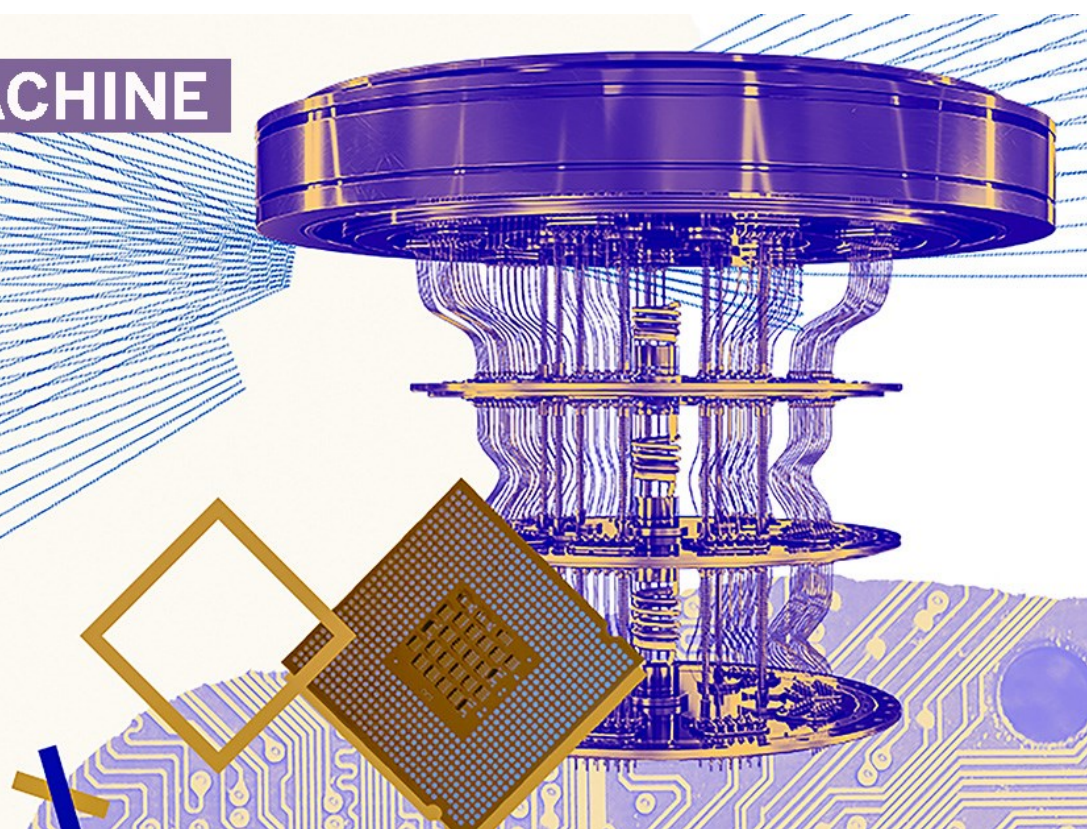


QUANTUM MACHINE LEARNING 1ST LEVEL



UNIVERSITY MASTER
LEVEL I EDITION II A.Y. 2024 – 2025

PRESENTATION

The Executive Master in Quantum Machine Learning explores and examines the themes of quantum computing. This is a recent approach to computing based on the principles of quantum mechanics. Unlike traditional computing, which encodes and processes information in terms of bits (zeros or ones), quantum computing takes advantage of the properties of quantum physics, such as the superposition of quantum states and entanglement. The advantage of this type of computing is its ability to easily solve problems that otherwise prove difficult for traditional computing in terms of both the hardware resources and calculation times required. Equally innovative are machine learning in its various forms and artificial intelligence broadly defined. These are a set of quantitative methods that are inspired by the way that advanced living beings and Nature “produce” intelligent processes. The main capacity of these methods is that they can develop problem-solving capabilities autonomously. Combining these two disciplinary areas is giving life to a new paradigm in the field of computing for automatic learning: quantum machine learning. The possibilities it offers for enabling smart systems to learn “easily” how to solve problems – even extremely complex problems – will have a disruptive impact on many industries and fields of research, such as trading, cybersecurity, molecular simulation, drug design, and weather forecasting. The Master’s degree program is, therefore, necessarily and deliberately multidisciplinary,

involving four departments at Ca' Foscari University of Venice (specifically, the Department of Economics, the Department of Management, the Department of Environmental Sciences, Computer Science and Statistics and the Department of Molecular Sciences and Nanosystems), and it presents and refines the knowledge needed to be able to understand and be an active part of this transitional phase from its earlier stages. In particular, knowledge will be dispensed regarding competencies in quantum computing, machine learning, mathematics, statistics, physics, computer science, economics, and finance.

The initial part of the Master's degree programme will be dedicated to reviewing the main mathematical and statistical foundations needed to be able to access the subsequent content effectively. The rest of the programme will focus on exploring the skills needed to understand, use and manage quantum machine learning methods and tools. In particular, after the initial overview, the following blocks of knowledge and skills will be developed:

- machine and deep learning;
- quantum computation;
- quantum machine and deep learning;
- FinTech and cybersecurity applications.

OBJECTIVE

The graduates of the Master's degree programme can go on to work at private firms in the following sectors:

- finance and insurance, e.g. asset and risk management, financial advising, insurance and actuarial services;
- biotechnology, chemical computation and pharmaceuticals.

Graduates of the Master's degree programme may also join government organisations or state owned companies that provide services for managing smart cities, the local Internet-of-Things and public big data investigation.

Graduates may also become independent professionals in these fields.

Finally, graduates may also work as independent professional quantum machine learning developers and data analyst quantum machine learning specialists.

SYLLABUS

MATHEMATICAL AND STATISTICAL PRELIMINARIES

Objective: Preliminary review of mathematics, statistics and probability calculation as prerequisites for the other modules.

Course hours: 24

INTRODUCTION TO QUANTUM MECHANICS

Objective: Introductory elements of quantum mechanics as prerequisites for the other modules.

Course hours: 24

QUANTUM INFORMATION AND COMPUTATION

Objective: Introduction to quantum information and computation.

Course hours: 24

QUANTUM ANNEALING

Objective: Provide knowledge and skills on quantum computing.

Course hours: 12

MACHINE/DEEP LEARNING

Objective: Provide knowledge and skills on the basic elements of Machine Learning, with practice in the Python environment.

Course hours: 36

QUANTUM MACHINE/DEEP LEARNING – GATE MODEL

Objective: Provide knowledge and skills: on quantum algorithms for linear algebra and optimization; on quantum hybrid computing; on variational quantum algorithms; on quantum machine learning methods.

Course hours: 18

QUANTUM MACHINE/DEEP LEARNING – ANNEALING

Objective: Provide knowledge and skills: on quantum graph computation; on applications of quantum methods for machine learning; on feature selection.

Course hours: 18

QUANTUM APPLICATIONS

Objective: Provide knowledge and skills on quantum cryptography.

Course hours: 12

DATA PROTECTION REGULATION

Objective: Provide knowledge and skills on introductory aspects of data protection.

Course hour: 8

INTRODUCTION TO FINANCE & FINTECH

Objective: Provide knowledge and skills:

- on quantitative finance;
- models for the selection and management of financial portfolios;
- Natural Language Processing for financial applications;
- on metaheuristic methods for optimization.

Course hours: 42

LABS

Objective: Provide opportunities to apply the knowledge and skills gained in previous modules

Course hours: 56

DURATION AND ACADEMIC CREDITS (CFUs)

The Master's has a duration of one year and consists of::

- **300 hours** of blended coursework
- **250 hours of internship** (participants already working in the sector can replace the internship with project work focusing on activities of interest)
- **1500 total hours of study**, including individual study and preparation of a final thesis
- **60 CFUs** awarded

QUALIFICATION ISSUED	Students who have attended the didactic activities, completed the internship activities and passed any mid-term and final tests will be awarded with the qualification of 1st Level Master's Degree in Quantum Machine Learning .
COURSE PERIOD	FEBRUARY 2025 – MARCH 2026
COURSE CALENDAR	Friday from 9.00 to 12.00 and from 14.00 to 17.00 Saturday from 9.00 to 12.00 and from 14.00 to 17.00 Online lessons Added to this are two weeks in attendance at the end of the course at the Ca' Foscari Challenge School headquarters * The teaching calendar will be defined in detail well in advance of the start of teaching activities and will be available for consultation on the Master's official website
TEACHING METHOD	Blended
LANGUAGE	The course will be taught in English.
ATTENDANCE	Attendance is compulsory for 70% of total hours and will be monitored by the master's staff. Award of the degree is conditional on completion of activities, including any intermediate examinations, internship/project work and final examination. Students who work in a sector relevant to the Master's degree may apply to have their work counted in lieu of the internship.
COURSE LOCATION	Ca' Foscari Challenge School, via della Libertà 12, 30175 Venezia (Vega Park) – Online platform.
ADMISSION REQUIREMENTS	FIRST LEVEL / Old system bachelor's degree/diploma in STEM discipline or equivalent foreign qualification./ Three-year bachelor's degree in STEM discipline or equivalent foreign qualification. /Equivalent foreign university qualification, subject to approval from the Teachers' Board / At the discretion of the Master's Programme's Teachers' Board, candidates holding undergraduate degrees in economics, finance or other social sciences with a significant quantitative component to their studies may also be admitted.
ADMISSION APPLICATION	To submit your application you must complete the online admission application, the details of which are defined in the art. 3 of the University's single call. Only applications accompanied by all the required documentation will be considered. The notice and related attachments are present and downloadable on the Master's web page. To compete for the award of any scholarships provided by the Master, please refer to the Master's web page

SELECTION PROCEDURE

A specially appointed commission will evaluate the applications through analysis of the CV and qualifications presented and the motivation letter. As part of the selection, the evaluation criteria will be: the qualification, the professional experiences, knowledge inherent to the topics of the master's degree and the motivation

GRADUATE ELIGIBILITY

Students about to graduate may also be admitted to the course, provided they qualify within one month from the start of the course. In this case, the enrolment in the Master's may only be finalised after the valid qualification for admission has been awarded.

If there are available places not covered by regular enrolment, students without undergraduate degrees may audit the courses and will be awarded an attendance certificate.

AVAILABLE PLACES

Maximum number of available places: **20**.

* The Master will only be activated when the minimum number of participants is reached envisaged by the organizational structure.

COURSE FEES:

€ 5.000

/ 1° instalment within **15/12/2024**: € 2.516 (inclusive of duty stamp of € 16)*

/ 2° instalment within **20/05/2025**: € 2.500

* *The cost of the revenue stamp is not refundable.*

SELECTION FEES:

€ 36 (inclusive of duty stamp of € 16)

Not refundable, to be paid by **24th novembre 2024** when submitting the application for admission, via the PagoPA system.

Failure to pay the selection fee will result in exclusion from the selection process and from admission to the Master's Programme.

STUDY SUPPORT

Information on possible scholarships to cover totally or partially the enrolment fee, if given, are updated on the Master's Programme web page on the website.

Loans are available from the University's partner banks (for more information: <http://www.unive.it/pag/8560/>).

ENROLMENT

ADMISSION APPLICATION SUBMISSION (online procedure, Call for Applications, art. 3): **within 24/11/2024**

SELECTION RESULT ANNOUNCEMENT: **within 05/12/2024**

ENROLMENT COMPLETION (online procedure, Call for Applications, art. 6): **within 15/12/2024**

Start of didactic programme: **14 febbraio 2025**

DIRECTOR

Prof. Marco Corazza

INFORMATIONS

For general information concerning the Master's Programme, enrolment procedures, access methods and internships, please contact the programme's project manager.

Project Manager of Master's Programme

Dott. Gianfilippo Vianello

Email: gianfilippo.vianello@unive.it



Università
Ca' Foscari
Venezia



Ca' Foscari
**Challenge
School**

Management

Ca' Foscari Challenge School - Segreteria Organizzativa
from 9.00 AM to 1.00 PM

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