CS319: Scientific Computing (with C++)

Projects

Monday, 20 March 2017

You have **one** remaining assignments to complete for CS319: an individual project. This is a development of your recent lab work, but has a variation for each of you.
The projects are somewhat open-ended, and we will scope them out together.
All the projects will have these qualities in common:

(a) A new data structure/class will be required.

(b) You will have to implement some algorithm.

(c) You will have to experiment to establish some properties (such as accuracy or efficiency) of your implementation.

The project

Here are a few ideas I have. I'll probably have a few more on Monday. In the mean time, feel free to suggest your own.

Examples:

1) design a class to store a sparse matrix in compressed row format; write an algorithm that solves an associated linear system using Conjugate Gradients; Experiment to determine how the complexity of the method depends on the matrix size.

2) Similar to the above, but using a different sparse format, and a different iterative algorithm (e.g., GMRES, SOR, ...)

3a) Similar to above, but using a direct solver, like LU-factorisation (=Gaussian Elimination) or Cholesky Factorisation.

3b) As above, but with a data structure the incorporates some structure of the matrix, e.g., that it is symmetric.

4) Implement some other sorting algorithm, like quick sort, and compare with Bubble and Merge, and `std::sort`.

The project

5) Write a class to store in image (gray scale, rgb, whatever) and run some algorithms on it, such as histogram equalisation, or, edge detection. [DN].
6) Write a class to store graphs (directed or undirected) and generate some visualisations. For example, construct Kneser graphs: https://en.wikipedia.org/wiki/Kneser_graph
7) Experiment with floating point numbers. E.g.,
   (a) to what does the harmonic series converge?
   (b) quantify the slow-down associated with subnormal numbers. For this, you may have to implement your own high-precision float.
8) Centrality analysis of networks
9) Estimate of the algebraic connectivity of a graph (second smallest eigenvalue of the Graph Lapacian).
10) Your own idea, so long as it involves a new class, some algorithm, and some experimentation.
11) RSA encryption and "very long" `int` [EM]

The project

12) PageRank with Wikipedia

13) The Gale-Shapley/Stable Marriage Problem for Final Year Project Allocation. [CH].

The deadline for completion of the project is ??? Friday, 31 March

14) Matrix Sorting. [OMcD]

15) Topological sorting / Depth-first. [GOC]

16) Images: Zooming In & out [KMcG]

CG	CH	IK	DMacL	EM	OMcD	KMcG	DN	GOC
	13		1 (Symmetric SOR)	11 (RSA)	14	16	5 (Hist)	15

The project