CSCI 3104 Spring 2023
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Quiz 14 Standard 14 - Analyzing Code II

Due Date ..... TODO
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Quiz Code (enter in Canvas to get access to the LaTeX template) ..... **DSGZH**

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Instructions

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Problem HC.

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Agreed (I agree to the above, Blake Raphael). □

14 Standard 14: Analyzing Code II – Dependent Nested Loops (4 points)

Problem 14. Analyze the *worst-case* runtime of the following algorithm. Clearly derive the runtime complexity function $T(n)$ for this algorithm, and then find a tight asymptotic bound for $T(n)$ (that is, find a function $f(n)$ such that $T(n) = \Theta(f(n))$). Specifically, we are looking for these **two** objectives: (a) number of operations and run time of the inner loop (b) number of operations and run time of the outer loop.

Algorithm 1 Nested Algorithm 2

```
1: procedure Foo3(Integer n)
2:     for i ← 1; i ≤ n; i ← i + 1 do
3:         print "from outer"
4:         for j ← i; j ≤ n − i; j ← j + 1 do
5:             print "from inner"
```

Answer. Here is the following for time complexity of our code:

- The outer-loop on line 2 has the following complexity: 1 step for initialization and for every iteration of the loop we have the following: 1 step for comparison, 2 steps for arithmetic and assignment, 1 step for print, 1 step for the initialization of the inner-loop, and the sum of the steps that the inner-loop takes.

- The inner-loop complexity beginning on line 4 has the following complexity: 1 step for initialization (covered in the outer loop), 1 step for comparison, 2 steps for arithmetic and assignment, and 1 step for printing.

So we get the following:

Inner-loop complexity: $\sum_{j=1}^{n-i} 1 + 2 + 1 = \sum_{j=1}^{n-i} 4$

Outer-loop complexity: $1 + \sum_{i=1}^{n} 1 + 2 + 1 + 1 + \sum_{j=1}^{n-i} 4 = 1 + \sum_{i=1}^{n} 5 + \sum_{j=1}^{n-i} 4$

So we get, $1 + \sum_{i=1}^{n} 5 + 4(n-i)$.

Which gives us, $1 + n(2n+3)$.

So, $T(n) \in \Theta(n^2)$.

□