

**Module Description, available in: EN**

## *Machine Learning in Computer Vision*

### General Information

**Number of ECTS Credits**

3

**Module code**

TSM\_CompVis

**Valid for academic year**

2026-27

**Last modification**

2024-10-17

**Coordinator of the module**

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**Explanations regarding the language definitions for each location:**

- Instruction is given in the language specified for each location and module execution.
- Documentation is available in the language(s) listed for each location and module execution. If the documentation is in multiple languages, the percentage distributed is indicated (100% = all documentation provided).
- The examination, including both questions and answers, is provided entirely (100%) in the language(s) specified for each location and module execution. The exams are on-site.

	Lausanne	Lugano	Zurich
<b>Instruction</b>			X E 100%
<b>Documentation</b>			X E 100%
<b>Examination</b>			X E 100%

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

### Entry level competences

**Prerequisites, previous knowledge****Prerequisites:**

- Basic knowledge of machine learning (e.g. Andrew Ng's ML course on Coursera)
- Good command of an imperative programming language, basic knowledge of Python (the module will use Python 3).
- <http://www.scipy-lectures.org/index.html> Sections 1.1, 1.2, 1.3, 3.6.1, 3.6.2
- Basic knowledge of probability, statistics, linear algebra (vectors, matrices)
- Students are expected to take their laptops for the Lab activities

## Brief course description of module objectives and content

Analyzing images is a complex task that has many important real-world applications. In this module, we first present some foundations of image processing, such as filters, binarization, edge detection and finding lines and objects. We then study methods based on machine learning and deep learning to classify images, detect and localize objects and segment images pixelwise for example for medical image analysis. The most important deep learning architectures are discussed as well as some advanced uses for image synthesis, such as adversarial networks and neural style transfer.

## Aims, content, methods

### Learning objectives and competencies to be acquired

- Students know how images and 3D data are represented and manipulated by software
- Students know the most important problems related to image analysis: e.g. image classification, segmentation and object detection and localisation
- Students can apply machine learning and deep learning techniques to solve image-related problems, and deal with practical issues arising in the field (dataset engineering, data augmentation, data normalization)
- Students have seen different examples of image analysis problems and common solution techniques, and are able to acquire additional expert knowledge from the scientific literature and online resources

### Module content with weighting of different components

- Introduction
- Basic image processing methods applied to document processing: binarization; edge detection, filtering, segmentation of text into lines, words and characters; connected component analysis.
- Image classification
  - applications to OCR: handcrafted features; convolutional neural networks.
  - Image classification with small datasets.
- Segmentation
  - applications to medical images (2D, 3D)
  - fully convolutional networks for semantic segmentation.
- Object detection
  - face detection with cascading classifiers
  - pedestrian detection for autonomous driving
  - 2 stage and single shot approaches for object detection and localisation
- Generative models and Image Synthesis
  - Applications to Image Inpainting;
  - Generative Adversarial Networks;
  - Neural style transfer.

### Teaching and learning methods

Classroom teaching; programming exercises using python and frameworks in python

### Literature

- Computer Vision: Algorithms and Applications, Richard Szeliski, 2010
- Deep Learning with Python, Francois Chollet, early 2018, Sections 5, 8.3, 8.5

## Assessment

### Additional performance assessment during the semester

The module does not contain an additional performance assessment during the semester

### Basic principle for exams

**As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.**

### Standard final exam for a module and written resit exam

Kind of exam

Written exam

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

No electronic aids permitted

**Other permissible aids**

10 A4 pages (2 sided)

**Exception: In case of an electronic Moodle exam, adjustments to the permissible aids may occur. Lecturers will announce the final permissible aids prior to the exam session.**

#### Special case: Resit exam as oral exam

**Kind of exam**

Oral exam

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted