Syllabus

Course Description

Course Title	Computer Vision
Course Code	73075
Course Title Additional	
Scientific-Disciplinary Sector	IINF-05/A
Language	English
Degree Course	Master in Computing for Data Science
Other Degree Courses (Loaned)	
Lecturers	Prof. Dr. Oswald Lanz, Oswald.Lanz@unibz.it https://www.unibz.it/en/faculties/engineering/academic-staff/person/46208
Teaching Assistant	
Semester	Second semester
Course Year/s	2
CP	6
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	- Image Formation: Geometric, Radiometric, Sensing Pipeline - Reconstruction: Features, Structure-from-Motion, Stereo Reconstruction, Shape-from-X - Probabilistic Graphical Models: Inference, Learning, and their applications in Vision - Image Recognition: Classification, Semantic Segmentation, Object Detection and Segmentation - Video Understanding: Optical Flow, Object Tracking, Simultaneous Localization and Mapping - Image/Video Generation: Occupancy Networks, Neural Radiance Fields, Diffusion Models

	- Self-Supervised Learning in Vision: Task-specific Models, Pretext Tasks, Contrastive Learning
Course Topics	This course will introduce the practical and theoretical principles of computer vision. Amongst other topics, we will cover image formation, scene reconstruction, image recognition and video understanding, as well as advanced image and video generation models and self-supervised learning in vision. In addition, computer vision and multimodal learning applications will be presented throughout the course. Guest talks from industry experts will also be delivered. The labs will deepen the understanding of computer vision algorithms and methods by implementing and applying them.
Keywords	Computer Vision, Multimodal Learning
Recommended Prerequisites	Knowledge of linear algebra, calculus and optimization, and solid machine and deep learning concepts. Basic Python coding skills.
Propaedeutic Courses	
Teaching Format	Frontal lectures, exercises, tutorials/labs, projects, seminars.
Mandatory Attendance	Attendance is not compulsory, but non-attending students have to contact the lecturers at the start of the course to agree on the modalities of the independent study.
Specific Educational Objectives and Learning Outcomes	The course belongs to the type "caratterizzanti – discipline informatiche". Students gain an understanding of the theoretical and practical concepts of computer vision including image formation, scene reconstruction, recognition and generation, and applications in computer vision and vision and language. After this course, students should be able to develop computer vision algorithms and trainable vision and multimodal models, reproduce research results and conduct original research in this area. Knowledge and understanding: - D1.1 - Knowledge of the key concepts and technologies of data science disciplines - D1.2 - Understanding of the skills, tools and techniques required for an effective use of data science - D1.3 - Knowledge of principles, methods and techniques for

	processing data in order to make them usable for practical purposes, and understanding of the challenges in this field - D1.7 - Knowledge of artificial intelligence techniques and methods for the implementation of intelligent systems Applying knowledge and understanding: - D2.1 - Practical application and evaluation of tools and techniques in the field of data science - D2.2 - Ability to address and solve a problem using scientific methods Making judgments - D3.2 - Ability to autonomously select the documentation (in the form of books, web, magazines, etc.) needed to keep up to date in a given sector Communication skills - D4.1 - Ability to use English at an advanced level with particular reference to disciplinary terminology. Learning skills - D5.3 - Ability to deal with problems in a systematic and creative way and to appropriate problem solving techniques
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	Oral exam and project work. The mark for each part of the exam is 18-30, or insufficient. The oral exam comprises verification questions, and open questions to test knowledge application skills. It counts for 50% of the total mark. The project consists of a computer vision project and verifies whether the student is able to apply the concepts taught or presented in the course to solve concrete problems. It is assessed through a final presentation, a demo, and a project report and can be carried out either individually or in a group of 2 students. It is discussed during the oral exam, and it counts for 50% of the total mark.
Evaluation Criteria	The final mark is computed as the weighted average of the oral exam and the project. The exam is considered passed when both marks are valid, i.e., in the range 18-30. Otherwise, the individual

	valid marks (if any) are kept for all 3 regular exam sessions, until also all other parts are completed with a valid mark. After the 3 regular exam sessions, all marks become invalid. Relevant for the oral exam: clarity of answers; ability to recall principles and methods, and deep understanding about the course topics presented in the lectures; skills in applying knowledge to solve exercises about the course topics; skills in critical thinking. Relevant for the project: skill in applying knowledge in a practical setting; ability to summarize in own words; ability to develop correct solutions for complex problems; ability to write a quality report; ability in presentation; ability to work in teams. Non-attending students have the same evaluation criteria and requirements for passing the exam as attending students.
Required Readings	All the required reading material will be provided during the course and will be available in electronic format.
Supplementary Readings	• Bishop: Deep Learning: Foundations and Concepts • Szeliski: Computer Vision: Algorithms and Applications • Hartley & Zisserman: Multiple View Geometry in Computer Vision • Scientific papers mentioned in the lecture slides Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it
Further Information	Software used: Python, OpenCV, PyTorch and TorchVision
Sustainable Development Goals (SDGs)	Quality education