CMSC 858K Fall 2017

Introduction to quantum information processing

Course website

http://ter.ps/introqip

Overview

A quantum mechanical representation of information allows one to efficiently perform certain tasks that are intractable within a classical framework. This course aims to give a basic foundation in the field of quantum information processing. Students will be prepared to pursue further study in quantum computing, quantum information theory, and related areas. No previous background in quantum mechanics is required.

Course topics

Basic model of quantum computation (reversible computing, qubits, unitary transformations, measurements, quantum protocols, quantum circuits); quantum algorithms (simple query algorithms, the quantum Fourier transform, Shor's factoring algorithm, Grover's search algorithm and its optimality); quantum complexity theory; mixed quantum states and quantum operations; quantum information theory (entropy, compression, entanglement transformations, quantum channel capacities); quantum error correction and fault tolerance; quantum nonlocality; quantum cryptography (key distribution and bit commitment); selected additional topics as time permits.

For a detailed lecture schedule with recommended readings, see the course website.

Prerequisites

Familiarity with complex numbers and basic concepts in linear algebra (e.g., eigenvalues, eigenvectors, Hermitian and unitary matrices) is required. Students are not expected to have taken previous courses in quantum mechanics or the theory of computation.

Coordinates

Tuesday/Thursday, 12:30 am–1:45 pm, CSI 3120

Instructor

Andrew Childs (amchilds@umd.edu)
Office hours: Tuesday, 2–3 pm (AVW 3225), Wednesday, 3:30–4:30 pm (CSS 3100F)

Teaching assistant

Tongyang Li (tongyang@cs.umd.edu)
Office hours: Tuesday, 3:30–4:30 (AVW 3225)

Texts

Primary: Paul Kaye, Raymond Laflamme, and Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press (2007).

Supplemental: Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press (2000).

Copies of both texts will be available on reserve in the Engineering and Physical Sciences Library (Math building, room 1403).

Evaluation

Your final grade will be determined as follows:

Assignments	8% each (40% total)
Project	30%
Final exam	30%

Assignments

There will be 5 homework assignments during the course. Assignments will be made available on the course website. You should submit completed assignments via the campus ELMS (https://myelms.umd.edu) in PDF format, either as a typeset document or a clear scan of handwritten solutions, by the *start of class* on the due date. The system will not accept submissions after the deadline, and since solutions will be posted on the course website promptly, extensions will not be granted. Graded assignments will be available on the ELMS.

You are encouraged to discuss homework problems with your peers, with the TA, and with the course instructor. However, your solutions should be based on your own understanding and should be written independently. For each assignment, you must either include a list of students in the class with whom you discussed the problems, or else state that you did not discuss the assignment with your classmates.

Project

Students will write an expository paper on a topic of their choice from the quantum information literature. Further details, including a list of possible project topics, will be posted on the course website. Please submit a project proposal by Thursday, October 12, including a one-paragraph summary of your topic and a list of selected references. Papers will be due by the date of the last lecture, Thursday, December 7. Both submissions should be made as PDF files via ELMS.

Final exam

The course will include a comprehensive, take-home final exam. The exam will be made available on the morning of Wednesday, December 13, and will be due by 4 pm on Friday, December 15 (via ELMS). Students may choose to take the exam during any three-hour period during that time.

Academic accommodations

Any student eligible for and requesting reasonable academic accommodations due to a disability is asked to provide, to the instructor during office hours, a letter of accommodation from the Office of Disability Support Services (DSS) within the first two weeks of the semester.

If you plan to observe any holidays during the semester that are not listed on the university calendar, please provide a list of these dates by the end of the first week of the semester.

As mentioned above, extensions to assignment due dates will not be granted for any reason, so that all students can have timely access to solutions. In the event of a medical emergency that affects your ability to complete coursework, appropriate accommodations will be made. However, you must make a reasonable attempt to notify the instructor prior to the due date, and you must provide written documentation from the Health Center or an outside health care provider. This documentation must verify dates of treatment and indicate the timeframe that you were unable to meet academic responsibilities. It must also contain the name and phone number of the medical service provider in case verification is needed. No diagnostic information will ever be requested.

Course evaluations

Student feedback is an important part of evaluating instruction. The Department of Computer Science and its faculty take this feedback seriously and appreciate your input. Toward the end of the semester, please go to http://www.courseevalum.umd.edu to complete your evaluation.