Data Structures and Algorithms
University of New Brunswick
Fredericton, New Brunswick, Canada

Spring 2023

Instructor:	Syed Eqbal Alam	**Date Due:**	February 20, 11:59pm
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Assignment part 1

Instructions: Every question has equal weight. All group members should participate equally.

1 Algorithm Analysis

Question 1.1. *Let ArrayA stores n positive integer values, and the array index starts from* 0*. Find the relationship between the array size n and the total number of basic operations required to perform the task in following code snippet. What is the upper bound of its time complexity?*

```
for(int i = 0; i < n; i++)
    for(int j = 1; j < ArrayA[i]; j = j * 2)
      System.out.println(j + " ");
```

Question 1.2. *For* $n \geq 2$*, if* $f(n) = 3n + 2n\log_2(n)$*. Then show that* $f(n)$ *is order of* $O(n \log_2 n)$*.*

Question 1.3. *For* $n \geq 1$*, if* $f(n) = 3n^2 + 2n\log_2(n)$*. Then show that* $f(n)$ *is* $O(n^2)$*.*

Question 1.4. *For* $n \geq 1$*, if* $f(n) = 3n^3 + 2n^2 + 5n\log_2(n)$*. Then show that* $f(n)$ *is* $O(n^3)$*.*

Question 1.5. *For* $n \geq 10$*, if* $f(n) = 3n^3 + 2^n$*. Then show that* $f(n)$ *is* $O(2^n)$*.*

Question 1.6. *For* $n \geq 4$*, if* $f(n) = 2^n + n!$*. Then show that* $f(n)$ *is* $O(n!)$*.*

Question 1.7. *Show that the Algorithm to find a number is even or odd is* $O(1)$*.*

Question 1.8. *Show that the Algorithm to find the maximum value of an array is* $O(n)$*.*

Question 1.9. *What is the upper bound, lower bound, and average bound of Binary search tree. Illustrate with an example.*

Question 1.10. *Show that calculating the minimum value in an array is* $O(n)$*.*

Question 1.11. *Show that bubble sort is* $O(n^2)$*.*

Question 1.12. *Show that Insertion sort is* $O(n^2)$*.*

Question 1.13. *Show that Merge sort is* $O(n \log n)$*.*

Question 1.14. *Find out the time complexity of Quick sort (the lower bound, average bound, and the upper bound).*

Question 1.15. *Show that matrix addition is* $O(n^2)$*.*

Question 1.16. *Show that matrix multiplication is* $O(n^3)$*.*

Question 1.17. *If $f(n) = \sum_{i=1}^{n} i$, then show that $f(n)$ is $O(n^2)$.*

Question 1.18. *If $f(n) = \sum_{i=1}^{n} i^2$, then show that $f(n)$ is $O(n^3)$.*

The following questions are from the book [1].

Question 1.19. *[1][Chapter 4, R-4.8]*

Question 1.20. *[1][Chapter 4, R-4.9]*

Question 1.21. *[1][Chapter 4, R-4.10]*

Question 1.22. *[1][Chapter 4, R-4.11]*

Question 1.23. *[1][Chapter 4, R-4.12]*

Question 1.24. *[1][Chapter 4, R-4.13]*

Question 1.25. *[1][Chapter 4, R-4.14]*

Question 1.26. *[1][Chapter 4, R-4.15]*

Question 1.27. *[1][Chapter 4, R-4.16]*

Question 1.28. *[1][Chapter 4, R-4.23]*

Question 1.29. *[1][Chapter 4, R-4.25]*

Question 1.30. *[1][Chapter 4, R-4.26]*

Bonus points

Solve the following questions (1.31 and 1.32) for bonus points:

Question 1.31. *[1][Chapter 4, C-4.52]*

Question 1.32. *[1][Chapter 4, C-4.53]*

References

[1] Michael T. Goodrich, Roberto Tamassia, and Michael H. Goldwasser. *Data Structures and Algorithms in Java*. Wiley, 6th edition, 2014. 2