Island Perimeter - Complete Documentation

1. 📘 Problem Statement

Given a grid representing a map where 1 represents land and 0 represents water, return the perimeter of the island.

- Grid is surrounded by water.
- There's precisely one island made of connected land cells (horizontally/vertically).
- There are no lakes (water not connected to the border).

2. 💡 Intuition

Each land cell initially contributes 4 sides to the perimeter. However, if two land cells are adjacent, they share an edge, and each such shared edge reduces the total perimeter by 2 (1 from each side).

3. 🔍 Key Observations

- Land cells can only be connected horizontally or vertically.
- Shared edges between land cells reduce the perimeter.
- It's enough to check the top and left neighbors only to avoid double-counting shared edges.

4. ⚙ Approach

i. Traverse every cell in the grid.
ii. If the cell island (1):
    a. Add 4 to the perimeter.
    b. Check the top neighbor:
        i. If it's also land, subtract 2 from the perimeter.
    c. Check the left neighbor:
        i. If it's also land, subtract 2 from the perimeter.
iii. Return the final perimeter value.

5. ⊘ Edge Cases

- A single land cell: [[1]] → Perimeter is 4.
- All water: [[0, 0], [0, 0]] → Perimeter is 0.
- Single row or column of land cells.
- Large grids (up to 100x100) with one connected island.

6. Complexity Analysis

 Time Complexity

- O(m × n): Every cell is visited once.

 Space Complexity

- O(1): Only variables used, no extra data structures.

7. Alternative Approaches

a. DFS / BFS

- Traverse the island and calculate the perimeter during traversal.
- More complex but useful if the island is not guaranteed to be connected or fully enclosed.

b. Count 1s and neighbors

perimeter = land_cells * 4 - shared_edges * 2

- Count total land cells and shared neighbor pairs.

8. □ Test Cases

Test Case	Input	Expected Output	Description
TC1	[[1]]	4	Single land cell
TC2	[[1,0]]	4	Horizontal single land
TC3	[[0,1,0,0],[1,1,1,0],[0,1,0,0],[1,1,0,0]]	16	Standard case
TC4	[[0,0],[0,0]]	0	All water
TC5	[[1,1],[1,1]]	8	A square block of land

9. 📝 Final Thoughts

- The problem emphasizes understanding grid traversal and adjacency logic.
- Optimized by avoiding double-counting.
- Can be extended for more complex problems like multiple islands, lakes, or diagonal connections using DFS/BFS.
- Elegant and efficient solution for interviews and real-world map-based grid problems.