Group project: Optimization

Selin Ataç

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

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Traffic simulation of Kid City

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Recommendations
Group organization
Project submission and presentation

Project overview

Aim:

- Full application of a **simulation-based optimization** example
- Apply the methods you learned to solve a real-world problem.
- The main purpose is to identify the **optimal** system configuration.
- Each group works on a different example.

Objectives:

- **Simulation**: develop a discrete events simulation and appropriately evaluate the performance in two different scenarios.
- **Optimization**: define and solve an optimization problem to obtain the optimal solution for the system.

Case study

Simulation:

- Develop a discrete events simulation.
- Identify the appropriate statistical indices.
- Correctly use simulation techniques to generate results.
- Correctly analyse the simulation results.
- Consider the efficiency and precision of simulation.

Optimization:

- Identify the decision variables.
- Define the objective function(s).
- Design an optimization algorithm to solve the problem.
- Achieve a meaningful result and good interpretation by identifying the "optimal" solutions (multi-objective solution necessary).

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Example project

Simulation-based project:

Traffic simulation of Kid City

Problem description

Discrete event simulation to represent the traffic in Kid City

What is the best street to close?

Decision variables

- Close roads

Objectives

- Traffic conditions (queue length)
- Cost

The optimization problem

Objective

- Identify the best location for the road closure

Objective function example

1. minimize mean-queue-length in the city
2. minimize the cost of closing the road

$$\min_{x \in X} Z(x)$$

$$Z = \theta\{f(x)\}$$

where

- x is the network with road i closed
- $f(x)$ is the desired indicator at solution x, e.g., average-queue-length with road i closed, and cost of closing road i
- θ is the statistic considered, e.g., maximum, 95-percentile, average

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Keep in mind

Optimization project

- Expand the discrete-event simulation
- Embed the discrete-event simulation in the optimization algorithm

Keep in mind

Tips

- Start by considering what the **objective function(s)** you want to minimize/maximize is
- Consider how you would **evaluate** the objective functions with the simulated data
- Start with **simple** constrained optimization
- Explore different objective functions, some examples you can try:
  - (maximize/minimize) mean value of X (revenue, capacity, time) across multiple simulations
  - (minimize) variance of X across multiple dimensions
  - objects, destinations...

Keep in mind

Attention!

- Computational time

Support

- Discord channel
  - `#lectures-optimization`: for optimization lectures
  - `#lab-discussions`: for lab exercises
  - `#project-questions`: for project discussions

Assigned projects

Group	Project	Title	Names	Time	Review
Group 1	Project 1	Train service	Cyrill Baumann Georgios Iatropoulos Jonas Paccolat Raffael Theiler	13:15-13:50	Group 3
Group 2	Project 2	Restaurant design	Michael Bombile Ismail Nejjar Yazan Safadi Shuhang Zhang	13:50-14:25	Group 4
15 minutes break					
Group 3	Project 3	Drone delivery service	Mikele Gajda Ben Lönnqvist Gaétan Raynaud Mengjie Zhao	14:40-15:15	Group 2
Group 4	Project 4	Online movie streaming	Tom Häring Tommaso Pavan Quentin Uhl	15:15-15:50	Group 1

Submission and presentation

Submission

- Submit **by e-mail** to `silvia.varotto@epfl.ch`
  1. **PDF file** for the presentation,
  2. **Jupyter notebook** for the project, and
  3. **Jupyter notebooks** for the labs (one notebook per group and lab).
- Deadline: **Noon on May 30, 2022, Monday**.
- Subject: "OptSim22 project: Group X"
- File: make one `.zip` file "GroupX.zip"

Submission and presentation

Presentation

- On **30 May 2022**.
- Make sure that the first presentation will start 13:15 on time.
- 25 minutes presentation and 10 minutes Q&A.
- You should include both simulation and optimization parts.

Required content for the optimization part

- Problem description
- Decision variables and objective function
- Optimization algorithm
- Results
- Suggested "optimal" solution

Any
Questions?