UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

DIPARTIMENTO
INTERUNIVERSITARIO DI FISICA

General information	
Academic subject	Deep Learning and generative models
Degree course	Physics
Academic Year	2
European Credit Transfer and Accumulation System (ECTS)	3
Language	English
Academic calendar (starting and ending date)	I semester
Attendance	Recommended

Professor/ Lecturer	
Name and Surname	Angelo Mariano
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Telephone	0831201564
Department and address	*Physics Department, Universityt of Bari, room 144*
Virtual headquarters (Microsoft Teams code)	
Tutoring (time and day)	Monday (on request)

Syllabus	
Learning Objectives	*Knowledge and understanding of deep learning algorithms both in supervised, unsupervised and reinforcement learning settings*
Course prerequisites	*Basic knowledge of a programming language and of linear algebra concepts*
Contents	*Deep Learning in physics as a new paradigm in basic and applied research.* *Introduction to neural networks and python libraries (pandas, scikit-learn, matplotlib, scipy, tensorflow, pytorch).* *Deep learning systems: forward pass, loss functions, gradient, optimizers, backward pass, learning rate, regularization techniques.* *Deep supervised learning: convolutional networks, max and average pooling; recurrent neural networks, LSTM, GRU, convolutional LSTM and Transformers.* *Deep unsupervised learning: autoencoders, generative adversarial networks, adversarial training.* *Deep reinforcement learning: state, action, reward, Markov decision processes, Deep Q-learning, Bellman's equation.* *Introduction to quantum machine learning*
Books and bibliography	*Slides provided by the teacher*
Additional materials	

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
31	16	15	0
ECTS			
3			

Teaching strategy	
	Slides presented by the teacher during lectures and interactive sessions on notebooks containing code describing different algorithms

Expected learning outcomes	
Knowledge and understanding on:	○ Deep Learning foundations ○ Machine Learning and Artificial Intelligence problem setting and solving ○ Data-driven approach in Physics ○ Quantum computing use in Machine Learning
Applying knowledge and understanding on:	○ Supervised learning problems ○ Unsupervised learning problems

	○ Reinforcement Learning problems ○ Generative models applications
Soft skills	• **Making informed judgments and choices** ○ Understand and develop a set of tools useful in Physics ○ Learn how to treat data to extract knowledge • **Communicating knowledge and understanding** ○ Learn how to discuss a project and how to show it ○ Learn how to apply knowledge acquired to different contexts • **Capacities to continue learning** ○ Acquire a reference framework to enter a data-driven approach

Assessment and feedback	
Methods of assessment	Oral presentation (100%) starting from a research project assigned by the teacher
Evaluation criteria	• **Knowledge and understanding** ○ Knowledge of principles of Deep Learning and of all the algorithms presented in the course • **Applying knowledge and understanding** ○ Ability to apply knowledge acquired to different contexts • **Autonomy of judgment** ○ Ability to understand which algorithm could be good for solving specific scientific problems • **Communicating knowledge and understanding** ○ Clarity and precision of presentation • **Communication skills** ○ Ability to present effectively the project and to explore different areas of deep learning and generative models • **Capacities to continue learning** ○ Ability to identify needs and solutions that can be provided by the subjects of this course
Criteria for assessment and attribution of the final mark	Effectiveness, deep understanding of the subject, clarity of exposition
Additional information	