



INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS

MA5191 - PROGRAMMING LABORATORY

Lab Project - V - Conjugate Gradient Sparse Libraries

I MSc (Mathematics and Statistics)

Max. MARKS: 500

SEMESTER II

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) 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.
10. Solve the linear system $Ax = b$ using conjugate gradient method, where b is known and x is unknown.

Gaming Project

Write a Antimagic Square Game using Python Language

1. Get the number of rows required in the antimagic square (preferably less than 10).
2. Get the total sum required from the user.
3. Get the starting and ending values from the user for the antimagic square.
4. Check the possibility to generate the antimagic square for the above conditions.
5. If it is possible to generate the antimagic square, generate and display the magic square.
6. Further, display the possible combinations of the antimagic square.
7. For more details: https://en.wikipedia.org/wiki/Antimagic_square
8. Try to address the open problems in the wikipedia page.