



INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS

MA5191 - PROGRAMMING LABORATORY

Lab Project - V - BiCGStab Sparse Libraries

I MSc (Mathematics and Statistics)
SEMESTER II

Max. MARKS: 500
Submission Date: 21 March 2021

Note: Except math libraries, other libraries are not allowed. For example, to compute norm in `bigstab`, create a function `norm`.

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. Create a Sparse Matrix Class
2. Use `__init__` method, getters and setters to get a square matrix A in the following format.
3. Get the number of non-zeros of each row (accumulated) and store the values in the array ptr
4. Get the indices where the non-zeros occur and store the indices in the array ind
5. Get the values of those non-zeros and store those values in the array val
6. Example:

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

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

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

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

7. For a given sparse matrix construct the CSR format.
8. 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

9. If A is sparse (square) matrix and x is a column vector, compute Ax .
10. Solve the linear system $Ax = b$ using Bi-Conjugate Gradient Stabilized (BiCGStab) method, where b is known and x is unknown.

Gaming Project

Write a Heterosquare Puzzle Game using Python Language

1. Get the number of rows required in the Heterosquare (preferably less than 10).
2. Check the possibility to generate the Heterosquare.
3. If it is possible to generate the Heterosquare, generate and display the Heterosquare.
4. Further, display the possible combinations of the Heterosquare, if any.
5. For more details: <https://mathworld.wolfram.com/Heterosquare.html>