02612
Constrained Optimization

Department of Applied Mathematics and Computer Science
Technical University of Denmark

When and Where

- Lectures
  - Tuesday 13:00 – 15:00
  - DTU-B303A-A049

- Exercises
  - Tuesday 15:00-17:00
  - Groups of 2-3.
    You must hand in an individual report
  - DTU-B305-IT005, DTU-303B-IT006
    Virtual - MS Teams

Who Teaches the Course

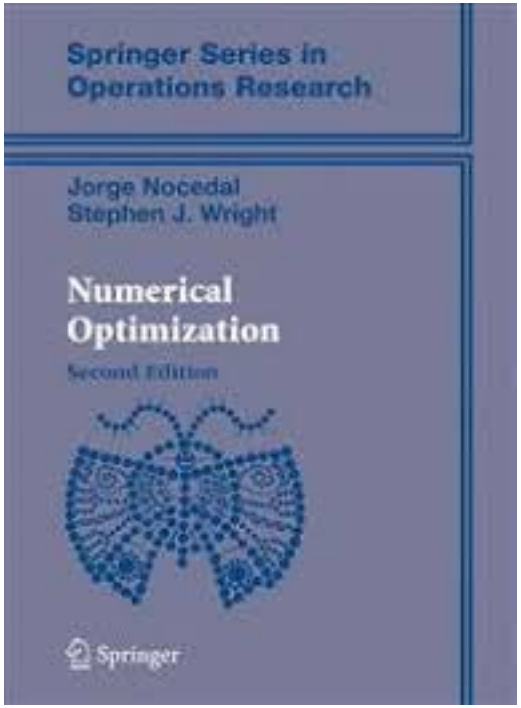
- Lectures
  - John Bagterp Jørgensen (course responsible)
    E-mail: jbjo@dtu.dk
- Exercises
  - Morten Ryberg Wahlgreen
  - Nicola Cantisani

Grading

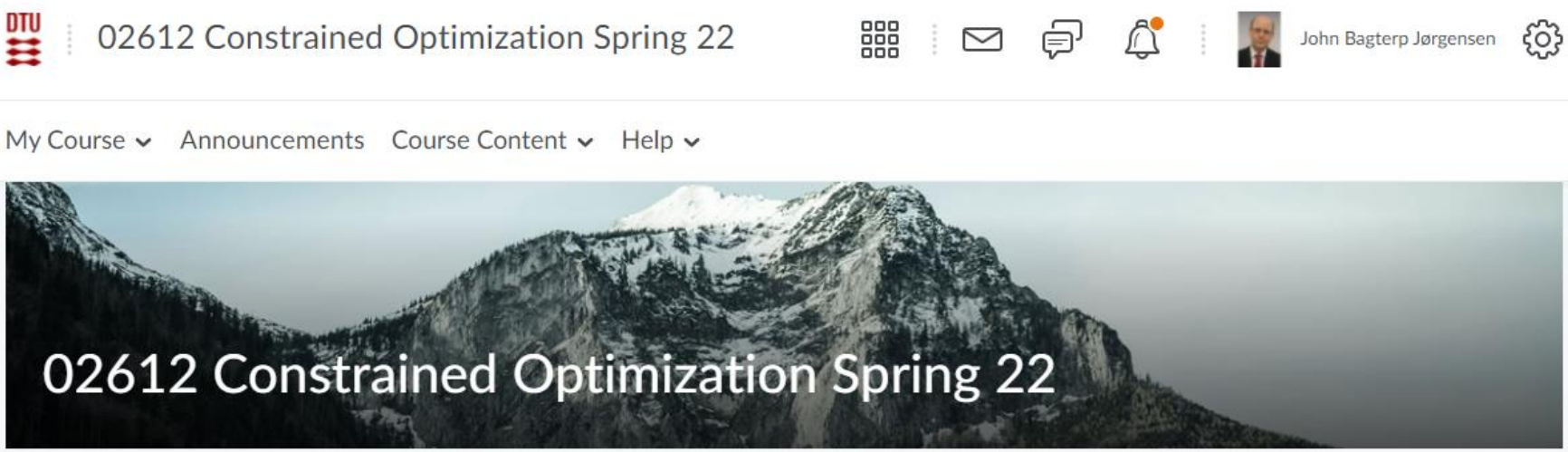
- Grading will be based on the 7-scale
  - Individual report based on the exercises
  - You can work in groups, but must hand in an individual report that you write yourself
  - Hand-in deadline 13:00 May 23, 2022

Course Material

- Jorge Nocedal & Stephen J. Wright
  Numerical Optimization
  2nd Edition, Springer
- Lecture notes and slides
- Exercise material
- Assignment material



Learn
learn.inside.dtu.dk



Course Content

Overview

Print Settings

02612 Constrained Optimization.

We will use Nocedal & Wright: Numerical Optimization, 2nd Edition, Springer (N&W). Using Findit you can obtain a pdf of the book.

The lectures are scheduled for Tuesday afternoon (13-17) in the spring semester. You can find the precise dates and topics in the Course Schedule and the Table of Contents.

General course objective:
When modelling a technical or economical problem it often happens that free parameters are determined by the solution to an optimization problem subject to some constraints on the solution. The simplest example is that the parameters must be positive or lie in certain intervals due to physical constraints in the underlying physical problem. In this course the participant learns about efficient algorithms for constrained optimization. The student will be able both to develop algorithms and to use existing software for numerical solution of optimization problems with constraints. The course concerns numerical algorithms for linear programming (LP), convex quadratic programming (QP), convex optimization, and non-linear programming (NLP).

Learning objectives:
A student who has met the objectives of the course will be able to:

- derive and explain the KKT optimality conditions for constrained optimization
- use the KKT conditions to construct active set and interior point algorithms
- derive, implement and use interior-point algorithms for LP, QP and NLP problems
- derive, implement and use interior-point algorithms for convex optimization
- derive, implement and use active set and interior point algorithms for convex quadratic programming (QP) and linear programming (LP)
- explain the principles of the SQP algorithm for nonlinear, constrained optimization problems
- combine the LP and QP algorithms into an SQP algorithm
- develop, test and compare alternative optimization algorithms in Matlab for the solution of a given problem
- use existing Matlab software libraries for constrained optimization
- use optimization algorithms for the solution of problems from engineering and finance
- apply convex optimization
- apply optimization algorithms to numerically solve dynamic optimization problems and optimal control problems

Content:

- **Module 1 - Introduction to constrained optimization**
  - Examples
  - Software for optimization
- **Module 2 - Theory of constrained optimization**
  - First and second order optimalitty conditions (KKT conditions)
  - Sensitivities
- **Module 3 - Algorithms for optimization**
  - Active set algorithms
  - Interior point algorithms
  - Line search
  - Trust region
  - Convergence
- **Module 4 - Quadratic Programming**
  - Unconstrained QP
  - Equality constrained QP. KKT conditions.
  - Inequality constrained QP: KKT conditions, active set algorithms, interior point algorithms
- **Module 5 - Linear Programming**
  - KKT conditions
  - Active-set algorithm (simplex)
  - Interior-point algorithm
- **Module 6 - Implementation of LP and QP algorithms**
  - Implementation of algorithms for LP and QP problems with different structure.
- **Module 7 - SQP algorithms**
  - Optimality conditions
  - SQP principle for an equality constrained optimization problem
  - Line search algorithm
  - Trust region algorithm
  - Hessian approximation
- **Module 8 - NLP algorithms**
  - Interior point algorithm
  - Augmented Lagrangian algorithm
  - Various algorithms
- **Module 9 - Applications**
  - Optimal control problems
  - Applications in engineering and finance
  - Convex and non-convex optimization examples