Rotate Image (In-Place)

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1. The strategy

Don't try to move 1 to 3's spot directly. Do it in two clean moves.

Original:

[1, 2, 3]

[4, 5, 6]

[7, 8, 9]

Step A: Transpose (Swap [i][j] with [j][i])

- we only touch the Upper Triangle (above diagonal) to avoid swapping things back.
- 2 (at 0,1) swaps with 4 (at 1,0)
- 3 (at 0,2) swaps with 7 (at 2,0)
- 6 (at 0,3) swaps with 8 (at 2, 1).

After Transpose:

[1, 4, 7] ← look, Row 0 is now what Col 0 was!

[2, 5, 8]

[3, 6, 9]

Step B: Reverse Rows

- Take Row 0: [1,4,7] → [7, 4, 1]
- Take Row 1: [2, 5, 8] → [8, 5, 2]
- Take Row 2: [3, 6, 9] → [9, 6, 3]

Final Result (Rotated):

[7, 4, 1]

[8, 5, 2]

[9, 6, 3]

2. The loop Trap (Transpose)

why range(i, n) and not range(0, n)?

If you loop j from 0:

1. when i=0, j=1 : You swap (0,1) with (1,0)
2. later, when i=1, j=0: You swap (1,0) with (0,1).
3. Result: You swapped it twice! You undid your work.
4. fix: range(i, n) ensures we only touch each pair once.

3. Complexity

- Time: $O(N^2)$ (we touch every cell once)
- Space: O(1) (we modified the list directly without making a copy).