

# Rsync Block Matching Complexity Proof

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## 1 Theorem: Block Matching Complexity

**Statement:** Finding matching blocks using rolling checksum in splay tree takes  $O(m \log n)$  time where  $m$  is number of blocks to match and  $n$  is number of stored blocks.

## 2 Proof

For each of  $m$  blocks:

1. Compute rolling checksum:  $O(1)$
2. Search in splay tree:  $O(\log n)$  amortized
3. Verify strong hash:  $O(1)$

Total:  $m \times O(\log n) = O(m \log n)$

### 2.1 With Splay Optimization

Frequently matched blocks move to root, reducing average search time for common patterns.

**Conclusion:** Block matching has  $O(m \log n)$  time complexity, with better average case for common patterns.