CONSIGLIO INTERCLASSE
IN MATEMATICA

COURSE OF STUDY TWO-YEAR MASTER OF SCIENCE PROGRAMME IN MATHEMATICS

ACADEMIC YEAR 2023-2024

ACADEMIC SUBJECT MATHEMATICAL METHODS FOR ARTIFICIAL INTELLIGENCE

General information	
Term	Second semester (February 26, 2024 – May 31, 2024)
European Credit Transfer and Accumulation System credits (ECTS)	7
SSD	MAT/08 – Numerical Analysis
Language	Italian
Mode of attendance	Not mandatory

Lecturers		
Name and surname	Felice Iavernaro (instructor of record)	Nicoletta Del Buono
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Department and office	Department of Mathematics room 2 fourth floor	Department of Mathematics room 24 second floor
Virtual meeting room		
Web page	https://www.dm.uniba.it/it/members/iavernaro	https://www.dm.uniba.it/it/members/delbuono
Office hours		By appointment via email

Work schedule				
	Total	Lectures	Hands-on learning	Self-study
Hours	175	48	15	112
ECTS credits	7	6	1	

Learning objectives	
	Introduction to the mathematical theory of machine learning and its basic tools, including learning algorithms, data analysis and related modelling of complex phenomena.

Course prerequisites	
	The fundamental knowledge acquired during the three-year Bachelor Programme in Mathematics, with particular emphasis on numerical calculus and classical mathematical analysis of one and several variables.

Course contents	Machine learning paradigms and historical introduction to AI. Curse of dimensionality. Underfitting and overfitting. Theorem bias and variance. Approximating functions. Universal approximation properties of functions. Performance evaluation of an AI algorithm. Artificial neural networks: introduction; perceptron; multilayer networks; activation functions; network classification; back-propagation algorithm. Gradient and stochastic gradient algorithms, their variants and applications to neural networks. Applications of

	neural networks to regression and classification problems in the Matlab environment.
Reference books	• S. Haykin, Neural Networks, A Comprehensive Foundation (2nd ed.), IEEE Press, 1998 • T. M. Mitchell, Machine learning, McGraw-Hill, 1997 • T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer Verlag
Additional course materials	
Repository	Notes and slides provided by the instructor and available on Microsoft teams

Expected learning outcomes	
Knowledge and understanding	Ability to identify the right Artificial Intelligence techniques to address and numerically solve classification and regression problems from real applications.
Applying knowledge and understanding	Acquisition of the language and advanced mathematical formalism necessary for the consultation and understanding of Artificial Intelligence texts.
Soft skills	*Making judgements*: Students must demonstrate adequate autonomy in the selection of theoretical concepts most suitable for solving practical artificial learning problems.
	Communication skills: Students must demonstrate an adequate expository ability of the contents studied and an adequate capacity for analysis and synthesis.
	Learning skills: Students must demonstrate a good ability to make interdisciplinary connections.

Teaching methods	
	- Lectures conducted with the aid of teaching aids (slides). - Computer-based exercises.

Assessment	
Assessment methods	Oral examination on the syllabus and exercises or project assigned by the lecturers
Evaluation criteria	• *Knowledge and understanding:* Students must demonstrate adequate knowledge of the main topics of the course. • *Applying knowledge and understanding*: Students must demonstrate adequate knowledge of the possible applications of the theoretical concepts and possess adequate ability to implement these methods to solve specific applications. • *Making judgement*: Students must demonstrate adequate autonomy in selecting the most appropriate theoretical concepts for solving practical problems. • *Communication skills*: Students must demonstrate an adequate expository capacity for the topics and an adequate capacity in analysis and synthesis. • *Learning skills*: Students must demonstrate a good ability to make interdisciplinary connections.
Grading policy	The final grade is given in thirtieths. The exam is considered passed when the grade is greater than or equal to 18. The following indicators will be considered in formulating the final grade: degree of knowledge of the content and topics of the teaching, ability, correctness in applying the fundamental concepts covered during the lectures and exercises, and quality of oral exposition. All program topics contribute equally to the formulation of the final grade.

Further information	
	Attendance at lectures and tutorials is strongly recommended.