Optimization Methods in Management Science

Master in Management
HEC Lausanne

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Fall 2019 Semester

About This Course

Topics that will be covered :

- *linear programming*
- *graph theory*
- *network optimization*
- *combinatorial optimization*
- *dynamic programming*
- *non-linear optimization :*
  - *Lagrange multipliers*
  - *descent methods*
  - *the conjuguate gradient algorithm*
  - *quasi-Newton methods*

About This Course (Cont'd)

Applications to :

- *logistics,*
- *manufacturing,*
- *transportation,*
- *resource allocation,*
- *modern portfolio theory,*
- *machine learning :*
  - *recognition of handwritten digits,*
  - *classification of species depending on their features,*

will be discussed during this course

About This Course (Cont'd)

This course also includes :

- a presentation about **numerical optimization** in *Python* with *SciPy*,
- examples in **portfolio optimization** and **machine learning** in *Python* in *Jupyter Notebook*

About This Course (Cont'd)

The focus of this course is :

- **not** the math
- **nor** the implementation of the algorithms

This is a course designed for master's students in Business School with a focus on the application of the algorithms seen during lectures

Teaching

- Lectures : 2 hours a week
- Exercise sessions : 2 hours a week

Theory vs Exercises

- Theory and exercises are **equally** important for the success of the class !
- To be successful in this final exam, you need to understand well the theory and to be able to do the exercises presented during the exercise sessions
- Exercise solution notes will be distributed for each exercise session
- **A Q&A session will be organized during the last exercise session of the semester**

Evaluation Methods

- One final written exam at the end of the semester
- A non-graded midterm exam

Reference Books

- Luenberger, D. G., Ye, Y., Linear and Nonlinear Programming, Fourth Edition, Springer, 2016.
- Bierlaire, M., Optimization : Principles and Algorithms, PPUR, 2015.
- Nocedal, J. ; Wright, S. J., Numerical Optimization, Second Edition, Springer, 2006.
- Bertsekas, D. P., Dynamic Programming and Optimal Control, Fourth Edition, Springer, 2017.

Additional Resources

Youtube videos about optimization posted by Prof. Michel Bierlaire :

- Intuitions on linear optimization
- Intuitions on linear optimization : an illustrative example
- Introduction à l'optimisation linéaire : solution de base
- Directions de base et coûts réduits
- Equivalence entre sommets et solution de base admissible
- Algorithme du simplexe : exemple illustratif
- Définition du problème dual
- Théorèmes de dualité
- Transbordement et tableau du simplexe
- Algorithme du plus court chemin
- Branch & Bound : exemple illustratif
- Algorithme de la plus forte pente

Main Sources for this Course

- Two important sources for this course :

  (1) de Werra, D., Liebling T. M., Hêche, J.-F., Recherche opérationnelle pour ingénieurs I, PPUR, 2003

  (2) Bierlaire, M., Introduction à l'optimisation différentiable, PPUR, 2006

- A number of examples, exercises, and graphics in this course are based on the Operations Research courses from ROSO group
- ROSO group was the team headed by Prof. Thomas Liebling when I was a research assistant a long time ago at the EPFL

A Special Thanks !

Warmest Thanks!

A special thanks to Prof. Thomas Liebling, Prof. Jean-François Hêche and Prof. Michel Bierlaire, who were my mentors when I was a research assistant and who made me discover the fascinating world of Operations Research !