ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

M.Sc. Program in Data Science
Department of Informatics

Optimization Techniques

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Content – Topics to be covered

- Convex Optimization
  - Linear Programming
    - Models and Formulation
    - Simplex, variants and other algorithms
    - LP Duality Theory and applications
  - Convex Non-Linear Optimization
    - Convex sets and convex functions
    - Unconstrained convex optimization, descent methods
    - Constrained optimization
  - Applications to Machine Learning
    - Linear Regression
    - Support Vector Machines

Content – Topics to be covered

- Combinatorial Optimization
  - (Mixed) Integer Programming and exact methods
    - Integer Programming formulations
    - Branch and bound techniques
  - Efficient exact methods
    - Constraint Programming
    - Benders Decomposition
  - (Meta-)heuristics
    - Local Search Algorithms, Tabu search, Simulated Annealing, Genetic Algorithms
    - Reinforcement learning for combinatorial optimisation

Main focus & prerequisites

- Theoretical foundations
- Basic algorithmic ideas behind commercial optimization tools

Required background:

- There are no formal requirements to take the course
- It helps if you have taken undergrad courses on calculus, discrete math or algorithms
- Generally, it suffices if you have developed an elementary math background via courses in your undergrad program

Timeline

- **Solving convex optimization (6 lectures)**
  - Linear Programming: Lectures 1-3
    - Models and formulations
    - Simplex, variants and other algorithms
    - LP Duality Theory
  - Convex Optimization: Lectures 3-5
    - Unconstrained optimization, descent methods
    - Constrained optimization
  - Applications to Machine Learning: Lecture 6
    - Regression
    - Support Vector Machines

Timeline

- **Solving combinatorial Optimization (6-10 lectures)**
  - Combinatorial Optimization: Lectures 6-7
    - Integer Programming
    - Branch and bound
  - Integrated optimisation methods: Lect. 7-8
    - Benders Decomposition
    - Constraint Programming
  - Metaheuristics: Lect. 9-10
    - Local Search: Basic version, Tabu Search, Simulated Annealing, Genetic Algorithms
    - Reinforcement learning for combinatorial optimization

Bibliography

Main Books:

- [HL] F. Hillier, G. Lieberman, "Introduction to Operations Research", 10th edition, [Chapters 2-4, 6, 12]
  - For Linear Programming, Integer Programming, Branch and Bound
- [BV] S. Boyd, L. Vandenberghe, "Convex Optimization", [Chapters 1-4, 9-10]
  - For Convex optimization
- More material already provided in Syllabus and will also be provided throughout the lectures
- **and many many resources on the WWW**

Grading Scheme

Full Course

- 1 Programming project **35%**
  - You can work in groups of 2 people
  - It will be announced by Lecture 6
- Final exam **50%**
- 1 Problem set **15%**
  - Individual
  - Announced by Lecture 4.

Half Course:

- 1 Problem Set **15%**
- Final Exam **85%**

Communication

- Office hours (Lefkados 33 & Evelpidwn 47A, 8th floor, office 801):
  - Tuesdays: 11:00 – 14:00
  - Or by appointment
- You can always email me regarding questions
- Eclass: Optimization Techniques 2025
  - Please check for announcements in a regular basis