Are analogue quantum computers still wishful thinking?

February 12 2015

Many challenges lie ahead before quantum annealing, the analogue version of quantum computation, contributes to solve combinatorial optimization problems.

Traditional computational tools are simply not powerful enough to solve some complex optimisation problems, like, for example, protein folding. Quantum annealing, a potentially successful implementation of analogue quantum computing, would bring about an ultra-performant computational method. A series of reviews in this topical issue of *EPJ ST*, guest-edited by Sei Suzuki from Saitama Medical University, Japan, and Arnab Das from the Indian Association for the Cultivation of Science, Kolkota, India, focuses on the state of the art and challenges in quantum annealing. This approach, if proven viable, could greatly boost the capabilities of large-scale simulations and revolutionise several research fields, from biology to economics, medicine and material science.

A Canadian company called D-Wave has been commercialising what it claims are two quantum annealers of 100 qubits, since 2011, and 500 qubits, since 2013. "Unlike a bit in a traditional computer, which can take values either 0 OR 1, a quantum bit (qubit) in a quantum computer can take values which are superimpositions of 0 AND 1, like a switch in a state of being on and off simultaneously," explains Das.

The trouble, Suzuki explains, is that "computation using the quantum mechanics is technically difficult and was thought to be unrealistic until

recently." Before the advent of the D-Wave machines, realising and manipulating such a superimposed state in real hardware beyond the size of a few (

There have been speculations from the science community as to whether the D-Wave technology actually delivers quantum annealing. "The reviews of our latest issue show that the performances of the D-Wave machines as quantum computers, while noteworthy, have remained essentially inconclusive," explains Das, "and scientists have not been able to definitively ascertain that such a device qualifies as a true quantum object."

More information: "S. Suzuki and A. Das (2015), Quo Vadis quantum annealing?", *European Physical Journal Special Topics* 224/1, DOI: 10.1140/epjst/e2015-02337-1

A. Das and S. Suzuki (2015), "Debate and discussion: Quo Vadis quantum annealing?", *European Physical Journal Special Topics* 224/1, DOI: 10.1140/epjst/e2015-02351-3

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