Quantum Information

PSI START, Summer 2023

Teaching Staff

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Zoom link:

https://pitp.zoom.us/j/94893453776?pwd=Uy9lMjcwaFdDcndiUVMzckwwUml4Zz09

Course summary:

The goal of this course is to introduce foundational ideas in quantum information theory, including entanglement, the Schmidt decomposition, mixed quantum states, and density matrices. We will also cover some applications, including quantum teleportation and possibly some simple quantum algorithms. The intended course schedule is below.

Learning goals:

By the end of this course students should:

- Understand tensor product Hilbert spaces
- Understand the meaning of entanglement
- Be familiar with the Schmidt decomposition, and know how to compute it using software such as Python or Mathematica
- Understand the idea of mixed quantum states, and their formulation as density matrices
- Be able to compute reduced density matrices
- (Time permitting) understand some simple applications of entanglement, such as teleportation and small quantum circuits

Course schedule:

Day 1: Review two-level systems, including change of basis; tensor product spaces

Day 2: Schmidt decomposition; several perspectives on entanglement

Day 3: Mixed quantum states; density matrices and reduced density matrices

Day 4: Quantum teleportation; SWAP test algorithm

Course requirements:

Students can receive official recognition of their participation in the course. This requires:

- Attending all sessions of the course on Zoom (excused absence possible with written permission from the instructor)

- Completing one homework assignment, during the weekend between week 1 and week 2 of the course; it will be due by the end of Monday, June 26. The HW will be marked as complete so long as you demonstrate a good-faith effort to solve all the problems.

Resources:

- Recordings of the lectures will be available to PSI START participants, so you may re-watch them; these are not a substitute for attending the live course sessions on Zoom.
- Lecture notes will also be posted after each course session, but they may not agree perfectly with the actual course content
- Solutions to the HW assignment will be provided before class on Tuesday, June 27.
- A second, ungraded, HW assignment will be available after the end of the course.

Land Acknowledgment

Perimeter Institute is located on the Haldimand Tract, in the traditional territory of the Anishinaabe, Haudenosaunee, and Neutral peoples. After the American Revolution, the tract was granted by the British to the Six Nations of the Grand River and the Mississaugas of the Credit First Nation as compensation for their role in the war and for the loss of their traditional lands in upstate New York. Of the 950,000 acres granted to the Haudenosaunee, less than 5 percent remains Six Nations land. Only 6,100 acres remain Mississaugas of the Credit land.

The policies of expulsion and assimilation that harmed and continue to harm Indigenous peoples directly benefited us in giving us the ability to live and work here. We have the responsibility to learn about and acknowledge these injustices so that we may begin to remedy the damages that have been done and those that are ongoing.

Accommodations

Accommodations will be made according to PI's Accommodation Policy. Students can contact Aaron or PI's People and Culture department if accommodations are required.

Academic integrity

Students are expected to know, understand, and follow the academic integrity policies detailed on the University of Waterloo Academic Integrity website (https://uwaterloo.ca/academic-integrity).