Here's a detailed comparison of the steps (like **Transpose**, **Reverse Rows**, and **Reverse Columns**) for rotating a matrix by **90°, 180°, and 270°** degrees, both clockwise and counterclockwise, in a step-by-step format.

**Original Matrix:**

Copy code

1 4 7

2 5 8

3 6 9

**Table: Rotation Steps (Clockwise vs Counterclockwise)**

| **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 |

**Explanation of Steps**

* **Transpose**: Switch rows with columns. For example, in the matrix:

Copy code

1 4 7

2 5 8

3 6 9

After transposing, it becomes:

Copy code

1 2 3

4 5 6

7 8 9

* **Reverse Each Row**: Reverse the order of elements in each row. For example:

Copy code

1 2 3 → 3 2 1

4 5 6 → 6 5 4

7 8 9 → 9 8 7

* **Reverse Each Column**: Reverse the order of elements in each column (flip from top to bottom). For example:

Copy code

1 4 7 → 7 4 1

2 5 8 → 8 5 2

3 6 9 → 9 6 3

**Breakdown for Each Rotation:**

**90° Clockwise:**

1. **Transpose** the matrix:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Row**:

Copy code

7 4 1

8 5 2

9 6 3

**90° Counterclockwise:**

1. **Transpose** the matrix:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Column**:

Copy code

3 2 1

6 5 4

9 8 7

**180° Clockwise/Counterclockwise:**

1. **Reverse Each Row**:

Copy code

7 4 1

8 5 2

9 6 3

1. **Reverse Each Column**:

Copy code

9 6 3

8 5 2

7 4 1

**270° Clockwise:**

1. **Transpose** the matrix:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Column**:

Copy code

3 2 1

6 5 4

9 8 7

**270° Counterclockwise:**

1. **Transpose** the matrix:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Row**:

Copy code

7 4 1

8 5 2

9 6 3

**Summary:**

* **Transpose** swaps rows and columns.
* **Reverse Rows** flips the elements of each row.
* **Reverse Columns** flips the elements of each column.

This table shows the steps and intermediate matrices for each rotation (clockwise and counterclockwise).

**Table: Rotation Steps for Counterclockwise**

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

**Explanation of Steps**

* **Transpose**: Swap rows with columns. For example, in the matrix:

Copy code

1 4 7

2 5 8

3 6 9

After transposing, it becomes:

Copy code

1 2 3

4 5 6

7 8 9

* **Reverse Each Row**: Reverse the order of elements in each row (flip from left to right). For example:

Copy code

1 2 3 → 3 2 1

4 5 6 → 6 5 4

7 8 9 → 9 8 7

* **Reverse Each Column**: Reverse the order of elements in each column (flip from top to bottom). For example:

Copy code

1 4 7 → 7 4 1

2 5 8 → 8 5 2

3 6 9 → 9 6 3

**Detailed Example for Each Rotation (Counterclockwise)**

**90° Counterclockwise:**

1. **Transpose the matrix**:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Column**:

Copy code

3 2 1

6 5 4

9 8 7

**180° Counterclockwise:**

1. **Reverse Each Row**:

Copy code

7 4 1

8 5 2

9 6 3

1. **Reverse Each Column**:

Copy code

9 6 3

8 5 2

7 4 1

**270° Counterclockwise:**

1. **Transpose the matrix**:

Copy code

1 2 3

4 5 6

7 8 9

1. **Reverse Each Row**:

Copy code

7 4 1

8 5 2

9 6 3

**Summary:**

For counterclockwise rotation:

* **90° Counterclockwise**: Transpose the matrix, then reverse each column.
* **180° Counterclockwise**: Reverse each row, then reverse each column (same as 180° clockwise).
* **270° Counterclockwise**: Transpose the matrix, then reverse each row.

These steps show how to perform each rotation counterclockwise, with intermediate matrices shown for every stage.

4o