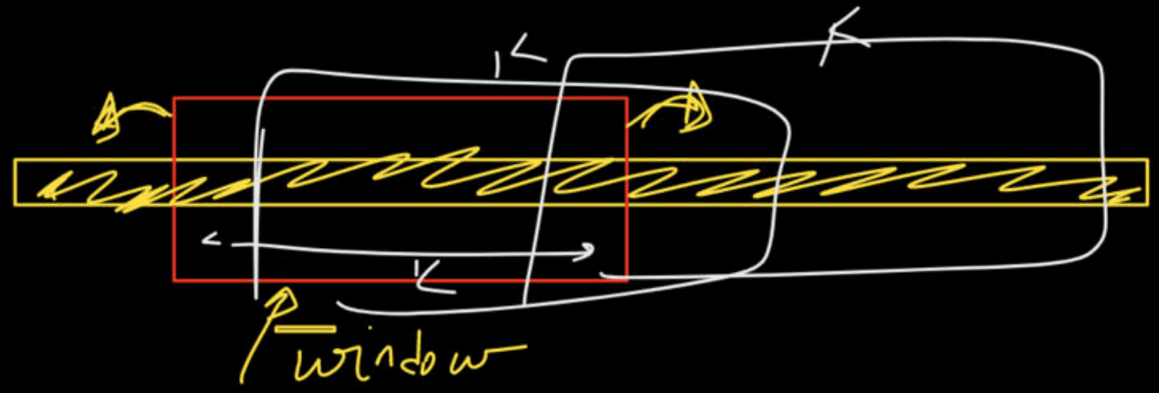
Sliding Window Technique

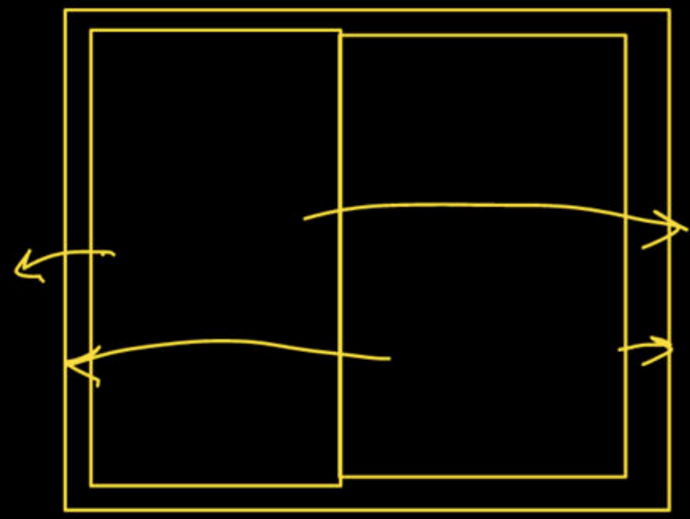
By Love Babbar

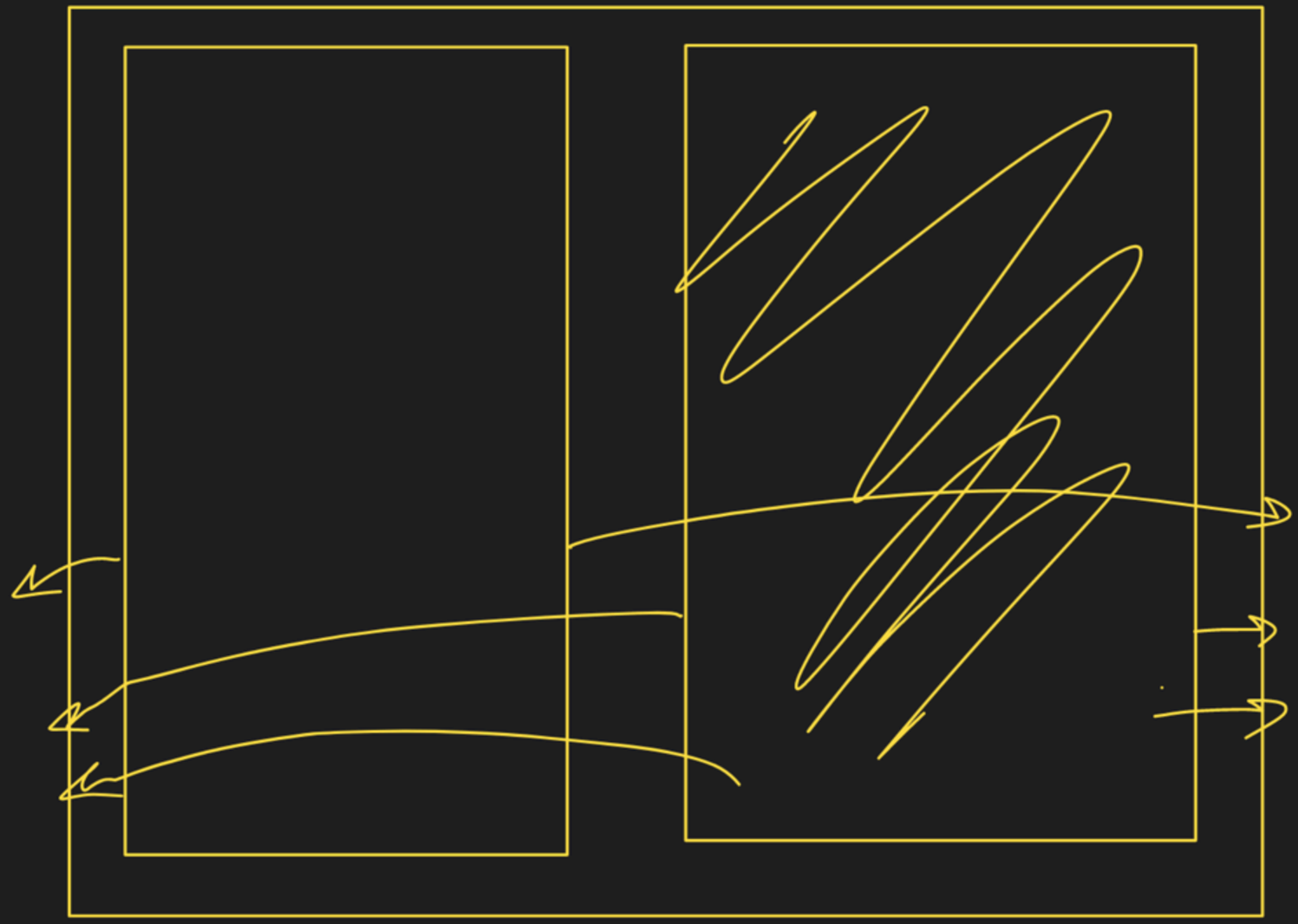
Bonus Class [Supreme Batch]

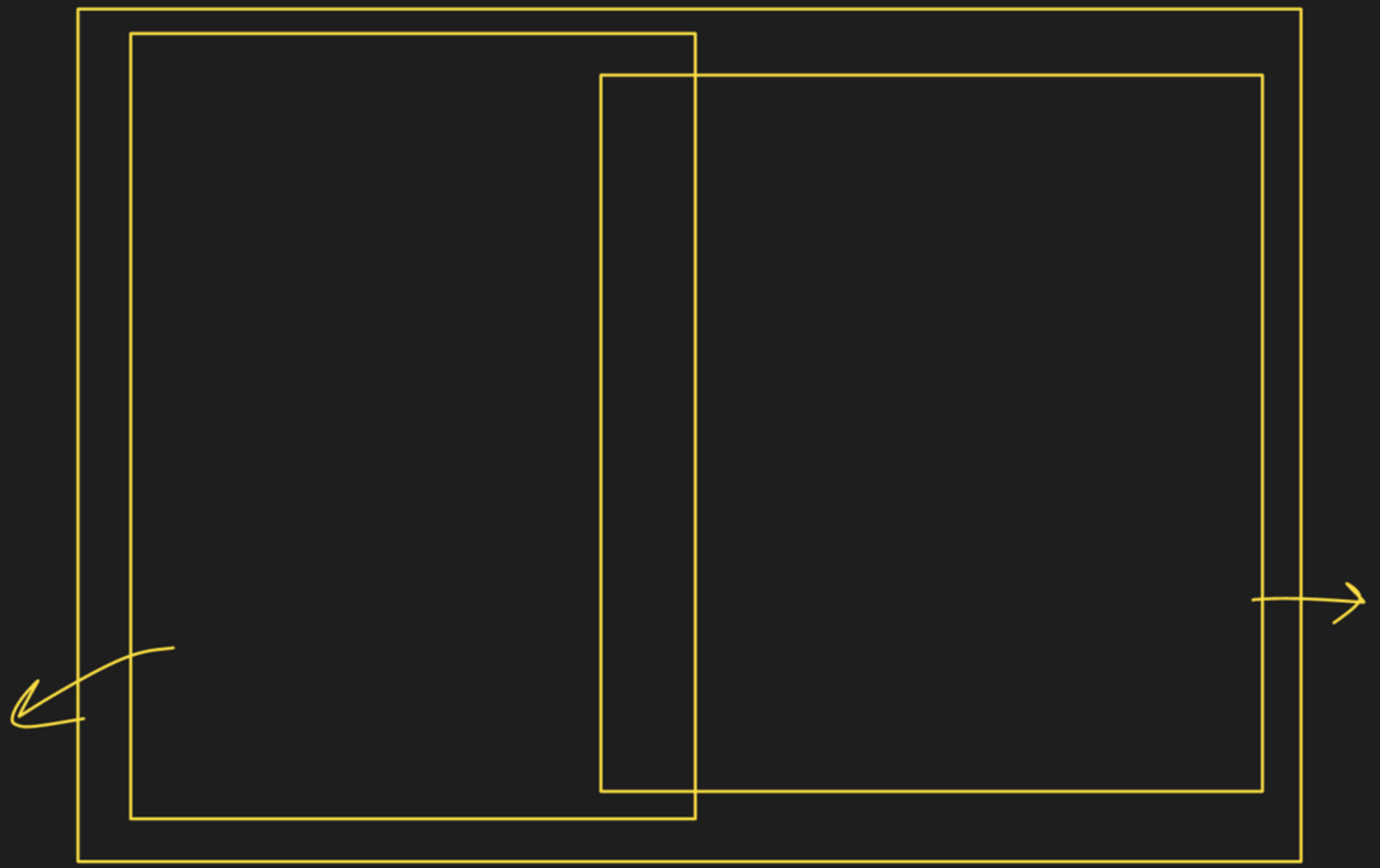
Sliding Window



- The sliding window technique is a common approach used to solve problems that involve finding or analyzing a subset of elements in a larger data structure, such as an array or string. Here are the key patterns often used in sliding window problem statements:
  - Fixed Size Window
  - Variable Size Window
  - Two Pointer Approach
  - Optimised Sliding Windows



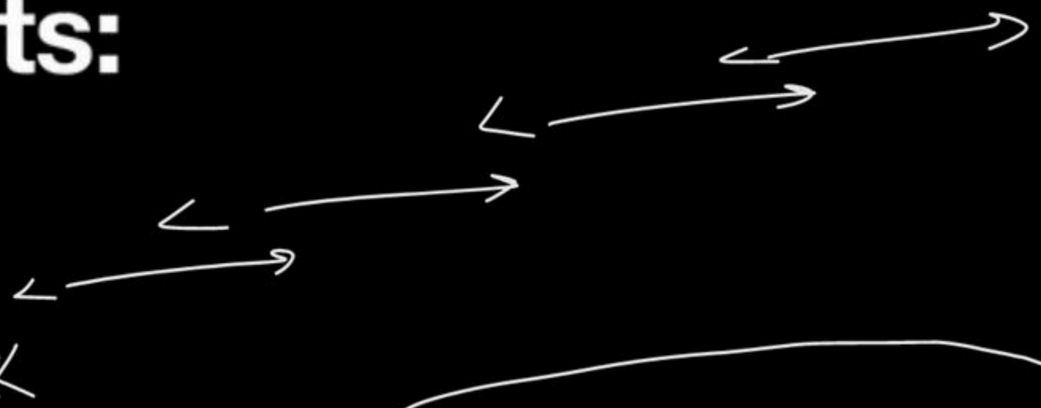




Fixed-Size Windows

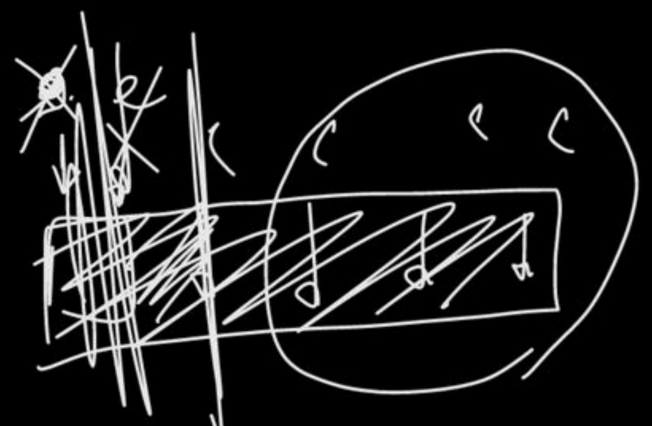
- Fixed Size Window:
  - Maintain a window of a fixed size (usually a contiguous subset of elements).
  - Slide the window one element at a time to process the data.
  - Useful for finding the maximum, minimum, or some other calculation within a fixed-sized window.

Problem Statements:



- Fixed Size Window:
  - Given an array of integers and a window size, find the maximum sum of any subarray of the given window size.
  - Given a string, find the length of the longest substring containing only unique characters within a fixed window size.
  - Given an array of temperatures, find the minimum number of days it takes for a contiguous window of size K to have increasing temperatures.
  - Given a binary array (containing only 0s and 1s), find the maximum number of consecutive 1s with at most K 0s allowed in the window.
  - Given a string of characters, find the smallest window length that contains all the characters of a given pattern.

Variable-Size Window



- Variable Size Window:
  - Start with a small window and gradually expand or shrink it based on certain conditions.
  - Useful when the size of the window is not fixed and depends on the problem requirements.
  - Often used to find a subarray or substring satisfying specific conditions (e.g., sum, product, or a certain property).

Problem Statements:

- Variable Size Window:
  - Given an array of positive integers and a target sum, find the minimum subarray length whose sum is greater than or equal to the target.
  - Given a string, find the longest substring with at most K distinct characters.
  - Given an array of non-negative integers, find the subarray of length K with the maximum average value.
  - Given a string, find the length of the longest substring that can be formed by repeating exactly K times.
  - Given an array of integers, find the maximum product of a subarray with size at most K.

2-Pointer Approach

- Two Pointers:
  - Use two pointers to define the boundaries of the window.
  - One pointer usually represents the start of the window, and the other represents the end.
  - Move the pointers within the data structure based on certain conditions.
  - Commonly used when the problem requires finding a target sum, a pair of elements, or a subarray with specific characteristics.

Problem Statements:

- Two Pointers:
  - Given an array of integers and a target sum, find two numbers that add up to the target.
  - Given a sorted array of integers, find two numbers whose absolute difference is closest to a given target value.
  - Given a string, find the longest palindrome substring.
  - Given a string, find the length of the longest substring without repeating characters.
  - Given an array of integers, find a subarray with the given sum.

Optimised Window:

- Optimized Sliding Window:
  - Apply additional optimization techniques to improve the sliding window solution.
  - Examples include precomputing sums or frequencies, utilizing data structures like heaps or hash maps, or skipping unnecessary calculations.
  - Helps to reduce the time complexity and optimize the overall solution.

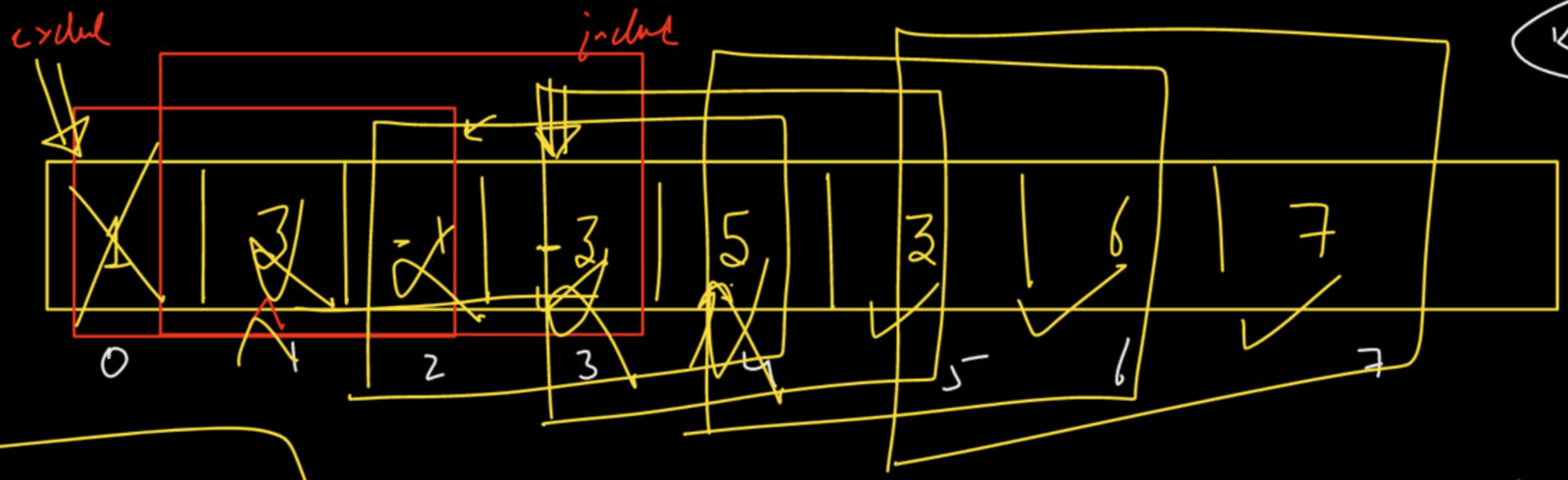
Problem Statements:

- Optimized Sliding Window:
  - Given an array of integers, find the subarray with the maximum sum using the Kadane's algorithm.
  - Given a string, find the longest substring with at most K distinct characters using a hash map for character frequency tracking.
  - Given an array of integers, find the median of every sliding window of size K using a min heap and max heap.
  - Given a binary array (containing only 0s and 1s), find the minimum size of a subarray that needs to be flipped to make all elements 1.
  - Given an array of integers and a target sum, find the subarray with the smallest length that sums up to the target using a two-pointer approach and dynamic window resizing.

Problem Statements:

- Given a string, find the longest substring that contains at most K distinct characters and has at least K/2 repeating characters.
- Given an array of integers, find the maximum product of a subarray with size at most K and the minimum product of a subarray with size at most K.
- Given two strings, find the minimum window in the first string that contains all the characters of the second string, considering multiple possible windows.
- Given a string, find the longest palindromic substring with at most K deletions allowed.
- Given an array of integers, find the maximum sum of K non-overlapping subarrays.

→ Fixed-size Window



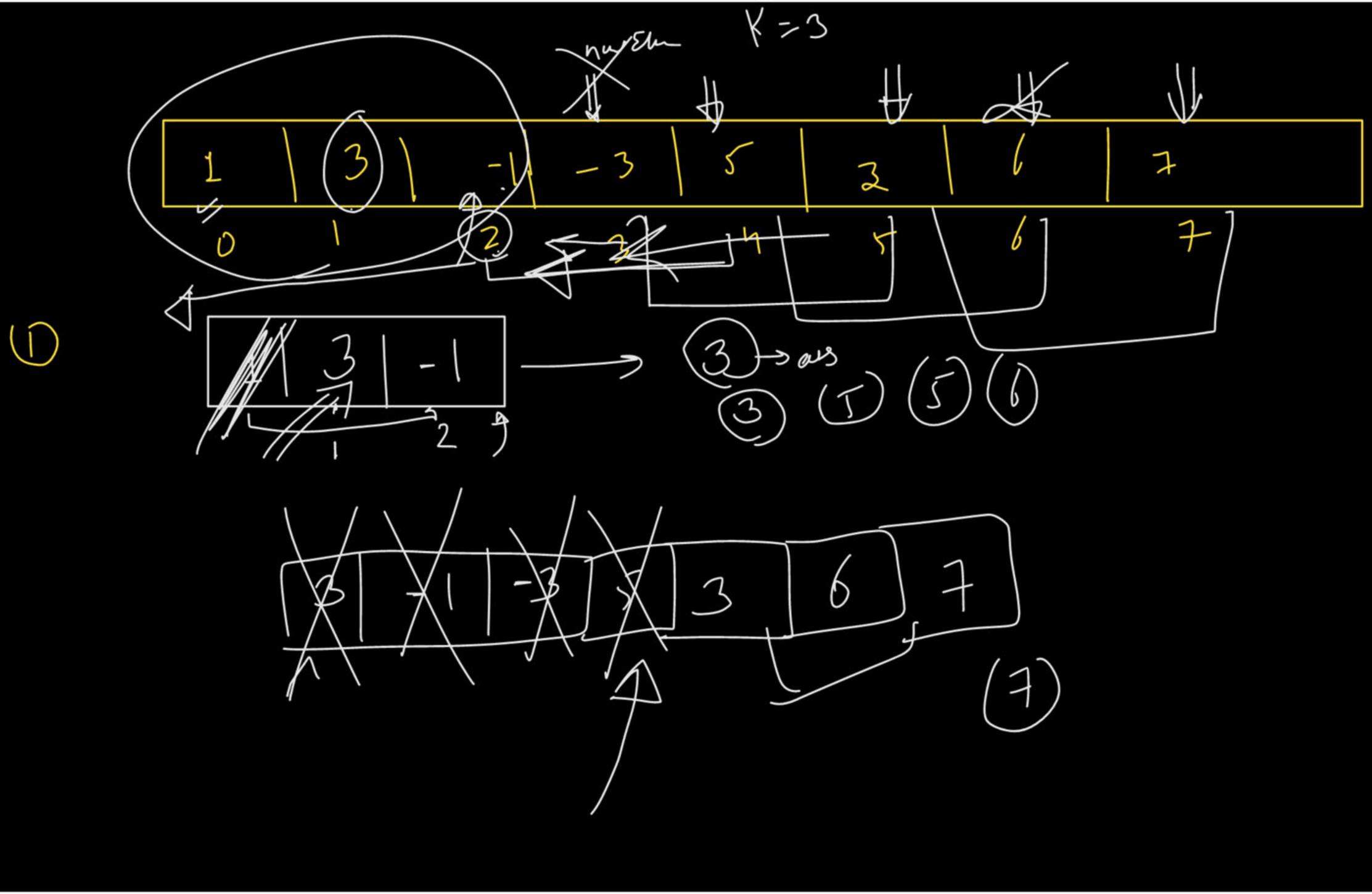
K = 3

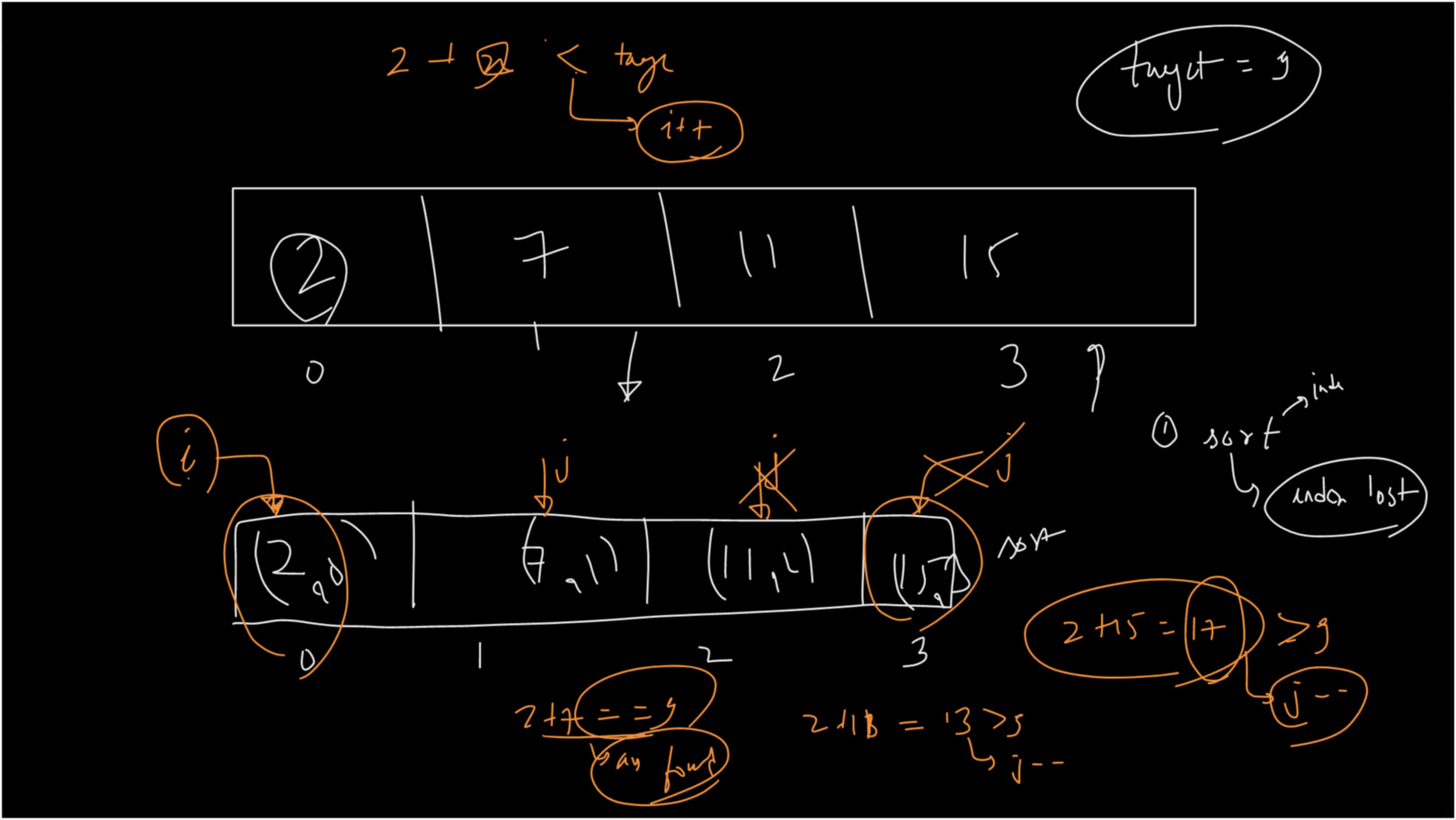
① process first window

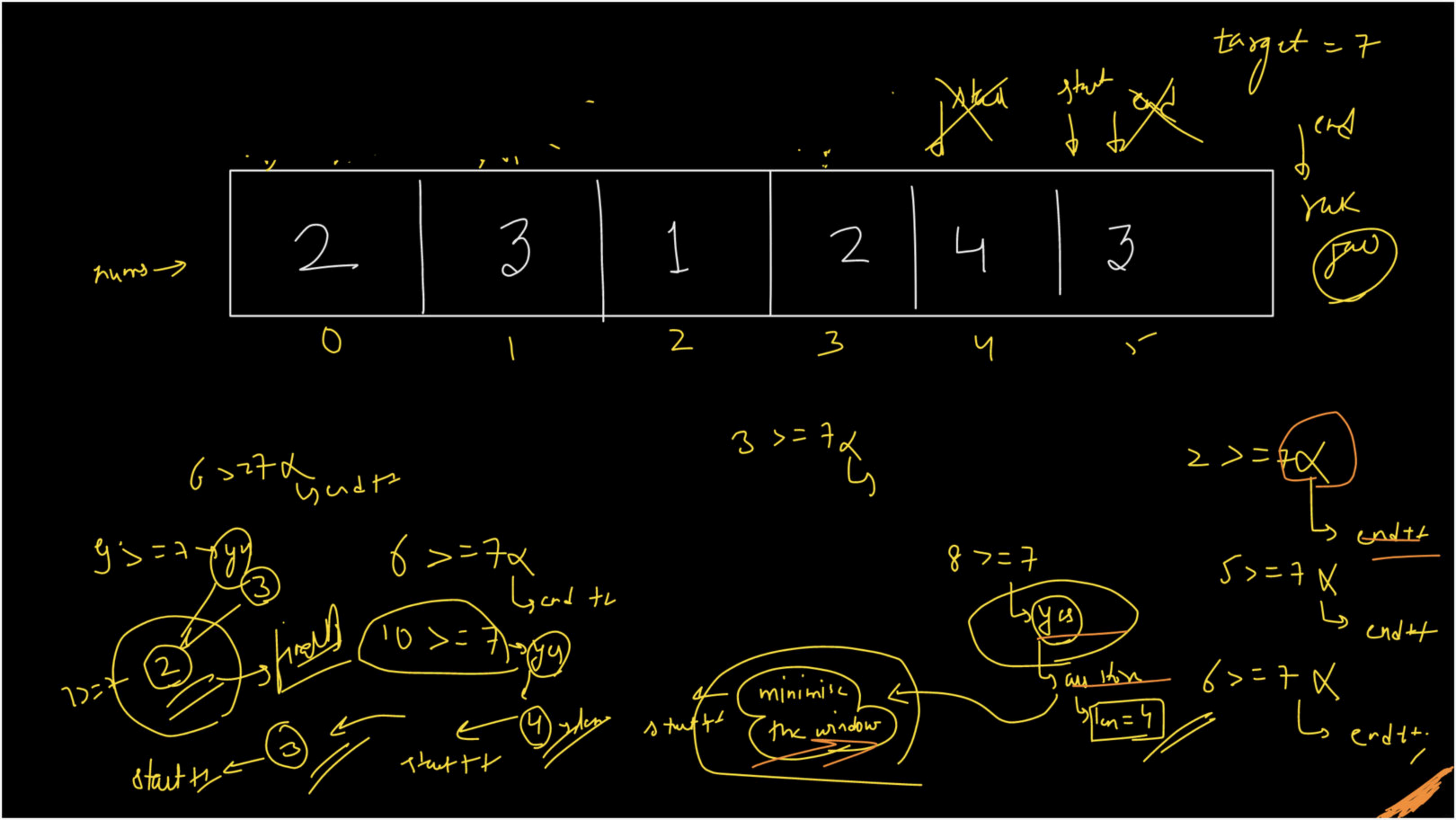
② process remaining windows → each window

- removal of out of window element
- addition of new element
- store your ans

ans → 3, 3, 5, 5, 6, 7


K=3
1
3
-1
-3
5
3
6
7
0
1
2
3
4
5
6
7
(1)
3
-1
1
2
3
ans
3
1
5
6
3
-1
-3
5
3
6
7
(7)


2 + 7 < target
i++
target = 9
2
7
11
15
0
1
2
3
i
j
j
0 sort → index
index lost
2+15 = 17 ≥ 9
j--
2+7 == 9
pair found
2+11 = 13 > 9
j--

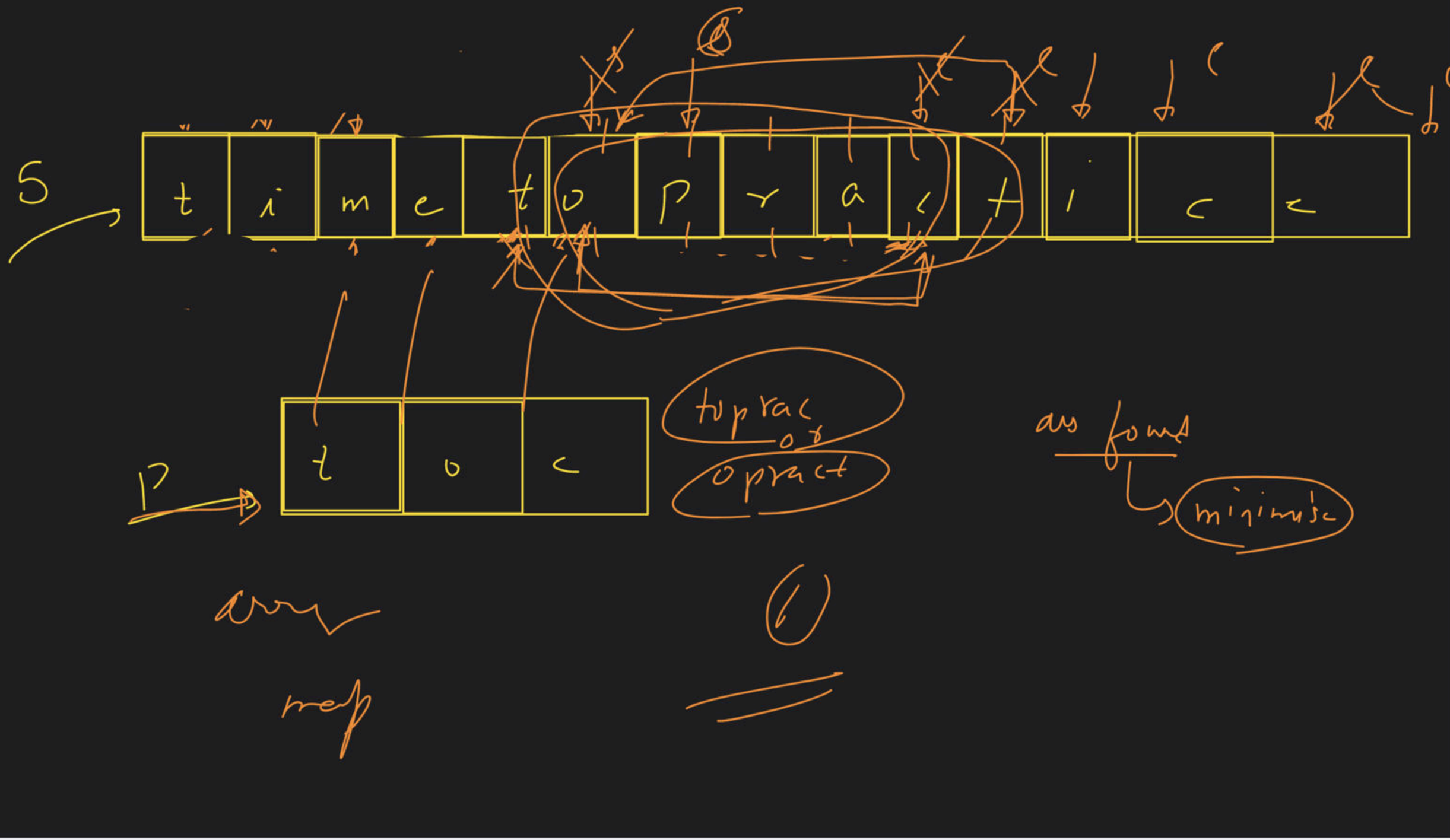

target = 7
start
end
nums →
2
3
1
2
4
3
0
1
2
3
4
6 >= 7 ✗
end++
3 >= 7 ✗
2 >= 7 ✗
end++
5 >= 7 ✗
end++
6 >= 7 ✗
end++
9 >= 7
y
3
2
result
10 >= 7
y
4
y
start++
start++
8 >= 7
y
can shrink
len = 4
minimise the window
start++

algo →

(1) start with 1 size window from the extreme left

(2) increment "end" till you achieve the target specified in P.S

(3) once you achieve the target, try minimising the window


S
t i m e t o p r a c t i c e
P
t o c
tuprac
o
opract
as fonts
minimise