Syllabus for Scientific Computing CSC 331-431

Course Description

This course presents fundamental numerical algorithms for solving problems in scientific computing and computational finance. Areas covered may include: error analysis, computer arithmetic, linear algebra, optimization problems, numerical integration (solvers), ordinary differential equations (ODE). The emphasis of the course is on the design and analysis of the computational methods. Algorithms will be implemented using mathematical software

Lecture time: Th 5:45PM - 9:00PM

Location: CDM 00220 at Loop Campus

Instructor: Enes Yilmaz

Office: 473 CDM

Phone: 312-362-5888

Office hours: Th 2:30PM - 4:00PM

Texts:

Required: Michael Heath, Scientific Computing, McGrawHill

Optional: http://www.amazon.com/Annotated-Algorithms-Python-Applications-Physics/dp/0991160401/

Grading

There will be 5 Quizzes (50%), a Midterm (25%) and one Final Exam/Project (25%).

Final grades are determined by averaging scores from: Best 4 Quizzes, Midterm and a Final Exam/Project. The lowest quiz score will not be included in the final score calculations, provided you have taken all five quizzes administered during the semester. Should you decide to not to take all quizzes given during the semester, your average will be calculated based on the quizzes you have taken and zeros for the quizzes you have not taken. In this case, the lowest score will not be dropped from the calculation of the final average.

The dates for Midterm and Final Exam/Project could be adjusted at the discretion of the instructor. Quizzes will be administered, with or without warning, during the semester. *No make-up quizzes will be given.*

Late work will be accepted at the instructor's discretion.

Prerequisites

PL2 and 2 course calculus sequence or instructor's permission.

Week by Week Schedule

Week 1:

Overview of Computational Problems. Approximations in Scientific Computation. Sources of Approximation. Absolute Error and Relative Error, Taylor series and convergence.

Week 2:

Computer Arithmetic. Floating-Point Numbers. Normalization. Properties of Floating-Point Systems. Rounding. Machine Precision. Exceptional Values. Floating-Point Arithmetic.

Week 3:

Linear Systems. Existence and Uniqueness. Vector Norms. Matrix Determinant. Matrix Inversion (Gauss-Jordan)

Week 4:

Solving Linear Systems. Problem Transformations. Triangular Linear Systems . Elementary Elimination Matrices. Gaussian Elimination and LU Factorization. Pivoting. Implementation of Gaussian Elimination. Complexity of Solving Linear Systems. Gauss-Jordan Elimination. Cholesky Factorization.

Week 5:

Applications of linear algebra to linear least squares.

Week 6:

Financial applications: The Markowitz portfolio optimization or simulated trading.

Week 7:

Solvers and Nonlinear Equations. Existence and Uniqueness. Convergence Rates and Stopping Criteria. Nonlinear Equations in One Dimension. Interval Bisection. Fixed-Point Iteration. Newton's Method. Secant Method. Inverse Interpolation. Linear Fractional Interpolation. Zeros of Polynomials

Financial applications: computing implied volatility from the Black-Scholes Equation.

Week 8:

Optimization Problems. Existence and Uniqueness. Convexity. Unconstrained Optimality Conditions. Constrained Optimality Conditions. Optimization in One Dimension. Golden Section Search. Newton's Method.

Week 9:

Integration. Numerical Quadrature. Newton-Cotes Quadrature. Gaussian Quadrature. Progressive Gaussian Quadrature. Composite Quadrature. Adaptive Quadrature.

Week 10:

Ordinary Differential Equations. Existence, Uniqueness, and Conditioning. Numerical Solution of ODEs. Euler's Method. Accuracy and Stability. Implicit Methods. Stiffness. Taylor Series Methods. Runge-Kutta Methods. Extrapolation Methods. Multistep Methods. Multivalue Methods.