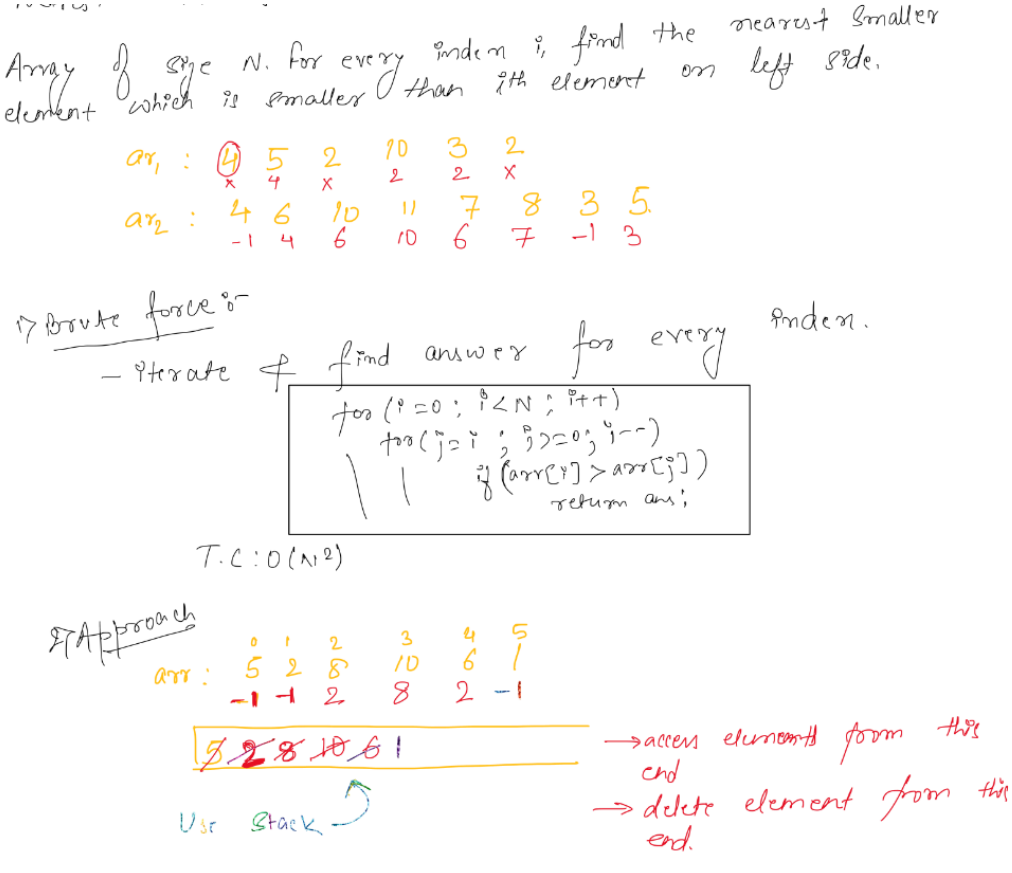
Stack Problems

Nearest Smaller / Nearest Greater
Largest Rectangle in Histogram
Sum of (max-min) of all subarrays

Nearest Smaller / Nearest Greater

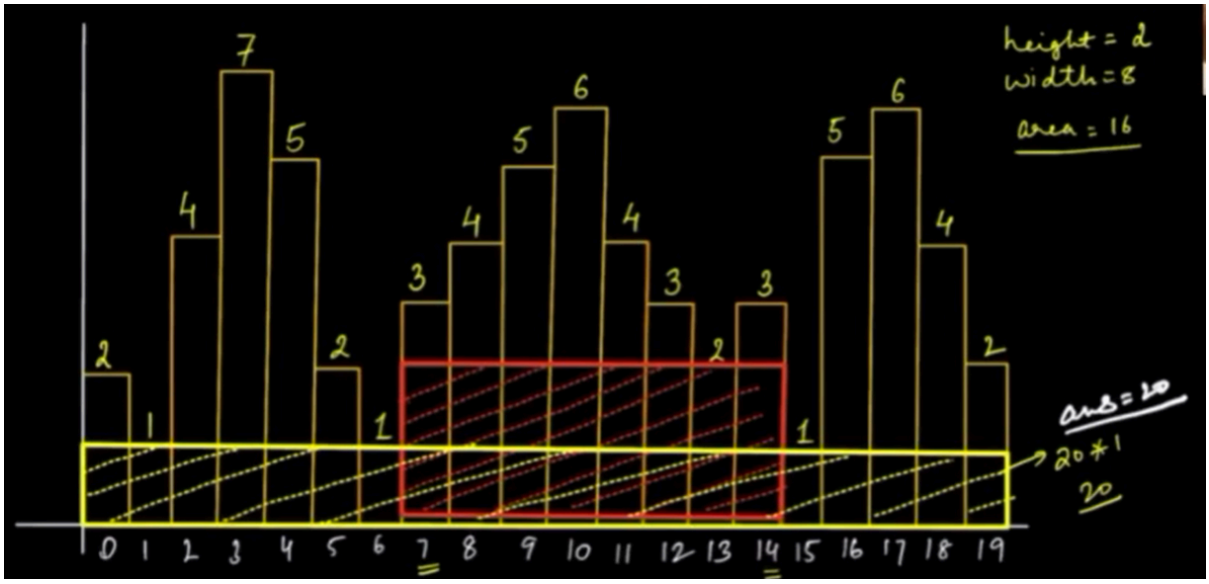


Code :

```
stack<int>  st;
int ans[] = {-1};
for(int i=1 ; i< N ; i++)
{
    while(!st.empty() && st.top() >= arr[i])
    {
        st.pop();
    }
    if(!st.empty()){
        ans[i] = st.top();
    }
    st.push(arr[i]);
}
return ans;
```

Check for all different variants of this problem.

Largest Rectangle in Histogram



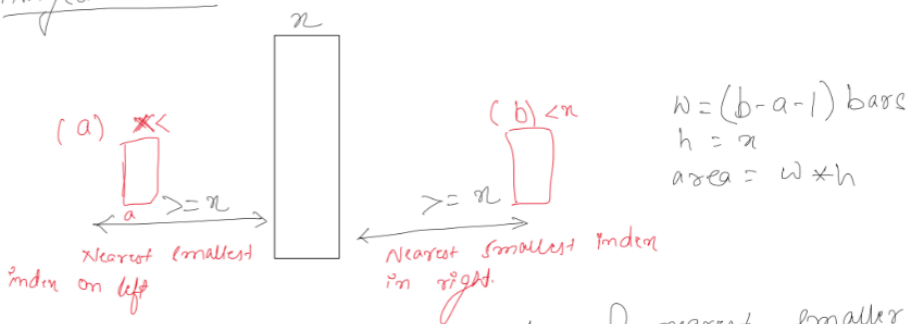
1) Brute force : Consider all possible points & find area.

```
for (i=0; i<N ; i++)
{  for (j=i; j<N ; j++){        T.C : O(N^3)
     // [i to j]
     h = min value from i to j
     w = j - i + 1
   } ans = max (ans, w*h);
}
```

2) Using Carry forward

```
h = min (h, a[j]);
```

3) optimized solution :



w = (b - a - 1) bars
h = x
area = w * h

1) Create an array to store index of nearest smaller element on left.
2) Create an array to store index of nearest smaller element on right.

```
for(int i=0; i<N ; i++) {
    int h = arr[i];
    int w = NSR[i] - NSL[i] - 1
    ans = max (ans, w*h)
}
return ans;
```

T.C : O(N)
S.C : O(N)

Sum of (max-min) of all subarrays

Q Find sum of (max - min) for all subarrays.

arr[3] : 2 5 3

	max	min	max - min
0 - 0	2	2	0
0 - 1	5	2	3
0 - 2	5	2	3
1 - 1	5	5	0
1 - 2	5	3	2
2 - 2	3	3	0
	25	17	8 = ans.

Brute Force

Consider all subarrays calculate (max - min) using carry forward ($O(n^2)$)

Approach 2

① $\sum max_s - \sum min_s = \sum (max - min)$

② using Contribution technique, calculate contributions.

$\sum max_s = \sum_{i=0}^{N-1}$ (In how many subarrays ith element is max) * arr[i]

[NGL] Nearest greater on left — ith — Nearest greater on right [NGR]

valid starts : [l+1, i] valid end : [i, r-1]

# of subarrays = $(i - l) * (r - i)$

$$\sum max_s = \sum_{i=0}^{N-1} ((i - NGL[i]) * (NGR[i] - i) * arr[i];$$

arr[] : {2 5 3} (0 1 2)

NGL[] : {-1 -1 1}

NGR[] : {1 3 3}

Similarly $\sum min_s = \sum_{i=0}^{N-1} ((i - NSL[i]) * (NSR[i] - i)) * arr[i]$

Iterate & find the answer.