Experiment-8(A)

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Subject Name: Advanced Programming Lab-2
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1. **Title:** Graphs (Number of Islands)

2. **Objective:** To count the number of islands in a given m x n 2D grid where '1' represents land and '0' represents water.

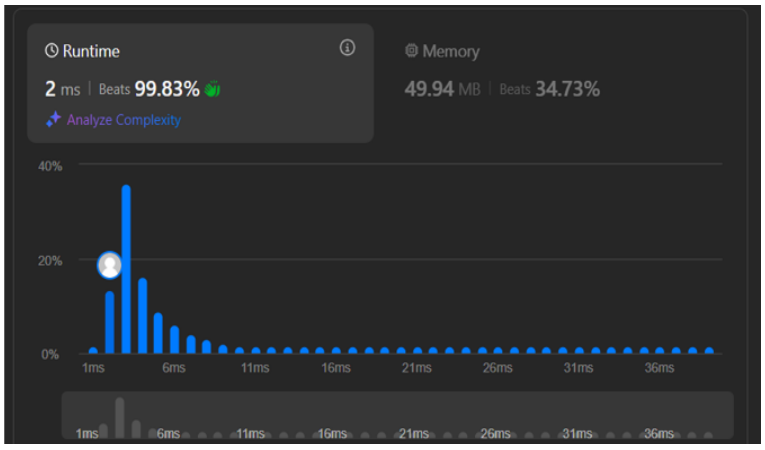
3. **Algorithm:**
   a) **Input:** A 2D grid representing land ('1') and water ('0').
   b) **Initialization:**
      a. Define `count = 0` to track the number of islands.
   c) **DFS Traversal:**
      a. For each cell `(i, j)` in the grid:
         i. If `grid[i][j] == '1'`:
            1. Increment `count` by 1.
            2. Call the **DFS** function to mark all connected '1's as visited.
   d) **DFS Function:**
      a. If cell `(i, j)` is out of grid boundaries or is '0', return.
      b. Otherwise, mark `grid[i][j] = '0'`.
      c. Recursively call DFS for its 4 adjacent cells (up, down, left, right).
   e) **Output:** Return the `count` as the total number of islands.

4. **Implementation/Code:**

```
class Solution {
    public int numIslands(char[][] grid) {
        if (grid == null || grid.length == 0) return 0;

        int count = 0;
        int rows = grid.length;
        int cols = grid[0].length;
```

```
            for (int i = 0; i < rows; i++) {
                for (int j = 0; j < cols; j++) {
                    if (grid[i][j] == '1') {
                        count++;
                        dfs(grid, i, j);  // Mark the entire island as
visited
                    }
                }
            }
            return count;
        }

        // DFS function to mark connected '1's as visited
        private void dfs(char[][] grid, int i, int j) {
            if (i < 0 || i >= grid.length || j < 0 || j >= grid[0].length ||
grid[i][j] == '0') {
                return;
            }

            grid[i][j] = '0'; // Mark the cell as visited
            dfs(grid, i + 1, j); // Down
            dfs(grid, i - 1, j); // Up
            dfs(grid, i, j + 1); // Right
            dfs(grid, i, j - 1); // Left
        }
    }
```

5. **Output:**



6. **Time Complexity:** O (m * n)

7. **Space Complexity:** O(m * n)

Experiment 8(B)

1. **Title:** Word Ladder

2. **Objective:** To find the shortest transformation sequence from beginWord to endWord such that:
   - Each transformed word must exist in the given word list.
   - Each transformation changes only one letter at a time.

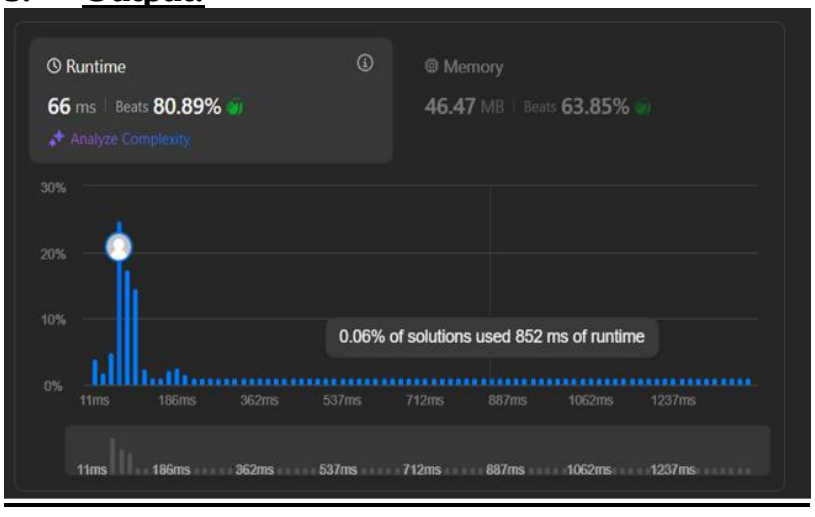
3. **Algorithm:**
   - **Input:** `beginWord`, `endWord`, and `wordList`.
   - **Check Condition:** If `endWord` is not in `wordList`, return 0.
   - **BFS Initialization:**
     - Use a queue for BFS traversal.
     - Add `beginWord` to the queue with `steps = 1`.
   - **BFS Traversal:**
     - While the queue is not empty:
       - Dequeue the front element.
       - For each letter position in the word:
     - Replace that letter with 'a' to 'z'.
     - If the new word is `endWord`, return `steps + 1`.
     - If the new word exists in `wordList`, add it to the queue.
   - **If no transformation found:** Return 0.

4. **Implementation/Code:**

```
import java.util.*;

class Solution {
    public int ladderLength(String beginWord, String endWord,
List<String> wordList) {
        Set<String> wordSet = new HashSet<>(wordList);
        if (!wordSet.contains(endWord)) return 0;

        Queue<String> queue = new LinkedList<>();
        queue.offer(beginWord);
        int steps = 1;

        while (!queue.isEmpty()) {
```

```
                int size = queue.size();
                for (int i = 0; i < size; i++) {
                    String word = queue.poll();
                    char[] wordArray = word.toCharArray();

                    for (int j = 0; j < wordArray.length; j++) {
                        char originalChar = wordArray[j];
                        for (char c = 'a'; c <= 'z'; c++) {
                            wordArray[j] = c;
                            String newWord = new String(wordArray);

                            if (newWord.equals(endWord)) return steps + 1;
                            if (wordSet.contains(newWord)) {
                                queue.offer(newWord);
                                wordSet.remove(newWord);
                            }
                        }
                        wordArray[j] = originalChar;
                    }
                }
                steps++;
            }
            return 0;
        }
    }
```

5. Output:



6. Time Complexity: O(n *m *26)

7. Space Complexity: O(n)

Experiment 8(C)

1. **Title:** Surrounded Regions

2. **Objective:** To modify the given board such that all regions surrounded by 'X' are captured.

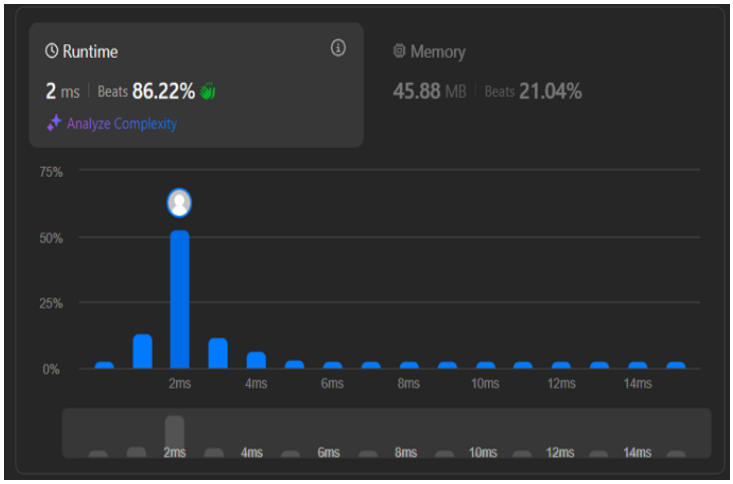
3. **Algorithm:**
   - **Input:** A 2D character array `board`.
   - **DFS Traversal:**
     - Perform DFS on all boundary 'O's and mark them as safe.
   - **Conversion Step:**
     - Iterate over the board:
       - Change remaining `'O'` to `'X'`.
       - Change safe-marked `'S'` back to `'O'`.
   - **Output:** Return the modified board.

5. **Implementation/Code:**

```
class Solution {
    public void solve(char[][] board) {
        int m = board.length, n = board[0].length;

        for (int i = 0; i < m; i++) {
            dfs(board, i, 0);
            dfs(board, i, n - 1);
        }

        for (int j = 0; j < n; j++) {
            dfs(board, 0, j);
            dfs(board, m - 1, j);
        }

        for (int i = 0; i < m; i++) {
            for (int j = 0; j < n; j++) {
                if (board[i][j] == 'O') board[i][j] = 'X';
                if (board[i][j] == 'S') board[i][j] = 'O';
            }
        }
    }

    private void dfs(char[][] board, int i, int j) {
        if (i < 0 || j < 0 || i >= board.length || j >= board[0].length ||
board[i][j] != 'O')
            return;
```

```
                board[i][j] = 'S';
                dfs(board, i + 1, j);
                dfs(board, i - 1, j);
                dfs(board, i, j + 1);
                dfs(board, i, j - 1);
            }
        }
```

6. Output:



8. Time Complexity: O(m * n)

9. Space Complexity: O(m * n)

10. Learning Outcomes:

- Learned effective strategies for marking visited nodes in a 2D matrix.
- Improved problem-solving skills using recursion for complex data structures.
- Learned BFS traversal for shortest path problems.
- Understood the efficient use of HashSet for quick lookups.
- Mastered DFS for connected component problems.
- Improved understanding of marking techniques in grid-based problems.