

# Laboratory overview

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# Laboratories

## Aims:

- Become familiar with simulation and optimization approaches
- Apply statistical techniques and heuristic algorithms
- Use simulation-based optimization methods

## How:

- Guided exercises in Python
- Group project to solve a real world problem

# Schedule

## LECTURES

Date	Topic
22.02.2024	Introduction to simulation
	Drawing from distributions
	The Poisson process
29.02.2024	Discrete events simulation
	Statistical analysis and bootstrapping
07.03.2024	Simulation project
14.03.2024	Simulation project
21.03.2024	Variance reduction
	Markov chain Monte Carlo methods
28.03.2024	Simulation project
04.04.2024	~~ Spring break ~~
11.04.2024	Simulation project
18.04.2024	Introduction to optimization
25.04.2024	Multi-objective optimization
02.05.2024	Optimization project
09.05.2024	~~ Bank holiday ~~
16.05.2024	~~ No in-class lecture and lab ~~
23.05.2024	Optimization project
30.05.2024	Project presentations

## • Laboratories:

- 7 weeks for **simulation**
- 4 weeks for **optimization**

## • Exam:

- 30 May 2024

## • Presentation exam:

- 20 min. presentation + 10 min. Q&A
- A date upon agreement

# Laboratory materials

- Find on the webpage.
- Material will be uploaded before the class.

## Optimization and simulation

**Spring 2024**

Michel Bierlaire  
Transport and Mobility Laboratory, ENAC



The objectives of the course are:

- Mastering the state-of-the-art methods in continuous optimization and simulation,
- Understanding the theoretical foundations of the algorithms and methods,
- Learning statistical techniques for interpreting simulation results, and
- Using simulation for complex optimization problems.

Work involves:

- Reading the material beforehand,
- Class hours to discuss the material and solve problems, and
- Class and homework group assignments.

# Evaluation

## ① Project presentation

- Both simulation and optimization parts must be presented.
- The evaluation criteria, group and project description will be announced in the third lab on 7 March 2024.
- **Everyone must be present during the final presentation.**

## ② Exam(to be decided)

- Exam date: 30 May 2024.
- The exam accounts for 25% of the final grade.
- The exam is in English.
- Details will be announced later.

## ③ Class & group involvement

## ④ Quality of the code, it should:

- Work properly.
- Be neat and clearly commented.

# Simulation laboratories

- Exercises:
  - 1 Random number generation
  - 2 Poisson process
  - 3 Discrete event simulation
  - 4 Statistical analysis and bootstrapping
  - 5 Variance reduction techniques
  - 6 Markov Chain Monte Carlo methods
- Simulation project:
  - Announced on 7 March 2024 (at the end of the third laboratory).

# Textbooks for simulation

- Ross (2012). Simulation. Fifth Edition. Academic Press.
- Gelman et al. (2013) Bayesian Data Analysis. CRC Press.

# Python

- You should have some basic knowledge of Python to follow the course.
  - Python is used in the computer labs.
  - Projects should be produced using Python.
- Software
  - Anaconda distribution: Jupyter, Spyder (to be installed locally).
  - Google Colab (cloud-based and interactive).



# Python

- Python self-study tutorials prepared by TRANSP-OR:
  - Github repo: <https://github.com/th389/DASstudents>
  - Python fundamentals:  
<https://tube.switch.ch/videos/B0gKSTbXUf>
  - Further Python techniques:  
<https://tube.switch.ch/videos/B0gKSTbXUf>
  - Numpy and Matplotlib:  
<https://tube.switch.ch/videos/LL8ckpvSer>
  - Pandas: <https://tube.switch.ch/videos/hG1t8uSAiz>

