

1. Given an array of integers. Find the Inversion Count in the array.
2. For an array, inversion count indicates how far (or close) the array is from being sorted. If array is already sorted then the inversion count is 0. If an array is sorted in the reverse order then the inversion count is the maximum.
3. Formally, two elements $a[i]$ and $a[j]$ form an inversion if $a[i] > a[j]$ and $i < j$.

Handwritten notes for Inversion Count:

Array: 2, 4, 1, 3, 5

Indices: 0, 1, 2, 3, 4

Handwritten pairs (i, j) where $a[i] > a[j]$ and $i < j$:

- (2, 1) ✓
- (4, 1) ✓
- (4, 3) ✓
- (4, 5) ✗
- (2, 3) ✗
- (2, 5) ✗
- (1, 3) ✗
- (1, 5) ✗
- (3, 5) ✗

Code snippet for counting inversions:

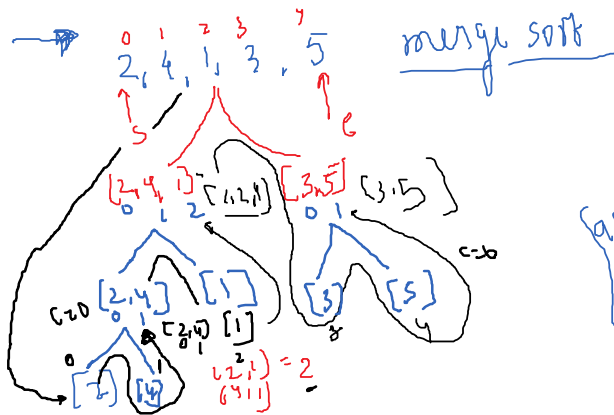
```

for (i = 0; i < n; i++)
    for (j = i + 1; j < n; j++)
        if (arr[i] > arr[j])
            invr++;
    
```

Complexity: $O(n^2)$

```

int cntinversion(vector<int>&arr, int n)
{
    int invr = 0;
    for (int i = 0; i < n; i++)
    {
        for (int j = i + 1; j < n; j++)
        {
            if (arr[i] > arr[j] && i < j)
            {
                invr++;
            }
        }
    }
    return invr;
}
    
```

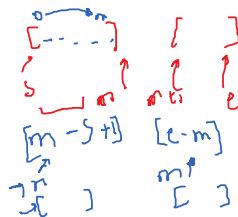
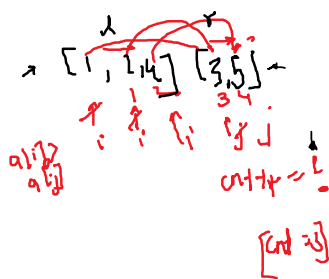


Handwritten notes:

$m = 2$

$\{a[i] > a[j] \mid i < j\}$

Handwritten note: **Order - pre - post**



Handwritten notes:

Inv = 2

Sum = 0

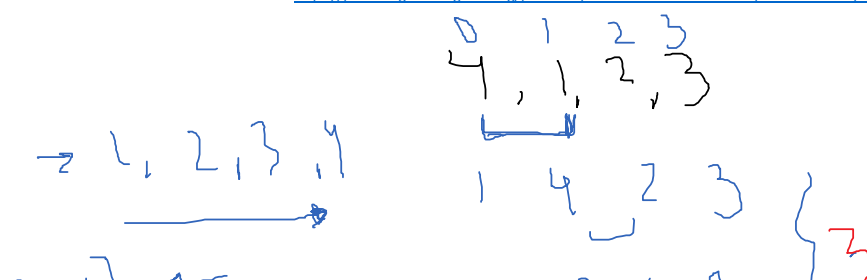
Mod = 1

2

2 →

Minimum number of swaps needed

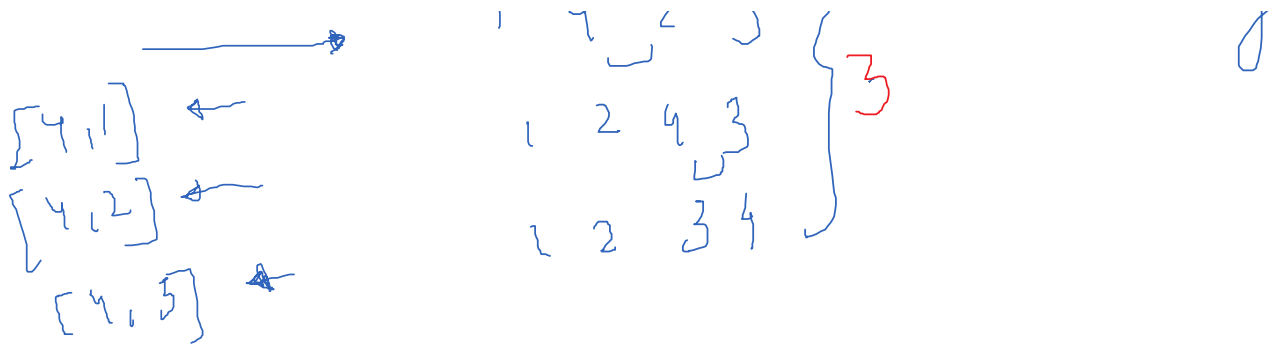
From <https://practice.geeksforgeeks.org/problems/minimum-number-of-swaps-needed2136/1#>



Handwritten notes:

$a[i] > a[i+1]$

$i < j$



3 →

Global and Local Inversions

1, 0, 2

local or global
 $a[i] > a[i+1]$

inv min → 0 (sorted)
 inv max → n (max)

→ $\begin{matrix} 0 & 1 & 2 \\ 2 & 1 & 0 \end{matrix}$ → $\begin{matrix} (2,1) \\ (2,0) \\ (1,0) \end{matrix}$



✓ $lc=1$ True
 $g=1$

✓ $l \rightarrow l, g$

$0-1=1$
 $1-0=1$
 $2-2=0$



$lc = (2,0)$
 $g = (2,0) - (1,0)$

1
 2

idx. val [idx] > 1
 $0-1=1$
 $1-2=1$
 $2-0=2$
 $i - a[i]$

Max → dec → 4 3 2 1

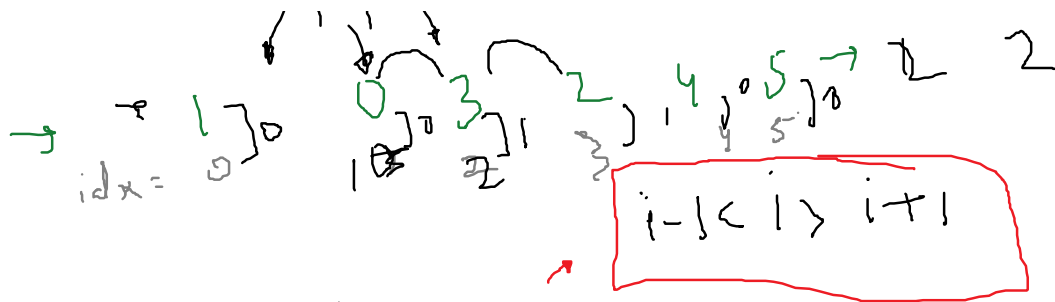
lci gi
 0 0

→ 0 1 2 3 →
 idx = 0 1 2 3



2 2





$abs(a[idx]) > 1$ - false
true

arr = [9, 1, 5, 4, 8, 7, 3, 2, 6, 0]

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

Binary search 1

12 July 2022 08:32

Linear Search.

→ 1 2 4 3 6 7

Worst - $O(n)$
Best - $O(1)$ sorted

① → $O(1)$
② → $O(n)$
③ → $O(n)$

if over array of sorted

Binary Search

nums = [-1, 0, 3, 5, 9, 12], target = 9
4

→ 9

①

0 1 2 3 4 5
-1 0 3 5 9 12

↑
5

↑
m

↑
s2 m+1

↑
mid

↑
e

s20
e: n-1

mid = $\frac{s+e}{2} = \frac{5+2}{2} = 2$

⇒ $\frac{3+5}{2} = 4$

mid = 4
9 == 9
mid = 4

3 < 4

7 = 2
mid = $\frac{s+e}{2} = 2$

⇒ $2 < \text{mid}$
⇒ $\text{mid} = \frac{s+1}{2} = 1$

mid = -1

-1 < 2

0 1 2 3 4 5
-1 0 3 5 9 12

mid = 2

↑
5

↑
m

↑
s2 m+1

↑
mid

↑
e

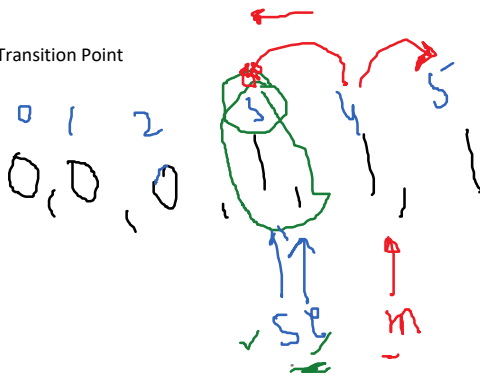
0 = 2

STL ⇒ $\text{binary_search}(\text{num.begin}(), \text{num.end}(), \text{target})$

→ lower-bound
→ upper-bound

3

Find Transition Point



$(s \leq e)$

$HM = 3$

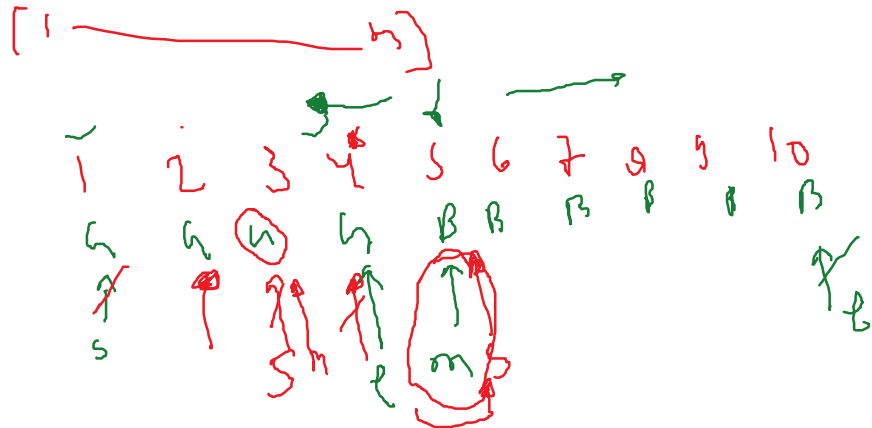
$m = 2$

$m = 4$

$nli] > s, m+1$
 $0 \rightarrow 1 \rightarrow r = m-1$
 $nli] = 1 \rightarrow e = m-1$

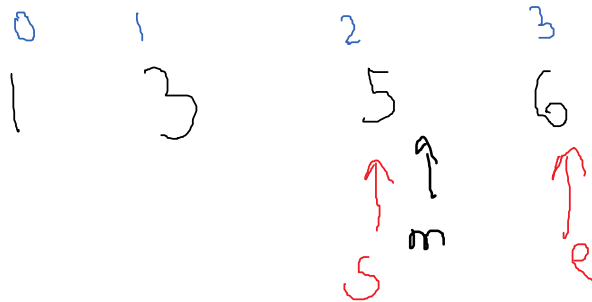
3

Bad value



4

Search Insert Position



{target = 5}

$s = 0$
 $e = n-1;$
 $while(s < e)$
 $\{$



Find First and Last Position of Element in Sorted Array

0 1 2 3 4 5
 5, 7, 7, 8, 8, 10

$T = 8$

11 12 13 14 15

- 1 first idx
- 2 last idx

Fix

Handwritten notes for a Huffman tree construction. At the top, a partial tree shows a root node with two children, one of which is a leaf node labeled 'a'. Below this, a list of numbers is shown: 0, 1, 2, 3, 4, 5, 6, 7, 7, 8, 8, 10. The number 3 is circled. To the right of the list, there are red arrows and the text 'm 5 e'.

$f = 0$

$g =$

$u: x/a$

✓

3

Binary Search 2

12 July 2022 22:56

No of occ

N = 7, X = 2
Arr[] = {1, 1, 2, 2, 2, 2, 3}
Output: 4

→ 1, 1, 2, 2, 2, 2, 3

5 - 2 ≠ 1

4

22 < 25
25

$m = r/2$

Booker

l wrong

f = mid

4 > 25

smile

res = mid 11/2 = 5

33 < 25
with mid

① val > mid

f = mid
l = m

② val < mid
f = mid
l = m + 1

0 1 2 3 4
[7, 14, 18, 25, 30]

↑ ↑ ↑

18

f = -1
l = 3
mid

→ [5, 6, 9, 10, 11]

f = -1
l = 5

f = 12
l = -1

f = 5
l = 5

3 →
h = [2, 3, 4, 9, 11]

h = [1, 5, 8]

