**Exercise 6: Library Management System**

1. **Understand Search Algorithms:**
   * *Explain linear search and binary search algorithms.*

* **Linear Search:**  
  Linear search involves traversing through each element in a list sequentially to find the target element. It does not require the list to be sorted and has a time complexity of O(n)O(n)O(n), where nnn is the number of elements.
* **Binary Search:**  
  Binary search requires the list to be sorted and operates by repeatedly dividing the search interval in half. The middle element is compared to the target, and based on the comparison, the search continues in the left or right half. The time complexity is O(log⁡n)O(\log n)O(logn).

1. **Analysis:**
   * *Compare the time complexity of linear and binary search.*

* **Linear Search:**

**Best-case:** O(1)— The book is found at the first position.

**Worst-case:** O(n)— The book is found at the last position or not found, requiring traversal of the entire list.

* **Binary Search:**

**Best-case:** O(1)— The book is found at the midpoint on the first comparison.

**Worst-case:** O(logn)— The book is found after repeatedly halving the search space.

* + *Discuss when to use each algorithm based on the data set size and order.*
* **Linear Search:**

**Advantages:** Simple to implement and works on unsorted data.

**Disadvantages:** Inefficient for large datasets due to its linear time complexity.

**Use Case:** Suitable for small datasets or when the data is not sorted.

* **Binary Search:**

**Advantages:** Much faster for large datasets due to logarithmic time complexity.

**Disadvantages:** Requires the data to be sorted, which may involve additional overhead.

**Use Case:** Ideal for large datasets that are sorted or can be sorted efficiently.