Candidate Course Project Topics (CMSC 657)

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Abstract

This document is meant to provide some useful guideline and references for finding projects in the field of quantum information and computation. The selection is *not comprehensive* and subject to the author's personal knowledge on the topics (mistakes are possible). Each topic comes with a brief description and a few representative references.

It is totally fine to pursue project topics beyond this document. However, please do identify your topic and relevant references in your proposal. Please feel free to contact me if you have difficulty identifying a project topic.

Contents

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5 Quantum Cryptography

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6 Quantum Programming Languages

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   - Symbolic bisimulation for quantum processes by Y. Feng, Y. X. Deng, M. S. Ying, ACM Transactions on Computational Logic, 15(2) (2014), 14:1-14:32.
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   - QWIRE: A Core Language for Quantum Circuits by Jennifer Paykin, Robert Rand, Steve Zdancewic. POPL 2017.

7 Fault-tolerant Quantum Computation

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8 Near-term Quantum Devices

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- Average-case complexity versus approximate simulation of commuting quantum computations by Michael J. Bremner, Ashley Montanaro, Dan J. Shepherd. QIP 2016. arXiv:1504.07999.
- Complexity-Theoretic Foundations of Quantum Supremacy Experiments by Scott Aaronson, Lijie Chen, arXiv:1612.05903. (CCC 2017)
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   - Taming the instruction bandwidth of quantum computers via hardware-managed error correction by S. Tannu. Proceeding MICRO-50 '17 Proceedings of the 50th Annual IEEE/ACM International Symposium on Microarchitecture Pages 679-691.

3. Better classical algorithms to simulate quantum applications.

   - Classical boson sampling algorithms with superior performance to near-term experiments by A. Neville et al. Nature Physics (2017) arXiv:1705.00686.
   - The Classical Complexity of Boson Sampling by Peter Clifford and Raphel Clifford. SODA 2018. arXiv:1706.01260.

9 Explorative topics

Topics in this section have almost no research result yet. (Please do correct me if I am wrong.)

1. Implement a quantum algorithm with the publicly accessible quantum machines (or simulators), e.g., IBM Q Experience, Microsoft Q#, and so on. Design some measures to compare them.
2. Survey the hardware specifications of publicly accessible quantum machines. Think of any practical method to verify the real quantum machines against their claimed specifications.
3. Please tell me if you have any idea along this line.