

Summative Assignment 1

LC Data Structures and Algorithms

due date 5 March 2025, 12pm

You are given an $n \times m$ matrix with integer entries that has the following properties:

- (1) Each row has a unique maximum value,
- (2) If the maximum value in row i of the matrix is located at column j , then the maximum value in row $i+1$ of the matrix is located at a column k , where $k \geq j$.

The goal of this assignment is to find the maximum value in such a matrix.

Question 1. Write a function `maxIndex` that finds the index of the maximum entry of a row between columns with indices `start` and `end` inclusively. The row is given as an array `row`. What is the time complexity of your solution? Explain your answer.

Question 2. A rectangular *block* of a matrix is given by a row and column of the upper-left corner in `startRow` and `startCol`, and row and column of the lower-right corner `endRow` and `endCol`, such that `startRow ≤ endRow` and `startCol ≤ endCol`. Write a function `blockMaxValue` that finds the value of the maximum entry of a given block assuming that the block satisfies the properties (1) and (2) above.

Hint: Use the divide-and-conquer strategy.

Question 3. Write a function `matrixMaxValue` that finds the maximum value of a matrix that satisfies properties (1) and (2) above, and provide a better upper bound for the time complexity of this function than $O(nm)$. Explain your answer.

Hint: The complexity of linear search is $O(nm)$, do better than that!

Submission

Submission is via Canvas, and it should contain two files:

- Java source code named 'solution.java' containing a `class Solution` with the following methods:

```
public class Solution {
    public static int maxIndex(int[] row, int start, int end);

    public static int blockMaxValue(int[][] matrix,
        int startRow, int startCol, int endRow, int endCol);

    public static int matrixMaxValue(int[][] matrix);
}
```

Do not rename the class or the methods, otherwise your solution will fail the test cases.

- A text/pdf file containing the explanation of the complexity of your code.