Quantum Machine Learning in Finance

Online course

Centre for Econometric Analysis
Delivered by: Dr Jan Novotny and Dr Jansen Zhikuan Zhao

Fees:

£360 City Students, Alumni, Staff

£420 External Students

£600 External rate

A 15% discount is available for groups of three or more participants

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Course overview

This course will introduce the new field of quantum machine learning with application in Finance. The objective is to equip the audience with the foundations of the quantum computations and the key quantum machine learning methods. The methods will be set within the standard machine learning workflow and applied on real financial dataset. The quantum algorithms will be run on real quantum computers.

The course consists of eight 2-hour long sessions, each of which introducing a new topic and deepening the knowledge gathered in the previous ones. The delegates are supposed to spend at least one hour of self-study per week to review and practice the techniques covered in the sessions. In addition, there will be a project assigned to delegates to practice the techniques in the real data environment.

Benefits

You will be introduced to concepts of the quantum computations and the key notion of qubit. You will see number of standard operations we can do with one or more qubits including things like quantum teleportation.

You will learn two machine learning methods: the quantum support vector machine, and quantum neural network. We will also review the elements of the machine learning. Subsequently, you will be guided to set the workflow such that the quantum machine learning methods can be included into your standard workflow.

Target audience

This course is particularly useful to both professionals and researchers working with machine learning techniques, who are keen to extend their knowledge to the new quantum tools.

Course prerequisites

Delegates are expected to have basic knowledge of Python (being able to run simple commands preferably using the Jupyter Notebooks), and basic knowledge of Mathematics and Statistics. Any prior knowledge of Quantum Physics is not required.

Contents

Topic 1: Introduction to quantum information technology and quantum computation

- Qubit and elementary quantum operations
- Quantum logic and Difference between classical and quantum computation
- Project introduction.

Topic 2: Elementary quantum algorithms

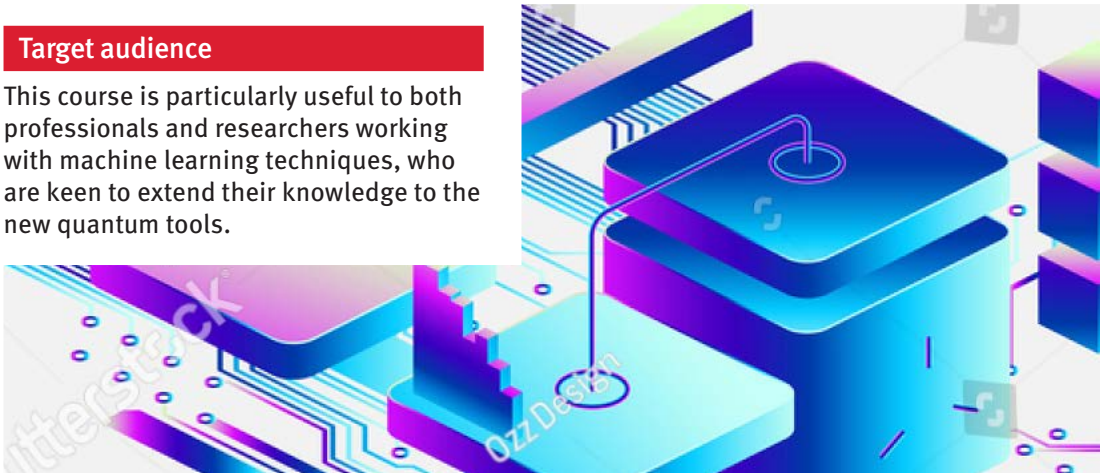
- Overview of quantum algorithms in ideal & in NISQ settings
- Lab: Setting up the quantum resources.

Topic 3: Programming on quantum computers

- Intro to IBM Quantum Platform and Qiskit
- Lab: Practice with quantum programming environments, simulation vs real quantum machines.

Topic 4: Quantum and Classical Support Vector Machine

- Kernel-based ML and Support Vector Machine
- Quantum formulation of SVM
- Lab: Using QSVM.



Topic 5: Quantum Neural Networks

- Classical Neural Networks
- Quantum analogue to Neural Networks
- Lab: Classical and quantum neural networks.

Topic 6: More on quantum machine learning (in the ideal setting)

- Quantum speedups in linear algebra
- Example use case: Quantum assisted Gaussian processes
- Lab: Implement phase estimation based quantum ML.

Topic 7: Quantum Assisted Monte-Carlo Methods

- Quantum search
- Quantum Monte-Carlo algorithms
- Application in Finance
- Lab: Experiment on quantum Monte-Carlo sampling.

Topic 8: Quantum Assisted Monte-Carlo Methods

- Project evaluation and discussion
- BYOP — bring your own problem: discussion about how to include QML into your.

Recommended reading

The following are recommended for this course:

Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information (Chapters: 1, 2, 4, 5 & 6)

https://www.nature.com/articles/s41586-019-0980-2

https://royalsocietypublishing.org/doi/10.1098/rspa.2015.0301

Registration, payment and cancellation policy

Payment of course fees is required prior to the course start date.

In case a course is cancelled, registered participants will receive the full refund.

Registration closes 7-calendar days prior to the start of the course.

Jan Novotny

Jan Novotny (PhD, Charles University, Czech Republic) is an eFX Quant at Nomura and research associate to the Centre for Econometric Analysis of Bayes Business School in London. Prior his current role, he was a front office quant at Deutsche Bank and HSBC in the electronic FX markets. Before joining the industry, he was working in the Centre for Econometric Analysis on the high-frequency time series econometric models and was visiting lecturer at Bayes Business School, giving lectures at Warwick Business School or Politecnico di Milano. He has co-authored a number of papers in peer-reviewed journals in Finance (Journal of Financial Econometrics, Journal of Financial Markets) and Physics (Physica A, The European Physical Journal A), co-authored the book Machine Learning and Big Data with kdb+/q, Wiley), 2019, and presented at numerous conferences and workshops around the world. During his PhD studies, he co-founded Quantum Finance CZ. He is a Machine Learning enthusiast and explores kdb+/q for this purpose.

Jansen Zhikuan Zhao

Jansen (PhD, Singapore University of Technology and Design) holds the role of a senior researcher at the computer science department of ETH Zurich. He is also the Chief Scientist and Co-Founder of SpinUp AI and Qbitcoin.tech. His research explores the emerging promise of quantum information processing and its potential significance across the realm of computer science. Specific domains of recent concern include machine learning, statistical inference, and scientific computation in chemistry and physics. Jansen completed his PhD at Singapore University of Technology and Design in the group of Prof. Joseph Fitzsimons in 2018, specialised in the theory and application of quantum computing. Before that, he did his Master of Physics at Oxford University specialised in theoretical and mathematical physics.