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## 2SC7410 – Decision Support : Models, algorithms and implementation

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**Instructors:** Vincent Mousseau

**Department:** DÉPARTEMENT GÉNIE INDUSTRIEL ET OPÉRATIONS

**Language of instruction:** FRANCAIS

**Campus:** CAMPUS DE PARIS - SACLAY

**Workload (HEE):** 60

**On-site hours (HPE):** 34,50

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### Description

Decision making is an intrinsic activity in the engineering profession and often leads to optimize one or more aspects of a system. But these decisions are also based on the judgments/preferences of a decision-maker/user. Preferences have therefore played a key role in many computer applications and modern information technologies. This is the case of computer marketing, recommendation systems, adaptive user interfaces, ... Decisions can be strategic, tactical or dynamic, in complex, competitive, uncertain, optimize or find a compromise between conflicting criteria ... To solve the complex decision problems between them, they must be confronted, the engineers must implement the concepts and methods and algorithms to formalize a problem of decision.

### Quarter number

ST7

### Prerequisites (in terms of CS courses)

none

### Syllabus

- Introduction to decision making, basic concepts,
  - Modeling of decision problems using mathematical programming.
- Presentation of modeling and resolution tools (modelers and solvers),
- Implementation using Python + GUROBI,
  - Decision in the presence of risk, decision in the uncertain, utility theory, decision trees,
  - Multi-criteria decision and modeling of preferences, aggregation models,
  - Empirical analysis of decision behavior,
  - Learning preference models from data, incremental learning,
  - Metaheuristics for combinatorial problems,
  - Multiobjective optimization

**Class components (lecture, labs, etc.)**

lectures: 13.5h

exercices: 10,5h

lab: 9h

this distribution may slightly vary

**Grading**

Final exam (1h30): 70% Lab evaluation: 30%

**Course support, bibliography**

Lecture slides and exercices will be provided.

Labs will be organized using a Jupyter notebook

**Bibliography:**

D. Bouyssou, T. Marchant, M. Piriot, P. Perny, A. Tsoukiàs, P. Vincke

"Evaluation and Decision models: A critical perspective", Kluwer, 2000.

W. Cooper, L. Seiford, and K. Tone, "Introduction to Data Envelopment Analysis and its use", Springer, 2006.

C. Guéret, C. Prins, M. Sevaux. "Programmation linéaire, 65 problèmes d'optimisation modélisés et résolus avec Visual Xpress", Eyrolles, 2003

C. Kwon, "Julia programming for operations research", 2019, second edition, <http://www.chkwon.net/julia>

P. Vallin, D. Vanderpooten, "Aide à la décision, une approche par les cas", 2e édition, Ellipses. 2002.

H.P. Williams. "Model building in mathematical programming". J. Wiley, New York, 2013. 5ème édition,

**Resources**

equipe enseignante (V. Mousseau + chargés de TD/TP à valider)

Software: Python + optimisation solvers + metaheuristics libraries

TD: ~30 students

TP: ~20 students

Wifi ABSOLUTELY REQUIRED for TD and TD

**Learning outcomes covered on the course**

This course aims to develop students' abilities to develop and implement models and algorithms relevant to a decision-making situation.

At the end of the course, students will master some methods / models for decision support. They will be able to manipulate models, use them in an operational way and implement them efficiently. They will also have the necessary elements to take a step back and have a critical sense in relation to these methods, and thus to distinguish their performances and their limits of application.



### **Description of the skills acquired at the end of the course**

C1 (all sub-competences): Analysis, design and implementation of complex systems made up of scientific, technological, social and economic dimensions.

C2.1: Thoroughly master a domain or discipline based on the fundamental sciences or the engineering sciences.

C2.3: Rapidly identify and acquire the new knowledge and skills necessary in applicable / relevant domains, be they technical, economic or others.

C6.3: Conceive, design, implement and authenticate complex software.

C6.4: Solve problems through mastery of computational thinking skills.

C6.5: Operate all types of data, structured or unstructured, including big data.