

## Agenda:

1. Find Maximum Subarray Sum
2. Find in row-wise and col-wise sorted matrix
3. Merge sorted Overlapping Intervals
4. Transpose of a square matrix
5. Rotate a matrix to 90 degree clockwise



Q → Given an integer array find max subarray sum.

$$A = [-20 \quad \begin{matrix} 0 \\ 30 \end{matrix} \quad \begin{matrix} 1 \\ 5 \end{matrix} \quad \begin{matrix} 2 \\ 16 \end{matrix} \quad \begin{matrix} 3 \\ -2 \end{matrix} \quad \begin{matrix} 4 \\ 0 \end{matrix} \quad \begin{matrix} 5 \\ 8 \end{matrix}]$$

continuous part  
of array

$$\text{Ans} = \underline{57}$$

$$A = [\begin{matrix} 0 \\ 4 \end{matrix} \quad \begin{matrix} 1 \\ 5 \end{matrix} \quad \begin{matrix} 2 \\ 2 \end{matrix} \quad \begin{matrix} 3 \\ 1 \end{matrix} \quad \begin{matrix} 4 \\ 6 \end{matrix}] \quad \text{Ans} = \underline{18}$$

$$A = [-4 \quad \begin{matrix} 0 \\ -3 \end{matrix} \quad \begin{matrix} 1 \\ -6 \end{matrix} \quad \begin{matrix} 2 \\ -9 \end{matrix} \quad \begin{matrix} 3 \\ -2 \end{matrix}] \quad \text{Ans} = \underline{-2}$$

Bruteforce →  $\forall$  subarrays calculate sum & take max.

$$TC = \underline{O(N^3)} \quad SC = \underline{O(1)}$$

carry Forward →

$\text{ars} = A[0]$

for  $i \rightarrow 0$  to  $(N-1)$  {

sum = 0

for  $j \rightarrow i$  to  $(N-1)$  {

sum +=  $A[j]$

$\text{ars} = \max(\text{ars}, \text{sum})$

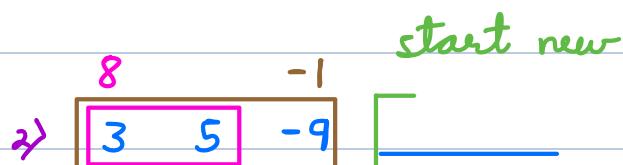
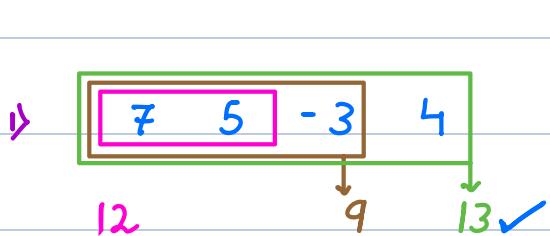
}

}

return ars

$TC = O(N^2)$     $SC = O(1)$

### Kadane's Algorithm



$$A = [5, 2, -3, -8, 6, 1, -5, 11, 0, -3]$$

$$\text{sum} = 5 \neq 1 \quad \cancel{-4}^0 \neq x \neq 13 \neq 10$$

$$\text{ars} = 5 \neq \underline{13}$$

✓   ✓   ✓   ✓   ✓   ✓   ✓  
 0      1      2      3      4      5      6

$$A = [-2 \ 3 \ 4 \ -1 \ 5 \ -10 \ 7]$$

$$\text{sum} = \cancel{-2}^0 + 3 + 7 + 6 + 1 + 8$$

$$\text{ans} = -2 \ 3 \ 7 \ \underline{+}$$

$$\text{ans} = A[0]$$

$$\text{sum} = 0$$

for  $i \rightarrow 0$  to  $(N-1)$  {

$$\text{sum} += A[i] \quad \checkmark$$

$$\text{if } (\text{sum} > \text{ans}) \quad \text{ans} = \text{sum}$$

$$\text{if } (\text{sum} < 0) \quad \text{sum} = 0$$

}

return ans

TC = O(N)

SC = O(1)

$$\text{ans} = A[0] \quad L = 0 \quad R = 0$$

$$// L — R$$

$$\text{sum} = 0$$

$$st = 0$$

for  $i \rightarrow 0$  to  $(N-1)$  {

$$\text{sum} += A[i]$$

$$\text{if } (\text{sum} > \text{ans}) \{ \text{ans} = \text{sum} \quad L = st \quad R = i \}$$

$$\text{if } (\text{sum} < 0) \{ \text{sum} = 0 \quad st = i + 1 \}$$

}

return ans

✓   ✓   ✓  
 0      1      2

$$A = [-5 \ -3 \ -8]$$

$$\text{sum} = \cancel{-5}^0 \ \cancel{-3}^0 \ \cancel{-8}^0 \quad \text{ans} = \underline{-5}^0 \ \underline{-3}^0$$

$$-3$$

for  $i \rightarrow 0$  to  $(N-1)$  {

$$\text{sum} += A[i] \quad \checkmark$$

$$\text{if } (\text{sum} > \text{ans}) \quad \text{ans} = \text{sum}$$

$$\text{if } (\text{sum} < 0) \quad \text{sum} = 0$$

}

return ans

TC = O(N)

SC = O(1)

$\Rightarrow$  Given a row-wise col-wise sorted matrix.

Check if given element  $K$  is present. *Ascending*

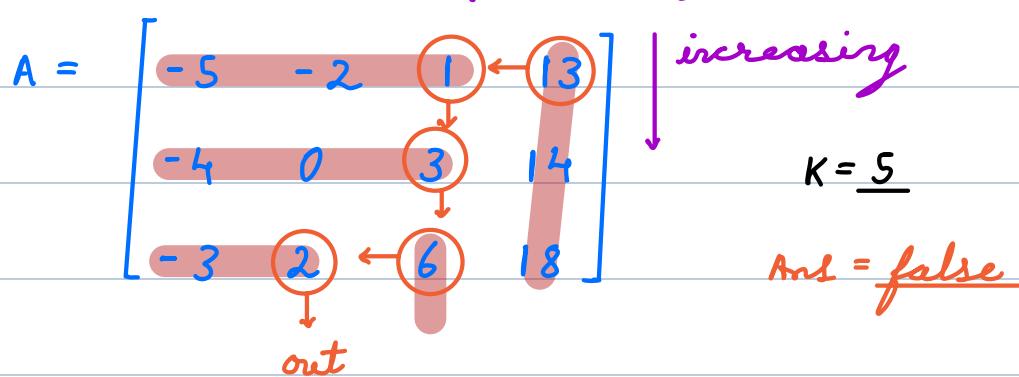
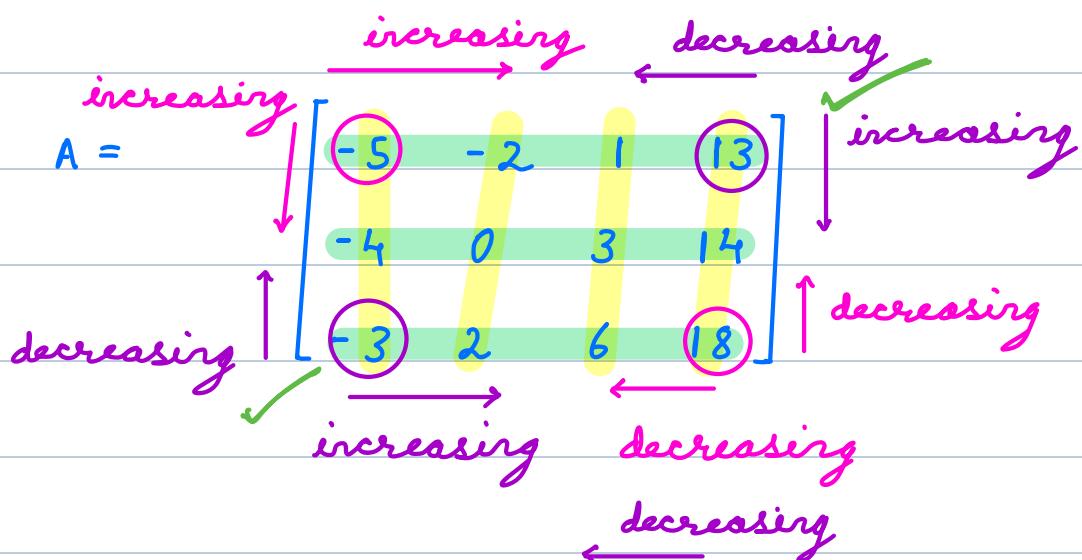
$$A = \begin{bmatrix} -5 & -2 & 1 & 13 \\ -4 & 0 & 3 & 14 \\ -3 & 2 & 6 & 18 \end{bmatrix}$$

$$K = 0 \quad \text{Ans} = \underline{\text{true}}$$

$$K = -1 \quad \text{Ans} = \underline{\text{false}}$$

Bruteforce  $\rightarrow$   $\forall i, j$  check if  $A[i][j] == K$ .

$$TC = \underline{O(N * M)} \quad SC = \underline{O(1)}$$



$i = 0 \quad j = M - 1$

while ( $i < N \ \&\& \ j \geq 0$ ) {

    if ( $A[i][j] == K$ ) return true

    if ( $A[i][j] < K$ )  $i++$

    else  $j--$

}

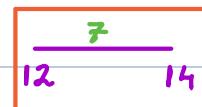
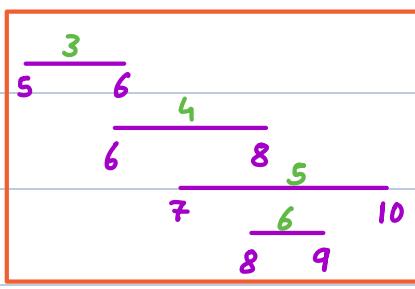
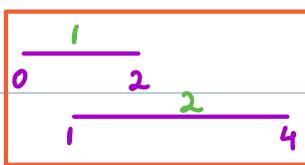
return false

$TC = O(N + M)$

$SC = O(1)$

Q → Given a list of intervals, sorted wrt start time.

Merge all overlapping intervals & return the sorted list of non-overlapping intervals.

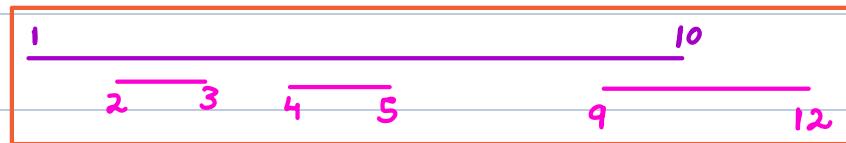


0  $\underline{\hspace{4cm}}$  4      5  $\underline{\hspace{4cm}}$  10      12  $\underline{\hspace{2cm}}$  14

Ans →

slot A & B are overlapping if  $\text{start of } B \leq \text{end of } A$ .

$$A = [ (1, 10) \quad (2, 3) \quad (4, 5) \quad (9, 12) ]$$



$$S = A[0][0] \quad E = A[0][1] \quad // A[i][0] — A[i][1]$$

for  $i \rightarrow 1$  to  $(N-1)$  {

if ( $A[i][0] \leq E$ )  $E = \max(E, A[i][1])$

else { print( $S, E$ )

$S = A[i][0]$   $E = A[i][1]$

}

}

print( $S, E$ )

TC =  $O(N)$  SC =  $O(1)$

$$A = \begin{bmatrix} 0 & 1 & 5 & 6 & 7 & 8 & 12 \\ 2 & 4 & 6 & 8 & 10 & 9 & 14 \end{bmatrix}$$

↓

$$S = \cancel{0} \quad \cancel{5} \quad 12$$

$$E = \cancel{2} \cancel{4} \cancel{6} \cancel{8} \cancel{10} \quad 14$$

o/p → 0, 4

5, 10

12, 14

$\square \rightarrow$  convert the given, matrix to its transpose.  
 square  
 row  $\leftrightarrow$  column

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \rightarrow \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$$

Matrix Transpose  $\rightarrow$  7 min

$i, j \leftrightarrow j, i$

for  $i \rightarrow 0$  to  $(N-1)$  {

    for  $j \rightarrow i+1$  to  $(N-1)$  {

$t = A[i][j]$  // swap  $i, j \leftrightarrow j, i$

$A[i][j] = A[j][i]$

$A[j][i] = t$

}

TC =  $O(N^2)$  SC =  $O(1)$

}

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$i$        $j$        $t$

Diagram showing the transpose operation. The original matrix has elements 1, 2, 3 in the first row, 4, 5, 6 in the second, and 7, 8, 9 in the third. The transpose matrix has elements 1, 4, 7 in the first row, 2, 5, 8 in the second, and 3, 6, 9 in the third. Red circles highlight the element 2 in the original matrix and its position 5 in the transpose matrix, illustrating the swap  $i, j \leftrightarrow j, i$ .

$\Rightarrow$  Rotate the given sq. matrix by  $90^\circ$  clockwise.

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$\begin{array}{c} \overbrace{\phantom{123}}^{+1 \quad 5 \quad -} \\ \overbrace{\phantom{456}}^{\infty \quad 5 \quad p} \\ \overbrace{\phantom{789}}^{0 \quad a \quad w} \end{array}$

Transpose       $\xrightarrow{90^\circ \text{ rotated}}$

$$\xrightarrow{\text{Reverse every row}} \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix} \quad \begin{bmatrix} 7 & 4 & 1 \\ 8 & 5 & 2 \\ 9 & 6 & 3 \end{bmatrix}$$

Sol  $\rightarrow$  1) Transpose the given matrix

2) Reverse every row

$$TC = \underline{O(N^2)} \quad SC = \underline{O(1)}$$