CSE 4077 Advanced Data Structures - Project 1
Solving the Minimum Area Query Problem
Due: 14.11.2023 11:59PM

In this project, you will implement an application, in any programming language you like; that takes a 2-dimensional array of integer numbers as input and preprocesses it to answer any given query that asks for the minimum number included inside the rectangular area with the upper-left corner (i, j) and the lower-right corner (k, l). This problem concerns a two-dimensional variant of RMQ called the minimum area query problem (MAQ).

The array indices will be assumed to start at "0". For example, consider the following array:

31	41	59	26	53	58	97
93	23	84	64	33	83	27
95	2	88	41	97	16	93
99	37	51	5	82	9	74
94	45	92	30	78	16	40
62	86	20	89	98	62	80

In this 2D array, A[0, 0] is the upper-left corner, and A[5, 6] is the lower-right corner. In this setting, the following are some example answers to some queries:

- MAQ_A ((0, 0), (5, 6)) = 2
- MAQ_A ((0, 0), (0, 6)) = 26
- MAQ_A ((2, 2), (3, 3)) = 5

Your responsibility in this project is to design and implement **three different methods that use different data structures** to solve the problem. One of your data structures will use full preprocessing and the other two should be composed of data structures we discussed in class (sparse tables, hybrid structures, …)

The user will be able to give different 2-D arrays as input. Your program will preprocess the given array and answer the queries for the corresponding input.

You will submit the source code of your program and your report using the Canvas service. The report shall include a detailed explanation of your solution approaches and the discussion about time and space complexities of your methods (both for preprocessing and query).

Note: You are welcome to work on this problem set either individually or in a pair. If you work with a partner, you should submit a single joint submission on Canvas, rather than two separate submissions.