HAW Kiel
Hochschule für Angewandte Wissenschaften Kiel
Kiel University of Applied Sciences

DL - Deep Learning

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Allgemeine Informationen	
Modulkürzel oder Nummer	DL
Eindeutige Bezeichnung	DeepLearnA-01-MA-M
Modulverantwortlich(e)	Prof. Dr. Schneider, Stephan (stephan.schneider@haw-kiel.de) Prof. Dr. Lüssem, Jens (jens.luessem@haw-kiel.de)
Lehrperson(en)	Prof. Dr. Lüssem, Jens (jens.luessem@haw-kiel.de)
Wird angeboten zum	Sommersemester 2026
Moduldauer	1 Fachsemester
Angebotsfrequenz	Regelmäßig
Angebotsturnus	In der Regel im Sommersemester
Lehrsprache	Englisch
Empfohlen für internationale Studierende	Ja
Ist als Wahlmodul auch für andere Studiengänge freigegeben (ggf. Interdisziplinäres Modulangebot - IDL)	Nein

Studiengänge und Art des Moduls (gemäß Prüfungsordnung)
Studiengang: M.Sc. - MCS - Computer Science (PO 2023, V1) Modulart: Wahlmodul Fachsemester: 1, 2
Studiengang: M.Sc. - MCS - Computer Science (PO 2023, V1) Schwerpunkt: Artificial Intelligence Modulart: Verpfl. Wahlmodul, PVO §3 Fachsemester: 1, 2
Studiengang: M.Sc. - MIE - Information Engineering (PO 2022, V3) Modulart: Wahlmodul Fachsemester: 1, 2, 3

Kompetenzen / Lernergebnisse
Kompetenzbereiche: Wissen und Verstehen; Einsatz, Anwendung und Erzeugung von Wissen; Kommunikation und Kooperation; Wissenschaftliches Selbstverständnis/Professionalität.
Students can specifically… • explain the term deep learning (DL) and classify it in the context of artificial intelligence (AI), • name, delimit, describe and explain the concepts, methods and models of supervised and unsupervised learning, • understand the mathematical and statistical foundations of the different types of artificial neural networks, • name and explain basic methods of data analysis and data pre-processing, especially acquisition, transformation, cleansing, partitioning, scaling, visualization and static description, • Describe the complete process of carrying out a DL project from analysis and pre-processing of the data to the application of the methods and development of models to the post-processing of the data (e.g. model-based forecast).

Students have/can generally... • Significantly expanded their knowledge at the level of university entrance qualifications, • demonstrate a broad and deep knowledge and understanding of the scientific foundations of content-related teaching areas (e.g. AI, DL, mathematics, statistics) based on the current state of research, • a critical understanding of the most important theories, principles and methods of the content-related teaching areas, • Critically reflect on technical and practice-relevant statements and check the plausibility of envisaged solutions to problems. Students can specifically (in terms of content)… • identify and assess the application potential of AI or DL in selected and mostly known application contexts, • solve specific problems using the R or Python languages and applications.
Students can generally... • formulate technical and factual solutions to problems within their actions and justify them in discourse with specialist representatives and non-specialists with theoretically and methodologically well-founded arguments, • communicate and cooperate with other subject representatives and non-specialists in order to solve a task responsibly, • Reflecting on and taking into account the different perspectives and interests of other participants.
Students can generally... • develop a professional self-image that is based on the goals and standards of professional action in professional fields that are primarily outside of science, • justify their own professional actions with theoretical and methodical knowledge, • Assess one's own abilities, autonomously reflect on factual design and decision-making freedoms and use them under guidance, • Recognize the framework conditions of professional action that are appropriate to the situation and justify their decisions in a responsible and ethical manner, • reflect critically on their professional actions in relation to social expectations and consequences.

Angaben zum Inhalt	
Lehrinhalte	1. Deep learning in the context of artificial intelligence 1.1. On the relationship between artificial intelligence (AI), machine learning (ML) and deep learning (DL) 1.2. Excursus: data and scale levels 1.3. Problem areas: regression, classification and clustering 1.4. General Types of Artificial Neural Networks (ANN) 2. General introduction to the structure and functionality of a unit as a component of an ANN 2.1. The neuron as a biological model 2.2. Mathematical description of the functional units of a unit 2.3. Mathematical description of learning an ANN using backpropagation and the gradient descent method 3. Multi-dimensional data structure (array) of the input layer as a passive data supplier 4. Exploratory data analysis and pre-processing of the data (pre-processing) 4.1. Procurement and Transformation 4.2. Statistical description and visualization 4.3. Missing Values 4.4. Runaway 4.5. dumbing down 4.6. Unbalanced amount of data 4.7. partitioning 4.8. scaling 5. Problems and optimization of an ANN 5.1. Overfitting and underfitting 5.2. Hyperparameter adjustment 5.3. Determination of forecast and model quality 6. Multi-Layer Perceptron (MLP) for regression 7. Multi-Layer Perceptron (MLP) for classification 7.1.1. Binary Classification 7.1.2. N-ary classification with single-label assignments 7.1.3. N-ary classification with multi-label assignments 8. Long Short-Term Memory (LSTM) for time series 8.1.1. regression 8.1.2. classification 8.1.2.1. scalar output 8.1.2.2. sequence output 9. Convolutional Neural Network (CNN) handling image data 9.1. Image classification 9.2. Object Recognition/Detection 9.3. semantic segmentation 9.4. instance segmentation 10. Self-Organizing Map (SOM) for clustering 11. Other model variants (autoencoder, generative adversarial networks (GAN) etc.)
Literatur	• Haykin, Simon S. (1999): Neural Networks: A Comprehensive Foundation. 2. Aufl., 1999. Upper Saddle River: Pearson Education. • Haykin, Simon S. (2009): Neural Networks and Learning Machines. 3. Aufl., 2009. Upper Saddle River: Pearson Education. • Goodfellow, I., Bengio, Y., Courville, A. (2016): Deep Learning. 2016. Cambridge: MIT Press. More literature will be announced at lecture time.

Lehrformen der Lehrveranstaltungen	
Lehrform	**SWS**
Lehrvortrag	2
Labor	2

Arbeitsaufwand	
Anzahl der SWS	4 SWS
Leistungspunkte	5,00 Leistungspunkte
Präsenzzeit	48 Stunden
Selbststudium	102 Stunden

Modulprüfungsleistung	
Voraussetzung für die Teilnahme an der Prüfung gemäß PO	Keine
DL - Technischer Test	Prüfungsform: Technischer Test Dauer: 120 Minuten Gewichtung: 100% wird angerechnet gem. § 11 Absatz 2 PVO: Nein Benotet: Ja