Homework 5

Due date: Feb 20, 2020, 9:30am

Objective

- Determine the time complexity of simple algorithms using the big-O notation.
- Determine the growth rates of various functions.

Exercises

For Exercises 1 and 2, download the file TimeComplexity.zip from the course website and open the project in Eclipse.

1. (6 / 6 / 6 points)
   In the controller package, run the StackOperationController, enter different numbers of iterations, and observe the runtimes.
   a) Explain the difference in the times for the SLLStack and DLLStack when running stackOperationsA.

   b) Methods stackOperationsA and stackOperationsB execute exactly the same number of push, peek, and pop operations. Explain the difference in the times between stackOperationsA and stackOperationsB when both are called for the SSLStack.

   c) Determine the big-O notation for each of the following operations below. Measure the time in the size of the stack:

```
SLLStack::push          DLLStack::push
SLLStack::peek          DLLStack::peek
SLLStack::pop           DLLStack::pop
```

2. (5 / 6 / 5 points)
   The class SummationController runs and times the method Summation::calculateSums. Test the method for different array sizes and observe the runtimes.
   a) Check out how the sums are calculated in method Summation::calculateSums and determine the big-O notation of the method.

   b) Modify the method to complete the same task more efficiently in respect to its time complexity. Attach the code (hand-written or printed printed) of your solution to the end of this homework.

   c) What is the big-O notation of your improved method?

3. (6 points)
   Find constants $C > 0$ and $k > 0$ such that $|f(n)| \leq C \cdot |g(n)|$ for all $n > k$ or determine that no such constants exist.
   a) $f(n) = 3^n$ and $g(n) = 2^n$

   b) $f(n) = 2n^3 + 5n^2$ and $g(n) = n^3$

4. (10 points)
   Mark each of the following as true or false.
   a) $10n^3 + 4n^5 = O(n^2)$
   b) $10n^3 + 4n^5 = O(n^3)$
   c) $10n^3 + 4n^5 = O(n^5)$
   d) $10n^3 + 4n^5 = O(n^6)$
   e) $n = O(3^{10})$
   f) $\log(n) = O(n)$
   g) $\sqrt{n} = O(n)$
   h) $\sqrt{n} = O(\log(n))$
   i) $3^n = O(2^n)$
   j) $3^n = O(2^{3n})$

Submission

Turn in a hard-copy with your solutions at the beginning of the class meeting on Feb 20. The solutions can be hand-written or typed.