



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN

DEPARTMENT OF MATHEMATICS
LABORATORY FOR QUANTITATIVE RISK CONTROL



quantLab Workshop Series • 2022

Machine Learning and Quantum Computing

with some Applications in Mathematical Finance

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Alexander Del Toro Barba, Daniel Wagner (Google)

Organized and supported by

Prof. Dr. A. Gnoatto (Uni Verona), Prof. Dr. M. Hellmich (Deloitte),

Prof. Dr. J. Kienitz (Uni Wuppertal), Dr. Andrea Mazzon (LMU)

main workshop:

Thursday, April 21st, 2022 (ML)

Friday, April 22nd, 2022 (QC)

optional exercise session:

Saturday, April 23rd, 2022

venue:

Online Workshop (Zoom)

details / registration

<http://quantlab.info/workshop/2022-1>

contact:

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Agenda (Tentative)

Machine Learning

Introduction to Machine Learning

- Concepts of supervised learning
- Bias–Variance trade–off and model performance
- Feature engineering

Linear and Non-Linear Regression Models

- Linear models
- Support vector machines

Classification Models

- Decision Trees
- Random Forest
- Gradient Boosting
- Model Ensembling

Deep Learning

- Stochastic gradient descent and optimization for neural networks
- Neural network architectures and applications

Model Interpretability

- Visualizations
- Causal Modelling

Helpful Knowledge (helpful, not required)

- Basic knowledge of R or Python – for ML
- Basis knowledge of Python or other Languages (Java, C++, C#, C) – for QC
- Basic knowledge in options pricing theory (for Applications from Finance)

Quantum Computing

Mathematical Foundations

- Tensor Space, Linear Operators
- Qubit, Quantum Register
- Entanglement
- Quantum Gates

Basic Algorithms

- Grover Algorithm
- Amplitude Estimation
- Quantum Error Correction

QC versus Classical Computing

- Programmer's view on QC

Quantum Computing Frameworks

- Circ

Application from Mathematical Finance

Hands-On Numerical Experiments