

CIVIL-459

Deep learning for autonomous vehicles

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Cursus	Sem.	Type
Civil Engineering	MA2, MA4	Opt.
Civil engineering minor	E	Opt.
Electrical and Electronical Engineering	MA2, MA4	Opt.
Robotics, Control and Intelligent Systems		Opt.
Robotics	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	During the semester
Workload	180h
Weeks	14
Hours	6 weekly
Lecture	2 weekly
Exercises	4 weekly
Number of positions	

Summary

Deep Learning (DL) is the subset of Machine learning reshaping the future of transportation and mobility. In this class, we will show how DL can be used to teach autonomous vehicles to detect objects, make predictions, and make decisions. (Fun fact: this summary is powered by DL)

Content

1. Introduction:
 - Defining Autonomous Vehicles, Artificial Intelligence, Machine Learning, and Deep learning
 - Overview of the 3 pillars of Autonomous Vehicles: Perception, Prediction, Planning
 - Quick overview of sensing modalities
2. Deep learning for Perception (how to extract meaningful information from raw data?)
 - Quick recap on the fundamentals of machine learning (fundamentals of regression and classification)
 - Intro to deep learning (Neural Network, CNN, regularization techniques)
 - State-of-the-art techniques (e.g., Self supervised learning, Vision Transformer)
- 3- Deep learning for Prediction
 - Intro to Recurrent Neural Networks
 - Learning to clone socially-accepted human behavior
 - State-of-the-art techniques (e.g., Graph Neural Network, Transformer, Diffusion...)
- 3- Deep Learning for Planning
- 4- Beyond Deep Learning: role of ethics
 - How to integrate ethical decisions?

Keywords

Deep Learning, Autonomous Vehicle, Artificial intelligence, Machine learning, Self-driving car, human-robot tandem race

Learning Prerequisites**Required courses**

- Knowledge of Python
- Understanding of linear algebra and calculus
- Introductory knowledge of Machine Learning concepts

Learning Outcomes

By the end of the course, the student must be able to:

- Define the fundamental steps behind an AI-driven system
- Design the building steps of an autonomous vehicle
- Implement an algorithm for each step
- Explain and understand the challenges and ethical impacts

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Communicate effectively, being understood, including across different languages and cultures.
- Demonstrate the capacity for critical thinking

Teaching methods

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Expected student activities

- Attend lectures and participate in discussions
- Complete weekly programming assignments
- Work on hands-on projects to apply deep learning techniques to autonomous vehicle tasks
- Engage in group projects and present findings
- Participate in a final project showcasing the application of deep learning in autonomous vehicles

Assessment methods

- Lab projects (Individual): 30%
- Midterm (Individual): 30%
- Final project (in group): 40%

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	Online Platform: Access to course materials, forums for discussion, and submission portals for assignments

Resources

Virtual desktop infrastructure (VDI)

No

Notes/Handbook

Online Resources: Access to online courses, tutorials, and documentation for deep learning frameworks

Moodle Link

- <https://go.epfl.ch/CIVIL-459>

Prerequisite for

- **Advanced Courses:** This course prepares students for more advanced topics in AI, robotics, and control systems
- **Industry Roles:** Equips students with skills relevant for careers in autonomous vehicle development, robotics engineering, and AI research
- **Research Projects:** Provides a foundation for conducting research in deep learning applications within the field of autonomous systems