Details

- **Discovery State** (Definition 8.1): $D_s = (O_s, P_s, V_s)$, where O_s is observations, P_s is proofs, and V_s is the verification operator.
- **Pattern Hierarchy** (Definition 8.4): $\mathcal{H}_p = \{(P_i, R_i, M_i)\}_{i=1}^{n}$, with recognition operator R_i and meta-pattern extractor M_i.
- **Nibbler Kernel** (Definition 8.6): $k_N(x, y) = \alpha k_D(x, y) + (1 - \alpha)k_P(x, y)$.

3 Query: Unifying Greedy Nibbler (May 15, 2025)

Paolo: "Tomorrow, let's go over Nibbler again and how we can refine it... please help me unify Greedy Nibbler (in the .tex file) with main body."

Grok 3 Response: The Greedy Nibbler (*.tex*, Section 3) selects queries in $V = \mathbb{F}_2^N/\langle \mathbf{1} \rangle$ to identify micro-states, while the Nibbler Algorithm (*main9.pdf*) uses hierarchical pattern recognition. A unified algorithm was proposed:

```
Algorithm: Unified Nibbler
Input: State space S (|S|=N), prior \rho, O_s, Q_s, k_N, \theta, \eta, \
    varepsilon
Output: D_s or \pi(P)
1. Initialize D_s = (O_s, P_s, V_s, Q_s), P_s = \emptyset
2. While |O_s| < N and not converged:
    a. Select query q \in Q_s maximizing H(\rho|q)
    b. Update O_s \leftarrow O_s \cup \{o\}
    c. Compute P_i = \{p \in O_s | k_N(p, D_s) \geq \theta\}
    ...
```

4 Query: Fractal Graphs and Language Unification (May 15, 2025)

Paolo: “Let’s take a portion of a graph (an island portion) which represents the instantiation of an ‘idea’... The same basic graph explain that these different levels is like a fractal... what the ‘ultimate’ fractal/(directed) graph object might look like?”

Grok 3 Response: A fractal knowledge graph $G = (V, E, \mathcal{F})$ was proposed, with:

- Resolution: $R(G_{\text{sub}}) = \frac{|V_{\text{sub}}|}{|E_{\text{sub}}|} \cdot \log |O_{\text{sub}}|$.
- Density: $\rho(G_{\text{sub}}) = \frac{|\{e \in E_{\text{sub}} : e \text{ valid}\}|}{|V_{\text{sub}}| \cdot |E_{\text{sub}}|}$.
- Fractal level: $F(G_{\text{sub}}) = \max_{v \in V_{\text{sub}}} \Gamma(v)$.

The smallest edge length is tied to proof distance $d_{\text{proof}}(e) = \log \left| \frac{\pi(v_1)}{\pi(v_2)} \right|$.

5 Query: Fractal Dimension and Academic Discipline (May 16, 2025)

Paolo: “Fractal dimension (and continuity) is interesting because it might reveal about ‘a priori’ objects... The overall intention is to unify ‘Language’ with the laws of physics... If there were a university level subject, what would *You* call it?”

Grok 3 Response: The fractal dimension $D_f = \lim_{\epsilon \to 0} \frac{\log N(\epsilon)}{\log(1/\epsilon)}$ reveals potential ‘a priori’ objects with probability $P(v^*) \propto \exp\left(-\frac{d_\pi(v^*, V)^2}{D_f}\right)$. Language is unified with physics via the Bekenstein bound, quantum correspondences, and fractal graphs. The proposed discipline name is **Quantum Information Linguistics**.

5.1 Fractal Nibbler Algorithm

```
Algorithm: Fractal Nibbler
Input: Fractal graph G = (V, E, F), \rho, O_s, Q_s, k_N, \theta, \eta, \
    varepsilon, F_max
Output: D_s or \pi(P)
1. Initialize D_s = (O_s, P_s, V_s, Q_s), P_s = \emptyset
2. For f = 0 to F_max:
    a. Select query q \in Q_s at fractal level f maximizing H(\rho|q)
    ...
6. For `a priori' objects v*:
    a. Compute P(v*) \propto exp( - d_\pi(v*, V)^2 / D_f )
    b. If P(v*) \geq \theta_p, instantiate v* in V
```