D-Wave and predecessors: From simulated to quantum annealing

June 23 2014

The D-Wave computer is currently the latest link of a long chain of computers designed for the solution of optimization problems. In what sense does it realize quantum computation? We describe the evolution of such computers and confront the different views concerning the quantum properties of the D-wave computer.

Quantum algorithms show several benefits over classical ones. One strong example suggested by Shor in 1994 is the ability to factor numbers which can be effectively done on a quantum computer but is very hard on a classical computer. However, the actual model for the physical construction of a quantum computer is not yet clear. Recently, it was suggested by several research groups that a network of superconducting, D-Wave type qubits, could realize a quantum adiabatic computer and efficiently solve optimization problems.

The D-wave quantum computer is hereby discussed. The novelty of the D-wave computer should be understood in light of its predecessors. It is an adiabatic quantum computer designed to solve optimization problems. The controversies concerning its quantum properties and its efficiency are best understood looking back at the history of optimization algorithms. Its predecessors are a linage of optimization algorithms from as far as the Monte-Carlo and Metropolis algorithm, through genetic algorithm, hill-climbing, simulated annealing, quantum adiabatic algorithm and quantum annealing. Special attention is given to the similarities and differences between the algorithms. The D-wave superconductor computer has raised harsh disputes over the question of its actual quantum properties. Therefore, along with the discussion of the works published by the D-wave group, we present a few opposing claims, e.g., those of Smolin, regarding both the quality and "quantumness" of the D-wave adiabatic computer. In addition, we follow the work of Lidar's group which performed several objective tests of the D-wave and compared its performance to other classical and quantum simulated annealing methods.

As an application of discussed algorithms, the authors suggest a novel simulated annealing algorithm for image restoration and outline also its quantum annealing extension. The authors also present a few related ideas concerning the connection between adiabatic computation and quantum protective measurement, and the relation to one-way quantum computers. In addition they discuss a few extensions of the discussed models, e.g. employing temporal rather than spatial correlations and applying the Tsallis distribution.

More information: The paper can be found in the *International Journal of Quantum Information*.: www.worldscientific.com/doi/ab … 42/S0219749914300022

Provided by World Scientific Publishing

Citation: D-Wave and predecessors: From simulated to quantum annealing (2014, June 23) retrieved 25 April 2024 from https://phys.org/news/2014-06-d-wave-predecessors-simulated-quantum-annealing.html