

CS2400 Final 2018 Project 4

Total points: 100

Due date: Monday, November 19th, 2018

Purpose:

1. Understand the structure of a binary heap.
2. Be able to analyze the complexities of an algorithm through experiments.

Task Description:

In this project, you are going to build a **max-heap** using array representation. In particular, your program should:

- Implement both methods of building a max heap:
 - Using sequential insertions (its time complexity: $O(n \log n)$).
 - Using the optimal (“smart”) method (its time complexity: $O(n)$).For both methods, you need to keep track of how many swaps (swapping parent and child) are required to build a heap.
- Allow the user to select one of the following two choices (Note that your program needs to implement both choices):
 - (1) test your program with 100 randomly generated integers (no duplicates, positive numbers with proper range);
 - (2) test your program with the sequence of 100 fixed values: 1, 2, 3, ..., and 100.
- For choice (1), you need to generate 20 sets of randomly generated integers; compute, print and document (in your project report) the average number of swaps for both methods. Your program should output the average number of swaps for both methods (an average over 20 sets).
- For choice (2), your program should output the first 10 integers in your array and the number of swaps for both methods. Then perform 10 removals on the heap and output the first 10 integers.

Your program should use an interactive interface with the format shown below (the user inputs are underlined):

```
=====
Please select how to test the program:
(1) 20 sets of 100 randomly generated integers
(2) Fixed integer values 1-100
Enter choice: 1
```

Average swaps for series of insertions: 107

Average swaps for optimal method: 87

=====

Please select how to test the program:

(1) 20 sets of 100 randomly generated integers

(2) Fixed integer values 1-100

Enter choice: 2

Heap built using series of insertions: 100,94,99,77,93,98,61,68,76,84,...

Number of swaps: 480

Heap after 10 removals: 90,89,62,77,88,53,61,68,76,84,...

Heap built using optimal method: 100,95,99,79,94,98,63,71,78,87,...

Number of swaps: 96

Heap after 10 removals: 90,89,63,79,88,55,62,71,78,87,...

In your project report, you need to analyze both methods of heap implementation in terms of their efficiency theoretically and experimentally. **Please also mention if Java interface and generic data type are used or not, as bonus will be considered for those who use Java interface and generic data type.**

What to Submit?

1. Source code
2. Project report (the outputs of your program and the analysis mentioned above)
3. Please zip all documents as yourname_p4.zip and submit it in blackboard.

You will be graded based on the quality of your program and your project report.