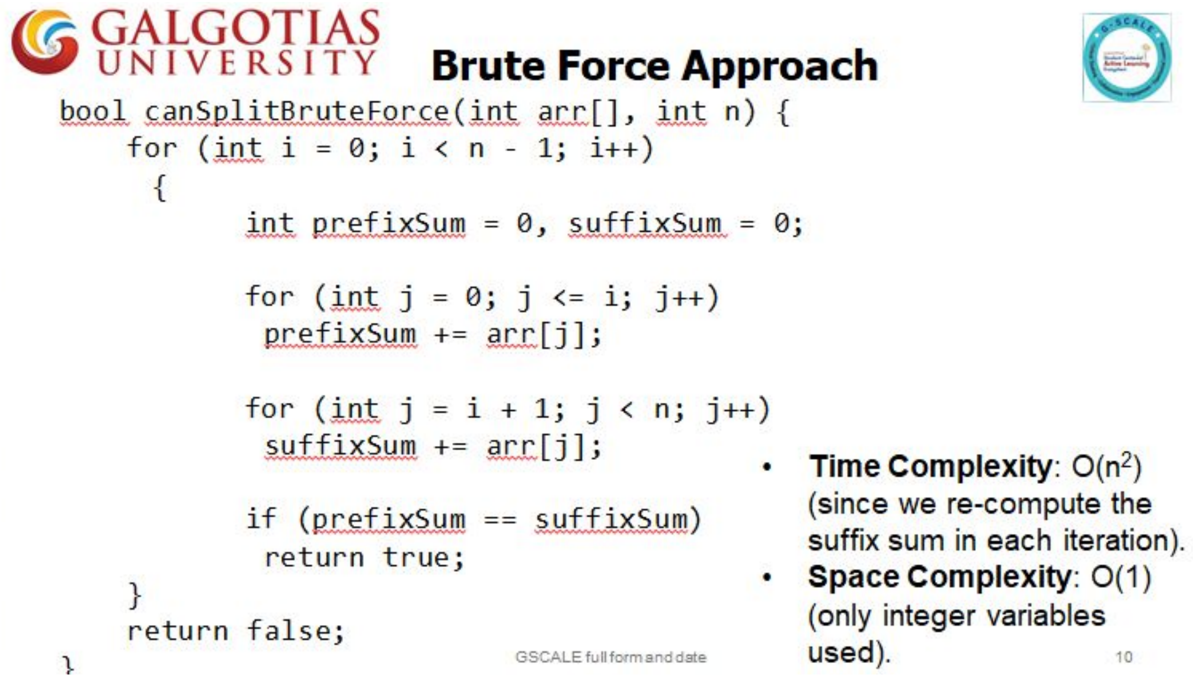
Find two numbers in a sorted array that add upto a target

Session No.: 3
Course Name: Advanced Algorithmic Problem Solving
Course Code: R1UC601B
Instructor Name: Dr. Mohamad Faiz
Duration: 50 mins
Date of Conduction of Class:

Recap of Previous Topic
Split Array in two equal parts

[1-mins]



Brute Force Approach

```
bool canSplitBruteForce(int arr[], int n) {
    for (int i = 0; i < n - 1; i++)
     {
          int prefixSum = 0, suffixSum = 0;

          for (int j = 0; j <= i; j++)
           prefixSum += arr[j];

          for (int j = i + 1; j < n; j++)
           suffixSum += arr[j];

          if (prefixSum == suffixSum)
           return true;
    }
    return false;
}
```

- **Time Complexity**: O(n^2) (since we re-compute the suffix sum in each iteration).
- **Space Complexity**: O(1) (only integer variables used).

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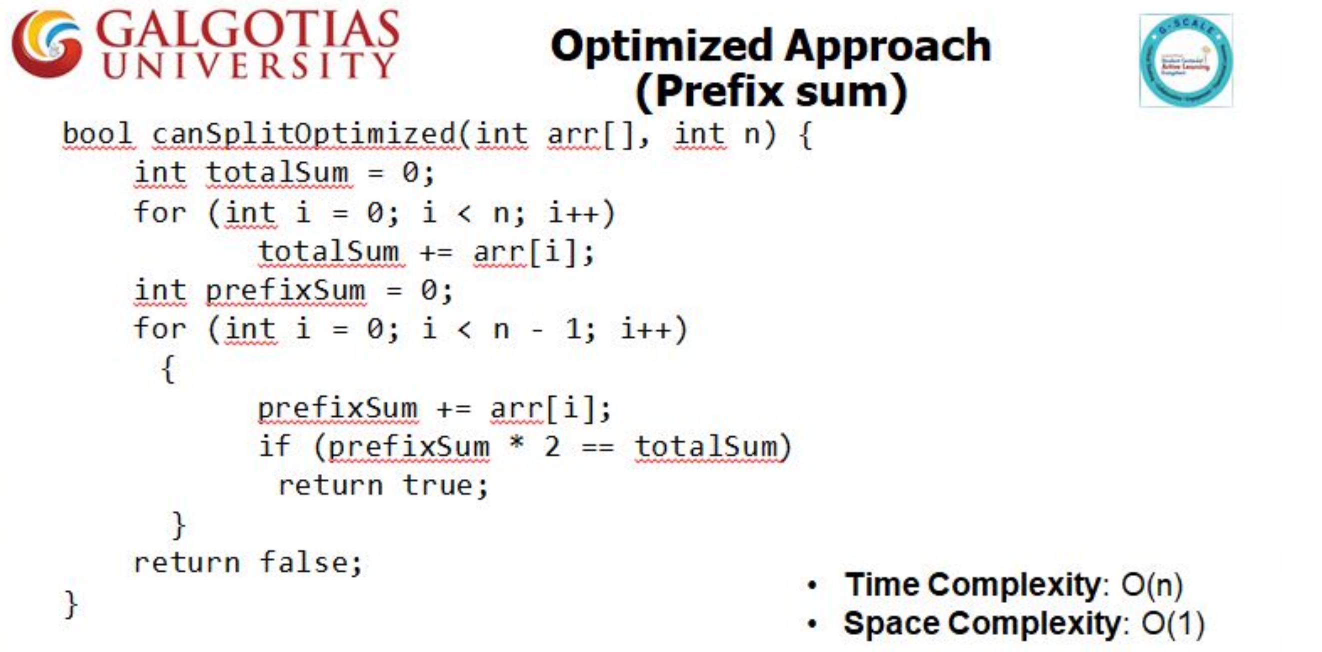


Optimized Approach (Prefix sum)

```
bool canSplitOptimized(int arr[], int n) {
    int totalSum = 0;
    for (int i = 0; i < n; i++)
          totalSum += arr[i];
    int prefixSum = 0;
    for (int i = 0; i < n - 1; i++)
     {
          prefixSum += arr[i];
          if (prefixSum * 2 == totalSum)
           return true;
     }
    return false;
}
```

- **Time Complexity**: O(n)
- **Space Complexity**: O(1)

Pre-Class Assessment

[2-mins]

How to participate?

1 Go to wooclap.com

2 Enter the event code in the top banner

Event code
JQOHCJ

[1-mins]

finding two numbers in a sorted array that sum up to a given target.

Learning Outcomes

[2-mins]

By the end of this session, You will be able to:

Explain the two-pointer approach for solving the problem.

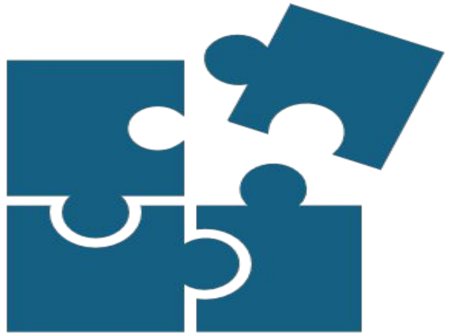
Implement an efficient algorithm to find two numbers that add up to a target in a sorted array.

Session Outline

- Introduce students to the problem of finding two numbers in a sorted array that sum up to a given target.
- Demonstrate the two-pointer approach for solving this problem efficiently.
- Provide hands-on coding practice for implementing this algorithm.

Activity-1 (Think – Pair – Share)

[1-mins]



Discuss in pairs possible methods to find two numbers that add up to a target in a sorted array

Example Input: [1, 2, 3, 4, 6], Target = 6

Example Output: (2, 4)

Concept and Definition for (LO-1) Find Two Numbers That Add Up to a Target

Brute Force Approach:

Iterate through each element and check if there is another element that sums up to the target.

Input:

arr[] = {1, 2, 3, 4, 6, 8, 9}, target = 10

Output:

Pair found: (1, 9)

Explanation:

1+9=10 (Pair found!)

```
void findPairBruteForce(int arr[], int n, int target)
{
   for (int i = 0; i < n; i++) {
     for (int j = i + 1; j < n; j++) {
        if (arr[i] + arr[j] == target) {
          cout << "Pair found: (" << arr[i] << ", " <<
                   arr[j] << ")\n";
            return;
            }
        }
    }
    cout << "No pair found\n";
}
```

Time Complexity: O(n^2)
Space Complexity: O(1)

Concept and Definition for (LO-2) Optimized Approach

Two-Pointer Technique:
Use two pointers: one at the start (left) and one at the end (right).

- If arr[left] + arr[right] == target, return the pair.
- If arr[left] + arr[right] < target, move left forward.
- If arr[left] + arr[right] > target, move right backward.

Time Complexity: O(n) (Single pass)

Activity 2 (Pen Paper): Coding Problem

Problem Statement:

- Given a sorted array and a target sum, find two numbers that add up to the target.
- Example Input: [1, 2, 3, 4, 6], Target = 6
- Example Output: (2, 4)

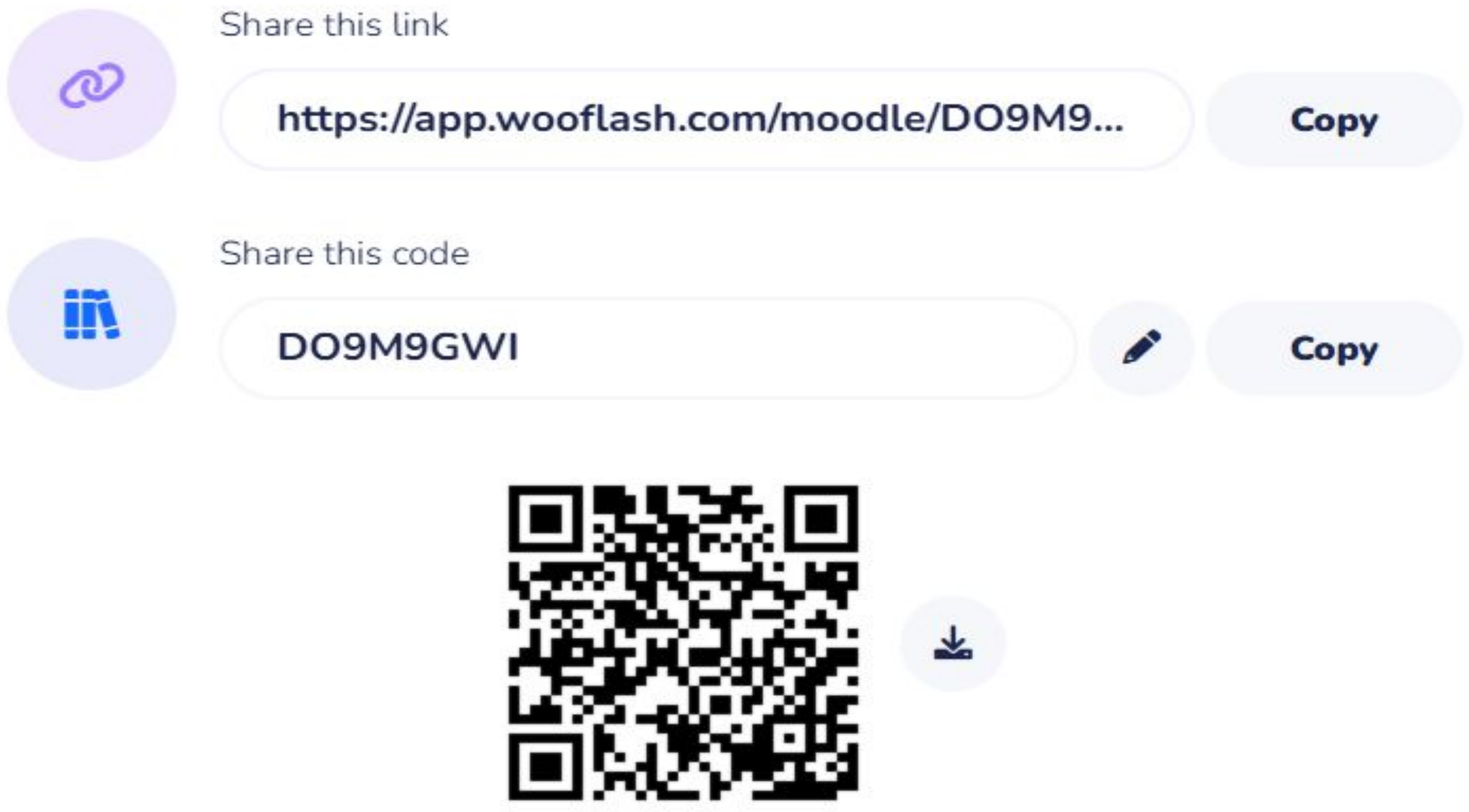
Optimized Approach (Two Pointer)

```
pair<int, int> findTwoSum(vector<int>& arr, int target)
{
    int left = 0, right = arr.size() - 1;
    while (left < right)
    {
        int sum = arr[left] + arr[right];
        if (sum == target)
      return {arr[left], arr[right]};
        else if (sum < target)
      left++;
        else
      right--;
    }
    return {-1, -1}; // No valid pair found
}
```

- **Time Complexity**: O(n)
- **Space Complexity**: O(1)

```
int main() {
    vector<int> arr = {1, 2, 3, 4, 6};
    int target = 6;
    pair<int, int> result = findTwoSum(arr, target);
    if (result.first != -1)
        cout << "Pair found: (" << result.first << ", " <<
result.second << ")" << endl;
    else
        cout << "No valid pair found." << endl;
    return 0;
}
```

Assessment: WooFlash Quiz



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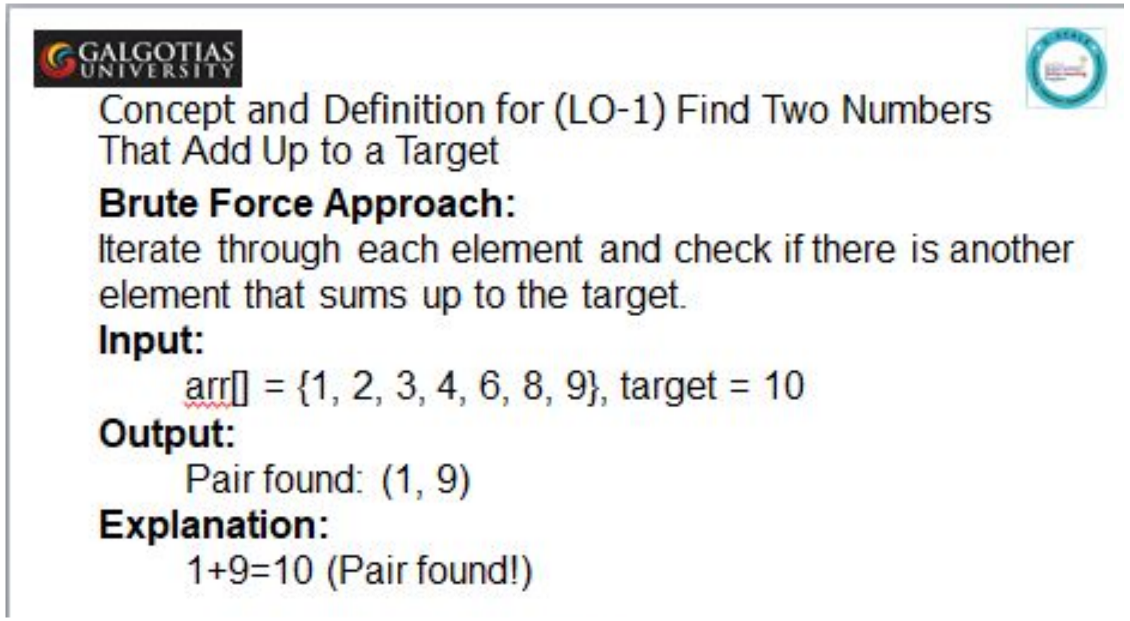
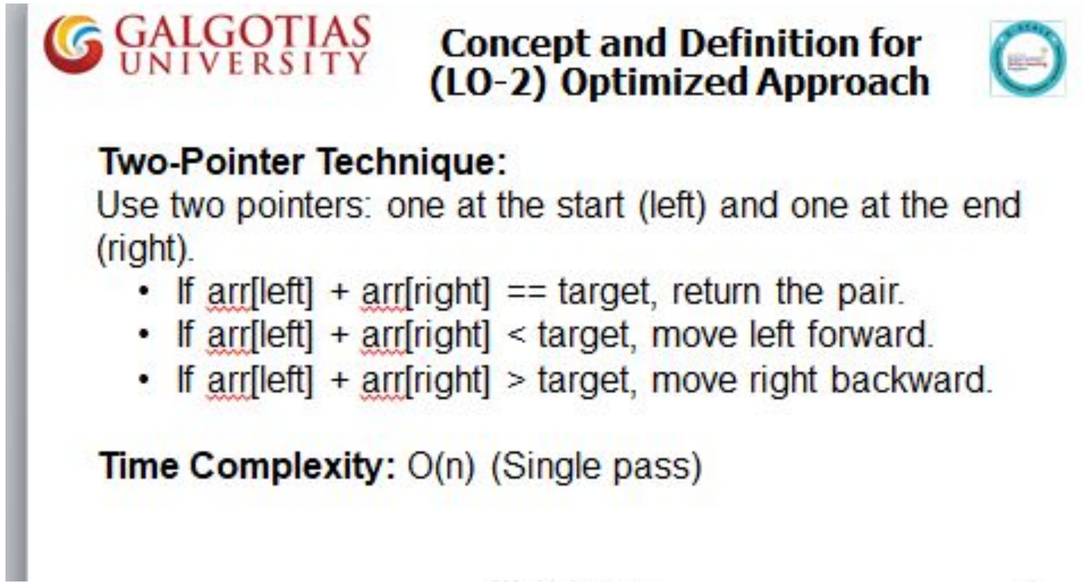
Summary

[1-mins]



Concept and Definition for (LO-1) Find Two Numbers That Add Up to a Target

Brute Force Approach:
Iterate through each element and check if there is another element that sums up to the target.
Input:
arr[] = {1, 2, 3, 4, 6, 8, 9}, target = 10
Output:
Pair found: (1, 9)
Explanation:
1+9=10 (Pair found!)



Concept and Definition for (LO-2) Optimized Approach

Two-Pointer Technique:
Use two pointers: one at the start (left) and one at the end (right).

- If arr[left] + arr[right] == target, return the pair.
- If arr[left] + arr[right] < target, move left forward.
- If arr[left] + arr[right] > target, move right backward.

Time Complexity: O(n) (Single pass)

Learning Outcomes

[2-mins]

Ensure attainment of LO’s in alignment to the learning activities:

Explain the two-pointer approach for solving the problem.

Implement an efficient algorithm to find two numbers that add up to a target in a sorted array.

Discussion on the post session activities

Key points:

1. **Brute-Force Approach**:
   - Time Complexity: **O(n^2)**
   - Space Complexity: **O(1)**
2. **Prefix Sum Approach**:
   - Time Complexity: **O(n)**
   - Space Complexity: **O(1)**

Homework Problem:

"Given a sorted array [1, 7, 5, 3, 10] unsorted array and a target sum of 8, find two numbers that add up to the target.“

Next Session:

Majority Element: Find the element that appears more than n/2 times in an array.

Review and Reflection from students