

SPARSE MATRIX



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Objectives

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To know what is sparse matrix

How to represent sparse matrix

Need of Sparse Matrix

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- A matrix is a very commonly used mathematical object.
- To represent a matrix, we need a **two-dimensional array** with two different indices for row and column references.
- The representation of a matrix for operations on it should be **efficient** so that the **space and time requirement is less**.

Need of Sparse Matrix

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	col 0	col 1	col 2		col 0	col 1	col 2	col 3	col 4	col 5
row 0	-27	3	4	row 0	15	0	0	22	0	-15
row 1	6	82	-2	row 1	0	11	3	0	0	0
row 2	109	-64	11	row 2	0	0	0	-6	0	0
row 3	12	8	9	row 3	0	0	0	0	0	0
row 4	48	27	47	row 4	91	0	0	0	0	0
				row 5	0	0	28	0	0	0

$m \times n$

5×3

Simple matrix

6×6

Sparse matrix

If most of the elements in a matrix is 0 then that matrix is a sparse matrix
NO precise definition when it is a sparse matrix

Example of Sparse Matrix

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$$LA = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad 7 \times 5$$

$$LB = \begin{pmatrix} 0 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad 7 \times 5$$

- The matrix LA is sparse with respect to 1s and dense with respect to 0s, whereas LB is sparse with respect to 0s and dense with respect to 1s.
- For a matrix of m rows and n columns, if m = n, then the matrix is called a square matrix

Example of Sparse Matrix

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$$A = \begin{pmatrix} 0 & 0 & 6 & 1 & 1 & 2 \\ 0 & 1 & 0 & 0 & 9 & 9 \\ 4 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 7 & 0 & 0 & 0 & 0 & 6 \\ 0 & 2 & 0 & 0 & 0 & 8 \end{pmatrix}_{6 \times 6}$$

Sparse square matrix

$$B = \begin{pmatrix} 10 & 0 & 0 \\ 21 & 90 & 0 \\ 45 & 28 & 15 \end{pmatrix}_{3 \times 3}$$

Sparse triangular matrix

Here, 0s may represent non-relevant data, or no change in consecutive readings of some experiment or consecutive positions

$$C = \begin{pmatrix} 9 & 88 & 0 & 0 \\ 22 & 8 & 95 & 0 \\ 0 & 33 & 6 & 44 \\ 0 & 0 & 56 & 47 \end{pmatrix}_{4 \times 4}$$

Sparse tridiagonal matrix

Sparse Matrix Representation

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- A sparse matrix can be represented by using TWO representations, those are as follows...
 - Triplet Representation (Array Representation)
 - Linked Representation

- Triplet Representation (Array Representation)

In this representation, we consider only non-zero values along with their row and column index values. In this representation, the 0th row stores the total number of rows, total number of columns and the total number of non-zero values in the sparse matrix.

Sparse Matrix Representation: Triplet Representation (Array Representation)

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	0	1	2	3	4	5
0	0	0	0	0	9	0
1	0	8	0	0	0	0
2	4	0	0	2	0	0
3	0	0	0	0	0	5
4	0	0	2	0	0	0

5x6



Rows	Columns	Values
5	6	6
0	4	9
1	1	8
2	0	4
2	3	2
3	5	5
4	2	2

Advantage of Sparse Representation

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- Consider a Sparse matrix of size 5000 x 5000, with very few non zero elements.
- By sorting such matrix by using sparse matrix representation using triplet, it reduces both space and time requirement

ADT for Sparse Matrix

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```
class Sparse_Matrix
{
    private:
        const int Max = 20
        int S_Mat[Max][3];
    public:
        void Read_SparseMatrix();
        Sparse_Matrix Simple_Transpose();
        Sparse_Matrix Fast_Transpose();
        Sparse_Matrix Add_SparseMatrix(Sparse_Matrix B);
        Sparse_Matrix Mpy_SparseMatrix(Sparse_Matrix B);
};
```

Question

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$$\begin{pmatrix} 10 & 20 & 0 & 0 & 0 & 0 \\ 0 & 30 & 0 & 40 & 0 & 0 \\ 0 & 0 & 50 & 60 & 70 & 0 \\ 0 & 0 & 0 & 0 & 0 & 80 \end{pmatrix}$$

For above given matrix, give its 0th row values, if it is represented in sparse represented matrix using Triplet.



Thank You