



5.00 credits

30.0 h + 22.5 h

Q2

Teacher(s)	Nunes Grapiglia Geovani ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	Basic knowledge of Nonlinear Analysis and Linear Algebra. The target audience is the students interested in scientific computing, machine learning and optimization in engineering.
Main themes	<ul style="list-style-type: none"> <li>• General nonlinear optimization.</li> <li>• Smooth and non-smooth convex optimization.</li> <li>• Interior-point methods.</li> </ul>
Learning outcomes	<p><b>At the end of this learning unit, the student is able to :</b></p> <p>Learning outcomes:</p> <ul style="list-style-type: none"> <li>• AA1.1, AA1.2, AA1.3</li> <li>• AA2.1</li> <li>• AA5.2, AA5.3</li> </ul> <p>After this course, the student will be able to :</p> <ol style="list-style-type: none"> <li>1. Estimate the actual complexity of Nonlinear Optimization problems.</li> <li>2. Apply lower complexity bounds, which establish the limits of performance of optimization method.</li> <li>3. Explain the main principles for constructing the optimal methods for solving different types of minimization problems.</li> <li>4. Use the main problem classes (general nonlinear problems, smooth convex problems, nonsmooth convex problems, structural optimization ' polynomial-time interior-point methods).</li> <li>5. Understand the rate of convergence of the main optimization methods.</li> <li>6. Two testing computer projects give a possibility to compare the theoretical conclusions and predictions with real performance of minimization methods</li> </ol> <p>Additional benefits :</p> <ul style="list-style-type: none"> <li>• Training in scientific English</li> <li>• Experience in solving difficult nonlinear optimization problems</li> </ul>
Evaluation methods	In the written exam (in English or French) there are four questions, one for each chapter of the course (up to 5 points for each question). The marks for the exam and the exercises are combined in the final mark.
Teaching methods	The course is given in 12-15 lectures. The computer projects are implemented by the students themselves with supporting consultations.
Content	<ul style="list-style-type: none"> <li>• General problem of nonlinear optimization. Black-box concept. Iterative methods and analytical complexity. Gradient method and Newton method. Local complexity analysis.</li> <li>• Convex optimization: convex sets and functions; minimization of differentiable and non-differentiable convex functions; lower complexity bounds; optimal methods.</li> <li>• Interior-point methods: notion of self-concordant functions and barriers; path-following methods; structural optimization.</li> </ul>
Inline resources	<a href="https://moodle.uclouvain.be/course/view.php?id=5537">https://moodle.uclouvain.be/course/view.php?id=5537</a> The full syllabus (in English) can be downloaded from the web page of the course.
Bibliography	<ul style="list-style-type: none"> <li>• Yu.Nesterov. "Introductory lectures on convex optimization. Basic course", Kluwer 2004</li> <li>• P. Polyak, « Introduction in optimization », J. Willey &amp; Sons, 1989</li> <li>• Yu. Nesterov, A. Nemirovsky, « Interior-point polynomial algorithms in nonlinear optimization », SIAM, Philadelphia, 1994.</li> </ul>
Faculty or entity in charge	MAP

<b>Programmes containing this learning unit (UE)</b>				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Data Science Engineering	DATE2M	5		
Master [120] in Data Science: Information Technology	DATI2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		