Binary Search

Steps of Binary Search:

1. **Start with two pointers: low (beginning of the array) and high (end of the array).**
2. **Calculate the mid index: mid = (low + high) / 2.**
3. **Compare the middle element with the target value:**
   - **If the middle element is equal to the target, return the index.**
   - **If the middle element is less than the target, narrow the search to the upper half by setting low = mid + 1.**
   - **If the middle element is greater than the target, narrow the search to the lower half by setting high = mid - 1.**
4. **Repeat the process until the target is found or the low pointer exceeds the high pointer.**

Example 3: Finding a Number in a Sorted Array

Array: [10, 20, 30, 40, 50, 60, 70, 80, 90]
Target: 50

1. **Initial State: low = 0**, **high = 8** (length of array - 1)
2. **First Iteration:**
   - Calculate **mid**: [mid = \frac{0 + 8}{2} = 4]
   - Check the middle element: [\text{array}[4] = 50]
   - Compare: **array[4] (50) == target (50)** → Found the target at index **4**.

Result: The target **50** is found at index **4**.

Example 4: Finding a Number Not Present in a Sorted Array

Array: [15, 25, 35, 45, 55, 65, 75, 85, 95]
Target: 100

1. **Initial State: low = 0**, **high = 8**
2. **First Iteration:**
   - Calculate **mid**: [mid = \frac{0 + 8}{2} = 4]
   - Check the middle element: [\text{array}[4] = 55]
   - Compare: **array[4] (55) < target (100)** → Search in the upper half by setting **low = mid + 1 → low = 5**.
3. **Second Iteration:**
   - Now, **low = 5**, **high = 8**
   - Calculate **mid**: [mid = \frac{5 + 8}{2} = 6]
   - Check the middle element: [\text{array}[6] = 75]

- Compare: **array[6] (75) < target (100)** → Search in the upper half by setting **low = mid + 1** → **low = 7**.

4. **Third Iteration:**
    - Now, **low = 7**, **high = 8**
    - Calculate **mid**: [mid = \frac{7 + 8}{2} = 7]
    - Check the middle element: [\text{array}[7] = 85]
    - Compare: **array[7] (85) < target (100)** → Search in the upper half by setting **low = mid + 1** → **low = 8**.
5. **Fourth Iteration:**
    - Now, **low = 8**, **high = 8**
    - Calculate **mid**: [mid = \frac{8 + 8}{2} = 8]
    - Check the middle element: [\text{array}[8] = 95]
    - Compare: **array[8] (95) < target (100)** → Search in the upper half by setting **low = mid + 1** → **low = 9**.
6. **End of Search:**
    - Now, **low = 9**, **high = 8**. Since **low** exceeds **high**, the search ends.

Result: The target **100** is not found in the array.

Example 5: Finding a Number in a Sorted Array

Array: [5, 12, 18, 23, 37, 45, 56, 67, 78, 89]
Target: 37

1. **Initial State: low = 0**, **high = 9** (length of array - 1)
2. **First Iteration:**
    - Calculate **mid**: [mid = \frac{0 + 9}{2} = 4]
    - Check the middle element: [\text{array}[4] = 37]
    - Compare: **array[4] (37) == target (37)** → Found the target at index **4**.

Result: The target **37** is found at index **4**.