

Quantum Computing Experiments on Real Hardware and Simulators

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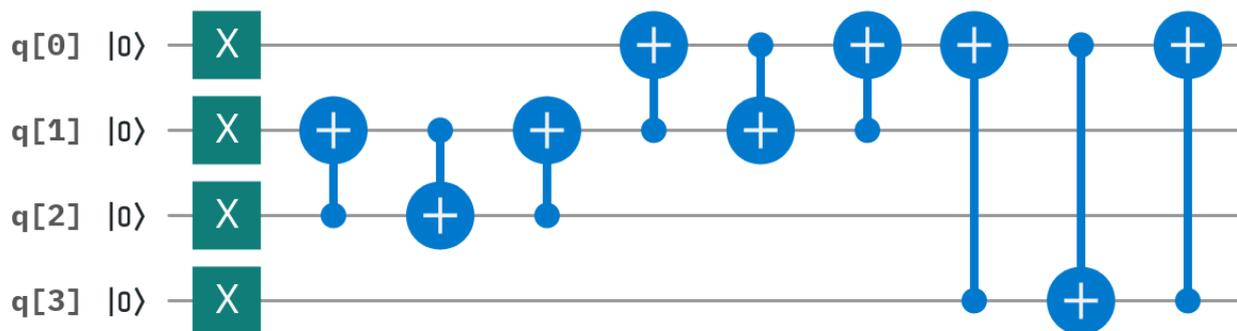
Introduction

Quantum Computing gets a lot of attention lately. The promises (and potential perils!) are extensive and revolutionary. Until recently, it was relatively hard for non-specialists (and even for experts) to sift through the information available. The construction of a few working quantum computers by IBM and others and the release of these resources to public access, especially by IBM, has changed the landscape completely. While the physical hardware can and will improve, we're no longer restricted to simulators! We still need simulators as backup, to save presenters from total embarrassment, or for developing larger algorithms. But there's nothing in a simulator that can replace the joy of seeing a real result being produced. This presentation tries to impart this enthusiasm to others. There is a moment in any programmer's life when the magic of seeing one's instructions executed sets the tone for their future career. I believe we're witnessing such a moment now and this doesn't happen very often.

The Experiments

A few significant algorithms will be presented, subject to time limits, with emphasis on those that can be run on a limited number of qubits. These include quantum search, period finding and quantum Fourier transforms, Shor's algorithm for factorisation and other proofs of concept from computer graphics.

One of the resources used is IBM's web based Quantum Composer which almost makes it a child's play to write algorithms (well, perhaps a well supervised child's play), as illustrated below.



Other resources are the QisKit Python scripting language, QCEngine, the IBM simulator and local simulators.

OTHER NOTES

The author makes no claim of originality for the algorithms presented and is continuously scouring the Internet for quantum algorithms that have NOT been invented yet (with poor to mixed success). This fact alone illustrates the recent explosion in interest about quantum computing. A small experiment via the web currently takes about 4-5 minutes (the actual running time is smaller). There is the possibility of access being difficult at any given time, which is where simulators become useful, even those running on local machines.

REFERENCES

1. IBM Quantum Experience, Available from <https://www.research.ibm.com/ibm-q/technology/experience>, Accessed 21 June 2019.
2. QisKit, Available from <https://qiskit.org>, Accessed 21 June 2019
3. QCEngine, Available from <http://qcengine.com>, Accessed 21 June 2019
4. N.Y. Yanofsky, M.A. Manucci, Quantum Computing for Computer Scientists, Cambridge University Press, 2008