

COURSE: Non Linear Optimization

Teacher: Francesca Maggioni

Dept. of Management, Economics and Quantitative Methods

University of Bergamo

Univ. tel: 0039 035 2052649

Mobile: 0039 340 5059292

e-mail: francesca.maggioni@unibg.it

Course description and objectives

The course carries 4CFU and its primary focus is on numerical methods for nonlinear optimization.

It is structured in several parts dedicated to a) methods for one-variable Optimization, b) methods for unconstrained optimization in n variables c) Gauss-Newton method for least-squares data fitting, d) introduction to Markowitz portfolio theory e) equality constrained problems f) inequality constrained problems g) minimax data-fitting via inequality constrained optimization and h) portfolio problems involving global optimization.

The course will enable doctoral students to get in-depth theoretical and practical knowledge of nonlinear optimization algorithms. Such methods can be applied to many practical problems in management and engineering. A description and derivation is given for most of the currently popular algorithms for continuous nonlinear optimization. For each method, important convergence results are outlined and complemented by numerical illustrations to give a flavour to the students of how the methods perform in practice.

Examples and case studies concerning with portfolio selection and with time-series problems such as fitting trendlines, are presented and discussed.

Exposure to foundation, seminal contributions as well as to current results and software developments will enable the students to link in a consistent and rigorous way state-of-the-art theory and practical approaches in this area.

Outline

- a) One-variable Optimization
 - Optimality conditions
 - Numerical methods for one-variable minimization (Simplex method, Bisection, Secant method, Newton method)
 - MATLAB implementations
- b) Unconstrained optimization in n variables
 - Optimality conditions
 - Numerical methods and examples
 - Simplex and univariate search
 - Steepest descent with perfect and weak line searches
 - Newton method, quasi-Newton methods, conjugate gradient methods
- c) Gauss-Newton method for least-squares data fitting
- d) Introduction to Markowitz portfolio theory
 - Minimum risk portfolios
 - Maximum return portfolios

- Other portfolio performance functions
- Two-asset portfolios leading to one variable minimization
- e) Equality constrained problems
 - Optimality conditions
 - Numerical methods
 - Quadratic programming, reduced gradients
 - Sequential unconstrained minimization
 - Sequential quadratic programming
 - Examples of portfolio calculations
- f) Inequality constrained problems
 - Optimality conditions
 - Numerical methods
 - Quadratic programming, reduced gradients
 - Sequential unconstrained minimization (including barrier functions)
 - Sequential quadratic programming
 - Interior point methods
 - Example of portfolio calculations
- g) Minimax data-fitting via inequality constrained optimization
- h) Portfolio problems involving global optimization

References

- Nonlinear Optimization with Financial Applications by Michael Bartholomew-Biggs, Springer, 261 p., Hardcover ISBN: 1-4020-8110-3
- Numerical Optimization by Jorge Nocedal and Stephen J.Wright, 2nd edition, Springer, ISBN-10: 0-387-30303-0
- Optimization – Theory and Practice by Wilhelm Forst and Dieter Hoffmann, Springer, ISBN: 978-0-38778976-7