Qiskit QCBMs

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Abstract

We describe our progress in *Qiskit QCBMs*, a project where we develop a set of tools for the implementation of Quantum Circuit Born Machines within the Qiskit 2.x and Qiskit Patterns framework. This project is part of Qiskit Advocate Mentorship Program QAMP 2025.

1 The project in a Nutshell

Quantum Circuit Born Machines (QCBMs) are generative models in which the probability distribution of a dataset is represented in terms of a quantum state via Born's rule. QCBMs are known for their expressive power and have been widely recognized as a useful component in hybrid algorithms with a potential for quantum advantage.

Our aim is to take advantage of various tools in the Qiskit ecosystem in order to optimize QCBMs for their use in near term devises. Qiskit QCBMs is being developed as a qiskit add-on which will be accompanied by a set of notebooks both showcasing the tools through examples and serving as an introduction to the theory.

2 Workflow, progress and status of the project

Our team, consisting of two mentees together with one mentor, has held weekly meetings since the beginning of the program in October 2025.

Through these meetings and in the individual tasks the members of the team has been assigned we have:

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Up tp this point we have accomplish an understanding of the relevant state of the art and have built the the framework and first components of the project.

A github repository with a substantial

3 Challenges

QCBMs are *intrinsic* generative models, in that we are able to sample from the resulting probability distribution although we do not have access to the underlying probability density function. This last point is crucial when devising an appropriate architecture and training loop for the models.

The circuit part of a QCBM consist of two kinds of layers:

- Rotation layers.
- Entanglement layers.

This structure can be seen as an instance of the efficient su2 circuit in qiskit.

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4 Challenges

5 From QAMPs Discord

Progress made – What have you accomplished so far?

Explorations and experiments – What have you tried? What worked? What didn't?

Key insights and learnings – What have you discovered through this work? Were there any unexpected findings?

Technical challenges – What obstacles have you faced and how did you overcome them?

Current status – Where does your project stand today?

Path forward – Clear plan for completing your MVP by January 30

You may include:

Images, diagrams, or screenshots to illustrate your progress

Links to short demo videos (demos only, not presentations or full reports)

References

[1] Kathleen E. Hamilton, Eugene F. Dumitrescu, and Raphael C. Pooser. Generative model benchmarks for superconducting qubits. *Phys. Rev. A*, 99:062323, Jun 2019.