



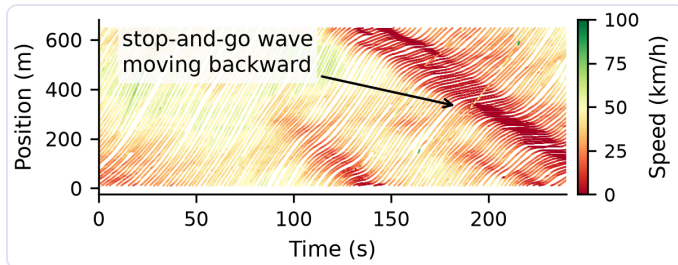
Data-Driven Mobility Modeling and Simulation

Why do traffic jams appear on a road with no accident and no bottleneck? And can an **AI driver that aces every test** still cause one? Learn the physics of traffic, then put it to work with real data, simulation and AI.

Graduate · 3 credits · Fridays 3 pm

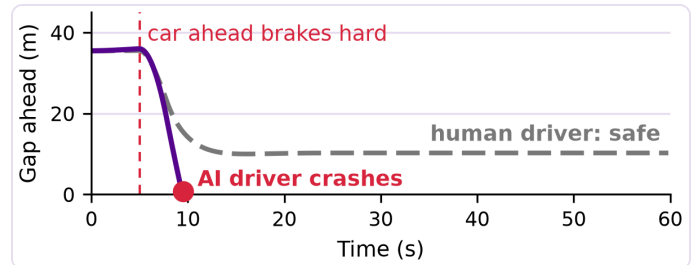
Civil & Urban Engineering · cross-listed with CUSP

Weekly Python labs



Real cars, real jam. Each line is one vehicle on a U.S. freeway (NGSIM, FHWA). The red wave moves *upstream* while every car moves forward.

On paper: rigor. Derive it by hand: conservation laws, shock-wave speeds, when a line of cars turns unstable. Built up step by step; no PDE background assumed.



An AI driver aced the driving test. Then the car ahead braked hard. Simulated result: trained on everyday driving, it scores near-perfect on held-out data, yet crashes in the emergency.

In code: practice. Then test it in the labs: check your predictions against small simulators you write yourself, or against real traffic data.

What you'll learn

- **Measure traffic.** Trajectories, road sensors, GPS, drones, LiDAR, and why two sensors on one road disagree.
- **Macroscopic models.** Traffic as a fluid: speed, flow and density, shock waves, bottlenecks.
- **Microscopic models.** Car-following, lane-changing, and when traffic turns unstable.
- **Calibration.** Least squares to Bayesian: which parameters fit, and how sure are we?
- **AI and ML.** Driver models and forecasts learned from data, then tested: do they behave like real traffic?
- **Digital twins.** Simulations kept in sync with real roads, with real signal controllers plugged in.

In the labs, step by step

10+ guided Colab labs with starter code: nothing to install, you fill in the key steps. For example:

- Code small simulators, one piece at a time: shock waves, a freeway, car-following and lane-changing.
- Forecast freeway traffic from sensor data, and find out when a simple rule beats machine learning.
- Mix one reinforcement-learning car with rule-following cars on a jammed ring road: can it smooth the jam?

Why it matters

Transportation engineers

Learn the fundamentals that professional simulation tools are built on, so they stop being black boxes, and how underlying models are calibrated.

Urban data scientists

Mobility data has physics. Learn models that respect it, and spot when a model with a great test score will fail on the street.

PhD students and future researchers

Leave grounded in traffic theory, data analysis and calibration, ready for open questions in automation, AI and new data.

Prerequisites

Formal: graduate standing or instructor's permission.

What you need: calculus and some Python. No traffic background required.

You'll do well if you...

- have written a little Python, or are ready to learn fast;
- like asking *why* a model works, not only *whether* it does;
- want to dig into real data to see how traffic works.



wx241.github.io/trgy7353

Open lecture notes with live simulations, labs and demos. Try the jam yourself before you enroll.

Lectures · Labs · Demos · Syllabus on request

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