Master's Department of Engineering Sciences

Name of the unit: Optimisation

Lecturer: OSSART Florence (florence.ossart@sorbonne-universite.fr)
Course code: UM4RBT10-Opt
Student workload: 8h of lectures, 6h of tutorial sessions, 10h of lab sessions@
Credits: 3 ECTS

Specialization tracks:	- **E3A** :	☐ CIMES	☐ Syscom	☒ IPS
	- **AR** :	☒ ROBOT	☒ SI	☒ MeDH
	- **MECA** :	☐ MS2	☐ MF2A	☐ CompMech
		☐ ACOU	☐ EE	☐ EE APP

Semester offered: ☒ S1 ☐ S2 ☐ S3 ☐ S4
Language of instruction: ☒ French ☐ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

This course aims to teach students how to define and numerically solve a simple continuous optimization problem, with or without constraints.
Keywords:

Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Mathematics: Systems of linear equations and matrices, functions of several variables
- Programming: Python basics, classical algorithms

Intended Learning Outcomes

By the end of this course, students will be able to:

1. Formulate a simple continuous optimization problem (decision variables, objective function, constraints), choose and implement a solution method and perform a critical analysis of the results
2. Know the theoretical bases of the main methods of continuous optimization without constraints (gradient descent, Newton)
3. Know the theoretical bases of the main methods of continuous optimization under constraint-equality (Lagrange multipliers)
4. Know the theoretical bases of the main methods of continuous optimization under constraint-inequality (KKT algorithm)
5. Understand what a multi-objective optimization problem is and the concept of dominance
6. Know the principle of some heuristic optimization methods (Monte-Carlo, genetic algorithms, SPO, ...)
7. Implement and code in python the solution of a simple optimization problem, analyze the behavior of the method according to the hyperparameters of the method used

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C1 (2h), TD1 (2h)	Unconstrained continuous minimization, analytical approach	Personal work in addition: visualization in python of the solutions of the tutorial exercises	AAV1, AAV2
S2	TP1 (4h)	Unconstrained continuous minimization, numerical approach (gradient descent)		AAV1, AAV2, AAV7
S3	C2 (2h), TD2 (2h)	Continuous minimization under equal constraints	Personal work in addition: visualization in python of the solutions of the tutorial exercises	AAV1, AAV3
S4	TP2 (4h)	Continuous minimization under equal constraints		AAV1, AAV3, AAV7
S5	C3 (2h), TD3 (2h)	Continuous minimization under constraints-inequalities - Multi-objective optimization	Personal work in addition: visualization in python of the solutions of the tutorial exercises	AAV1, AAV4, AAV6, AAV7
S6	C4 (2h), TP3 (2h)	Multi-objective optimization - Some heuristic methods of optimization		AAV1, AAV5, AAV6, AAV7
S7	TP4 (2h)	Examination		AAV7

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
7 ou plus	Individual	In-person	Written	AAV1 à AAV6	60 %
7 ou plus	Individual	In-person	Practical	AAV7	30 %
1 to 6	Individual	Remote	Practical	AAV1 à AAV7	10 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Individual	In-person	Written	AAV1 to AAV6	60 %
1	Individual	In-person	Practical	AAV7	30 %
1	Individual	Remote	Practical	AAV1 à AAV7	10 %

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