Artificial Intelligence and Machine Learning (5171020)

Module name english	Artificial Intelligence and Machine Learning					
Type of module	Pflichtmodul		**Responsible for module**		Prof. Dr. Andreas Lehrmann	
Lecturer	Prof. Dr. Andreas Lehrmann					
Language of instruction, L. of examination	Englisch		**Semester**		1	
SWS	4		**Teaching and learning formats**		Seminaristischer Unterricht	
ECTS-Credits	5		**Type of examination**		Schriftliche Prüfung (90 Min.)	
Bonus benefits						
Workload	**Workload (Total)**	150	**Attendance time**	60	**Self-Study time (incl. exam preparation)**	90
Duration of module	1 Semester		**Frequency**		ME/OE	
Type of grading	Differenzierte Note		**Verwendbarkeit**		Artificial Intelligence	
Conditions for participation	None					
Recommended prerequisites						
Module's learning outcomes	Upon completion of this module the students have a broad understanding of machine learning and its subfields, including the following: • They can independently collect/analyze data and take the necessary steps to prepare them for learning and inference tasks. • They are familiar with a variety of supervised/unsupervised models and understand their principles and properties. • They can select an appropriate model for a given task and design, implement, optimize, run, and analyze the corresponding machine learning pipeline. • They understand the balance between expressiveness and generalization. They are able to employ selection, regularization, and meta-learning techniques to maximize model performance.					
Module content	This course provides a comprehensive introduction to the field of machine learning. Starting from basic principles, we are going to develop a data-driven framework that allows us to express representation and prediction tasks as learning problems, either supervised or unsupervised. In both cases, our discussion of the relationship between data and model will lead to a broad spectrum of approaches with different properties: linear vs. non-linear, parametric vs. non-parametric, deterministic vs. non-deterministic, and classification vs. regression. We are going to explore how these models are formulated, how they can be optimized, and how they can be applied to new data. In a parallel track, we are going to explore theoretical properties of machine learning models, including their robustness, complexity, and meta-level behaviour. In particular, the course covers the following topics: • Data: collection & representation • Data: statistical & visual exploration • (Linear/Probabilistic/Non-parametric) classification • (Linear/Non-Linear/Robust) regression • Meta learning: ensembling & boosting • Clustering • Outlier Detection • (Stochastic) gradient descent • (Feature/Model) selection • Regularization • Convolutions • Kernel Trick • Maximum likelihood & maximum a-posteriori • Principal component analysis • Gaussian processes • Multi-dimensional scaling • Neural networks & deep learning					

Literature	1. Bishop, Christopher M.: Pattern Recognition and Machine Learning. Springer, 2006. 2. Murphy, Kevin P.: Probabilistic Machine Learning: An Introduction. The MIT Press, 2022. 3. Hastie, Trevor and Tibshirani, Robert and Friedman, Jerome: The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer, 2009.