Bachelor of Applied Science in Computer Engineering

Algorithm Analysis and Design DSAL 3001

Assignment #11 25 marks 20 % 21/03/2022

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1. Give a formal definition for Big O. [2 marks]

Big O is a mathematical notation that shows how efficient/effective an algorithm is in the worst case scenario relative to its input size.
Two things have to be taken into consideration when it comes to Big O:
1. Time complexity
2. Space Complexity

2. Use that definition to show that 8n + 5 is O(n). [5 marks]

Show that 8n+ 5 is O(n)
let k = 1
Assuming that n >1
8n+5/n <8n+5n/n = 13n/n = 13
Choose C = 10 (Please note that 5 < 5n)
Thus 8n + 5 is O(n) because 8n + 5 ≤ 13n whenever n > 1.

3. **Algorithm** doEx (A**, *n***)

```
Input an array X of n integers
t ← 0
for i ← 0 to n – 1 do
        t ←  t + A[0]
         for j← 1 to i do
                t ← t + A[j]
                 B[i] = t
return t
```

i. What does the above algorithm do? Give a high level statement that a non-programmer can easily understand. [5 marks]

This algorithm consists of two loops:
Loop 1: the variable t increments according to the first number in Array (A[0])
Loop 2: This algorithm sum all the values in the array and stores it in the variable t.
It then stores it in array B.

ii. Give a big O characterization of this algorithm. Clearly show how you arrive at your answer, showing any working if necessary.

[5 marks]

$2n + n + 1 + 3x + x + 2x = 6x + 3n + 1$
$6[n(n + 1)/2] + 3n + 1$
$3[n(n + 1)] + 3n + 1$
$3n^2 + 3n + 3n + 1 = 3n^2 + 6n + 1$
$(3n^2)$ signifies that the algorithm is in $O(n^2)$.

4. i. An array has 2000 items in sorted order. How many comparisons are required if a linear search is carried out on the array before it can be determined that the search target is not present in the array. [3 marks]

You will need to carry out n comparisons. If the target is not found in the array, it must return -1 (thus 2001 comparisons).

iii. If a binary search is used instead, what is the maximum number of comparisons required to find an item if it exists in the array? [2 marks]

to check comparisons for binary search is logn (base 2). So for the value 2000, the closest number is 11 (2^11 = 2048, 2^10 = 1024 (10 is less)). The number is between 10 and 11 so use 11.
So the number of comparisons is $\log_2(11)$ (11 Comparisons)

iv. If this number is increased to 4000, how many comparisons will then be required? [3 marks]

As above we are following logn (base 2). If the value is doubled, the closest number is 12 (2^12 =4096, 2^11 =2048 (11 is less)). The number is between 11 and 12 so use 12.
So the number of comparisons is $\log_2(12)$ (12 comparisons)