

Experimental Large-Scale Quantum Approximate Optimization For Ising Problems

Wednesday 19 November 2025 12:30 (30 minutes)

Quantum Approximate Optimization (QAO) is an umbrella term for various methods that attempt to use quantum devices to find solutions to classical combinatorial optimization problems. QAO is widely considered one of the leading candidates for potentially useful quantum computation. In this talk, I will discuss some of our recent efforts on the experimental implementation of the QAO algorithms (most experiments were performed last year). Results include relatively performant optimization (see Table IV in [4]) of fully-connected spin glass systems on 82-qubit systems (on Rigetti's QPU) using p=1 QAOA implemented in conjunction with Noise-Directed Adaptive Remapping (NDAR) meta-algorithm that we developed in [1]. The talk will be based on (to a varying degree of detail) on the following works: [1] Filip B Maciejewski, Jacob Biamonte, Stuart Hadfield, Davide Venturelli, Improving Quantum Approximate Optimization by Noise-Directed Adaptive Remapping, *Quantum* 9, 1906 (2025). [2] Filip B. Maciejewski, Bao G. Bach, Maxime Dupont, P. Aaron Lott, Bhuvanesh Sundar, David E. Bernal Neira, Ilya Safro, Davide Venturelli, A Multilevel Approach for Solving Large-Scale QUBO Problems with Noisy Hybrid Quantum Approximate Optimization, 2024 IEEE High Performance Extreme Computing Conference (HPEC), 1-10 (2024). [3] Filip B Maciejewski, Stuart Hadfield, Benjamin Hall, Mark Hodson, Maxime Dupont, Bram Evert, James Sud, M Sohaib Alam, Zhihui Wang, Stephen Jeffrey, Bhuvanesh Sundar, P Aaron Lott, Shon Grabbe, Eleanor G Rieffel, Matthew J Reagor, Davide Venturelli, Design and execution of quantum circuits using tens of superconducting qubits and thousands of gates for dense Ising optimization problems, *Physical Review Applied* 22 (4), 044074 (2024). Other references: [4] Amira Abbas, et al, Challenges and opportunities in quantum optimization, *Nature Reviews Physics* volume 6, pages 718–735 (2024)

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