Assignment 2

Responsible TA: Claudi Lleyda Moltó

Delivery instructions

You can deliver as many times as you want before the deadline on Blackboard. Delivery should be done in a single file according to the following specifications.

The theoretical question answers must be uploaded as PDF, how you answer the questions (handwritten scans, Word, LaTeX etc.) doesn't matter, as long as they are delivered as a single PDF file and the answers are readable. The filename should contain your NTNU username and the assignment number, for instance: `karinor-02.pdf`.

Theory

Task 1 - Asymptotic growth rate

Express the following functions using Theta notation (i.e., find the "simplest" function g such that $f(n) = \Theta(g(n))$ for each of the functions). Justify your answer.

1. $f(n) = n^2 - 10n + 20$
2. $f(n) = 3n + k\log_2(n)$, where $k > 0$
3. $f(n) = (n+k)^2 2^{n+k}$, where $k > 0$
4. $f(n) = n(\log_2(n) + \log_3(n) + \log_4(n))$
5. $f(n) = \sqrt[3]{kn} + 4$, where $k > 0$
6. $f(n) = 6 * 2^n + 2 * 6^n$
7. $f(n) = n^2 + n^k \log(n)$, where $k > 0$

Task 2 - Runtime analysis

Analyse the runtime complexity of the following algorithm, providing the time complexity in big-O notation. Justify your answer.

```
function FindMaxSubarraySum(Data array; Integer low, high)
    if $low = high$ then
        return $array[low]$
    end if
    $mid \leftarrow \frac{low+high}{2}$
    $leftMax \leftarrow$ FindMaxSubarraySum($array, low, mid$)
    $rightMax \leftarrow$ FindMaxSubarraySum$(array, mid + 1, high)$
    $crossMax \leftarrow$ FindMaxCrossSubarraySum$(array, low, mid, high)$
    return max$(leftMax, rightMax, crossMax)$
end function

function FindMaxCrossSubarraySum(Data array; Integer low, mid, high)
    $leftSum \leftarrow -\infty$
    $sum \leftarrow 0$
    for $iter$ from $mid$ to $low$ do
        $sum \leftarrow sum + array[iter]$
        if $sum > leftSum$ then
            $leftSum \leftarrow sum$
        end if
    end for
    $rightSum \leftarrow -\infty$
    $sum \leftarrow 0$
    for $iter$ from $mid + 1$ to $high$ do
        $sum \leftarrow sum + array[iter]$
        if $sum > rightSum$ then
            $rightSum \leftarrow sum$
        end if
    end for
    return $leftSum + rightSum$
end function
```

Task 3 - Priority queues

Write a simple pseudocode implementation of the `enqueue` and `dequeue` operations for a priority queue using a stack as base type. What is the big-O running time of each operation? Justify your answer.