



**MASTER DEGREE IN  
DATA SCIENCE AND SCIENTIFIC COMPUTING  
CLASS LM 44  
STUDY PLAN**

**for students enrolling in the 1st year in the a.y. 2022/23**

The Master Degree in Data Science and Scientific Computing is articulated in 3 curricula:

- Curriculum “Artificial Intelligence and Machine Learning”
- Curriculum “Data Science for Applications”
- Curriculum “Computational Science and Engineering”

**Curriculum “Artificial Intelligence and Machine Learning”**

The Artificial Intelligence and Machine Learning curriculum is devoted to train expert in modern Artificial Intelligence techniques, in particular Machine Learning techniques. You will learn skills in machine learning, artificial intelligence, statistics, modelling, high performance computing and management of databases for big data.

<b>Curriculum “Artificial Intelligence and Machine Learning”</b>			
<b>I year (60 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Foundations of High Performance Computing	ING-INF/05	B	9
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Numerical Analysis	MAT/08	B	6
Data Management for Big Data	INF/01	B	9
Reinforcement Learning	INF/01	C	6
Probabilistic Machine Learning	INF/01	B	6
<b>II year (60 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Deep Learning	INF/01	B	6



Elective courses		C	6
Free courses		D	12
Internship		F	12
Thesis		E	24

You can add to the study plan some elective courses (TAF A, B, C) among the following ones:

<b>Elective Courses</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Cyber-Physical Systems	ING-INF/05	C	6
Computer Vision and Pattern Recognition	ING-INF/04	C	6
Software Development Methods	ING-INF/05	C	6
Natural Language Processing	ING-INF/05	C	6
Information Theory	INF/01	C	6
Control Theory	ING-INF/04	C	6
Unsupervised Learning	FIS/07	C	6
Advanced Topics in Machine Learning	INF/01	C	6
Global and Multi-Objective Optimization	INF/01	C	6

You can include some free courses (TAF D) in the study plan, selected among the following ones. You are encouraged to verify their availability for the year of interest.

<b>Free Courses</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
All the courses from the previous tables		D	
Stochastic Modelling and Simulation	INF/01	D	6
Information Retrieval and Data Visualization	INF/01	D	6



Identification and Estimation of Systems	ING-INF/04	D	6
Mathematical Optimisation	MAT/09	D	6
Bayesian Statistics	SECS-S/01	D	6
Open Data Management and the Cloud	ING-INF/05	D	6
Statistical Learning for Data Science	SECS-S/01	D	6
Parallel Programming for HPC	ING-INF/05	D	6
Advanced Probability	MAT/06	D	6
Advanced Data Management and Curation	INF/01	D	6
Other courses (****) (****) These courses can belong to any field, but the study plan needs to be approved		D	



## Curriculum “Data Science and Applications”

The curriculum in Data Science and Applications is devoted to train experts in the management and analysis of data, particularly of Big Data. You will learn skills in statistics, modelling, data analytics, programming, high performance computing and management of databases for big data, as well as experience in an application domain.

Curriculum “Data Science and Applications”				
I year (60 CFU)				
Course Name	Field	TAF	CFU	
Advanced Programming and Algorithmic Design	ING-INF/05	B	12	
Foundations of High Performance Computing	ING-INF/05	B	9	
Introduction to Machine Learning	ING-INF/05	B	6	
Statistical Methods for Data Science	SECS-S/01	C	6	
Numerical Analysis	MAT/08	B	6	
Data Management for Big Data	INF/01	B	9	
<i>An exam chosen between the two below</i>				
Statistical Learning for Data Science	SECS-S/01	C	6	
Unsupervised Learning	FIS/07	C	6	
Probabilistic Machine Learning	INF/01	B	6	
II year (60 CFU)				
Course Name	Field	TAF	CFU	
For the elective courses, the student must choose between option A and option B				
A	Computational Biology	INF/01	C	6



B	Information Retrieval and Data Visualization	INF/01	C	6
Elective Courses			C	6
Free Courses			D	12
Internship			F	12
Thesis			E	24

You can include some free courses (TAF A, B, C) in the study plan, selected among the following ones:

Elective Courses			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Statistical Analysis of Networks	SECS-S/05	C	6
Bayesian Statistics	SECS-S/01	C	6
Deep Learning	INF/01	C	6
Health Data Analytics	MED/01	C	6
Software Development Methods	ING-INF/05	C	6
Molecular Simulation	ING-IND/24	C	6
Mathematical Optimisation	MAT/09	C	6
Earth Sciences Analytics	GEO/10	C	6
Advanced Data Management and Curation	INF/01	C	6

You can include some free courses (TAF D) in the study plan, selected among the following ones. You are encouraged to verify their availability for the year of interest.

Free Courses			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
All the courses from the previous tables		D	



Data Science for Insurance	SECS-S/01	D	6
Parallel Programming for HPC	ING-INF/05	D	6
Digital Transportation	MAT/09	D	6
Stochastic Modelling and Simulation	INF/01	D	6
Computer Vision and Pattern Recognition	ING-INF/04	D	6
Open Data Management and the Cloud	ING-INF/05	D	6
Natural Language Processing	ING-INF/05	D	6
Parallel programming for HPC	ING-INF/05	D	6
Management of Health Data	ING-INF/06	D	6
Geophysics Analytics	GEO/10	D	6
Advanced Topics in Machine Learning	INF/01	D	6
Global and Multi-Objective Optimization	INF/01	D	6
Other courses (****) (****) These courses can belong to any field, but the study plan needs to be approved		D	



## Curriculum “Computational Science and Engineering”

The curriculum in Computational Science and Engineering is devoted to train experts in the simulation-based science and engineering. You will learn skills in mathematical modelling, numerical methods and simulation, fundamentals of data analytics, programming, high performance computing and scientific programming.

Curriculum “Computational Science and Engineering”			
I year (57 CFU)			
Course Name	Field	TAF	CFU
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Foundations of High Performance Computing	ING-INF/05	B	9
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Numerical Analysis	MAT/08	B	6
Stochastic Modelling and Simulation	INF/01	B	6
Mathematical Optimization	MAT/09	B	6
<i>One free course between options A and B</i>			
A. Advanced Numerical Analysis	MAT/08	B	6
B. Probabilistic Machine Learning	INF/01	B	6
II year (63 CFU)			
Course Name	Field	TAF	CFU
Elective Courses		C	12
Free Courses		D	15
Internship		F	12
Thesis		E	24



You can include some free courses (TAF A, B, C) in the study plan, selected among the following ones:

<b>Elective Courses</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Control Theory	ING-INF/04	C	6
Parallel Programming for HPC	ING-INF/05	C	6
Fluid Dynamics	ICAR/01	C	6
Physics and Modelling of Turbulent Flows	ICAR/01	C	6
Computational Physics Laboratory	FIS/01	C	6
Computational Quantum Chemistry	CHIM/02	C	6
Molecular Simulation	ING-IND/24	C	6
Galaxy Astrophysics	FIS/05	C	6
Formation of Cosmological Large-Scale Structures	FIS/05	C	9
Software Development Methods	ING-INF/05	C	6
Introduction to Quantum Mechanics and Quantum Computing	FIS/02	C	6
Introduction to Quantum Information Theory	FIS/02	C	6
Information Theory	INF/01	C	6

You can include some free courses (TAF D) in the study plan, selected among the following ones. You are encouraged to verify their availability for the year of interest.

<b>Free Courses</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
All the courses from the previous tables		D	





Deep Learning	INF/01	D	6
Global and Multi-Objective Optimization	INF/01	D	6
Open Data Management and the Cloud	ING-INF/05	D	6
Bayesian Statistics	SECS-S/01	D	6
Computer Vision and Pattern Recognition	ING-INF/04	D	6
Statistical Mechanics	CHIM/02	D	6
Radiative Processes in Astrophysics	FIS/05	D	6
Numerical Methods in Quantum Mechanics	FIS/03	D	6
Simulation of Multibody Systems	FIS/03	D	6
Advanced Probability	MAT/06	D	6
Advanced Data Management and Curation	INF/01	D	6
Advanced Quantum Computation	FIS/02	D	6
Other courses (****) (****) These other courses can belong to any field, but the study plan needs to be approved		D	



### Curriculum “Data Science and Applications” for part-time students, 3 years

This section provides a suggested division of the courses of the Data Science and Applications curriculum for part-time students who choose a 3-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Data Science and Applications” - part time – 3 years</b>			
<b>I year (39 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Data Management for Big Data	INF/01	B	9
<i>Un esame a scelta tra A e B</i>			
A. Statistical Learning for Data Science	SECS-S/01	C	6
B. Unsupervised Learning	FIS/07	C	6
<b>II year (39 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
Probabilistic Machine Learning	INF/01	B	6
Elective courses within the limitations of 2-years degree program		C	12
Free Courses		D	6
<b>III year (42 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Free Courses		D	6
Internship		F	12
Thesis		E	24



### Curriculum “Data Science and Applications” for part-time students, 4 years

This section provides a suggested division of the courses of the Data Science and Applications curriculum for part-time students who choose a 4-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Data Science and Applications” - part time – 4 years</b>			
<b>I year (33 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Data Management for Big Data	INF/01	B	9
<b>II year (27 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
<i>Un esame a scelta tra A e B</i>			
C. Statistical Learning for Data Science	SECS-S/01	C	6
D. Unsupervised Learning	FIS/07	C	6
Probabilistic Machine Learning	INF/01	B	6
<b>III year (36 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Elective Courses within the limitations of 2-years degree program		C	12
Free Courses		D	12
Internship		F	12
<b>IV year (24 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Thesis		E	24



### Curriculum “Artificial Intelligence and Machine Learning” part-time students, 3 years

This section provides a suggested division of the courses of the Artificial Intelligence and Machine Learning curriculum for part-time students who choose a 3-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Artificial Intelligence and Machine Learning” - part time – 3 years</b>			
<b>I year (39 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Data Management for Big Data	INF/01	B	9
Probabilistic Machine Learning	INF/01	B	6
<b>II year (42 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
Deep Learning	INF/01	B	6
Reinforcement Learning	INF/01	C	6
Elective Courses within the limitations of 2-years degree program		C	6
Free Courses		D	6
<b>III year (42 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Free Courses		D	6
Internship		F	12
Thesis		E	24



### Curriculum “Artificial Intelligence and Machine Learning” part-time students, 4 years

This section provides a suggested division of the courses of the Artificial Intelligence and Machine Learning curriculum for part-time students who choose a 4-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Artificial Intelligence and Machine Learning” - part time - quadriennale</b>			
<b>I year (33 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Data Management for Big Data	INF/01	B	9
<b>II year (27 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
Reinforcement Learning	INF/01	C	6
Probabilistic Machine Learning	INF/01	B	6
<b>III year (36 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Deep Learning	INF/01	B	6
Elective Courses within the limitations of 2-years degree program		C	6
Free Courses		D	12
Internship		F	12
<b>IV year (24 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Thesis		E	24



### Curriculum “Computational Science and Engineering” part-time students, 3 years

This section provides a suggested division of the courses of the Computational Science and Engineering curriculum for part-time students who choose a 3-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Computational Science and Engineering” -part time – 3 years</b>			
<b>I year (36 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Mathematical Optimization	MAT/09	B	6
Stochastic Modelling and Simulation	INF/01	B	6
<b>II year (42 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
<i>One free course between options A and B</i>			
A. Advanced Numerical Analysis	MAT/08	B	6
B. Probabilistic Machine Learning	INF/01	B	6
Elective Courses within the limitations of 2-years degree program		C	12
Free courses		D	9
<b>III year (42 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Free Courses		D	6
Internship		F	12
Thesis		E	24



### Curriculum “Computational Science and Engineering” part-time students, 4 years

This section provides a suggested division of the courses of the Computational Science and Engineering curriculum for part-time students who choose a 4-years duration of the degree program. Study plans different from the proposed one can be presented by students, but need to be approved by the CCS.

<b>Curriculum “Computational Science and Engineering” - part time – 4 years</b>			
<b>I year (30 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Advanced Programming and Algorithmic Design	ING-INF/05	B	12
Introduction to Machine Learning	ING-INF/05	B	6
Statistical Methods for Data Science	SECS-S/01	C	6
Mathematical Optimization	MAT/09	B	6
<b>II year (27 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Foundations of High Performance Computing	ING-INF/05	B	9
Numerical Analysis	MAT/08	B	6
Stochastic Modelling and Simulation	INF/01	B	6
<i>One free course between options A and B</i>			
A. Advanced Numerical Analysis	MAT/08	B	6
B. Probabilistic Machine Learning	INF/01	B	6
<b>III year (33 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Elective Courses within the limitations of 2-years degree program		C	12
Free Courses		D	9
Internship		F	12
<b>IV year (30 CFU)</b>			
<i>Course Name</i>	<i>Field</i>	<i>TAF</i>	<i>CFU</i>
Free Courses		D	6
Thesis		E	24