Introduction to the course

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Learning objectives

At the end of this chapter you will be able to:

- describe the path of every chapter: management problem, model, Python and solver, interpretation;
- tell the classes QP and NLP apart, and say when a model is convex;
- find your way in the map of the models of the course.

Prerequisites

- From the module *LP Modelling*, Chapter 2 «Background: linear programming and sensitivity analysis»: linear models, duality and the sensitivity protocol
- From the module *Convex Optimization*, Chapter 6 «Convex and concave optimization problems»: convex sets and functions, and convex optimization problems

What we will do

From the management problem to the model

- Every chapter starts from a concrete management problem: how much risk to accept, which price to set, where to locate a service, how smooth a plan should be
- It turns it into a **nonlinear** optimization model, implemented in Python and solved with Gurobi
- Then it **questions** it: how much is one more unit of a resource worth? how much does a smoother plan cost?

Classes of models

QP and NLP

- **QP**: quadratic objective, linear constraints
- **NLP**: general nonlinear objective or constraints
- **Convex**: every local minimum is global; for QP and NLP it depends on the functions, and we point it out every time
- Continuous variables only: the KKT conditions and the multipliers hold

Map of the models

Map of the models (1/2)

- Production with quadratic smoothing — convex QP
- Supply chain and sustainability — convex NLP
- Markowitz portfolio — convex QP
- Pricing and revenue management — NLP
- Advertising budget — convex NLP

Map of the models (2/2)

- Continuous location — convex NLP
- EV charging with a smooth profile — convex QP
- Capacity and waiting times — convex NLP
- Support Vector Machine — convex QP
- Least-squares regression — convex QP

Production, EV charging and least squares are the quadratic variants of cases that stay linear in LP Modelling: same data, different objective.

Organization of the course

The essential path

1. Markowitz and the efficient frontier
2. Production with smoothing and the multipliers of QPs
3. Nonlinear modelling: pricing or budget
4. A project of your choice with a management presentation

The numbers of every chapter come from the scripts in `python/` (and from the notebooks in Colab).