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Solving Optimization Problems Using Quantum Annealing

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Quantum computers make use of quantum effects such as superposition, allowing the representation of information in *qubits* encoding simultaneously the states of 0 and 1, and quantum entanglement and tunneling, enabling large number of states in a search space to be explored simultaneously. Hence, machines such as the commercially available quantum computers by D-Wave Systems have provided researchers with a new tool to tackle NP-hard problems that are difficult to solve by classical means. We describe the structure of such a computer, D-Wave 2X, with over 1000 qubits, and its advantages and limitations, as well as some mathematical problems related to its efficient usage. We assess the performance of such a computer for solving NP-hard optimization problems and illustrate the algorithm development and analysis techniques on the problem of finding a maximum clique in a graph, a fundamental and important NP-hard problems.

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