Solving quadratic optimization problems with bosonic quantum computer simulator

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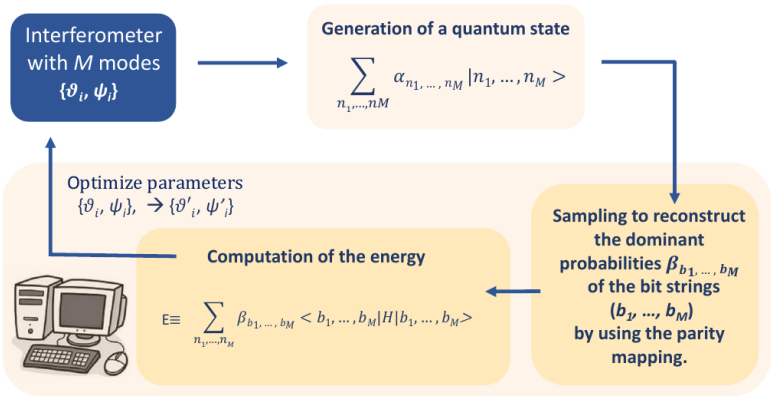
1 Introduction

An interesting problem is whether boson sampling devices can be turn into near-term quantum processors making the alleged quantum supremacy useful. As a standalone device producing just measurement samples it seems unlikely, but perhaps as part of a quantum-classical hybrid system equipped with an active feedback and a classical optimizer evaluating an objective function the chances are higher. This type of general near-term device going under the name variational quantum eigensolver without active error-correction has been proposed for almost all non-photonic quantum computing platforms. A recent pioneering work has formulated the concept of variational quantum solvers also for bosonic systems[1], proposing a way to solve binary optimization problems using boson sampling devices.



2 Description of the project

In this project we will examine the properties of the variational quantum solver formulated in Ref. [1]. In our studies the role of a quantum processor will be filled by the Piquasso bosonic quantum computer simulator[2, 3] framework developed by our research group. The Piquasso package contains highly optimized computational engines making possible to simulate the process of boson sampling even on smaller computational devices up to certain problem size. The objective of the project is to

1. Learn the basic concept of variational quantum solvers.
2. Learn the usage of the Piquasso quantum computer simulation package.
3. Develop an implementation for the variational quantum solver in Python programming language.
4. Solve small-scaled quadratic binary optimization problems using the developed tools.

The students choosing this project are expected to be familiar with

- Quantum Mechanics
- Python programming language
- Linux operating systems.

References

[1] Kamil Bradler and Hugo Wallner. Certain properties and applications of shallow bosonic circuits, 2021.

[2] Piquasso. https://piquasso.com/, 2021.

[3] Piquasso boost libraries. https://github.com/Budapest-Quantum-Computing-Group/piquassoboost, 2021.