# Search Algorithms

Brute Force Approach - Linear Search
Divide and Conquer Approach - Binary Search

# Problem Statement: Search

- Given a list of records, where each record has an associated key
- Give efficient algorithm for searching for a record containing a particular key.
- Efficiency is quantified in terms of average time analysis (number of comparisons) to retrieve an item.

# Linear / Sequential Search

It is used for unsorted and unordered small list of elements.

It has a time complexity of O(n), which means the time is linearly dependent on the number of elements.

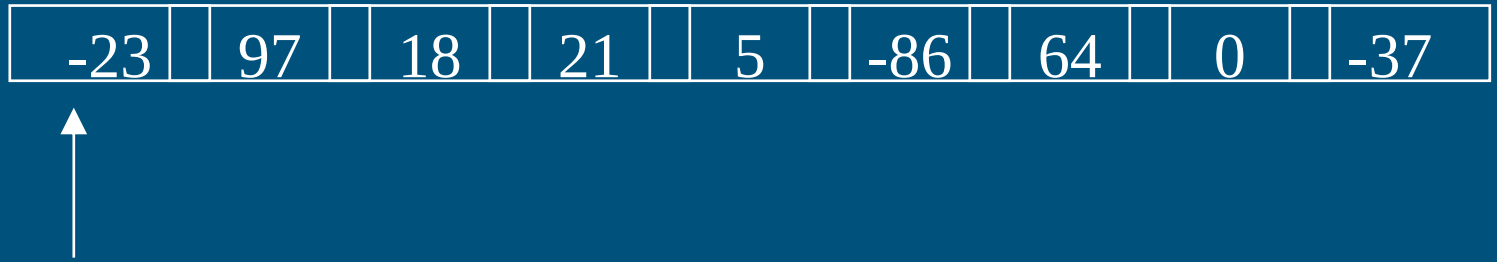
# How to Find a Value in an Array?

| -23 | 97 | 18 | 21 | 5 | -86 | 64 | 0 | -37 |
|---|---|---|---|---|---|---|---|---|

Suppose you have a big array full of data, and you want to find a particular value.

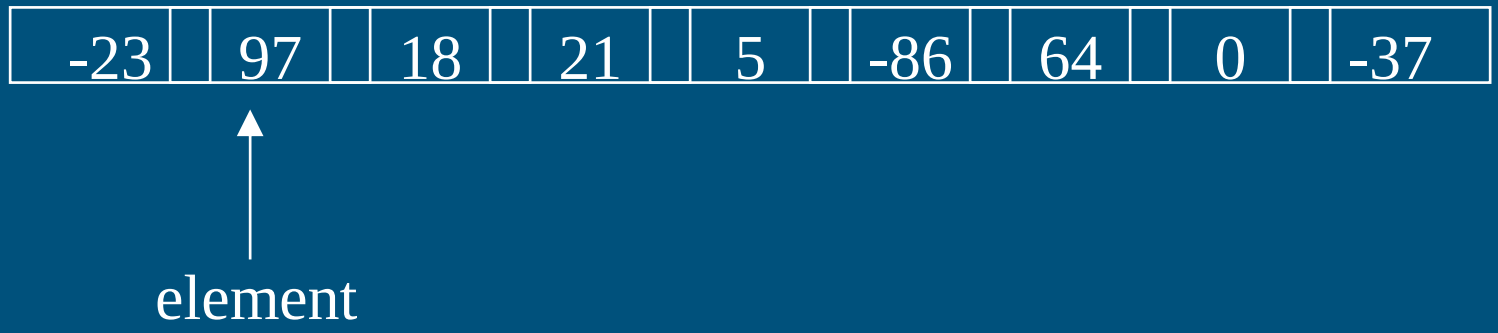
How will you find that value?

# Linear Search Example #1



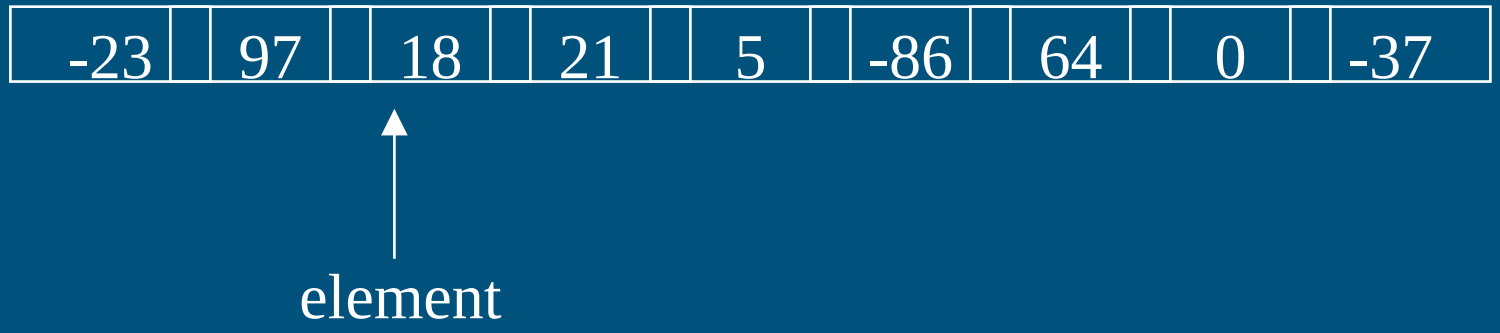

Searching for -86.

# Linear Search Example #2



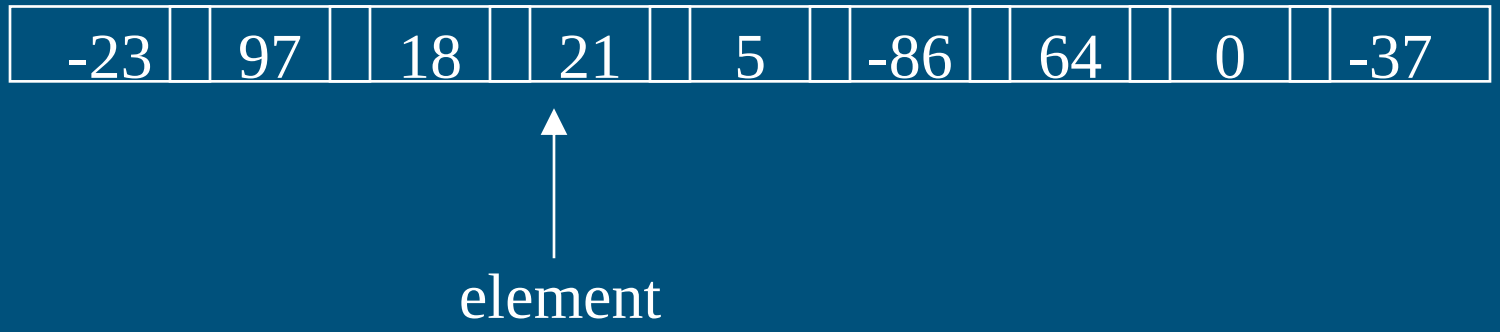

Searching for -86.

# Linear Search Example #3



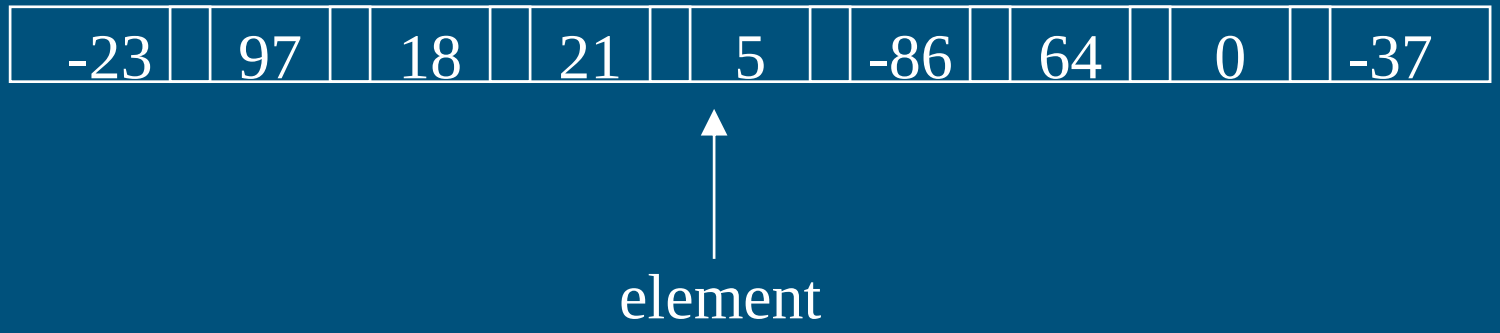

Searching for -86.

# Linear Search Example #4



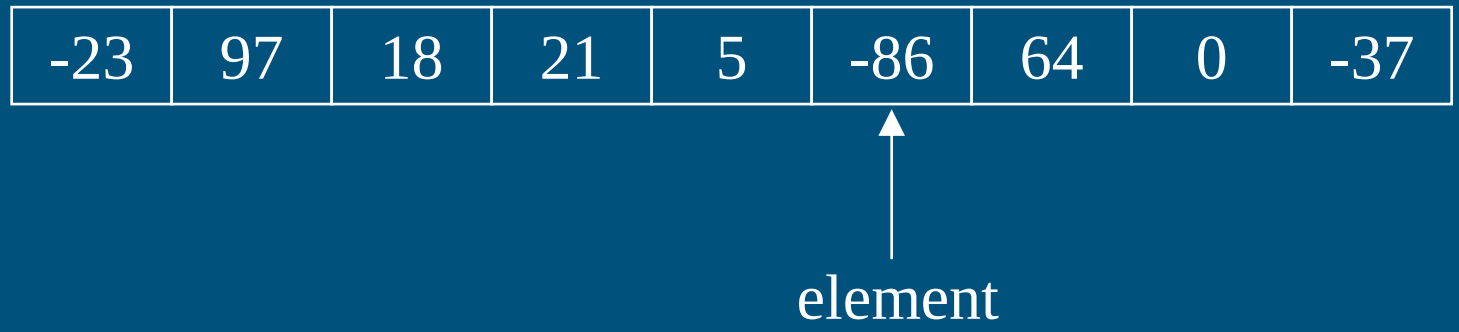

Searching for -86.

# Linear Search Example #5




Searching for -86.

# Linear Search Example #6




Searching for -86: found!

# Linear Search

| -23 | 97 | 18 | 21 | 5 | -86 | 64 | 0 | -37 |
|---|---|---|---|---|---|---|---|---|

***Linear search*** means looking at each element of the array, in turn, until you find the target value.

# Binary Search

- Used with sorted array or list.
- Steps to search ‘x’ in list[l..r]:
  1. Compute mid = (l+r) / 2
  2. Compare x with list[mid].
  3. If matched, return mid.
  4. If not, check whether x is less or greater than list[mid].
  5. If x > list[mid], then pick the elements on the right side of the middle element, i.e., set l=mid+1(as the list/array is sorted, hence on the right, we will have all the numbers greater than the middle number), and goto step 1.
  6. If x < list[mid], then pick the elements on the left side of the middle element, i.e., set r=mid-1 and start again from the step 1.

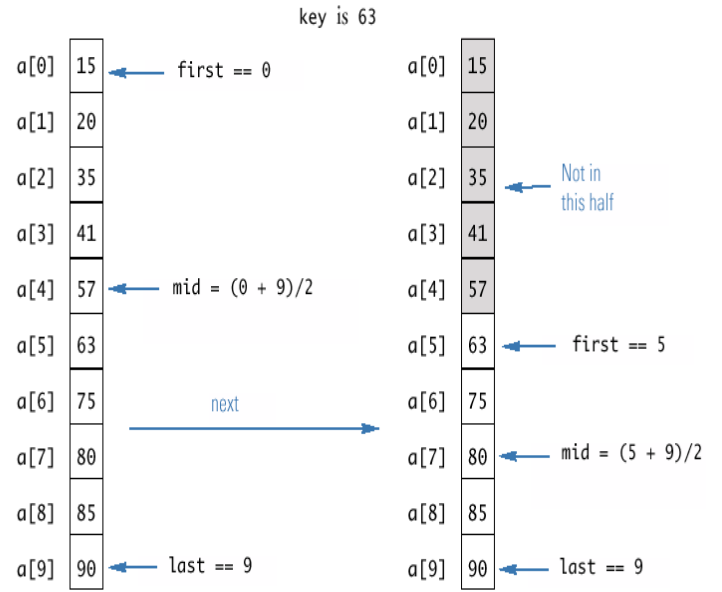
# Algorithm

Algorithm binary_search
  A ← sorted array
  n ← size of array
  x ← value to be searched

  Set lowerBound = 1
  Set upperBound = n

```
  while x not found
    if upperBound < lowerBound
      EXIT: x does not exists.

    set midPoint = lowerBound + ( upperBound - lowerBound ) / 2

    if A[midPoint] < x
      set lowerBound = midPoint + 1

    if A[midPoint] > x
      set upperBound = midPoint - 1

    if A[midPoint] = x
      EXIT: x found at location midPoint
  end while

end procedure
```

**Display 11.7 Execution of the Method search**




**Display 11.7 Execution of the Method search** (continued)