**Exercise 6: Library Management System**

**Scenario:**

You are developing a library management system where users can search for books by title or author.

**Steps:**

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

**Linear search:** A linear search is also known as a sequential search that simply scans each element at a time. Suppose we want to search an element in an array or list; we simply calculate its length and do not jump at any item.

**Algorithm:**

LINEAR\_SEARCH(A, N, VAL)

Step 1: [INITIALIZE] SET POS = -1

Step 2: [INITIALIZE] SET I = 1

Step 3: Repeat Step 4 while I<=N

Step 4: IF A[I] = VAL

SET POS = I

PRINT POS

Go to Step 6

[END OF IF]

SET I = I + 1

[END OF LOOP]

Step 5: IF POS = –1

PRINT “VALUE IS NOT PRESENT IN THE ARRAY”

STEP 6: EXIT

**Binary search:**

A binary search is a search in which the middle element is calculated to check whether it is smaller or larger than the element which is to be searched. The main advantage of using binary search is that it does not scan each element in the list. Instead of scanning each element, it performs the searching to the half of the list. So, the binary search takes less time to search an element as compared to a linear search.

The one ***pre-requisite of binary search*** is that an array should be in sorted order, whereas the linear search works on both sorted and unsorted array. The binary search algorithm is based on the divide and conquer technique, which means that it will divide the array recursively.

**Algorithm:**

BINARY\_SEARCH(A, lower\_bound, upper\_bound, VAL)

Step 1: [INITIALIZE] SET BEG = lower\_bound

END = upper\_bound, POS = - 1

Step 2: Repeat Steps 3 and 4 while BEG <= END

Step 3: SET MID = (BEG + END)/2

Step 4: IF A[MID] = VAL

SET POS = MID

PRINT POS

Go to Step 6

ELSE IF A[MID] > VAL

SET END = MID - 1

ELSE

SET BEG = MID + 1

[END OF IF]

[END OF LOOP]

Step 5: IF POS = -1

PRINT “VALUE IS NOT PRESENT IN THE ARRAY”

[END OF IF]

Step 6: EXIT

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Algorithm** | **Best-case** | **Average-case** | **Worst-case** |
| Linear Search | O(1) | O(n) | O(n) |
| Binary Search | O(1) | O(log n) | O(log n) |

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

**Linear search:**

* Use when the data set is small or unsorted.
* Use when the search is not frequent.

**Binary search:**

* Use when the data set is large and sorted.
* Use when the search is frequent.