CAS MA539 – Methods of Scientific Computing

Boston University, Fall 2005

Instructor
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Class Meetings: MWF 1:00pm - 2:00pm, MCS 149

Texts:

1. Heath, M.T. (2002). *Scientific Computing: An Introductory Survey. Second Edition.* Boston: McGraw-Hill. (REQUIRED)

2. Press *et al.* (2002) *Numerical Recipes in C++: The Art of Scientific Computing.* Cambridge: Cambridge University Press. (OPTIONAL)

Course Description: This course offers a survey of methods for computing numerical solutions to a variety of standard mathematical problems, and is likely to be of interest to students across a broad range of quantitative disciplines, including mathematics, computer science, statistics, engineering, finance, geography, physics, chemistry, and computational biology. Emphasis will be on a balance of mathematical, algorithmic, and computing issues. Material in the course is organized around three modules: computational linear algebra, numerical methods for curves and surfaces, and methods of stochastic simulation. Substantial usage of computers will be made in this course, both inside and outside of the classroom.

Prerequisites: MA 225 (Multivariate Calculus); MA 242 (Linear Algebra);
CS 330 (Analysis of Algorithms) *or consent of instructor!*

Course Syllabus:

Wk 1: Introduction and Background. [Ch 1.0]

Wks 2 - 4: Computational Linear Algebra.

Solution of linear systems of equations. [Ch 2.1-2.5]

Linear least squares and the SVD. [Ch 3.1-3.7]

Wks 5 - 9: Numerical Methods for Curves and Surfaces.

Interpolation. [Ch 7.1-7.4]

Numerical integration. [Ch 8.1-8.5]

Numerical solution of initial-value problems. [Ch 9.1-9.3]

Zero-finding. [Ch 5.1-5.6]

Optimization. [Ch 6.1-6.5]

Wks 10 - 13: Stochastic Simulation.

Pseudo-random numbers. [Ch 13.1-13.3]

Generation of random variables. [Ch 13.3]

Monte Carlo integration & related topics.

Course Requirements and Evaluation:

1. Homework: Regular homework assignments (every 1-2 weeks) will be assigned, usually consisting of a combination of mathematical and computational problems.
2. Projects: A final project for the course will be required, due near the end of the semester. Details will be supplied as the semester progresses.
3. Grading: Of the final grade given for the course, 70% will derive from the homework assignments, and 30% from the project.

Computer Work:

Computers clearly will play a fundamental role in this course. However, this is **not** a course on computer programming. Hence, while some issues of coding, program organization, and such will be addressed periodically in lectures, it will be assumed that the student has a general knowledge of computers and a specific knowledge of (or is able to quickly learn) a programming language (e.g., C++, FORTRAN, etc.) or environment (e.g., Matlab, *Mathematica,* R, etc.). The majority of the computing demonstrated in class will be done using Matlab.