CIVIL 324 Urban Public Transport systems

Group Project Description

Spring 2025

1 Overview

This project aims to engage you in a comprehensive analysis and design of an urban public transport system to tackle a particular mobility challenge. You will be expected to apply the models and optimization tools from the course to practical problems and collaborate in groups.

2 Main Tasks

You will perform the following tasks in sequence to complete the project.

- **Select service region and service mode:**

  Select one of the provided scenarios and propose a public transport service for a particular subregion. Optional service modes include

  - Fixed-route transit: shuttle, bus, tram/metro, railway
  - On-demand mobility: demand-responsive bus, ride-hailing/taxi, ride-sharing, bike-sharing/scooter-sharing
  - Intermodal service: an integration of fixed-route transit and on-demand mobility

- **Analyze demand pattern and prepare design inputs:**

  Analyze the spatial and temporal pattern of travel demand in the selected service region. Key demand attributes include

  - Hourly demand rate
  - Trip distance distribution
  - Origin-destination matrix

  Identify key input parameters for the service design. Some basic parameters and their references are provided in 'parameter.xlsx', including

  - Traveler's value of time
  - Mode-specific operation cost
  - Vehicle and walking speeds
  - Stopping and transfer times

  You may also propose other estimates with supporting references.

- **Model and optimize service design:**

  Define main design problems, identify design variables, and set design objectives. Typical design problems include

- Stop location and line planning
- Timetabling and schedule coordination
- Fleet sizing, capacity planning, and vehicle scheduling
- Pricing

Build the design model based on the general models introduced in the course and adapt it for the selected region, demand pattern, and design objectives. Solve the design problem using methods and optimization tools introduced in the course.

- **Assess feasibility and impacts**

  Evaluate system performance and welfare effect of different stakeholders (e.g., operator and user) under the proposed service design. Conduct sensitivity analyses on the most uncertain and influential input parameters (e.g., how much the design variables and the system outputs change when demand doubles).

3 Scenarios

Two scenarios are generated for this project based on real-world urban areas. Both areas are presented by hexagons with equal side lengths of 100 meters. The travel demand is aggregated hourly between two hexagon zones. For simplicity, you may assume all trips are generated at the centroid of each zone. The Jupyter Notebook 'scenario.ipynb' provides examples of loading and plotting the network and demand data.

The zone centroids are defined as candidate stop locations. Hence, a transit line can be constructed by connecting a series of zone centroids, regardless of the actual road network, and the minimum stop spacing is 200 meters. For station-free on-demand mobility, you may assume vehicles are uniformly distributed within each zone.

3.1 Lausanne area

The Lausanne area consists of 1,545 zones that cover zones 11 and 12 of the Mobilis network (see Figure 1). All demand starts and ends inside the area and assume there exists no other public transport services.

3.2 Renens area

The Renens area consists of 263 zones that cover several communes around EPFL (see Figure 2). The demand is categorized into three types:

- start and end inside the area
- start from Renens Gare and end inside the area
- start inside the area and end at Renens Gare

For the second and third types, the demand is further divided into 'east-bound' and 'west-bound', indicating the travel direction from Renens Gare (e.g., to Lausanne and to Morges). Assume there exists no other public transport services in the area except trains stopping at Renen Gare. The timetable is detailed in 'SBB_timetable.pdf'.

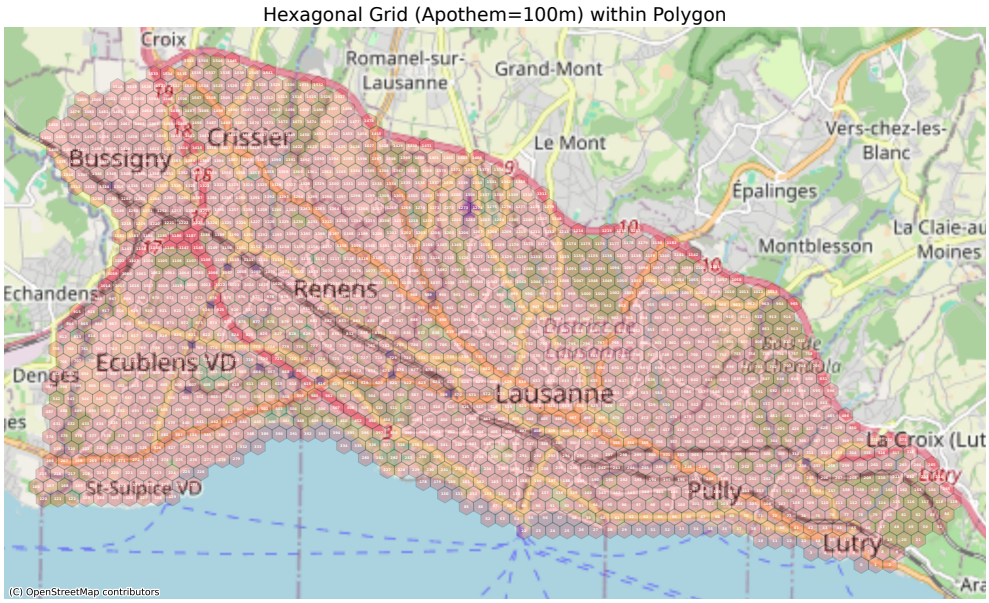

Figure 1: Lausanne network

4 Timeline

Important milestones are listed as follows:

- Apr. 7: Publish project
- Apr. 13: Form group and select scenario
- Apr. 28: Proposal presentation (10%)
- May. 26: Final presentation (15%)
- Jun. 8: Final report (15%)

Group and scenario

Each group should have no more than 4 persons. The group leader shall submit the list of group members and selected scenario on Moodle.

Proposal presentation

The proposal presentation is 5 minutes per group and should answer the following questions:

- **What** is the service mode?
- **Where** is the proposed service operated?
- **Who** are served?
- **How** to design the service? What are the design variables, and what is the design objective?

Final presentation

The final presentation is 7 minutes per group, plus 3 minutes Q&A. The presentation should give an overview of the proposed service and discuss the main findings.

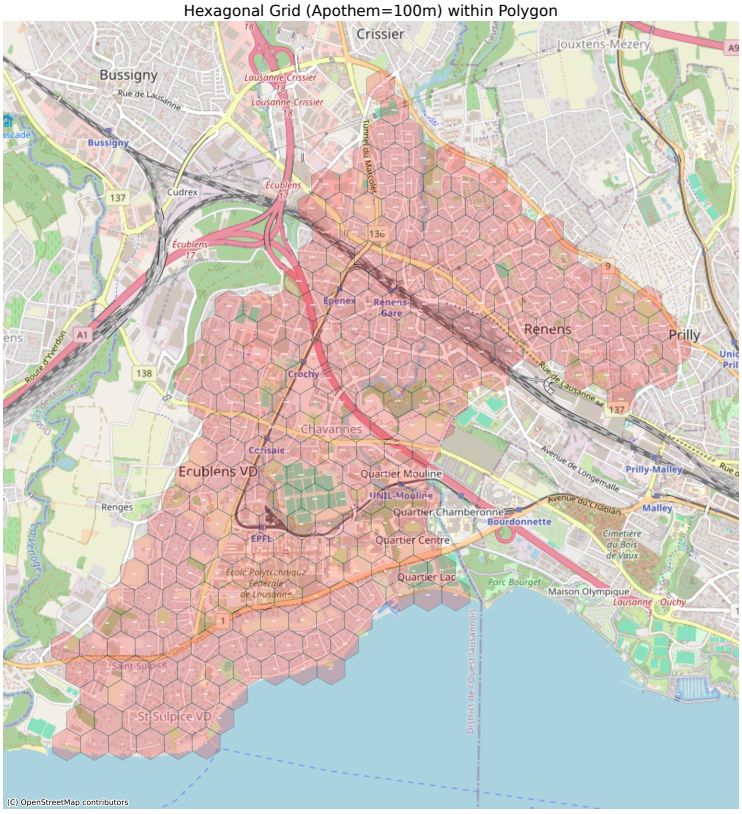

Figure 2: Renen network

Final report

The final report is at most 10 pages and summarizes the design process, including

- Service region and mode selection
- Demand analyses
- Model and solution method
- Numerical analyses
- Summary of proposed service
- Statement of contributions

The statement of contributions is mandatory and describes the contribution of each group member to the project.

5 Evaluation criteria

The project will be evaluated based on the following criteria:

- **Innovation and creativity:**

  Whether you showcase thorough thoughts in the design process and demonstrate originality in the proposed service.

- **Technical proficiency:**
  Whether you develop a rigorous model and correctly solve the service design problem.
- **Practical significance:**
  Whether you deliver a comprehensive analysis of feasibility and impacts on stakeholders.