COMP 301 Analysis of Algorithms, Fall 2021
Instructor: Zafer Aydın
Lab Assignment 8

Introduction

In this lab you will compare the running times of heap sort and merge sort algorithms. Submit your answers to the questions below in a text file (e.g. Word document, pdf). Name your file in name_surname.docx format. Submit your solution document and Java codes as a compressed folder (.zip, .rar) in name_surname format to Canvas.

You can use the code templates in `heap.java` in this lab.

Problem Statement

Given an array of integers sort the numbers in this array in ascending order. You can implement heap by an array.

Assignment

1. (a) Implement Java methods for the heap sort algorithm given below.

```
PARENT(i)
1  return ⌊i/2⌋

LEFT(i)
1  return 2i

RIGHT(i)
1  return 2i + 1
```

```
MAX-HEAPIFY(A, i)
1  l = LEFT(i)
2  r = RIGHT(i)
3  if l ≤ A.heap-size and A[l] > A[i]
4       largest = l
5  else largest = i
6  if r ≤ A.heap-size and A[r] > A[largest]
7       largest = r
8  if largest ≠ i
9       exchange A[i] with A[largest]
10      MAX-HEAPIFY(A, largest)
```

```
BUILD-MAX-HEAP(A)
1  A.heap-size = A.length
2  for i = ⌊A.length/2⌋ downto 1
3       MAX-HEAPIFY(A, i)
```

```
HEAPSORT(A)
1  BUILD-MAX-HEAP(A)
2  for i = A.length downto 2
3       exchange A[1] with A[i]
4       A.heap-size = A.heap-size − 1
5       MAX-HEAPIFY(A, 1)
```

(b) Test your algorithm by choosing a heap of size 10 (implemented as an array). Initialize your heap by random numbers from 0 to 99. Make sure your program sorts arrays correctly. Include the output of your program for this sample input in your report. [5, 14, 20, 24, 32, 58, 60, 75, 81, 92]

(c) Choose input sizes in the table below, which are powers of 4, and randomly initialize the key values in your array. Compute the running times of heap sort and merge sort in

nanoseconds for each of these input sizes and include the table below in your report.

Input size	Heap sort running time	Merge sort running time
4	6663	9722
64	139842	94029
256	59124	465456
1024	265221	488719
4096	1037370	1106263
16384	2612432	4775559
65536	9858366	9587988
262144	29804693	36647157
1048576	133308483	143096569
4194304	536559599	497207044
16777216	2279613202	1964022833
67108864	9828270510	8464036972

(d) Set the input size to 67108864. Run the heap sort. Open a terminal window and type top. Find the process for heap sort and record the RAM usage in MEM column for this process. Include the RAM usage of heap sort in your report. 550 Megabyte

(e) Repeat part (d) for merge sort. Does merge sort use more RAM as compared to heap sort?

950 Megabyte. MergeSort use more ram than heapsort because mergesort creates array and in order to do that it allocates space in ram. Mergesort allocates memory for array nearly double times of heapsort.

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