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Introduction to Matrix

What is Matrix?

- A matrix is a 2D array or a grid-like structure.
- Think of it as a collection of 1D arrays stacked on top of each other, where:
  - Rows represent horizontal slices.
  - Columns represent vertical slices.
- Each element in the matrix is uniquely identified by its row index and column index.

Real-World Representation:

- Board games like chess, Sudoku, and tic-tac-toe can be represented as matrices.
- Spreadsheet tables like Excel grids are essentially matrices.
- Example of a 3x3 matrix:

[1, 2, 3]
[4, 5, 6]
[7, 8, 9]

Rows: [1, 2, 3], [4, 5, 6], [7, 8, 9]

Columns: [1, 4, 7], [2, 5, 8], [3, 6, 9]

Why Matrix?

Real-Life Applications:

- **Board Games:** Represent game states (e.g., Sudoku grid).
- **Image Processing:** Images are stored as matrices of pixel intensities.
- **Data Science and Machine Learning:** Represent datasets for mathematical operations.

Algorithmic Problems:

- **Graph Representation:** Adjacency matrix for representing connections between nodes.
- **Backtracking Algorithms:** Solve maze or pathfinding problems using grid traversal.
- **Dynamic Programming:** Solve problems like the longest common subsequence (LCS) using a DP matrix.

Matrix Dimensions

- The **dimension** of a matrix specifies its size in terms of rows and columns:
  - Represented as rows x columns.
- **Examples:**
  - A **single row matrix**: 1xN (e.g., [1, 2, 3, 4]).
  - A **single column matrix**: Nx1 (e.g., [1], [2], [3]).
  - **Square Matrix:** Equal number of rows and columns (e.g., 3x3).
  - **Rectangular Matrix:** Rows and columns differ (e.g., 3x4).

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Matrix Traversal

Matrix Traversal

- The process of visiting each element in a matrix systematically.

- Matrix operations, such as searching, modifying values, or applying algorithms.

How Traversal Works

- **Matrix Representation:** A matrix is represented as matrix[row][col]:
  - row denotes the horizontal index.
  - col denotes the vertical index.

- Traversing requires iterating through rows and columns using **two nested loops**:
  - **Outer loop**: Controls the rows.
  - **Inner loop**: Controls the columns.

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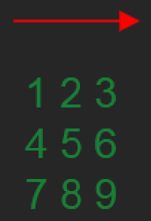
Row Column Specific Traversal

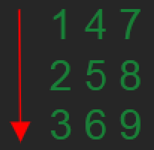
Types of Matrix Traversal

1. **Row-Wise Traversal:**
    - For each row, traverse all the columns.
    - **Example :**



1 2 3
4 5 6
7 8 9

2. **Column-Wise Traversal:**
    - For each column, traverse all the rows.
    - **Example :**



1 4 7
2 5 8
3 6 9

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Diagonal Traversal

Diagonal Traversal

- Visit elements along the diagonals of the matrix.
- **Primary Diagonal:** Elements where row = col (e.g., [1, 5, 9]).
- **Secondary Diagonal:** Elements where row + col = n-1 (e.g., [3, 5, 7]).
- **Optimized Diagonal Traversal (O(n)):**
  - Use the relationship between rows and columns to directly access diagonal elements without full traversal.

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Activity 2

Activity 2

- </> Magic Squares in Grid - In Session
- </> Rotate Image
- </> Pyramid Pattern
- </> Binary Search