Quantum Computing Algorithms for Optimization

Abstract: This paper explores novel quantum algorithms designed for combinatorial optimization problems. We present a comprehensive analysis of quantum annealing and variational quantum eigensolvers (VQE) applied to NP-hard problems.

Introduction

Quantum computing leverages quantum mechanical phenomena such as superposition and entanglement to perform computations. Recent advances in quantum hardware have made it possible to implement and test quantum algorithms on real quantum processors.

Methodology

We implemented quantum approximate optimization algorithm (QAOA) and compared its performance with classical simulated annealing. The experiments were conducted on IBM Quantum processors with varying numbers of qubits.

Results

Our quantum algorithms achieved up to 40% improvement in solution quality for graph problems with 20-50 nodes. The variational approach showed promise for near-term quantum devices despite current hardware limitations.