Submodule	**TM abbreviation**
Deep Learning	DDLM

Responsible person	Faculty
Teacher / Lecturer	**Frequency of supply**
Vincent BARRA	

Teaching form

Semester of study according to curriculum	Teaching scope [SWS or UE]	Teaching language	Work effort [ECTS credits]
	4	English	5

Time commitment:

Classroom study	Self-study

Study and examination performance

Each week: slides covering a theme, with both methodological, applicative and implementation issues.

Evaluation

- Weekly programming assignments which should be done on an individual basis (not evaluated).
- Final exam: challenge (gathering knowledge collected during the programming assignments).

Contents

- Introductory course
  - Introduction to Machine Learning and Deep Learning
  - Introduction to the development tools
- Artificial neural networks: perceptron and multilayer perceptron
  - Artificial neuron model
  - Perceptron
  - Multilayer perceptron
  - Backpropagation algorithm
- Convolutional neural Networks
  - Layers definition
  - Initialization
  - Regularization
  - Explainability
- Recurrent Neural Networks & Transformers
  - RNN training
  - LSTM and GRU
  - Transformers

- Autoencoders
  - Definition
  - Sparse, contrastive and denoising autoencoders
- Transfer Learning
  - Some classical deep neural networks
  - Transfer learning and fine tuning
- Generative models
  - Generative Adversarial Networks
  - Variational Autoencoders
  - Diffusion models
  - LLMs

Learning objectives: Professional competence

After successful completion of the submodule, students are able to:

- Understand Machine Learning paradigms (2)
- Understand Deep Learning paradigm and architectures (2)
- Analyse a classification or regression problems and solve using Deep Learning approaches (3)
- Code and Employ Neural Networks and Deep Learning Architectures (2,3)

Learning objectives: Personal competence

After successful completion of the submodule, students are able to:

- Read, write, and present in an academic environment in English language (3)
- Interactively discuss subject-matter topics with other students and reflect their viewpoints (3)
- Organize themselves independently (3)
- Create work results with certain boundary conditions set for a given due date (3)

Teaching media

Slides (pdf), Jupyter notebooks, videos.

Literature

- I Goodfellow, Y Bengio and A Courville, A. Deep Learning. MIT Press, 2016 (https://www.deeplearningbook.org)
- S Haykin. Neural networks and machine learning, Prentice Hall, 2008.
- F Chollet, Deep Learning with Python, Manning, 2018
- S Russel, P Norvig, Artificial Intelligence: A Modern Approach, 2022 (https://aima.cs.berkeley.edu)
- E Stevens, L Antiga, T Viehmann, Deep Learning wth PyTorch, Manning, 2020

The numbers in brackets indicate the levels to be reached: 1 - know, - 2can, - 3understand and apply