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Mastering Binary Search

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1 What is Binary Search?

Binary search is an efficient algorithm used to find a target element in a sorted array by repeatedly dividing the search interval in half. If the target value is less than the midpoint, the search continues in the left half, otherwise in the right half.

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2 Question 1 - Find the Index of a Target

Find the index of a target value in a sorted array.

Array: [1, 2, 3, 4, 5, 6, 7]

Target: 4

Binary Search

```
function binarySearch(arr, target) {
    let left = 0, right = arr.length - 1;
    while (left <= right) {
        let mid = Math.floor((left + right) / 2);
        if (arr[mid] === target) return mid;
        else if (arr[mid] < target) left = mid + 1;
        else right = mid - 1;
    }
    return -1;
}
```

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3 Explanation for Question 1

Explanation:

1. We start with left = 0 and right = arr.length - 1.
2. Calculate the middle index: mid = Math.floor((left + right) / 2).
3. If arr[mid] equals the target, return mid.
4. If the target is less than arr[mid], adjust right. Otherwise, adjust left.
5. Continue until left > right.

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4 Question 2
First Occurrence of a Target

Find the first occurrence of a target value in a sorted array.

Array: [1, 2, 2, 2, 3, 4, 5]

Target: 2

Binary Search

```
function firstOccurrence(arr, target) {
    let left = 0, right = arr.length - 1, result = -1;
    while (left <= right) {
        let mid = Math.floor((left + right) / 2);
        if (arr[mid] === target) {
            result = mid;
            right = mid - 1;  // Continue searching left side
        } else if (arr[mid] < target) left = mid + 1;
        else right = mid - 1;
    }
    return result;
}
```

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5 Explanation for Question 2

Explanation:

1. The binary search looks for the target's first occurrence.
2. When found, it updates result and continues to search the left half (right = mid - 1).
3. This ensures we find the first position of the target.

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6 Question 3
Last Occurrence of a Target

Find the last occurrence of a target value in a sorted array.

Array: [1, 2, 2, 2, 3, 4, 5]

Target: 2

Binary Search

```
function lastOccurrence(arr, target) {
    let left = 0, right = arr.length - 1, result = -1;
    while (left <= right) {
        let mid = Math.floor((left + right) / 2);
        if (arr[mid] === target) {
            result = mid;
            left = mid + 1;  // Continue searching right side
        } else if (arr[mid] < target) left = mid + 1;
        else right = mid - 1;
    }
    return result;
}
```

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7 Explanation for Question 3

Explanation:

1. The search works similarly to the first occurrence, but when found, we continue searching the right side by adjusting left = mid + 1
2. The result will be the last occurrence of the target.

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8 Question 4
Smallest Element in a Rotated Array

Find the smallest element in a rotated sorted array.

Array: [4, 5, 6, 7, 0, 1, 2]

Binary Search

```
function findMinInRotatedArray(arr) {
    let left = 0, right = arr.length - 1;
    while (left < right) {
        let mid = Math.floor((left + right) / 2);
        if (arr[mid] > arr[right]) left = mid + 1;
        else right = mid;
    }
    return arr[left];
}
```

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9 Explanation for Question 4

Explanation:

1. The smallest element is the pivot point in the rotated array.

2. If arr[mid] > arr[right], the pivot is in the right half, so we move left to mid + 1.

3. If not, the pivot is in the left half, so we move right to mid.

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10 Remaining Questions are your home work

1. Search in a Rotated Array
2. Find the First Element ≥ Target
3. Find the Last Element ≤ Target
4. Find the Closest Element to Target

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Thanks for reading

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Share your thoughts on Binary Search