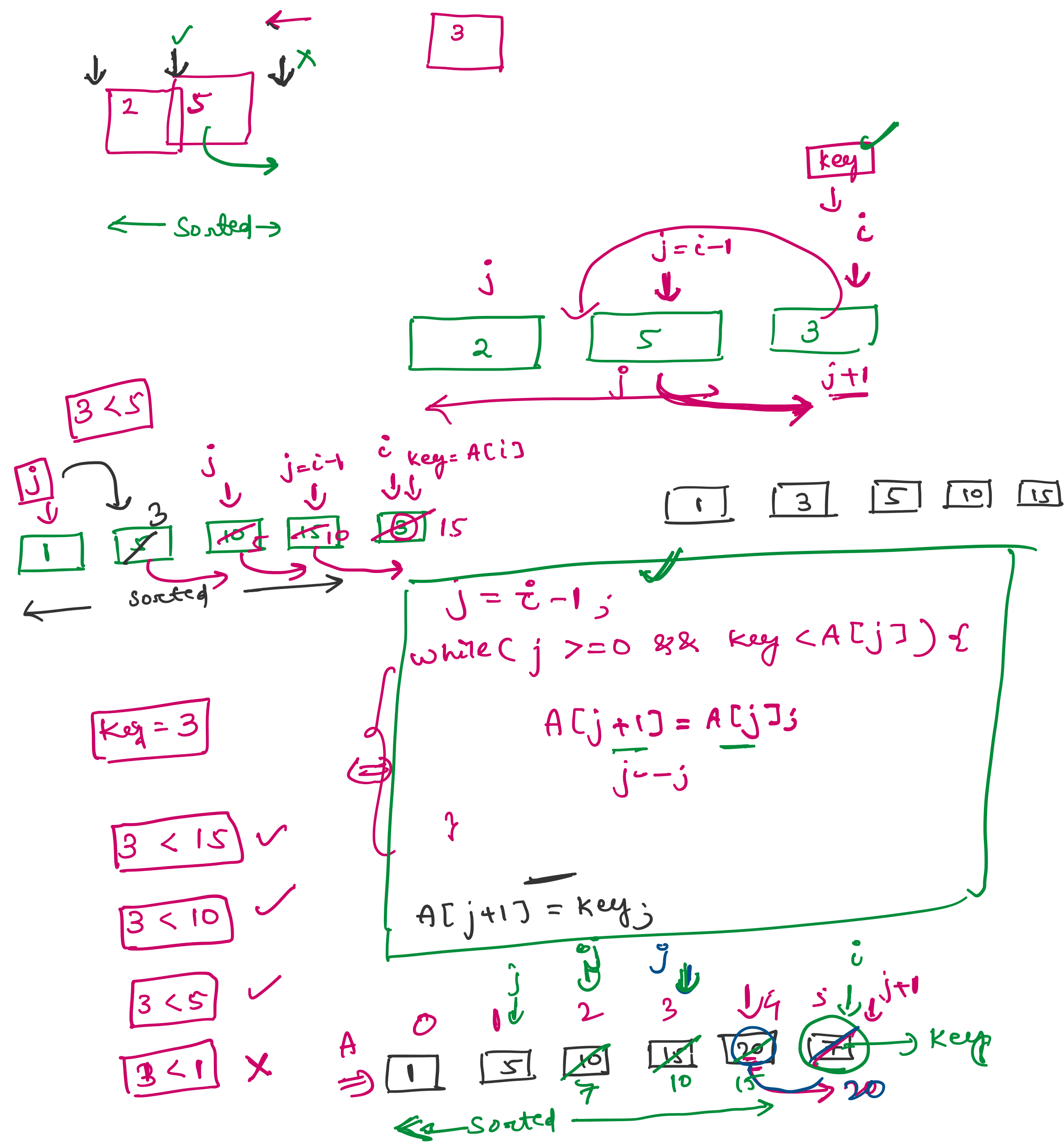


Insertion Sort

↳ Playing Cards in your hands



$A[j+1] = A[j]$

$15 > 7$ ✓

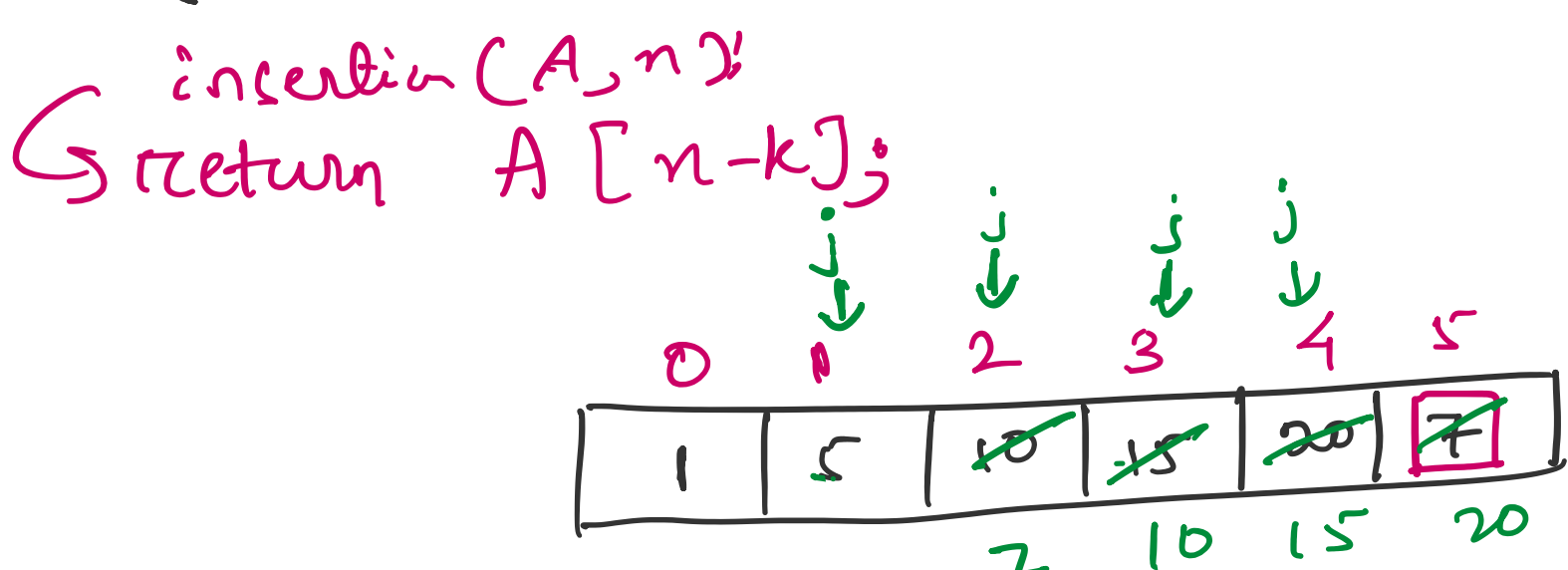
$A[4] = A[3]$

$10 > 7$

$T.C = O(n^2)$
 $S.C = O(1)$

$O(n)$

```
insertion(A, n) {  
  for(i=1; i<n; i++) {  
    let key = A[i];  
    j = i-1;  
    while(j >= 0 & A[j] > key) {  
      A[j+1] = A[j];  
      j--;  
    }  
    A[j+1] = key;  
  }  
}
```

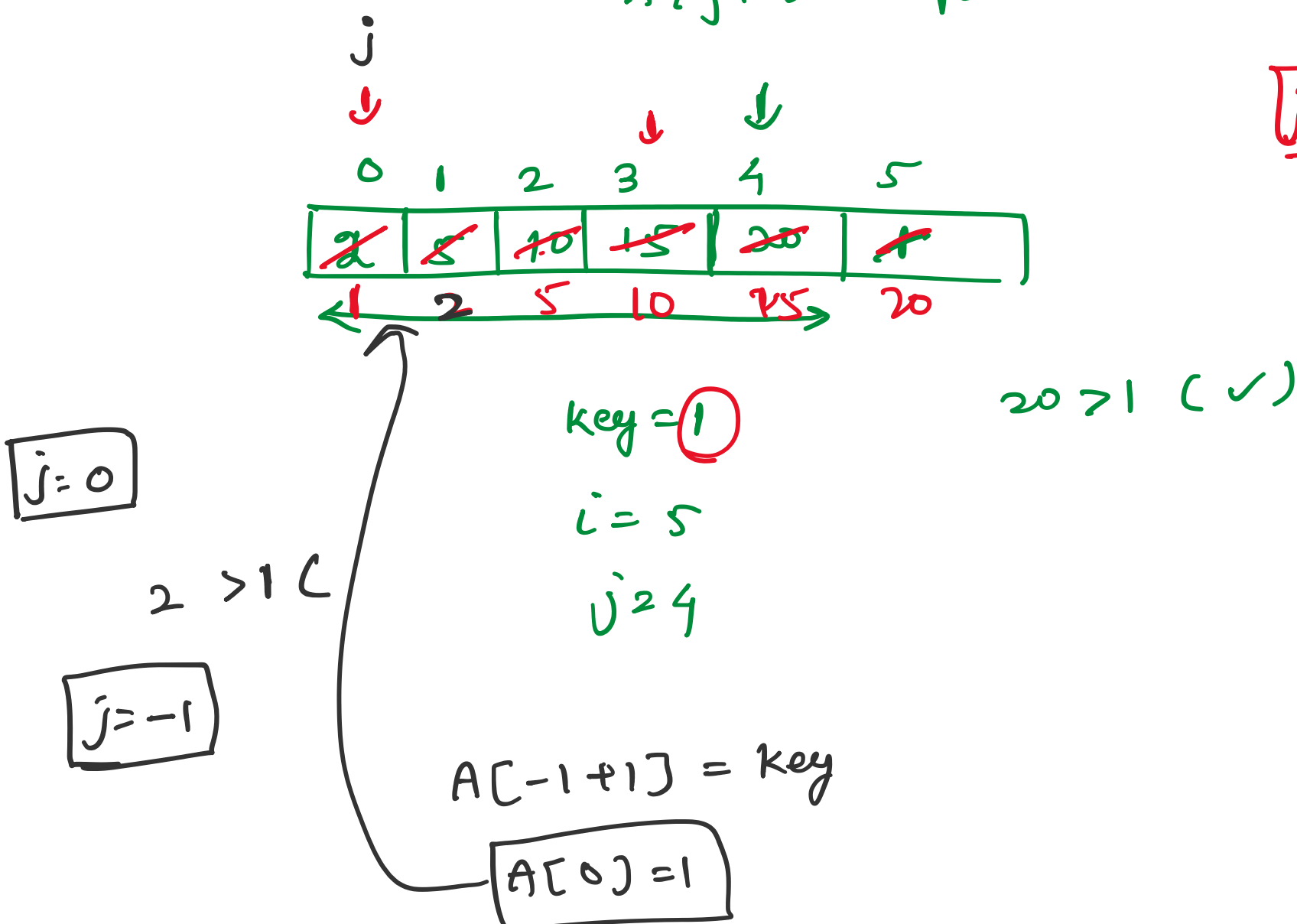


$key = 7$

$i = 5$

$j = i-1 = 4$

$A[j+1] = key$



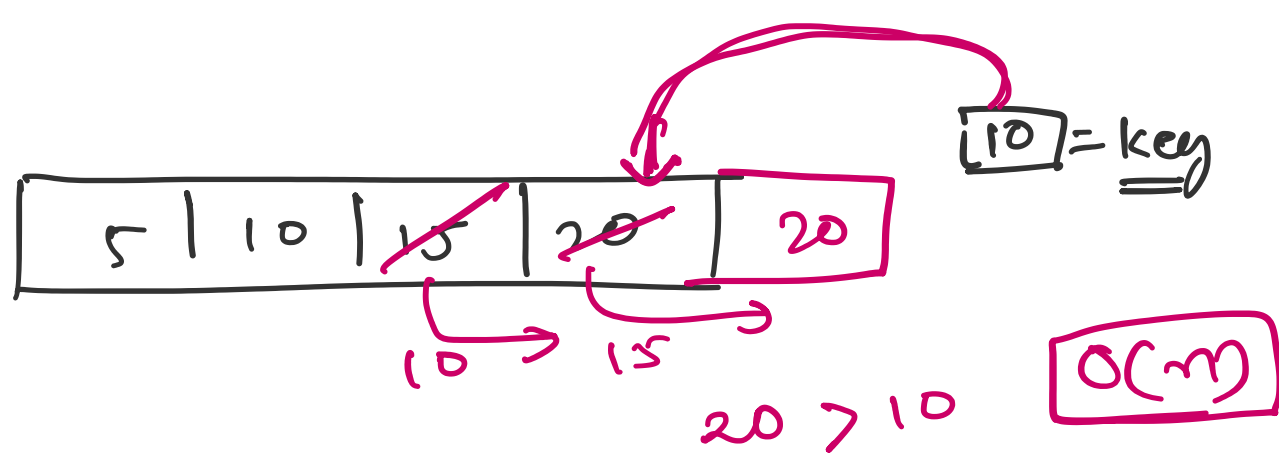
$j = 0$

$2 > 1$

$j = -1$

$A[-1+1] = key$

$A[0] = 1$



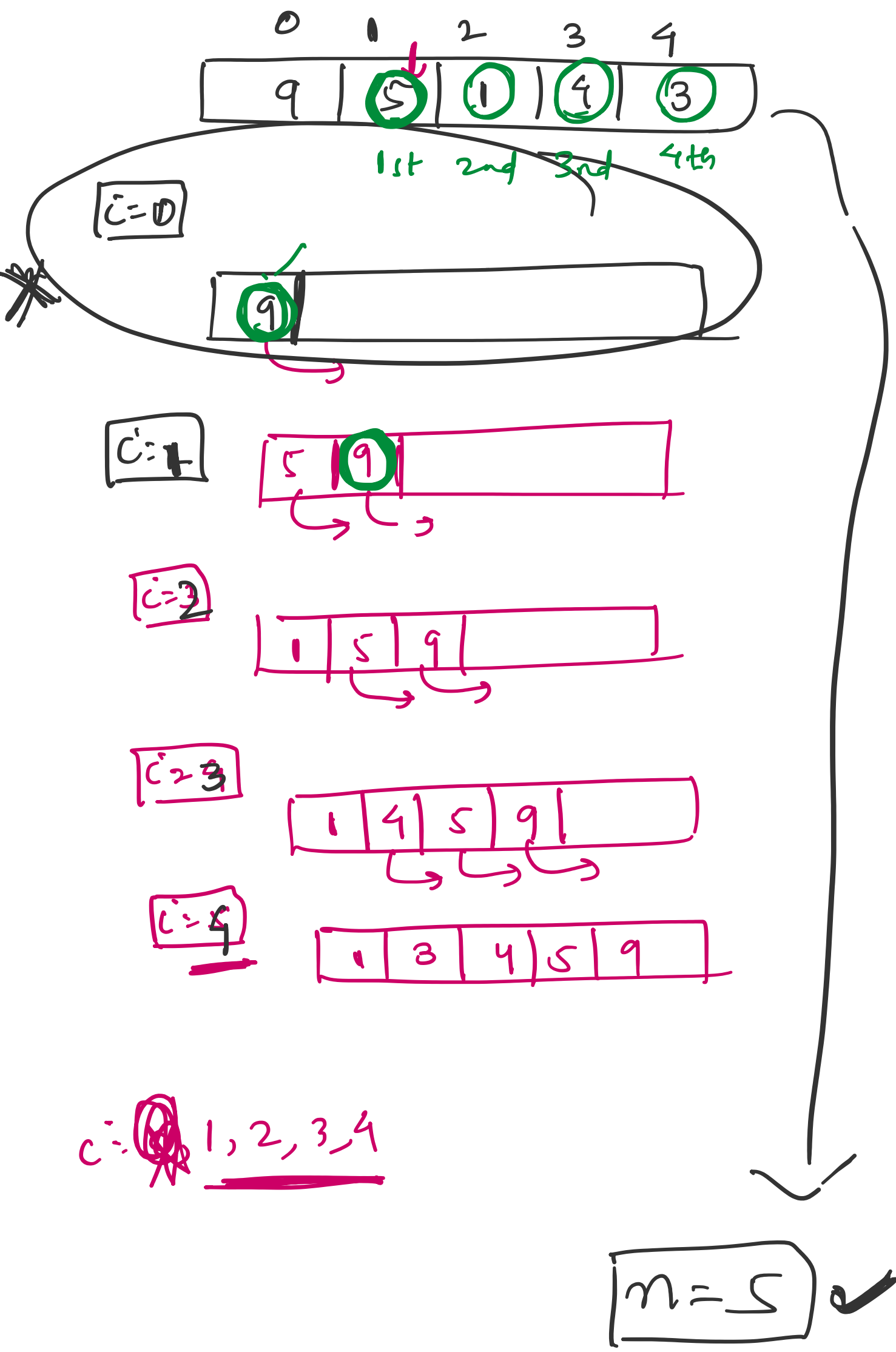
$10 = key$
 $10 > 10$ $O(n)$

$O(n^2)$ \leftarrow $\left. \begin{array}{l} arr.push(10); \\ bubbleSort(arr); \end{array} \right\}$

$key = 7$

$20 > 7$

$A[5] = A[4]$



$i = 1, 2, 3, 4$

$n = 5$ ✓

$i = 1, 2, 3, 4$ \uparrow $4 < 5$

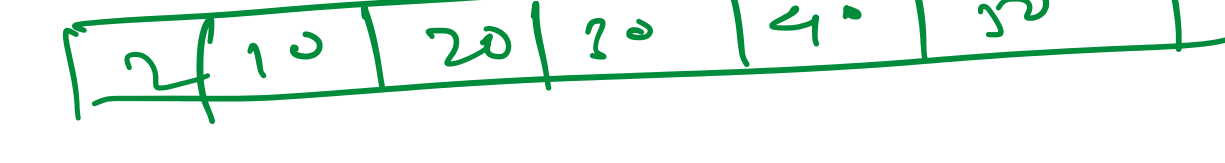
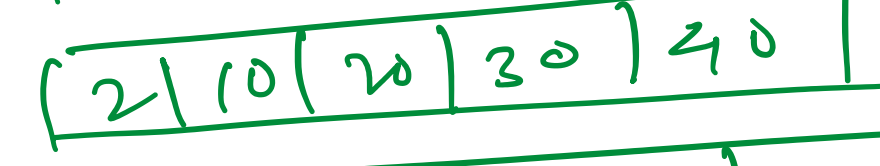
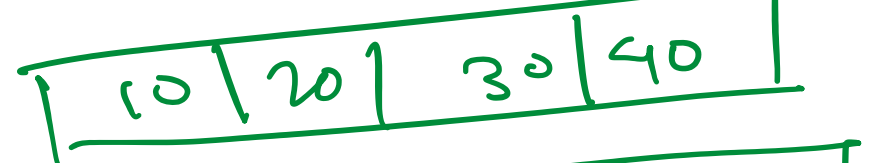
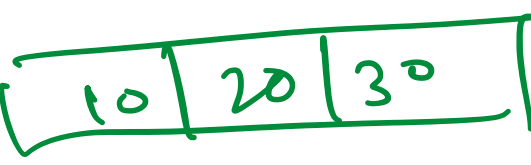
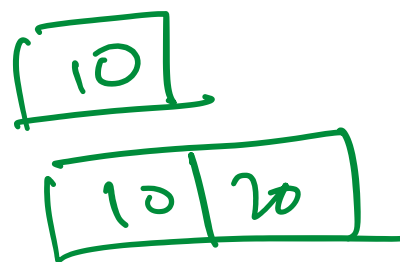
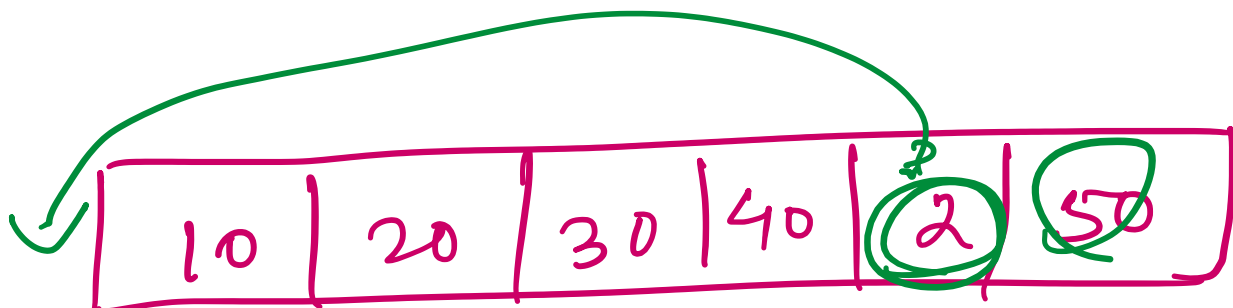
$20 > 7$ (✓)

$15 > 7$ (✓)

$10 > 7$ (✓)

$5 > 7$ (✗)

$j >= 0$



Best Case

↳ Array is already sorted

↓

$T.C = O(n)$

$S.C = O(1)$

Average Case / Worst Case:

$T.C = O(n^2)$

$S.C = O(1)$