Merge Sorted Arrays (with Extra Space)

A1: 2 4 5 7 8 — O(N)

A2: 1 3 6 9 10 11 12 — O(M)

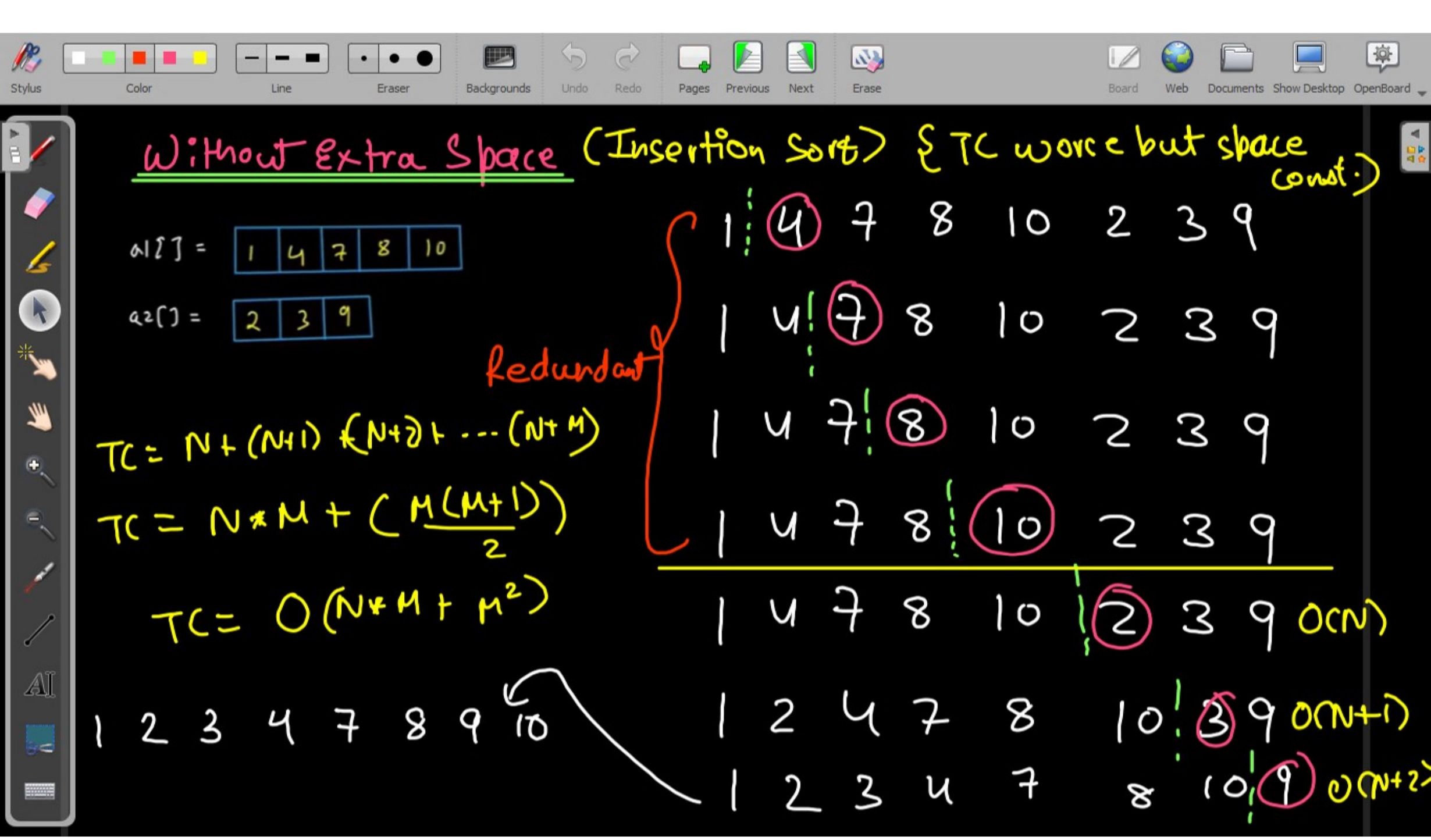
ans = 1 2 3 4 5 6 7 8 9 10 11 12

TC = O(N+M)

SC = O(N+M)

Code With Extra Space

```
class Solution {
    public void merge(int[] nums1, int m, int[] nums2, int n) {
        int[] c = new int[n + m];

        int i = 0;
        int j = 0;
        int k = 0;

        while(i < m && j < n) {
            if(nums1[i] < nums2[j]) {
                c[k++] = nums1[i++];
            } else {
                c[k++] = nums2[j++];
            }
        }

        while(i < m) {
            c[k++] = nums1[i++];
        }

        while(j < nums2.length) {
            c[k++] = nums2[j++];
        }

        for(int x=0;x<c.length;x++) {
            nums1[x] = c[x];
        }
```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Without Extra Space (Insertion Sort) { TC worse but space const.)
a1[] = 1 4 7 8 10
a2[] = 2 3 9
Redundant
TC = N + (N+1) + (N+2) + ... (N+M)
TC = N*M + (M(M+1))/2
TC = O(N*M + M^2)
1 2 3 4 7 8 9 10
1 4 7 8 10 2 3 9
1 4 7 8 10 2 3 9
1 4 7 8 10 2 3 9
1 4 7 8 10 2 3 9
1 4 7 8 10 2 3 9 O(N)
1 2 4 7 8 10 3 9 O(N+1)
1 2 3 4 7 8 10 9 O(N+2)

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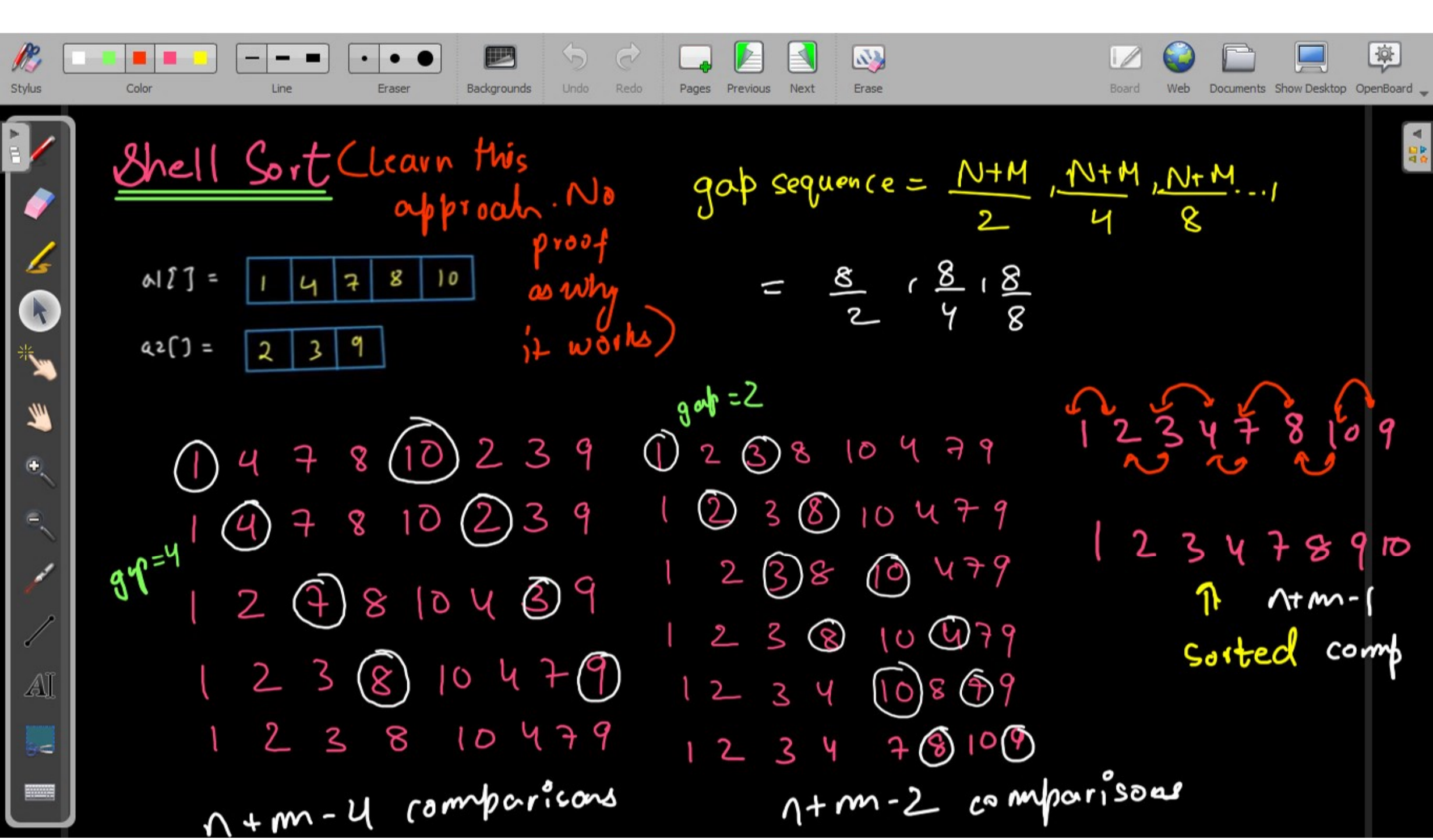
Code for Insertion Sort Approach (constant space)

```java
class Solution {

    private void swap(int[] arr, int i, int j) {
        int temp = arr[i];
        arr[i] = arr[j];
        arr[j] = temp;
    }

    public void merge(int[] nums1, int m, int[] nums2, int n) {
        for(int i=m;i<m+n;i++) {
            nums1[i] = nums2[i - m];
        }

        for(int i=m;i<m+n;i++) {
            for(int j=i;j>0;j--) {
                if(nums1[j] < nums1[j-1]) {
                    swap(nums1,j,j-1);
                } else {
                    break;
                }
            }
        }
    }
}
```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Shell Sort (learn this approach. No proof as why it works)
a1[] = 1 4 7 8 10
a2[] = 2 3 9
gap sequence = N+M/2 , N+M/4 , N+M/8 ...1
= 8/2 , 8/4 , 8/8
gap=4
1 4 7 8 10 2 3 9
1 4 7 8 10 2 3 9
1 2 7 8 10 4 3 9
1 2 3 8 10 4 7 9
1 2 3 8 10 4 7 9
n+m-4 comparisons
gap=2
1 2 3 8 10 4 7 9
1 2 3 8 10 4 7 9
1 2 3 8 10 4 7 9
1 2 3 8 10 4 7 9
1 2 3 4 10 8 7 9
1 2 3 4 7 8 10 9
n+m-2 comparisons
1 2 3 4 7 8 10 9
1 2 3 4 7 8 9 10
n+m-1
Sorted comp

Code using Shell Sort

```
    public void swap(int[] nums, int i, int j) {
        nums[i] = nums[i] ^ nums[j];
        nums[j] = nums[i] ^ nums[j];
        nums[i] = nums[i] ^ nums[j];
    }

    public void merge(int[] nums1, int m, int[] nums2, int n) {
        for(int i=m;i<m+n;i++) {
            nums1[i] = nums2[i-m];
        }

        for(int gap = (m + n + 1)/2;gap >= 1;gap = gap / 2) {
            for(int i=0,j=i+gap;j<m+n;i++,j++) {
                if(nums1[i] > nums1[j]) {
                    swap(nums1,i,j);
                }
            }
        }

        for(int i=0,j=1;j<m+n;i++,j++) {
            if(nums1[i] > nums1[j]) {
                swap(nums1,i,j);
            }
        }
    }
```

swap using XOR

a = a^b
b = a^b
a = a^b

More proper code

```
public void merge(int[] nums1, int m, int[] nums2, int n) {
    for(int i = m; i < m+n; i++){
        nums1[i] = nums2[i - m];
    }

    for(double gap = (m + n) / 2.0; gap > 0; gap = gap/2.0){
        int jStart = (int)Math.ceil(gap);
        for(int i=0, j=jStart; j<m+n; i++, j++){
            if(nums1[i] > nums1[j]){
                swap(nums1, i, j);
            }
        }
        if(jStart == 1) break;
    }
}
```

→ 1 Gap k liye chalana padega roz ho sakta hai end me gap 1 na a ya ha ho.

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```java
public void merge(int[] nums1, int m, int[] nums2, int n) {
    for(int i = m; i < m+n; i++){
        nums1[i] = nums2[i - m];
    }

    for(double gap = (m + n) / 2.0; gap > 0; gap = gap/2.0){
        int jStart = (int)Math.ceil(gap);
        for(int i=0, j=jStart; j<m+n; i++, j++){
            if(nums1[i] > nums1[j]){
                swap(nums1, i, j);
            }
        }
        if(jStart == 1) break;
    }
}
```

$gap = \frac{N}{2}$ $N - \frac{N}{2}$

$\frac{N}{4}$ $N - \frac{N}{4}$

$\frac{N}{8}$ $N - \frac{N}{8}$

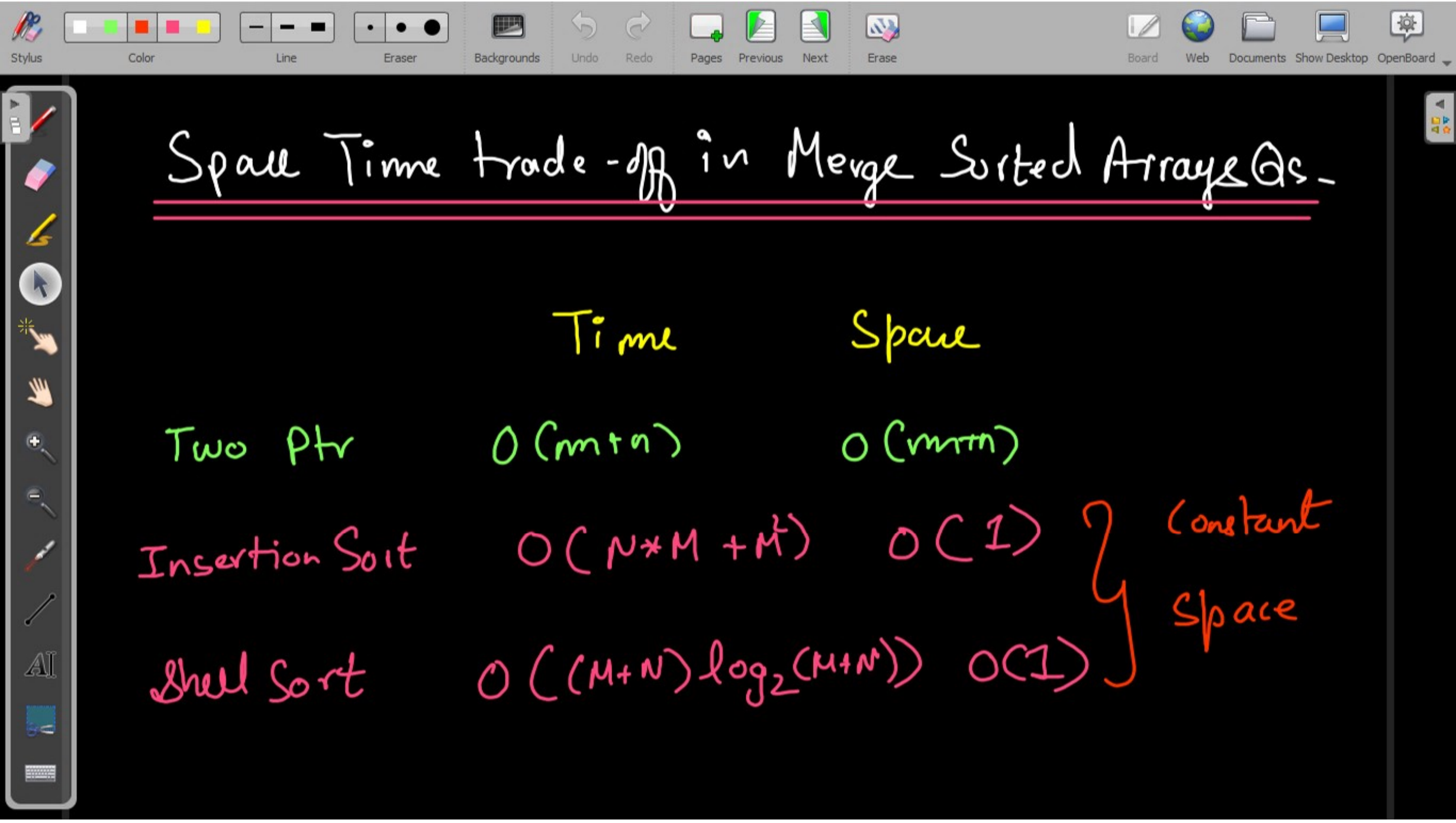
$\vdots$

1 $N-1$

$TC = O(N\log_2 N - N\{\frac{1}{2} + \frac{1}{4} \cdots\})$

$Tc = O(N\log_2 N - 2N)$

$\approx TC = O(N\log_2 N)$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Space Time trade-off in Merge Sorted Arrays Qs.
Time
Space
Two Ptr
O(m+n)
O(m+n)
Insertion Sort
O(N*M + M²)
O(1)
Shell Sort
O((M+N) log₂(M+N))
O(1)
Constant Space

Merge Sort (with extra space) {In Place} & Stable}

mergeSort (arr, 0, 7)

0	1	2	3	4	5	6	7
2	8	4	3	1	7	6	5

mid

2 3 4 8 | 1 5 6 7

merge ⇒ Merge technique should be O(1) space technique.

1 2 3 4 5 6 7 8

Code for MergeSort (In-Place) with Extra Space-

```java
public void mergeSort(int[] nums,int lo, int hi) {

    if(lo >= hi) {
        return;
    }

    int mid = (lo + hi) /2;
    //sort the left part
    mergeSort(nums,lo,mid);
    //sort the right part
    mergeSort(nums,mid + 1, hi);

    //merge the sorted parts in place
    merge(nums,lo,mid,mid+1,hi);
}
```

```java
public int[] sortArray(int[] nums) {
    mergeSort(nums,0,nums.length-1);
    return nums;
}
```


```java
public int[] sortArray(int[] nums) {
    mergeSort(nums,0,nums.length-1);
    return nums;
}
```

Time complexity

$$T(n) = T(n/2) + T(n/2) + O\underbrace{\left(\frac{N}{2} + \frac{N}{2}\right)}_{\text{merging}}$$

$x = \log_2 N$

$$T(n) = 2T(n/2) + O\left(\frac{N}{2} + \frac{N}{2}\right)$$

$$2T(n/2) = 2^2 T(n/4) + 2O\left(\frac{N}{4} + \frac{N}{4}\right)$$

$$2^2 T(n/4) = 2^3 T(n/8) + 2^2 O\left(\frac{N}{8} + \frac{N}{8}\right)$$

$$\vdots$$

$$2^x T(1) = 2T(0) + O(1)$$

$$T(n) = O(N) + 2 * O\left(\frac{N}{2}\right) + 2^2 * O\left(\frac{N}{4}\right) + \cdots 2^x * O(1)$$

$O(N * \log_2 N)$

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Time Complexity without Extra Space (Shell sort)

$O(N \log_2^2 N)$

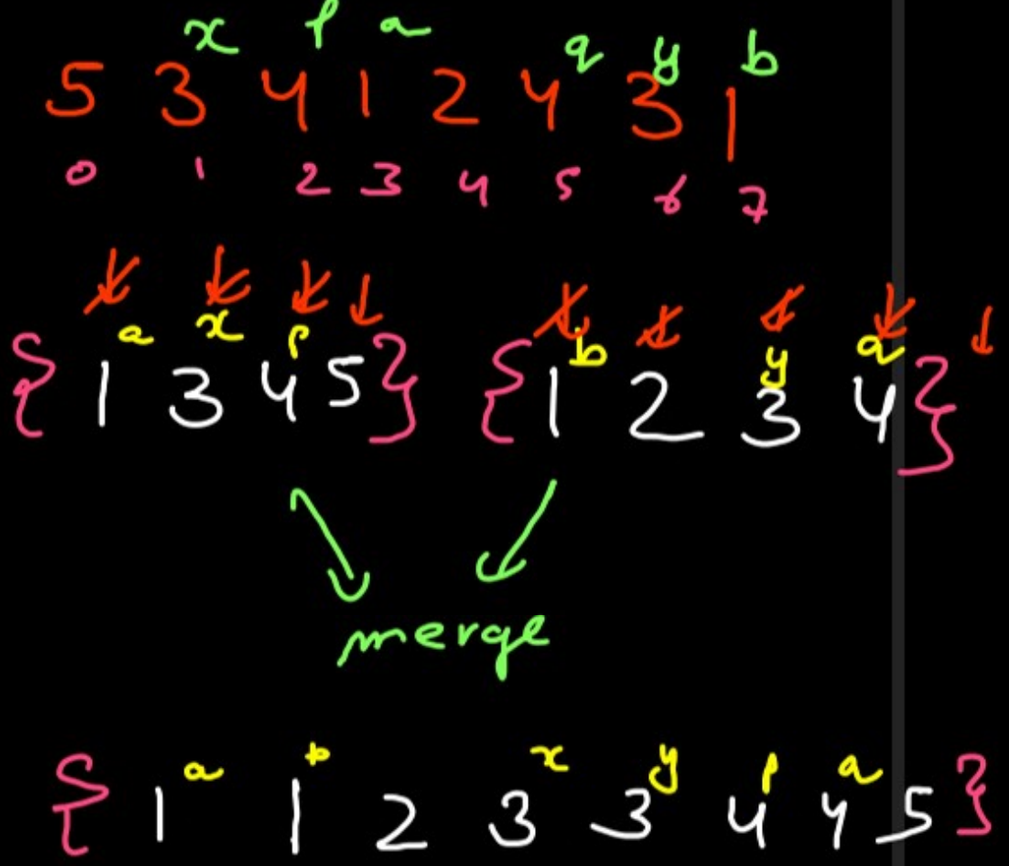
#RR

$$T(n) = 2T(n/2) + O(N \log_2 N)$$

Merge Sort is Stable

```java
public void merge(int[] nums, int a1l, int a1h, int a2l, int a2h) {
    int size = (a1h-a1l+1) + (a2h-a2l+1);
    int[] res = new int[size];
    int i=a1l,j=a2l,k=0;

    while(i <= a1h && j<= a2h) {
        if(nums[i] <= nums[j]) {
            res[k++] = nums[i++];
        } else {
            res[k++] = nums[j++];
        }
    }

    while(i<= a1h) {
        res[k++] = nums[i++];
    }

    while(j<= a2h) {
        res[k++] = nums[j++];
    }

    for(int x=a1l;x<=a2h;x++) {
        nums[x] = res[x-a1l];
    }
}
```

Stable coz of this line.



Quick Sort { Partition an Array }

4 5 9 6 4 2 8 1 6 9 3 6 4

l r

4 2 1 5 9 6 5 9

3 4

pi = left - 1

4 4 2 1 3 4 8 6 6 9 5 6 9

<= pivot > pivot

0 to l-1 → ≤ pivot

l to r-1 → > pivot

r to N → unexplored

```
if(arr[right] > pivot)
    right++
else {
    swap(arr[left], arr[right])
    left++;
    right++;
}
```

variations

→ -ve, +ve

→ 0, 1

→ 3ven, non-3ven

→ odd, even

→ <=pivot, >pivot

DNf Sort / Sort 012/ Three Way Partitioning

// travel using j pointer

```
if (arr[j] == 0)
{ swap(i,j);
  i++; j++;
}
else if(arr[j] == 1)
{
  j++;
}
else {
  swap(j,k);
  k--;
}
```

Inversion Count {Count Inversion}

count the No of pairs (i,j) such that i<j and a[i] > a[j].

Brute force : $O(N^2)$

(8,5) (8,3) (8,4) (8,1) (8,6) (8,2)

(5,3) (5,4) (5,1) (5,2)

(3,1) (3,2)

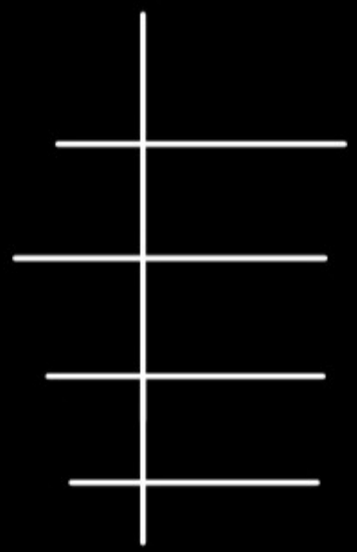
(4,1) (4,2)

(6,2)

Ans = 15

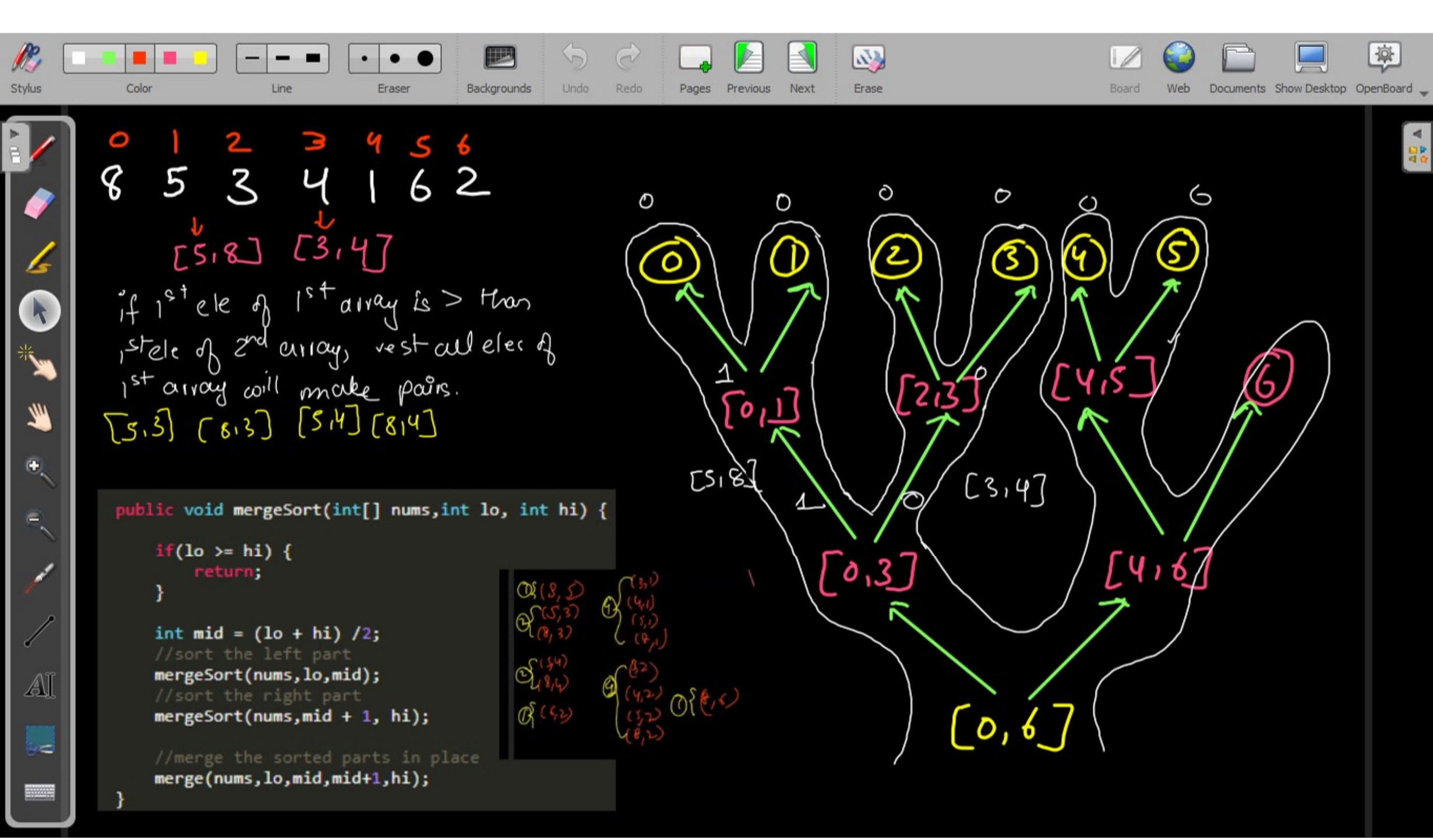
The Qs is to return the count only.

There are various optimizations possible for this DS.



- Merge Sort ✓
- fenwick Tree
- Policy Based DS (ordered set + Indexing)
- Self Balancing BST (Red Black Tree)

We are studying using MS.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0 1 2 3 4 5 6
8 5 3 4 1 6 2
[5,8] [3,4]
if 1st ele of 1st array is > than 1st ele of 2nd array, rest all elec of 1st array will make pairs.
[5,3] [8,3] [5,4] [8,4]
[0,1] [2,3] [4,5] 6
[5,8] [3,4]
[0,3] [4,6]
[0,6]
public void mergeSort(int[] nums,int lo, int hi) {
if(lo >= hi) {
return;
}
int mid = (lo + hi) /2;
//sort the left part
mergeSort(nums,lo,mid);
//sort the right part
mergeSort(nums,mid + 1, hi);
//merge the sorted parts in place
merge(nums,lo,mid,mid+1,hi);
}

Code for Inversion Count

```java
public static long mergeSort(long[] nums,int lo, int hi) {

    if(lo >= hi) {
        return 0l;
    }

    int mid = (lo + hi) /2;
    //sort the left part
    long left = mergeSort(nums,lo,mid);
    //sort the right part
    long right = mergeSort(nums,mid + 1, hi);

    //merge the sorted parts in place
    long ans = merge(nums,lo,mid,mid+1,hi);

    return left + right + ans;
}
```

```java
static long inversionCount(long arr[], long N)
{
    return mergeSort(arr,0,(int)N-1);
}
```

```java
public static long merge(long[] nums, int a1l, int a1h, int a2l, int a2h) {
    int size = (int)(a1h-a1l+1l) + (int)(a2h-a2l+1l);
    long[] res = new long[size];
    int i=a1l,j=a2l,k=0;

    long invCount = 0l;
    while(i <= a1h && j<= a2h) {
        if(nums[i] <= nums[j]) {
            res[k++] = nums[i++];
        } else {
            res[k++] = nums[j++];
            invCount += (a1h - i + 1l);
        }
    }

    while(i<= a1h) {
        res[k++] = nums[i++];
    }

    while(j<= a2h) {
        res[k++] = nums[j++];
    }

    for(int x=a1l;x<=a2h;x++) {
        nums[x] = res[x-a1l];
    }

    return invCount;
}
```

→ 1st array k Saare rem element.

Reverse Pairs (leetcode Hard : 493)

$i < j, \quad a[i] > 2 * a[j]$

0	1	2	3	4	5	6
40	25	19	12	9	6	2

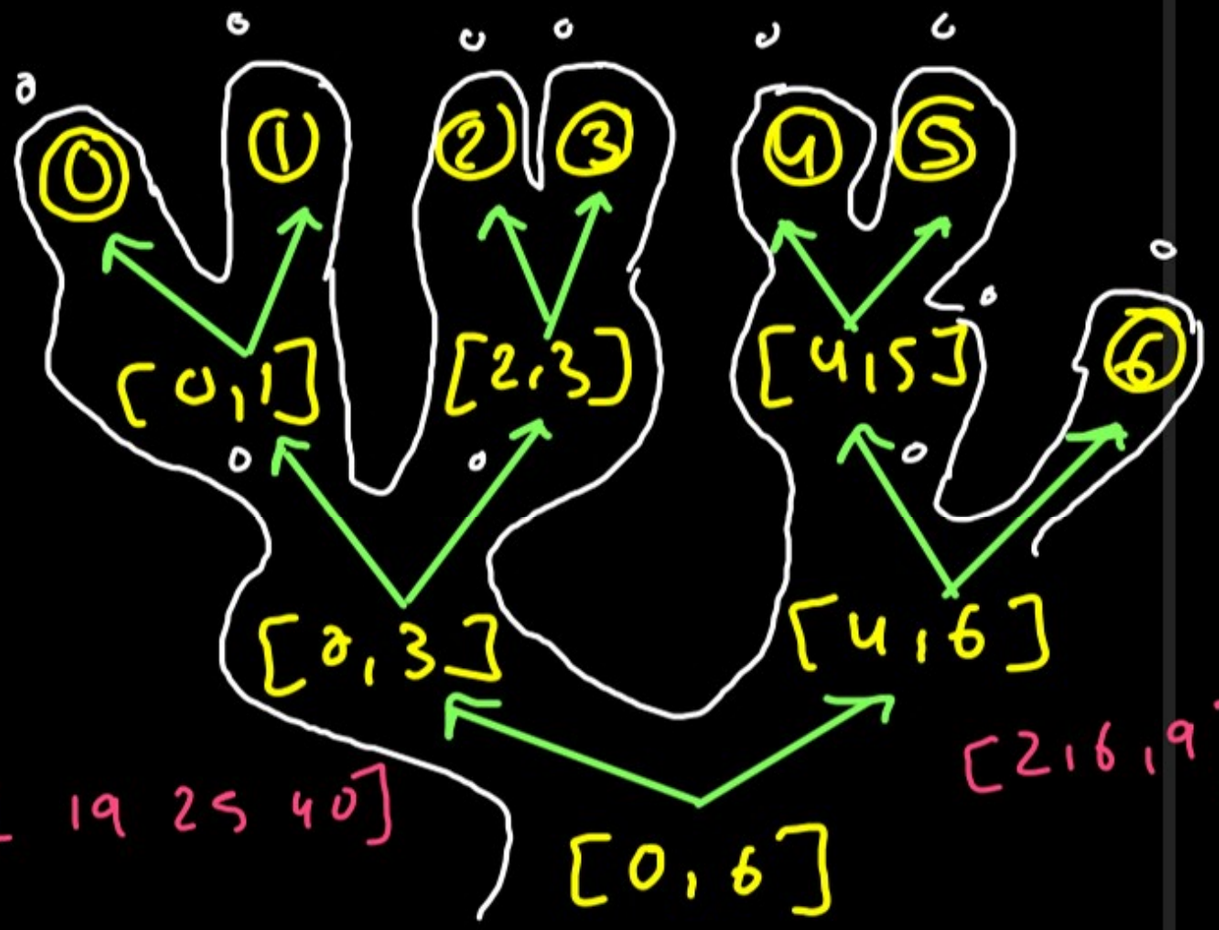
[12,19,25,40] [2,6,9]

{4, 12, 18}

[12,2] [19,2] [25,2] [40,2]

[19,6] [25,6] [40,6]

[19,9] [25,9] [40,9]



Why should we merge & count the reverse pairs seperately?

⇒ If we do merging and counting simultaneously:

{25, 40} {12, 19}

[12]

+2 (25, 12) (40, 12)

{25, 40} {12, 19}

No pair added However {40, 19}

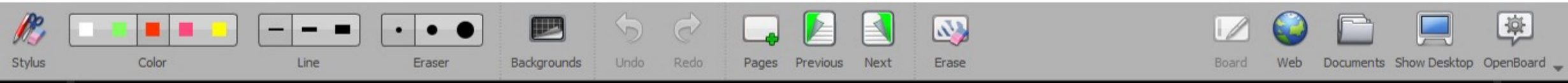
[12, 19]

Because while merging we only see a[i] > a[j] & not a[i] > 2 * a[j]

Now only merging will occur

{25, 40}

[12, 19, 25, 40] → (40, 19) pair was missed



```java
public int mergeSort(int[] nums,int lo, int hi) {

    if(lo >= hi) {
        return 0;
    }

    int mid = (lo + hi) /2;
    //sort the left part
    int left = mergeSort(nums,lo,mid);
    //sort the right part
    int right = mergeSort(nums,mid + 1, hi);

    //merge the sorted parts in place
    int ans = merge(nums,lo,mid,mid+1,hi);

     return left + right + ans;
}
```

```java
public int findInversionCount(int[] nums, int a1l, int a1h, int a2l, int a2h) {
    int invCount = 0;
    int i=a1l,j=a2l,k=0;
    while(i <= a1h && j<= a2h) {
        if((long)nums[i] <= 2l* (long)nums[j]) {
            k++;i++;
        } else {
            invCount += (a1h - i + 1);
            k++;j++;
        }
    }
    return invCount;
}
```

```java
public int merge(int[] nums, int a1l, int a1h, int a2l, int a2h) {
    int size = (a1h-a1l+1) + (a2h-a2l+1);
    int[] res = new int[size];

    int invCount = findInversionCount(nums,a1l,a1h,a2l,a2h);

    int i=a1l,j=a2l,k=0;

    while(i <= a1h && j<= a2h) {
        if(nums[i] <= nums[j]) {
            res[k++] = nums[i++];
        } else {
            res[k++] = nums[j++];
        }
    }

    while(i<= a1h) {
        res[k++] = nums[i++];
    }

    while(j<= a2h) {
        res[k++] = nums[j++];
    }

    for(int x=a1l;x<=a2h;x++) {
        nums[x] = res[x-a1l];
    }

    return invCount;
}
```

```java
public int reversePairs(int[] nums) {
    return mergeSort(nums,0,nums.length - 1);
}
```

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Count Winning Streaks (NADOS)

{LC 2031 count subarrays with more 1s than 0s} {Premium}

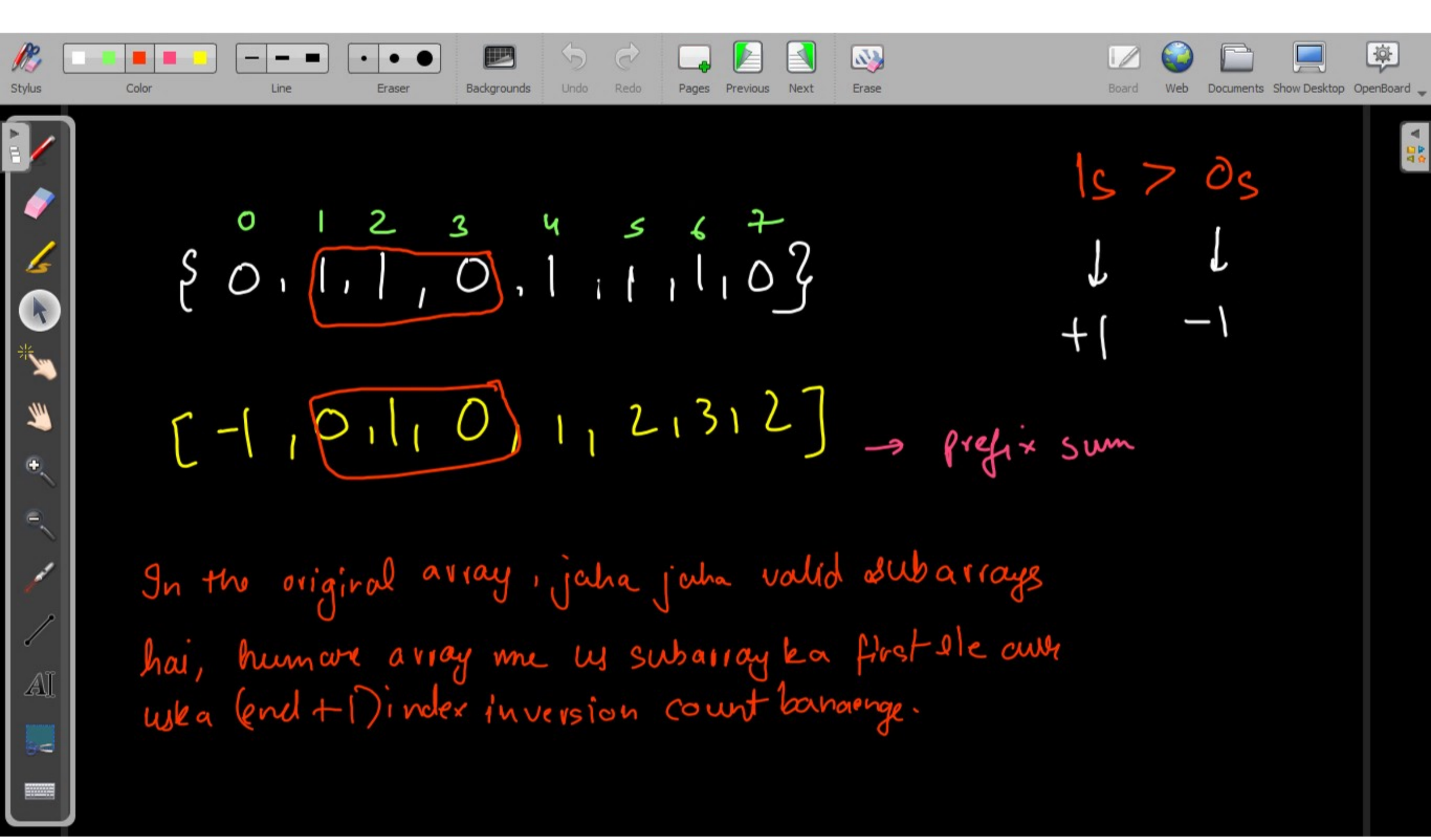
0 1 2 3 4 5 6 7

{0, 1, 1, 0, 1, 0, 1, 0}

```java
public static int winningStreak(int[] arr){
    int ans = 0;

    for(int st=0;st<arr.length;st++) {
        int countOf0s = 0, countOf1s = 0;
        for(int end=st;end < arr.length;end++) {
            if(arr[end] == 0) {
                countOf0s++;
            } else {
                countOf1s++;
            }

            if(countOf1s > countOf0s) {
                ans++;
            }
        }
    }

    return ans;
}
```

$O(N^2)$ approach

Gives TLE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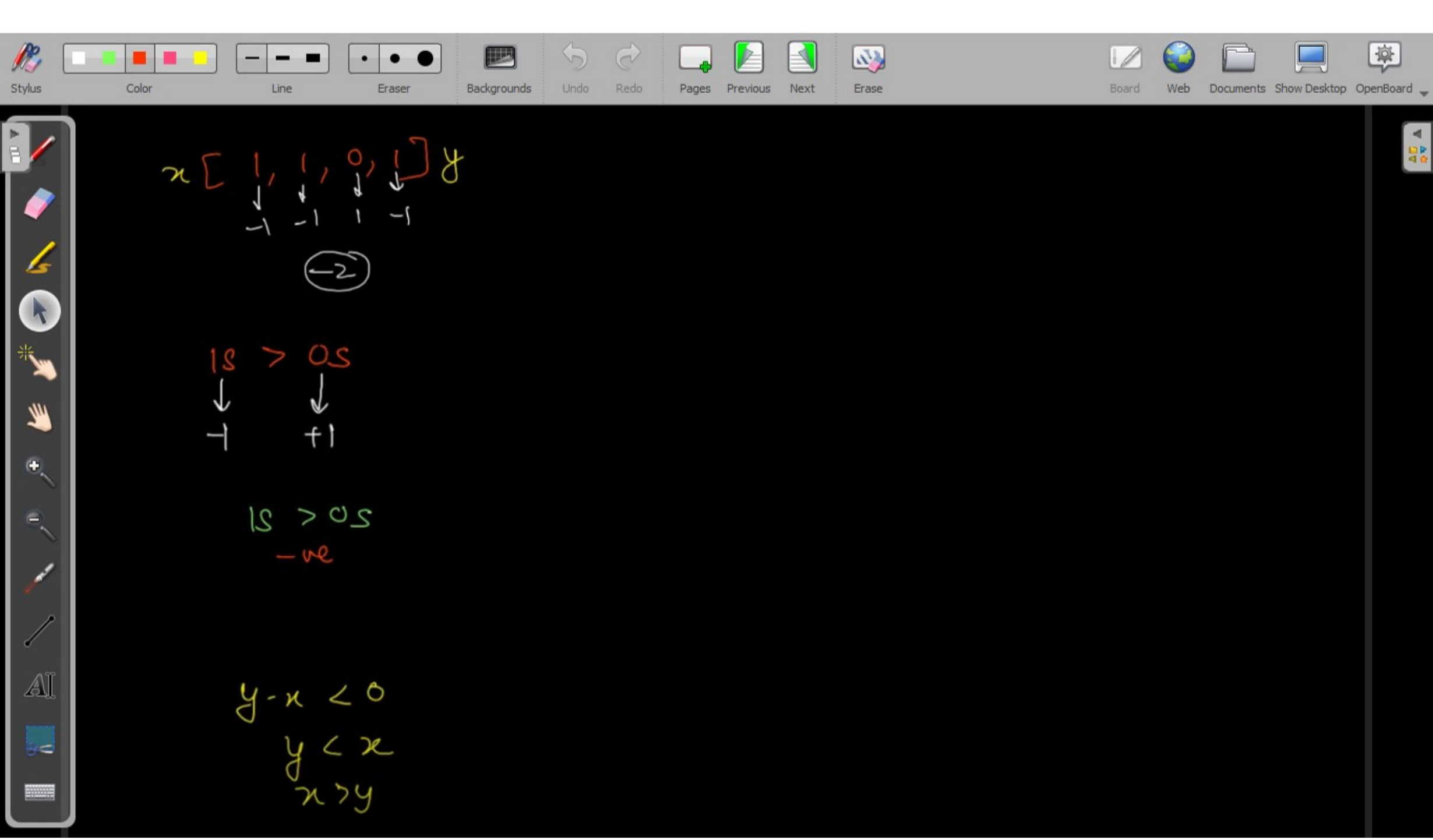
0 1 2 3 4 5 6 7
{0, 1, 1, 0, 1, 1, 1, 0}
1s > 0s
+1
-1
[-1, 0, 1, 0, 1, 2, 3, 2]
→ prefix sum
In the original array, jaha jaha valid subarrays
hai, humare array me us subarray ka first ele
uska (end+1) index inversion count banaenge.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x [1, 1, 0, 1] y
-1 -1 1 -1
-2
1s > 0s
-1
+1
1s > 0s
-ve
y - x < 0
y < x
x > y

Minimum Swaps to Sort (Swapping only adjacent eles)

(MinSwaps II)

Minimum Swaps to Sort

Medium Accuracy: 50.0% Submissions: 89710 Points: 4

Given an array of n distinct elements. Find the minimum number of swaps required to sort the array in strictly increasing order.

{ 8, 5, 3, 4, 1, 6, 2 }

{ 1, 2, 3, 4, 5, 6, 8 }

So, if I want to take 8 to the last pos, I need to swap 8 with all the elements that are greater than 8 and are to its right. (Inversion count for 8)

{8, 5, 3, 4, 1, 6, 2}

↓ After 8 reaches its correct position

{(5, 3, 4, 1, 6, 2) 8}

↓

Ans for 5 is in remaining array. This means that the ans for 5 does not concern 8. This implies (in original array) that $i < j$ { for $a[i] > a[j]$ }.

bubble sort-

Min adjacent swaps to Sort

≡

Inversion Count

```java
public static int merge(int[] nums, int a1l, int a1h, int a2l, int a2h) {
    int size = (int)(a1h-a1l+1l) + (int)(a2h-a2l+1l);
    int[] res = new int[size];
    int i=a1l,j=a2l,k=0;

    int invCount = 0;
    while(i <= a1h && j<= a2h) {
        if(nums[i] <= nums[j]) {
            res[k++] = nums[i++];
        } else {
            res[k++] = nums[j++];
            invCount += (a1h - i + 1l);
        }
    }

    while(i<= a1h) {
        res[k++] = nums[i++];
    }

    while(j<= a2h) {
        res[k++] = nums[j++];
    }

    for(int x=a1l;x<=a2h;x++) {
        nums[x] = res[x-a1l];
    }

    return invCount;
}
```

```java
public static int mergeSort(int[] nums,int lo, int hi) {

    if(lo >= hi) {
        return 0;
    }

    int mid = (lo + hi) /2;
    //sort the left part
    int left = mergeSort(nums,lo,mid);
    //sort the right part
    int right = mergeSort(nums,mid + 1, hi);

    //merge the sorted parts in place
    int ans = merge(nums,lo,mid,mid+1,hi);

    return left + right + ans;
}
```

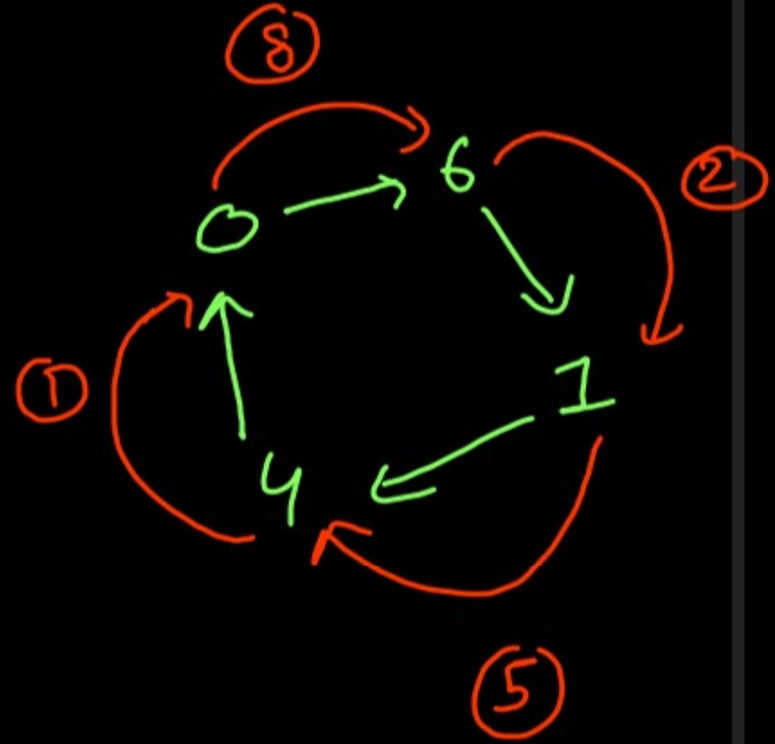
```java
int countSwaps(int nums[], int n) {
    // code here
    return mergeSort(nums,0,n-1);
}
```

Minimum Swaps to Sort -I

0	1	2	3	4	5	6
8	5	3	4	1	6	2

0	1	2	3	4	5	6
1	2	3	4	5	6	8

	src, dest
8	(0, 6)
5	(1, 4)
3	(2, 2)
4	(3, 3)
1	(4, 0)
6	(5, 5)
2	(6, 1)



Min Swaps = 4

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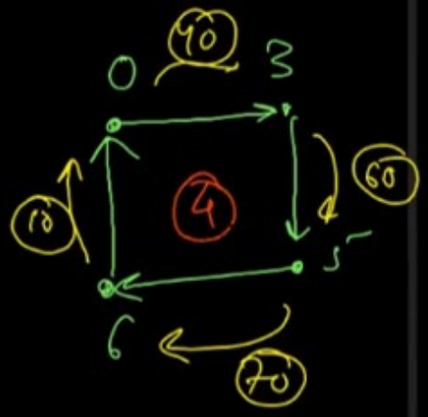
Multiple Cycles are also Possible. (Add all cycles length for ans)

40	50	30	60	20	70	10	80
0	1	2	3	4	5	6	7
10	20	30	40	50	60	70	80



One node cannot be a part of 2 cycles as one node will always have only one incoming & one outgoing edge. (Except self loops)

```java
public static class Pair implements Comparable<Pair>{
    int ele;
    int idx;

    Pair(int ele, int idx) {
        this.ele = ele;
        this.idx = idx;
    }

    public int compareTo(Pair other) {
        return this.ele - other.ele;
    }
}

public int cycleSize(List<Pair> list, int start, boolean[] vis) {
    int res = 0;
    int j = start;

    while(vis[j] == false) {
        vis[j] = true;
        j = list.get(j).idx;
        res++;
    }

    return res - 1;
}
```

```java
    public int minSwaps(int nums[])
    {
        int n = nums.length;
        List<Pair> list = new ArrayList<>();

        for(int i=0;i<n;i++) {
            Pair p = new Pair(nums[i],i);
            list.add(p);
        }

        Collections.sort(list);
        boolean[] vis = new boolean[n];
        int res = 0;
        for(int i=0;i<n;i++) {
            if(vis[i] == false)
                res += cycleSize(list,i,vis);
        }

        return res;
    }
}
```

Count Sort (Without Stability)

9	6	3	5	3	4	3	9	6	4	6	5	8	2	9
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

① 1st iteration → find Max & Min.

0	1	2	3	4	5	6	7
1	1,2,3	1,2	1,2	1,2,3		1	1,2,3
2	3	4	5	6	7	8	9

2nd iteration

0	1	2	3	4	5	6	7
1	3	2	2	3	0	1	3
2	3	4	5	6	7	8	9

2 3 3 3 4 4 5 5 6 6 8 9 9 9

3rd iteration

TC = O(N)

SC = O(max - min + 1)

Bucket Sort

① Characters → Sorting a String

Lower case → 26 buckets

Uppercase → 52 buckets

All ASCII characters → 256 buckets

② Marks → (0, 100)

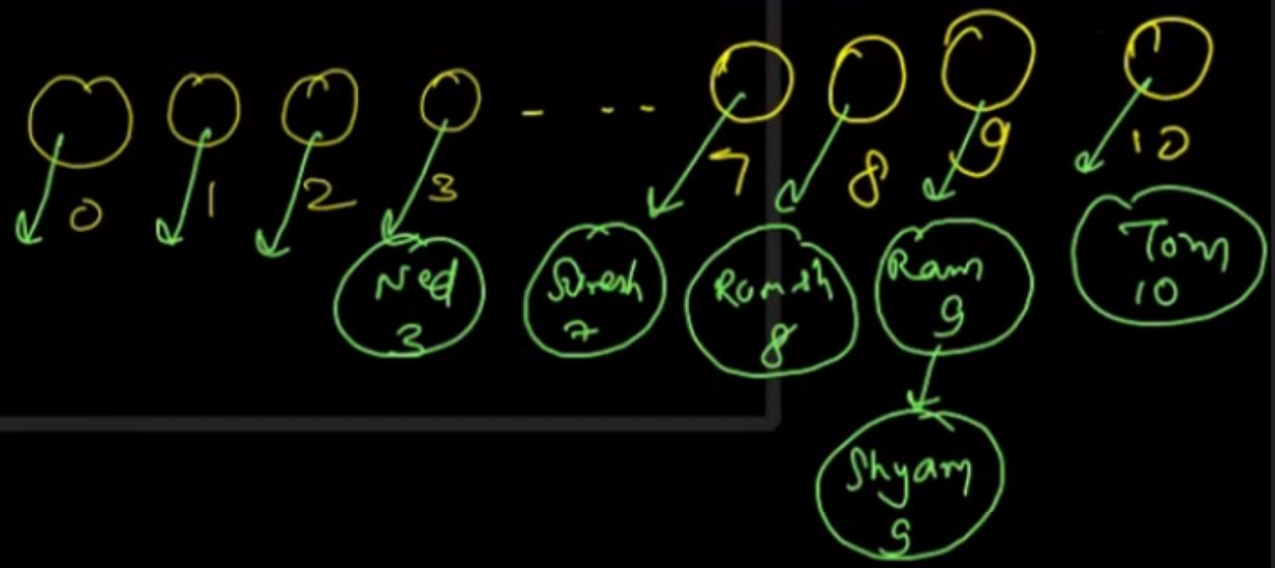
③ Values corresponding to index: Nelements & values are 1 to N or 0 to N-1

HashMap kind of chaining. This is Stable.

(2) Marks → (0, 100)

Ram → 9
Ramesh → 8
Shyam → 9
Suresh → 7

Sorting objects based

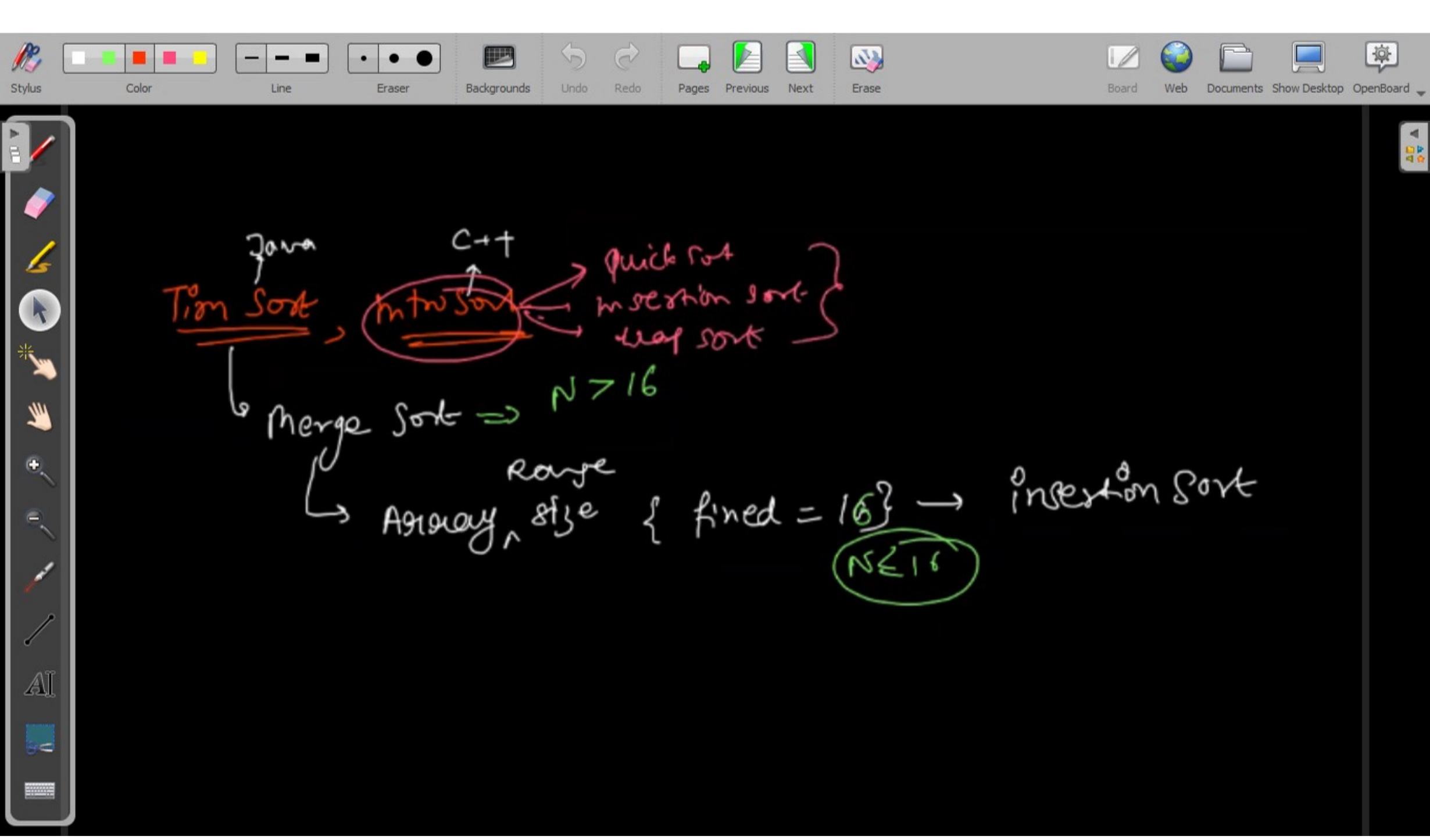


Tom → 10
Ned →

No. of buckets = no of distinct elements

Total space = No of buckets + (N) → No of elements

if N is very greater than No of buckets. SC = O(N)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Tim Sort
Intro Sort
Quick Sort
Insertion Sort
Heap Sort
Merge Sort ⇒ N > 16
Range
Array size { fixed = 16 } → Insertion Sort
N ≤ 16

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451. Sort Characters By Frequency

Medium 4156 181 Add to List Share

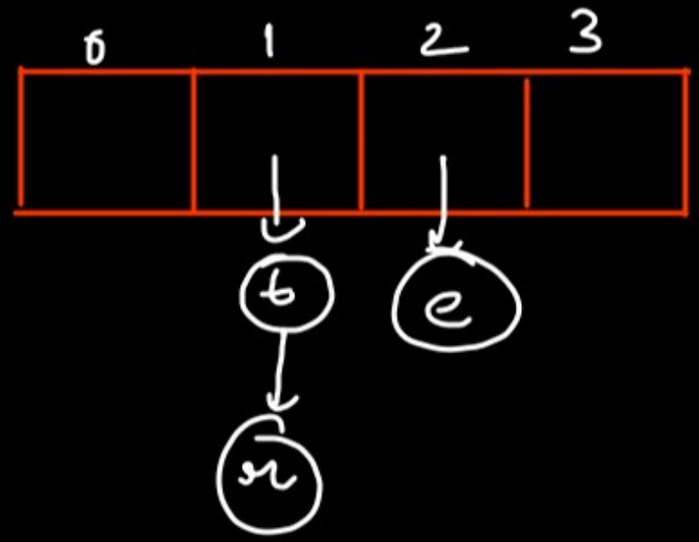
Given a string `s`, sort it in **decreasing order** based on the **frequency** of the characters. The **frequency** of a character is the number of times it appears in the string.

Return *the sorted string*. If there are multiple answers, return *any of them*.

tree

1

make an array of size s.length()+1 as max freq of a character can be s.length() & min 0.



} Now traverse each bucket But traverse this array of buckets in reverse order as we want max freq 1st.

eetr ⇒ Ans.

```java
class Solution {
    public String frequencySort(String s) {
        HashMap<Character,Integer> freq = new HashMap<>();

        for(int i=0;i<s.length();i++) {
            char ch = s.charAt(i);
            int oFreq = freq.getOrDefault(ch,0);
            freq.put(ch, oFreq + 1);
        }

        ArrayList<Character>[] buckets = new ArrayList[s.length() + 1];
        for(int i=0;i<buckets.length;i++) {
            buckets[i] = new ArrayList<>();
        }

        for(Character ch : freq.keySet()) {
            int val = freq.get(ch);
            buckets[val].add(ch);
        }

        StringBuilder sb = new StringBuilder("");
        for(int b=buckets.length-1;b>=0;b--) {
            for(Character ch : buckets[b]) {
                for(int f=0;f<b;f++) {
                    sb.append(ch);
                }
            }
        }

        return sb.toString();
    }
```

1636. Sort Array by Increasing Frequency

Easy 1400 55 Add to List Share

Given an array of integers `nums`, sort the array in **increasing** order based on the frequency of the values. If multiple values have the same frequency, sort them in **decreasing** order.

Return the *sorted array*.

Same as prev ques. Just, the buckets will point to a treeSet instead of ArrayList because of this reason.

TreeSet (Java)
Ordered set (C++)
↳ Self Balancing BST

```java
public int[] frequencySort(int[] nums) {
    HashMap<Integer,Integer> freq = new HashMap<>();
    for(int i=0;i<nums.length;i++) {
        int oFreq = freq.getOrDefault(nums[i],0);
        freq.put(nums[i],oFreq + 1);
    }

    TreeSet<Integer>[] buckets = new TreeSet[nums.length + 1];
    for(int i=0;i<buckets.length;i++) {
        buckets[i] = new TreeSet<>();
    }

    for(Integer x : freq.keySet()) {
        int freqVal = freq.get(x);
        buckets[freqVal].add(x); //x will be added in ordered manner itself
    }

    int[] res = new int[nums.length];
    int idx = 0;

    for(int b=0;b<buckets.length;b++) {
        for(Integer x : buckets[b].descendingSet()) {
            for(int f=0;f<b;f++) {
                res[idx++] = x;
            }
        }
    }

    return res;
}
```

WC TC : $O(N \log_2 N)$

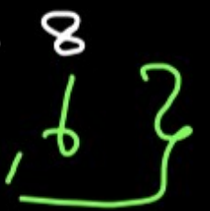
BC TC : $O(N)$

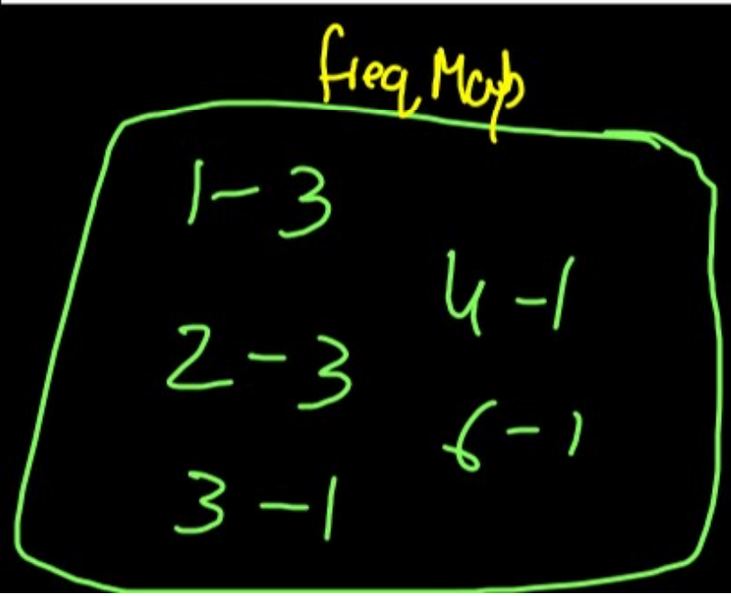
Top K Elements {LC:347}

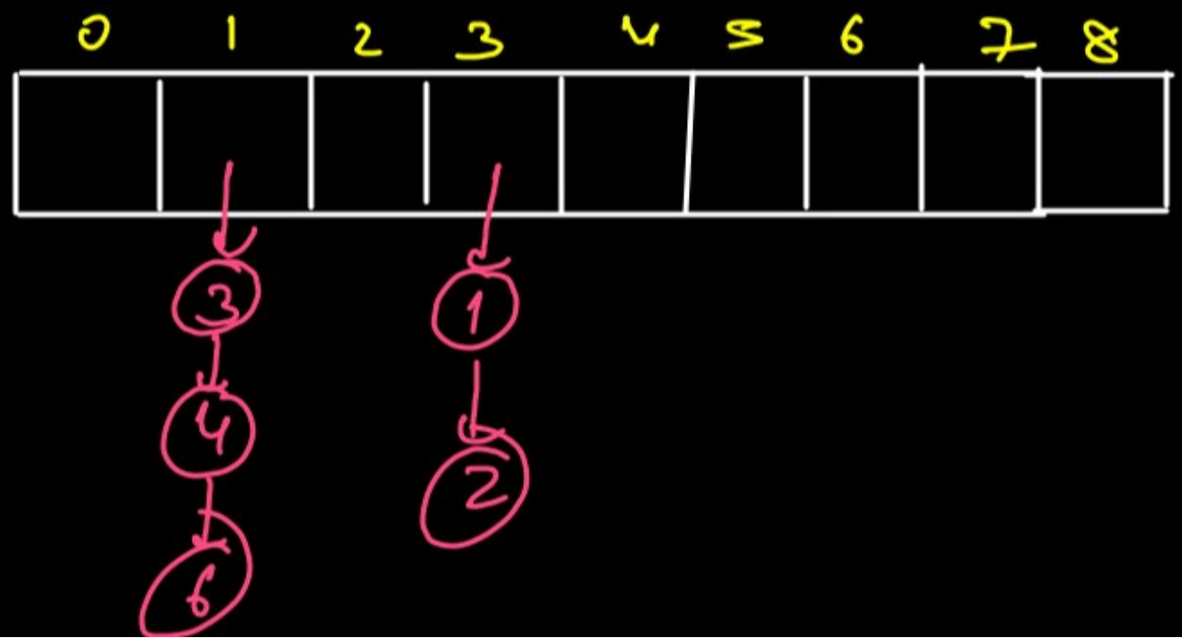
347. Top K Frequent Elements

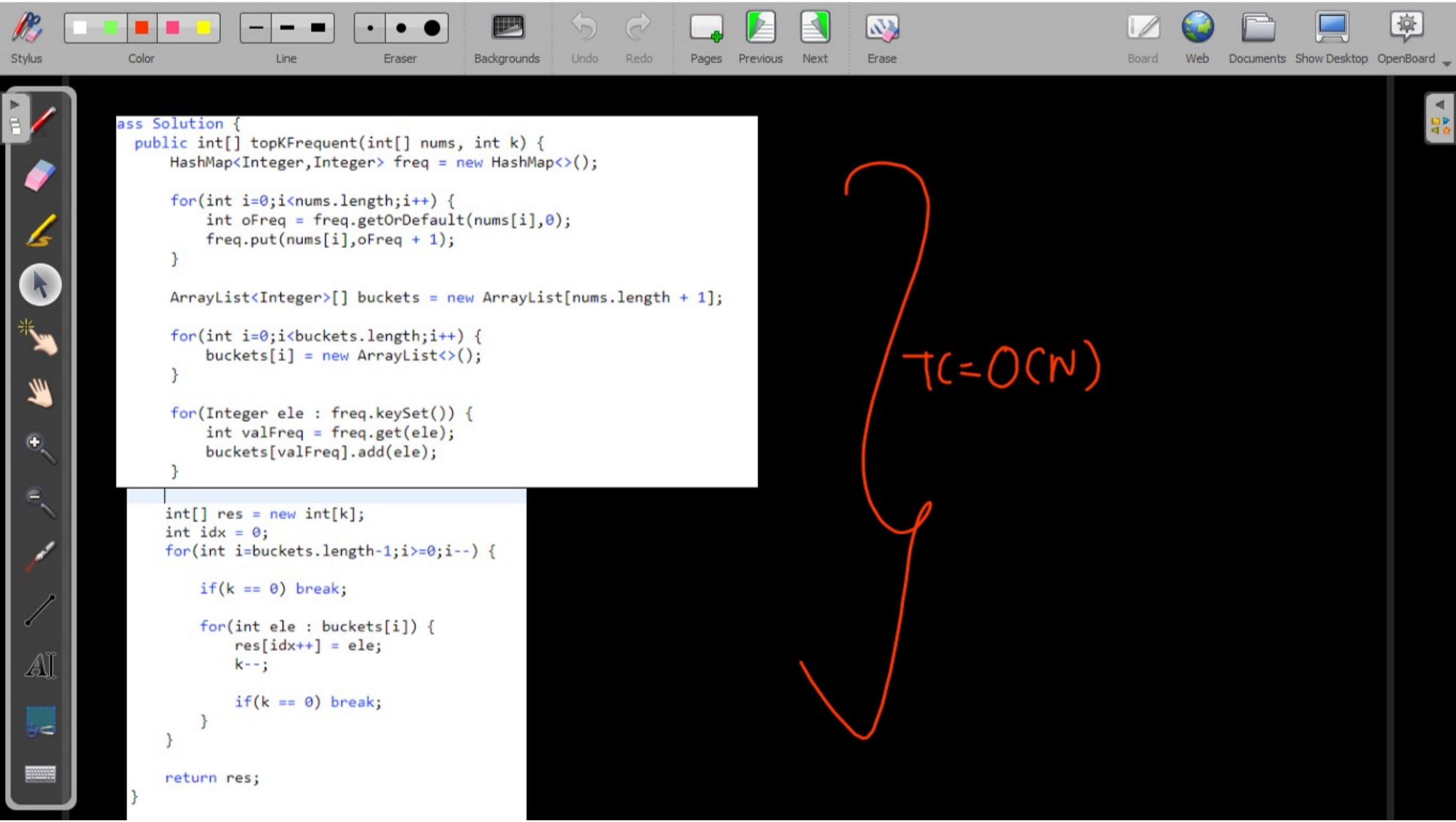
Medium 9285 374 Add to List Share

Given an integer array `nums` and an integer `k`, return *the* `k` *most frequent elements*. You may return the answer in **any order**.





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ass Solution {
public int[] topKFrequent(int[] nums, int k) {
HashMap<Integer,Integer> freq = new HashMap<>();
for(int i=0;i<nums.length;i++) {
int oFreq = freq.getOrDefault(nums[i],0);
freq.put(nums[i],oFreq + 1);
}
ArrayList<Integer>[] buckets = new ArrayList[nums.length + 1];
for(int i=0;i<buckets.length;i++) {
buckets[i] = new ArrayList<>();
}
for(Integer ele : freq.keySet()) {
int valFreq = freq.get(ele);
buckets[valFreq].add(ele);
}
int[] res = new int[k];
int idx = 0;
for(int i=buckets.length-1;i>=0;i--) {
if(k == 0) break;
for(int ele : buckets[i]) {
res[idx++] = ele;
k--;
if(k == 0) break;
}
}
return res;
}
TC=O(N)

Top k Words (LC: 692)

692. Top K Frequent Words

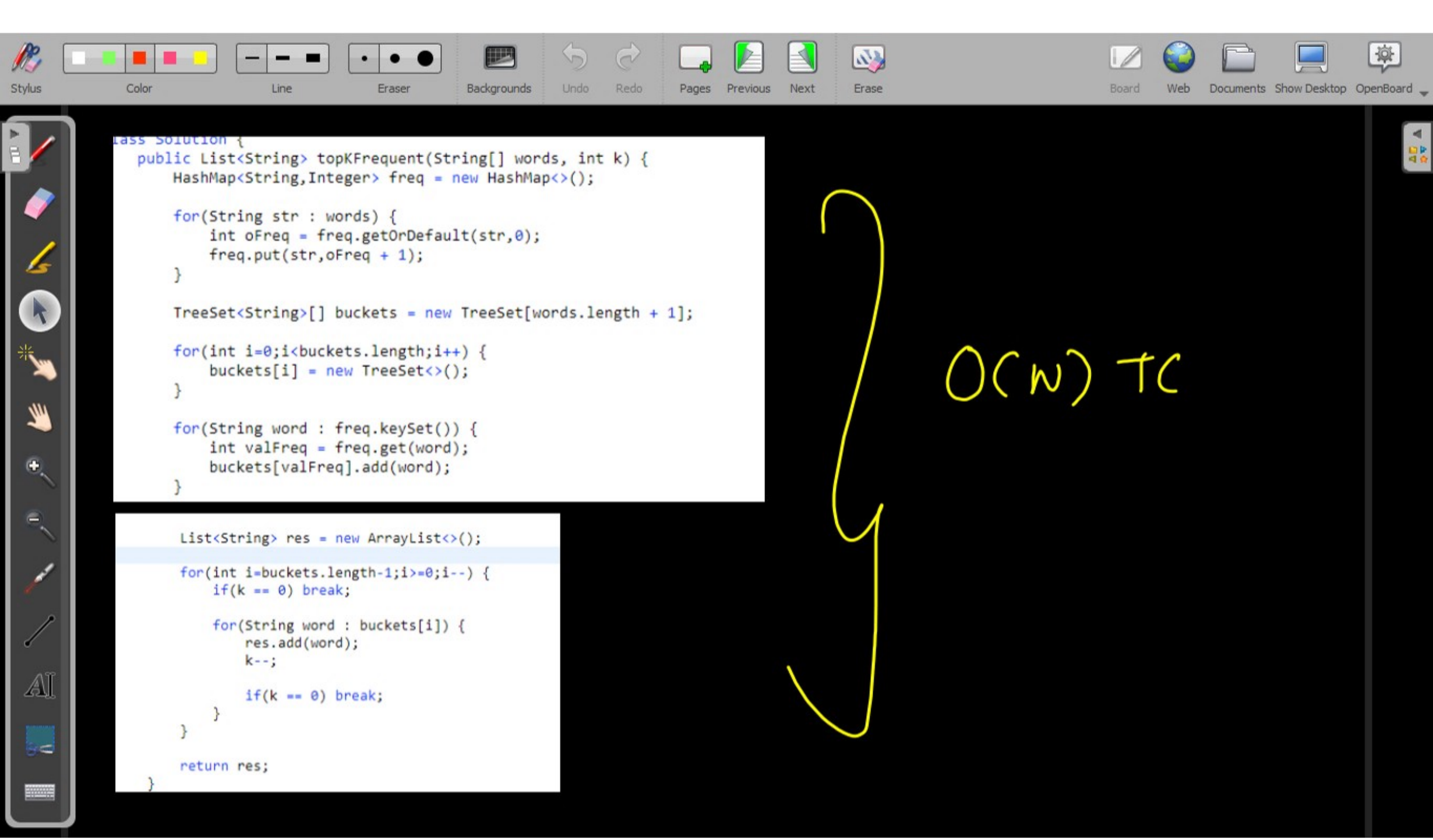
Medium 4484 252 Add to List Share

Given an array of strings `words` and an integer `k`, return *the* `k` *most frequent strings.*

Return the answer **sorted** by **the frequency** from highest to lowest. Sort the words with the same frequency by their **lexicographical order**.

Example 1:

Same as prev ques. But use Treeset instead of Arraylist to maintain lexicographical order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class Solution {
public List<String> topKFrequent(String[] words, int k) {
HashMap<String,Integer> freq = new HashMap<>();
for(String str : words) {
int oFreq = freq.getOrDefault(str,0);
freq.put(str,oFreq + 1);
}
TreeSet<String>[] buckets = new TreeSet[words.length + 1];
for(int i=0;i<buckets.length;i++) {
buckets[i] = new TreeSet<>();
}
for(String word : freq.keySet()) {
int valFreq = freq.get(word);
buckets[valFreq].add(word);
}
List<String> res = new ArrayList<>();
for(int i=buckets.length-1;i>=0;i--) {
if(k == 0) break;
for(String word : buckets[i]) {
res.add(word);
k--;
if(k == 0) break;
}
}
return res;
}
O(N) TC

Coordinate Compression.

Convert an array to reduced form

Medium Accuracy: 69.45% Submissions: 4206 Points: 4

Given an array with **N** distinct elements, convert the given array to a reduced form where all elements are in range from **0** to **N-1**. The order of elements is same, i.e., **0** is placed in place of smallest element, **1** is placed for second smallest element, ... **N-1** is placed for largest element.

{10, 40, 20}

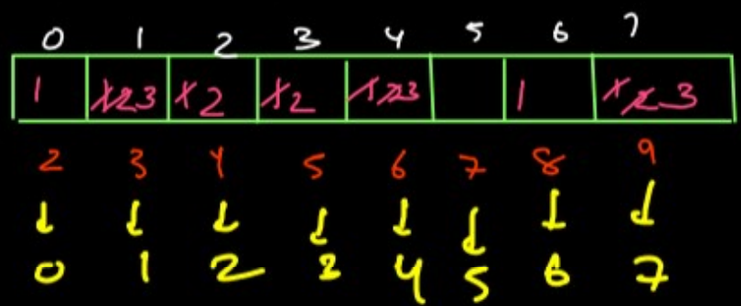
{10-0 40-1 20-2}

↓ Sort

{10-0 20-2 40-1}

0 2 1

Count sort was also coordinate compression



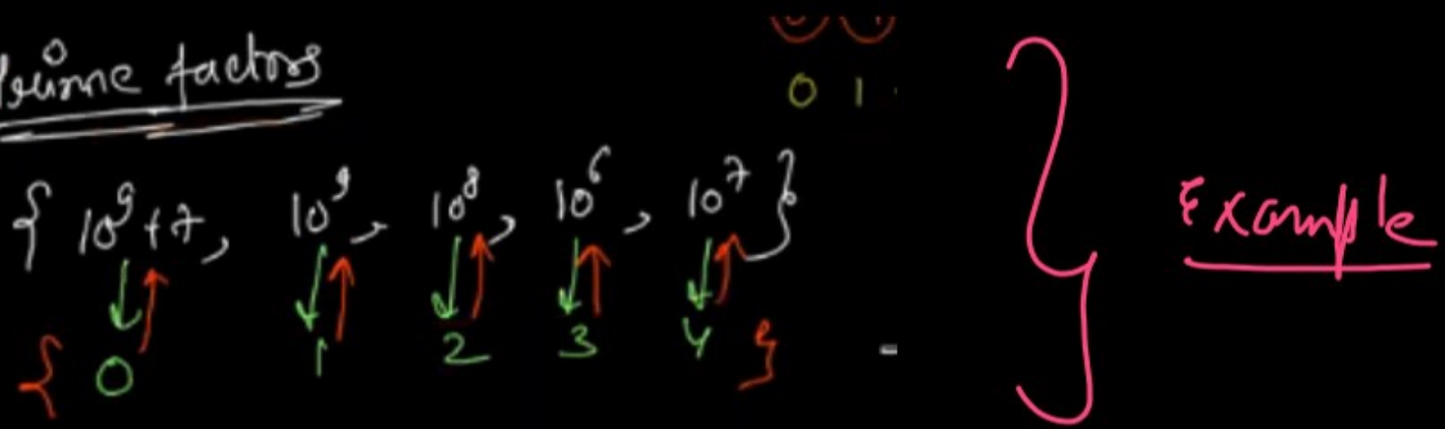
2 ko value 0

3 ko value 1

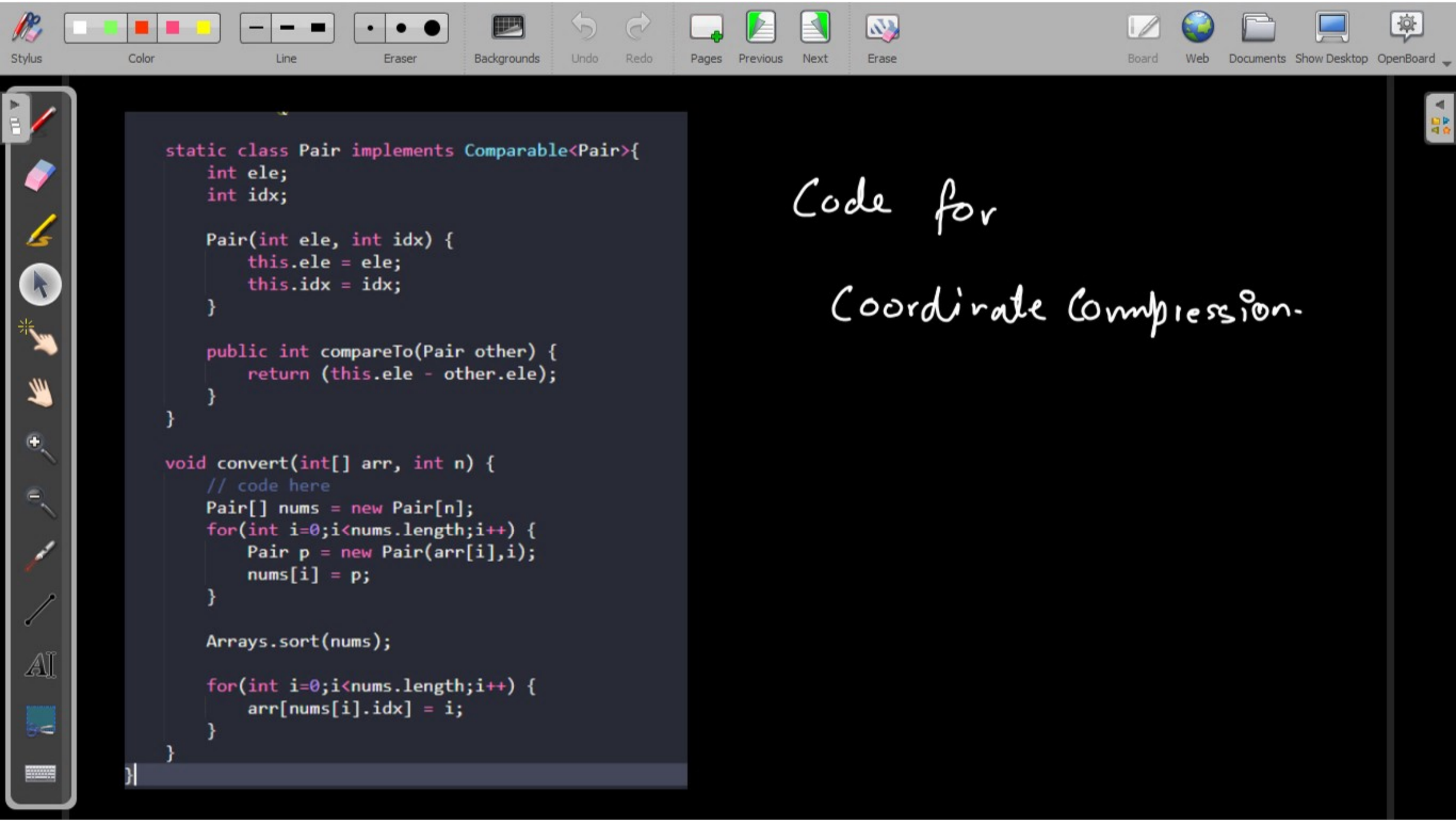
& soon

Coordinate compression can be used in many questions

* Prime factors



Example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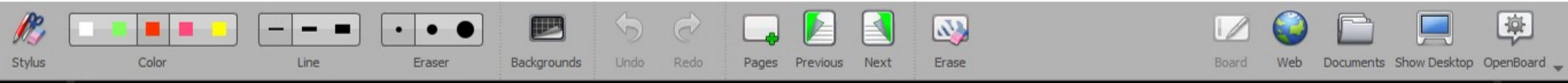
static class Pair implements Comparable<Pair>{
int ele;
int idx;
Pair(int ele, int idx) {
this.ele = ele;
this.idx = idx;
}
public int compareTo(Pair other) {
return (this.ele - other.ele);
}
}
void convert(int[] arr, int n) {
// code here
Pair[] nums = new Pair[n];
for(int i=0;i<nums.length;i++) {
Pair p = new Pair(arr[i],i);
nums[i] = p;
}
Arrays.sort(nums);
for(int i=0;i<nums.length;i++) {
arr[nums[i].idx] = i;
}
}
}
Code for
Coordinate Compression.



164. Maximum Gap

Hard 2127 287 Add to List Share

Given an integer array `nums`, return *the maximum difference between two successive elements in its sorted form.* If the array contains less than two elements, return `0`.

You must write an algorithm that runs in linear time and uses linear extra space.

Radix Sort

```java
class Solution {

//     Radix Sort karna hai
//     Yaani har digit pe count sort
//     Since integer me max 10 digits honge
//     TC -> O(10 * N)
//     SC -> O(N)

    void countSort(int[] nums,int exp) {
        int n = nums.length;
        int[] output = new int[n];
        int[] count = new int[10];

        for(int i=0;i<n;i++)
            count[(nums[i]/ exp) % 10]++;

        for(int i=1;i<10;i++) {
            count[i] += count[i-1];
        }

        for(int i=n-1;i>=0;i--) {
            output[count[(nums[i] / exp) % 10] - 1] = nums[i];
            count[(nums[i] / exp) % 10]--;
        }

        for(int i=0;i<n;i++)
            nums[i] = output[i];
    }
```

```java
    public int maximumGap(int[] nums) {
        if(nums.length <= 1) return 0;

        //Radix Sort
        int n = nums.length;
        int max = Integer.MIN_VALUE;
        for(int i=0;i<nums.length;i++) {
            max = Math.max(max,nums[i]);
        }

        for(int exp=1;max/exp > 0; exp*= 10) {
            countSort(nums,exp);
        }

        int res = 0;
        for(int i=0;i<n-1;i++) {
            res = Math.max(res,nums[i+1] - nums[i]);
        }

        return res;
    }
}
```

H-Index

274. H-Index

Medium 1239 1857 Add to List Share

Given an array of integers `citations` where `citations[i]` is the number of citations a researcher received for their `i^th` paper, return compute the researcher's `h` **-index.**

According to the definition of h-index on Wikipedia: A scientist has an index `h` if `h` of their `n` papers have at least `h` citations each, and the other `n - h` papers have no more than `h` citations each.

If there are several possible values for `h`, the maximum one is taken as the `h` **-index.**

{3, 0, 6, 1, 5}
0 1 2 3 4

↓ Sort

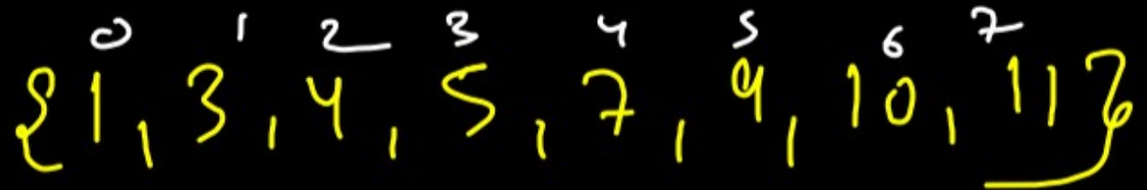
{0, 1, 3, 5, 6}

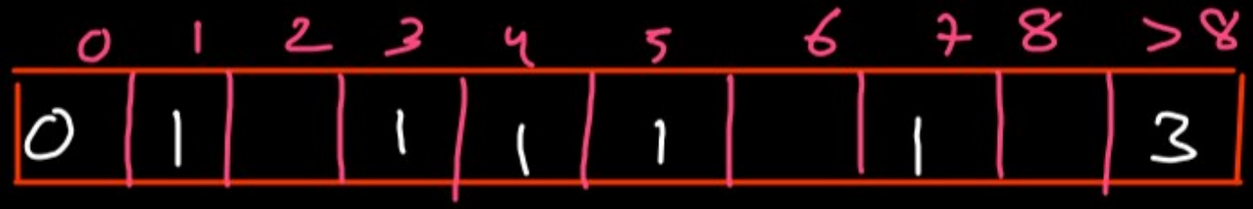
There are not atleast 5 papers with value ≥ 5.

kamse kam 0 papers with value ≥ 0

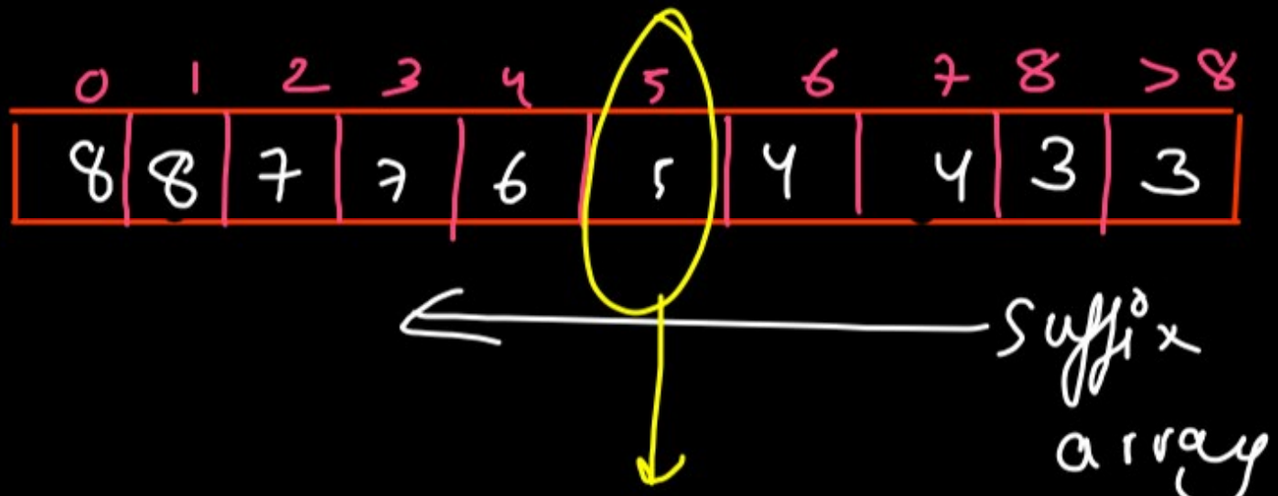
Highest such value is an

kamse kam 5 papers with value ≥ 5

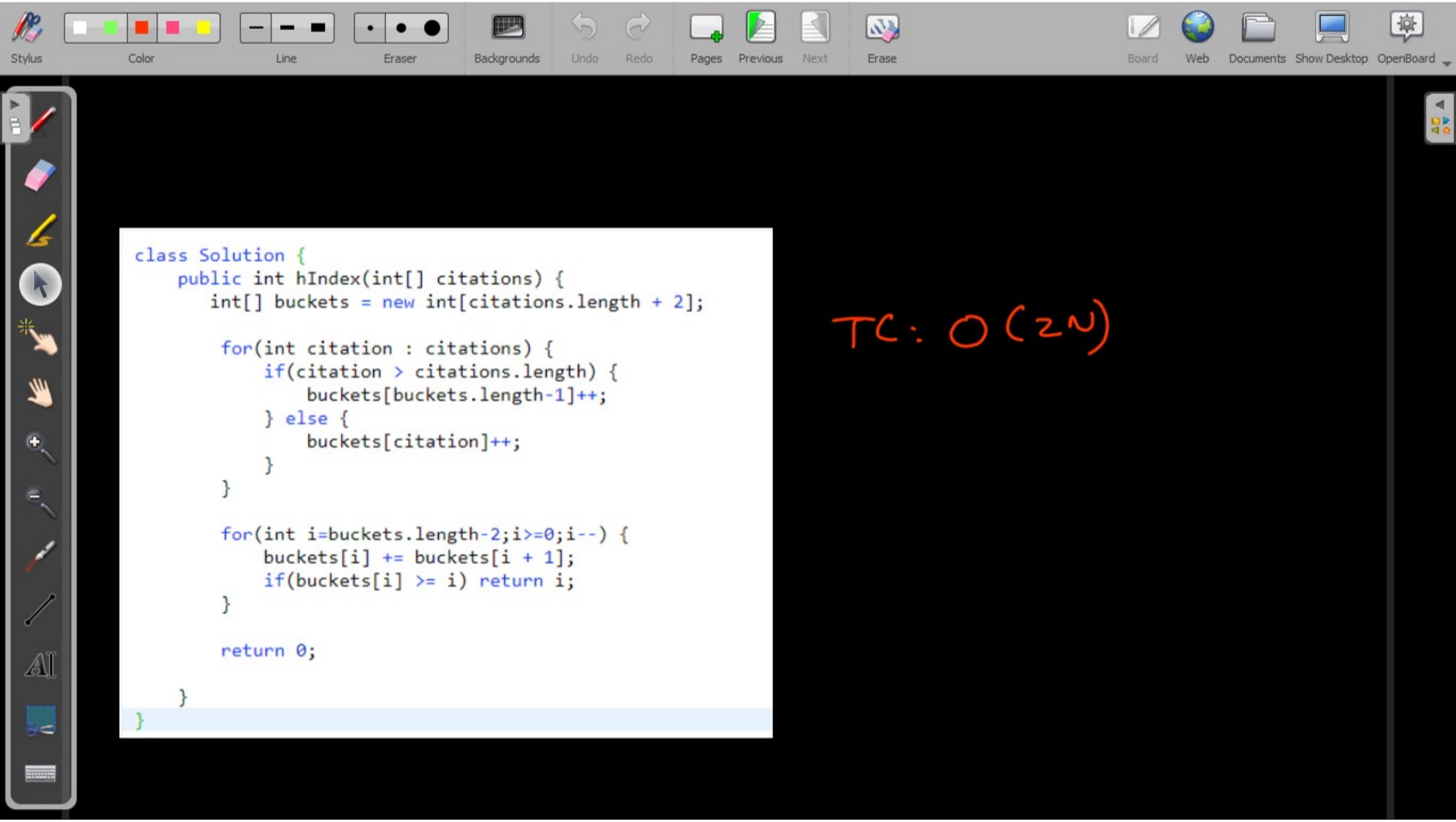




→ freq



ans = 5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class Solution {
public int hIndex(int[] citations) {
int[] buckets = new int[citations.length + 2];
for(int citation : citations) {
if(citation > citations.length) {
buckets[buckets.length-1]++;
} else {
buckets[citation]++;
}
}
for(int i=buckets.length-2;i>=0;i--) {
buckets[i] += buckets[i + 1];
if(buckets[i] >= i) return i;
}
return 0;
}
}
TC: O(2N)