**Exercise 6: Library Management System**

**Linear Search:**

* **Description:** Linear search sequentially checks each element of the list until the target element is found or the list ends.
* **Time Complexity:**
  + **Best Case:** O(1). When the target element is at the first position.
  + **Average and Worst Case:** O(n). When the target element is at the end or not present in the list.
* **Space Complexity:** O(1)
* **Pros and Cons:** Simple to implement and works on unsorted lists, but inefficient for large datasets.

**Binary Search:**

* **Description:** Binary search works on sorted lists by repeatedly dividing the search interval in half. It compares the target value to the middle element of the interval and eliminates half of the search space.
* **Time Complexity:**
  + **Best Case:** O(1). When the target element is at the middle position.
  + **Average and Worst Case:** O(log n). Due to repeatedly halving the search space.
* **Space Complexity:** O(1)
* **Pros and Cons:** Much faster than linear search for large datasets but requires the list to be sorted.

**Time Complexity Comparison:**

* **Linear Search:**
  + **Best Case:** O(1). If the target element is the first element.
  + **Average and Worst Case:** O(n). If the target element is at the end or not present.
* **Binary Search:**
  + **Best Case:** O(1). If the target element is the middle element.
  + **Average and Worst Case:** O(log n). Due to repeatedly halving the search space.

**When to Use Each Algorithm:**

* **Linear Search:**
  + **Unsorted Data:** Use linear search when the data is unsorted, and the cost of sorting the data is higher than the cost of searching.
  + **Small Datasets:** For small datasets, the difference in performance between linear and binary search is negligible, making linear search a simpler choice.
* **Binary Search:**
  + **Sorted Data:** Use binary search when the data is sorted, as it significantly reduces the search time.
  + **Large Datasets:** For large datasets, the logarithmic time complexity of binary search provides a substantial performance improvement over linear search.