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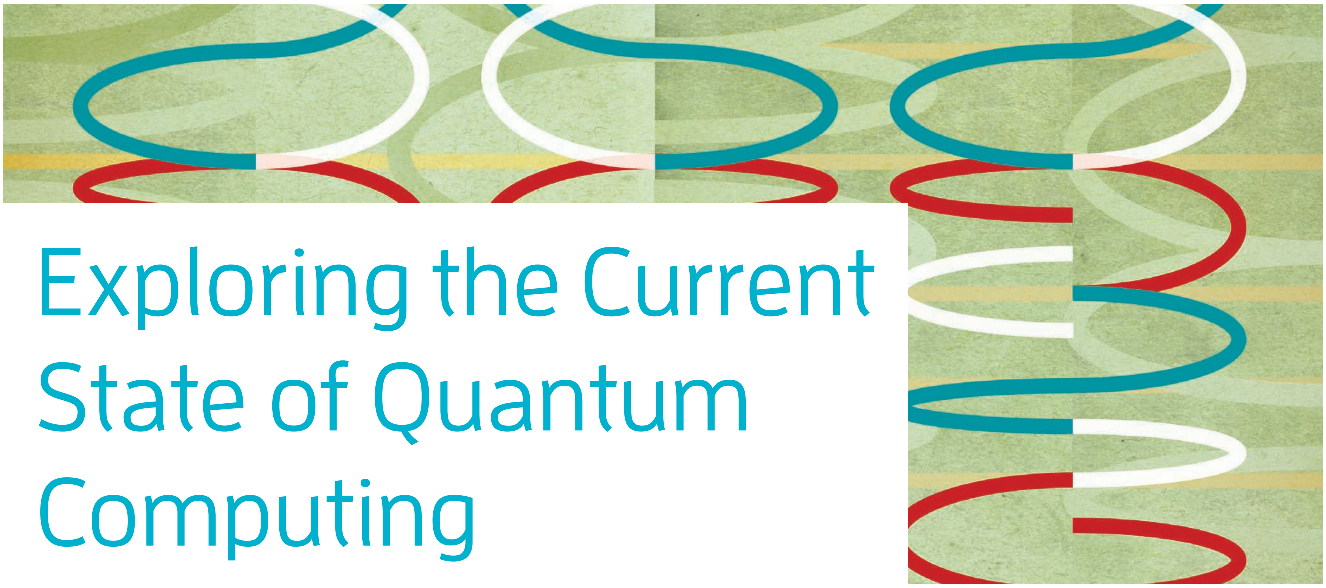

Exploring the Current State of Quantum Computing

David Alan Grier, Djaghe, LLC

Quantum computing promises to help us someday reach impressive computing speed. How close are we to this reality, and what else will it do for us?

To prepare for the future, I commonly turn to the past, especially when I am not an expert on the present. So it was natural for me to prepare for this issue of *Computer* by reading the foundational paper of the field, Daniel Deutsch's "Quantum Theory, the Church–Turing Principle and the Universal Quantum Computer." For the most part, the paper develops the ideas of quantum computing in a way that I expected. It starts with the model of the Turing machine, maps that machine into the world of quantum physics, and then develops computing results from that model.

Once I had grasped the basic ideas of Deutsch's paper, I was better able to understand the current literature on quantum computing. This literature can seem a little alien to a computer scientist because, as Deutsch suggests, quantum computing not only turns the foundation of computer science into "a branch of physics. It also makes part of experimental physics into a branch of computer science."[1] Much of the literature deals with elements of computing, such as quantum gates, that are much easier for a physicist to grasp than a conventional computer scientist.

Scanning the present literature, I was struck that much of it is speculative. It hypothesizes that we will someday be able to exert some control over artifacts at the quantum scale, and, from that control, we will attain substantial new computing capacity. At the moment, our ability to gain that control is far from a settled question. In fact, one author quipped that quantum computing was an exercise in error control. Any actual computing was a mere side effect.

In this issue, our guest editors assess what we've accomplished in quantum computing, what ideas we have demonstrated, and where the path to the future lies. We have traveled a substantial distance from Deutsch's 1985 paper, and so I will let them explain the current state of quantum computing and results of quantum realism that we need to understand.

REFERENCE

1. D. Deutsch, "Quantum theory, the Church-Turing principle and the universal quantum computer," *Proc. Roy. Soc. London Series A, Math. Physical Sci.*, vol. 400, no. 1818, pp. 97–117, July 8, 1985.

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