

Intitulé du cours

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| Course title – Intitulé du cours | Introduction to Bilevel Optimization |
| Level / Semester – Niveau / semestre | M2 |
| School – Composante | Ecole d'Economie de Toulouse |
| Teacher – Enseignant responsable | David Salas |
| Other teacher(s) – Autre(s) enseignant(s) | |
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| Lecture Hours – Volume Horaire CM | 15h |
| TA Hours – Volume horaire TD | |
| TP Hours – Volume horaire TP | |
| Course Language – Langue du cours | English |
| TA and/or TP Language – Langue des TD et/ou TP | |

Teaching staff contacts – Coordonnées de l'équipe pédagogique :

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Course Objectives – Objectifs du cours :

The topic of the course will be “Introduction to bilevel optimization”, and it will be divided in 4 units. The first three unit are the classic ones, providing a primer on the field. The last unit is focused on variants of bilevel programming.

- I.- Formulation of Bilevel programming problems (2h)
- II.- Existence of solutions for Bilevel programming problems (5h)
- III.- Single-Level reformulations and algorithms (5h)
- IV.- Extensions (3h)

At the end of the course, the student is expected to be able to:

- formulate bilevel optimization problems
- to identify well-posedness of formulations and evaluate their algorithmic difficulty
- apply direct methods to prove existence of solutions
- apply algorithms to search global solutions for Linear bilevel programming

Prerequisites – Pré requis :

An M1 level course on optimization. The students are expected to be familiar with linear programming, Karush-Kuhn-Tucker first-order optimality conditions, and basic convex optimization.

Practical information about the sessions – Modalités pratiques de gestion du cours :

Grading system – Modalités d'évaluation : Defense of a project.

Bibliography/references – Bibliographie/références :

Session planning – Planification des séances

The detail of the units is as follows:

I.- Formulation of Bilevel programming (2h)

- Stackelberg games
- Optimistic and pessimistic bilevel programming
- Linear bilevel programming
- Examples

II.- Existence of solutions for Bilevel programming problems (5h)

- Preliminaries on Set-Valued Analysis
- Berge Maximum Theorem
- Existence results for Optimistic Bilevel Optimization
- Existence results for Pessimistic Bilevel Optimization

III.- Single-Level reformulations and algorithms (5h)

- Value-function formulation
- KKT reformulation of optimistic Bilevel Optimization
- Strong-Duality formulation for Linear bilevel programming
- Hardness of Linear bilevel programming
- Branch-and-bound

IV.- Extensions (3h)

- Mixed-Integer bilevel programming
- Bilevel games
- Bayesian approach for bilevel programming

Distance learning – Enseignement à distance :

Distance learning can be provided when necessary by implementing:

- *Interactive virtual classrooms*
- *Recorded lectures (videos)*
- *MCQ tests and other online exercises / assignments*
- *Remote (online) tutorials (classes)*
- *Chatrooms*

En cas de nécessité, un enseignement à distance sera assuré en mobilisant:

- *Classe en ligne interactive*

- *Vidéo enregistrée de la présentation du matériel pédagogique*
- *QCM et exercices en ligne*
- *TP/TD à distance*
- *Forum...*