Methods and Models for Combinatorial Optimization

Course Content

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Course webpage

http://www.math.unipd.it/∼luigi/courses/metmodoc.html

Course goals

- Introduction to advanced modelling and solution techniques for combinatorial optimization problems: selecting among a huge number of alternatives.

- The course aims at providing mathematical and algorithmic tools to solve optimization problems of practical interest, also with the use of the most popular software packages or libraries.

- Relevant applications to / from Data Science:
  - **Complex network** analysis (e.g social networks, transportation networks)
  - **Data-Driven optimization** for huge optimization problems (e.g. Air Traffic Flow Management, deterministic approximation of stochastic optimization problems)
  - **Hybridization** of optimization and learning techniques (e.g. learning promising neighbor solutions)
  - ...

MeMoCO: Preliminary Programme (i)

- Review, advanced topics and application of Mathematical Programming and Duality
  - Linear Programming models, simplex method, basic notions of duality theory
  - Column generation technique for large size linear programming models
  - Applications: network flows, production planning optimization, traffic, telecommunication and social networks

- Advanced methods for Mixed **Integer** Linear Programming (MILP)
  - Alternative formulations, Branch & Bound, Branch & Cut
  - Applications: TSP, Facility Location, Set Covering etc.

MeMoCO: Preliminary Programme (ii)

- **Meta-heuristics** for Combinatorial Optimization
  - Neighbourhood search and variants
  - Evolutionary Algorithms
  - Hybridizations (e.g. Matheuristics, learning promising neighbor solutions)

- Network Optimization
  - Modelling optimization problems on graphs and flow networks
  - Application to complex network analysis

- **Labs**
  - On-line optimization servers (e.g., NEOS)
  - Optimization software and Algebraic modelling languages (e.g. AMPL, **IBM-OPL**)
  - Optimization libraries (e.g. **IBM Cplex**, Coin-OR, Scip)

Practical info

- **Schedule**:
  - First semester: Thursday, Friday 8:30 - 10:30
  - room 1BC50 **or** LabTA
- **Textbooks and course material**
  - Lecture notes provided by the teacher + articles from scientific journals (available **before** the class: read them!)
  - Optimization software packages available on line and in labs
  - *http://www.math.unipd.it/∼luigi/courses/metmodoc/metmodoc.html*
- **Examination methods**
  - **Two lab exercises**: implementation of 1) a MILP model and 2) a metaheuristic, to be delivered some days before the oral examination.
    Mandatory [1-10 /30, minimum 5]
  - **Oral examination** on course contents.
    Mandatory [1-20 /30, minimum 10].
  - Short project. Optional [+2 to +6 /30] (e.g., after the oral to improve the score if necessary)

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