

Tutorial/Lab 8 - Developing Efficient Algorithms

Aim

This tutorial/lab aims to further the understanding of the topics covered in Week 8's lecture. Meanwhile, it aims to get students familiar with the question types that might be appeared in their future test.

Exercise 8.1 Time Complexity

Q1. How many stars are displayed in the following code if n is 10? How many if n is 20? Use the Big O notation to estimate the time complexity.

(a)

```
for (int i = 0; i < n; i++) {
    System.out.print("*");
}
```

(b)

```
for (int i = 0; i < n; i++) {
    for (int j = 0; j < n; j++) {
        System.out.print("*");
    }
}
```

(c)

```
for (int k = 0; k < n; k++) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            System.out.print("*");
        }
    }
}
```

(d)

```
for (int k = 0; k < 10; k++) {
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            System.out.print("*");
        }
    }
}
```

Exercise 8.2 Design

Design an $O(n)$ time algorithm for computing the sum of numbers from n_1 to n_2 for ($n_1 < n_2$). Can you design an $O(1)$ for performing the same task?

Exercise 8.3 Analysis

Analyze the following sorting algorithm, the Big O for its worst case is $O(\text{_____})$?

```
for (int i = 0; i < list.length - 1; i++) {
```

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```
if (list[i] > list[i + 1]) {  
    swap list[i] with list[i + 1];  
    i = -1;  
}  
}
```

Exercise 8.4 Divide-and-Conquer

Write a method that uses the divide-and-conquer approach to find the largest number in a list.

Hint:

- Given the list is 178, 33, 4, 2, -3, 5
- Recognize that if the list has only one element, that element is inherently the largest. For a list with two elements, simply compare them directly.
- Calculate the middle index to split the array into two halves. This will allow the method to recursively find the largest number in each half.
- Once you have the largest number from each half, compare these two numbers to determine the largest overall. This is where you combine results to solve the larger problem.