Laboratory overview

Pavel Ilinov

Transport and Mobility Laboratory
School of Architecture, Civil and Environmental Engineering
École Polytechnique Fédérale de Lausanne

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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

- **Laboratories**:
  - 7 weeks for **simulation**
  - 5 weeks for **optimization**
- **Exam:**
  - 28 May 2025
- **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 2025

Michel Bierlaire
Transport and Mobility Laboratory, ENAC

EPFL

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 5 March 2025.
   - **Everyone must be present during the final presentation**.

2. Class & group involvement

3. 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 5 March 2025 (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/DAStudents
    - Python fundamentals:
      https://tube.switch.ch/videos/BOgKSTbXUf
    - Further Python techniques:
      https://tube.switch.ch/videos/BOgKSTbXUf
    - Numpy and Matplotlib:
      https://tube.switch.ch/videos/LL8ckpvSer
    - Pandas: https://tube.switch.ch/videos/hG1t8uSAiz