Optimization
Version from November 2, 2012

Teachers.

- Javier Cano, javier.cano@it.uu.se, room ITC 2440
- Markus Kowalewski, markus.kowalewski@it.uu.se, room ITC 2439
- Katharina Kormann, katharina.kormann@it.uu.se

Office hours. Tuesday and Thursday between 16:00 - 17:00

Course home page. All course-related information is collected at studentportalen.uu.se. The course home page is an alternative source of information.

Text book.


Syllabus. The time will be divided about equally between linear programming, unconstrained nonlinear optimization, and nonlinear programming (that is, nonlinear optimization with constraints). We will define Linear Programs (LPs) and describe the simplex method for the solution of LPs. More general types of optimization problems are called Nonlinear Programs (NLPs). We will first discuss iterative methods to find local optima for unconstrained NLPs. Finally, we will discuss nonlinear optimization problems with constraints, characterizations of solutions to such problems, and give a short orientation of numerical methods for solving NLPs.

Each block consists of four lectures followed by one problem solving lesson and a computer lab (preparing the assignments). In the end, there will be a fourth lesson which summarizes the course and prepares the exam. Table 1 gives a preliminary syllabus for each lecture together with reading instructions.

Appendix D can be downloaded here.

Assignments. There will be three mandatory assignments.

Rules for the assignments:

- Absolute deadline for this year’s assignments January 14, 2013 for hand-in of new assignments and January 21, 2013 for corrections. After this date, the next opportunity for handing in the assignments is when the course is given again next year.

- The deadlines for the three assignments are: November 13 5:00 pm, November 27 5:00 pm, and December 13 5:00 pm. A 0.5 bonus point will be given for correct solutions provided before the deadline for each assignment. These points are added to your result on the final exam in December 2012. Note that the bonus deadlines are absolute.
Table 1: Reading instructions for the lectures.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Chapter in Griva/Nash/Sofer</th>
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<tbody>
<tr>
<td>Linear programming</td>
<td></td>
</tr>
<tr>
<td>1 Introduction, Geometry of linear programming</td>
<td>1, 2 (just skim it), 4</td>
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<tr>
<td>2 Geometry of linear programming (cont)</td>
<td>4</td>
</tr>
<tr>
<td>3 Simplex</td>
<td>5.2.1–5.2.2, 5.4.1, 5.5</td>
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<tr>
<td>4 Duality</td>
<td>6.1–6.2</td>
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<tr>
<td>Unconstrained nonlinear optimization</td>
<td></td>
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<tr>
<td>5 Convergence, Optimality conditions</td>
<td>2.5, 11.1–11.2</td>
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<tr>
<td>6 Newton</td>
<td>11.3–11.5</td>
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<tr>
<td>7 Quasi-Newton</td>
<td>12.2–12.4</td>
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<td>8 Nonlinear Least-squares</td>
<td>Appendix D</td>
</tr>
<tr>
<td>Nonlinear programming</td>
<td></td>
</tr>
<tr>
<td>9 Optimality conditions</td>
<td>14.1–14.6</td>
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<tr>
<td>10 Penalty and barrier methods</td>
<td>14.6, 16.1–16.2, 16.3–16.7 (just skim it)</td>
</tr>
<tr>
<td>11 Active set, SQP</td>
<td>15.4–15.5, 15.1–15.3 (just skim it)</td>
</tr>
</tbody>
</table>

- For each assignment, there will be a computer lab. During the lab, you will work on the assignment and have the opportunity to discuss difficulties with the teacher. It is highly recommended to start working on the assignment before the lab. At least, you should have prepared the theoretical parts.

- Hand in a written report containing a short presentation of the problem, results, discussion, source code, and a print-out of the result from your Matlab sessions (please state which version of Matlab you are using). A readable hand written report is OK for all parts except for the source code and the print-out of the runs. Answer all questions and comment your results. If the report is incomplete, we will return it for completion before starting to grade it. For Assignment 1, there will be an additional rule which will be specified on the handout.

- Please hand in the report in paper form (rather than by email) to box 37 marked “IN”, Optimization. The box is located at the second floor in ITC building 2. Graded reports will be returned to box 38 marked “OUT”.

- You may work alone or in groups of two or three. All persons in a group should contribute to the solution and the report. Discussions between the groups are encouraged. If you receive substantial help from another group, say so in the report. You are not allowed to copy solutions or computer codes from others.

- On the first page, clearly state first and last name as well as personal number of each student of the group. Only if the full information is provided, the assignment will be graded.

- The grade on each assignment is pass or fail. Fail means that you have to hand in a corrected report for grading. When you return the new or corrected report, please attach the old one.

- For the assignments, we use MATLAB’s optimization toolbox. MATLAB is available in the computer rooms and for installation on your private computer (see the information page).
Exam. You should bring the following items to the exam on December 20:

- Ruler, pen
- Pocket calculator
- One sheet of A4 paper with formulae/notes. The sheet must be written by yourself and you decide freely what you want to have on the sheet. You can use both sides of the paper. Font size must be at least 10pt Times New Roman / 10pt Computer Modern (Latex font). Hand-written notes on the sheet are not allowed.

No other items are allowed during the exam (except food and drinks).

Recommended exercises.

- During each lecture, you will get a small exercise which helps you to repeat the topics of the lecture and which you should solve before the following lecture (where the solution will be presented in some form).
- List of recommended exercises from the text book:
  - p52: 3.2, 3.3
  - p98–100: 1.1 (at least a few)
  - p105: 2.1–2.3
  - p114: 3.1, 3.2
  - p141-143: 2.2, 2.3, 2.7
  - p185-188: 2.1, 2.4
  - p374: 4.4, 4.5
  - p386: 5.3, 5.4
  - p408–409: 2.1, 2.2, 2.4
  - p420–421: 3.1, 3.2, 3.5
  - p489–490: 2.1, 2.2, 2.5–2.7
  - p501: 4.1, 4.2, 4.5, 4.11
  - p508: 5.2, 5.5, 5.11
  - p617: 2.1, 2.2
  - p626: 5.1
  - p752: 2.2, 2.5, 2.8, 2.9 (Appendix D)

Old exams. A collection of old exams with solutions can be found here