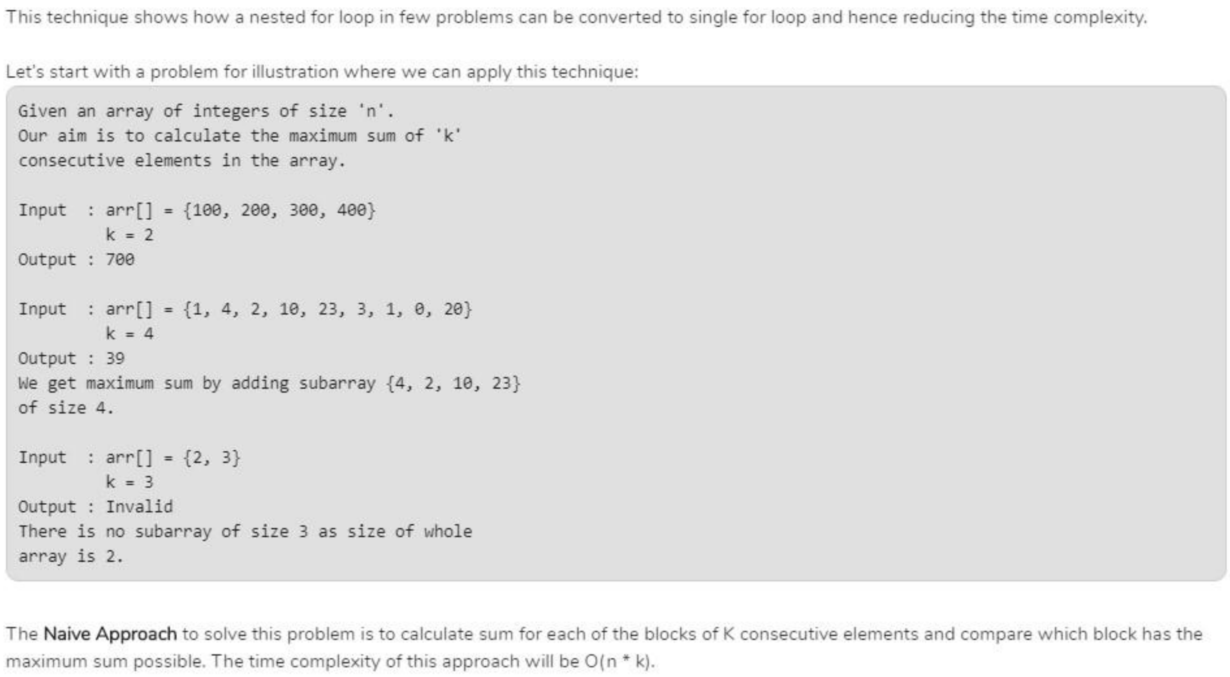
Sliding Window Technique



This technique shows how a nested for loop in few problems can be converted to single for loop and hence reducing the time complexity.

Let's start with a problem for illustration where we can apply this technique:

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Given an array of integers of size 'n'.
Our aim is to calculate the maximum sum of 'k'
consecutive elements in the array.

Input  : arr[] = {100, 200, 300, 400}
         k = 2
Output : 700

Input  : arr[] = {1, 4, 2, 10, 23, 3, 1, 0, 20}
         k = 4
Output : 39
We get maximum sum by adding subarray {4, 2, 10, 23}
of size 4.

Input  : arr[] = {2, 3}
         k = 3
Output : Invalid
There is no subarray of size 3 as size of whole
array is 2.
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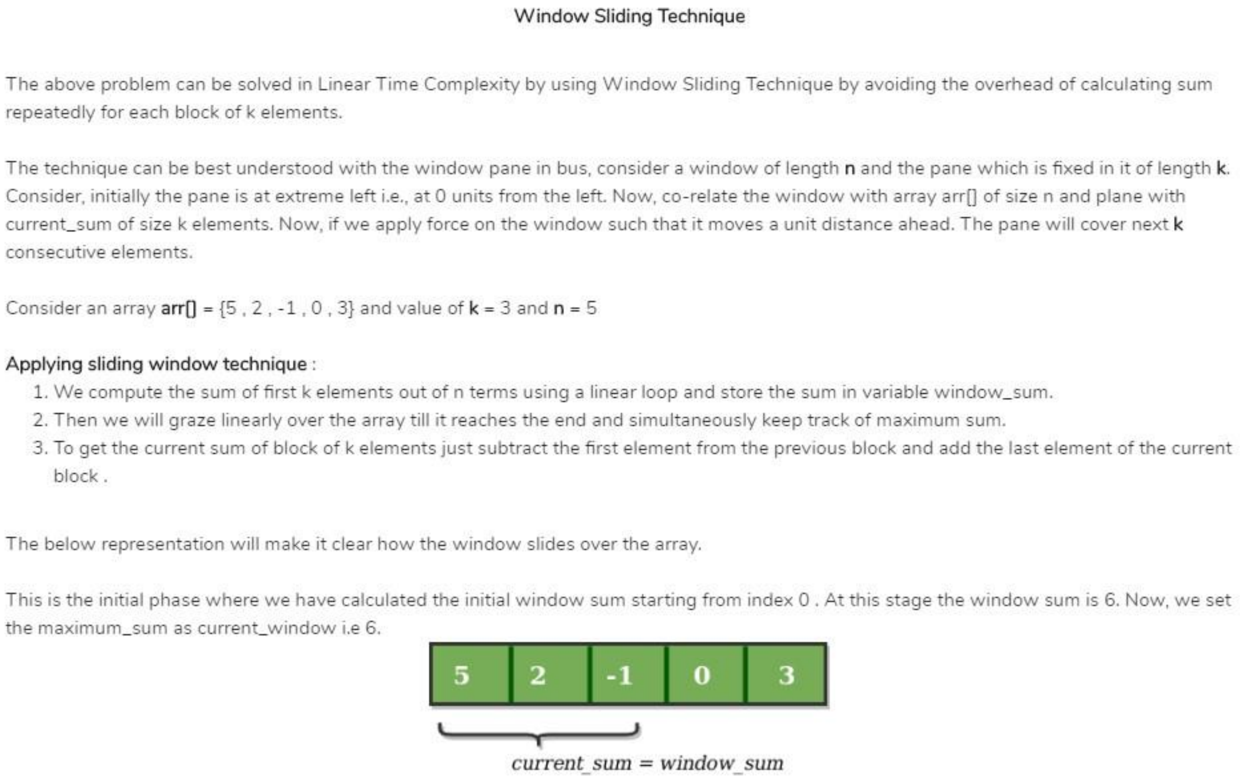
The **Naive Approach** to solve this problem is to calculate sum for each of the blocks of K consecutive elements and compare which block has the maximum sum possible. The time complexity of this approach will be O(n * k).



Window Sliding Technique

The above problem can be solved in Linear Time Complexity by using Window Sliding Technique by avoiding the overhead of calculating sum repeatedly for each block of k elements.

The technique can be best understood with the window pane in bus, consider a window of length **n** and the pane which is fixed in it of length **k**. Consider, initially the pane is at extreme left i.e., at 0 units from the left. Now, co-relate the window with array arr[] of size n and plane with current_sum of size k elements. Now, if we apply force on the window such that it moves a unit distance ahead. The pane will cover next **k** consecutive elements.

Consider an array **arr[]** = {5 , 2 , -1 , 0 , 3} and value of **k** = 3 and **n** = 5

Applying sliding window technique :

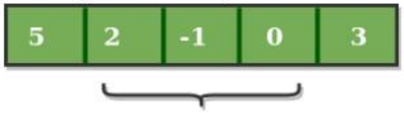
1. We compute the sum of first k elements out of n terms using a linear loop and store the sum in variable window_sum.
2. Then we will graze linearly over the array till it reaches the end and simultaneously keep track of maximum sum.
3. To get the current sum of block of k elements just subtract the first element from the previous block and add the last element of the current block .

The below representation will make it clear how the window slides over the array.

This is the initial phase where we have calculated the initial window sum starting from index 0 . At this stage the window sum is 6. Now, we set the maximum_sum as current_window i.e 6.

5	2	-1	0	3

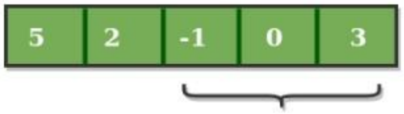
Now, we slide our window by a unit index. Therefore, now it discards 5 from the window and adds 0 to the window. Hence, we will get our new window sum by subtracting 5 and then adding 0 to it. So, our window sum now becomes 1. Now, we will compare this window sum with the maximum_sum. As it is smaller we wont the change the maximum_sum.



current_sum = window_sum + (-5) + (0)

Similarly, now once again we slide our window by a unit index and obtain the new window sum to be 2. Again we check if this current window sum is greater than the maximum_sum till now. Once, again it is smaller so we don't change the maximum_sum.

Therefore, for the above array our maximum_sum is 6.



current_sum = window_sum + (-2) + (3)