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What is subarray : It is contigious part of array

1 2 3 4

(1 2) (1 2 3) (1) (2) (3) (4)

(2,3) (2 3 4)

(3,4)

What is subsequence

It is a seq. of array/string which can be obtained by deleting zero or more elements but order should same.

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1
1 2
1 2 3
1 2 3 4

2
2 3
2 3 4

3
3 4

4

Subarray

X

1 2 3
1 3 4

1 4
3 4

1 2 4

Sub-seq

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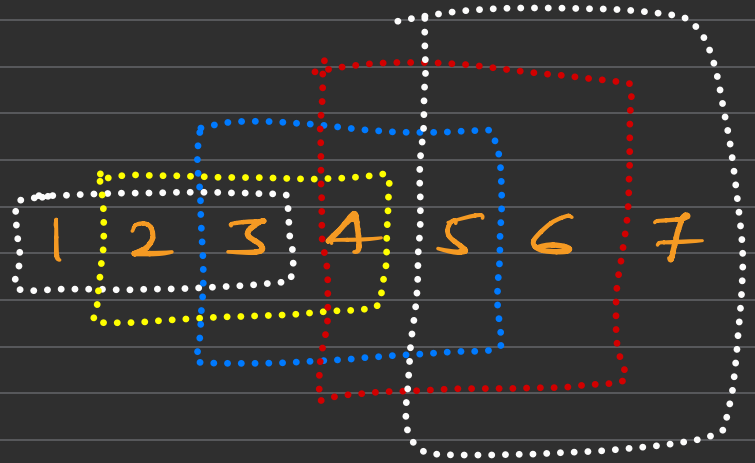
Types of Sliding Window (Not an algorithm)

Array / String

- ✓ Fixed Window Size
- Variable Window Size



K = 3 (Window Size)

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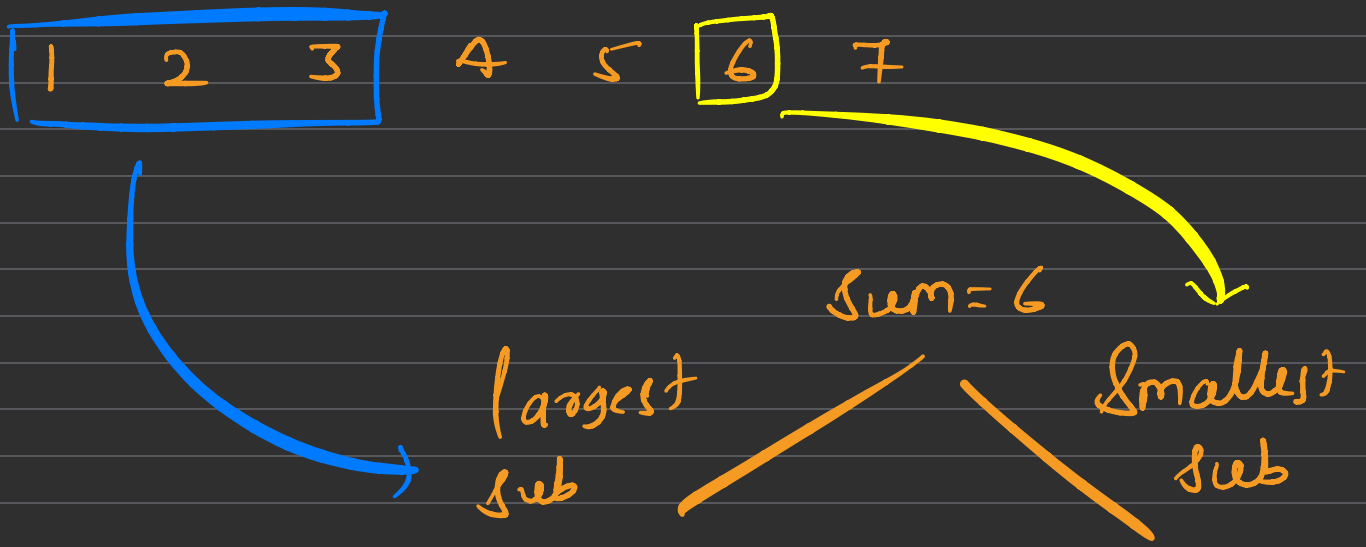
* Variable Window Size



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How to approach the problem

1. Generate all the subarrays/substrings and pick the optimal one
2. Then optimise by moving the window slowly until certain conditions.
3. For variable window size, use the two pointer approach.

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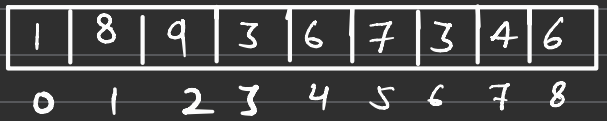
Given an array of integers, find all the subarrays




```
for ( i=0 : i<n ; i++)
{
    for ( j= i : j <n ; j++)
    {
        for ( k= i : k ≤ j : k++)
        {    println ( a(k))
        }
        println("\n")
    }
}
```

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Given a string, generate all the substrings.

String = abcdfh

Sub-strings

a	b	c	d	f	h
abc	bc	cd	df	fh	
abcd	bcd	cdf	dfh		
abcdf	bcdf	cdfh			
abcdfh	bcdfh				

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1
1 2
1 2 3
1 2 3 4

2
2 3
2 3 4

3
3 4

4

```
for ( i=0 ; i<n ;i++)
{
    for ( j= i ; j<n ;j++)
    {
        for ( k= i ; k≤j ; k++)
        {    println ( a(k))
        }
        println("\n")
    }
}
```

N=4

```
for ( i=0 ; i<n ;i++)
{
    for ( j= i ; j<n ;j++)
    }
```

1 2 3 4

2 3 4

3 4

4

```
}
}
```

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- given an array, print sum of all subarray
- given an array, find min from all subarray (print min. of each sub-array)
- = // = (max)

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Max Sum Subarray of size K

Difficulty: **Easy** Accuracy: **49.6%** Submissions: **194K+** Points: **2**

Given an array of integers **arr[]** and a number **k**. Return the **maximum sum** of a subarray of size k.

Note: A subarray is a contiguous part of any given array.

Examples:

Input: arr[] = [100, 200, 300, 400] , k = 2
Output: 700
Explanation: $arr_3 + arr_4 = 700$, which is maximum.

Input: arr[] = [100, 200, 300, 400] , k = 4
Output: 1000
Explanation: $arr_1 + arr_2 + arr_3 + arr_4 = 1000$, which is maximum.

Input: arr[] = [100, 200, 300, 400] , k = 1
Output: 400
Explanation: $arr_4 = 400$, which is maximum.

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fixed window

N = 8

K = 3

7	2	1	1	4	3	9	1
0	1	2	3	4	5	6	7

maxSum = 0

$O(N-K)$ ⟵ `for (i=0; i<=n-k ;i++)`

`{ sum=0`

$O(K)$ ⟵ `for (j=i ; j<i+k ; j++)`

`{ sum = sum + a(j)`

`}`

`if (sum > maxSum)`

`{ maxSum = sum`

`}`

`}`

`return maxSum`

$O(N-K) \times O(K)$

$O(N \times K) - K^2$

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7	2	1	1	4	3	9	1
0	1	2	3	4	5	6	7

N = 8 K = 3

1 2 3 4 5 6 K=3

1 + 2 + 3 = 6

2 + 3 + 4 = 9

3 + 4 + 5 = 12

4 + 5 + 6 = 15

Sum = 9 + 5 − 2 = 12

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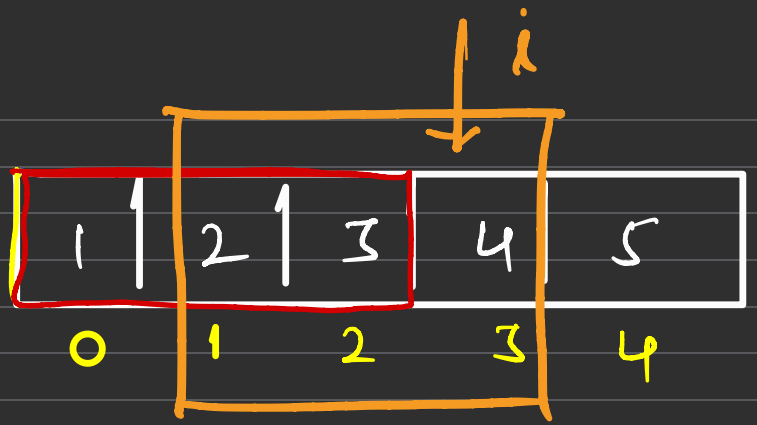

$k = 3$

$i = 3 - k$

$= 3 - 3 = 0$

Sum = 6

$$Sum = Sum - a(i-k) + a(i).$$

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_ Steps for fixed Window

① first perform operation on first k elements. (0, 1 .... $k-1^{th}$ index) ($i < k$)

② Start from k ($i = k$) & slide forward but remove out of Windows element { a[i-k] } & add current element in window

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```
int maxSubarraySum ( arr[], n , K)
{
    sum = 0

    for (i=0 ; i<K ; i++)                    ——— Step 1
        sum += a(i)

    maxSum = sum

    for (i= K ;  i<n ; i++)                  ——— Step 2
    {     sum = sum - a(i-K)                 ——— Removed out of Win.

          sum = sum + a(i)                   ——— Add curr element

    maxSum = max (sum, maxSum)
}
```

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Given an array **arr[]** and an integer **K**, the task is to calculate the sum of all subarrays of size K.

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Given an array of integer, task is to find the subarray with minimum sum of size k

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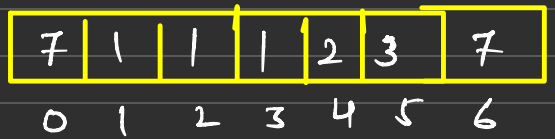
given an array, find min no. from every sub. of size K.



K = 2

```
for(i=0 ; i ≤ N-K ; i++)
    num = a(i)
    for(j=i ; j < i+K : j++)
        if (a(j) < num)
            num = a(j)
    println( num
```

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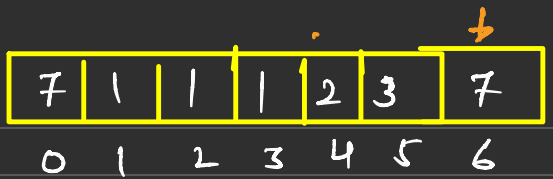


k = 3

map

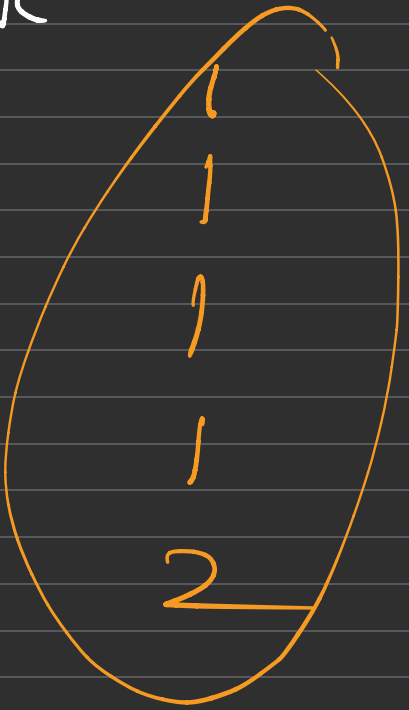
{7, 1}
{3, 1}
{2, 1}

map
{key, value}

1. Perform pattern first k

② i = k

i = ~~3 4 5~~ 6



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```
void printMin(arr[], N, K)
{
    map<int, int> mp
    for (i=0 ; i<K ; i++)
        mp[a(i)]++
```

— step ①

begin (min { key → first, value → second

```
cout << ((*mp.begin()).first
    for (i=K ; i<n ; i++)
    { int out = a[i-K]
        mp(out)--
        if (mp(out) == 0)
            mp.erase(out)
```

a(i-K)

x = a(i-K))

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```
int cur = a[i]
mp[cur]++
cout << ((*mp.begin()).first
}
}
```

Made with Goodnotes