



Experiment-7

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Section: 22BET_IOT-702 'A'

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Sub Name: Advanced Programming Lab-2

Subject Code: 22ITP-351

Problem 1

1. Aim:

You are climbing a staircase. It takes n steps to reach the top. Each time you can either climb 1 or 2 steps. In how many distinct ways can you climb to the top?

2. Objective:

1. Find the number of distinct ways to reach the n th step when you can climb 1 or 2 steps at a time.
2. Use dynamic programming or mathematical approaches to optimize computation.
3. Implement an efficient solution with minimal time and space complexity.
4. Explore different approaches like Recursion, DP, Iteration, and Matrix Exponentiation for performance trade-offs.

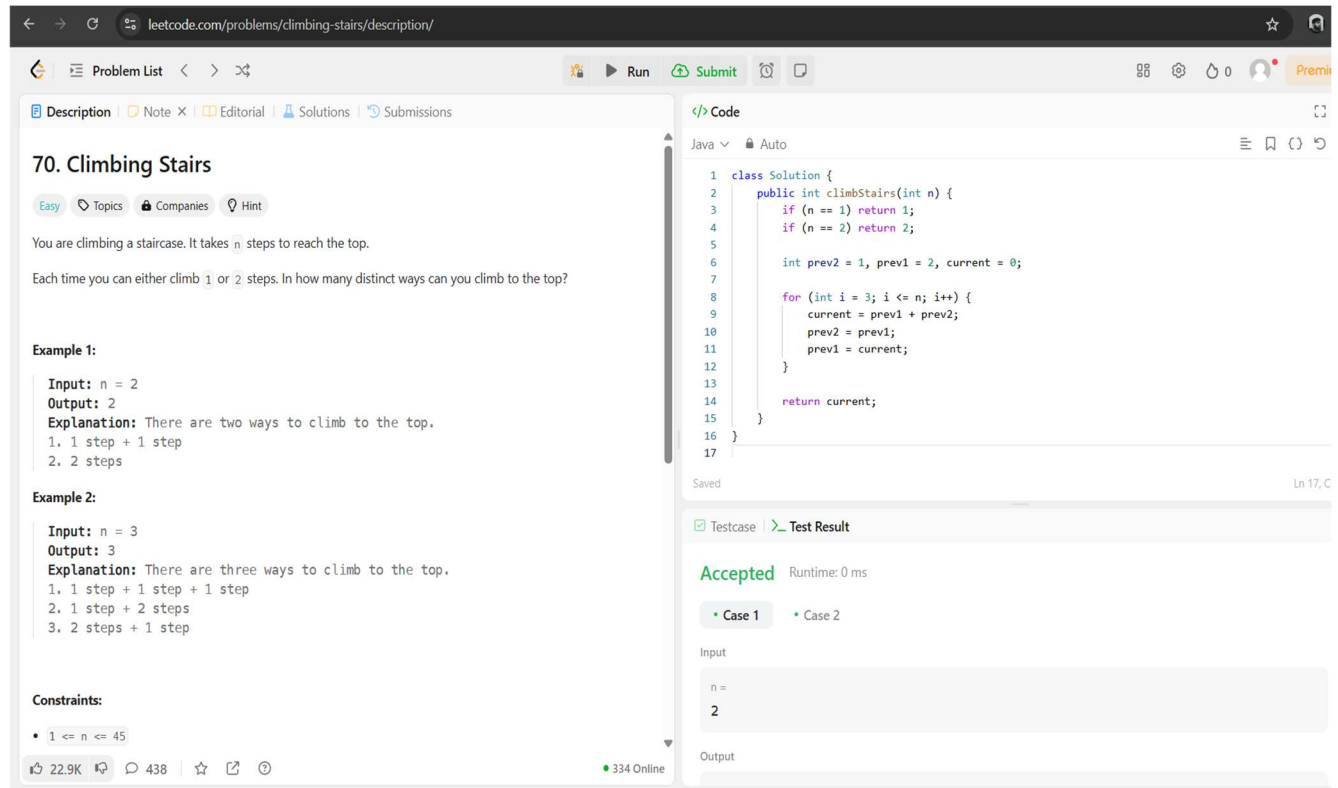
3. Code:

```
class Solution {
public int climbStairs(int n) {
    if (n == 1) return 1;
    if (n == 2) return 2;
    int prev2 = 1, prev1 = 2, current = 0;
    for (int i = 3; i <= n; i++) {
        current = prev1 + prev2;
        prev2 = prev1;
        prev1 = current;
    }
}
```

```
    return current;
```

```
}
```

4. Output:



The screenshot shows the LeetCode interface for problem 70, "Climbing Stairs". The problem description states: "You are climbing a staircase. It takes n steps to reach the top. Each time you can either climb 1 or 2 steps. In how many distinct ways can you climb to the top?"

Example 1:
 Input: $n = 2$
 Output: 2
 Explanation: There are two ways to climb to the top.
 1. 1 step + 1 step
 2. 2 steps

Example 2:
 Input: $n = 3$
 Output: 3
 Explanation: There are three ways to climb to the top.
 1. 1 step + 1 step + 1 step
 2. 1 step + 2 steps
 3. 2 steps + 1 step

Constraints:
 $1 \leq n \leq 45$

The code editor shows a Java solution using a sliding window approach to calculate the number of ways to climb stairs:

```
1 class Solution {
2     public int climbStairs(int n) {
3         if (n == 1) return 1;
4         if (n == 2) return 2;
5
6         int prev2 = 1, prev1 = 2, current = 0;
7
8         for (int i = 3; i <= n; i++) {
9             current = prev1 + prev2;
10            prev2 = prev1;
11            prev1 = current;
12        }
13
14        return current;
15    }
16 }
17
```

The test result shows "Accepted" with a runtime of 0 ms. The input is $n = 2$ and the output is 2.

Climbing the stairs

5. Learning Outcomes:

1. Understanding Dynamic Programming and how to optimize recursion.
2. Recognizing the Fibonacci sequence pattern in real-world problems.
3. Implementing space-optimized DP to reduce memory usage.
4. Exploring efficient mathematical techniques like matrix exponentiation for faster computation.



Problem 2

1. Aim:

Write a program for best time to buy and sell stock.

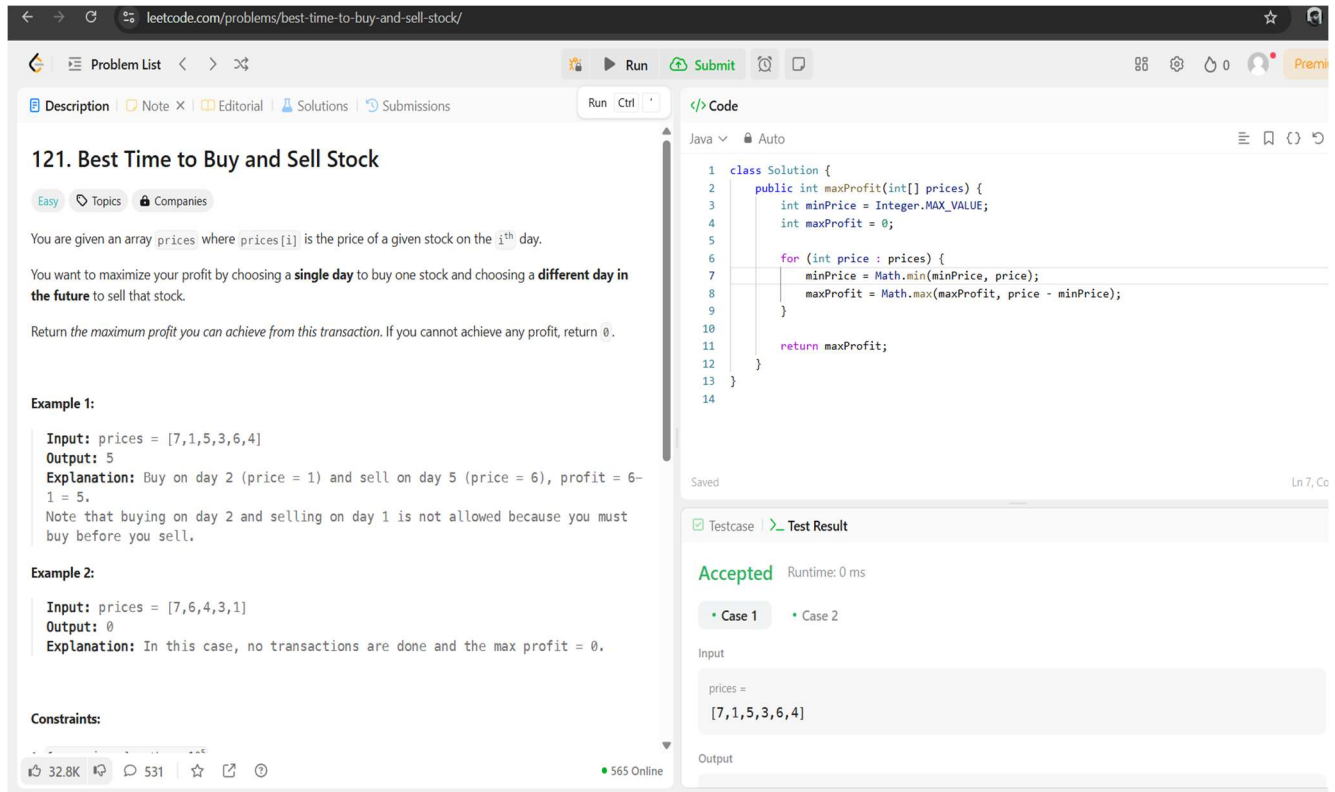
2. Objective:

1. Maximize profit by buying and selling a stock once.
2. Ensure the buy happens before the sell in the given price list.
3. Optimize the solution to run in $O(n)$ time complexity with $O(1)$ space.
4. Utilize dynamic tracking of the minimum price and maximum profit.

3.Code:

```
class Solution {  
  
    public int maxProfit(int[] prices) {  
  
        int minPrice = Integer.MAX_VALUE;  
  
        int maxProfit = 0;  
  
        for (int price : prices) {  
  
            minPrice = Math.min(minPrice, price);  
  
            maxProfit = Math.max(maxProfit, price - minPrice);  
  
        }  
  
        return maxProfit;  
  
    }  
}
```

4.Output:



The screenshot shows the LeetCode interface for problem 121, "Best Time to Buy and Sell Stock". The problem description states: "You are given an array prices where prices[i] is the price of a given stock on the ith day. You want to maximize your profit by choosing a single day to buy one stock and choosing a different day in the future to sell that stock. Return the maximum profit you can achieve from this transaction. If you cannot achieve any profit, return 0." Example 1 shows input [7,1,5,3,6,4] and output 5. Example 2 shows input [7,6,4,3,1] and output 0. The constraints are: 1 ≤ prices.length ≤ 10⁵, 0 ≤ prices[i] ≤ 10⁴. The code editor shows a Java solution:

```
1 class Solution {
2     public int maxProfit(int[] prices) {
3         int minPrice = Integer.MAX_VALUE;
4         int maxProfit = 0;
5
6         for (int price : prices) {
7             minPrice = Math.min(minPrice, price);
8             maxProfit = Math.max(maxProfit, price - minPrice);
9         }
10
11         return maxProfit;
12     }
13 }
14
```

 The test result shows "Accepted" with runtime 0 ms. The input is [7,1,5,3,6,4] and the output is 5.

Buy & sell books

5.Learning Outcomes:

1. Greedy approach for optimal decision-making.
2. Tracking min/max values dynamically in a single pass.
3. Efficient array traversal without extra space.
4. Real-world application of stock trading logic in programming.



Problem 3

1.Aim:

Given an integer array `nums` representing the amount of money of each house, return the maximum amount of money you can rob tonight without alerting the police.

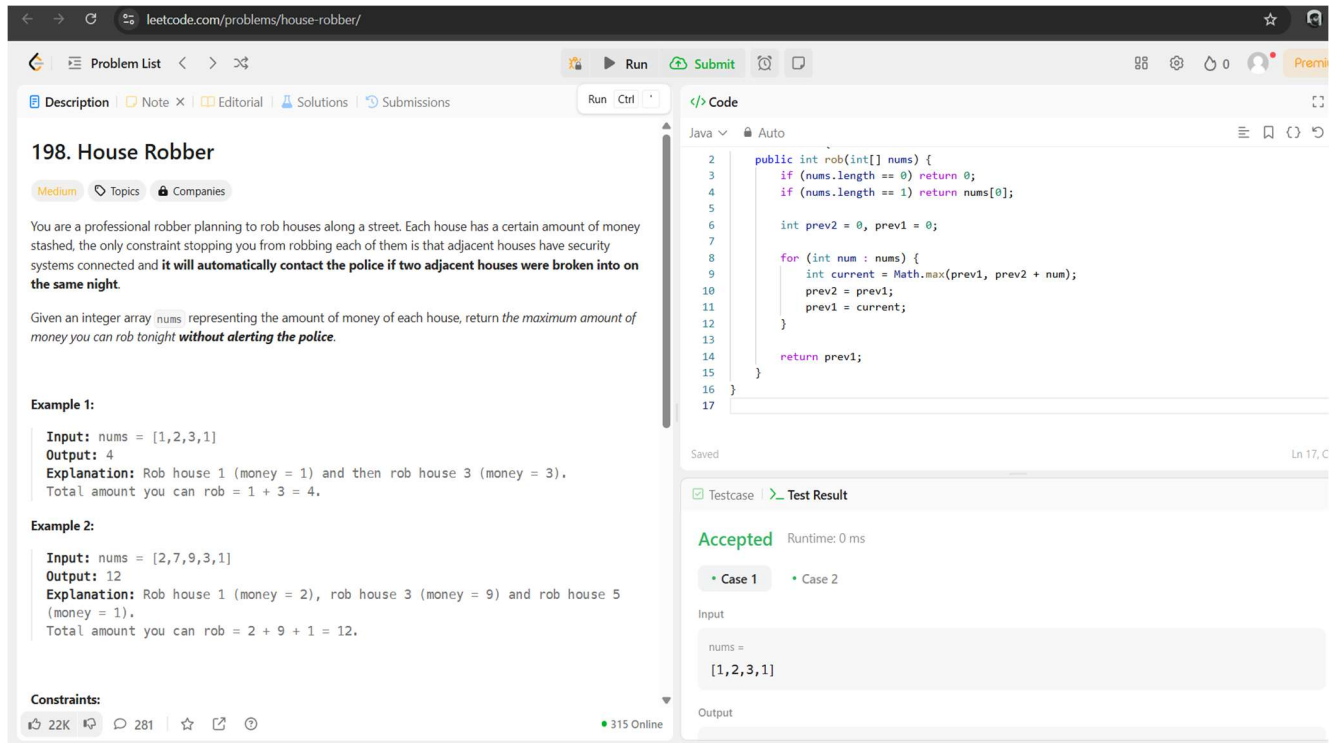
2.Objective:

1. Maximize the amount of money robbed without robbing two adjacent houses.
2. Use dynamic programming to track the optimal subproblems.
3. Achieve $O(n)$ time complexity and $O(1)$ space optimization if possible.
4. Utilize bottom-up DP approach or memoization to improve efficiency.

3.Code:

```
class Solution {  
  
    public int rob(int[] nums) {  
  
        if (nums.length == 0) return 0;  
  
        if (nums.length == 1) return nums[0];  
  
        int prev2 = 0, prev1 = 0;  
  
        for (int num : nums) {  
  
            int current = Math.max(prev1, prev2 + num);  
  
            prev2 = prev1;  
  
            prev1 = current;  
  
        }  
  
        return prev1;  
  
    }  
}
```

4. Output:



The screenshot shows the LeetCode interface for problem 198, "House Robber". The problem description states: "You are a professional robber planning to rob houses along a street. Each house has a certain amount of money stashed, the only constraint stopping you from robbing each of them is that adjacent houses have security systems connected and it will automatically contact the police if two adjacent houses were broken into on the same night. Given an integer array `nums` representing the amount of money of each house, return the maximum amount of money you can rob tonight *without alerting the police*."

Example 1:
Input: `nums = [1,2,3,1]`
Output: 4
Explanation: Rob house 1 (money = 1) and then rob house 3 (money = 3). Total amount you can rob = 1 + 3 = 4.

Example 2:
Input: `nums = [2,7,9,3,1]`
Output: 12
Explanation: Rob house 1 (money = 2), rob house 3 (money = 9) and rob house 5 (money = 1). Total amount you can rob = 2 + 9 + 1 = 12.

Constraints:
22K votes, 281 comments, 315 Online

The code editor shows a Java solution:

```
public int rob(int[] nums) {  
    if (nums.length == 0) return 0;  
    if (nums.length == 1) return nums[0];  
  
    int prev2 = 0, prev1 = 0;  
  
    for (int num : nums) {  
        int current = Math.max(prev1, prev2 + num);  
        prev2 = prev1;  
        prev1 = current;  
    }  
  
    return prev1;  
}
```

The test result shows "Accepted" with a runtime of 0 ms. The input is `nums = [1,2,3,1]` and the output is empty.

House Robber

5. Learning Outcomes:

1. Understanding dynamic programming for optimization.
2. Learning to handle constraints efficiently (avoiding adjacent selections).
3. Implementing state transition logic dynamically in a single pass.
4. Applying real-world security logic in algorithmic thinking.



Problem 4

1.Aim:

Write a program to decode the string in different ways.

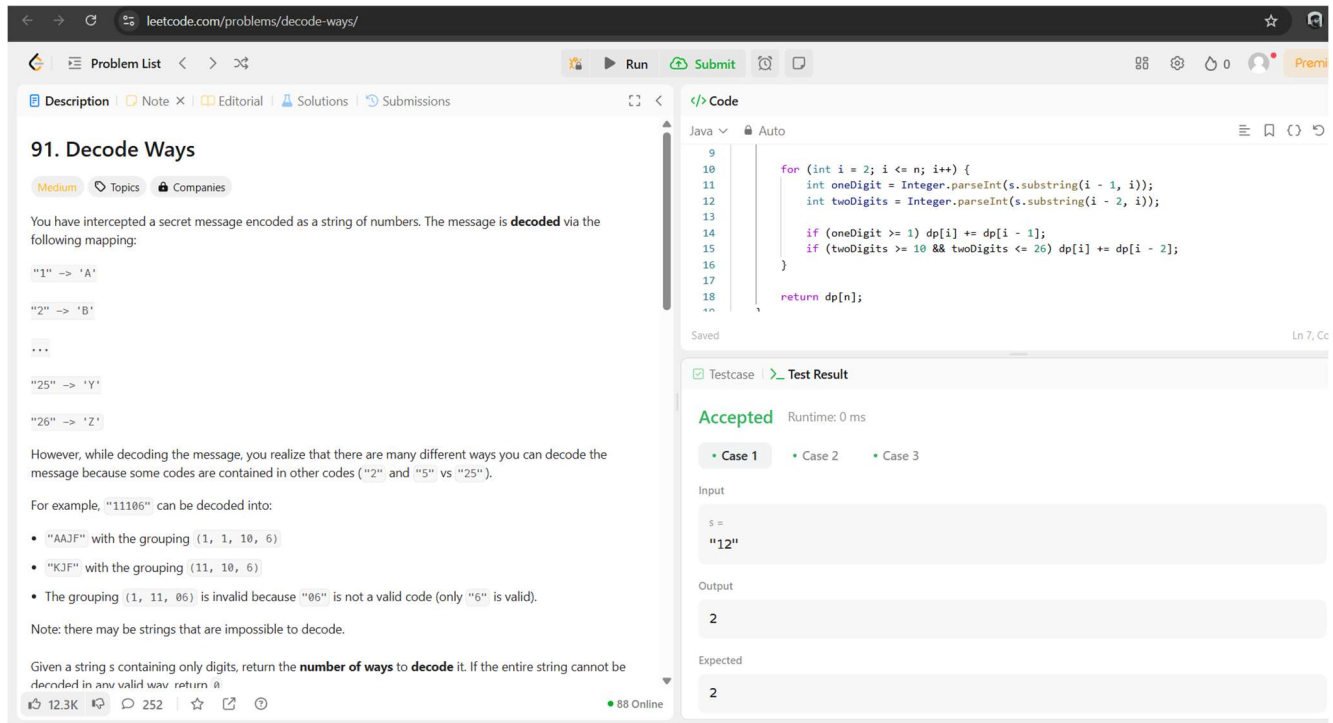
2.Objective:

1. Count the number of ways to decode a given numeric string where:
2. '1' \rightarrow 'A', '2' \rightarrow 'B', ..., '26' \rightarrow 'Z'.
3. Handle leading zeros and invalid sequences correctly.
4. Use Dynamic Programming (DP) to optimize the solution in O(n) time.
5. Implement bottom-up DP or recursive memoization to avoid recomputation.

3.Code:

```
class Solution {
public int numDecodings(String s) {
    if (s == null || s.length() == 0 || s.charAt(0) == '0') return 0;
    int n = s.length();
    int[] dp = new int[n + 1];
    dp[0] = 1;
    dp[1] = s.charAt(0) != '0' ? 1 : 0;
    for (int i = 2; i <= n; i++) {
        int oneDigit = Integer.parseInt(s.substring(i - 1, i));
        int twoDigits = Integer.parseInt(s.substring(i - 2, i));
        if (oneDigit >= 1) dp[i] += dp[i - 1];
        if (twoDigits >= 10 && twoDigits <= 26) dp[i] += dp[i - 2];
    }
    return dp[n];
}
```

4. Output:



The screenshot shows the LeetCode interface for problem 91, "Decode Ways". The problem description states that a secret message is encoded as a string of numbers, and the goal is to determine the number of ways to decode it. The mapping is: "1" -> 'A', "2" -> 'B', ..., "25" -> 'Y', "26" -> 'Z'. The example shows "11106" can be decoded into "AAJF" (1, 1, 10, 6) or "KJF" (11, 10, 6), but "06" is invalid. The solution provided is a Java code snippet using dynamic programming. The test results show the solution is "Accepted" with a runtime of 0 ms for Case 1, where the input is "12" and the output is 2.

91. Decode Ways

Medium Topics Companies

You have intercepted a secret message encoded as a string of numbers. The message is **decoded** via the following mapping:

"1" -> 'A'
"2" -> 'B'
...
"25" -> 'Y'
"26" -> 'Z'

However, while decoding the message, you realize that there are many different ways you can decode the message because some codes are contained in other codes ("2" and "5" vs "25").

For example, "11106" can be decoded into:

- "AAJF" with the grouping (1, 1, 10, 6)
- "KJF" with the grouping (11, 10, 6)
- The grouping (1, 11, 06) is invalid because "06" is not a valid code (only "6" is valid).

Note: there may be strings that are impossible to decode.

Given a string *s* containing only digits, return the **number of ways to decode** it. If the entire string cannot be decoded in any valid way, return 0.

12.3K 252 88 Online

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```




Problem 5

1.Aim:

Given a string *s* and a dictionary of strings *wordDict*, return true if *s* can be segmented into a space-separated sequence of one or more dictionary words.

2.Objective:

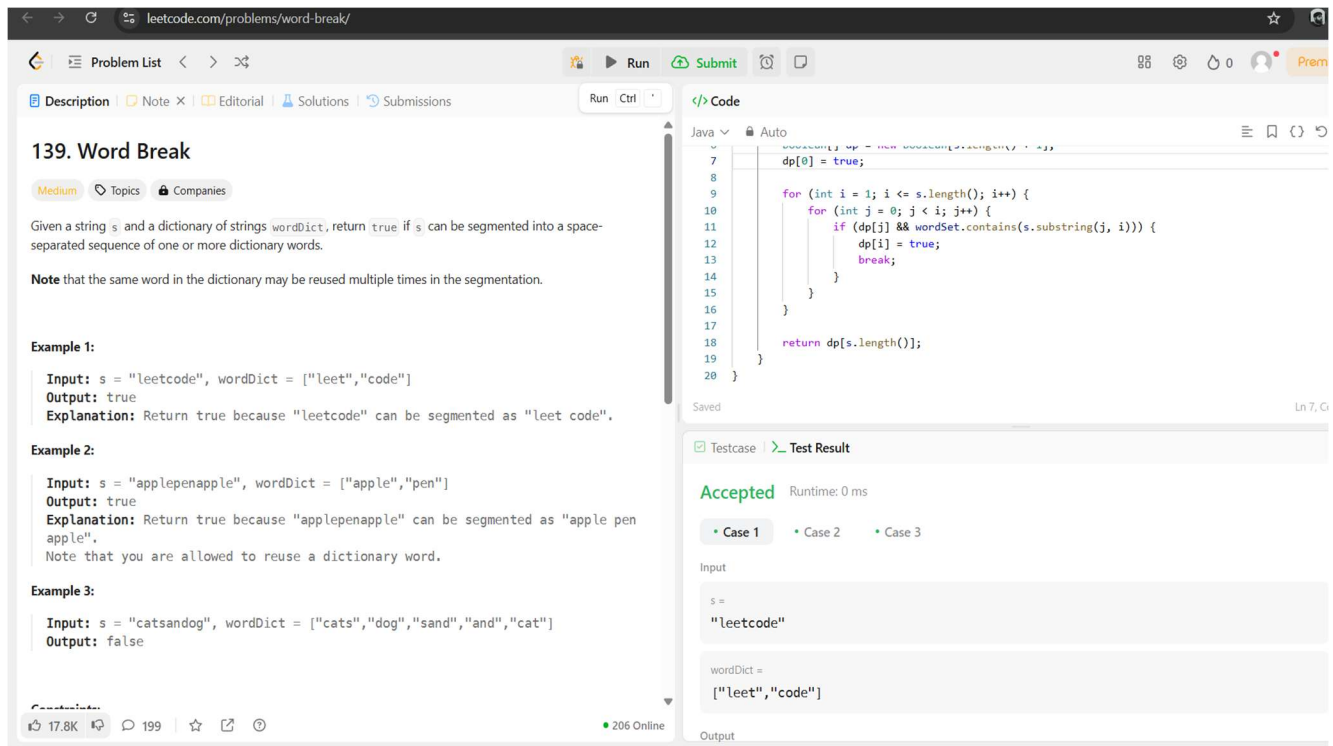
1. Determine if a given string can be segmented into words from a dictionary.
2. Use Dynamic Programming (DP) to efficiently check valid partitions.
3. Optimize the solution to run in $O(n^2)$ time complexity.
4. Utilize a HashSet for fast lookups and bottom-up DP for efficiency.

3.Code:

```
import java.util.*;

class Solution {
    public boolean wordBreak(String s, List<String> wordDict) {
        Set<String> wordSet = new HashSet<>(wordDict);
        boolean[] dp = new boolean[s.length() + 1];
        dp[0] = true; // Base case: empty string is valid
        for (int i = 1; i <= s.length(); i++) {
            for (int j = 0; j < i; j++) {
                if (dp[j] && wordSet.contains(s.substring(j, i))) {
                    dp[i] = true;
                    break;
                }
            }
        }
        return dp[s.length()];
    }
}
```

4. Output:



The screenshot shows the LeetCode interface for problem 139, "Word Break". The problem description states: "Given a string *s* and a dictionary of strings *wordDict*, return *true* if *s* can be segmented into a space-separated sequence of one or more dictionary words. Note that the same word in the dictionary may be reused multiple times in the segmentation."

Example 1:
Input: *s* = "leetcode", *wordDict* = ["leet", "code"]
Output: true
Explanation: Return true because "leetcode" can be segmented as "leet code".

Example 2:
Input: *s* = "applepenapple", *wordDict* = ["apple", "pen"]
Output: true
Explanation: Return true because "applepenapple" can be segmented as "apple pen apple". Note that you are allowed to reuse a dictionary word.

Example 3:
Input: *s* = "catsandog", *wordDict* = ["cats", "dog", "sand", "and", "cat"]
Output: false

The code editor shows a Java solution using dynamic programming. The code is as follows:

```
7 dp[0] = true;
8
9 for (int i = 1; i <= s.length(); i++) {
10     for (int j = 0; j < i; j++) {
11         if (dp[j] && wordSet.contains(s.substring(j, i))) {
12             dp[i] = true;
13             break;
14         }
15     }
16 }
17
18 return dp[s.length()];
19 }
20 }
```

The test result shows "Accepted" with a runtime of 0 ms. The input is *s* = "leetcode" and *wordDict* = ["leet", "code"].

Word Break

5. Learning Outcomes:

1. Mastering Dynamic Programming for string segmentation problems.
2. Efficient use of HashSet for fast word lookups.
3. Understanding substring processing and nested iteration optimization.
4. Applying real-world NLP techniques for text segmentation.



Problem 6

1.Aim:

Given an integer n , return the least number of perfect square numbers that sum to n .

2.Objective:

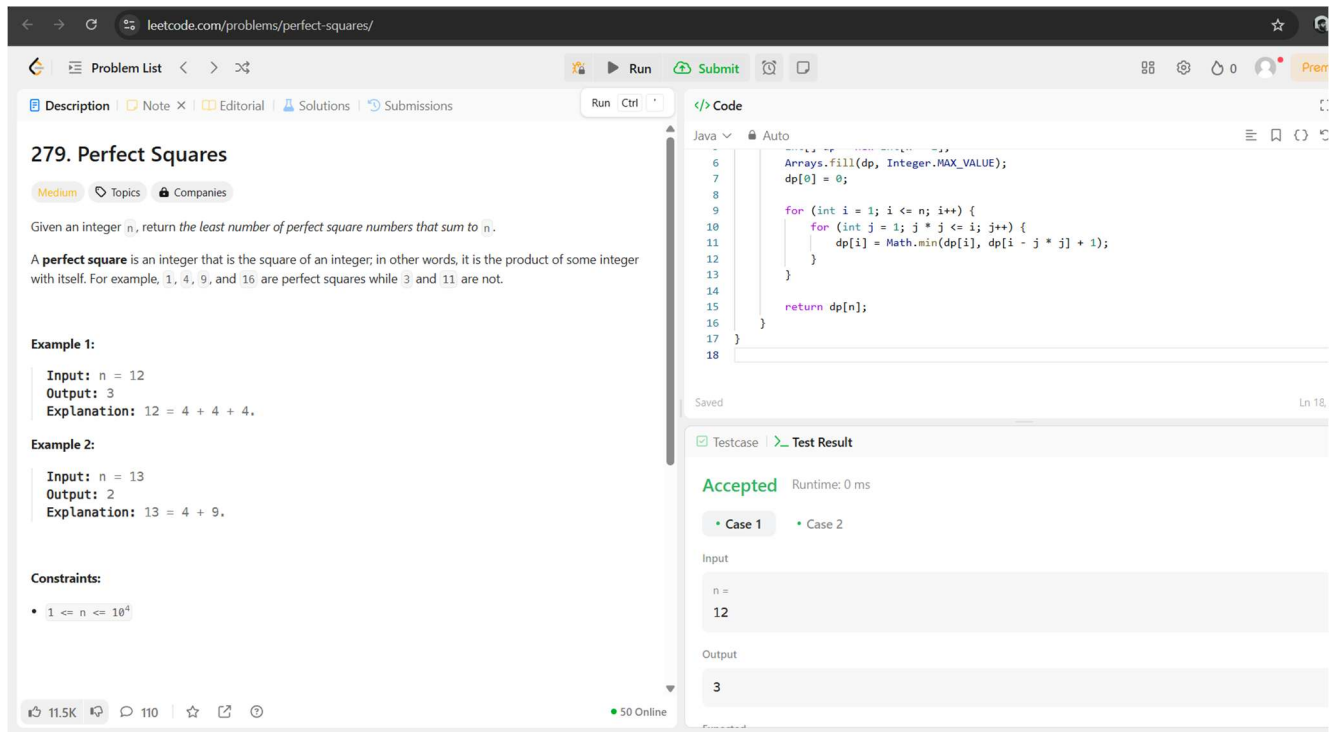
1. Find the minimum number of perfect squares (e.g., 1, 4, 9, 16, ...) that sum up to n .
2. Use Dynamic Programming (DP) or BFS for an optimal solution.
3. Achieve $O(n\sqrt{n})$ time complexity using DP or $O(\sqrt{n})$ using Lagrange's Four-Square Theorem.
4. Implement an efficient approach avoiding redundant calculations.

3.Code:

```
import java.util.*;

class Solution {
    public int numSquares(int n) {
        int[] dp = new int[n + 1];
        Arrays.fill(dp, Integer.MAX_VALUE);
        dp[0] = 0;
        for (int i = 1; i <= n; i++) {
            for (int j = 1; j * j <= i; j++) {
                dp[i] = Math.min(dp[i], dp[i - j * j] + 1);
            }
        }
        return dp[n];
    }
}
```

4.Output:



The screenshot shows the LeetCode interface for problem 279, "Perfect Squares". The problem description states: "Given an integer n , return the least number of perfect square numbers that sum to n ." It provides examples: for $n=12$, the output is 3 (since $12 = 4 + 4 + 4$); for $n=13$, the output is 2 (since $13 = 4 + 9$). The constraints are $1 \leq n \leq 10^4$.

The code editor shows a Java solution using dynamic programming. The code initializes a DP array and iterates through numbers from 1 to n , calculating the minimum number of squares required for each value.

```
6 Arrays.fill(dp, Integer.MAX_VALUE);
7 dp[0] = 0;
8
9 for (int i = 1; i <= n; i++) {
10     for (int j = 1; j * j <= i; j++) {
11         dp[i] = Math.min(dp[i], dp[i - j * j] + 1);
12     }
13 }
14
15 return dp[n];
16 }
17
18
```

The test result section shows "Accepted" with a runtime of 0 ms. The input is $n = 12$ and the output is 3.

Perfect Square

5.Learning Outcomes:

1. Understanding DP for partitioning problems (breaking n into squares).
2. Optimizing nested loops for performance.
3. Exploring alternative approaches like BFS and Mathematical methods.
4. Applying graph traversal (BFS) for shortest path problems.



Problem 7

1.Aim:

You are given an integer array coins representing coins of different denominations and an integer amount representing a total amount of money. Return the fewest number of coins that you need to make up that amount. If that amount of money cannot be made up by any combination of the coins, return -1.

2.Objective:

1. Find the minimum number of coins needed to make a given amount.
2. Use Dynamic Programming (DP) to optimize the solution efficiently.
3. Achieve $O(n * m)$ time complexity using bottom-up DP, where n is the amount and m is the number of coins.
4. Implement an iterative DP approach or BFS for shortest path optimization.

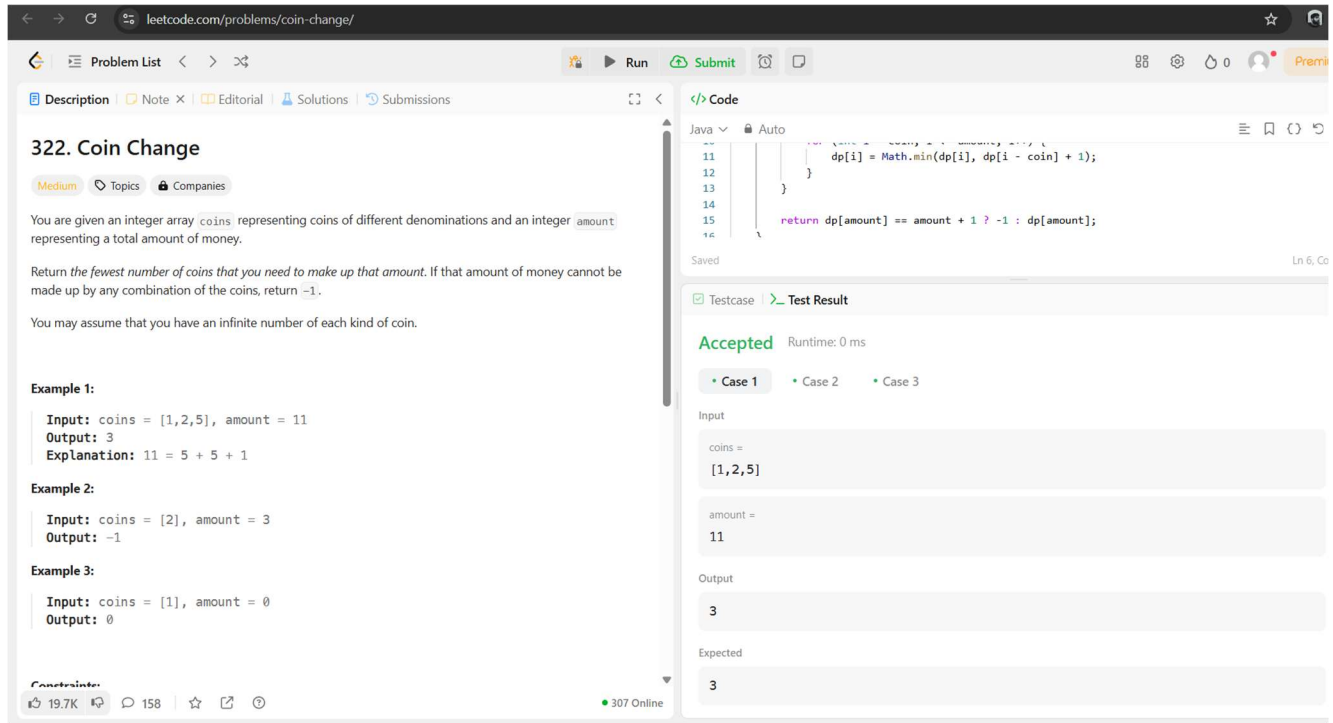
3.Code:

```
import java.util.*;

class Solution {
    public int coinChange(int[] coins, int amount) {
        int[] dp = new int[amount + 1];
        Arrays.fill(dp, amount + 1);
        dp[0] = 0;

        for (int coin : coins) {
            for (int i = coin; i <= amount; i++) {
                dp[i] = Math.min(dp[i], dp[i - coin] + 1);
            }
        }
        return dp[amount] == amount + 1 ? -1 : dp[amount];
    }
}
```

4. Output:



The screenshot displays the LeetCode interface for the '322. Coin Change' problem. The problem description states: 'You are given an integer array `coins` representing coins of different denominations and an integer `amount` representing a total amount of money. Return the fewest number of coins that you need to make up that amount. If that amount of money cannot be made up by any combination of the coins, return `-1`. You may assume that you have an infinite number of each kind of coin.'

Examples provided:

- Example 1: Input: `coins = [1,2,5]`, `amount = 11`. Output: `3`. Explanation: `11 = 5 + 5 + 1`.
- Example 2: Input: `coins = [2]`, `amount = 3`. Output: `-1`.
- Example 3: Input: `coins = [1]`, `amount = 0`. Output: `0`.

The 'Code' section shows a Java solution using dynamic programming:

```
11 dp[i] = Math.min(dp[i], dp[i - coin] + 1);
12 }
13 }
14 }
15 return dp[amount] == amount + 1 ? -1 : dp[amount];
16 }
```

The 'Test Result' section shows the solution is 'Accepted' with a runtime of 0 ms. The input is `coins = [1,2,5]` and `amount = 11`. The output is `3`, which matches the expected result.

Coin Change

5. Learning Outcomes:

1. Mastering Dynamic Programming for minimization problems.
2. Efficiently handling unbounded knapsack-like problems.
3. Implementing bottom-up DP with state transitions.
4. Exploring alternative solutions like BFS for shortest path computation.