CS310: ALGORITHMS AND

DATA STRUCTURES

Searching Problem

Input: A sequence of n numbers: a₁, a₂, a₃, ..., a_n and a value v

Output: If v is present in the sequence, provide its location. Else say it is not present

Linear Search

A[1...n]
for I =1 to n
 if A[i] == v then return index end if
end for
return not_found

Computational Analysis

- Best case analysis is bogus
- Average case analysis is complex
- What is going to happen in worst case?

 $\Theta(n)$ which means O(n) and $\Omega(n)$

Can we do better than linear search?

- □ Yes, if the input sequence is sorted
- Enables us to do efficient searching binary search

Binary Search – Pseudo Code

```
lower = 1; upper = n
while (lower \leq = upper)
  middle = floor((lower + upper)/2)
  if v == A[middle]
      return middle
  else if v < A[middle]
      upper = middle - 1
  else if v > A[middle]
      lower = middle + 1
end while
```

Binary Search – Pseudo Code

```
binary_search(A, v, lower, upper)
 middle = floor((lower + upper)/2)
 if v == A[middle]
     return middle
 else if v < A[middle]
     binary_search(A, v, lower, middle – 1)
 else
```

binary_search(A, v, middle + 1, upper)

Quiz

Show all values of lower, upper and middle indices when binary search used to search for 9 in the given array. It is your responsibility to make the array suitable for the binary search algorithm

{1,4,7,8,3,6,5,2}

Assume middle is the floor of the average of upper and lower indices.

What do you think the run time equation of binary search would look like?

Binary Search – Analysis

 \Box T(n) = T(n/2) + c

Divide and Conquer

- Divide The overall problem into sub problems
- (A sub problem is a smaller instance of the same type of problem)
- Conquer Recursively solve the sub problems
 (When the sub problems get small enough, solve them directly)
- Combine The answers to the sub problems

Run Time of DIVIDE-CONQUER

- If DIVIDE step divides a problem in a sub problems, each sub problem may be of size n/b
- The COMBINE step may take f(n) time

$$\Box T(n) = a T(n/b) + f(n)$$

- Values of a, b and f(n):
 - □ for merge sort?
 - for binary search?