INTENDED LEARNING OUTCOMES OF THE MASTER OF SCIENCE IN ARTIFICIAL INTELLIGENCE

CORE AREA OF STUDY

Knowledge and Understanding

Graduates will have acquired fundamental advanced and interdisciplinary knowledge related to:	Knowledge and Understanding will be achieved through the following courses:
1. Mathematics and Computer Science Methods:	
1.1 A topic, chosen on the basis of the student's previous background, to complement the preparation acquired during the first level studies and to reach an advanced level of knowledge and skills: Algorithmic techniques and data structure design principles or discrete probability and combinatorics and advanced linear algebraic techniques.	1.1 Analysis of algorithms and data structures or Mathematical Methods in Computer Science
1.2 Methods for the design of algorithms for continuous and discrete optimization problems and of techniques to bound converge time and accuracy. Elements of convex optimization and methods to model inference problems as optimization problems.	1.2 Algorithms for optimization and inference
1.3 Methods to develop large collaborative software projects and elements of software engineering and of object-oriented programming.	1.3 Software engineering
1.4 Advanced mathematical and algorithmics methods of machine learning including deep learning and reinforcement learning. Knowledge of machine learning software libraries and of techniques to train and implement machine learning models.	1.4 Deep Learning and Reinforcement Learning
1.5 Information theory fundamentals ranging from probabilistic foundations to modern applications in data compression, error correction, machine learning, biological information and quantum information.	1.5 Information theory
2. Core Machine Learning Applications to be examined in two application domains: (1) image processing (2) natural language processing and (3) through a project-oriented AI lab.	
2.1 Techniques to analyse and understand images, methods to apply deep learning tools to image processing and understanding, and to solve problems of image classification and image detection.	2.1 Computer vision and image processing
2.2 Techniques to find structure in text (such as clustering and word embeddings) and for predicting and generating text, particularly with the use of neural networks such as transformers.	2.2 Language technology
2.3 Methods to develop a fully-functioning Machine Learning system for a real-world case study.	2.3 Machine learning Lab

3. Computer Science Methods and Applications beyond machine learning and Applications of computer science to other sciences. Students will learn about other areas of computer science for example about 3.1) cryptographic methods to securely store, transmit, and process information or 3.2) techniques from theoretical physics to model and solve discrete optimization problems. Students will also learn about applications of computer science techniques to other sciences for example 3.3) the use of computational methods in biology and medicines or about 3.4) computational models of how the brain stores and processes information.	3.1 Cryptography and security 3.2 Complex systems and physical models 3.3 Bio-informatics 3.4 Computational Neuroscience

Ability to apply knowledge and understanding

Graduates will be able to:	Ability to Apply Knowledge and Understanding will be achieved through the following courses:
1. Regarding Mathematics and Computer Science Methods: 1.1 Design and analyse algorithms and data structures or reason formally about discrete structures and apply linear algebraic techniques to data analysis. 1.2 Design algorithms for discrete and continuous optimization problems, prove correctness and analyze accuracy. Moreover, they will be able to implement such algorithms and test them on real-world data. 1.3 Develop a large collaborative software project, use tools that support such development, and apply best practices of software engineering. 1.4 Understand the mathematical formulation of different types of machine learning models (including deep learning and reinforcement learning), understand the conceptual challenges and open problems, and design applications to real-world problems, including decision-making problems under uncertainty. 1.5 Build on the probabilistic framework of information theory in order to apply the concept of entropy to any real-world probabilistic model. Moreover, they will be able to apply fundamental algorithms for data compression, error-correcting and inference in application domains such as data transmission, data storage, computational biology and quantum computing.	1.1 Analysis of algorithms and data structures or Mathematical Methods in Computer Science 1.2 Algorithms for optimization and inference 1.3 Software engineering 1.4 Deep Learning and Reinforcement Learning 1.5 Information theory
2. Regarding Core Machine Learning Applications: 2.1 Design algorithms for image clustering and image classification, and train such systems using real-life data. 2.2 Design systems that extract structure from natural language, that can infer sentiment from sentences, and that can generate meaningful natural language sentences. Moreover, 2.3 Develop a fully functioning Machine Learning system based on a real-life application.	2.1 Computer vision and image processing 2.2 Language technology 2.3 Machine learning Lab

3a) Regarding Computer Science Methods and Applications beyond machine learning: Apply other computer science techniques other than machine learning to model real world problems and to develop solutions, for example 3.1) reason about the security of data storage, transmission and processing to implement secure cryptographic systems or 3.2) use techniques from theoretical physics to model combinatorial optimization problems and to develop algorithms.	3.1 Cryptography and security 3.2 Complex systems and physical models
3b) Regarding applications of computer science to other sciences: Apply computer science techniques to other sciences, for example 3.3) implement computational techniques in biology and medicines or 3.4) reason about mathematical and computational models of brain activity.	3.3 Bio-informatics 3.4 Computational Neuroscience

COMPLEMENTARY AREA OF STUDIES

Knowledge and Understanding

Graduates will have acquired knowledge related to:	Knowledge and Understanding will be achieved through the following courses:
4.1 a topic with a strong mathematical, statistical or computational content in a discipline other than computer science (e.g. fintech, economics, etc.).	4.1 "attività a scelta" n. 1
4.2 a topic in any disciplinary fields, identified on the basis of individual interests to widen / deepen the personal preparation.	4.2 "attività a scelta" n. 2
4.3 Regarding languages, besides English (which is an entry requirement), graduates will acquire knowledge of another EU language (Italian: at least level A2; other EU language among those listed in the University Guide: at least level B1 business; Italian is compulsory for non-Italian native speakers).	4.3 Foreign language

Ability to apply knowledge and understanding

Graduates will be able to:	Ability to Apply Knowledge and Understanding will be achieved through the following courses:
4.1e2 Make use of the key concepts acquired (and related to the chosen topics) by applying the methods and tools they have been provided with.	4.1 e 2 "attività a scelta" n. 1 and 2
4.3 Regarding languages, besides English (language of the program) graduates will write, read, speak and listen in another EU language (at least elementary level; the exit level depends on the language – Italian or other EU language – and on the student's entry level).	4.3 Foreign language

Making Judgements	Graduates will be aware of the ethical dimension of the digital transformation and of the societal impact of computing and AI; moreover, they will be able to think in an innovative manner when framing, modelling and developing computer science solutions for real world problems.
Communication	Graduates will be able to interact and lead responsibly within diverse teams and organizations and to convey technical concepts in an accessible way to stakeholders. Moreover, they will be able to provide high quality (clear and detailed) documentation of their software projects.
Lifelong Learning Skills	Graduates will have acquired deep methodological knowledge that will likely underpin future technologies; this will allow them to effectively and autonomously learn new technologies, adapt to rapidly changing environments and, above all, to be innovation leaders.