



INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS
MA5191 - PROGRAMMING LABORATORY

Lab Project - III - Sparse Matrix Libraries

I MSc (Mathematics and Statistics)
SEMESTER II

Max. MARKS: 500
Submission Date: 21 March 2021

Scientific Project

Write a Python program to implement the following tasks:

A matrix is said to be **sparse** if the number of zero elements are greater than the number of non-zero elements.

1. Get a square matrix A
2. Get the number of non-zeros of each row (accumulated) and store the values in the array ptr
3. Get the indices where the non-zeros occur and store the indices in the array ind
4. Get the values of those non-zeros and store those values in the array val
5. Example

$$\begin{bmatrix} 1 & 0 & 1 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 & 0 \\ 0 & 2 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 \end{bmatrix}$$

$$ptr = [0 \ 2 \ 3 \ 5 \ 8 \ 10]$$

$$ind = [0 \ 2 \ 1 \ 2 \ 3 \ 1 \ 3 \ 4 \ 3 \ 4]$$

$$val = [1 \ 1 \ 2 \ 1 \ 2 \ 2 \ 1 \ 1 \ 1 \ 1]$$

6. For a given sparse matrix construct the CSR format.
7. Do the following operations for given two sparse matrices (square) A and B

- (a) Check symmetric
- (b) Find A^T, A^2
- (c) AB
- (d) $\text{Trace}(A)$
- (e) Determinant of A

8. If A is sparse (square) matrix and x is a column vector, compute Ax .
9. Give a rough idea of to solve the linear system $Ax = b$. If possible, solve the system.

Gaming Project

Write a Number 2048 Game using Python language

1. Generate a empty matrix of size 4×4
2. Generate 2 random cells with element 2
3. Display the option of Play
4. When the user's choice is Play, display the list of navigation commands
5. A or a for Left, s or S for Down, d or D for right, w or W for up, q or Q for quit
6. When user presses Q or q, confirm again to quit and then quit
7. When the user plays the game, for each of his key press, show the matrix (nicely formatted)
8. If the key in from user is A or a, then sum up adjacent entries in left direction if they are equal
9. Similar method for S, D, W in their respective direction
10. For more details about the game, have a look at <https://play2048.co/>