# 2-pointers

**Pointers** mean an index in an array.

Q. You are given 2 sorted arrays: A of size n and B of size m. Merge them into one sorted array.
Eg.
Input :
A = [1, 6, 9, 13, 18, 18]
B = [2, 3, 8, 13, 25]

Output:
[1, 2, 3, 6, 8, 9, 13, 13, 18, 18, 25]

Link:
https://codeforces.com/edu/course/2/lesson/9/1/practice/contest/307092/problem/A

Sol:

```
#include <bits/stdc++.h>

using namespace std;

typedef long long ll;

int32_t main() {
 int n, m;
 cin >> n >> m;
```

```cpp
vector<int> a(n), b(m);


for (int i = 0; i < n; i++) {
  cin >> a[i];
}

for (int i = 0; i < m; i++) {
  cin >> b[i];
}

int i = 0, j = 0;
vector<int> c;

while (i < n && j < m) {
  if (a[i] <= b[j]) {
    c.push_back(a[i]);
    i++;
  } else {
    c.push_back(b[j]);
    j++;
  }
}

while (j < m) {
  c.push_back(b[j]);
  j++;
}
```

```
 while (i < n) {
   c.push_back(a[i]);
   i++;
 }

 for (int i = 0; i < m + n; i++) {
   cout << c[i] << ' ';
 }

 return 0;
}
```

TIme Complexity: O(n + m)

Q: https://cses.fi/problemset/task/1641

A[] = {2,7,5,1}
X = 8
2 -> sumLeft = 8-2 = 6

A[] = {1,2,3,4,5,6,7,8}
1 -> sumLeft = x-1 = 6 //x=7
Sum = 10
*Sum == sumLeft -> we have found a triplet -> 1,2,8
*sum<sumLeft - > we can ignore the minimum number i.e. the leftmost number
*sum>sumLeft -> we can ignore the maximum number i.e. the righmost number .

2,7,5,1 -> 1,3,4
1,2,3,4
1,2,5,7 -> 1,2,3

Sol:

```
    int n,x;
    cin>>n>>x;
    vector<pii > v(n);
    for(int i=0;i<n;i++){
        cin>>v[i].fi;
        v[i].se = i;
    }
    sort(v.begin(),v.end());
    vector<int> ans;
    for(int i=0;i<n;i++){ //v[i].fi is the 1st number of the
triplet
        int sumLeft = x-v[i].fi;
        int l=i+1,r=n-1;
        while(l<r){
            int sum = v[l].fi+v[r].fi;
            if(sum==sumLeft){ //a pair has been found
                // triplet = {v[i].se,v[l].se,v[r].se}
                ans.pb(v[i].se);
                ans.pb(v[l].se);
                ans.pb(v[r].se);
                break;
            }else if (sum<sumLeft){
                l++;
            }else{
```

```
            r--;
        }
    }
    if(ans.size()!=0){
        break;
    }
}
sort(ans.begin(),ans.end());
if(ans.size()!=0){
    cout<<ans[0]+1<<" "<<ans[1]+1<<" "<<ans[2]+1;
}else{
    cout<<"IMPOSSIBLE";
}
```

Q: https://codeforces.com/contest/279/problem/B

N books numbered from 1 to n
Ith book takes a[i] minutes
Free Time available: T minutes

Basically, we need to find largest continuous segment of the array such that the sum of elements in this segment <=t

We can take 2 pointers - l and r

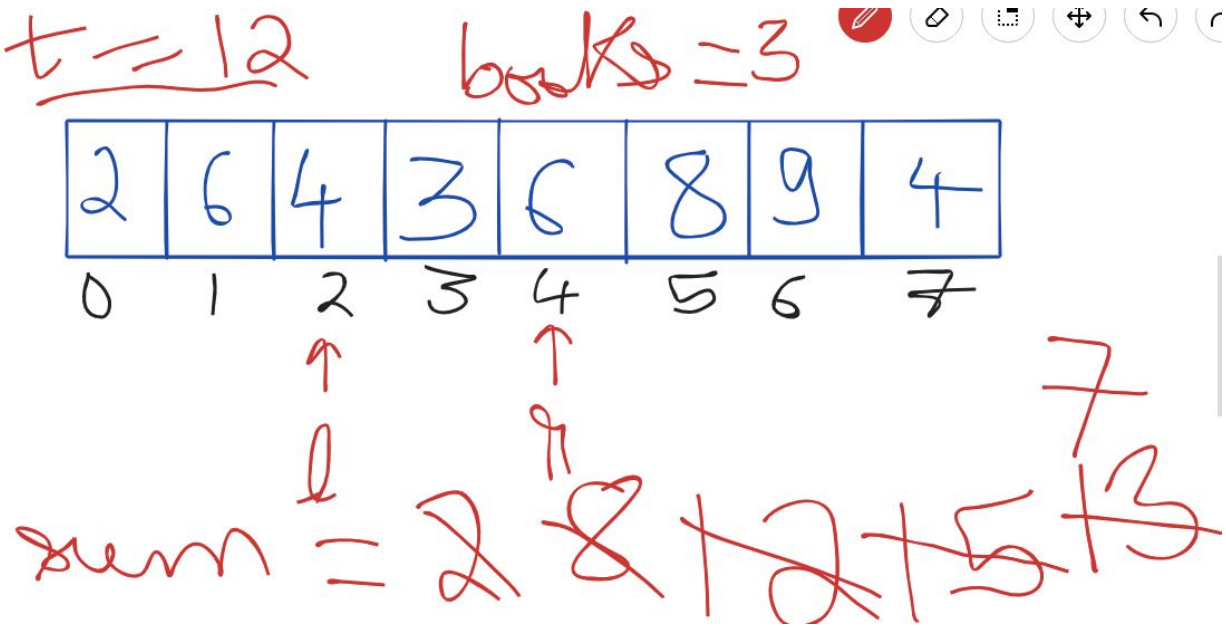
If sum within the range [l, r] <=t, then we can increment r.
Otherwise if sum>t, we can increase l until sum becomes <=t

Sol:

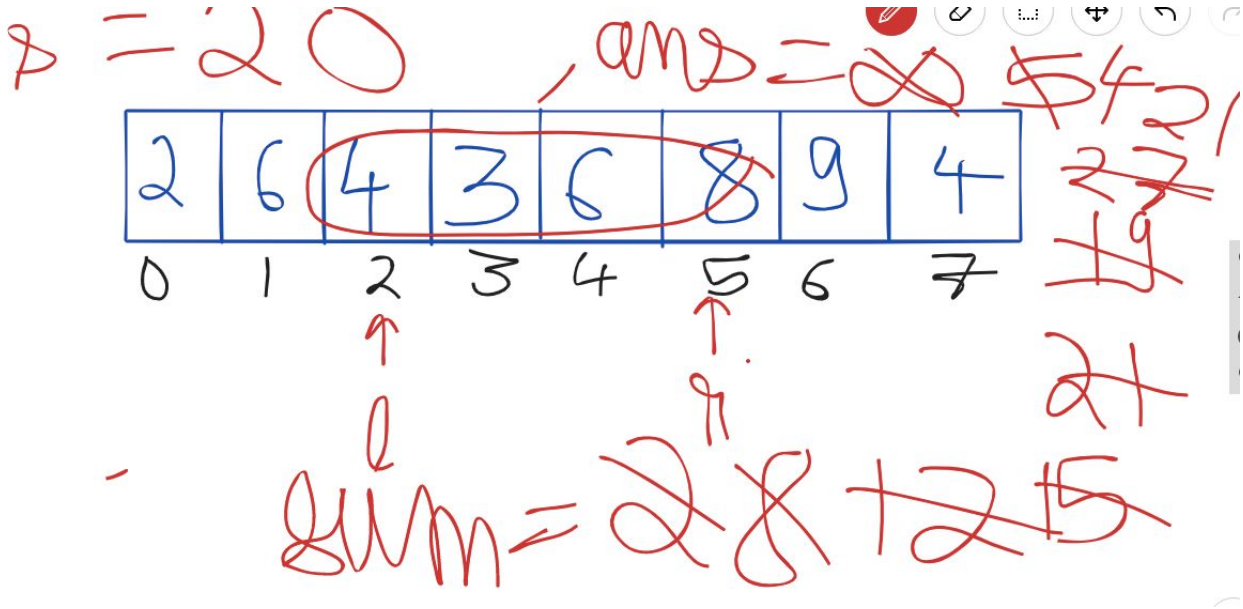
```cpp
#include <bits/stdc++.h>
#define int long long

using namespace std;

typedef long long ll;

int32_t main() {
 int n, t;
 cin >> n >> t;

 vector<int> a(n);

 for (int i = 0; i < n; i++) {
   cin >> a[i];
 }

 int sum = 0, ans = 0;
 int l = 0;
 for (int r = 0; r < n; r++) {
   sum = sum + a[r];
   while (sum > t) {
     sum -= a[l];
     l++;
   }
   ans = max(ans, r - l + 1);
 }
 cout << ans;
```

```
 return 0;
}
```

Time complexity: O(n)




Q.
https://codeforces.com/edu/course/2/lesson/9/2/practice/contest/307093/problem/B



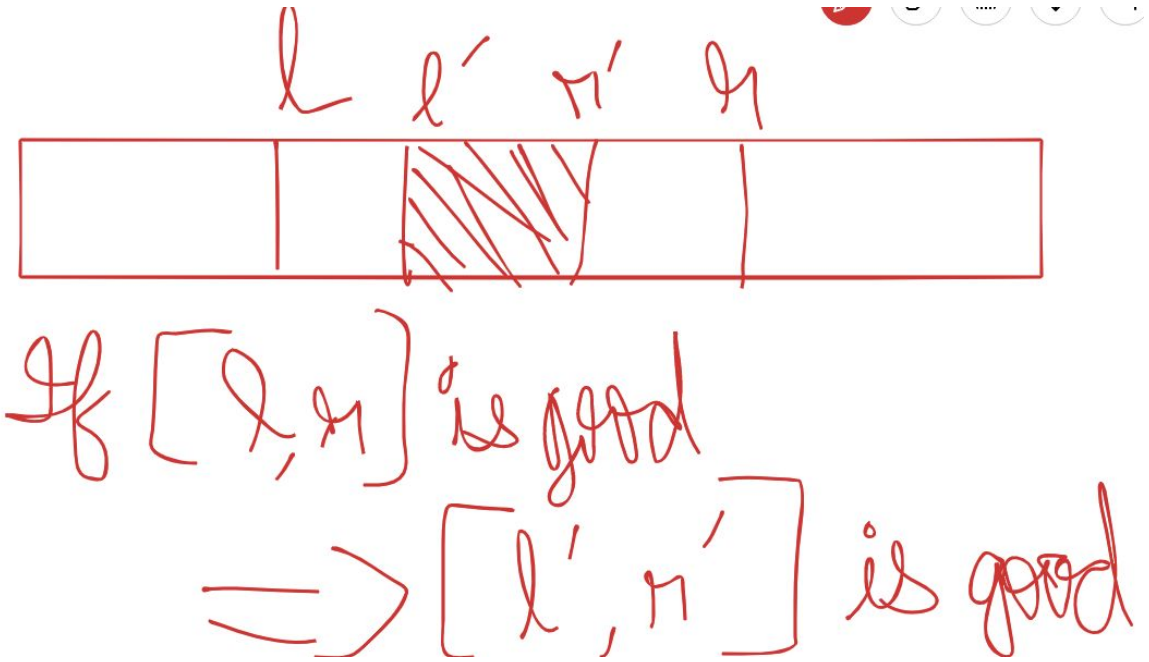

```cpp
#include <bits/stdc++.h>
#define int long long

using namespace std;

typedef long long ll;

int32_t main() {
  int n, s;
  cin >> n >> s;

  vector<int> a(n);

  for (int i = 0; i < n; i++) {
    cin >> a[i];
  }

  int sum = 0, ans = 1e5 + 1;
```

```
  int l = 0;

  for (int r = 0; r < n; r++) {
    sum = sum + a[r];
    while (sum - a[l] >= s) {
      sum = sum - a[l];
      l++;
    }
    if (sum >= s) ans = min(ans, r - l + 1);
  }

  if(ans == 1e5 + 1)
    cout<<-1;
  else
      cout << ans;

  return 0;
}
```

**Time Complexity**: O(n)

## When we can use 2-pointers?

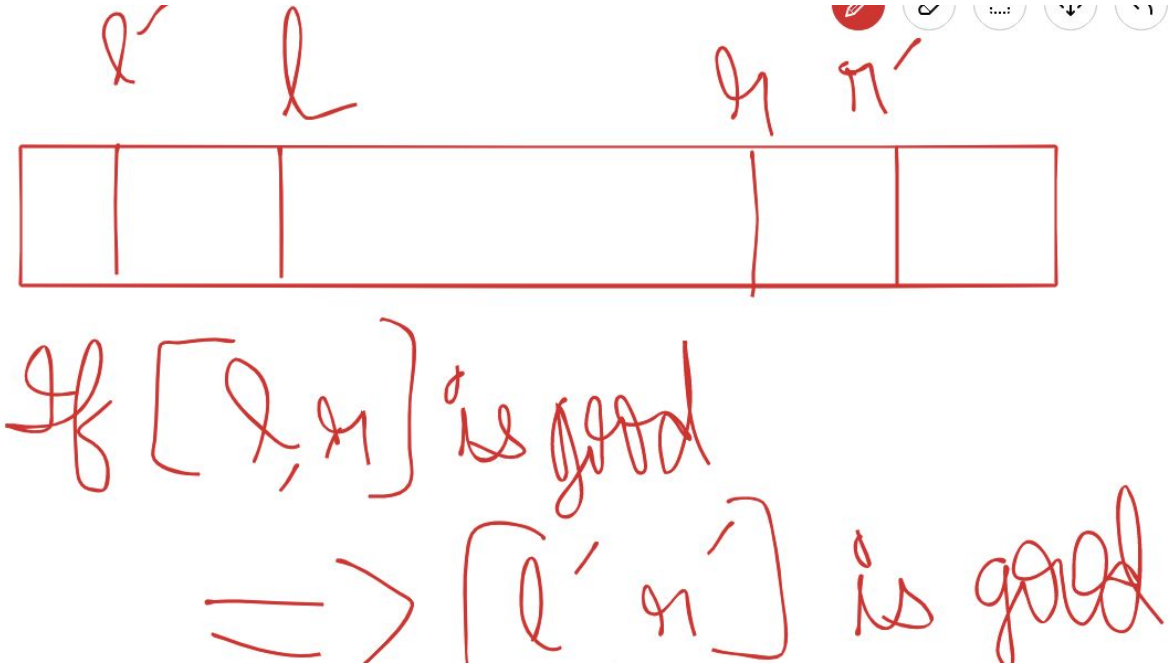
**Case 1:**




**Example:**

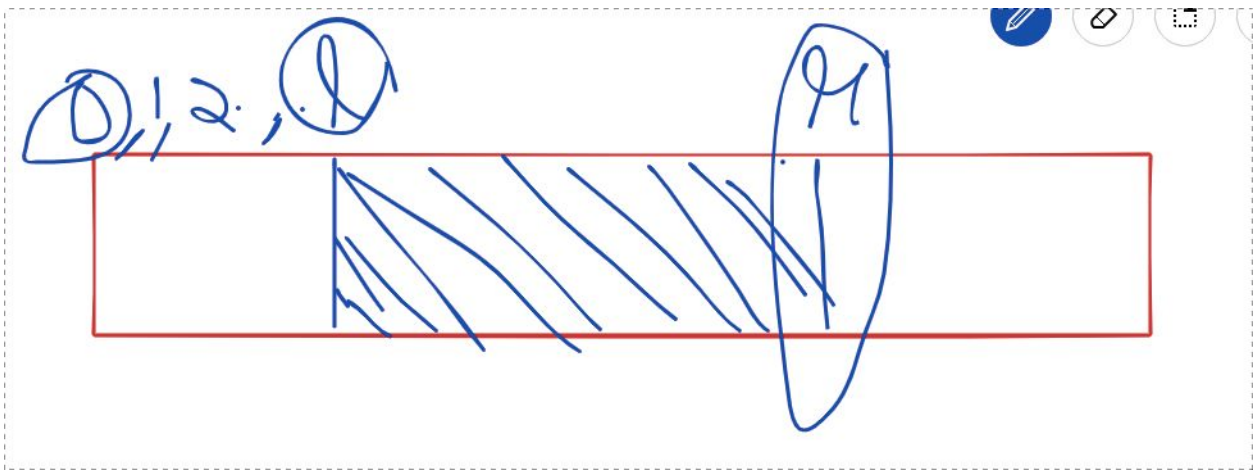
Sum of elements <= t ( as solved in previous question - B. Books)

**Case 2:**



**Example:**
Sum of elements >= s (as solved in the previous )

Q.
https://codeforces.com/edu/course/2/lesson/9/2/practice/contest/307093/problem/D



```
#include <bits/stdc++.h>
#define int long long

using namespace std;

typedef long long ll;

int32_t main() {
 int n, s;
 cin >> n >> s;
```

```
 vector<int> a(n);

 for (int i = 0; i < n; i++) {
   cin >> a[i];
 }

 int sum = 0, ans = 0;
 int l = 0;

 for (int r = 0; r < n; r++) {
   sum = sum + a[r];
   while (sum - a[l] >= s) {
     sum = sum - a[l];
     l++;
   }
   if (sum >= s) ans = ans + l + 1;
 }
 cout << ans;

 return 0;
}
```

**Time Complexity**: O(n)

**Practice Questions:**

1. https://codeforces.com/edu/course/2/lesson/9/2/practice/contest/307093/problem/C

2. https://codeforces.com/edu/course/2/lesson/9/2/practice/contest/307093/problem/E
3. https://codeforces.com/edu/course/2/lesson/9/1/practice/contest/307092/problem/B
4. https://cses.fi/problemset/task/1640
5. https://codeforces.com/problemset/problem/702/C
6. Try to solve the problems at: https://codeforces.com/edu/course/2/lesson/9/3/practice