Lab 7

● Graded

Group

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✎ View or edit group

Total Points

7.75 / 9 pts

Question 1

Problem 1

1 / 1 pt

+ 0 pts Options below are **in alternative**

✔ **+ 1 pt** Correct: f (e d | d e) b (a c | c a).
(functions (e) and (d) have the same order of growth, and so do (a) and (c)).

+ 0.8 pts One mistake in the sequence.

+ 0.6 pts A couple of mistakes

+ 0.2 pts Multiple mistakes

+ 0 pts blank or nonsense

Question 2

Problem 2

1 / 2 pts

+ 0 pts Options below are **cumulative**

✔ **+ 1 pt** part (a) correct answer (no points if wrong or missing)

+ 0.3 pts part (b) correct reduction steps

+ 0.7 pts part (b) correct n_0 and c values

Question 3

Problem 3

2 / 2 pts

+ 0 pts Options below are **cumulative**

✔ **+ 1 pt** part (a) correct answer (no points if wrong or missing)

✔ **+ 0.3 pts** part (b) correct reduction steps

✔ **+ 0.7 pts** part (b) correct n_0 and c values

Question 4

Problem 4 — **3.75** / 4 pts

4.1 (a) — **1** / 1 pt

+ **0 pts** Options are **cumulative**

✔ + **0.5 pts** best-case is correct

✔ + **0.5 pts** runtime is correct

4.2 (b) — **0.75** / 1 pt

+ **0 pts** Options are **cumulative**

✔ + **0.5 pts** worst-case is correct

+ **0.5 pts** runtime is correct

+ **0.25 pts** It should be the theta bound

4.3 (c) — **2** / 2 pts

+ **0 pts** Options are **in alternative**

✔ + **2 pts** correct and complete answer

+ **1.5 pts** Correct but steps not shown in sufficient detail

+ **1.5 pts** Mostly correct and steps fully shown but something went wrong in simplification

+ **1 pt** Partially correct and not enough details

+ **0.5 pts** minimally correct

+ **0 pts** Nonsense or missing

CS 2230 Data Structures

Lab 7: Asymptotic Analysis

This lab should be done in teams of two or three people. Find a partner or two.

Write your answers directly on this PDF (using apps such as Acrobat Reader or Apple Preview). Alternatively, print this file, write you answers on it and then scan the page into a single PDF document. Then submit on ICON to the Lab 7 assignment. This will take you to Gradescope. **Only one person per group should submit**. When submitting, **make sure to add your teammates**. You can check this short video on how to do that.

The purpose of this prelab is to give you practice for HW4. All of the problems will be of the same type as those on the homework.

Learning objectives

- Get familiar with Big-Oh/Theta/Omega
- Determine the worst-case complexity of simple algorithms

Helpful documentation

See the readings in *Asymptotic Analysis* for help with these topics.

Problem 1

Order the following functions by asymptotic order of growth (lowest to highest)

a) $10000 + 200n + 90n^2 + 55n^2 \log n + 1.1n^3$
b) $5n \log n + 4n$
c) $5n^3$
d) $10n + 2$
e) n
f) $400^3 \log n$

Lowest → f e d b a c ← Highest

Problem 2

For the function $f(n) = 2n^4 + 7n$, find $g(n)$ such that $f(n) \in O(g(n))$.

a. Pick a correct and tight $g(n)$.

g(n) = n^4

b. Prove your answer by finding a suitable c and n_0 such that $\forall n \geq n_0, f(n) \leq c \cdot g(n)$.

7n <= 2*n^4 for all n >= 2, because 7 <= 2*n^3

2n^4 <= 2*n^4 for all n >= 2, because 1 <= 1

Problem 3

Find a $g(n)$ such that the $f(n) \in \Theta(g(n))$ where $f(n) = 15n^2 + 3n \log n + 2n$.

a. Pick a correct and tight g(n).

g(n) = n^2

b. Prove your answer by finding a suitable c_1 , c_2, and n_0 such that
$\forall n \geq n_0, c_1 \cdot g(n) \leq f(n) \leq c_2 \cdot g(n)$.

15 * n^2 <= 15n^2 +3nlogn +2n <= 20*n^2

for all n >= 1

Problem 4

Let R(n) be runtime of method `m(x,n)` below:

```
public static int m(int x, int n) {
    int sum = 0;
    if (x <= 1) return 0;
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            sum += x/2;
        }
    }
    return sum;
}
```

a. Describe the best-case input (causing the smallest runtime) and its corresponding runtime.

If x is <= 1 it would return 0 and the runtime would O(1)

b. Describe the worst-case input (causing the largest runtime) and its corresponding Θ-bound. Simplify the summation from (c) to show your bound is right.

The worst case is whenever x > 1 because it would be forced to go through both loops which is a O (n^2) runtime.

c. Provide the summation you used to calculate the number of steps for the worst case. Comment on how each line of code relates to the summation. Recall that for loops you need to consider the number of iterations and the number of constant-time steps per iteration.

$$\sum_{i=1}^{n} \sum_{j=1}^{n} 1$$

Each for loop has a runtime of O(n). Since they are nested it has a runtime of O(n^2)

Notes

- Runtime is in terms of n only.
- For questions (a) and (b), you need to provide an explanation in terms of both input values (for `x` and `n`).