Math 343 **Winter 2017**

Project Assignment: GMRES

1 Description

- Write tools (library of functions) for operating on sparse matrices, using CSR (compressed sparse row) format (discussed previously and described in an earlier file). More specifically:
    - It should be able to read matrix data from 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.
    - 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).
    - 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).
    2. Produce $B = A^T$ in CSR format.
    3. 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, 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:

We should agree beforehand what kind of test matrices A will be used in the study. 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 March 20 (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.