

Advanced machine learning

Course title - Intitulé du cours	Advanced Machine Learning
Level / Semester - Niveau / semestre	M2 / S1
School - Composante	Ecole d'Economie de Toulouse
Teacher - Enseignant responsable	Christophe GAILLAC
Other teacher(s) - Autre(s) enseignant(s)	
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Other teacher(s) - Autre(s) enseignant(s)	
Lecture Hours - Volume Horaire CM	15
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 :

Christophe GAILLAC christophe.gaillac@unige.ch

Modes d'interaction privilégiés: sortie de cours et par mail

Course Objectives – Objectifs du cours :

The goal of this course is to introduce Machine Learning tools that are useful for applied economists. You will understand and learn how to critically use modern machine learning techniques, from their predictive power to their revolutionary handling of unstructured data, to infer causal relationships from data. The course covers estimation of treatment effect heterogeneity, implications for optimal policy learning, an introduction to online learning and applications, and natural language processing (NLP) techniques and their applications in economics. If time permits, the course will finally touch on ethics and Machine Learning. Each session will contain a series of empirical examples, programs, and exercises to facilitate the students adoption and implementation of the techniques

Prerequisites – Pré requis :

Students should have followed Introduction to Machine Learning, Econometrics, and R and/or Python Programming classes

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

- Computers are allowed;
- The class is interactive and collaborative;
- Students are not allowed to join the class after 20 minutes from the start.

Grading system – Modalités d'évaluation :

Oral presentation reporting an empirical or simulation exercise (mi-december).

Bibliography/references – Bibliographie/références :

- Chernozhukov, V. et al. (2024+). Applied Causal Inference Powered by Machine Learning and AI. <https://causalml-book.org/> — Includes many online notebooks and empirical examples.
- Gaillac, C., & L'Hour, J. (2025). Machine Learning for Econometrics. Oxford University Press

Session planning – Planification des séances

1. Heterogeneous Treatment Effects Estimation using Machine Learning
 - CATE Estimation and Validation
 - Generic Machine Learning
 - Applications to targeting in RCT and Advertising A/B Testing
2. Optimal Policy Learning in Practice
 - Introduction to Optimal Policy Learning
 - Prediction Policy Problems
 - Applications: Prediction of Outcomes or Prediction of Impacts?
3. Online Learning and Active Learning in Practice
 - Introduction to Online Learning and Bandit problems
 - Application to adaptive experiments
4. Natural Language Processing for the Applied Economist
 - NLP 1.0: Text as Data
 - NLP 2.0 and 3.0: from static to contextual embeddings
 - Practice session on Modern NLP for economic prediction
5. LLMs in Economics
 - Applications of LLMs in Economics
 - Uncertainty quantification, robustness
6. Ethics and Machine Learning
 - Fairness of ML: auditing and solutions
 - Introduction to explainability

Distance learning – Enseignement à distance :