Teaching Quantum Computing without a Quantum Computer

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Teaching Quantum Computing without a Quantum Computer

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Quantum computing is an important technology that promises far-reaching and as yet unimagined impacts on the future of computing. It is important for students who are enrolled in computing majors to be exposed to the current state-of-the-art as well as future expectations in quantum computing. However, most universities do not have quantum machines and many do not have access to the hardware or services. We present a learning module that has been developed in recent years for the purpose of introducing our students to the world of quantum computing without the need for expensive investments in hardware. After a discussion of the theoretical foundations of quantum computing, we introduce the students to a hybrid computing architecture that creates abstractions for some of the low-level, hardware-specific components. A hands-on lab demonstrates how these abstractions can be used to create quantum computing programs which, while relying on simulated hardware today, can be reconfigured to use actual quantum hardware in the future. Degree programs in quantum computing are rare and those that do exist are often housed in departments of physics or engineering. We endeavor to show that our undergraduate students in computing majors benefit from this introduction to quantum computing and hope that it will enable others to benefit as well.

Keywords: Quantum computing, information technology, computing architecture, quantum hardware, Higher Education in computing.