Syllabus

Course Description

Course Title	Deep Learning
Course Code	73058
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	First semester
Course Year/s	2
CP	6
Teaching Hours	40
Lab Hours	20
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	- Deep Neural Networks - Regularization and Optimization - Convolutional Neural Networks - Sequence models and Transformers - Graph Neural Networks - Generative models
Course Topics	This course will introduce the practical and theoretical principles of deep neural networks. Amongst other topics, we will cover computation graphs, activation

	functions, loss functions, training, regularization and data augmentation as well as various basic deep neural network architectures including convolutional networks, recurrent networks and graph neural networks. The course will also address deep generative models such as auto-encoders and generative adversarial networks, and transformers. In addition, applications from various fields will be presented throughout the course. The labs will deepen the understanding of deep neural networks by implementing and applying them in PyTorch.
Keywords	Deep Learning, Neural Networks
Recommended Prerequisites	Knowledge of linear algebra, calculus and numerical optimization, and basic machine 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 deep neural networks including optimization, inference, architectures and applications. After this course, students should be able to develop and train deep neural networks, 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 - D1.7 - 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 - D2.6 - Ability to apply innovative techniques of data mining and machine learning to extract knowledge from complex and heterogeneous data 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. - D4.3 - Ability to structure and draft scientific and technical documentation Learning skills - D5.1 - Ability to autonomously extend the knowledge acquired during the course of study - D5.2 - Ability to autonomously keep oneself up to date with the developments of the most important areas of data science - 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 deep learning 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. Copy of the slides will be available as well.
Supplementary Readings	• Bishop: Deep Learning: Foundations and Concepts • Goodfellow, Bengio, Courville: Deep Learning • Zhang, Lipton, Li, Smola: Dive into Deep Learning • Deisenroth, Faisal, Ong: Mathematics for Machine Learning • Scientific papers mentioned in the lecture slides Subject Librarian: David Gebhardi, David.Gebhardi@unibz.it
Further Information	Software used: Python and PyTorch
Sustainable Development Goals (SDGs)	Quality education