# Advanced Machine Learning

Summer Term

## Organisation



Lecture (3 SWS) Practical lesson (2 SWS)

Workload

Credits

Subject-related prerequisites

Type of exam

Language

Online-Ressourcen

Prof. Dr.-Ing. André Stuhlsatz weekly weekly 150h | 75h (attendance) | 75h (self-study) 5 CP Understanding of Engineering Mathematics, Computer Science (in particular, Matlab or Python skills) oral exam (30 min) English (optional German) Moodle Link



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**Topic:** Machine Learning (ML), as a subfield of Artificial Intelligence, primarily deals with learning algorithms and data analysis methods. Numerous ML techniques are now available to the public in various software packages, addressing practical challenges such as speech recognition or image recognition. The rapid advancement and success of Deep Learning, propelled by companies like Google and others, are significantly influencing ML as a cross-cutting technology that increasingly impacts various aspects of our daily lives.

The lecture conveys the theoretical fundamentals of machine learning and, building upon them, practical and relevant machine learning techniques. In addition to theoretical considerations, the learned methods are applied through application-oriented examples such as image recognition or learning game strategies. This application process enables the acquisition of competence to explain, classify, and transfer these methods to other application scenarios. The following topics are covered in detail:

- Stochastic Decision/Learning Theory: Bayesian decision theory, classification, and regression, un/supervised learning, maximum likelihood, and Bayesian parameter estimation, including LDA and PCA.
- Non-parametric methods: k-Nearest-Neighbor, Parzen Windows, Decision Trees, Ensemble Methods.
- Kernel-based methods: Support Vector Machines, Kernel-PCA, Kernel-FDA.
- Neural Networks: Deep NN, Convolutional NN, Recurrent NN, Autoencoders, GANs, Boltzmann Learning, Restricted Boltzmann Machines.
- Reinforcement Learning: (Deep) Q-Learning.

## **Advanced Machine Learning**

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Literatur



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#### David J. C. MacKay Richard O. Duda Prov I. Hart David G. Stark ATTERN RECOGNITION Information Theory, Inference, Trevor Hastie Robert Tibshirani Jerome Friedman AND MACHINE LEARNING and Learning Algorithms Pattern CHRISTOPHER M. BISHOI Classification The Elements of Statistical Learning **Data Mining, Inference, and Prediction** Learning An Introduction per Services in the Data Sciences Charu C. Aggarwal DEEP LEARNING Learning with Kernels Neural Networks and independ the for Manhouse, Republic and an institution Deep Learning atimination, and Ream Architectures **Deep Learning** A Mathematical Approach Bernhard Schilkapf and Alexander 3 Smale A lextbook \*



Reinforcement Richard S. Sutton and Andrew G. Barto