Math 343 **Fall 2019**

Project Assignment: GMRES

1 Description

- Write tools (library of functions) for operating on sparse matrices, using CSR (compressed sparse row) format. More specifically:
  - It should be able to read matrix data from a file (the i, j and data entries a_{ij} for all non-zero entries of the matrix.)
  - It should be able to perform A times a vector, and A^T times a vector.
  - Optionally, given A in CSR format generate A^T in the same format. This function should use minimal operations (as little as you can think of).
  - Optionally, given two matrices A and B in CSR format, compute $C = AB$ and store it also in CSR format.

  Task 1: There should be a test driver that you write, which can:

  1. Read a matrix A (could be simply the adjacency matrix of a directed or undirected graph). (Matrices A will be provided separately or use link https://sparse.tamu.edu/ .)
  2. Optionally: Produce $B = A^T$ in CSR format.
  3. Optionally: Compute $C = AB$. Check if C is symmetric.

  Task 2: Use some of the functions from your library, for an appropriately given input matrix A (provided separately, e.g., read from the link above), and
  - Implement the GMRES algorithm with restart (provided in a separate .pdf file).
  - Perform study when you vary $m_{\max} = 5, 10, 15, ...$ the maximal number of steps allowed in the algorithm, and document the total number of iterations and total time to convergence for a given tolerance ϵ (and a given matrix). Write your conclusions from the study.

Grading:

You will have to document (describe) the implementation of the library and the GMRES algorithm in a project report. The project report is due no later than December 9 (earlier the better).

You need to demonstrate that the code runs (i.e., can generate approximate solution $\mathbf{x}$ for various r.h.s. vectors $\mathbf{b}$, sizes of $m_{\max}$, and tolerance ϵ).)

The project will be graded after a discussion and looking at your project report on how the library and the GMRES algorithm were implemented.