

# CSE222 / BIL505

## Data Structures and Algorithms

### Homework #6

In this homework, you are asked to implement 4 different well-known sorting algorithms in Java. You are also asked to prepare a report for this homework. The details are explained below.

#### Sorting Algorithms

You must write a complete Java program which sorts an array of integers by using the following algorithms:

- 1) Selection Sort
- 2) Bubble Sort
- 3) Quick Sort
- 4) Merge Sort

All of these algorithms must be implemented by you in Java, without using a library. While implementing these algorithms, you must count the number of **comparisons** and the number of **swaps** made by each algorithm. These counters should also be printed along with the sorted array.

#### Report

You must write a report, analyzing and comparing these algorithms in terms of time and space complexity. You are not asked to make a mathematical calculation in this part (for instance, in order to show merge sort is faster than selection sort). Instead, you must use the number of comparisons and swaps to explain which algorithm makes unnecessary work or which algorithm optimizes the space usage. You can refer to your code in your explanation. While comparing the algorithms, make sure you mention different types of inputs: a sorted array, a reversely sorted array, and a randomized array. You will receive a report template. You should stick to it and keep your report at most 2 pages long.

**PS:** The report should be submitted in PDF format.

#### Class Structure and Programming Details

In this homework, you will receive a template for the program. In this template, the classes and methods are already defined. You are asked to fill these methods, making sure the program works correctly. You should obey the following instructions in order to receive full credit.

- You cannot add new classes.
- You cannot add new methods.
- You cannot change the variables of a class.
- If a method is provided with its code in the template, you cannot change it.
- You cannot change the parameters of the given classes (or you cannot add new ones).

- You cannot use libraries.
- You will also receive a makefile, you cannot corrupt it.
- You must add comments to each method.

The input array will be given within the code. This homework doesn't require reading an input from the keyboard.

## Sample Screenshots

The output of the program should be as seen in the examples below.

|                                |    |                        |                  |                               |
|--------------------------------|----|------------------------|------------------|-------------------------------|
| Initial Array: 1 2 3 4 5 6 7 8 |    |                        |                  |                               |
| Selection Sort                 | => | Comparison Counter: 28 | Swap Counter: 7  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Bubble Sort                    | => | Comparison Counter: 7  | Swap Counter: 0  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Quick Sort                     | => | Comparison Counter: 28 | Swap Counter: 35 | Sorted Array: 1 2 3 4 5 6 7 8 |
| Merge Sort                     | => | Comparison Counter: 12 | Swap Counter: 0  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Initial Array: 4 2 6 5 1 8 7 3 |    |                        |                  |                               |
| Selection Sort                 | => | Comparison Counter: 28 | Swap Counter: 7  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Bubble Sort                    | => | Comparison Counter: 27 | Swap Counter: 12 | Sorted Array: 1 2 3 4 5 6 7 8 |
| Quick Sort                     | => | Comparison Counter: 14 | Swap Counter: 10 | Sorted Array: 1 2 3 4 5 6 7 8 |
| Merge Sort                     | => | Comparison Counter: 15 | Swap Counter: 0  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Initial Array: 8 7 6 5 4 3 2 1 |    |                        |                  |                               |
| Selection Sort                 | => | Comparison Counter: 28 | Swap Counter: 7  | Sorted Array: 1 2 3 4 5 6 7 8 |
| Bubble Sort                    | => | Comparison Counter: 28 | Swap Counter: 28 | Sorted Array: 1 2 3 4 5 6 7 8 |
| Quick Sort                     | => | Comparison Counter: 28 | Swap Counter: 19 | Sorted Array: 1 2 3 4 5 6 7 8 |
| Merge Sort                     | => | Comparison Counter: 12 | Swap Counter: 0  | Sorted Array: 1 2 3 4 5 6 7 8 |

## General Information About the Homework:

- Cheating is not permitted. The students who cheat will receive NA from the course.
- You should submit your work as a single **zip** file (including the report).
- The Problem Session on May 7 will describe the homework in detail. If you have any questions, you should ask them in PS. Any other questions before/after the PS will be ignored unless there is a mistake or missing information in this PDF. In such a case, the announcement will be made on Teams, you are responsible for reading them in time.
- Late submission is not allowed. The due date will not be postponed.

## Grading Details

| Part           | Grade     |
|----------------|-----------|
| Selection Sort | 20 points |
| Bubble Sort    | 20 points |
| Quick Sort     | 20 points |
| Merge Sort     | 20 points |
| Report         | 20 points |

***For each sorting algorithm, you will receive 15 points for correctly sorting the array and 5 points for the counters (number of comparisons and number of swaps).***

Additionally, you must be careful with the following situations.

| Behavior                                                                                                                                                    | Result                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| If your program doesn't work due to an error                                                                                                                | You will only receive points from the report (up to 20 points).                                                                                                                                                             |
| If you use additional libraries                                                                                                                             | You will lose 20 points per library.                                                                                                                                                                                        |
| If you add a new method/class or change the structure of a given method/class                                                                               | That method/class will be deleted.<br>If your program works fine without it, nothing changes.<br>If your program doesn't work without it (due to an error), you will only receive points from the report (up to 20 points). |
| If you don't add comments                                                                                                                                   | You will lose 10 points.                                                                                                                                                                                                    |
| If your report is longer than 2 pages                                                                                                                       | You will lose 5 points per extra page.                                                                                                                                                                                      |
| If you hand-in your work in a format other than zip (you should submit it as a single zip file, the name of the zip file is not important in this homework) | You will lose 10 points.                                                                                                                                                                                                    |