Valid from 2026.HS

Module description: Deep Learning

Module Code	t.BA.DS.DL-EN.26HS
ECTS Credits	4
Language of Instruction/Examination	English
Organizational Unit	CAI
Module Coordinator	Jasmina Bogojeska
Legal Framework	The module description is part of the legal basis in addition to the general academic regulations. It is binding. During the first week of the semester a written and communicated supplement can specify the module description in more detail.
Module Characteristic	Type 3f 2 asynchronous lessons per semester week for each yearly starting-class + 2 weekly lab lessons per semester week in half-class groups
Module Description	We focus on the theory and practical application of deep learning (DL). We start with the DL foundations and dive into the details of the most frequently used modern deep learning models, their capabilities and limitations and their application on real-world use cases from different domains.
Module Content	• Advanced machine learning (ML) solutions based on deep learning (DL) have shown impressive performance on challenging, practically relevant problems in many different domains and are also present in increasingly many aspects of our lives, such as image analysis (face recognition, quality control); speech technologies (virtual assistants, emotion recognition); time series analysis (investment modeling, sensor data fusion); personalized healthcare (diagnosis, drug design); personalized advertising; or autonomous vehicles. Deep neural networks have thus become a critical component of computing in general and are an important element of many job profiles in computer and data science. In this module we will provide a thorough introduction to deep learning, starting by covering the fundamentals (main concepts, basic building blocks of neural networks, backpropagation, gradient descent, optimization) that will lay the way for the deep dive into the details of modern deep neural architectures, such as different variants of convolutional neural networks, recurrent neural networks, graph neural networks, and transformers. We will investigate these models and algorithms, analyze their advantages, limitations and discuss the challenges. **Topics** • - Introduction to DL (e.g., current applications and success, fundamental principles, deep feedforward networks, gradient-based learning, backpropagation, optimization, regularization) - Convolutional neural networks (e.g., VGG, ResNet) - Sequence modeling (e.g., RNN, LSTM, attention mechanism and transformers) - Graph neural networks (e.g, GCN) - Generative models - Selected topics **Accompanying Labs** • To apprehend the proper application of the deep learning methods in practice, we will discuss real-world applications from several different domains (e.g., computer vision, natural language processing, healthcare) and provide a large set of practical examples on real-world datasets using state-of-the-art tools and frameworks. In a real-world practical projects the participants can apply and deepen the acquired knowledge and skills.

Module description: Deep Learning

Prerequisite Knowledge

- General introduction to machine learning and neural networks, such as successful completion of MLDM1
- Python

Learning Objectives (Competencies)

Students...	Competencies	Taxonomies
can explain the application of deep neural networks, discuss their challenges and provide example tasks where they are applicable	F, M	K3, K4
can explain the main concepts of (deep) neural networks: linear/nonlinear modules, depth, width, gradient-based learning, backpropagation, regularization, optimization, hyperparameters	F	K2
can describe the advantages and limitations of certain deep neural networks architectures, algorithms and methods covered in the course	M, F	K2, K4
can design, implement, train, tune and properly evaluate the discussed deep learning methods on your own in a DL framework and can apply them to real-world tasks and datasets	F, M	K3, K5

Performance Assessment

End-of-module exam	Assessment	Length (min.)	Weighting	Social Form	Scenario/Format
written exam		90	80%	acc. to module agreement	

	Assessment	Length (min.)	Weighting	Social Form	Scenario/Format
Project	Grade		20%	acc. to module agreement	

Classroom Attendance Requirement

None

Learning material

- Simon J. D., P. (2023). Understanding Deep Learning. MIT Press. ISBN 978-0262048644. https://udlbook.github.io/udlbook/ .
- Raschka, S. & Liu, Y. & Mirjalili, V. (2022). Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python. Packt Publishing. ISBN 978-1801819312.

Comments