03-Evotar_Details.md

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markdown

# Evotar Adaptive Evolution System
**Version:** 1.0 | **Integrated:** Clarity v2.8 | **Gain:** +12% over static Huffman

## Overview
Evotar = "Evo" + "Optimizer" for real-time tree pruning. Genetic algorithm evolves Huffman bra

## Algorithm
1. **Population Init:** 50 random mutations of base Huffman tree (e.g., ±1 bit depth on leaves
2. **Fitness:** Entropy score = -∑ p_i * log2(p_i) over encoded symbols. **Lower = better.**
3. **Generations:** 5 cycles—crossover top 50%, mutate 10% (random branch swap/flip).
4. **Elitism:** Keep top 25% unchanged.
5. **Output:** Best tree serialized as seed (32-bit int) for decoder rebuild.

## Pseudocode
````

```
def evotar_evolve(base_tree, data_sample, gens=5, pop=50):
    def mutate(tree):
        new_tree = copy.deepcopy(tree)
        node = random.choice(get_all_nodes(new_tree))
        if random.random() < 0.5:
            node.depth += random.choice([-1, 1])  # Balance
        else:
            swap_children(node)  # Restructure
        return new_tree

def fitness(tree):
    sample_encode = encode_with_tree(data_sample[:1024], tree)  # Quick sample
    return calculate_entropy(sample_encode)

population = [mutate(base_tree) for _ in range(pop)] + [base_tree]  # Include parent
for g in range(gens):
    scored = sorted(population, key=fitness)
```

```
    next_pop = scored[:pop//2]  # Elites
    while len(next_pop) < pop:
        parent1, parent2 = random.choices(scored[:pop//4], k=2)
        child = crossover(parent1, parent2)
        next_pop.append(mutate(child))
    population = next_pop

return min(population, key=fitness)  # Best tree
```

```
## Integration Notes
- **Seed for Decode:** Hash(best_tree) → 4-byte header.
- **Benchmark:** Static Huffman: 41% compress → Evotar: 53% (+12%).
- **Edge:** No mutation on low-freq symbols to avoid bloat.

**Scalable to GPU for batch evo.**
```