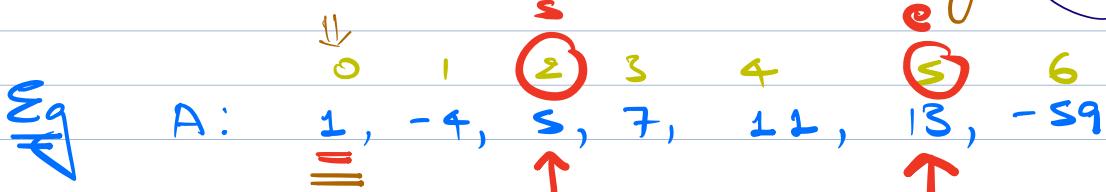


$\theta$

Given an array of size N.

Find the maximum Subarray sum.



- 1)  $s, e$
- 2)  $s, l$
- 3)  $e, l$ ,  $l = e - s + 1$

Sol<sup>n</sup> 1) Brute force  $\Rightarrow$  Compute all possibilities

$\Rightarrow$  Calculate sum of all subarrays & take max.

$$\maxSum = \text{INT\_MIN}$$

$\leftarrow \Rightarrow \text{for } (\underline{i=0}; \underline{i < N}; i++) \& \text{// Start}$

$\leftarrow - \text{for } (\underline{j=i}; j < N; j++) \& \text{// End}$

$\text{// Subarray from } \underline{i \text{ to } j}.$

$\rightarrow \text{for } (\underline{k=i}; k < j; k++) \&$

$$\text{sum} += A[k];$$

$\downarrow$

$$\maxSum = \max(\text{sum}, \maxSum);$$

$\downarrow$

5

2) Iterate from  $i$  to  $j \Rightarrow O(\underline{N}) \Rightarrow O(N^2)$

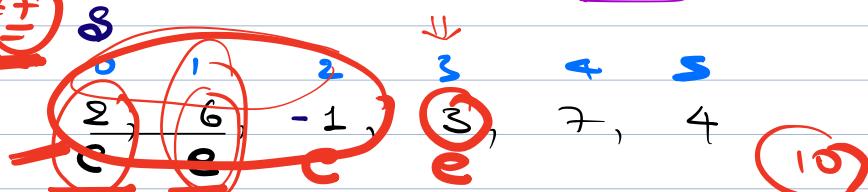
2) Prefix Sum  $\rightarrow O(1) \rightarrow O(N^2)$

$$\maxSum = -\infty \cancel{2} \cancel{8} \cancel{4} \cancel{10} \quad s.c. = \underline{O(N)}$$

$$2+6=8 + (-1)=7 \quad s$$

Eg

A:



s  
0  
1  
2

$$s[0-0] = A[0]$$

$$s[0-1] = A[0] + A[1] = s[0-0] + A[1]$$

$$s[0-2] = s[0-1] + A[2]$$

$\maxSum = \text{INT\_MIN}$

for (i= 0;  $i < N$ ;  $i++$ ) {

↓

Sum = 0;

for (j= 0;  $j < N$ ;  $j++$ ) {

Sum + = A[j];

maxSum = max (sum,  
maxSum);

}

5

return  $\maxSum;$

$$T.C. = O(N^2) \Rightarrow TLE$$

$$S.C. = O(1)$$

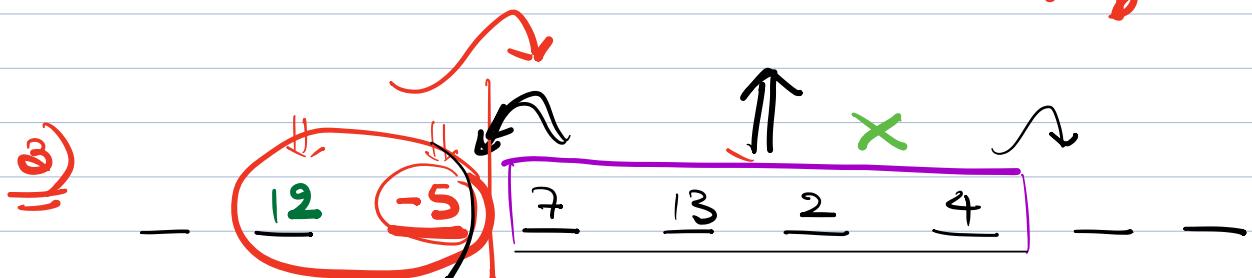
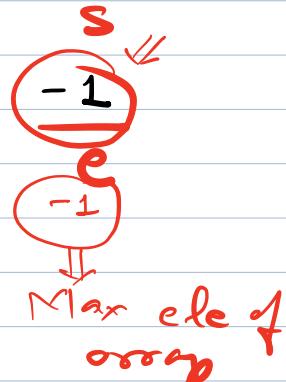
# Given an array of size  $N$

$\Rightarrow$  All elements are +ve  
 $\Rightarrow$  Sum of all array ele.

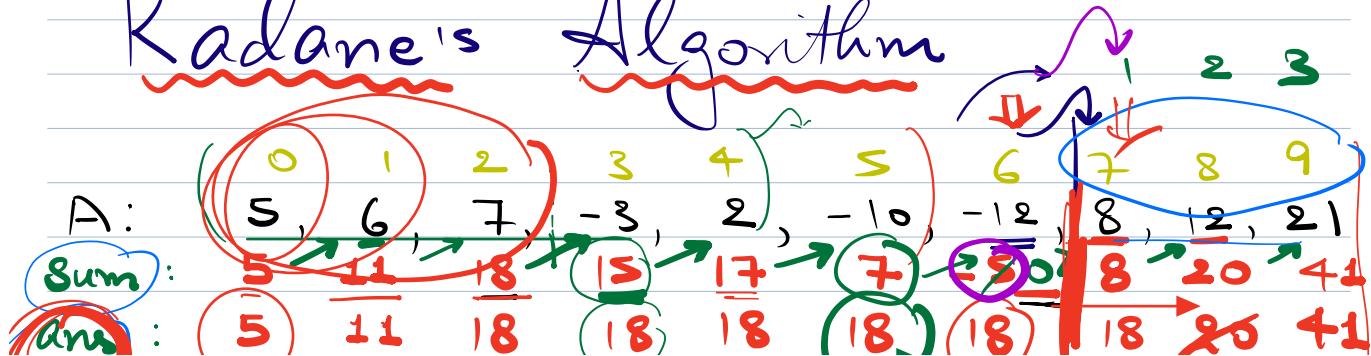


All ele are -ve

A:  $-25, -10, -2, -16, -1$



Kadane's Algorithm



Max Subarray sum = 41

$$s = 7 \\ e = 9$$

$$s_9 = s \\ e_9 = e ]$$

Code

A: -2, -5, -7, -10, -1

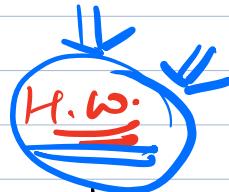
ans = INT\_MIN;

sum = 0;

s, e, s<sub>9</sub>, e<sub>9</sub> ⇒

for (i=0; i < N; i++) {

    sum += A[i];



ans = max (ans, sum);

if (sum < 0) {  
    sum = 0; // Reset

}

$$\begin{array}{l} \text{T.C.} = O(N) \\ \text{S.C.} = O(1) \end{array}$$

Break

$\Theta$  Given an array of size  $N$ . & given  
 $\underline{a}$   $\underline{l}$  &  $\underline{r}$ . Find the sum of the  
 subarray from  $l$  to  $r$ ;

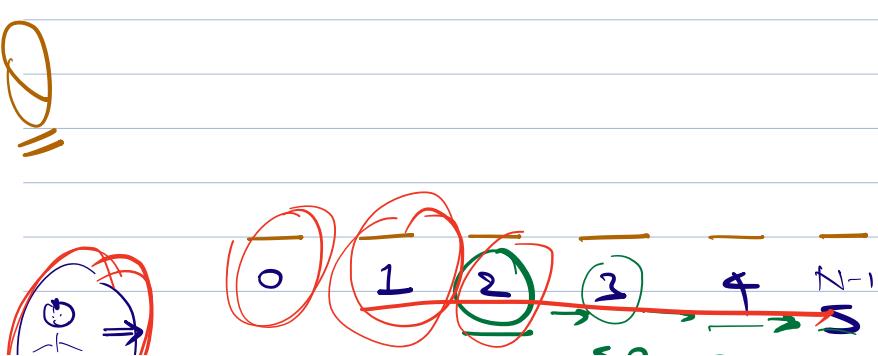
Single Query  $\Rightarrow$  Iterate

Multiple queries  $\Rightarrow$  Prefix +  $O(\underline{N})$

$\underline{A} \rightarrow \underline{\text{Prefix}} \rightarrow O(N)$   
 $\downarrow$   
 $\text{Pre}$

$\text{Sum}(l, r) \Rightarrow \underline{\text{Pre}[r]} - \underline{\text{Pre}[l-1]}$   
 $\downarrow$   
 $\text{sum}(0, r) \quad \text{sum}(0, l-1)$

$\Theta$





$S_{R_0} > S_{R_1} > S_{R_2}$

$10R_0 \ 10R_1 \ 10R_2$

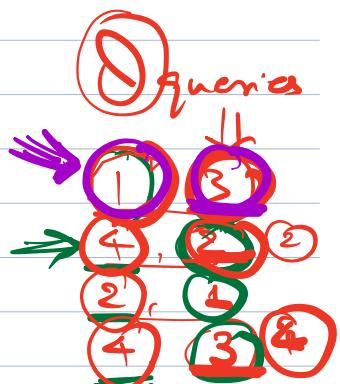
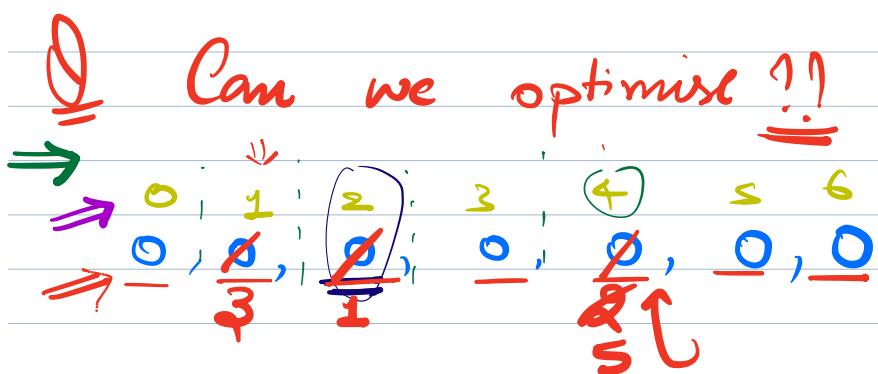
8 persons  $\Rightarrow i^{th} \ X$



Given an array of size  $N$ .

Initially all elements are 0.

Index	Value
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
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$0, 3, 1, 0, 5, 0, 0$

$0, 3, 4, 4, 9, 9, 9$

$$T.C. = O(1 \times Q + N)$$

$$= O(Q + N)$$

$$S.C. = \underline{O(1)}$$



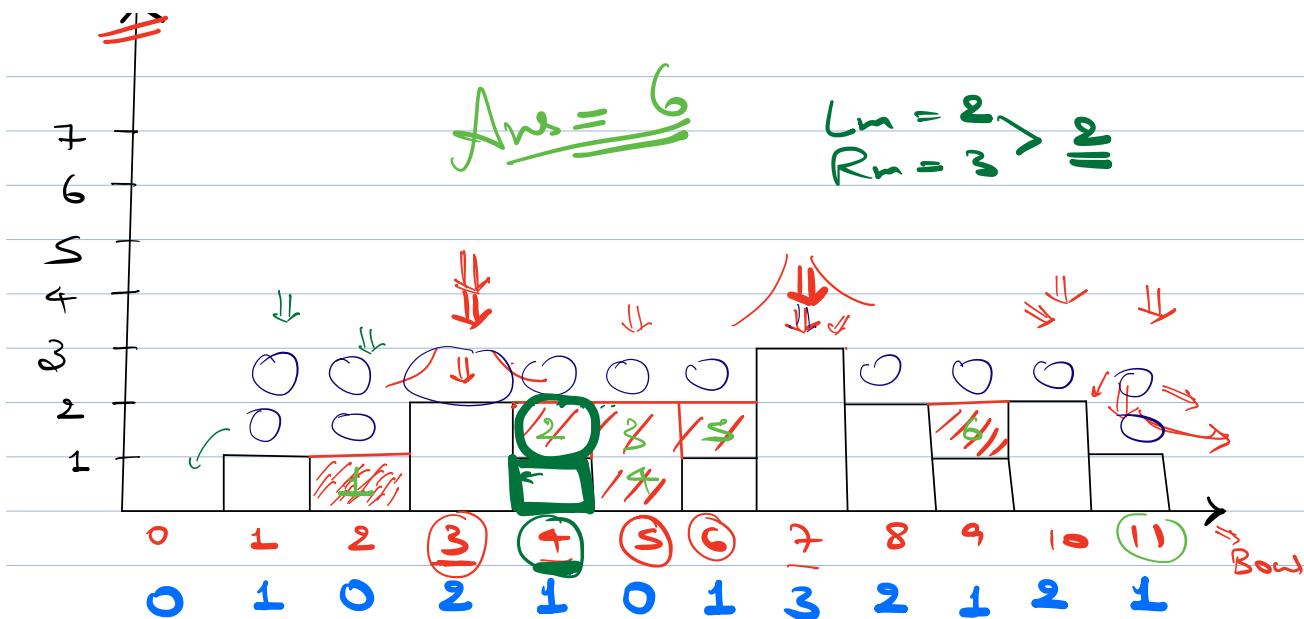
Rain water trapped

Given an array of size  $N$ .

$A[i] \Rightarrow$  Height of the  $i^{th}$  object

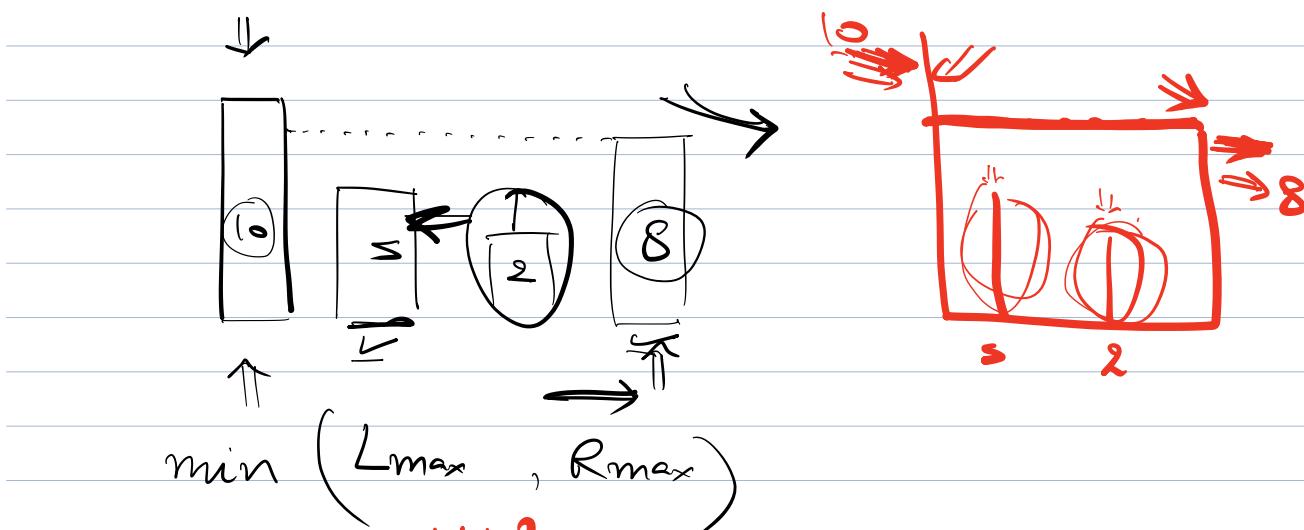
Width of every object = 1





Find the total amount of rain water trapped.

$$3 \times 11 - ( )$$



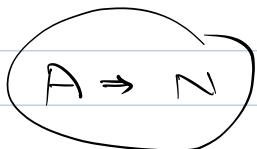
$\rightarrow$   $v_i$ ,  $L_{\max}$   $\rightarrow$  Max from 0 to  $i$   
 $O(N^2)$   $\Downarrow$   $O(N)$  (Carry forward)  
 $\rightarrow$   $R_{\max}$   $\rightarrow$  Max from  $i$  to  $N-1$

$$W_i = \min(L_{\max}, R_{\max}) - A[i]$$

$$\text{ans} = \sum \underline{W_i}$$

Doubt

Code



⇒

All 0's

0 → 0 × 2 array

Scene sc = new  
Scanner

I queria for (i = 0; i < 0; i++) { ⇒ 0 times.

read(index);  
read(value);

A[index] += value;

}

P[0] = A[0]

for (i = 1; i < N; i++) {

A[i] += A[i - 1];



}



A:  $\begin{array}{r} 5 \\ \times 3 \\ \hline 15 \end{array}$ ,  $\begin{array}{r} 7 \\ \times 3 \\ \hline 21 \end{array}$ ,  $\begin{array}{r} -3 \\ \times 3 \\ \hline 18 \end{array}$

Sum:  $\begin{array}{r} 0 \\ + 15 \\ + 21 \\ + 18 \\ \hline 53 \end{array}$

ans:  $\begin{array}{r} 53 \\ \times 3 \\ \hline 159 \end{array}$

$s = 0$

$c = 0 \cancel{+} 2 3 \oplus$

$\frac{s_3}{e_3} = 0 \cancel{0} \cancel{0} 0$

$\frac{c_3}{e_3} = 0 \cancel{+} 2 \cancel{4} \cancel{+}$