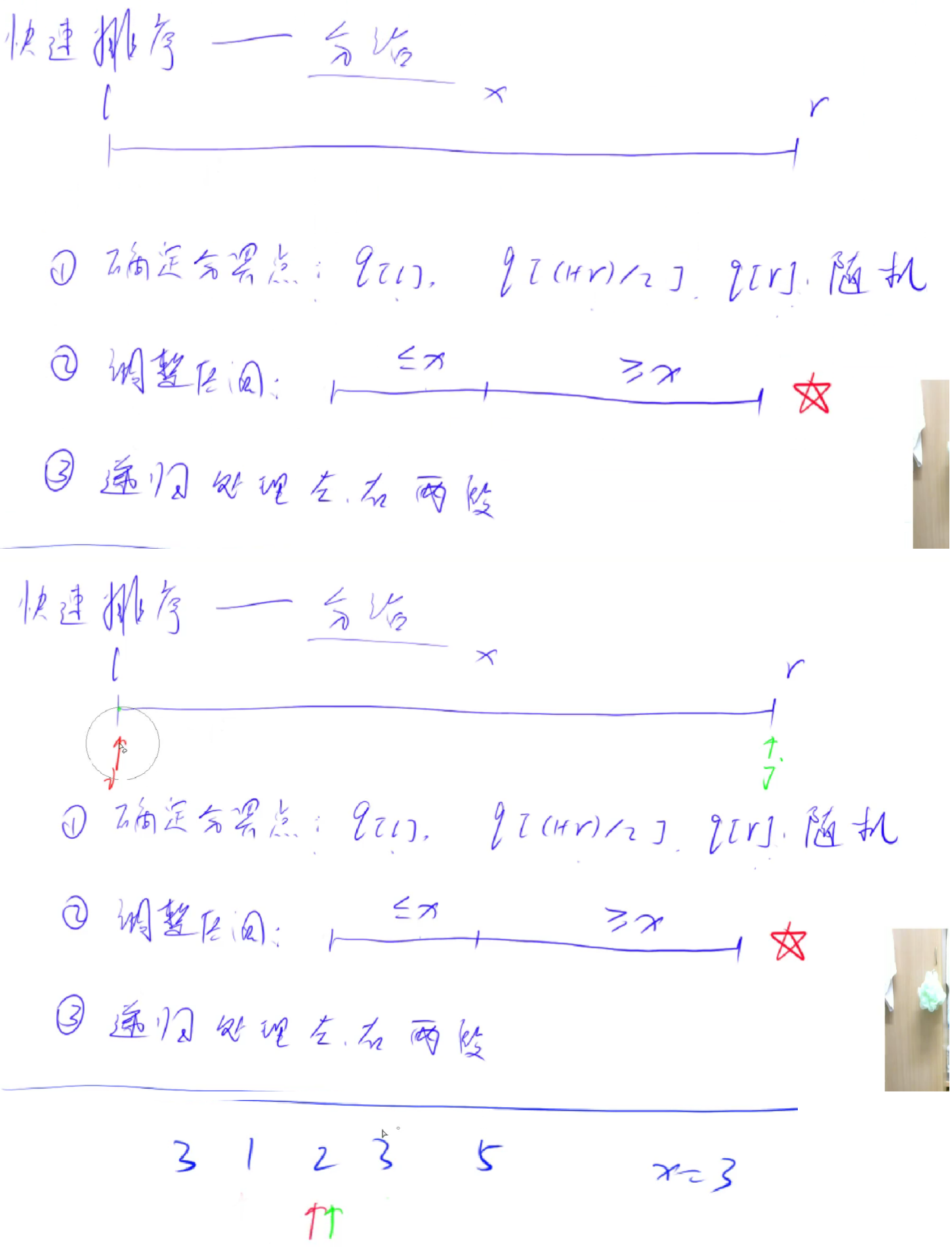
Lesson1

排序

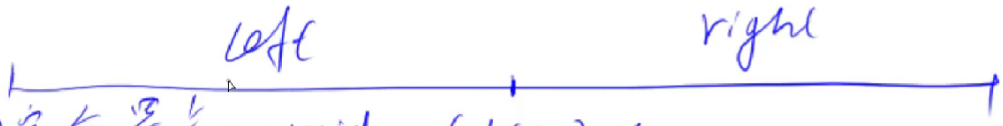
- 快速排序




```cpp
int n, q[N];

inline void quick_sort(int *q, int l, int r) {
    if (l >= r) return;

    int x = q[l+r>>1], i = l - 1, j = r + 1;
    while (i < j) {
        do i++; while (q[i] < x);
        do j--; while (q[j] > x);
        if (i < j) swap(q[i], q[j]);
    }

    quick_sort(q, l, j), quick_sort(q, j+1, r);
}
```

- 归并排序

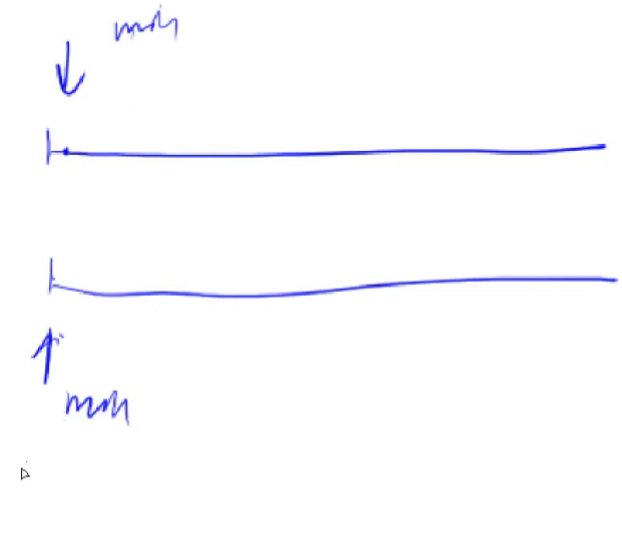
算法2：归并排序 —— 分治



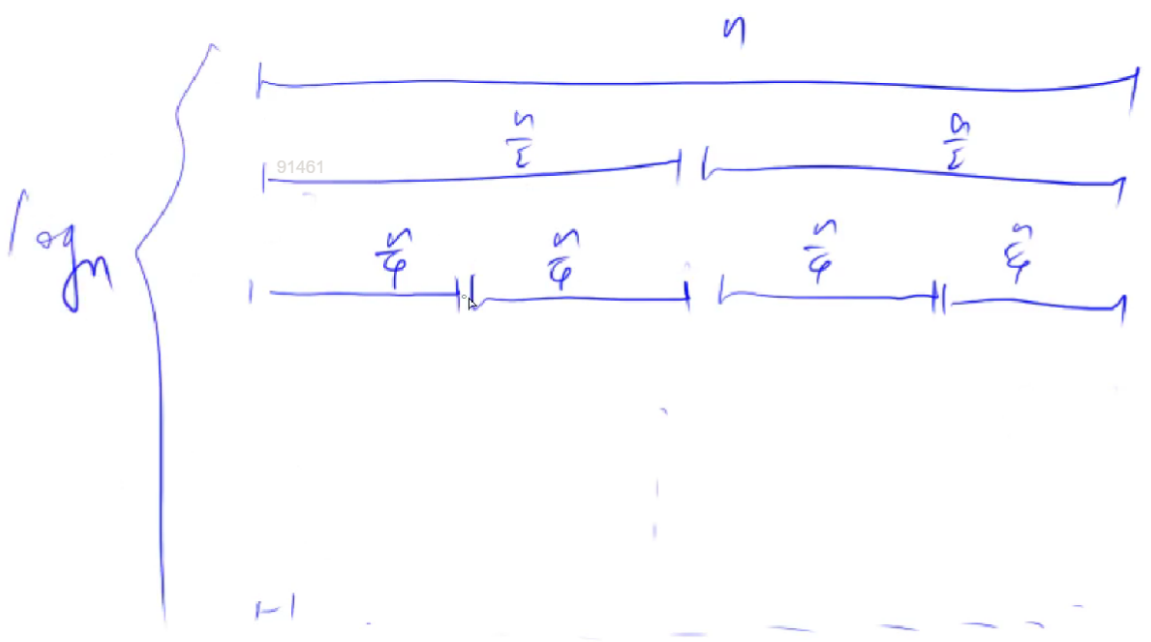
① 确定分界点：mid = (l+r)/2

② 递归排序 left, right

③ 归并 —— 合二为一 ☆



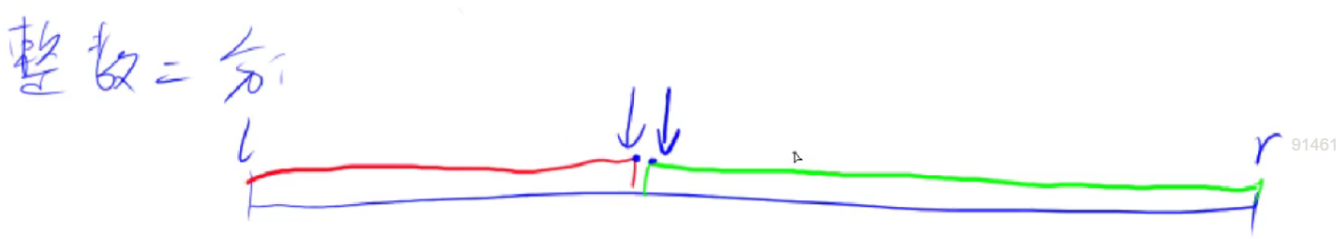
③ 归并 —— 合二为一




```cpp
int n, q[N], tmp[N];

inline void merge_sort(int *q, int l, int r) {
    if (l >= r) return;

    int mid = l + r >> 1;
    merge_sort(q, l, mid), merge_sort(q, mid+1, r);

    int k = 0, i = l, j = mid+1;
    while (i <= mid && j <= r) {
        if (q[i] <= q[j]) tmp[k++] = q[i++];
        else tmp[k++] = q[j++];
    }

    while (i <= mid) tmp[k++] = q[i++];
    while (j <= r) tmp[k++] = q[j++];
```

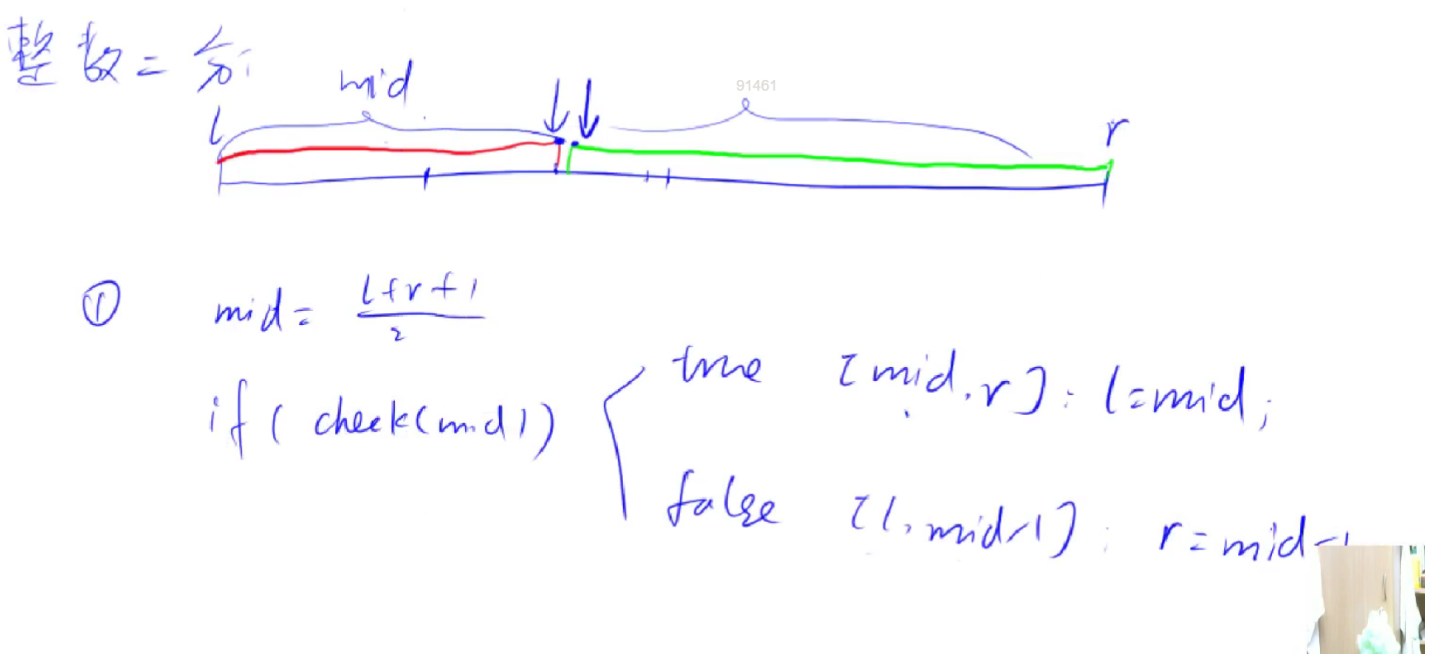
```
17
18      for (int i=l, j=0; i<=r; i++, j++) q[i] = tmp[j];
19  }
```

二分



- 有单调性一定可以二分，可二分不一定需要有单调性

- 二分左区间中答案

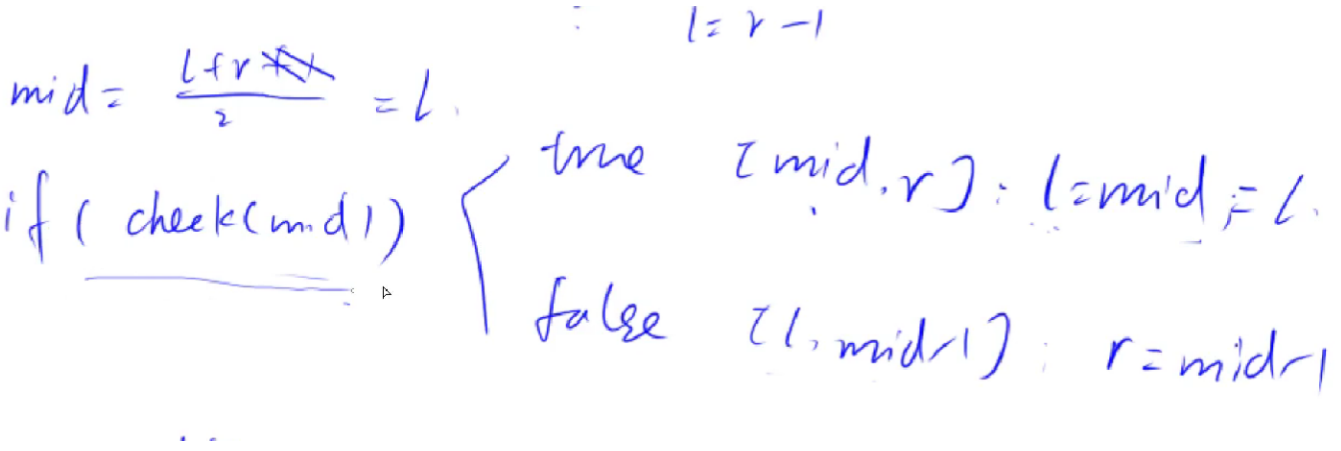



```
1  while (l < r) {
2      mid = l + r + 1  >> 1;
3      if (check(mid))
4      true: ans in [mid, r], 更新方式 l = mid
5      false: ans in [l, mid-1], 更新方式 r = mid - 1;
6  }
```

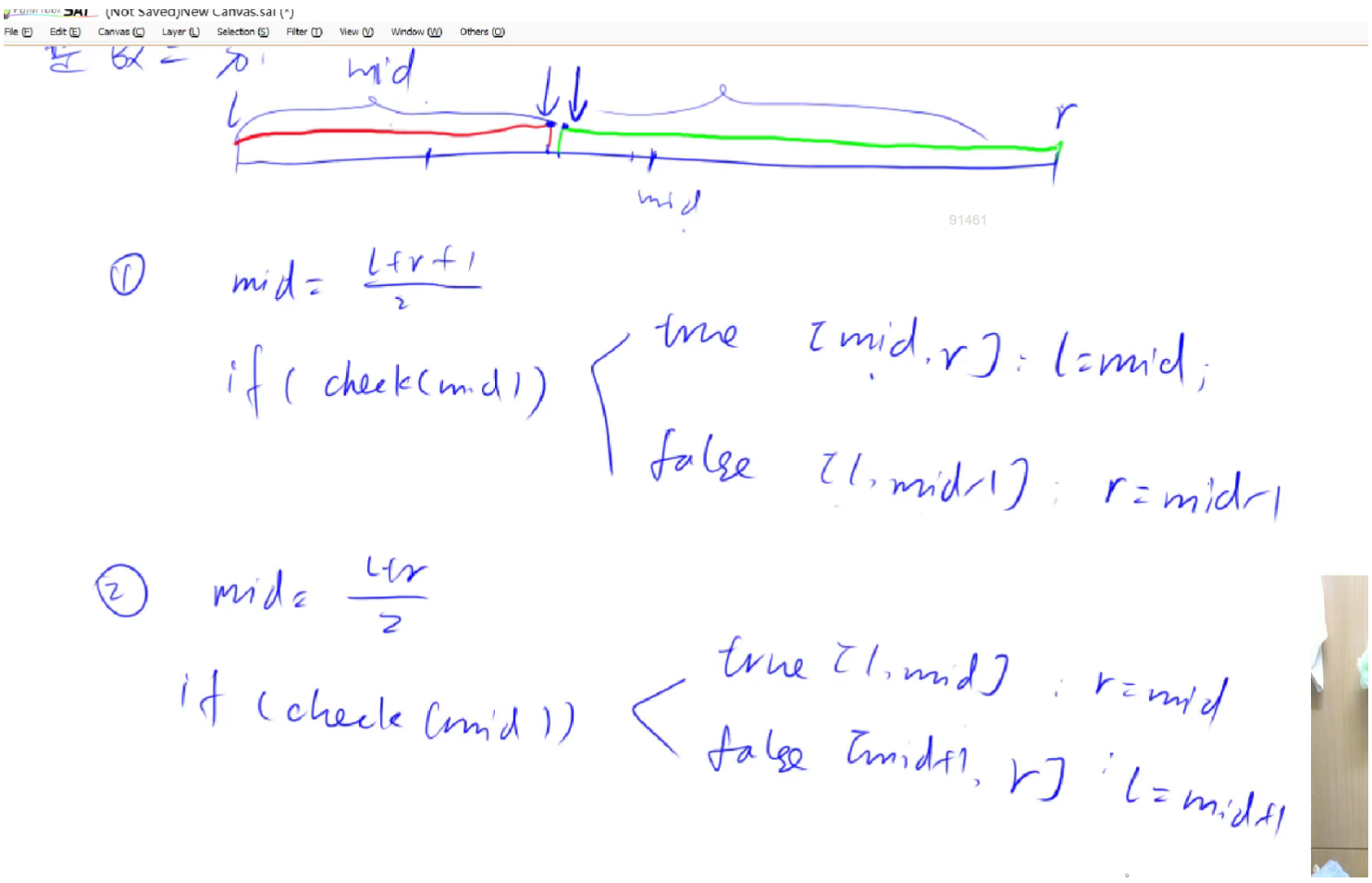
  - 为何 +1 ？

    防止死循环

    例如：l = r - 1，check为true时发生死循环

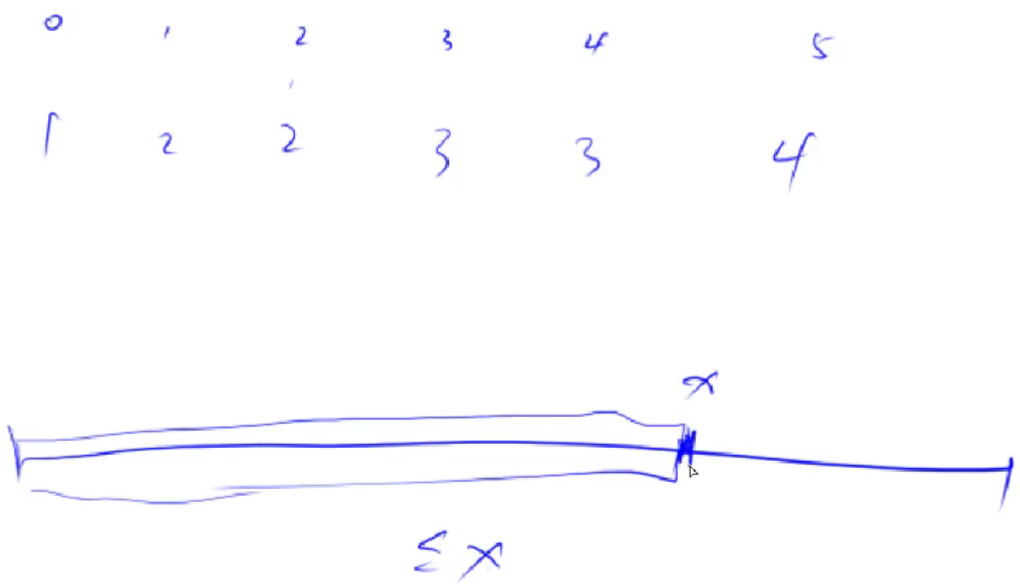


- 二分右区间中答案




```
while (l < r) {
    mid = l + r >> 1;
    if (check(mid))
    true: ans in [l, mid], 更新方式 r = mid
    false: ans in [mid+1, r], 更新方式 l = mid + 1;
}
```

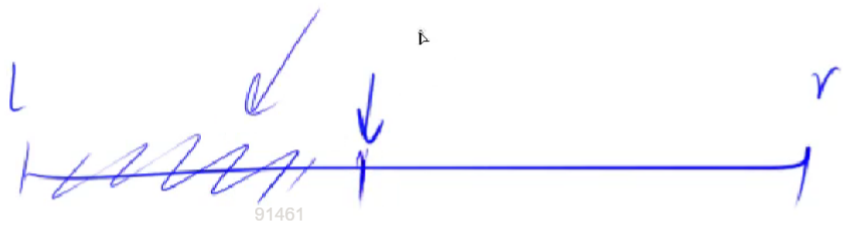
- eg

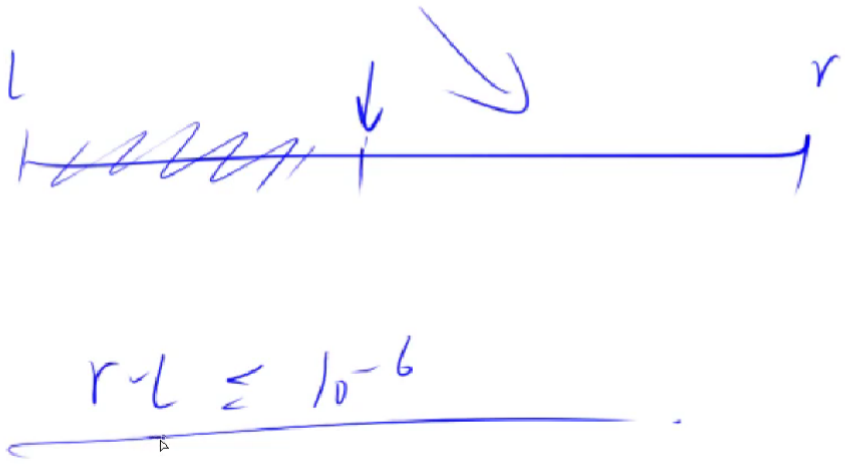



```
#include <iostream>

using namespace std;

const int N = 1e5+10;

int n, m;
int q[N];

int main(void) {
    scanf("%d%d", &n, &m);

    for (int i=0; i<n; i++) scanf("%d", &q[i]);

    while (m--) {
        int x; scanf("%d", &x);

        int l = 0, r = n - 1;
        while (l < r) {
            int mid = l + r >> 1;
            if (q[mid] >= x) r = mid;
            else l = mid + 1;
        }

        if (q[l] != x) cout << "-1 -1" << endl;
        else {
            cout << l << " ";
```

```
28
29              l = 0, r = n - 1;
30              while (l < r) {
31                  int mid = l + r + 1 >> 1;
32                  if (q[mid] <= x) l = mid;
33                  else r = mid - 1;
34              }
35
36              cout << l << endl;
37          }
38      }
39
40      return 0;
41  }
```

- 浮点数二分






```
1   #求数的三次方根
2   #include <iostream>
3
4   using namespace std;
5
6   int main(void) {
7       double x;
8       scanf("%lf", &x);
9
10      double l = -100, r = 100;
11
12      while (r - l > 1e-8) {
13          double mid = (l + r) / 2;
14          if (mid * mid * mid >= x) r = mid;
15          else l = mid;
16      }
17
18      printf("%.6lf", l);
19
20      return 0;
21  }
```