

Quiz 1 Set A

CS 2383 Data Structures and Algorithms
Faculty of Computer Science
University of New Brunswick
Fredericton, New Brunswick, Canada

Spring 2023

Student's Name:

University Id:

Date: February 14, 2023

Time: 12:00pm – 1:00pm

Total points: 20

Each question is of 1 point weightage. Logarithms (log) used in the questions have base 2.

Useful formulas:

(i) For a natural number n , we have $\sum_{i=1}^n i = \frac{n(n+1)}{2}$.

(ii) $(a + b)^3 = a^3 + b^3 + 3a^2b + 3ab^2$.

Question 1 The functions $f(n)$ with input size n and the types of asymptotic growth is given in Table 1. Tick mark the correct boxes.

$f(n)$	Constant	Logarithmic	Linear	$n \log n$	Polynomial	Exponential
10						
$5n + 10$						
$3n^3$						
$4n^2$						
$5 \log n + 15$						
$2^n + 5$						
$2n \log n + 11$						

Question 2 Arrange the following functions in increasing order of asymptotic growth rate.

(i) 2^5

(ii) $n + 15$

(iii) $n \log n + 3$

Answer:

Question 3 Arrange the following functions in increasing order of asymptotic growth rate.

(i) $n^2 + 2^5$

(ii) $\log n + 2$

(iii) $n^2 \log n + 3$

Answer:

Question 4 Arrange the following functions in increasing order of asymptotic growth rate.

(i) $n^3 + 1$

(ii) $n \log n + 2$

(iii) $2^n + 1$

Answer:

Question 5 For $n \geq 1$, if $f(n) = 3n^2 + 2n \log(n)$. Then $f(n)$ is $O(\text{---})$.

Question 6 For $n \geq 1$, if $f(n) = n^3 + n^3 \log n$. Then $f(n)$ is $O(\text{---})$.

Question 7 If $f(n) = (n + 1)^3$. Then $f(n)$ is $O(\text{---})$.

Question 8 If $f(n) = \sum_{j=1}^n j$. Then $f(n)$ is $O(\text{---})$.

Question 9 What is the upper bound of the time complexity of Algorithm 1 ----- .

Algorithm 1: The product of elements in the array *arrayA*.

```

1 Input: Array of length  $n$ , arrayA;
2 Initialization:  $prodVal = 1$ ;
3 Output:  $prodVal$ ;
4 for ( $i = 0; i < n; i++$ )
5      $prodVal = prodVal * arrayA[i]$ ;
6 return  $prodVal$ ;
```

Question 10 Let $f(n)$ denote the total number of basic/primitive operations required to complete the task for the given input size n in Algorithm 1. Then, what is the approximate value of $f(n)$?

Answer:

$f(n) =$

Algorithm 2: To find whether an input value (integer) is even or odd.

```

1 Input: val;
2 Initialization: val = 1;
3 Output: Even, Odd;
4 if val % 2 = 0 then
5     print Even;
6 end
7 else
8     print Odd;
9 end

```

Question 11 Let $f(n)$ denote the total number of basic/primitive operations required to complete the task for the given input size n in Algorithm 2. Then, what is the approximate value of $f(n)$? And what is the time complexity of Algorithm 2.

Answer:

$f(n) =$

$f(n)$ is $O(- - - -)$.

Question 12 For $n \geq 2$, if $f(n) = 5n \log n + 2$. Which of the following is the correct option.

(i) $f(n)$ is $\Omega(n)$

(ii) $f(n)$ is $\Omega(n^2)$

(iii) $f(n)$ is $\Omega(n^2 \log n)$.

Question 13 For $n \geq 1$, if $f(n) = 3n^2 \log n + 2n \log n$. Then $f(n)$ is $\Theta(- - - -)$.

Question 14 For $n \geq 2$, if $f(n) = \log n + 12$. Choose all the correct options:

(i) $f(n)$ is $O(n)$

(ii) $f(n)$ is $O(\log n)$

(iii) $f(n)$ is $O(n \log n)$

(iv) $f(n)$ is $O(1)$.

Question 15 Algorithm 3 consists of two blocks, Block 1 and Block 2; the time complexity of Block 1 is $O(n)$, and the time complexity of Block 2 is $O(n \log n)$. What is the time complexity of Algorithm 3? Choose the correct option.

(i) $O(n)$

(ii) $O(\log n)$

(iii) $O(n \log n)$

(iv) $O(1)$.

Algorithm 3:

```
1 if condition then
2   Block 1;
3 end
4 else
5   Block 2;
6 end
```

Question 16 In Algorithm 4, Block 1 and Block 2 have the same time complexity $O(1)$. What is the time complexity of the Algorithm? Choose the correct option.

(i) $O(1)$

(ii) $O(\log n)$

(iii) $O(n)$

(iv) $O(n^2)$.

Algorithm 4:

```
1 for ( $i = 1; i \leq n; i++$ ) do
2   Block 1;
3   for ( $j = 1; j \leq i; j++$ ) do
4     Block 2;
5   end
6 end
```

Question 17 In Algorithm 5, Block 1 and Block 2 have the same time complexity $O(1)$. What is the time complexity of the Algorithm? Choose the correct option.

(i) $O(1)$

(ii) $O(\log n)$

(iii) $O(n)$

(iv) $O(n^2)$.

Algorithm 5:

```
1 for ( $i = 1; i \leq n; i++$ ) do
2   Block 1;
3   for ( $j = 1; j \leq n; j++$ ) do
4     Block 2;
5   end
6 end
```

Question 18 In Algorithm 6, Block 1 has $O(1)$ time complexity. What is the time complexity of the Algorithm?

(i) $O(1)$

- (ii) $O(\log n)$
- (iii) $O(n \log n)$
- (iv) $O(n^2)$.

Algorithm 6:

```

1 for (i = 1; i <= n; i++) do
2   for (j = 1; j <= i; j = j * 2) do
3     Block 1;
4   end
5 end

```

Question 19 Figure 1 illustrates the plot of three functions. Which of the following options best describes the relationship among them? Choose all the correct options.

- (i) $f(n)$ is $\Theta(g(n))$
- (ii) $f(n)$ is $\Theta(n \log n)$
- (iii) $f(n)$ is $O(n \log n)$
- (iv) $f(n)$ is $\Omega(n \log n)$

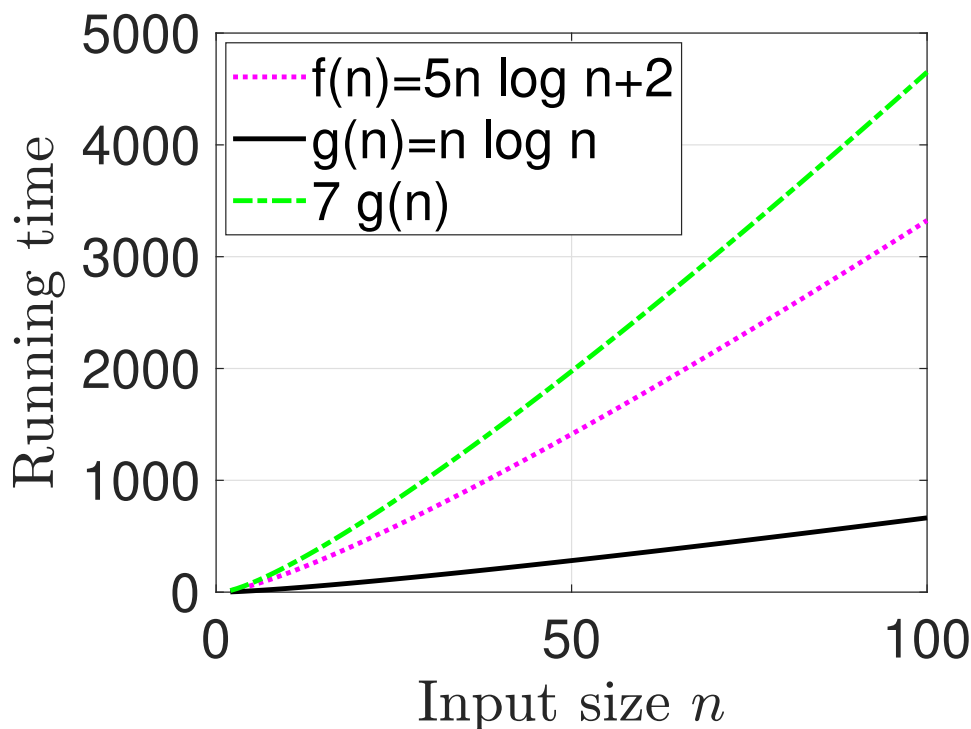


Figure 1

Question 20 Figure 2 illustrates the plot of two functions $f(n)$ and $g(n)$. Which of the following options best describes the relationship between them?

- (i) $f(n)$ is $\Theta(g(n))$

(ii) $f(n)$ is $\Omega(g(n))$

(iii) $f(n)$ is $O(g(n))$

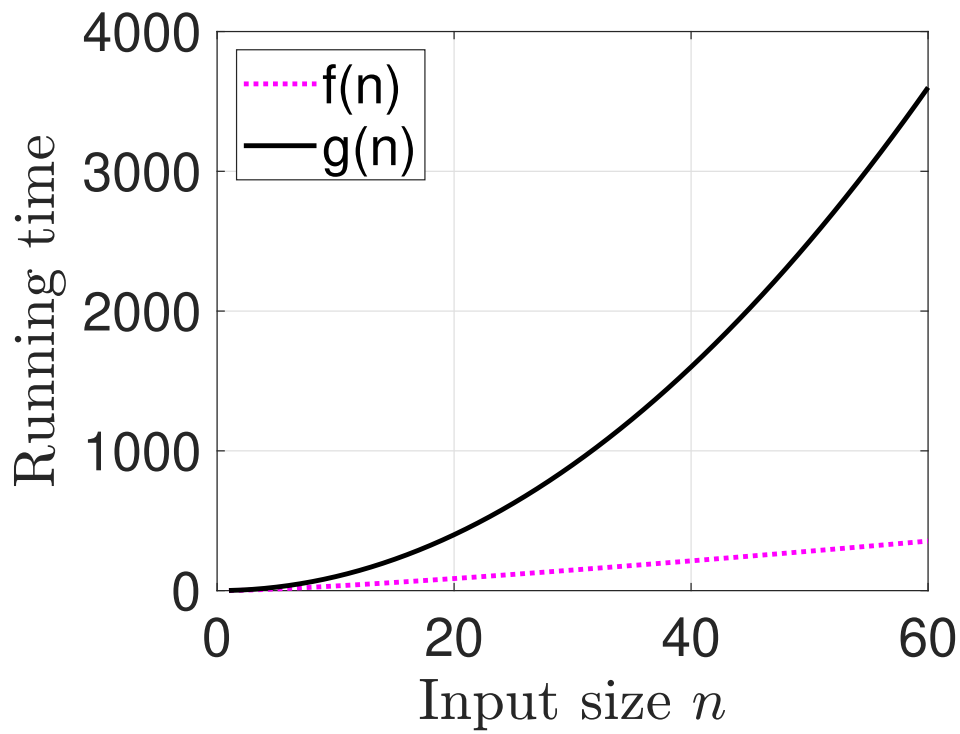


Figure 2

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