Given an array of N elements, how many subarrays are possible : $\frac{N^*(N+1)}{2}$

Amazon
Airtel
Ola

Q Given an array. Rotate the array by K positions from right to left.

3, 7, 1, 6, 8, -2, 9

K = 3

↓

8, -2, 9, 3, 7, 1 6

14, 7, 8, 3, 4, 1, 6, 1, 2, 14, 7, 8, 3

1 3 8 7

3	8	7	1

3, 7, 1, 6, 8, -2, 9

New Array : | | | | | | | |

TC : O(N)

SC : O(N) ← New array.

(Extra Space)

Auxillary Space

N-K | K

$\boxed{3,\ 7,\ 1,\ 6}$, $\boxed{8,\ -2,\ 9}$ K

K=3

K = 1 9, 3, 7, 1, 6, 8, -2

K = 2 -2, 9, 3, 7, 1, 6, 8

K = 3 $\boxed{8,\ -2,\ 9}$, $\boxed{3,\ 7,\ 1,\ 6}$

K | N-K

K=5

a_0 a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9

a_5 a_6 a_7 a_8 a_9 a_0 a_1 a_2 a_3 a_4

Reverse

Reverse Reverse

0 K-1 K N-1

$\boxed{a_9,\ a_8,\ a_7,\ a_6,\ a_5}$, $\boxed{a_4,\ a_3,\ a_2,\ a_1,\ a_0}$

✓ Step I Reverse the complete array ⇒ Reverse [0, N-1] ⇒ O(N)

✓ Step II Reverse the first K elements ⇒ Reverse [0, K-1] ⇒ O(N)

✓ Step III Reverse the remaining N-K elements ⇒ Reverse [K, N-1] ⇒ O(N)

TC ; O(N)
SC : O(1)
(Extra Space)

1	2	3	4	5	6	7

K=3

↓ Reverse

7, 6, 5, 4, 3, 2 1

↓ Reverse ↓ Reverse

5, 6, 7, 1, 2, 3, 4

if K > N ? ⟹ K % N times

Remainder when you divide K by N.

$a_0, a_1, a_2, a_3, a_4, a_5$ K=9

K=1 $a_5, a_0, a_1, a_2, a_3, a_4,$ ⇒ K = 7, 13

K=2 $a_4, a_5, a_0, a_1, a_2, a_3$ ⇒ K = 8, 14

K=3 $a_3, a_4, a_5, a_0, a_1, a_2,$ ⇒ K = 9, 15

⋮

K=5 $a_1, a_2, a_3, a_4, a_5, a_0$ ⇒ K = 11

K=6 ↳N $a_0, a_1, a_2, a_3, a_4, a_5$ ⇒ K = 0, 6, 12

K = 68

66 ⟶ original array 2 rotate

Q Print the start and end index of all the subarrays of length k.

A : $\underbrace{\overset{0}{3}, \overset{1}{4}, \overset{2}{2}, \overset{3}{-1}, \overset{4}{6}, \overset{5}{7}}$, $\overset{6}{8}$, $\overset{7}{9}$, $\overset{8}{3}$, $\overset{9}{2}$, $\overset{10}{-1}$, $\overset{11}{4}$

K : 6

		s	e
1st	$\rightarrow$	0	5
2nd	$\rightarrow$	1	6
3rd	$\rightarrow$	2	7
4th	$\rightarrow$	3	8
⋮			
last	$\rightarrow$	$\cancel{x}$ $\boxed{N-K}$	$(N-1)$

$\boxed{[a, b] = b - a + 1}$ $[3, 7] \Rightarrow 5$

$[x, N-1] \Rightarrow K$ element

$(N-1) - x + 1 = K$

$\boxed{N - K = x}$

$[0, x] = K$

$x - 0 + 1 = K$

$x = K - 1$

if the start index is i

end index $\Rightarrow x$

$[i, x] = K$

$x - i + 1 = K$

$x = K + i - 1$ e

Learning:

$\boxed{\text{How to iterate over all subarrays of a given length}}$

```
for (i = 0; i <= N-K; i++) {
        s = i;
        e = K+i-1;
        Print (s, e);
}
```

TC : O(N)

SC (ES) : O(1)

Q Find the max subarray sum of length K.

Amazon
PayTM

A : $\overset{0}{-3},\ \overset{1}{4},\ \overset{2}{-2},\ \overset{3}{5},\ \overset{4}{3},\ \overset{5}{-2},\ \overset{6}{8},\ \overset{7}{2},\ \overset{8}{-1},\ \overset{9}{4}$

K = 5

[Size of array = N]

[0, 4] ⇒ 7
[1, 5] ⇒ 8
[2, 6] ⇒ 12
[3, 7] ⇒ 16 ⇐ ans
[4, 8] ⇒ 10
[5, 9] ⇒ 11

```
Max sum = -∞;
for (i = 0; i<= N-K ; i++){
    s = i;
    e = K+i-1 ;
    Sum = 0;
    for(j= s; j<= e; j++){
        Sum = sum + ar[j];
    }
    if (sum > MaxSum){
        Max Sum = sum;
    }
}
```

-2, -1, -3   K = 2

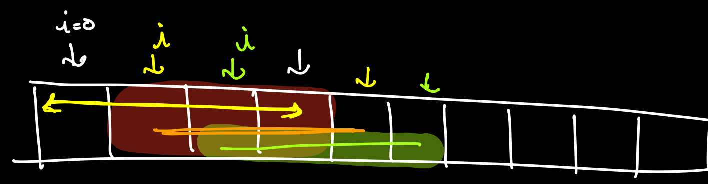
[0, 1) ⇒ -3 =   Max Su 0
[1, 2] ⇒ -4   ~~>~~ 0
    ~~>~~ 0

TC : $O(N^2)$

$\underbrace{(N-K+1)}_{\text{No of Subarrays of Size K}} \times K$ } Iterations

No of iterations = $K(N-K+1)$
= $KN - K^2 + K$

if $K = \frac{N}{2}$ ⟶ $\frac{N}{2} \times N - \left(\frac{N}{2}\right)^2 + \frac{N}{2} \Rightarrow \frac{2N^2}{4} - \frac{N^2}{4} + \frac{N}{2} \Rightarrow \frac{N^2}{4} + \frac{N}{2}$



$K=6$ A : $-3, 4, -2, 5, 3, -2, 8, 2, -1, 4$

S: $[0, 5] = 5$

$[1, 6] = S - a[0] + a[6] \Rightarrow$

$= 16$

$[2, 7] = 16 - 4 + 2$

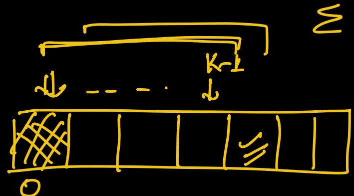
$= 14$

$[3, 8] = 14 - a[2] + a[8]$

$14 - (-2) + (-1)$

15

Sum of 1st subarray of size K = S



$\Sigma [0, K-1] \Rightarrow S$

$\Sigma [1, K] = S - a[0] + a[K]$

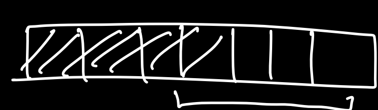
1st subarray sum $\longrightarrow$ S $O(K)$

2nd subarray sum $\longrightarrow$ $O(1)$

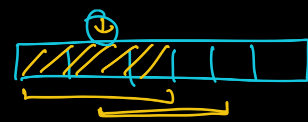
3rd subarr sum $\longrightarrow$ $O(1)$

⋮

last subarray sum $\longrightarrow$ $O(1)$



Sliding Window




```
Sum = 0;
for (i=0; i<K; i++){          // sum of 1st Subarray.
    sum = sum + arr[i]
}
MaxSum = sum;
for (i=1; i<=N-K; i++){
    sum = Sum - arr[i-1] + arr[i+K-1];
    if (sum > MaxSum){
        MaxSum = sum;
    }
}
```

Create a window

Slide the window

TC : $O(N)$

SC (Extra) : $O(1)$

Break till 10:55 pm

→ Understand (what ?)

→ Observe

↳ Conclusions

→ Execute

$(2N)^2$

↳ 1 Val

↳ $O(1)$

Q Print sums of all the sub-arrays of an array.

$O(N^3)$

for (s = 0 → N-1)

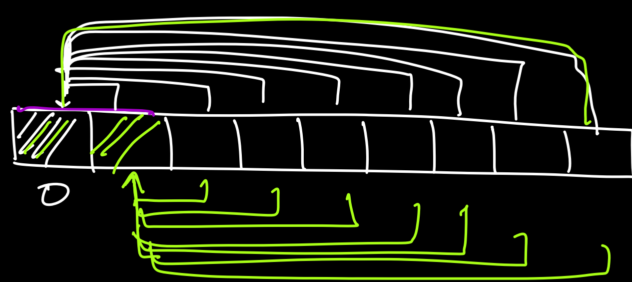
  for (e = s → N-1)   ] → Iterate over all sub array

    for (s → e)   ] → Calculate the sum.

    Print (s) ⇐ $\left(\frac{N \times (N+1)}{2}\right)$

↓

$O(N^2)$



$O(N)$

s	e			
0	0	$a[0] = S_0$		→ $O(1)$
0	1	$= S_0 + a[1]$	$= S_1$	→ $O(1)$
0	2	$= S_1 + a[2]$	$= S_2$	→ $O(1)$
0	3	$= S_2 + a[3]$	→	$O(1)$
⋮				
0	N-1	$= S_{N-2} + a[N-1]$	→	$O(1)$
0	e	$= S_{(e-1)} + a[e]$	→	$O(1)$

$s=0$

s	e		
1	1	$\Rightarrow a[1]$	$\Rightarrow S_1$
1	2	$\Rightarrow S_1 + a[2]$	$\Rightarrow S_2$
1	3	$\Rightarrow S_2 + a[3]$	

Carry Forward

```
for (s = 0; s < N ; s++) {
    [ sum = 0;
    for ( e = s ; e < N; e++) {
        sum = sum + arr[e];
        Print (sum);
    }
}
```

1	2	3	1
0	1	2	3

s	e	Sum
0	0	1
0	1	3
0	2	6
0	3	7
		0 ←
1	1	2
1	2	5
1	3	6
		0 ←

TC : $O(N^2)$

SC [Extra] : $O(1)$

Q Given an array. Return the sum of all possible subarrays.

A : $\overset{0}{3}$, $\overset{1}{-2}$, $\overset{2}{4}$, $\overset{3}{-1}$, $\overset{4}{2}$, $\overset{5}{6}$

N

[0, 0] ⇒ 3	[1, 1] ⇒ −2	[2, 2] ⇒ 4
[0, 1] ⇒ 1	[1, 2] ⇒ 2	[2, 3] ⇒ 3
[0, 2] ⇒ 5	[1, 3] ⇒ 1	[2, 4] ⇒ 5
[0, 3] ⇒ 4	[1, 4] ⇒ 3	[2, 5] ⇒ 11
[0, 4] ⇒ 6	[1, 5] ⇒ 9	
[0, 5] ⇒ 12		

3
↳ 4
1
7
4 → 3
8
5 → 6

Sum of all subarrays : 90

If we are iterating over all the subarrays can TC be less than $O(N^2)$ ✗

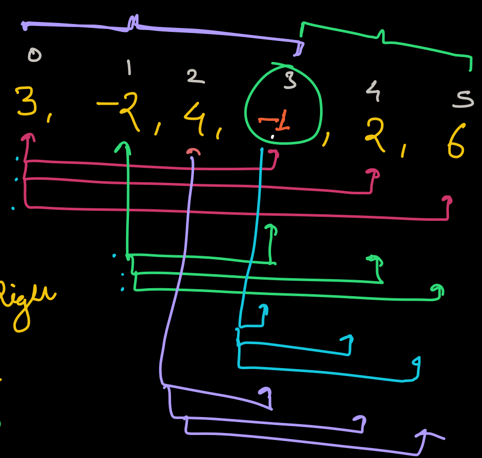
$\Downarrow$

x {
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[N-1]
}

a[1]
+
a[1] + a[2]
+
a[1] + a[2] + a[3]
⋮
a[1] + a[2] ... a[N-1]

$\underline{a[0] \times N} + a[1] \times \underline{(N-1)}$

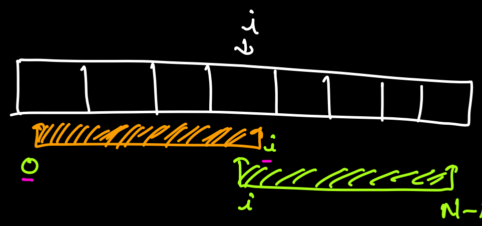
Quiz



(0,3)

left s	Right e
0	3
1	4
2	5
3	

How many subarrays will contain element at index i $= \underline{(i+1) \times (N-i)}$



$s : [0, i]$ $\leftarrow$

$e : [i, N-1]$

$$\boxed{[a, b] = b - a + 1}$$

$|s| = (i+1)$

$|e| = (N-i)$

```
Sum = 0;
for (i=0; i<N; i++){
    s = i+1;
    e = N-i;
    Sum = sum + a[i] x (s x e);
}
```

TC : $O(N)$

SC : $O(1)$
(Extra)

Take Aways :

1. How to iterate over all the subarrays of a given length.
2. How to use the Sliding Window tech.
3. How to get the ans by counting the contribution of individual elements.

Doubts

When to start interview ?

Amazon
MS
Adobe
Google
FB

Big MNC → SDE - I
DS / Algo
CS - Fundamentals

≥ 1.5 years Exp as SDE → SDE - II
DS / Algo
CS - Funda
LLD
HLD

Start ups → DS / Algo
LLD
HLD
MVC framework. —] Dev

IIIT-H
↳ CS

1st

CS [Counter Strike] ×
↳ C → C++ → Java
RoR

Cheat Sheet

What ? → google / documentation / Stack Overflow

↳ From where ?

vector<int>

5-10 → 400-800

Concept

Tough

↳ Sorting

Syntax → yourself

(Not)