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

2025-26

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 defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction					**X** E 100%		
Documentation					**X** E 100%		
Examination					**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