CSC466-2305S Numerical Methods for Optimization Problems Spring 2024

Lecturer : Christina C. Christara (ccc@cs.toronto.edu)
Lectures : Tuesday 15:10-17:00 Room MP 134
Tutorial : Thursday 15:10-16:00 Room MP 134 (tutorial times may be used for lectures)
Office Hours : Wednesday 13:00-14:00 Room BA 4226 (please wear a mask) or
: online (send me a message)
Textbook : Jorge Nocedal and Steven Wright, Numerical Optimization, Springer NY, 2006
available as an e-book from the UT library
Web site : `http://www.cs.toronto.edu/~ccc/Courses/466-2305.html`
Bulletin board : `https://bb-2024-01.teach.cs.toronto.edu/c/csc466` (after first week)

Other references

Michael Heath, Scientific Computing: an introductory survey, SIAM 2018
The chapter on numerical optimization is useful for the start.

Topics to be covered

- Introduction
- (1D optimization) Golden section search, Newton's
- Line search methods
- Trust region methods
- Conjugate gradient methods
- Quasi-Newton'smethods
- Approximating derivatives, the gradient, the Jacobian, the Hessian

Aims of course

- Review the basic concepts in numerical optimization.
- Introduce numerical methods for solving continuous (mostly unconstrained) optimization problems.
- Evaluate numerical optimization methods with respect to their accuracy, convergence, time and memory complexities.
- Develop and practice computer skills in implementing numerical optimization methods efficiently on the computer, as well as skills to judge the correctness of numerical results.
- Use high level software for studying numerical optimization methods.

Prerequisites

Courses: a numerical methods course (e.g. csc336), a multivariate calculus course (e.g. mat235, mat237), a linear algebra course (e.g. mat221, mat223, mat240).
General: Ability to handle notation and to do algebraic manipulation. Fluency in matrix and vecgor manipulation.
Calculus: Differentiation and integration of polynomial, trigonometric, exponential, logarithmic and rational functions, continuity, limits, graphs of functions, Taylor series, Rolle's theorem, mean-value theorem, de l' Hospital's rule, partial derivatives, gradient, multi-dimensional Taylor series
Linear Algebra: Matrix and vector addition and multiplication, elementary row operations, linear (in)dependence, inverse matrix, banded and sparse matrices, properties of matrices, matrix norms, condition numbers, eigenvalues, eigenvectors, various decompositions, etc
Programming: strong coding abilities in some programming language, such as MATLAB, python, C or FORTRAN.
Other Mathematics: induction.

Computer accounts

You will get (or have already) a computer account on the CDF Unix system. Consoles/workstations are located in the Bahen building. You must log-in frequently and read mail, news and other messages relating to the course through your account.

Marks distribution

Assignment 1	Due Friday, February 2, 2024	6 PM	20%
Term test	Tuesday, February 27, 2024	3-5 PM	35%
Assignment 2	Due Friday, March 15, 2024	6 PM	22.5%
Assignment 3	Due Friday, April 5, 2024	6 PM	22.5%

- The assignments include substantial computer work.
- **Term test**: calculators are the only aids permitted.

Late assignment policy

Assignments are due the day posted, during class time. Assignments submitted late have a reduction of marks based on the maximum total marks the assignment could get had it been submitted on time (and not on the total marks the assignment actually got). Each day costs 10%, to a maximum of 2 (two) days. Assignments submitted later than 2 days after the due date do not receive any marks. If applicable, weekends and holidays count as regular days for the purpose of late assignment policy.

Academic integrity

Assignments, homeworks and exams must be your own individual work and using only course materials. While students at your level are well aware of what academic integrity means, please note that violating academic integrity includes more things than presenting others' work as one's own. For example, *not taking reasonable measures to protect your work from being plagiarized by others is also a violation of academic integrity*. This is becoming particularly important now, when so many things are online.

You should *never post anywhere or share with anyone* assignments (or parts thereof), exams (or parts thereof) or solutions (or parts thereof), *even after the deadline*.

Additional information

Assignments will be submitted electronically; details to be given with each assessment.

Assignments will be preferably typed in latex. A template is given in the course website. Other document processors are acceptable, as long as they produce pdf output. If an assignment is *very cleanly* handwritten and scanned *on a proper scanner* as a single pdf file, and *not photographed*, then it is also acceptable. Photographed assignments will receive 0 marks.

Tests/exams will be synchronous and in-person.

Tutorial times will be used for lectures.

Office hours will be available at my office, either at default times posted, or at other mutually agreeable times. If there is need for remote office hours, this is possible with advance notice.
Office hours will be for individual students, not for a group of students. Please wear a mask before coming in; only one student at a time.

Presentation of assignments

General

Include your name and student id in the front page and underline last name. Use font size 12 or larger. Use fixed width fonts (e.g. Courier) for code and output. *Never* use dark background, for anything.

Tables and code output

Always align output with an appropriate format statement. (Align to match equivalent order digits.) Use exponential format for very large numbers (e.g. condition numbers) and very small numbers (e.g. errors, residuals) Use integer format for number of iterations, grid sizes, etc. Always use headers for columns in tables.

Plots

When we say plot quantity A versus B, we mean A is in the vertical (y) axis and B in the horizontal (x). Always use captions for plots/figures, and proper diacritical marks and legends when drawing more than one line.

Submission

Do NOT submit zip, rar and similar files on MarkUs. Only submit pdf, image (eps, png, etc), text (incl. code, latex), etc.

Other

Do not use any symbolic computation, such as symbolic differentiation, etc.