**Memory updated**

**Alright, let’s break down rotating an N×NN \times NN×N matrix by 90 degrees clockwise in a way that’s easy to visualize and understand.**

**Matrix Rotation Basics**

**Imagine you have a square grid (matrix) of numbers or colors, and you want to rotate this grid 90 degrees to the right. Here's how you can think about it:**

**Original Matrix**

**Let’s use a 3x3 matrix as an example:**

**1 2 3**

**4 5 6**

**7 8 9  
The main diagonal elements are 1, 5, and 9. They are located at positions [0][0], [1][1], and [2][2], respectively.**

**1 - -**

**- 5 -**

**- - 9**

**Transposing the Matrix**

**When you transpose the matrix, you are essentially flipping it over this diagonal. This means that:**

* **The elements on the diagonal stay in the same place.**
* **The elements above the diagonal swap places with the elements below the diagonal.**

**Transpose the Matrix:**

* **Swap [0][1] with [1][0] (2 with 4)**
* **Swap [0][2] with [2][0] (3 with 7)**
* **Swap [1][2] with [2][1] (6 with 8)**

**Transposed Matrix**

**1 4 7**

**2 5 8**

**3 6 9  
But the elements not on the diagonal have swapped places:**

* **2 and 4**
* **3 and 7**
* **6 and 8**

**Why It Helps Rotate the Matrix**

**By transposing the matrix, the rows and columns are switched. This lays the foundation for rotating the matrix because each row in the transposed matrix corresponds to a column in the original matrix. Reversing each row of the transposed matrix then aligns the elements to their final positions for a 90-degree clockwise rotation.**

**7 4 1**

**8 5 2**

**9 6 3**

**Here's a comparison table for rotating a matrix by 90°, 180°, and 270° clockwise and counterclockwise. The table includes the necessary steps for each rotation.**

| **Rotation** | **Clockwise Steps** | **Result** | **Counterclockwise Steps** | **Result** |
| --- | --- | --- | --- | --- |
| **90°** | **1. Transpose the matrix 2. Reverse each row** | **90° Clockwise Matrix** | **1. Transpose the matrix 2. Reverse each column** | **90° Counterclockwise Matrix** |
| **180°** | **1. Reverse each row 2. Reverse each column** | **180° Clockwise Matrix** | **1. Reverse each row 2. Reverse each column (same as clockwise)** | **180° Counterclockwise Matrix** |
| **270°** | **1. Transpose the matrix 2. Reverse each column** | **270° Clockwise Matrix** | **1. Transpose the matrix 2. Reverse each row (same as 90° clockwise)** | **270° Counterclockwise Matrix** |

**Explanation of the Steps:**

* **Transpose the Matrix: Swap rows with columns, where each element at position [i][j] is swapped with [j][i].**
* **Reverse Each Row: Reverse the order of elements in each row (left to right).**
* **Reverse Each Column: Reverse the order of elements in each column (top to bottom).**

**Detailed Example for 90°, 180°, and 270° Rotations**

**Original Matrix:**

**Copy code**

**1 4 7**

**2 5 8**

**3 6 9**

| **Rotation** | **Clockwise Steps** | **Matrix After Each Step** | **Counterclockwise Steps** | **Matrix After Each Step** |
| --- | --- | --- | --- | --- |
| **90°** | **1. Transpose** | **1 2 3 4 5 6 7 8 9** | **1. Transpose** | **1 2 3 4 5 6 7 8 9** |
|  | **2. Reverse Each Row** | **7 4 1 8 5 2 9 6 3** | **2. Reverse Each Column** | **3 2 1 6 5 4 9 8 7** |
| **180°** | **1. Reverse Each Row** | **7 4 1 8 5 2 9 6 3** | **1. Reverse Each Row** | **7 4 1 8 5 2 9 6 3** |
|  | **2. Reverse Each Column** | **9 6 3 8 5 2 7 4 1** | **2. Reverse Each Column** | **9 6 3 8 5 2 7 4 1** |
| **270°** | **1. Transpose** | **1 2 3 4 5 6 7 8 9** | **1. Transpose** | **1 2 3 4 5 6 7 8 9** |
|  | **2. Reverse Each Column** | **3 2 1 6 5 4 9 8 7** | **2. Reverse Each Row** | **7 4 1 8 5 2 9 6 3** |