

NEASQC project

Next ApplicationS of Quantum Computing

<NE|AS|QC>

Boosting practical applications of quantum computing on the early quantum computers – the NISQ (Noise Intermediate-Scale Quantum) systems

About us

- A multidisciplinary consortium of 12 companies and research labs
- A 4-year project started 1st September 2020
- Funded by the European Commission's Horizon 2020 programme as part of the Quantum Technology Flagship

Our 4 objectives

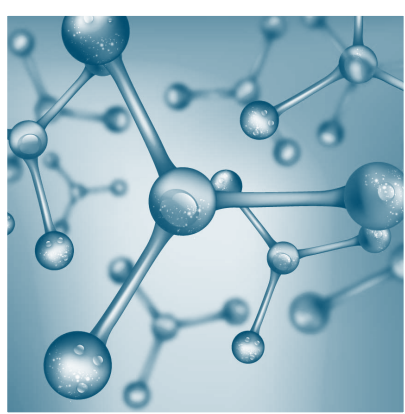
- 1 Develop **industrial Use Cases** for NISQ machines
- 2 Develop **open-source application libraries** for the myQLM free programming platform
- 3 Build a strong **community** dedicated to industrial NISQ applications
- 4 Develop SW stacks and benchmarks for the **QT Flagship HW platforms**

Our publications



Our 9 NISQ-compatible use cases

Each use case is endorsed by an industrial partner and investigated by an integrated team of industrial and academic partners. Each use case has published open source beta software and/or publications, visit their web page to access those documents.



Chemistry

Bridging the gap between the recent proof-of-concept quantum chemical computations on NISQ processors and actual, industrial-scale quantum chemistry problems:

- 1 **CO₂ capture** by Metal Organic Frameworks (MOFs) and other relevant chemical surfaces
Our first SW (open source) allows for the calculation of the ground state energy of benzene under spatial deformations by using a state-of-the-art quantum computing methodology - the variational quantum eigensolver - <https://github.com/NEASQC/D4.2>
- 2 **Drug discovery**, calculation of energy of large number of molecular conformations
Our SW (open source) implements the variational Hamiltonian ansatz state preparation for chemical systems – and first results show its efficiency https://github.com/NEASQC/Variationals_algorithms

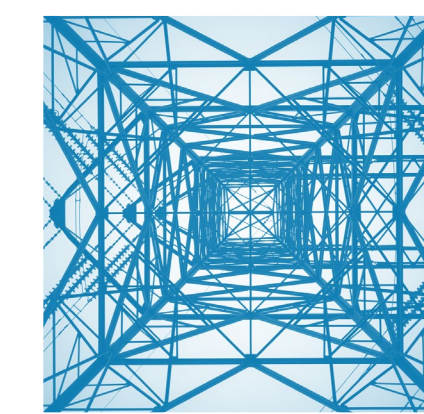


Machine Learning & Optimisation

Quantum-enhanced machine learning & optimization methods for

- 3 Quantum reinforcement learning for **optimal inventory management**
- 4 QAOA*-type algorithms for **mesh segmentation problems**
- 5 QAOA*-type algorithms for **smart-charging of electrical vehicles and Vehicle2Grid optimization**.
We are developing a hybrid quantum/classical architecture for tackling large instances of these problems, as well as a ZX-Diagrams based approach to optimize QAOA circuits
- 6 Applications of QML optimisation and quantum Monte-Carlo methods in **finance**, such as Option pricing or Value-at-Risk estimation
We recently proposed a general-purpose framework to implement quantum algorithms relying upon an efficient handling of arrays. The cornerstone of the framework is the direct embedding of information into quantum amplitudes, thus avoiding hampering square roots

* QAOA = Quantum Approximate Optimisation Algorithm



Symbolic AI and graph algorithmics

Developing methodologies and implementations in the areas of Artificial Intelligence and graph algorithms for:

- 7 Quantum **natural language processing** for sentence similarity computations and topic detection
Our alpha SW prototypes explore a) the DisCoCat-based model using parameterised quantum circuits to encode a pre-defined dataset of sentences and b) Dressed Quantum Circuits in which pre-trained classical models are used as pre-processing layers in a transfer learning fashion https://github.com/NEASQC/WP6_ONLP/tree/v0.2-alpha-d0.9
- 8 Quantum **probabilistic safety assessment** for large infrastructure installations
- 9 Quantum rule-based systems for **diagnosis and treatment** of Breast Invasive Ductal Carcinoma
Main efforts have been done in a) implementation of inferential networks in a quantum environment, and b) definition of a quantum model for dealing with inaccurate knowledge



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