Quiz 02

COSC 211: Data Structures, Fall 2021

Instructions. This quiz is open book and open note—you may freely use your notes, lecture notes, or textbook while working on it. You may *not* consult any living resources such as other students or web forums. The quiz must be submitted by the beginning of class on Thursday, *September 23rd, 2021*. If you do not attend class in person, you may email your scanned or typeset solution to the professor using the subject line `[COSC 211] Quiz 02`.
Affirmation. I attest that that work presented here is mine and mine alone. I have not consulted any disallowed resources while taking this quiz.

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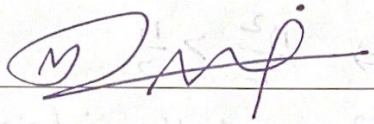
Signature: 

Question 1. Consider the following method:

```
1   static void populate(int[] arr) {
2       int n = arr.length;
3       arr[0] = 1;
4
5       for (int i = 1; i < n; ++i) {
6           int sum = 0;
7
8           for (int j = 0; j < i; ++j) {
9               sum += arr[j];
10          }
11
12          arr[i] = sum;
13      }
14  }
```

→ defining a method [O(1)]
→ primitive ops & array access [O(1)]
→ primitive ops & array access [O(1)]
overarching loop only O(n) due to n iterations
→ primitive ops [O(1)]
→ primitive ops & array access [O(1)]
nested loop ⇒ [O(i)] due to "i" iterations.
→ primitive ops & array access [O(1)]

Let n denote the length of the array `arr` passed to this method. Using big O notation, what is the running time of the `populate` method as a function of n? Justify your answer. (You may freely appeal to the assumptions laid out in the notes *Asymptotic Analysis and Big O Notation*.)

- The combined running time for lines 1, 2, 3 is $O(1)+O(1)+O(1) = \boxed{O(1)}$
- The running time of line 12 is $\boxed{O(1)}$
- The nested for loop [lines 8 to 10] has runtime $\boxed{O(i)}$
- line 6 has run time $\boxed{O(1)}$
- so, lines 6 to 10 has combined run time of $\boxed{O(i)}$
- Now, the overarching for loop starting at line 5 has its own time complexity of $\boxed{O(n)}$.
- But, due to nesting, the time complexity of that chunk will be $\boxed{O(n)\cdot O(i)}$
- In entirety, the runtime of method will be $\boxed{O(1)+[O(n)\cdot O(i)]}$

⇒ $[O(n)\cdot O(i)]$, as we are looking at the worst case, for Big-O notation, the time complexity of "populate" will be $\boxed{O(n^2)}$

Moreover, the nested for loops adds the time complexities like...

$$\sum_{i=1}^{n} O(i) = O(1) + O(2) + O(3) + \cdots + O(n)$$

$$= O\left(\frac{n(n+1)}{2}\right) = O\left(\frac{n^2}{2} + \frac{n}{2}\right)$$

To prove: $\left(\frac{n^2}{2} + \frac{n}{2} < n^2\right)$

we know, $n^2 > n$

$$\Rightarrow \frac{n^2}{2} > \frac{n}{2}$$

adding $\frac{n^2}{2}$ on both sides

$$\Rightarrow n^2 > \frac{n^2}{2} + \frac{n}{2}$$, Hence Proved

Hence, the time complexity of given method is $O(n^2)$