

## Assignment 3

1. [10 points] Say you have an  $N \times N$  matrix  $A$ .
  - a. [2.5+2.5] Please write the following two functions for it. Also describe their time complexity.  $A$  is globally/objectively accessible to the two functions
    - `def setValue(x, y):` # sets a value at row  $x$  and column  $y$  in  $A$
    - `def subRectangleSum(x1, y1, x2, y2):` # calculates the sum value of rectangle encased #within the two given point  $(x1, y1)$  and  $(x2, y2)$ . Eg:  
if  $A = \begin{bmatrix} 1 & 2 & 1 & 2 \\ 2 & 1 & 2 & 1 \\ 1 & 2 & 1 & 2 \\ 2 & 1 & 2 & 1 \end{bmatrix}$   
Then `subRectangleSum(1, 1, 2, 3)` returns 9, `subRectangleSum(0, 0, 2, 1)` returns 9.  
Write pseudocode. Explanation of your algorithm and clearly stating and explaining the complexity are mandatory.
  - b. [5] Now very carefully consider this condition. The queries made upon  $A$  are in an indefinite stream, such that you have to execute the two functions repeatedly. If, for example, `SubRectangleSum()` runs in  $O(n^3)$  time, that time would be repeated for as long as you have your stream of query executing. Your goal is to bring the time complexity of the function to  $O(1)$ . You can use an extra matrix (also globally available) of the same size. You can also write helper functions to aid you in the program. Write the new algorithm for helper function and `SubRectangleSum()`. The conditions of writing pseudocode and explanation stand as always.
2. [5 Point] Please read through 15.2 from CLRS text book, which describes algorithm for Balanced Parenthesis in conjunction with Matrix Chain Multiplication. Please give a detailed algorithm to create Balanced Parenthesis using Dynamic Programming. Clearly state the time complexity and space complexity of the proposed algorithm.