

## XY vs X mixer in Quantum Alternating Operator Ansatz for optimization problems with constraints

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Quantum Approximate Optimization Algorithm,[1] further generalized as Quantum Alternating Operator Ansatz (QAOA),[2] is a family of algorithms for combinatorial optimization problems. It is a leading candidate to run on emerging universal quantum computers to gain insight into quantum heuristics. In constrained optimization, penalties are often introduced so that the ground state of the cost Hamiltonian encodes the solution (a standard practice in quantum annealing). An alternative is to choose a mixing Hamiltonian such that the constraint corresponds to a constant of motion and the quantum evolution stays in the feasible subspace.[2,3] Better performance of the algorithm is speculated due to a much smaller search space. We consider problems with a constant Hamming weight as the constraint. We also compare different methods of generating the generalized W-state, which serves as a natural initial state for the Hamming-weight constraint. Using graph-coloring as an example, we compare the performance of using XY model as a mixer that preserves the Hamming weight with the performance of adding a penalty term in the cost Hamiltonian.

[1] Farhi, Goldstone, Gutmann, arXiv:1411.4028.

[2] Hadfield et. al, arXiv:1709.03489

[3] Hen, Sarandy, Phys. Rev. A 93, 062312 (2016).