Computer Science 406: Numerical Optimization

Instructor: Yves Lucet (NKC, ASC350, ext 79505), yves.lucet@ubc.ca
Duration: Winter 2012 term 2, 3 credits Lectures: 3 hours/week. Tue Thu 9:30-11:00
Lab: 2 hours/week Fri 12:30pm-2:30pm
Office hours: 2 hours per week TBD or by appointment.
Required Textbook: None. The following references may prove useful:
- Convex Optimization, Boyd and Vandenberghe, (available online), 2004
- Thrust-Region Methods, Conn et al., 2000.
and as more general references:
- Numerical Optimization, Nocedal & Wright, 2006
- Convex Analysis and Optimization, Bertsekas et al., 2003
- Methods of Mathematical Economics: Linear and Nonlinear Programming, Fixed-Point Theorems, Franklin, 2002
Course Description: Formulation and analysis of algorithms for continuous optimization problems; linear, quadratic, semi-definite, nonlinear (constrained and unconstrained), convex (smooth and nonsmooth) optimization; large-scale problems; software packages and their implementation; elements of duality theory. The course counts toward the numerical analysis requirement of the computer science major.
Learning Objectives: The course will provide 3rd and 4th year students with an introduction to numerical analysis with particular emphasis on the computational implementation. It will expose the students to the fundamental ideas of modern numerical optimization, and the limitations of the standard optimization models. They will build from simple linear models to more complex nonlinear models, and see the state of the art in continuous optimization. The laboratory component will treat the efficient implementation of the algorithms exposing the many practical issues that needs to be solved in practice.
The course supplements several existing UBCO courses with some areas of overlap with MATH 340 Introduction to Linear Programming, and MATH 461 Continuous Optimization.
Calendar Dates: See http://okanagan.students.ubc.ca/calendar/
(Tentative) Course content:
- Syllabus, intro: Examples, LEGO
- Modeling
- Lagrangian relaxation/Lagrangian duality
- Cutting plane, bundle method
- Newton, Line-Search, BFGS, Trust Region
- Equality/Inequality constraints, KKT
- Linear Programming: Active set (simplex) vs. penalization (interior points)
- Quadratic Programming (conjugate gradient)
- IEEE 754, sensitivity analysis, scaling
- numerical differentiation
The content of the course will be drawn from several books. Optimality condition will only be treated to the extent they help understand the algorithm strategy.
Topics not covered: Heuristic algorithms, Parallel Optimization

Marking: There will be two 80 minute midterms (worth 20%), lab assignments (worth 20%), Quizzes (worth 10%), and one 3 hour final exam (worth 40%). Midterms can only improve your mark i.e. your
mark is the best of the following weights:

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<tr>
<td><strong>Assignments</strong></td>
<td>20</td>
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<td><strong>Quizzes</strong></td>
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<td><strong>Midterm I</strong></td>
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<td><strong>Midterm II</strong></td>
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<td><strong>Final</strong></td>
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(The rationale is to use the midterms to improve your mark but never to penalize.) In addition, you need to pass the final to pass the course. Failing to pass the final will result in a maximum mark of 45%.

**Sickness:** In case you cannot be present at a midterm because of sickness, notify the instructor immediately and bring a note from your doctor at the next class. The weight of that midterm will be distributed among your other midterm and the final. If you cannot attend two midterms for sickness, both weights will be assigned to the final. If you cannot attend the final, see the associate dean.

**Calendar Dates:** See [http://www.calendar.ubc.ca/okanagan/](http://www.calendar.ubc.ca/okanagan/)

**Plagiarism and collaboration:** The "default" assumption is that students will work on assignments independently. Students who complete assignments with the aid of collaborators or other sources (e.g. other text-books) must

- acknowledge this fact (including the name(s) of other sources) at the start of their homework submission (see above),
- produce an independent write-up (copied submissions are not permitted),
- be prepared to explain their solutions in further detail, if asked, and
- be prepared to have the assignment grade adjusted accordingly.

Collaborating in groups of size greater than three is not permitted.

Plagiarism (the submission of work of another person as your own) and other anti-intellectual behavior will not be tolerated. Your attention is directed to the "Student Discipline" section of the University Calendar as well as the UBC-V computer science Department Policy on "Plagiarism and Collaboration", available through the Undergraduate Web Page at [http://www.cs.ubc.ca/our-department/administration/policies/collaboration](http://www.cs.ubc.ca/our-department/administration/policies/collaboration). In particular, note that it is not acceptable to make a solution available as an aid to others.

**Cooperation vs. Cheating:** Working with others on assignments is a good way to learn the material and we encourage it. However, there are limits to the degree of cooperation that we will permit. Any level of cooperation beyond what is permitted is considered cheating.

When working on programming assignments, you must work only with others whose understanding of the material is approximately equal to yours. In this situation, working together to find a good approach for solving a programming problem is cooperation; listening while someone dictates a solution is cheating. You must limit collaboration to a high-level discussion of solution strategies, and stop short of actually writing down a group answer. Anything that you hand in, whether it is a written problem or a computer program, must be written by you, from scratch, in your own words. If you base your solution on any other written solution, you are cheating.

There will be random audit of assignment solutions through internet-based source code search engine: Any assignment found to be significantly similar to a publicly available source code without the proper acknowledgment will trigger an investigation for academic dishonesty in addition to any copyright violation.

If you have any doubt that an action you are considering might be construed, by anyone, as cheating, DON'T DO IT. Ask permission first.

**Academic Integrity:** The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required.
This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the break down of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating usually result in a failing grade or mark of zero on the assignment or in the course. Careful records are kept to monitor and prevent recidivism. A more detailed description of academic integrity, including the policies and procedures, may be found at http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,959. If you have any questions about how academic integrity applies to this course, consult with the instructor.

Disability Assistance: If you require disability-related accommodations to meet the course objectives, please contact the Coordinator of Disability Resources located in the Student Development and Advising area of the student services building. For more information about Disability Resources or academic accommodations, please visit the website at http://web.ubc.ca/okanagan/students/disres/welcome.html.

Equity, Human Rights, Discrimination and Harassment
UBC Okanagan is a place where every student, staff and faculty member should be able to study and work in an environment that is free from human rights based discrimination and harassment. If you require assistance related to an issue of equity, discrimination or harassment, please contact the Equity Office, your administrative head of unit, and/or your unit’s equity representative.

UBC Okanagan Equity Advisor: email equity.ubco@ubc.ca
Web: www.ubc.ca/okanagan/equity
Unit Equity Representatives:
http://www.ubc.ca/okanagan/equity/programs/equityreps/unitcontacts.html

The present syllabus is tentative, and subject to change according to the needs and interests of the class.