University of Milano-Bicocca

Teaching regulation

Study course	F9102Q - ARTIFICIAL INTELLIGENCE FOR SCIENCE AND TECHNOLOGY
Course Type	Master's degree
Class	Master's degree in Techniques and methods of the Information Society (LM-91)
Ordering Year	2022/2023
Regulation Year	2024/2025

Presentation

Reference teaching structure	Department of Physics "GIUSEPPE OCCHIALINI"
Reference teachers	- DANIELE BAJONI - SIMONE BIANCO - ALESSANDRO BISIO - FEDERICO ANTONIO NICCOLO' AMEDEO CABITZA - ISABELLA CASTIGLIONI - LUIGI CELONA - GIULIA CISOTTO - GABRIELE CIVITARESE - MARCO COSENTINO LAGOMARSINO - RUGGERO DONIDA LABATI - PAOLO ETTORE GAMBA - FRANCESCA GASPARINI - ANGELO GENOVESE - FRANCESCA GRESELIN - ALBERTO MARIO MAIOCCHI - PAOLO NAPOLETANO

	- IRENE NUTINI - FLAVIO PICCOLI - VINCENZO PIURI - ENRICO PRATI
Tutor	- DANIELE BAJONI - PIETRO GOVONI - VINCENZO PIURI
Duration	2 years
CFU	120
Degree awarded	Master's degree in ARTIFICIAL INTELLIGENCE FOR SCIENCE AND TECHNOLOGY
Joint degree	Yes
Partner universities	Università di Pavia Date: 29/12/2021 Università degli Studi di Milano Date: 29/12/2021
Double degree	No
Teaching method	Conventional
Language/s in which the course is held	English
Internet Address	https://elearning.unimib.it/course/index.php?categoryid=9164
The course is	newly instituted
Maximum number of credits recognised	12
Corsi della medesima classe	F9101Q - DATA SCIENCE
Location of course	MILAN (Teaching responsibility)

Art.1 The course in brief

The master's degree program in Artificial Intelligence for Science and Technology, Class LM-91 - Techniques and methods for the information society, is jointly organized by the University of Milan- Bicocca, the University of Milan, and the University of Pavia. The master's degree program has a normal duration of two years and involves the acquisition of 120 ECTS to obtain the master's degree. This master's program is open admission. Admission is subject to verification of the curricular requirements and assessment of the candidate's personal preparation. To be admitted to the program, a level of knowledge of the English language equal to or higher than level B2 is also required.
The master's degree program is taught in English to allow graduates to integrate more easily in an international professional scenario, with the ability to dialogue and operate profitably in international workgroups and economic environments and to promote international mobility for study.

At the end of the studies, the title of Master's Degree in Artificial Intelligence for Science and Technology is issued jointly by the University of Milan-Bicocca, the University of Milan, and the University of Pavia. This master's degree allows access to second level Masters and PhD's degree programs.

The administrative headquarters is the University of Milan-Bicocca. The campuses and logistical structures to support teaching activities are those made available by the University of Milan-Bicocca, the University of Milan and the University of Pavia.

Art.2 Specific educational objectives and description of the educational path

The international master's degree course in Artificial Intelligence for Science and Technology (taught in English) is specifically aimed at training master's graduates specialized in the advanced aspects of the theoretical foundations, techniques, methodologies and methods of use of artificial intelligence in complex applications in scientific and technological sectors, including industry, environment, biomedical systems, embedded systems and complex physical systems. Master's graduates in Artificial Intelligence for Science and Technology will therefore be able to contribute significantly and in a targeted manner to the dissemination and advancement of knowledge and skills in this discipline and in the application sectors, promoting technological innovation also for complex problems and systems, encouraging management modernization in companies and public administrations and contributing in an innovative and creative way to the economic and social development of the country.

The master's graduate in this course of study will have highly interdisciplinary knowledge and skills in a variety of areas that characterize the study courses in artificial intelligence in the best international practices. The master's graduate will receive a solid and in-depth common specialist training in the fundamentals of some areas of computer science, mathematics, physics and statistics, specifically focused on those that allow a thorough understanding of the theoretical aspects and advanced techniques of artificial intelligence, as well as those foundations for its use in the scientific, industrial and technological innovation fields. He/she will also receive the necessary training both in the organizational-managerial field to understand, manage and integrate information and communication technologies in the company, and in the legal field essential to understand the constraints that limit the socially acceptable use

of artificial intelligence. The master's graduate will also have the opportunity to make some choices, based on his/her personal objectives, to enrich the common specialist training with additional knowledge and skills useful for applying artificial intelligence in an advanced way for complex systems in specific areas, such as industrial automation, environmental monitoring, embedded systems, biomedical and health systems, modeling of complex systems, systems for physics and quantum technologies. The graduate of this master's degree program will therefore be able to contribute, on the basis of constantly updated interdisciplinary knowledge and skills, to design and implement innovative solutions based on advanced artificial intelligence techniques for complex applications in both the public and private sectors.

The master's degree program is structured with a succession of activities aimed at providing in-depth specialist knowledge and developing the skills necessary for entering the world of work with the ability to successfully tackle complex problems. The master's degree program is structured as follows:
- the first year generally includes advanced training activities dedicated to the founding core of specialist training in artificial intelligence, mandatory for all students, in the areas of information and communication sciences and technologies as well as the related mathematical, statistical and physical bases;
- the first year also includes the experimentation of artificial intelligence in application areas, through some training activities recommended to the student depending on the application area chosen from those offered by the degree program;
in the second year, training is completed both in the "Business-organizational" field and in the "Human, social, legal and economic disciplines" field;
in the second year, it is also possible to deepen knowledge and skills in the chosen application area by selecting additional training activities suggested to the student, as well as freely choosing some courses according to their cultural interests;
typically in the second year, the student deepens the understanding of artificial intelligence, also in application areas, through the theoretical-experimental internship activity for the preparation of the degree thesis, aimed at refining knowledge and skills in a specific theoretical or application theme, to be carried out in a university, institution or company, in Italy or abroad;
the training path is completed with the final exam.

Particular attention will be given not only to conceptual aspects, but also to practical experimentation in laboratory training activities, especially for the courses more oriented to the study of the use of artificial intelligence in application areas, in order to facilitate entry into the world of work through immediately usable practical skills.

To ensure adequate homogenization and appropriate alignment of the knowledge and skills of students from three-year degrees with diversified training paths, even with limited focus on information and communication technologies, with a view to a coherent training in artificial intelligence, activities will be offered regarding specific topics to allow students to achieve, at the end of the first year, those solid knowledge and skills in the areas of information and communication technologies, mathematics and physics that are relevant to base the specific knowledge and skills offered by the course of study on artificial intelligence. In particular, training activities will be offered in the mathematical area to better support discrete and continuous modeling of complex systems, in the physical area to better support observation, description, analysis and modeling of elementary phenomena and systems, and in the information and communication technologies area to better support data management, algorithm design and the use of dedicated processing architectures and distributed processing systems.

The expected learning outcomes are expressed through the European Descriptors of the

qualification:
Knowledge and understanding (summary)
Graduates of the master's degree course in Artificial Intelligence for Science and Technology acquire:
- a solid theoretical and methodological knowledge of those aspects of computer science, mathematics, statistics and physics that are relevant to artificial intelligence, in particular in relation to scientific and technological application areas;
- a broad and full mastery of the techniques and specialized methodologies of artificial intelligence in the area of information and communication technologies, including for example the analysis of data of various types and complexity, knowledge extraction and representation, automatic reasoning, machine learning, modeling of complex problems, decision support tools, signal and image processing, distributed processing and communication infrastructures;
- an awareness of the use, implications and impact of artificial intelligence in the organization, management and administration of companies, both in the public and private sectors;
- an awareness of the legal implications of the use of artificial intelligence tools in decision-making and information processing processes;
- knowledge of the techniques and methodologies relating to the application area chosen by the student among those offered by the master's degree course with specific advanced insights into the use of artificial intelligence in areas such as, for example: monitoring and control of manufacturing processes, environmental monitoring, embedded systems, biomedical systems, complex physical systems, quantum technologies.
Such knowledge is acquired through lectures, practical exercises and practical-experimental activities in the laboratory, adapted to the specific characteristics of each teaching. The practical-experimental activities in the laboratory, both guided and free, will be particularly important to ensure training that is not only conceptual, but also with practical knowledge of the application of artificial intelligence in the area chosen by the student among those offered by the course.
The verification of the knowledge acquired in the various training activities consists of the forms most suited to the specific types and characteristics of training activities. The forms of verification typically consist of written and/or oral exams, reports on the activities carried out and the knowledge acquired, intermediate tests, as well as the final test for the achievement of the qualification.

Ability to apply knowledge and understanding
(summary)

The training activities of the master's degree course allow graduates to develop solid and broad abilities to apply specialist knowledge and understanding of the topics covered, in relation to the founding interdisciplinary topics of artificial intelligence, especially those oriented to applications in scientific and technological areas, on which the master's degree course focuses.
In particular, graduates of the master's degree course acquire:
- the ability to use methodologies and tools of artificial intelligence specific to the area of information and communication sciences and technologies, specifically the ability to represent knowledge, reasoning and machine learning, computational intelligence, signal and image processing and distributed processing and communication infrastructures, as well as to define techniques and algorithms based on artificial intelligence for solving problems, even complex ones, and implement them through efficient programs;
- the ability to apply the knowledge related to artificial intelligence acquired in the mathematical and statistical area, with specific reference to the ability to apply techniques and methods of discrete mathematics, continuum mathematics, probability and statistics for problem solving in the design of solutions based on artificial intelligence;
- the ability to apply the knowledge related to artificial intelligence acquired in the area of

physics, specifically the ability to apply techniques and methods of experimental and theoretical physics, sensors, data acquisition and quantum information, modeling of physical systems;
- the ability to apply the knowledge related to artificial intelligence acquired in the business-organizational area, specifically in reference to use, implications and impact in the organization, processes, management and business administration, both in the public and private sectors;
- the ability to apply the knowledge related to artificial intelligence acquired in the legal area, specifically in reference to the social acceptability of applications, privacy and data security.
Particular emphasis will be given to practical-experimental activities in the laboratory, through individual or group projects and experiments, to harmoniously develop and deepen the ability to apply knowledge, promote solid operational autonomy, foster the ability to operate in work groups and stimulate creativity and innovation. The verification of the skills acquired in the various training activities, such as the ability to apply knowledge and understanding, will be carried out in the forms most suited to the specific types of teaching, typically through written and/or oral tests that will include exercises aimed at verifying the ability to use the knowledge acquired to solve problems of varying complexity, practical-experimental activities in the laboratory, theoretical-experimental internship activities for the preparation of the degree thesis, intermediate tests.

“Knowledge and understanding” and “Ability to apply knowledge and understanding”: Detail

1. Common interdisciplinary specialist training area Knowledge and understanding
The master's degree course in Artificial Intelligence for Science and Technology offers a solid and in-depth common specialist training in the fundamentals of some areas of computer science, mathematics, physics and statistics, specifically focused on those that allow a thorough understanding of the theoretical aspects and advanced techniques of artificial intelligence, as well as those foundations for its use in the scientific, industrial and technological innovation fields. The necessary legal training is also provided, which is essential to understand the constraints that limit the socially acceptable use of these techniques.

The common specialist training, mandatory for all students, consists of teaching activities that cover the following disciplinary areas:
- computer science area, which includes teachings on the advanced computer science foundations of the theoretical and applicative aspects of artificial intelligence in the area of science and technology, such as: advanced data management; advanced techniques for extracting, representing, processing and managing knowledge; advanced machine learning; advanced automatic reasoning; advanced computational intelligence techniques; advanced methods and techniques for solving complex problems using artificial intelligence;
- mathematical and statistical area, which includes courses on the advanced mathematical-statistical foundations of the theoretical and applicative aspects of artificial intelligence in the area of science and technology, such as advanced mathematical analysis, advanced statistical inference and modeling, and complex dynamic systems;
- physical area, which includes courses related to advanced experimental and theoretical physics, as well as quantum technologies, always from the point of view of the physical foundations and possible applications in the field of artificial intelligence;
- business-organizational area, which includes relevant aspects on the use, implications and impact of artificial intelligence in the organization, processes, management and administration of companies, both in the public and private sectors;
- legal area, which includes relevant aspects in the most recent developments and in the best international training experiences in artificial intelligence, such as the law in this field relating to social acceptability, privacy and data security.

Such knowledge is acquired through lectures, practical exercises and practical-experimental activities in the laboratory, adapted to the specific characteristics of each teaching. The practical-experimental activities in the laboratory, both guided and free, will be particularly important to ensure training that is not only conceptual, but also with practical knowledge of the application of artificial intelligence in the area chosen by the student among those offered by the course.

The verification of the knowledge acquired in the various training activities consists of the forms most suited to the specific types and characteristics of training activities. The forms of verification typically consist of written and/or oral exams, reports on the activities carried out and the knowledge acquired, intermediate tests, as well as the final test for obtaining the qualification.

Ability to apply knowledge and understanding

The training activities of the master's degree course allow graduates to develop solid and broad skills to apply specialist knowledge and understanding of the topics covered, in relation to the founding interdisciplinary topics of artificial intelligence, especially those oriented to applications in scientific and technological areas, on which the master's degree course focuses. In particular, graduates of the master's degree course acquire:
- the ability to use artificial intelligence methodologies and tools specific to the area of information and communication sciences and technologies, specifically the ability to represent knowledge, reasoning and machine learning, computational intelligence, signal and image processing and distributed processing and communication infrastructures, as well as to define techniques and algorithms based on artificial intelligence for solving problems, even complex ones, and implement them through efficient programs;
- the ability to apply the knowledge related to artificial intelligence acquired in the mathematical and statistical area, with specific reference to the ability to apply techniques and methods of discrete mathematics, continuum mathematics, probability and statistics for problem solving in the design of solutions based on artificial intelligence;
- the ability to apply the knowledge related to artificial intelligence acquired in the physics area, specifically the ability to apply techniques and methods of sensing, data acquisition, physical bases of signal and image processing, and quantum information, modeling of physical systems;
- the ability to apply the knowledge related to artificial intelligence acquired in the business-organizational area, specifically in reference to use, implications and impact in the organization, processes, management and business administration, both in the public and private sectors;
- the ability to apply the knowledge related to artificial intelligence acquired in the legal area, specifically in reference to the social acceptability of applications, privacy and data security.

The ability to apply specialized knowledge and understanding of the topics covered are acquired in practical-experimental activities in the laboratory, through individual or group projects and experiments. Particular emphasis will be given to these activities to harmoniously develop and deepen not only the ability to apply knowledge, but also to promote solid operational autonomy, foster the ability to operate in work groups, and stimulate creativity and innovation.

The verification of the skills acquired in the various training activities, such as the ability to apply knowledge and understanding, will be carried out in the forms most suited to the specific types of teaching, typically through written and/or oral tests that will include exercises aimed at verifying the ability to use the knowledge acquired to solve problems of varying complexity, practical-experimental activities in the laboratory, theoretical-experimental internship activities for the preparation of the degree thesis, intermediate tests.

Knowledge and skills are acquired and verified in the following training activities:

Advanced Foundations of Mathematics for AI
Advanced Foundations of Statistics for AI
Advanced Foundations of Physics for AI
Advanced Foundations of Artificial Intelligence
Advanced Foundations of Law and regulations in privacy and data protection
Data-driven organizations and management

2. Area of professionalizing specialized training
Knowledge and understanding
The student will have the opportunity to make some choices, based on his/her personal objectives, to enrich the common specialized training with additional knowledge and skills useful for applying artificial intelligence in an advanced way for complex systems in specific scientific-technological areas, in order to complete his/her professionalizing training in line with the needs expressed today by the world of work. The student will in fact be able to choose one of the application areas offered by the master's degree course (such as industrial automation and environmental monitoring, embedded and health systems, signal and image processing, modeling of complex systems and quantum technologies), focused on the use of artificial intelligence in the relevant area.
The training activities of each of these application areas, based on the advanced fundamental knowledge acquired in the common teachings, decline this knowledge and the related skills in the specific application sector through some specific teachings that allow to understand the essential aspects, without aiming to create experts in these application sectors, but experts in the use of artificial intelligence in them.
Particular attention will be given not only to the conceptual aspects, but also to practical experimentation in training activities in the laboratory, especially for the teachings more oriented to the study of the use of artificial intelligence in the application areas, in order to facilitate entry into the world of work through immediately usable practical skills.

The knowledge acquired in each of these application areas are respectively:

Specialist in artificial intelligence for industry and the environment: The graduate will acquire specialized knowledge of artificial intelligence techniques and methodologies for the development of computer systems and applications for monitoring and managing manufacturing processes and the environment. In particular, the student will acquire knowledge of advanced computer architectures (including internet-of-things), analysis of industrial and environmental data, extraction of information and knowledge in manufacturing and environmental processes, extraction of information and knowledge regarding the qualities and characteristics of products, analysis of signals and images in manufacturing and environmental fields, decision support, management of industrial production and the environment, management of intelligent and adaptive environments.

Specialist in artificial intelligence for intelligent embedded systems: The graduate will acquire specialized knowledge of artificial intelligence techniques and methodologies for the development of computer systems and applications for intelligent embedded systems for various application areas, including consumer electronics, medical devices and systems, prosthetics, automobiles and transportation. In particular, he/she will acquire knowledge of embedded system architectures, analysis of data from sensors and human-system interfaces, extraction of information and knowledge on the behavior of the embedded system and the environment in

which it operates, extraction of information and knowledge from interaction with users and usability support, analysis of signals and images in intelligent embedded systems, human-system interaction, decision support.

-Specialist in artificial intelligence for detection and processing of signals and images in healthcare and the environment: The graduate will acquire specialized knowledge of artificial intelligence techniques and methodologies for the collection and analysis of multi-sensory data both in environmental monitoring with Earth observation and sensory networks, and in the healthcare sector to support medical decisions with analysis of images and biomedical signals. In particular, the graduate will acquire knowledge of multi-sensory management, collection and processing of signals and images with attention to their physical meaning, extraction of information and knowledge regarding the state of the environment, extraction of information and knowledge regarding the state of health of patients, medical diagnostic tools, environmental observation tools, decision support.

Specialist in artificial intelligence for complex systems and quantum technologies: The graduate will acquire specialized knowledge of artificial intelligence techniques and methodologies to understand and model complex physical systems and process information with quantum technologies. In particular, the graduate will acquire knowledge of data analysis and knowledge to model complex physical systems, understand their functioning, extract characteristic behaviors and simulate their behavior; design and develop quantum algorithms for solving complex application problems through quantum computation, also in support of artificial intelligence when technologies have sufficient computational capacity.

Such knowledge is acquired through lectures, practical exercises and practical-experimental activities in the laboratory, adapted to the specific characteristics of each course. The practical-experimental activities in the laboratory, both guided and free, will be particularly important to ensure training that is not only conceptual, but also with practical knowledge of the application of artificial intelligence in the area chosen by the student among those offered by the course.

Verification of the knowledge acquired in the various training activities consists of the forms most suited to the specific types and characteristics of training activities. The forms of verification typically consist of written and/or oral exams, reports on the activities carried out and the knowledge acquired, intermediate tests, as well as the final test for obtaining the qualification.

Ability to apply knowledge and understanding
The graduate of this course acquires the following abilities to apply knowledge and understanding related to artificial intelligence in the application area chosen by the student among those proposed by the degree course, specifically:

Specialist in artificial intelligence for industry and the environment: The graduate will develop the ability to apply data analysis and knowledge extraction techniques and methodologies for manufacturing and environmental processes, product characteristics, management of industrial production and environment, and management of intelligent environments.
Specialist in artificial intelligence for intelligent embedded systems: The graduate will develop the ability to apply the techniques and methodologies of data analysis and knowledge extraction in intelligent embedded systems, human-system interaction, usability, and management of embedded systems.
- Specialist in artificial intelligence for detection and processing of signals and images in healthcare and environment: The graduate will develop the ability to apply the techniques and methodologies of multi-sensory data collection and analysis and knowledge extraction both in

Earth observation systems and sensor networks, and in healthcare systems supporting medical decisions with images and signals.
- Specialist in artificial intelligence for complex systems and quantum technologies: The graduate will develop the ability to apply the techniques and methodologies of modeling complex physical systems, extracting characteristic behaviors, and simulating their behavior, as well as developing quantum algorithms.

The ability to apply specialist knowledge and understanding of the topics covered are acquired in practical-experimental activities in the laboratory, through individual or group projects and experiments. Particular emphasis will be given to these activities to harmoniously develop and deepen not only the ability to apply knowledge, but also to promote solid operational autonomy, foster the ability to operate in work groups, and stimulate creativity and innovation.

Verification of the skills acquired in the various training activities, such as the ability to apply knowledge and understanding, will be carried out in the forms most suited to the specific types of teaching, typically through written and/or oral tests that will include exercises aimed at verifying the ability to use the knowledge acquired to solve problems of varying complexity, practical-experimental activities in the laboratory, theoretical-experimental internship activities for the preparation of the degree thesis, intermediate tests.
Knowledge and skills are achieved and verified in the following training activities: Systems for Industry 4.0 and environment (IoT)
Advanced data management and decision support systems
Advanced artificial intelligence, machine learning and deep learning Sensing and vision for industry and environment
Intelligent monitoring and control systems Environmental monitoring and management
Embedded systems architectures and design
Ambient intelligence
Embedded systems for biomedical applications
Intelligent consumer technologies
Advanced computational techniques for big imaging and signal data
Machine learning for modeling
Signal and imaging acquisition and modeling in healthcare
Signal and imaging acquisition and modeling in environment
Physical sensors and systems for biomedical signals
Physical sensors and systems for environmental signals
Physical sensors and systems for biomedical imaging
Physical sensors and systems for environmental imaging
AI models for Physics
Statistical learning
Foundations of Quantum Computing
Advanced statistical mechanics and disordered systems
Quantum information and algorithms
Statistical Mechanics of Neural Networks
Quantum computers and technologies
Privacy and Data Protection
High-Performance Computing for AI applications in Physics
Artificial vision

Making judgements

Master's graduates will be able to integrate the knowledge and skills acquired to address concrete problems related to the design of artificial intelligence systems through personal use

of the techniques learned; they will also be able to predict and evaluate the implications of their technical and methodological choices, also assuming responsibility from a corporate-organizational and legal point of view.
These skills are acquired through teaching methods oriented towards problem solving and through projects, including ongoing projects, to be carried out individually or in groups. The verification of the autonomy of judgement takes place through the evaluation of the projects, in individual exams, in practical-experimental activities in the laboratory, as well as during the evaluation of the final exam.

Communication skills

Master's degree graduates will be able to communicate the results of their analyses and the proposed solutions clearly and effectively to both specialist and non-specialist interlocutors in artificial intelligence. In particular, Master's degree graduates will possess significant communication and collaboration skills in work groups and in heterogeneous and interdisciplinary environments. This objective is achieved through projects, including ongoing projects, and developed in groups, which include presentations in class by the students themselves. Communication skills are verified through the presentation of the activities carried out in the projects, during oral exams and during the discussion of the degree thesis.

Learning skills

Master's degree graduates will be able to independently extend their knowledge and skills through the personal study of scientific publications and technical reports.
These skills are acquired in the context of the implementation of projects, including ongoing ones, of practical-experimental activities in the laboratory and of exercises aimed at solving specific problems and studying cases, as well as in the context of theoretical-experimental internships for the preparation of the degree thesis. Learning skills will be assessed both through ongoing tests and projects and in the final exam.

Art.3 Professional profiles and employment opportunities

SPECIALIST IN ARTIFICIAL INTELLIGENCE FOR INDUSTRY AND THE ENVIRONMENT

Function in a work context:
The master's graduate will be able to enter the world of work in the field of industrial manufacturing processes and environmental management. In particular, he/she will have specialist skills regarding the use of artificial intelligence for the monitoring, control and automation of manufacturing processes, for monitoring product quality and for environmental monitoring to support the management of the environment itself.
In these areas, the master's graduate will be able to use artificial intelligence specifically for: the analysis of industrial and environmental data; the extraction of information and knowledge regarding the behavior of manufacturing and environmental processes; the extraction of information and knowledge regarding the qualities and characteristics of products; the analysis of signals and images in the manufacturing and environmental fields; decision support in the respective application fields; the management of industrial production and the environment; the management of intelligent and adaptive environments (for example: smart buildings, smart cities, intelligent infrastructures); the management of manufacturing processes and intelligent environments to support sustainability.

The functions that the master's graduate will typically be able to perform in the work context are consultancy, analysis, design, management, maintenance, user support and marketing of products and systems based on artificial intelligence in the manufacturing and environmental sectors, as well as coordination and management of work groups in these activities.
The graduate will be able to tackle these tasks also for complex systems, create innovative technologies and applications of artificial intelligence in the areas mentioned above, and reach higher levels of responsibility in the company in the context of the use of artificial intelligence in the specific sector considered.

Skills associated with the function:
For this professional profile, the course provides solid specialist knowledge of artificial intelligence techniques and methodologies for the development of IT systems and applications for the management of manufacturing processes and the environment, as well as the culture necessary to adapt to continuous technical and methodological evolution and to tackle new applications in these sectors. The professional profile in fact provides skills in computer science, mathematics, statistics, physics, signal and image processing, industrial automation and robotics, and advanced IT architectures (including internet-of-things), oriented to industrial and environmental application areas, as well as those similar in methodologies and objectives. The master's graduate will also have awareness of the use, implications and impact of artificial intelligence in business organization and management, both in the public and private sectors, as well as legal issues related to data processing and privacy. The master's graduate will have the ability to understand and operate in interdisciplinary environments and with interdisciplinary technologies.

The master's graduate will be able to use the English language in the world of work, as well as in the specific area of expertise.
Finally, the master's graduate will be able to work in a group, coordinate work groups, operate autonomously, promptly fit into work environments that are also highly interdisciplinary, and interact with people with extremely diverse disciplinary backgrounds.

Career opportunities:
The master's graduate will be able to work in the field of design, implementation and management of IT systems, including complex ones, for industrial manufacturing and environmental applications, as well as coordinate and lead work groups in these areas.
In particular, the master's graduate will be able to make the most of his skills in artificial intelligence methodologies and techniques, signal and image processing, industrial automation and robotics, and environmental monitoring. This activity can be carried out, even as a freelancer, in all areas of the private and public sector that operate in the industrial and environmental fields, as well as in aspects of environmental health relevance. The main market segments involved are: manufacturing industries, companies operating in the sector of intelligent environments (including smart buildings and smart cities) and intelligent infrastructures (including the energy and transport sectors); service companies and public administrations operating in the industrial, environmental and environmental health sectors; research institutions and universities for technical support to research and experimentation activities in the areas of knowledge and skills of this professional profile.

SPECIALIST IN ARTIFICIAL INTELLIGENCE FOR INTELLIGENT EMBEDDED SYSTEMS

Function in a work context:
The master's graduate will be able to enter the world of work in the field of embedded systems for various application areas, including consumer electronics, medical devices and systems,

prosthetics, automobiles and transport. In particular, he/she will have specialist skills regarding the use of artificial intelligence in embedded systems in order to ensure intelligent adaptive behaviors and natural interaction with people.
In these areas, the master's graduate will be able to use artificial intelligence specifically for: the analysis of data from sensors and human-system interfaces; the extraction of information and knowledge regarding the behavior of the embedded system itself and the environment in which it operates; the extraction of information and knowledge from interaction with users and usability support; the analysis of signals and images in intelligent embedded systems; decision support in the respective application areas.
The functions that the master's graduate will typically be able to perform in the work context are consultancy, analysis, design, management, maintenance, user support and marketing of products and systems based on artificial intelligence in embedded systems in many sectors (including for example: consumer electronics, medical systems, automobiles and transportation). The master's graduate will also be able to coordinate and direct work groups in these activities.
The master's graduate will be able to tackle these tasks even for complex systems, create innovative technologies and applications of artificial intelligence in the above-mentioned areas, and reach higher levels of responsibility in the company in the use of artificial intelligence in the specific sector considered.

Skills associated with the function:
For this professional profile, the course provides solid specialist knowledge of artificial intelligence techniques and methodologies for the development of computer systems and applications for intelligent embedded systems, as well as the culture needed to adapt to the continuous technical and methodological evolution and to address new applications in these sectors. The professional profile provides skills in computer science, mathematics, statistics, physics, signal and image processing, control, and human-system interaction, oriented to applications in intelligent embedded systems, as well as to areas related to methodologies and objectives. The master's graduate will also have awareness of the use, implications and impact of artificial intelligence in business organization and management, both in the public and private sectors, as well as legal issues related to data processing and privacy.
The master's graduate will have the ability to understand and operate in interdisciplinary environments and with interdisciplinary technologies.
The master's graduate will be able to use the English language in the world of work, as well as in the specific area of expertise.

Finally, the master's graduate will be able to work in a group, coordinate work groups, operate autonomously, quickly fit into work environments that are also highly interdisciplinary, and interact with people with extremely diverse disciplinary backgrounds.

Career opportunities:
The master's graduate will be able to work in the field of design, implementation and management of computer systems, including complex ones, for intelligent embedded systems and their various areas of application, as well as coordinate and lead work groups in these areas. In particular, the master's graduate will be able to make use of his/her skills in artificial intelligence methodologies and techniques, signal and image processing, control and human-system interaction. This activity can be carried out, even as a freelancer, in all areas of the private and public sector that operate in the field of embedded systems in a wide range of sectors, including industrial, biomedical, automotive and transport. The main market segments involved are: companies in the consumer electronics area; biomedical companies; automotive and transport companies; service companies and public administrations operating in the industrial, environmental, biomedical, healthcare, automotive and transport sectors; research institutions

and universities for technical support to research and experimentation activities in the areas of knowledge and skills of this professional profile or that require intelligent embedded systems for their activities.

SPECIALIST IN ARTIFICIAL INTELLIGENCE FOR DETECTION AND PROCESSING OF SIGNALS AND IMAGES IN HEALTHCARE AND ENVIRONMENT

Function in a work context:
The master's graduate will be able to enter the world of work in the field of systems for the analysis of signals and images in environmental and healthcare applications. In particular, he/she will have specialist skills regarding the use of artificial intelligence for the collection and analysis of multi-sensory data both in the field of environmental monitoring through Earth observation and sensory networks, and in the healthcare field to support medical decisions through the analysis of images and biomedical signals.
In these areas, the master's graduate will be able to use artificial intelligence specifically for: multi-sensory management; the collection and processing of signals and images, from sensors to medical and environmental applications, with particular attention to aspects relating to the understanding of physical phenomena and the physical meaning of the signals and images detected; the extraction of information and knowledge regarding the state of the environment and its evolution; the extraction of information and knowledge regarding the state of health of patients; medical diagnostic tools; environmental observation tools; decision support in the respective application areas.
The functions that the master's graduate will typically be able to perform in the work context are consultancy, analysis, design, management, maintenance, user support and marketing of products and systems based on artificial intelligence in the sector of signal and image processing for healthcare and the environment, as well as coordinating and directing work groups in these activities.
The master's graduate will be able to tackle such tasks even for complex systems, create innovative technologies and applications of artificial intelligence in the above-mentioned areas, and reach higher levels of responsibility in the company in the field of the use of artificial intelligence in the specific sector considered.

Skills associated with the function:
For this professional profile, the course provides solid specialist knowledge of artificial intelligence techniques and methodologies for the development of computer systems and applications for signal and image processing for the healthcare and environmental sectors, as well as the culture needed to adapt to continuous technical and methodological evolution and to address new applications in these sectors. The professional profile provides skills in computer science, mathematics, statistics, physics, signal and image processing, oriented to the application areas of healthcare and the environment, as well as those similar in methodologies and objectives. The master's graduate will also have awareness of the use, implications and impact of artificial intelligence in business organization and management, both in the public and private sectors, as well as legal issues related to data processing and privacy.
The master's graduate will have the ability to understand and operate in interdisciplinary environments and with interdisciplinary technologies.
The master's graduate will be able to use the English language in the world of work, as well as in the specific area of expertise.
Finally, the master's graduate will be able to work in a group, coordinate work groups, operate autonomously, promptly fit into work environments that are also highly interdisciplinary, and interact with people with extremely diverse disciplinary backgrounds.

Career opportunities:
The master's graduate will be able to work in the field of design, implementation and management of IT systems, including complex ones, for signal and image processing applications in healthcare and environmental observation, as well as coordinate and lead work groups in these areas.
In particular, the master's graduate will be able to make the most of his/her skills in artificial intelligence methodologies and techniques, sensors, signal and image processing, and knowledge extraction from environmental and biomedical images and signals. This activity can be carried out, even as a freelancer, in all areas of the private and public sector that operate in the healthcare and environmental fields. The main market segments involved are: companies operating in the sector of the production of components and systems for healthcare and the environment; service companies and public administrations operating in the health and environmental sectors; research institutions, universities and hospitals for technical support to research, experimentation, diagnosis and medical assistance activities in the areas of knowledge and skills of this professional profile.

SPECIALIST IN ARTIFICIAL INTELLIGENCE FOR COMPLEX SYSTEMS AND QUANTUM TECHNOLOGIES

Function in a work context:
The master's graduate will be able to enter the world of work in various fields in which the ability to understand and model complex physical systems and process information with quantum technologies is required. In particular, he/she will have specialist skills regarding the use of artificial intelligence both for the identification, modeling and analysis of complex physical systems, including quantum systems, and for the processing of information with quantum techniques.
In these fields, the master's graduate will be able to use artificial intelligence specifically for: the analysis of data and knowledge to model systems, understand their functioning, extract characteristic behaviors and simulate their behavior; design and develop quantum algorithms to solve complex application problems using quantum computing, also in support of artificial intelligence when technologies have sufficient computational capacity. The functions that the master's graduate will typically be able to perform in the work context are activities of consulting, analysis, design, management, maintenance, user support and marketing of products and systems based on artificial intelligence in the sectors of modeling of complex systems and quantum processing, as well as coordinating and managing work groups in these activities.
The master's graduate will be able to tackle these tasks also for complex systems, create innovative technologies and applications of artificial intelligence in the areas mentioned above, and reach higher levels of responsibility in the company in the use of artificial intelligence in the specific sector considered.

Skills associated with the function:
For this professional profile, the course provides solid specialist knowledge of artificial intelligence techniques and methodologies for the modeling of complex systems and for quantum computation, as well as theoretical methods for the analysis of artificial intelligence algorithms in physical applications and the culture necessary to adapt to the continuous technical and methodological evolution and to address new applications in these sectors. The professional profile provides computer science, mathematics, statistics and physics skills, oriented to the application areas of complex systems modeling and quantum algorithms, as well as those similar in methodologies and objectives. The master's graduate will also have awareness of the use, implications and impact of artificial intelligence in business organization and management, both in the public and private sectors, as well as legal issues related to data processing and privacy.

The master's graduate will have the ability to understand and operate in interdisciplinary environments and with interdisciplinary technologies.
The master's graduate will be able to use the English language in the world of work, as well as in the specific area of expertise.
Finally, the master's graduate will be able to work in a group, coordinate work groups, operate autonomously, promptly fit into work environments that are also highly interdisciplinary, and interact with people with extremely diverse disciplinary backgrounds.

Career opportunities:
The master's graduate will be able to work in the field of design, implementation and management of computer systems, including complex ones, for the modeling, analysis and simulation of physical systems and for applications based on quantum computing, as well as coordinate and lead work groups in these areas.
This activity can be carried out, even as a freelancer, in all areas of the private and public sector that need to model complex physical systems and can benefit from the use of quantum approaches to information processing. The main market segments involved are: companies operating in various sectors in which it is useful to model complex physical phenomena and systems or to be able to adopt quantum approaches to deal with complex problems (including manufacturing industry, new materials, pharmaceutical and chemical industry, environmental management, healthcare); service companies and public administrations operating in these sectors; research institutions and universities for technical support for research and experimentation activities in the areas of knowledge and skills of this professional profile.

The course prepares for the profession of (ISTAT codes):

Software analysts and designers - (2.1.1.4.1) System analysts - (2.1.1.4.2)
Web application analysts and designers - (2.1.1.4.3)
Marketing specialists in the information and communication technology sector - (2.5.1.5.3)

Art.4 Rules relating to access

To be admitted to the master's degree course in Artificial Intelligence for Science and Technology, it is necessary to have a degree or a three-year university diploma, or a qualification obtained abroad and recognized as suitable.

Basic knowledge of computer science, mathematics, statistics and physics is required. Therefore, it is required to have at least 30 CFU in total in the scientific-disciplinary sectors INF/01, ING-INF/05, ING-INF/03, from MAT/01 to MAT/09, from SECS-S/01 to SECS-S/06, from FIS/01 to FIS/08.

To be admitted, a level of knowledge of the English language equal to or higher than B2 is also required to allow understanding and participation in training activities.

Art.5 Admission Procedure

Once the curricular requirements have been verified, admission to the course is subject to the

evaluation of the adequacy of personal preparation. The adequacy of personal preparation will be assessed through an interview by a special Commission.
The interview will focus on the assessment of basic knowledge in Computer Science, Mathematics, Statistics and Physics. In particular, basic knowledge of the following topics will be verified:
● Computer Science: Programming, Algorithms, Data Structures, Artificial Intelligence.
● Mathematics: Linear Algebra, Differential and Integral Calculus in one or more variables, Numerical Series.
● Statistics: Descriptive Statistics, probability, random variables, inference, linear model.
● Physics: elements of Statics, Dynamics, Energy, Thermodynamics, Electromagnetism and Optics.

Students in possession of the curricular requirements (at least 30 CFU in total in the following scientific-disciplinary sectors: INF/01, ING-INF/05, ING-INF/03, from MAT/01 to MAT/09, from SECS-S/01 to SECS-S/06, from FIS/01 to FIS/08) are exempted from the interview if:

1. they have a three-year degree with a grade equal to or higher than 100/110; or:
2. they have a master's degree in one of the following classes: LM-17, LM-18, LM-21, LM-25, LM-27, LM-32, LM-35, LM-40, LM-44, LM-66, LM-82, LM-91, or a master's degree obtained abroad and recognized as suitable by the Commission.

Students who satisfy all of the following 4 conditions are also exempted from the interview:

1. Bachelor's degree obtained with a grade equal to or higher than 95/110 and lower than 100/110, or with a cumulative/overall average equal to or higher than 3.45 (on a scale of 0 to 4);
2. the CFU of Computer Science (CFU/equivalent hours) obtained in the previous university career (in the scientific-disciplinary sectors: INF/01, ING-INF/05) are at least 20;
3. the CFU of Mathematics (CFU/equivalent hours) obtained in the previous university career (in the scientific-disciplinary sectors: MAT/01, MAT/02, MAT/03, MAT/04, MAT/05, MAT/07, MAT/08 and MAT/09) are at least 15;
4. the CFU of Statistics and Probability obtained in the previous university career (in the scientific-disciplinary sectors: from SECS-S/01 to SECS-S/06 or MAT/06) are at least 5.

Students in possession of the curricular requirements (at least 30 CFU overall in the following scientific-disciplinary sectors: INF/01, ING-INF/05, ING-INF/03, from MAT/01 to MAT/09, from SECS-S/01 to SECS-S/06, from FIS/01 to FIS/08) and who do not fall into the cases of exemption from the interview are admitted to take the interview if they satisfy all 4 of the following conditions:

1. three-year degree obtained with a grade equal to or higher than 85/110 and lower than 100/100, or with a cumulative/overall average equal to or higher than 3.3 (on the scale from 0 to 4);

2. the CFU of Computer Science (CFU/equivalent hours) obtained in the previous university career (in the scientific-disciplinary sectors: INF/01, ING-INF/05) are at least 10;

3. the CFU of Mathematics (CFU/equivalent hours) obtained in the previous university career (in the scientific-disciplinary sectors MAT/01, MAT/02, MAT/03, MAT/04, MAT/05, MAT/07, MAT/08 and MAT/09) are at least 6;

4. the CFU of Statistics and Probability (CFU/equivalent hours) obtained in the previous

university career (in the scientific-disciplinary sectors from SECS-S/01 to SECS-S/06 or MAT/06) are at least 4.

Students who do not fall into one of the cases indicated above will not be admitted to the master's degree course.

Interviews will be held remotely.

A level of knowledge of the English language equal to or higher than B2 is also required for admission. The requirement of knowledge of the English language is considered satisfied if the candidate:

a) has a certification, recognized by the University of Milan-Bicocca and issued by an accredited body, corresponding to level B2 or higher;

b) has obtained the Open Badge Bbetween English B2 of the University of Milan-Bicocca, or has passed the Placement test in English B2 of the University of Milan;

c) has obtained a degree entirely (or predominantly) in English.

The application procedures, as well as the dates of the interviews, will be published on the web page dedicated to the course of study.

Art.6 Course Organization

6.1 Educational Activities

The course includes characterizing activities for a total of 48 CFU (30 CFU in the field of "IT Technologies", 12 CFU in the field of "Business - Organizational", 6 CFU in the field of "Human, Social, Legal and Economic Disciplines"), similar and integrative activities for a total of 30 CFU, "student's free choice" activities that give rise to the acquisition of 12 CFU, additional linguistic knowledge (3 CFU), internship for the preparation of the master's thesis (6 CFU) and final exam (21 CFU).

FIRST YEAR training course
MANDATORY TRAINING ACTIVITIES

- Advanced Foundations of Mathematics for AI, MAT/07, 6 CFU
- Advanced Foundations of Statistics for AI, SECS-S/01, 6 CFU
- Advanced Foundations of Physics for AI, FIS/01, 6 CFU
- Advanced Foundations of Artificial Intelligence (12 CFU), consisting of the modules: Artificial Intelligence, ING-INF/05, 6 CFU
AI for Signal and Image Processing, INF/01, 6 ECTS

COMPULSORY EDUCATIONAL ACTIVITIES
The student can choose one of the following application areas:

Application area 1: AI for Industry and Environment
- Systems for Industry 4.0 and environment (IoT), ING-INF/05, 6 CFU
- Advanced data management and decision support systems, INF/01, 6 CFU

- Advanced artificial intelligence, machine learning and deep learning, INF/01, 6 CFU
- Sensing and vision for industry and environment (12 CFU), consisting of the modules: Intelligent sensing and remote sensing, ING-INF/03, 6 CFU
Vision for industry and environment, INF/01, 6 CFU

Application area 2: Intelligent Embedded Systems
- Embedded systems architectures and design, ING-INF/05, 6 CFU
- Advanced data management and decision support systems, INF/01, 6 CFU
- Advanced artificial intelligence, machine learning and deep learning, INF/01, 6 CFU
- Ambient intelligence (12 CFU), consisting of the modules: Advanced human-system interfaces, INF/01, 6 CFU Ambient intelligence and domotics, INF/01, 6 CFU

Application area 3: Sensing and Signal/Image Processing for Healthcare and Environment
- Advanced computational techniques for big imaging and signal data, INF/01, 6 CFU
- Machine learning for modeling (12 CFU), consisting of the modules: Supervised learning, INF/01, 6 CFU
Unsupervised learning, INF/01, 6 CFU
- Signal and imaging acquisition and modeling in healthcare, FIS/07, 6 CFU
- Signal and imaging acquisition and modeling in environment, FIS/01, 6 CFU

Application area 4: Complex Systems and Quantum Technologies
- AI models for Physics, FIS/02, 6 CFU
- Machine learning for modeling (12 CFU), consisting of the modules: Supervised learning, INF/01, 6 CFU
Unsupervised learning, INF/01, 6 CFU
- Statistical learning, INF/01, 6 CFU
- Foundations of Quantum Computing, FIS/03, 6 ECTS SECOND YEAR

MANDATORY TRAINING ACTIVITIES

- Advanced Foundations of Law and regulations in privacy and data protection, IUS/04, 6 CFU
- Data-driven organizations and management, SECS-P/10, 6 CFU
- Freely elective courses, 12 CFU
- Further linguistic knowledge, 3 CFU
- Internship for the preparation of the master's thesis, 6 CFU
- Final exam, 21 CFU

MANDATORY CHOICES OF TRAINING ACTIVITIES

In relation to the chosen Application Area, the student must choose ONE ACTIVITY of a similar type, 6 CFU, among the following:

Application Area 1: AI for Industry and Environment
- Intelligent monitoring and control systems, ING-INF/05, 6 CFU
- Environmental monitoring and management, ING-INF/03, 6 CFU
- Privacy and Data Protection, INF/01, 6 CFU
- Artificial vision, ING-INF/05, 6 CFU

Application area 2: Intelligent Embedded Systems
- Embedded systems for biomedical applications, ING-INF/06, 6 CFU
- Intelligent consumer technologies, INF/01, 6 CFU
- Privacy and Data Protection, INF/01, 6 CFU

Application area 3: Sensing and Signal/Image Processing for Healthcare and Environment
- Physical sensors and systems for biomedical signals, FIS/03, 6 CFU
- Physical sensors and systems for environmental signals, GEO/12, 6 CFU
- Physical sensors and systems for biomedical imaging, FIS/07, 6 CFU
- Physical sensors and systems for environmental imaging, FIS/07, 6 CFU

Application area 4: Complex Systems and Quantum Technologies
- Advanced statistical mechanics and disordered systems, FIS/02, 6 CFU
- Quantum information and algorithms, INF/01, 6 CFU
- Statistical Mechanics of Neural Networks, FIS/02, 6 CFU
- Quantum computers and technologies, FIS/02, 6 CFU
- High-Performance Computing for AI applications in Physics, FIS/02, 6 CFU

6.2 Similar or complementary training activities

The course includes similar and integrative activities, for 30 CFU, which integrate the specialized training, providing knowledge and skills on the use of artificial intelligence in the related application areas. The training activities pertain to the following Scientific-disciplinary Sectors: MAT/07, ING-INF/03-05- 06, INF/01, FIS/01-02-03-07, GEO/12.

6.3 Training activities chosen by the student

12 CFU are provided for training activities independently chosen by the student. Students can obtain credits by passing exams to which a total number of credits at least equal to that required is attributed.
The courses can be freely chosen from those activated in the Master's Degree in Artificial Intelligence for Science and Technology, from the courses offered by the University's Master's Degree Courses and by the Master's Degree Courses of the Universities of Milan and Pavia, subject to approval of the study plan. According to current legislation, for the purposes of calculating the total number of exams, the student's freely chosen activities count for only one exam.

6.4 Further linguistic knowledge (art.10, paragraph 5, letter d DM 270/2004)

The acquisition of 3 CFU relating to "Further linguistic knowledge" occurs according to the methods specified below.

ITALIAN students:
- passing a University test to verify knowledge of a foreign language, at level B2, other than English, chosen between French, Spanish or German,
or
- passing a University test to verify knowledge of the English language, at level C1.

Italian students who already have an Open Badge issued by the University of Milan-Bicocca or certifications issued by bodies accredited by the University, certifying linguistic knowledge, at a level equal to or higher than B2 for French, Spanish or German, or certifying linguistic knowledge, at a level equal to or higher than C1 for English, will be entitled to exemption from the test

and to the recognition of the expected credits.

FOREIGN students:
- passing a University test to verify a level B2 knowledge of the Italian language.

Foreign students who already have an Open Badge issued by the University of Milan-Bicocca or certifications issued by bodies accredited by the University, certifying linguistic knowledge of Italian, at a level equal to or higher than B2, will be entitled to exemption from the test and to the recognition of the expected credits.
Information about the procedures for carrying out the tests or acquiring credits are defined at the University level and will be available on the University website, at https://www.unimib.it/didattica/lingue-unimib.

6.5 Internship

The training program includes a theoretical-experimental internship (6 CFU).
The internship is mandatory and is aimed at preparing the master's thesis, constituting its theoretical-experimental part. The internship can be carried out at Universities, Institutions or Companies, in Italy or abroad.
The student is followed by an internal teacher (university tutor) and, if he/she carries out his/her activity outside the University, by a company tutor, according to the provisions of the training program agreed between the University and the Institution/Company for carrying out the internship.
The recognition of the CFU is subject to the achievement of the training objectives by the student. Only if the evaluation is positive, the student obtains the corresponding credits.

6.6 Teaching methods

Teaching activities consist of lectures, exercises and laboratory.
The acquisition of knowledge and skills by the student is assessed in University Training Credits (CFU). 1 CFU corresponds to the average time commitment for a student of the course equal to 25 hours, including the training activities implemented by the master's degree course and the commitment reserved for personal study or other individual training activities. To acquire 1 CFU, 8 hours of lectures are required, or 12 hours of exercises, or 12 hours of laboratory.
The credits corresponding to each training activity are attributed to the student upon passing the profit exam or following another form of verification of the preparation and skills acquired.

6.7 Methods of profit assessment

The credits corresponding to the characterizing, similar or integrative training activities and to the final exam are obtained by the student by passing the exam or another form of assessment of profit, in accordance with the University Teaching Regulations. The exams will be held in English. The exams involve the assignment of a grade out of thirty and can be carried out orally and/or in writing, as prescribed by the University Teaching Regulations and the Student Regulations of the University of Milan-Bicocca. However, the written exam cannot be based exclusively on multiple-choice questions.
Details on the assessment and evaluation methods for each individual course included in the training path can be found in the respective syllabus. The syllabi are published on the course website, at https://elearning.unimib.it/course/index.php?categoryid=9164, under "Teachings".
For the internship activity and for additional linguistic knowledge, an evaluation expressed with a judgement is foreseen.

6.8 Attendance

Attendance of the courses is not mandatory, however it is strongly recommended.

6.9 Study plan

Upon enrollment, the student is automatically assigned a Study Plan called statutory, which includes all the mandatory training activities.
Subsequently, the student must present his/her own Study Plan with the indication of the optional activities and those of free choice. The periods for the presentation of the study plans are indicated on the page https://www.unimib.it/servizi/studenti-e-laureati/segreterie/piani-degli-studi/area-scienze. The study plan is approved by the Teaching Coordination Council. The student can take exams only if present in his/her own Study Plan.
The Study Plan must respect the number of credits to be acquired, the constraints and the rules of propaedeutics established by the Course Teaching Regulations.
It is possible to develop an individual study plan that also includes training activities other than those provided for in the teaching regulations, provided that they are consistent with the teaching organization of the Study Course of the academic year of enrollment, subject to verification of the congruence with the training objectives of the Study Course by the Teaching Coordination Council. For anything not provided for, please refer to the University Regulations for students.

6.10 Prerequisites

There are no prerequisites. However, it is advisable for the student to ensure that he/she possesses the prerequisites required by each course as reported in the syllabus of each activity, available on the course website.

6.11 Schedule of training activities and exam sessions

The training activities are divided into two semesters: October-January and March-June.
The teaching activities will take place in the Milan-Bicocca, Milan and Pavia locations, according to alternation rules that will be published promptly on the course website.
The exam sessions, scheduled during the periods of suspension of lessons, are distributed in the three winter, summer and autumn sessions and will take place at the University of Milan-Bicocca.
The lesson timetable, the exam calendar, the times and the place where the exams are held are published in the student's web agenda, at the address http://gestioneorari.didattica.unimib.it/PortaleStudentiUnimib.

6.12 Orientation and tutoring activities, job placement

As part of incoming orientation, the three Universities organize meetings (Open days), aimed at graduates and undergraduates, to present in detail the master's degree course, its peculiarities, the courses, the organization of teaching and tutoring services.
For enrolled students, specific disciplinary tutoring activities are planned for some courses, carried out by students and/or PhD students, supervised by the professors.
Orientation activities will also be organized for the construction of the individual study plan and support for the choice of internship activities. The referent professors for each activity will be indicated on the course website.
With respect to outgoing orientation, students of the course can make use of the services offered by the Job Placement Office of the University of Milan-Bicocca, as well as participate in all the initiatives promoted jointly with the University of Milan and the University of Pavia.

6.13 Agreements for international student mobility

The course pays particular attention to internationalization by promoting and consolidating forms of international exchange within the University mobility programs. In particular, exchange programs will be planned:
- at European level, with the Erasmus+ (for study purposes) and Erasmus+ Traineeship programs;
- at the extra-European level, with the Exchange extra-EU program.
All information on the opportunities offered will be published on the page: https://www.unimib.it/internazionalizzazione/mobilita-internazionale

Art.7 Final exam

The master's degree in Artificial Intelligence for Science and Technology is obtained by passing a final exam, consisting of the presentation and discussion of a degree thesis. The degree thesis is developed in an original way by the student, under the guidance of a supervisor, and consists of a written report on a topic chosen within the training path of the master's degree course and the subject of the theoretical-experimental internship activity. The report typically describes the activities carried out by the student, the knowledge and skills acquired in the theoretical and/or experimental study, as well as the connections with the current state of the relevant knowledge in the field of artificial intelligence. In particular, the scientific and technological results obtained will be presented, highlighting the innovation and relevance in the specific scientific-technological and/or applicative field. The internship activity aimed at the thesis can be carried out at universities, institutions or companies, in Italy or abroad.

Art.8 Method of carrying out the Final Exam

The final exam, which gives rise to the achievement of 21 CFU, consists in the discussion of the thesis before a special commission. The thesis must be written and discussed in English. The degree grade is expressed in hundredths. The calendar of sessions, deadlines and operational instructions are published on the website of the Degree Course.

Art.9 Credit recognition and transfer methods

Students transferred from another master's degree course or students who have withdrawn, lapsed or in possession of another master's degree must request an evaluation of their career in order to verify the adequacy of their personal preparation and possession of the curricular requirements. The Teaching Coordination Council will decide on the total or partial recognition of the teaching activities already completed.

In the case of transfer of the student from another master's degree course belonging to Class LM-91, the quota of credits relating to the same scientific-disciplinary sector, directly recognized to the student cannot be less than 50% of the credits already earned (Ministerial Decree 16 March 2007).

According to the Ministerial Decree 270/2004 and L. 240/2010, universities may recognize as university training credits the professional knowledge and skills certified individually in accordance with the legislation in force on the matter, as well as other knowledge and skills acquired in post-secondary level training activities for which the university has contributed to the design and implementation for a maximum of 12 CFU, in total between bachelor's and master's degree courses.
Activities already recognized for the purposes of awarding university training credits in the context of bachelor's degree courses cannot be recognized again as training credits in the context of master's degree courses.

Art.10 Research activities in support of the training activities that characterize the profile of the Degree Course

The training activities that make up the Master's Degree Course and, especially, the practical-experimental activities and the internship activities for the preparation of the Master's Degree thesis can be linked to the research activities developed, in particular, in the research laboratories in Departments of the three Universities involved:

- Department of Physics "G. Occhialini" of the University of Milan-Bicocca (administrative headquarters)
- Department of Computer Science, Systems and Communications of the University of Milan-Bicocca
- Department of Mathematics and Applications of the University of Milan-Bicocca
- Department of Statistics and Quantitative Methods of the University of Milan-Bicocca
- Department of Computer Science of the University of Milan
- Department of Mathematics of the University of Milan
- Department of Physics of the University of Milan
- Department of Philosophy of the University of Milan
- Department of Industrial and Information Engineering of the University of Pavia
- Department of Mathematics of the University of Pavia
- Department of Physics of the University of Pavia
- Department of Nervous System and Behavioral Sciences of the University of Pavia

These research activities include both basic research and applied research and technology transfer, in collaboration with companies, research institutions, other universities, hospitals and public administrations, in Italy and abroad. In particular, students will be able to carry out the activities related to the internship for the preparation of the master's thesis also in the context of these research activities.

As regards the specific disciplines covered by the master's degree course in Artificial Intelligence for Science and Technology, some research topics, especially in the laboratories connected to the course itself, are: artificial neural networks, recurrent neural networks, deep learning, Bayesian methods, kernel methods, machine learning, advanced learning strategies, transfer learning, federated learning, fuzzy systems, evolutionary computation, hybrid artificial intelligence, knowledge representation, automatic reasoning, symbolic artificial intelligence, vision, speech understanding, person-system interfaces, affective computing, biometrics, gesture analysis, AI explainability, AI interpretability, data analytics, sensors, biomedical sensors, environmental sensors, measurement systems, wireless sensor networks, mobile

sensing, hyperspectral imaging, remote sensing, signal and image processing, AI processing architectures, dedicated architectures for signal and image processing, embedded architectures, internet-of-things, cyber-physical systems, cloud/fog/edge computing, real-time and embedded operating systems, system and network security, privacy, data protection, data management, big data systems, industrial monitoring and control systems, quality control in manufacturing systems, fault and defect detection, environmental signal and image processing, environmental monitoring systems, ambient intelligence, home automation, assisted living, biomedical signal and image processing, biomedical applications and systems, consumer electronics applications and systems, complex system modeling, complex system simulation, quantum computers and technologies, quantum information and algorithms, social implications of technology, ethics in technology and applications, legal aspects of artificial intelligence and applications.

Art.11 Course teachers

For the academic year 2024-2025 the course teachers are:

Arosio Paolo, FIS/07, UNIMI
Bajoni Daniele, FIS/03, UNIPV
Bianco Simone, INF/01, UNIMIB
Borrotti Matteo, SECS-S/01, UNIMIB
Braione Pietro, INF/01, UNIMIB
Bisio Alessandro, FIS/02, UNIPV
Cabitza Federico, INF/01, UNIMIB
Castiglioni Isabella, FIS/07, UNIMIB
Cattaneo Paolo Walter, FIS/07
Celona Luigi, INF/01, UNIMIB
Cisotto Giulia, INF/01, UNIMIB
Civitarese Gabriele, INF/01, UNIMI
Cogliati Sergio, GEO/12, UNIMIB
Corvo Luigi, SECS-P/07, UNIMIB
Coscia Pasquale, ING-INF/05, UNIMI
Cosentino Lagomarsino Marco, FIS/02, UNIMI
D'Auria Daniela, INF/01, UNIMIB
De Guio Federico, FIS/01, UNIMIB
Dell'Acqua Fabio, ING-INF/03, UNIPV
Donida Labati Ruggero, INF/01, UNIMI
Faccioli Pietro, FIS/07, UNIMIB
Faroldi Federico, IUS/20, UNIPV
Gamba Paolo Ettore, ING-INF/03, UNIPV
Gasparini Francesca, INF/01, UNIMIB
Genovese Angelo, INF/01, UNIMI
Gianini Gabriele, INF/01, UNIMIB
Govoni Pietro, FIS/01, UNIMIB
Greselin Francesca, SECS-S/01, UNIMIB
Leporati Francesco, ING-INF/05, UNIPV
Maiocchi Alberto, MAT/07, UNIMIB
Marafioti Elisabetta, SECS-P/07, UNIMIB
Marenzi Elisa, ING-INF/05, UNIPV
Napoletano Paolo, INF/01, UNIMIB

Nutini Irene, FIS/04
Piccoli Flavio, INF/01, UNIMIB
Piuri Vincenzo, ING-INF/05, UNIMI
Pizzichemi Marco, FIS/07, UNIMIB
Prati Enrico, FIS/03, UNIMI
Sironi Laura, FIS/07, UNIMIB
Sorrenti Domenico, ING-INF/05, UNIMIB
Stella Fabio, MAT/09, UNIMIB
Torti Emanuele, ING-INF/05, UNIPV
Virga Epifanio, MAT/07, UNIPV
Zini Simone, INF/01, UNIMIB
Zoppis Italo, INF/01, UNIMIB

Art.12 Other information

The administrative headquarters of the course is the University of Milan-Bicocca, Department of Physics "Giuseppe Occhialini", Piazza della Scienza 3, 20126 Milan.

For information regarding admission, transfers and administrative aspects, write to: segr.studenti.scienze@unimib.it
For information regarding the training path, write to: ai4st@unimib.it

For the procedures and deadlines of the University regarding registrations/enrolments, transfers, presentation of Study Plans, consult the website www.unimib.it.

All information regarding the organisation of teaching and contacts, for any further clarification, are published on the website of the course of study, at the address https://elearning.unimib.it/course/index.php?categoryid=9164

Non-substantial changes to these Teaching Regulations are possible. In particular, for the courses indicated as elective, activation will be subject to the number of students enrolled.

The following is the table of training activities distributed based on the type of activity, field and scientific-disciplinary sector.

Class/Path

Class	Class of master's degrees in Techniques and methods for the Information society (LM-91)
Study path	Common path

Framework of teaching activities

Core				
Disciplinary area	**CFU**	**Range of CFU from RAD**	**SSD**	**Teaching activities**
Computer technology	30	30 - 42	INF/01	F9102Q009M - ADVANCED ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND DEEP LEARNING, 6 CFU F9102Q015M - ADVANCED COMPUTATIONAL TECHNIQUES FOR BIG IMAGING AND SIGNAL DATA, 6 CFU F9102Q023M - STATISTICAL LEARNING, 6 CFU F9102Q030M - VISION FOR INDUSTRY AND ENVIRONMENT, 6 CFU (Module of complete teaching activity: SENSING AND VISION FOR INDUSTRY AND ENVIRONMENT (F9102Q029)) F9102Q035M - AI FOR SIGNAL AND IMAGE PROCESSING, 6 CFU (Module of complete teaching activity: ADVANCED FOUNDATIONS OF ARTIFICIAL INTELLIGENCE (F9102Q004)) F9102Q04301 - ADVANCED HUMAN-SYSTEM INTERFACES, 6 CFU (Module of complete teaching activity:

				AMBIENT INTELLIGENCE (F9102Q043)) F9102Q04302 - AMBIENT INTELLIGENCE AND DOMOTICS, 6 CFU (Module of complete teaching activity: AMBIENT INTELLIGENCE (F9102Q043)) F9102Q04501 - SUPERVISED LEARNING, 6 CFU (Module of complete teaching activity: MACHINE LEARNING FOR MODELLING (F9102Q045)) F9102Q04502 - UNSUPERVISED LEARNING, 6 CFU (Module of complete teaching activity: MACHINE LEARNING FOR MODELLING (F9102Q045))
			ING-INF/03	F9102Q029M - INTELLIGENT SENSING AND REMOTE SENSING, 6 CFU (Module of complete teaching activity: SENSING AND VISION FOR INDUSTRY AND ENVIRONMENT (F9102Q029))
			ING-INF/05	F9102Q004M - ARTIFICIAL INTELLIGENCE, 6 CFU (Module of complete teaching activity: ADVANCED FOUNDATIONS OF ARTIFICIAL INTELLIGENCE (F9102Q004))
Business/organizational	12	12 - 18	SECS-P/10	F9102Q005M - DATA-DRIVEN ORGANIZATIONS AND MANAGEMENT, 6 CFU
			SECS-S/01	F9102Q002M - ADVANCED FOUNDATIONS OF STATISTICS FOR AI, 6 CFU
Humanities, Social, Law, Economics	6	6 - 12	IUS/04	F9102Q006M - ADVANCED FOUNDATIONS OF LAW AND REGULATIONS IN PRIVACY AND DATA PROTECTION, 6 CFU
Total Core	48	48 - 72		
Similar/Complementary				

Disciplinary area	CFU	Range of CFU from RAD	SSD	Teaching activities
Similar or complementary teaching activities	30	24 - 36	FIS/01	F9102Q003M - ADVANCED FOUNDATIONS OF PHYSICS FOR AI, 6 CFU F9102Q017M - SIGNAL AND IMAGING ACQUISITION AND MODELLING IN ENVIRONMENT, 6 CFU
			FIS/02	F9102Q022M - AI MODELS FOR PHYSICS, 6 CFU F9102Q025M - ADVANCED STATISTICAL MECHANICS AND DISORDERED SYSTEMS, 6 CFU F9102Q027M - STATISTICAL MECHANICS OF NEURAL NETWORKS, 6 CFU F9102Q028M - QUANTUM COMPUTERS AND TECHNOLOGIES, 6 CFU F9102Q041 - HIGH-PERFOMANCE COMPUTING FOR AI APPLICATIONS IN PHYSICS, 6 CFU
			FIS/03	F9102Q018M - PHYSICAL SENSORS AND SYSTEMS FOR BIOMEDICAL SIGNALS, 6 CFU F9102Q039 - FOUNDATIONS OF QUANTUM COMPUTING, 6 CFU

			FIS/07	F9102Q016M - SIGNAL AND IMAGING ACQUISITION AND MODELLING IN HEALTHCARE, 6 CFU F9102Q020M - PHYSICAL SENSORS AND SYSTEMS FOR BIOMEDICAL IMAGING, 6 CFU F9102Q021M - PHYSICAL SENSORS AND SYSTEMS FOR ENVIRONMENTAL IMAGING, 6 CFU
			GEO/12	F9102Q042 - PHYSICAL SENSORS AND SYSTEMS FOR ENVIRONMENTAL SIGNALS, 6 CFU
			INF/01	F9102Q008M - ADVANCED DATA MANAGEMENT AND DECISION SUPPORT SYSTEMS, 6 CFU F9102Q014M - INTELLIGENT CONSUMER TECHNOLOGIES, 6 CFU F9102Q026M - QUANTUM INFORMATION AND ALGORITHMS, 6 CFU F9102Q040 - PRIVACY AND DATA PROTECTION, 6 CFU
			ING-INF/03	F9102Q011M - ENVIRONMENTAL MONITORING AND MANAGEMENT, 6 CFU
			ING-INF/05	F9102Q007M - SYSTEMS FOR INDUSTRY 4.0 AND ENVIRONMENT (IoT), 6 CFU F9102Q012M - EMBEDDED SYSTEMS ARCHITECTURES AND DESIGN, 6 CFU F9102Q044 - INTELLIGENT MONITORING AND CONTROL SYSTEMS, 6 CFU F9102Q046 - ARTIFICIAL VISION, 6 CFU

			ING-INF/06	F9102Q013M - EMBEDDED SYSTEMS FOR BIOMEDICAL APPLICATIONS, 6 CFU
			MAT/07	F9102Q001M - ADVANCED FOUNDATIONS OF MATHEMATICS FOR AI, 6 CFU
Total Similar/Complementary	30	24 - 36		

Student-selected activities				
Disciplinary area	**CFU**	**Range of CFU from RAD**	**SSD**	**Teaching activities**
Student-selected	12	8 - 12	NN	F9102Q304 - FREE CHOICE CFU TAKEN IN OTHER UNIVERSITIES - 6 CFU, 6 CFU F9102Q302 - CHOSEN ACTIVITIES TAKEN DURING THE ERASMUS PERIOD - 6 CFU, 6 CFU F9102Q303 - CHOSEN ACTIVITIES TAKEN DURING THE ERASMUS PERIOD - 8 CFU, 8 CFU F9102Q301 - CHOSEN ACTIVITIES TAKEN DURING THE ERASMUS PERIOD - 4 CFU, 4 CFU F9102Q300 - CHOSEN ACTIVITIES TAKEN DURING THE ERASMUS PERIOD - 12 CFU, 12 CFU F9102Q305 - FREE CHOICE CFU TAKEN IN OTHER UNIVERSITIES - 12 CFU, 12 CFU
Total Student-selected activities	12	8 - 12		

Language/Final exam				
Disciplinary area	**CFU**	**Range of CFU from RAD**	**SSD**	**Teaching activities**
For final exam	21	19 - 30	PROFIN_S	F9102Q038 - FINAL EXAMINATION, 21 CFU
Total Language/Final test	21	19 - 30		

Other				
Disciplinary area	**CFU**	**Range of CFU from RAD**	**SSD**	**Teaching activities**
Further language knowledge	3	3 - 3	NN	F9102Q035 - FURTHER LINGUISTIC KNOWLEDGE - SPANISH - B2 LEVEL (OR HIGHER), 3 CFU F9102Q034 - FURTHER LINGUISTIC KNOWLEDGE - GERMAN - B2 LEVEL (OR HIGHER), 3 CFU F9102Q036 - FURTHER LINGUISTIC KNOWLEDGE - ITALIAN - B2 LEVEL (OR HIGHER), 3 CFU F9102Q033 - FURTHER LINGUISTIC KNOWLEDGE - FRENCH - B2 LEVEL (OR HIGHER), 3 CFU F9102Q032 - FURTHER LINGUISTIC KNOWLEDGE - ENGLISH - C1 LEVEL (OR HIGHER), 3 CFU
Stage and orientation activities	6	6 - 9	NN	F9102Q037 - STAGE, 6 CFU
Total Other	9	9 - 12		
Total	120	108 - 162		