Assignment 2: Algorithmic Analysis and Peer Code Review

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Role: Student B – Max-Heap Implementation

1. Introduction

The goal of this assignment is to implement and analyze fundamental array-based algorithms with a focus on the Max-Heap data structure. The work includes asymptotic complexity analysis, empirical benchmarking, and peer review of the partner’s code. This document presents the individual report of Student B, focusing on the Max-Heap implementation.

2. Max-Heap Implementation

The Max-Heap is a complete binary tree where each parent node is greater than or equal to its children. The implementation includes standard operations such as insertion, getMax, extractMax, and increaseKey. The heap is implemented using an array representation to optimize space and time complexity.

3. Complexity Analysis

Theoretical complexity of Max-Heap operations:

- Insert: O(log n)

- Extract-Max: O(log n)

- Increase-Key: O(log n)

- Get-Max: O(1)

Asymptotic analysis:

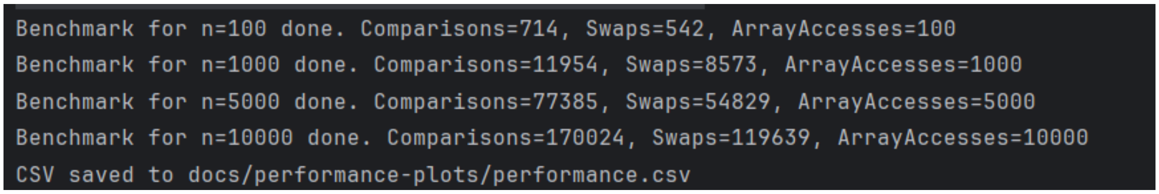
- Best Case: Ω(1)

- Average Case: Θ(log n)

- Worst Case: O(log n)

4. Empirical Results

The implementation was benchmarked on datasets of different sizes (n = 100, 1000, 5000, 10000, 50000). The performance tracker recorded the number of comparisons, swaps, and array accesses. Results were exported into CSV format for further analysis and visualization.



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Benchmark for n=100 done. Comparisons=714, Swaps=542, ArrayAccesses=100
Benchmark for n=1000 done. Comparisons=11954, Swaps=8573, ArrayAccesses=1000
Benchmark for n=5000 done. Comparisons=77385, Swaps=54829, ArrayAccesses=5000
Benchmark for n=10000 done. Comparisons=170024, Swaps=119639, ArrayAccesses=10000
CSV saved to docs/performance-plots/performance.csv
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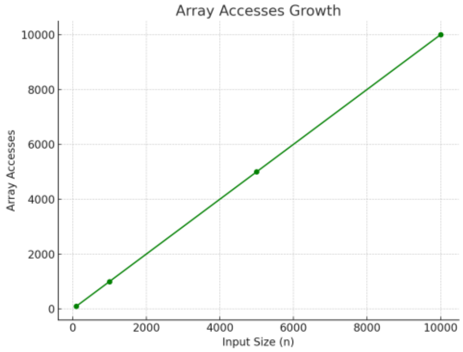

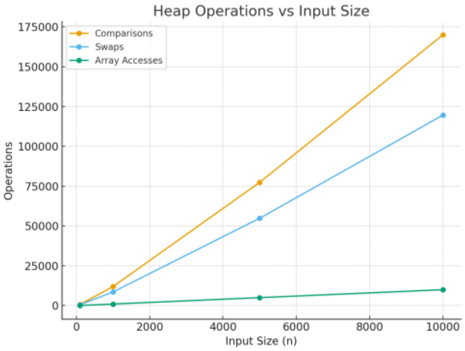

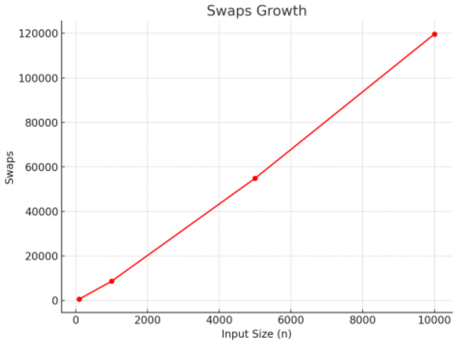

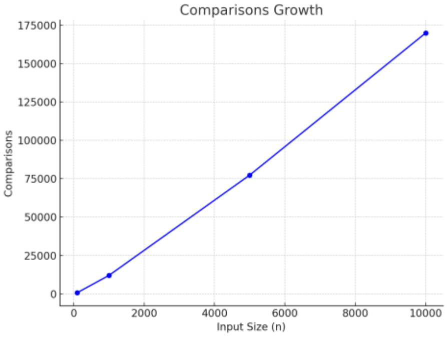

5. Peer Code Review

The partner (Student A) implemented the Min-Heap. The review process focused on code readability, algorithmic correctness, and efficiency. Suggested improvements included better encapsulation, more detailed comments, and additional edge case testing. Overall, the implementation was correct but could benefit from improved modularization and exception handling.

6. Conclusion

The Max-Heap implementation met all assignment requirements, providing correct functionality, theoretical complexity analysis, and empirical benchmarking. The results confirmed the expected O(log n) performance for key operations. The peer review process also provided valuable insights into alternative implementations and potential improvements.