Grokking the Coding Interview: Patterns for Coding Questions

70% completed

Search Course

Introduction

Pattern: Sliding Window

Pattern: Two Pointers

Pattern: Fast & Slow pointers

Pattern: Merge Intervals

Pattern: Cyclic Sort

Pattern: In-place Reversal of a LinkedList

Pattern: Tree Breadth First Search

Pattern: Tree Depth First Search

Pattern: Two Heaps

Pattern: Subsets

Pattern: Modified Binary Search

- Introduction
- Order-agnostic Binary Search (easy)
- Ceiling of a Number (medium)
- Next Letter (medium)
- Number Range (medium)
- Search in a Sorted Infinite Array (medium)
- Minimum Difference Element (medium)
- Bitonic Array Maximum (easy)
- Problem Challenge 1
- Solution Review: Problem Challenge 1
- Problem Challenge 2
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- Problem Challenge 3
- Solution Review: Problem Challenge 3

Pattern: Bitwise XOR

- Introduction
- Single Number (easy)

Solution Review: Problem Challenge 2

We'll cover the following

- Search in Rotated Array (medium)
- Solution
- Code
  - Time complexity
  - Space complexity
- Similar Problems
  - Problem 1
  - Solution
  - Code
  - Time complexity
  - Space complexity

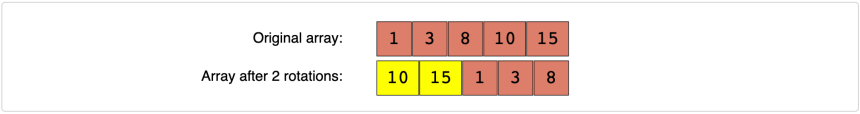
Search in Rotated Array (medium)

Given an array of numbers which is sorted in ascending order and also rotated by some arbitrary number, find if a given 'key' is present in it.

Write a function to return the index of the 'key' in the rotated array. If the 'key' is not present, return -1. You can assume that the given array does not have any duplicates.

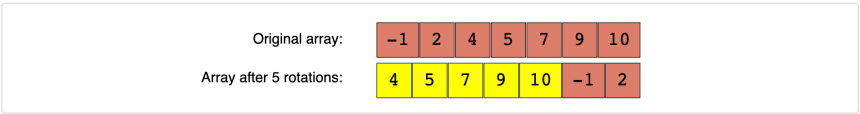
Example 1:

```
Input: [10, 15, 1, 3, 8], key = 15
Output: 1
Explanation: '15' is present in the array at index '1'.
```



Example 2:

```
Input: [4, 5, 7, 9, 10, -1, 2], key = 10
Output: 4
Explanation: '10' is present in the array at index '4'.
```



Solution

The problem follows the **Binary Search** pattern. We can use a similar approach as discussed in Order-agnostic Binary Search and modify it similar to Search Bitonic Array to search for the 'key' in the rotated array.

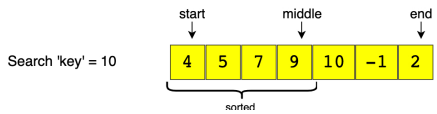
After calculating the `middle`, we can compare the numbers at indices `start` and `middle`. This will give us two options:

1. If `arr[start] <= arr[middle]`, the numbers from `start` to `middle` are sorted in ascending order.
2. Else, the numbers from `middle+1` to `end` are sorted in ascending order.

Once we know which part of the array is sorted, it is easy to adjust our ranges. For example, if option-1 is true, we have two choices:

1. By comparing the 'key' with the numbers at index `start` and `middle` we can easily find out if the 'key' lies between indices `start` and `middle`; if it does, we can skip the second part => `end = middle -1`.
2. Else, we can skip the first part => `start = middle + 1`.

Let's visually see this with the above-mentioned Example-2:



- Two Single Numbers (medium)
- Complement of Base 10 Number (medium)
- Problem Challenge 1
- Solution Review: Problem Challenge 1

Pattern: Top 'K' Elements

- Introduction
- Top 'K' Numbers (easy)
- Kth Smallest Number (easy)
- 'K' Closest Points to the Origin (easy)
- Connect Ropes (easy)
- Top 'K' Frequent Numbers (medium)
- Frequency Sort (medium)
- Kth Largest Number in a Stream (medium)
- 'K' Closest Numbers (medium)
- Maximum Distinct Elements (medium)
- Sum of Elements (medium)
- Rearrange String (hard)
- Problem Challenge 1
- Solution Review: Problem Challenge 1
- Problem Challenge 2
- Solution Review: Problem Challenge 2
- Problem Challenge 3
- Solution Review: Problem Challenge 3

Pattern: K-way merge

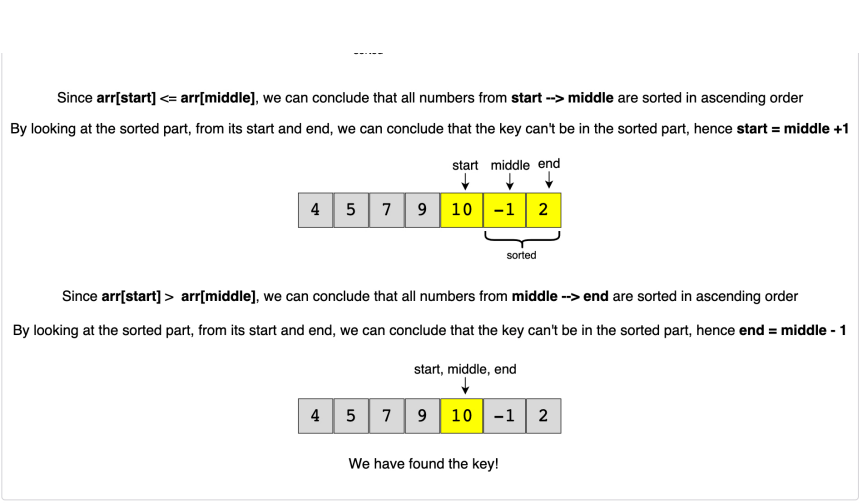
- Introduction
- Merge K Sorted Lists (medium)
- Kth Smallest Number in M Sorted Lists (Medium)
- Kth Smallest Number in a Sorted Matrix (Hard)
- Smallest Number Range (Hard)
- Problem Challenge 1
- Solution Review: Problem Challenge 1

Pattern : 0/1 Knapsack (Dynamic Programming)

- Introduction
- 0/1 Knapsack (medium)
- Equal Subset Sum Partition (medium)
- Subset Sum (medium)
- Minimum Subset Sum Difference (hard)
- Problem Challenge 1
- Solution Review: Problem Challenge 1
- Problem Challenge 2
- Solution Review: Problem Challenge 2

Pattern: Topological Sort (Graph)

- Introduction
- Topological Sort (medium)
- Tasks Scheduling (medium)
- Tasks Scheduling Order (medium)
- All Tasks Scheduling Orders (hard)
- Alien Dictionary (hard)



Since there are no duplicates in the given array, it is always easy to skip one part of the array in each iteration. However, if there are duplicates, it is not always possible to know which part is sorted. We will look into this case in the 'Similar Problems' section.

Code

Here is what our algorithm will look like:

Java | Python3 | C++ | JS

```
function search_rotated_array(arr, key) {
  let start = 0;
  let end = arr.length - 1;
  while (start <= end) {
    mid = Math.floor(start + (end - start) / 2);
    if (arr[mid] === key) {
      return mid;
    }

    if (arr[start] <= arr[mid]) { // left side is sorted in ascending order
      if (key >= arr[start] && key < arr[mid]) {
        end = mid - 1;
      } else { // key > arr[mid]
        start = mid + 1;
      }
    } else { // right side is sorted in ascending order
      if (key > arr[mid] && key <= arr[end]) {
        start = mid + 1;
      } else {
        end = mid - 1;
      }
    }
  }
  // we are not able to find the element in the given array
  return -1;
}
```

RUN | SAVE | RESET | Close

Output 2.469s

```
1
4
```

Time complexity

Since we are reducing the search range by half at every step, this means that the time complexity of our algorithm will be $O(logN)$ where 'N' is the total elements in the given array.

Space complexity

The algorithm runs in constant space $O(1)$.

Similar Problems

Problem 1

How do we search in a sorted and rotated array that also has duplicates?

The code above will fail in the following example!

Example 1:

```
Input: [3, 7, 3, 3, 3], key = 7
Output: 1
Explanation: '7' is present in the array at index '1'.
```

Problem Challenge 1
Solution Review: Problem Challenge 1
Problem Challenge 2
Solution Review: Problem Challenge 2

Miscellaneous

Kth Smallest Number (hard)

Conclusions

Where to Go from Here

Mark Course as Completed

Solution

The only problematic scenario is when the numbers at indices `start`, `middle`, and `end` are the same, as in this case, we can't decide which part of the array is sorted. In such a case, the best we can do is to skip one number from both ends: `start = start + 1` & `end = end - 1`.

Code

The code is quite similar to the above solution. Only the highlighted lines have changed:

Java | Python3 | C++ | JS

```
function search_rotated_with_duplicates(arr, key) {
  let start = 0;
  let end = arr.length - 1;
  while (start <= end) {
    mid = Math.floor(start + (end - start) / 2);
    if (arr[mid] === key) {
      return mid;
    }

    // the only difference from the previous solution,
    // if numbers at indexes start, mid, and end are same, we can't choose a side
    // the best we can do, is to skip one number from both ends as key !== arr[mid]
    if (arr[start] === arr[mid] && arr[end] === arr[mid]) {
      start += 1;
      end -= 1;
    } else if (arr[start] <= arr[mid]) { // left side is sorted in ascending order
      if (key >= arr[start] && key < arr[mid]) {
        end = mid - 1;
      } else { // key > arr[mid]
        start = mid + 1;
      }
    } else { // right side is sorted in ascending order
      if (key > arr[mid] && key <= arr[end]) {
        start = mid + 1;
      } else {
        end = mid - 1;
      }
    }
```

RUN | SAVE | RESET

Close

Output 2.137s

```
1
```

Time complexity

This algorithm will run most of the times in $O(logN)$. However, since we only skip two numbers in case of duplicates instead of half of the numbers, the worst case time complexity will become $O(N)$.

Space complexity

The algorithm runs in constant space $O(1)$.

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Problem Challenge 2

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Problem Challenge 3

Mark as Completed