

Numerical PDE HW 1

Our approximations for PDEs always require us to solve linear systems $Ax = b$. Our matrices $A \in \mathbb{R}^{n \times n}$ are almost always large ($n > 10^6$), sparse (99% or more zero) and unstructured. We want to get some experience working with such matrices.

1. look at the real world matrices at <http://math.nist.gov/MatrixMarket/> and download three different matrices. Import them into the software of your choice and recreate the structure plot from MatrixMarket for these matrices. Report the name, a brief description of the application, size, sparsity, and memory used for these matrices. You can substitute matrices from your own work if you want.
2. Matrix Multiply
 - 2.1. Create suitable vectors for your matrices and compute Ax . Report the time it took to do the matrix vector multiply in seconds. Note you may need to average timings to get a good measurement.
 - 2.2. Convert the matrices to dense storage and report the memory used and the timings for the multiplication in dense storage format.
 - 2.3. Plot the times against matrix size on a (log-log scale) for the dense and full storage.
3. Linear Solve
 - 3.1. Create suitable right hand sides for your matrices and solve the resulting linear systems. Check the accuracy of your results and report the time it took to solve the linear system in seconds. Note you may need to average the timings to get a good measurement.
 - 3.2. Convert the matrices to dense storage and report the memory used and the timings to solve the linear systems in dense storage format.
 - 3.3. Plot the times against matrix size on a (log-log scale) for the dense and full storage.
 - 3.4. Find out the name(s) of the algorithms your software uses.
4. Download at least six different sized problems from one problem family in MatrixMarket. Repeat the sparse and dense timing exercises for multiplication and linear solve. Plot the memory used and solution time against matrix size and the solution time against matrix size on a log-log scale for the family.
5. Report the RAM on your computer. Estimate the largest problems (for dense and sparse storage) from your family that would fit in memory. Estimate the largest problems (for dense and sparse storage) that could be solved in less than 5 minutes on your computer