Innovative teaching/research related to sustainable and smart TRAFFIC FLOW

Iceland Liechtenstein Norway grants

DŮM ZAHRANIČNÍ SPOLUPRÁCE D Z S

CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

Vladimír Faltus

Department of Transport Telematics

UiS, JAN 24, 2023

faltus@fd.cvut.cz

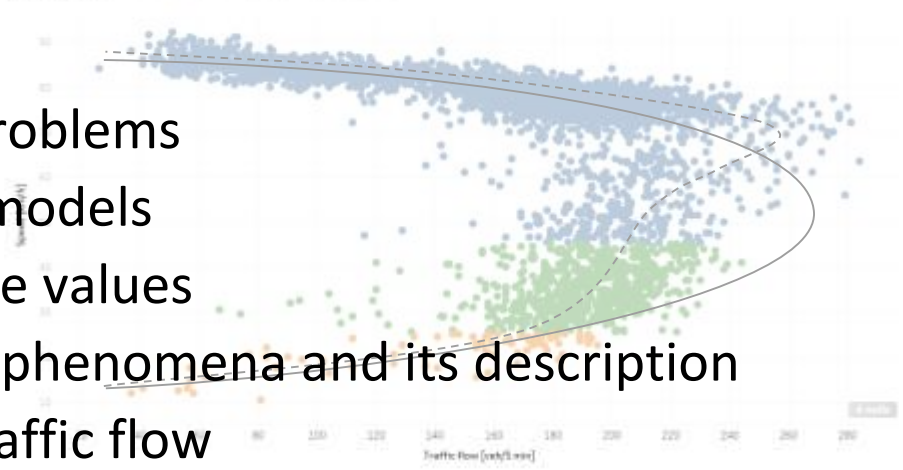
Faculty prerequisites (CTU FTS)

- **Challenge Based Learning (CBL)** … a collaborative learning experience in which teachers and students work together to learn about compelling issues, propose solutions to real problems, and take action
- FTS has prerequisites for CBL
- Long time running link to practical experience – **project-oriented education** is a practical implementation of CBL principles in long-term and also sometimes in a short-term scale
- The projects lead towards the **final thesis**
- The current goal is to **extend** this experience into the standard education (lectures/seminars)

www.challengebasedlearning.org

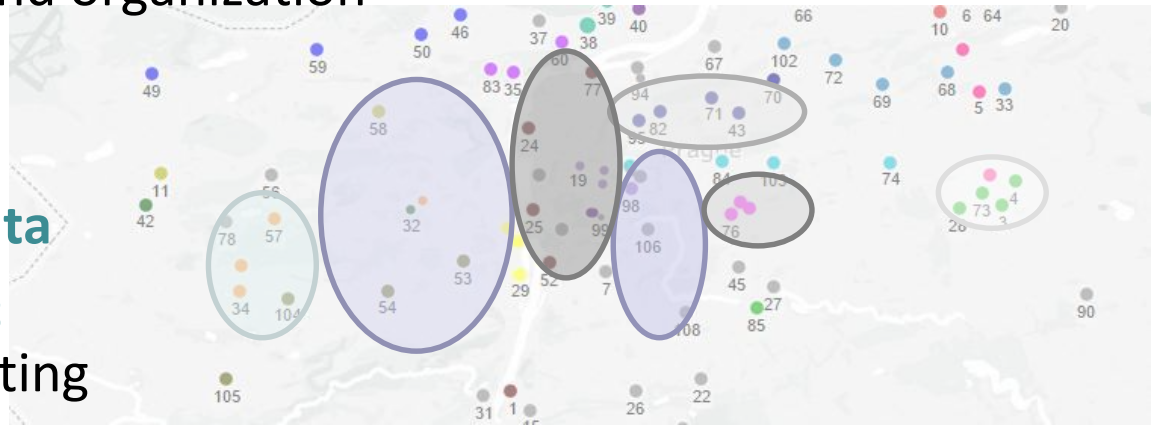
Presentation of selected course example: Traffic flow theory

- Master study, 1st semester, 2+1 hrs/week (lectures + seminars)
- Goals:
  - Getting to know the basics of traffic flow theory based on **traffic parameters**
  - Creation of traffic **models** – macroscopic, microscopic, statistical traffic flow physical phenomena
  - Links to how to use the issues to **improve traffic flow**
- Content
  - Human mobility and related problems
  - Traffic parameters, relations, models
  - Obtaining and evaluation of the values
  - Traffic flow behaviour, special phenomena and its description
  - Using the values to improve traffic flow



How a climate change, smartness and sustainability can be addressed in Traffic flow theory

- **Pillars of environmentally friendly, smart & sustatinable transportation:**
  - **Road/track capacity** & construction
  - Vehicles (type/size, energy, capacity, construction, automation)
  - Shared transportation (incl. PT)
  - **Traffic management** and organization



  - Effective **work with data**
  - **Optimization of traffic** in the sense of eliminating traffic problems
  - What is a sustainable traffic flow?

What will change when using the CBL approach

Ideas with innovative character

- Today, the student receives data that is obtained and pre-verified by the teacher from locations chosen by the teacher
  - The student then works on the task (model creation and application)
    - In a team in seminars
    - Independently (homework)
      + consultation with the teacher

- Solution: **CBL + OpenData access**
  - Team work (collaboration) in all tasks
  - Students are in deep touch with the traffic data and solve reality
    - Incl. obtaining the data
    - Incl. validity check
    - Incl. knowledge about time & space

What will change when using the CBL approach

Ideas with innovative character

TODAY | FUTURE

- Obtaining the data
  - **PASSIVE:** To get from the teacher
  - **ACTIVE:** To search and obtain by the student based on agreement in a team
- Selection of the data
  - **PASSIVE:** Unknown for the student, pre-selected by the teacher
  - **ACTIVE:** Values, time and location selected in a team
- Evaluation of the data
  - **PASSIVE:** Validated by the teacher previously
  - **ACTIVE:** Looking for errors, other validation by the student/team
- Experience sharing
  - **PASSIVE:** Everyone has a similar experience
  - **ACTIVE:** There may be specifics to share in a team how tho work with the data

- **ENGAGE** phase: find a challenge
- **INVESTIGATE** phase: find a solution
- **ACT** phase: implement the solution

OpenData source example – Prague

Prague city data – Golemio: www.golemio.cz

- A set of technical tools for working with urban data
- **Open Data Platform** – whenever possible, the data is published openly
- **OpenSource software** with freely accessible source codes
- Operated under the public administration of Prague within the municipal organization (Operator ICT)
- Allows collecting and publishing **traffic data**
  ... from roads, vehicles, PT and other sources … from a specific location and time
- Has a set of **tools** for working with data
- **Further data**... air pollution, energy consumption of buildings, waste management, shared accommodation, etc.
- The possibility of broader analyzes of sustainability

GOLEMIO
PRAGUE CITY DATA

Using the CBL for the selected case

SWOT analysis

Strengths	Weaknesses
• Students activation – pulling the students into the problem • Mutual sharing of information and experience • The habit of teamwork makes education more attractive	• The work may be of different difficulty for different students • The result assessed for the credit may not reflect the individual qualities of the student
Opportunities	**Threats**
• The students will gain valuable experience with traffic data for practical work • Generalization of acquired experience on the part of the teacher and subsequent use for research and practice	• There may not be motivation for individual performance in some cases • Unclear data quality can mean higher demands for teachers and thus less time to devote to students individually to a sufficient extent

RESEARCH impacts: Climate-neutral and smart cities, adaptation

- **Costs** of climate/smartness in traffic flow
  - Pollutions (noise, dust, emissions)
  - Energy consumption
  - Time spent in traffic
  - Incidents …
- **What is a sustainable** (climate-neutral and smart) **traffic** in this case? **3 issues to discuss…**
  - Traffic flow: Sustainability vs. traffic speed
  - Traffic systems: Sustainability vs. life-time
  - How automation will influence sustainability

Traffic flow: Sustainability vs. traffic speed

Research topics

Advantages:

- **50 – 60 km/h:** ↓ noise, ↓ dust, ↓ emissions, ↓ energy, ↑ safety
- **70 – 80 km/h:** ↑ capacity, ↓ queues, ↑ safety
- **> 100 km/h:** ↓ time spent in traffic, ↑ psychology, ↑ motivation

What is green and how much?

What is sustainable and how much?

Traffic systems: Sustainability vs. lifetime

Research topics

Source: Metroprojekt Praha

- Influence: intelligent technologies, vehicles, road/track constructions...
- **Technological lifetime** ... tendency ↑
  - Urban/area planning
  - Production (sources, energy)
  - Installation
  - Disposal / recycling
- **Moral lifetime** ... tendency ↓
  - Energy efficiency
  - Maintenance
  - New algorithms / SW changes

What is green/sustainable and how much?

How automation influence sustainability?

Research topics

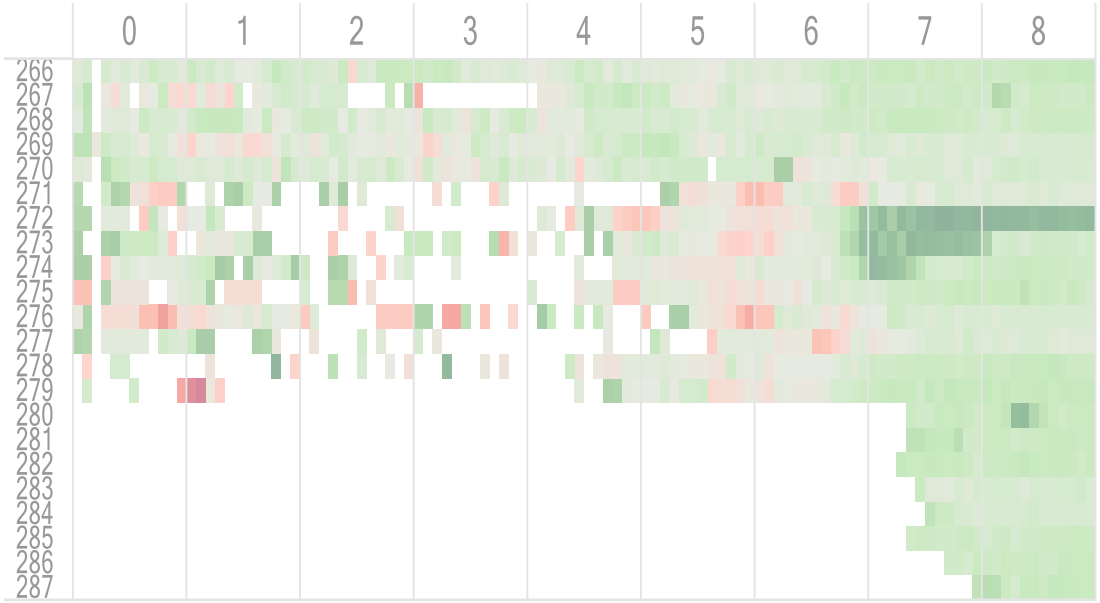
- Influence: capacity, queues, delays, safety, pollutions, energy...
- **Driver (car-following)**

- **Automation (autonomous vehicles)**

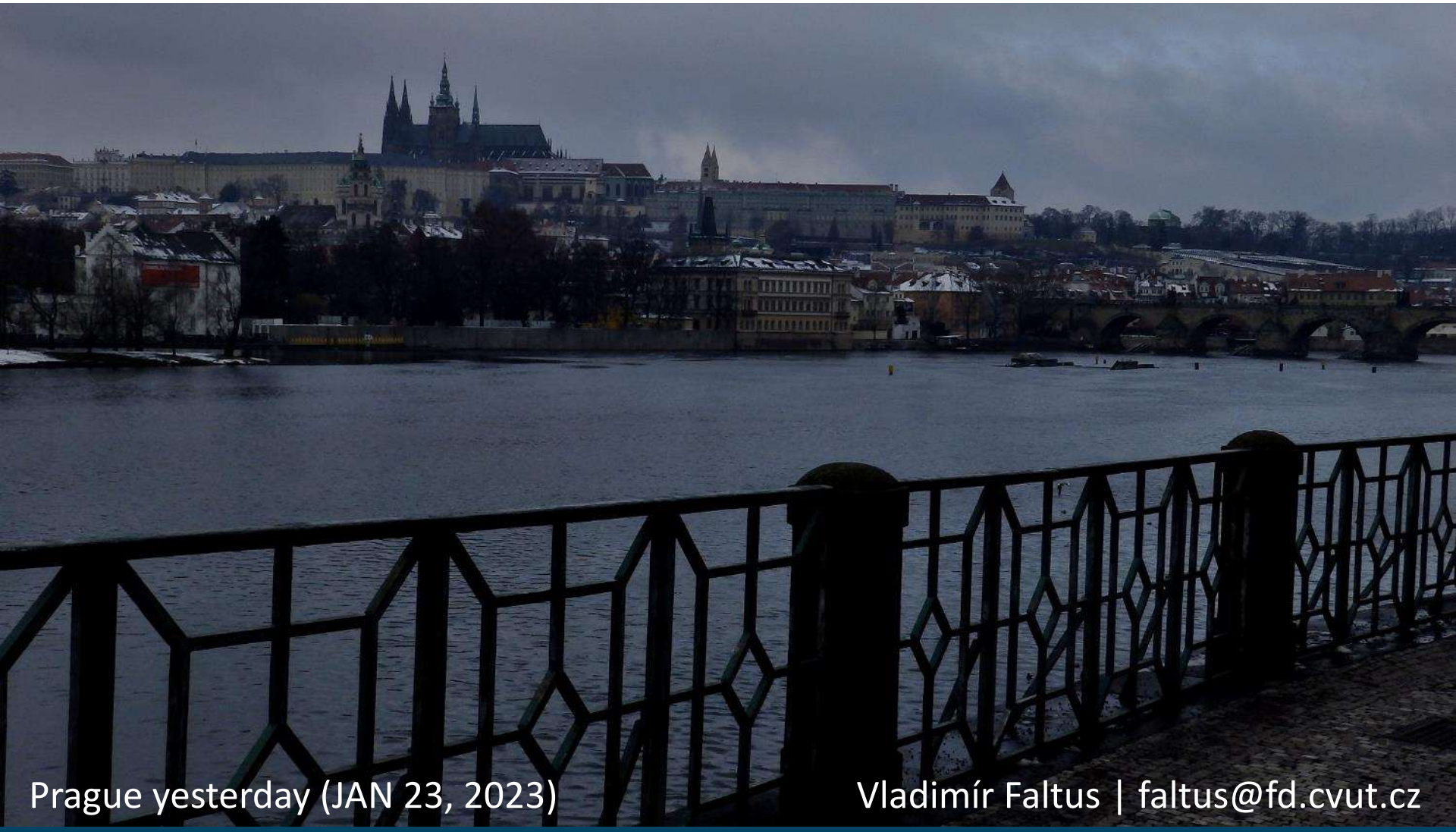
- **Automation (cooperative vehicles)**

Conclusions

- „Traffic Flow theory“ course available for **CBL deeper implementation**
- CBL can be more included into the seminars thanks to **OpenData access**
- CBL in standard courses brings many **advantages** but also may bring some **issues**
- Outputs of CBL useful for **R&D**
- **Sustainability of traffic** is a complex problem



Thank you!



Prague yesterday (JAN 23, 2023)

Vladimír Faltus | faltus@fd.cvut.cz