

Real-world applications based on neutral atom quantum computers - QC-755

Project type: Research

Desired discipline(s): Computer science, Mathematical Sciences, Mathematics

Company: PASQAL Canada Inc.

Project Length: 6 months to 1 year

Preferred start date: As soon as possible.

Language requirement: English

Location(s): Sherbrooke, QC, Canada

No. of positions: 1

Desired education level: PhD

Open to applicants registered at an institution outside of Canada: Yes

About the company:

PASQAL is a full-stack company that builds quantum computers from ordered neutral atoms in 2D arrays and provides the compute system through cloud services with the suite of software to enable easy programming of the quantum system. PASQAL was founded in 2019 by Georges-Olivier Reymond, Christophe Jurczak, Professor Dr. Alain Aspect, Nobel Prize Winner Physics, 2022, Professor Dr. Antoine Browaeys, and Dr. Thierry Lahaye.

Describe the project.:

What is the project about? The project is about inventing new quantum algorithms with real-world applications or employing an existing quantum algorithm and applying it to a real-world problem.

What is the main goal of the company (a final product, software, knowledge in a specific area, etc)? The main goal of the company is to advance the science in Canada, train experts in the quantum computing industry, identify new use cases of quantum computing, and improve the quantum algorithms based on neutral atom platform

What are the main tasks to be performed by the candidate?

Conduct research at the interface of quantum algorithms, real-world applications, optimization/machine learning, and neutral atom quantum computers. In addition candidates will use real-data (when available), or well known benchmark data to test algorithms, develop user-friendly and modular code, and perform algorithm validation using emulators, HPC, and quantum hardware.

What methodology/techniques are to be used?

Depending on the choice of applications (in finance, pharmaceuticals, logistics, renewable energies), techniques such as optimization and machine learning will be used in which the entire process or part of it is adapted to computation with neutral atom quantum computers. Currently, there are algorithms for optimization and machine learning using neutral atoms. Each project aims to either advance the existing algorithms or propose alternative algorithms and methodology to improve speed, required quantum resources, number of steps, or the accuracy of results.

Quantum Evolution Kernel (QEK) (<https://arxiv.org/abs/2107.03247>), (<https://arxiv.org/abs/2211.16337>)

Graph-Colouring (<https://arxiv.org/abs/2301.02637>)

Maximum Independent Set

(MIS) (<https://arxiv.org/abs/2209.05164>), (<https://medium.com/pasqal-io/predicting-fallen-angels-in-finance-with-qu...>), (<https://arxiv.org/abs/2212.03223>), (<https://arxiv.org/abs/2012.14859>), (<https://arxiv.org/abs/2309.12129>)

Graph Transformers, (<https://arxiv.org/abs/2210.10610>)

QAOA (<https://arxiv.org/abs/2006.15438>)

Required expertise/skills:

1. Python
2. Math & linear algebra
3. Quantum computing/mechanics (familiarity)
4. Integer programming OR Machine learning (in-depth theory)
5. Familiarity with at least one compute intensive domain (computational chemistry, condensed matter physics, etc.)