# Optimization Problems solved with the Python Language

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*This course (given in English) considers topics in integer and linear optimization, taking advantage of what the Python language offers in terms of optimization libraries and capabilities. It has 5 lectures of 3 hours each plus a final exam, totaling 18 hours.*

*Python is an interpreted, high-level, general-purpose programming language. It supports multiple programming paradigms and is designed to be highly extensible. It strives for a simpler, less-cluttered syntax and grammar while giving programmers a choice in their coding methodology, making Python an ideal language for optimization and simulation problems, data-science visualization, and machine learning.*

**Lecture 1 (3 hours): Linear Programming**

- Basic theory.
- Modelling linear programming problems: manufacturing industry, transportation, and distribution.

**Lecture 2 (3 hours): Methods in Linear Programming**

- The graphical method.
- The Simplex method (hints).

**Lecture 3 (3 hours): Python and its Libraries**

- Programming in Python.
- Using the **PuLP** library to solve linear problems.

**Lecture 4 (3 hours): Integer Linear Programming: part 1**

- Basic theory.
- Modelling combinatorial optimization problems: knapsack, bin packing, and facility location.

**Lecture 5 (3 hours): Integer Linear Programming: part 2**

- The branch-and-bound method.
- Solution of integer linear programming problems with Python

**Lecture 6 (3 hours):**

- Final exam: model an integer linear problem and program a code in Python to solve it.

**Bibliography:**

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- CONFORTI, M.; CORNUEJOLS, G.; ZAMBELLI, G. *Integer programming*. Switzerland: Springer International Publishing, 2014.
- DANTZIG, G.; WOLFE, P. *Decomposition principle for linear programs*. Operations Research, v. 8, p.101-111, 1960.
- NEMHAUSER, G. L.; WOLSEY, L. A. *Integer and Combinatorial Optimization*. John Wiley and Sons, New York, 1988.
- VANDERPLAS, J. *Python Data Science Handbook*. O'Reilly Media, Sebastopol, 2016.

# Advanced Optimization Problems and their Exact and Heuristic solutions with the Python Language

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*This course (given in English) is an extension of the first course and considers how to model combinatorial optimization problems and solve them using the Python language methods. It has 5 lectures of 3 hours each plus a final exam, totaling 18 hours.*

**Lecture 1 (3 hours): Exact methods for combinatorial optimization**

- Cutting plane method.
- branch-and-cut method.

**Lecture 2 (3 hours): Heuristic methods for combinatorial optimization**

- Constructive heuristics.
- Local search-based heuristics.

**Lecture 3 (3 hours): The traveling salesman problem**

- Modeling the problem.
- Implementing a branch-and-bound and a branch-and-cut with Python.

**Lecture 4 (3 hours): The vehicle routing problem**

- Modeling the problem.
- Implementing a constructive heuristic with Python.

**Lecture 5 (3 hours): The integrated facility location and vehicle routing problem**

- Implementing a local search-based heuristic with Python.

**Lecture 6 (3 hours):**

- Final exam: program a heuristic in Python to solve a combinatorial optimization problem.

**Bibliography:**

- CONFORTI, M.; CORNUEJOLS, G.; ZAMBELLI, G. Integer Programming. Switzerland: Springer International Publishing, 2014.
- CORMEN, T. H.; LEISERSON, C. E.; RIVEST, R. L.; STEIN. C. *Introduction to algorithms*. MIT Press, Cambridge, 2001.
- FERREIRA, K. M.; ALVES DE QUEIROZ, T. A. Two effective simulated annealing algorithms for the location-routing problem. Applied Soft Computing, v. 70, p. 389-422, 2018.
- LOPES, M. C. et al. Heuristics for a hub location-routing problem. Networks, v. 68, p. 54–90, 2016.
- TALBI, E.-G. Metaheuristics: From Design to Implementation. New Jersey: John Wiley & Sons, 2009.
- TOTH, P.; VIGO, D. (Ed.). The Vehicle Routing Problem. SIAM, 2002. (SIAM Monographs on Discrete Mathematics and Applications).
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# Courses' Schedule

*Each course (given in English) considers topics in integer and linear optimization, taking advantage of what the Python language offers in terms of optimization libraries and capabilities. Each course has 5 lectures of 3 hours each plus a final exam.*

| **Course 1: Optimization Problems solved with the Python Language** | | | **Course 2: Advanced Optimization Problems and their Exact and Heuristic solutions with the Python Language** | |
|---|---|---|---|---|
| Lecture 1 | February 15th 16:00 – 19:00 | | Lecture 1 | March 01st 16:00 – 19:00 |
| Lecture 2 | February 17th 16:00 – 19:00 | | Lecture 2 | March 03rd 16:00 – 19:00 |
| Lecture 3 | February 19th 16:00 – 19:00 | | Lecture 3 | March 05th 16:00 – 19:00 |
| Lecture 4 | February 22sd 16:00 – 19:00 | | Lecture 4 | March 08sd 16:00 – 19:00 |
| Lecture 5 | February 24th 16:00 – 19:00 | | Lecture 5 | March 10th 16:00 – 19:00 |
| Final exam | February 26th 16:00 – 19:00 | | Final exam | March 12th 16:00 – 19:00 |