492. Construct the Rectangle - Full Documentation

1. Problem Statement

Given an integer area, design a rectangle (length L and width W) such that:

- L * W == area
- L >= W
- L - W is minimized (i.e., length and width should be as close as possible).

Return the rectangle dimensions [L, W].

2. Intuition

We want to make the rectangle as close to a square as possible because:

- A perfect square naturally has L = W.
- If not a perfect square, the closest factors around the square root will minimize the difference.

Thus, starting from the square root of the area makes finding the best pair efficient.

3. Key Observations

- The closer L and W are, the smaller the difference L - W.
- L should be greater than or equal to W.
- The width W must divide the area exactly (area % W == 0).

4. Approach

- Start from the integer part of the square root of the given area.
- Decrease W one by one until it divides area perfectly.
- Once found, compute L = area // W.
- Return [L, W].

Step-by-Step:

1. Initialize w = int(area ** 0.5).
2. While area % w != 0, decrement w by 1.
3. When found, L = area // w.
4. Return [L, W].

5. **Edge Cases**

- Perfect squares (e.g., area = 4) → Return [2, 2].
- Prime numbers (e.g., area = 37) → Only divisors are 1 and itself → Return [37, 1].
- Minimum area (e.g., area = 1) → Only [1, 1] possible.
- Large numbers (e.g., area = 10^7) → Efficient solution needed to avoid timeouts.

6. **Complexity Analysis**

Time Complexity

- In the worst case, we check all numbers from sqrt(area) down to 1.
- Therefore, time complexity is O(√area).

Space Complexity

- We use only a few variables (w, L), so space complexity is O(1) (constant space).

7. **Alternative Approaches**

- Brute-force method:
  Check all pairs from 1 to area, but it will be very slow (O(area) time).
- Optimized factor search:
  Start from 1 and collect all factor pairs. Then choose the one with the minimum difference.But starting from √area is simpler and faster.

8. Test Cases

Test Case	Input	Expected Output	Explanation
1	area = 4	[2, 2]	Perfect square
2	area = 37	[37, 1]	Prime number
3	area = 122122	[427, 286]	Large number
4	area = 1	[1, 1]	Smallest area
5	area = 10000000	[5000, 2000]	Very large area, efficient search needed

9. Final Thoughts

- Efficiency is achieved by starting from the square root.
- Guarantees minimal difference because we start from the "most balanced" dimension.
- Simple yet powerful — no extra arrays or heavy computations.
- For larger areas, this method ensures you find the best answer fast without time limit issues.