

Machine Learning I

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Machine Learning for Computer Vision
TU Dresden



<https://mlcv.cs.tu-dresden.de/courses/26-winter/ml1/>

Winter Term 2026/2027

Machine Learning I



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- ▶ Course consisting of
 - ▶ lectures in TRE/PHYS/E on Fridays, 9:20–10:50
 - ▶ exercise groups starting October 20th
 - in POT/0081/H on Tuesdays, 16:40–18:10
 - in BAR/SCHÖ/E on Thursdays, 14:50–16:40
 - ▶ self-study
 - ▶ final examination (covering lectures and exercises).
- ▶ Registration:
 - ▶ All participating students need to register through OPAL
 - ▶ Additional rules for registration may apply, depending on the study program.
- ▶ No recordings/reproductions of the lectures or exercises!

Machine Learning is an area of computer science focused on the research of mathematical models, algorithms, software, and systems for analyzing, understanding and interpreting data.

Motivation: Machine Learning

- ▶ poses challenging problems
- ▶ combines insights and methods from
 - ▶ mathematics (esp. combinatorics, optimization, probability theory, statistics)
 - ▶ computer science (esp. algorithms, complexity, software engineering)
- ▶ provides an opportunity for applying analytical and engineering skills
- ▶ has impact on applications (scientific, medical, robotic, consumer)

This introductory course focuses on machine learning **problems** and **algorithms**. It has four main parts:

1. Supervised learning

- ▶ Binary decision trees
- ▶ Disjunctive normal forms
- ▶ Linear functions
- ▶ Composite functions (i.e. deep learning)
- ▶ Attention
- ▶ Transformers

Exercises only!

2. Unsupervised and transductive learning

- ▶ Partitioning (of sets)
- ▶ Clustering (of graphs)
- ▶ Ordering
- ▶ Classifying with multiple classes

3. Structured learning

- ▶ Conditional graphical models

4. Mathematical foundations

- ▶ Linear and integer optimization for machine learning
- ▶ Partial optimality for machine learning

Exercises only!

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Prerequisites:

- ▶ Mathematics
 - ▶ Linear algebra
 - ▶ Multivariate calculus (basics)
 - ▶ Probability theory (basics)
- ▶ Computer Science
 - ▶ Algorithms and data structures (basics)
 - ▶ Theoretical computer science (basics of complexity theory)

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► Textbooks:

- Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012
- Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Jonathan Taylor. An Introduction to Statistical Learning. Springer 2023
- Christopher M. Bishop, Hugh Bishop. Deep Learning: Foundations and Concepts. Springer 2024
- Marc Peter Deisenroth. Mathematics for Machine Learning. Cambridge University Press 2020

► Scholarly journals (selection):

- Journal of Machine Learning Research (JMLR)
- Transactions on Pattern Analysis and Machine Intelligence (TPAMI)
- Transactions on Machine Learning Research (TMLR)

► Academic conferences (selection):

- International Conference on Machine Learning (ICML)
- Neural Information Processing Systems (NeurIPS)
- International Conference on Learning Representations (ICLR)

Machine Learning I



<https://mlcv.cs.tu-dresden.de/teaching.html>

Related course we are offering this term:

- **Computer Vision I**
in HSZ/AUDI/H on Mondays, 11:10–12:40

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- ▶ Given any set J and, for any $j \in J$, a set S_j , we denote by $\prod_{j \in J} S_j$ the Cartesian product of the family $\{S_j\}_{j \in J}$, i.e.

$$\prod_{j \in J} S_j = \left\{ f: J \rightarrow \bigcup_{j \in J} S_j \mid \forall j \in J: f(j) \in S_j \right\} . \quad (1)$$