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Q.1 Max Subarray Sum   Amazon, MS, GS, Paytm, JPM.-

$\underbrace{\text{Subarray}}$ → Contiguous part of the Array.

Quiz No. of subarrays in an array of size N.

$$N + (N-1) + (N-2) + \cdots + 1$$

$$\boxed{\frac{N(N+1)}{2}}$$

```
*   s → 0 to N-1
    e → s to N-1
    ans = -∞
    for(s = 0; s < N; s++) {
        for(e = s; e < N; e++) {
            // find sum of subarray [s,e]
            sum = 0
            for(i = s; i <= e; i++){
                sum += A[i]
            }
            ans = max(ans, sum);
        }
    }
    return ans;
```

TC: $O(N^3)$
SC: $O(1)$

* Idea 2 : Prefix Sum.

$$PS[i] = PS[i-1] + A[i]$$

$$Sum[s,e] = Ps[e] - Ps[s-1]$$

→ Build the PS Array

```
ans = -∞
for(s = 0; s < N; s++) {
        for(e = s; e < N; e++) {
                // find sum of subarray [s,e]
                sum = PS[e] - PS[s-1]   (check for s=0)
                ans = max(ans, sum);
        }
}
return ans;
```

TC: $O(N^2)$

SC: $O(N)$

↳ Ps Array.

Idea 3 Carry forward

s	e	sum
0	0	A[0]
0	1	A[0] + A[1]
0	2	A[0] + A[1] + A[2]
0	3	A[0] + A[1] + A[2] + A[3]

```
ans = -∞

for(s = 0; s< N; s++){
    sum = 0
    for(e = s; e< N; e++){
        sum += A[e];
        ans= max(ans, sum);
    }
}
```

```
s=0
sum=0
      +A[0]
      +A[1]
      +A[2]
      +A[3]
s=1
sum=0
      +A[1]
      +A[2]
      +A[3] . . .
```

$$\boxed{\begin{array}{l} TC : O(N^2) \\ SC : O(1) \end{array}}$$

$$\begin{array}{lccccc} TC: & N^3 & \longrightarrow & N^2 & \longrightarrow & N^2 \\ SC: & 1 & & N & & 1 \end{array}$$

Observations.

1. All array elements are +ve.

[1, 5, 2, 4, 8]

ans = 20

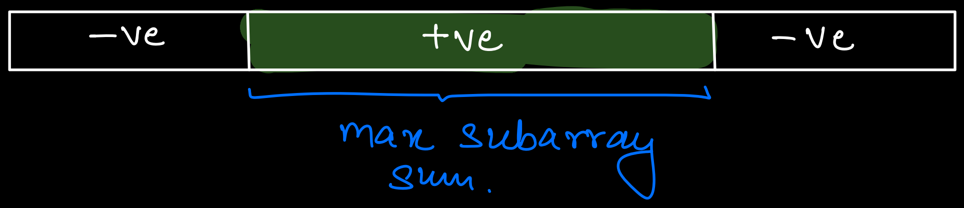
→ Sum(Array)

2. All array elements are -ve.

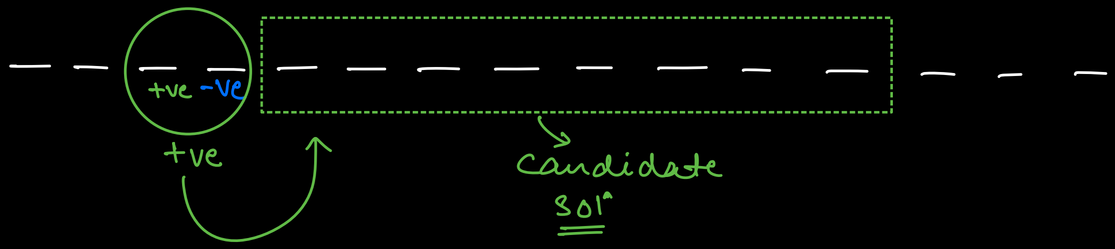
-25, -10, -5, -8, -1

→ Return man element of the Array.

3.



4.



Note : If something +ve is present on the left then we should add that in the candidate sol^n.

	5	6	7	-3	2	-10	-12	8	12	21	-4	7
sum=0	5	11	18	15	17	7	~~-5~~ 0	8	20	41	37	44
ans=-∞	5	11	18	18	18	18	18	18	20	41	41	44

Sum has become -ve, NO need to carry forward to next sum values. Reset it to Zero.

Ex

	-20	10	-2	6	11	8	-16	25
sum=0	~~-20~~ 0	10	8	14	25	33	17	42
ans=-∞	-20	10	10	14	25	33	33	42

Ex

	-20	-10	-1	-5
sum=0	~~-20~~ 0	~~-10~~ 0	~~-1~~ 0	-5
ans=-∞	-20	-10	-1	-1

Ex

	5	-5	5	-5
sum=0	5	0	5	0
ans=-∞	5	5	5	5

Code

```
ans = -∞
sum = 0
for(i = 0; i < N; i++){
        sum += A[i]
        ans = max(ans, sum);
        if(sum < 0)
              sum = 0;
}
return ans;
```

TC : O(N)
SC : O(1)
} KADANE's Algorithm.

Todo :- find s & e index of max sum subarray.

Q. Given an Array of size N & Q queries. Each query will contain → x & value
Add the value to all the indices from x to N-1.
Initially array contains all zeroe's. Return the final state of the Array.

Q=3

		0	1	2	3	4	5	6
	A :	0	0	0	0	0	0	0
x	value							
1	3	0	3	3	3	3	3	3
4	2	0	3	3	3	5	5	5
2	1	0	3	4	4	6	6	6
4	4	0	3	4	4	10	10	10

Brute Force

```
for ( K = 1 ; K <= Q ; K++ ) {
        // x & value
        for ( i = x ; i < N ; i++ ) {
                A[i] += value;
        }
}
```

TC : O(Q·N)
SC : O(1)

A :				
a_0	a_1	a_2	a_3	a_4

PF

a_0	a_0 + a_1	a_0 + a_1 + a_2	a_0 + a_1 + a_2 + a_3	a_0 + a_1 + a_2 + a_3 + a_4

0	1	2	3	4	5	6
0	~~0~~	~~0~~	0	~~0~~	0	0
	3	1		~~2~~ 6		

x	Value	
1	3	⇒ A[1] += 3
4	2	⇒ A[4] += 2
2	1	⇒ A[2] += 1
4	4	⇒ A[4] += 4

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

↓ PS

Ans ⇒ 0 3 4 4 10 10 10

```
for( K = 1 ; K <= Q ; K++ ) {
        // x & value
        A[x] += value;
}                                    O(Q)
```

3

// find PS of Array A] O(N)

TC: O(Q+N)

SC: O(1)

Q. Beggar's Outside Temple.

Google.

Given N array elements & Q queries.
Initially all array elements are Zero.
In each query ⇒ s, e, value
Add value to indices from [s, e]
Return array after all the queries.

s	e	x	0	1	2	3	4	5	6	7
A:			0	0	0	0	0	0	0	0
2	5	3	0	0	3	3	3	3	0	0
1	3	1	0	1	4	4	3	3	0	0
4	7	5	0	1	4	4	8	8	5	5
0	4	2	2	3	6	6	10	8	5	5

```
for( K = 1 ; K <= Q ; K++ ) {
        // s, e, value
        for( i = s ; i <= e; i++ ) {
                A[i] += value;
        }
}
```

TC: O(Q·N)

SC: O(1)

$$\boxed{\begin{array}{l} A[s]\ += \text{value} \\ A[e+1]\ -= \text{value} \ (e < N-1) \end{array}}$$

	0	1	2	3	4	5	6	7
A:	~~0~~ 2	~~0~~ 1	~~0~~ 3	0	~~0~~ ~~1~~ 4	~~0~~ -2	~~0~~ -3	0

N=8

s	e	x	
2	5	3	⇒ A[2]+=3 , A[6]-=3
1	3	1	⇒ A[1]+=1 , A[4]-=1
4	7	5	⇒ A[4]+=5
0	4	2	⇒ A[0]+=2 , A[5]-=2

A:	2	1	3	0	4	-2	-3	0
PS(A)	2	3	6	6	10	8	5	5

——— * ———