Goal

- Today we will be taking a further look at binary search.
- We will cover the following functions:
  1. lower_bound
  2. upper_bound

Resources

Lower Bound

- https://cplusplus.com/reference/algorithm/lower_bound/
- If the element you are looking for exists in the container, then `lower_bound` will return an iterator pointing to it's first occurrence.
- If the element is not in the container, then `lower_bound` will return an iterator pointing to the position where it would be if it were inserted.
  - In other words, it will return an iterator to the first occurrence of the smallest value that is larger than the element.

Upper Bound

- https://cplusplus.com/reference/algorithm/upper_bound/
- It will return an iterator pointing to the first occurrence of the smallest value that is larger than the element.

Questions

Lower Bound

1. Given an integers n and q.
   - Followed by a list of n integers in ascending order.
   - Now you will be given q integers.
     - For each integer output the index, if the integer exists in the list given above.
     - If the integer doesn't exist in the list, print -1.
     - You checking should be performed using lower_bound.
   - sample_input

```
10 5
1 2 3 4 5 6 7 8 9 10
7
3
11
1
10
```

- sample_output

```
6
2
-1
0
9
```

2. https://cses.fi/problemset/task/1091
   - Hint: Sets and Maps have a `.lower_bound()` method. Use that!

Upper Bound

1. Given an integers n and q.
   - Followed by a list of n integers in ascending order.
   - Now you will be given q integers.
     - For each integer output the index, if the integer exists in the list given above.
     - If the integer doesn't exist in the list, print -1.
     - You checking should be performed using lower_bound.
   - sample_input

```
10 5
1 2 3 4 5 6 7 8 9 10
7
3
11
1
10
```

   - sample_output

```
6
2
-1
0
9
```

2. https://cses.fi/problemset/task/1091
   - Hint: Sets and Maps have a `.upper_bound()` method. Use that!