



# MASTER'S IN QUANTUM MACHINE LEARNING LEVEL I – EDITION II A/Y 2023-2024

## 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;



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

## Objectives

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, Computation and Annealing

#### **Objective**

Introduction to quantum information and computation.

*Course hours: 36*



### Machine/Deep Learning

#### **Objective**

Introductory elements of classical machine learning and deep learning.

*Course hours: 36*

### Quantum Machine/Deep Learning – Gate Model

#### **Objective**

Introduction to quantum machine learning and deep learning with a particular focus on the approached based on the gate model.

*Course hours: 30*

### Quantum Machine/Deep Learning (Annealing) and Quantum Computing on Graphs **Objective**

Introduction to quantum machine learning and deep learning with a particular focus on the approach based on annealing.

*Course hours: 30*

### Quantum Applications

#### **Objective**

Quantum machine learning applications: quantum cryptography, cybersecurity and biotech

*Course hours: 18*

### Introduction to Finance & FinTech

#### **Objective**

Introductory elements of finance and applications of classical and quantum machine learning to finance.

*Course hours: 52*

## 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)
- **1,500 total hours of study**, including individual study and preparation of a final thesis
- **60 CFUs** awarded



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## 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

March 2024 – March 2025

## Course calendar

Fridays and Saturdays online\* full time, in addition to around two weeks of classroom lessons at the end of the course.

\* *The detailed didactic calendar will be available to consult well in advance before the start of the academic activities.*

## 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 Venice (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

Candidates must fill in the on-line admission application, the details of which are defined under article 3 of the University's Call for Applications. Only applications accompanied by all the required documentation will be considered. The Call for Applications and relative attachments can be downloaded from the Master's web page.

## Selection procedure

A specially appointed commission will assess the candidates through analysis of their CVs and qualifications and a possible face-to-face or video conference interview (date, time and location will be communicated in advance by email).

Within the framework of the selection, the evaluation criteria will be: academic qualification, professional experience, knowledge relating to the field of the master's programme and motivation. Please refer to the Master's Programme's dedicated webpage for information about applying for any scholarships.

## 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's course will only begin when it reaches at least 15 enrolled students.

## Course fees: € 5,000

/ 1st instalment 28/01/2024: € 2,516 (inclusive of duty stamp of € 16)\*

/ 2nd instalment 21/04/2024: € 2,500

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

## Selection fee: € 36 (inclusive of duty stamp of € 16)

Not refundable, to be paid by **28 January 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/>).



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## Enrolment

ADMISSION APPLICATION SUBMISSION (online procedure, Call for Applications, art. 3)

**by 28/01/2024**

SELECTION RESULT ANNOUNCEMENT

**by 05/02/2024**

ENROLMENT COMPLETION (online procedure, Call for Applications, art. 6)

**by 18/02/2024**

Start of didactic programme: **beginning of March 2024**

## Director

Prof. Marco Corazza

## Didactic and Operational Coordinator

Prof. Davide Raggi

## For information

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**

Mr. Lorenzo Paolini Manfucci  
e-mail: [lorenzo.paolini@unive.it](mailto:lorenzo.paolini@unive.it)

### **Master's Programme tutor**

e-mail: [tutor.masterqml@unive.it](mailto:tutor.masterqml@unive.it)

**Ca' Foscari Challenge School - Administration Office, from 9 AM to 1 PM**  
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