The Frazzoli Group at ETH Zurich

The Frazzoli Group

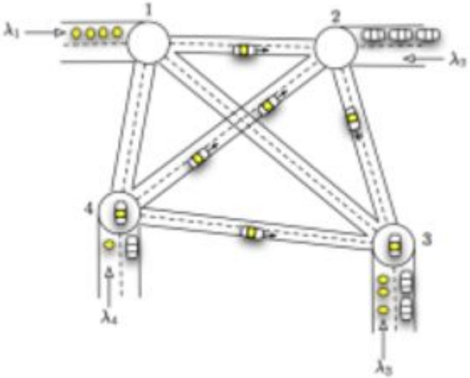
Department of Mechanical and Process Engineering (D-MAVT)

Institute for Dynamic Systems and Control (IDSC)

- Staff
  - 2 Administration
  - 2 Senior assistants
  - 3 Ph. D. students
  - 3 Technical staff
  - ~15 students (rolling average) at Master and Bachelor level

Main directions

Planning, control, perception, learning for AVs, embodied AI



Transportation networks and autonomous mobility on demand

robotics education and dissemination

Main directions

- Autonomous vehicles

- Smart (urban) mobility

An autonomous go-kart

Duckietown: an accessible platform for smart mobility rapid prototyping

The AI Driving Olympics

ETH zürich

ETH Zürich, University of Montréal, NCTU (Taiwan), TTIC (Chicago), Tsinghua (China), Georgia Tech, Duckietown Foundation, nuTonomy, Amazon Web Services.

amazon web services

nuTonomy

DUCKIETOWN

AIDO 1: The first *embodied learning* competition at **NIPS 2018**
AIDO 2: Second edition at **ICRA 2019**
AIDO 3: Third edition at **NeurIPS 2019**

Platform

sensing

computing

Challenges

lane following

dynamic obstacles

coordination

Simulated AMoD

Reproducible Learning Protocol

learn from logs

and / or

learn in simulation

→

evaluate on simulation

→

evaluate in robotariums

- **Simulation to reality:** can we learn in simulation and act in reality?
- **Granularity in learning:** should we learn modules, or end-to-end architectures?
- Can we **learn complex tasks,** instead of simple sensorimotor skills?
- How can we deal with **resource constraints?** (e.g. planning-aware perception.)

For more information:
AI-DO.duckietown.org

Machine Learning for Robotics

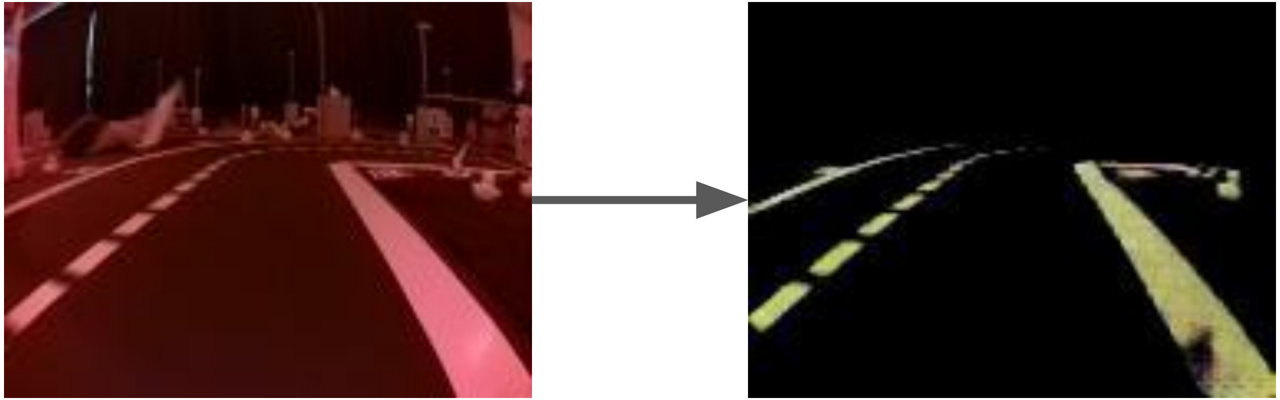
Special circumstances of embodied AI

- Real-time constraints
- Limited training data
- Disturbances in data

AI Driving Olympics as a testbed

Machine Learning for Robotics

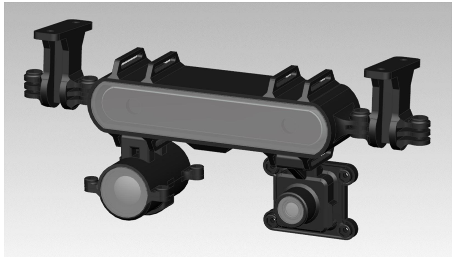
Focus on methods to increase “structure” in data using learning



Multimodal sensing - Does a hierarchy of sensors exists?

Zauron:

- Rgb
- Thermal
- Event-based

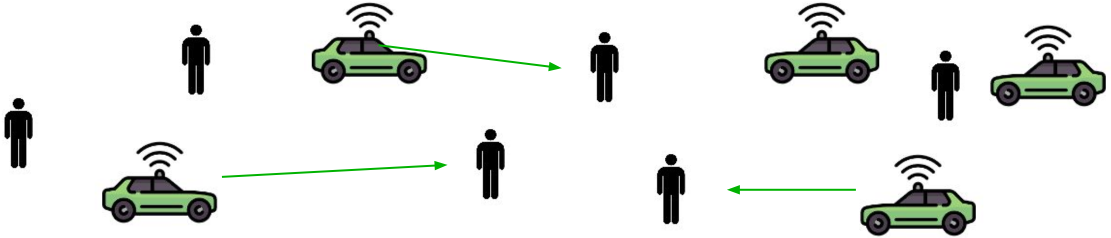


In **wormhole learning** we showed how learning to recognize objects across modalities is beneficial even for the first “teacher”.

Autonomous Go-kart

- Trajectory planning at speeds up to 20 km/h
- Advanced control for speeds up to 32 km/h

Mobility-on-Demand: Fleet Control & Transportation System Analysis



A well-performing autonomous mobility-on-demand system uses as few taxis as possible to pickup and deliver as many customers as possible with minimal waiting and journey times while keeping the fleet mileage to a minimum.

Some examples of past and answered research questions:

- What influence do **fleet operational policies** have on service quality and price? [Hörl, Sebastian, et al. "Fleet control algorithms for automated mobility: A simulation assessment for zurich." *Transportation Research. Part C, Emerging Technologies* (2018).]
- End-to-end reinforcement learning, can **fleet operational policies** be acquired with **reinforcement learning**? [Fluri, Christian, et al. "Learning to Operate a Fleet of Cars." *European Control Conference (ECC 2019)*. ETH Zurich, 2018.]
- **Model-free rebalancing:** where should empty vehicles be replaced (rebalanced) if no model of the demand is available? [Ruch, Claudio, et al. "The+ 1 Method Model-Free Adaptive Repositioning Policies for Robotic Multi-Agent Systems." (2019).]
- How large is the **price of anarchy**, i.e., the performance loss due to lack of fleet coordination? [Ruch, Claudio, Spencer Richards et al. "The Value of Coordination in mobility-on-demand systems" (2019).]
- ...