Computer Vision I

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Machine Learning for Computer Vision
TU Dresden

https://mlcv.cs.tu-dresden.de/courses/25-winter/cv1/

Winter Term 2025/2026

Computer Vision I

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- Course consisting of
  - lectures in BEY/0E40/H on Mondays, 11:10–12:40
  - exercise groups starting this week

In APB-E065	on Tuesdays, 13:00–14:30
In APB-E065	on Tuesdays, 14:50–16:20
In APB-E067	on Thursdays, 11:10–12:40
In APB-E067	on Thursdays, 13:00–14:30
Online (see OPAL)	on Wednesdays, 13:00–14:30

  - self-study
  - final examination (covering lectures and exercises).
- Registration:
  - All participating students need to register through OPAL
  - All participating students enrolled in the study program Computational Modeling and Simulation need to register additionally via CampusNet.
- No recordings/reproductions of the lectures or exercises!

Computer Vision is an area of computer science devoted to the research of mathematical models, algorithms, software and systems for analyzing and interpreting images (including volume images, videos, depth maps, laser scans, etc.). It

- poses challenging problems
- combines insights and methods from multiple disciplines
  - mathematics (esp. optimization, probability theory, statistics)
  - computer science (esp. algorithms, complexity, software engineering)
  - engineering (optical, electrical, mechanical)
- provides an opportunity for applying analytical and engineering skills
- is rewarding by visual results
- has impact on applications (scientific, medical, robotic, consumer, etc.)

[Videos removed]

Computer Vision I

Operators on digital images

- Digital images
- Point operators
- Linear operators
- Non-linear operators, including edge and corner detection

Classification of digital images

- Logistic regression
- Gradient descent algorithm
- Deep learning for computer vision (basics)
- Backward propagation algorithm

Segmentation of digital images

- Image segmentation as a (lifted) multicut problem
- Semantic segmentation as a node labeling (lifted) multicut problem
- Local search algorithms

Object recognition in digital images

- Single object recognition as a partial quadratic assignment problem
- Multiple object recognition as a node labeling multicut problem

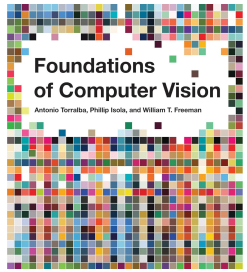
Object tracking in digital images

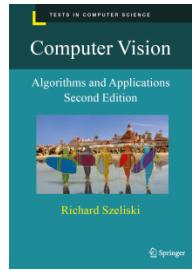
- Single object tracking as coupled partial quadratic assignment problems
- Multiple object tracking as an integer linear program

Linear and integer optimization for computer vision

- Introduction
- Simplex algorithm
- Branch-and-bound/branch-and-cut algorithms

Computer Vision I





- Textbooks:
  - Torralba A., Isola P. and Freeman. W. T. *Foundations of Computer Vision*, 2024, MIT Press.
  - Szeliski, R. *Computer Vision: Algorithms and Applications*, 2nd ed., 2020, available online at http://szeliski.org/Book/
- Leading scholarly journals:
  - Transactions on Pattern Analysis and Machine Intelligence (TPAMI)
  - International Journal on Computer Vision (IJCV)
  - Journal on Mathematical Imaging and Vision (JMIV)
  - Journal on Machine Learning Research (JMLR)
- Leading academic conferences:
  - Computer Vision and Pattern Recognition (CVPR)
  - International Conference on Computer Vision (ICCV)
  - European Conference on Computer Vision (ECCV)
  - International Conference on Machine Learning (ICML)
  - Neural Information Processing Systems (NeurIPS)
  - International Conference on Learning Representations (ICLR)

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

Related courses we offer:

- **Machine Learning I**
  TRE/PHYS/E (Zellescher Weg 16), Fridays, 9:20–10:50
  Creditable also to CMS-COR-MLD
- **Research Projects**
  APB-2026, Mondays, 14:50–16:20. Kick-off meeting: October 20th
  Creditable to INF-25-MA-FP, INF-PM-FPG, INF-PM-FPA and CMS-PRO