Lecture I — Introduction & Fundamentals of quantum computing

Welcome:

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All material on Stine: Scripts, literature, projects...

Learning Goals: 'hands-on' quantum computing & quantum annealing

- What is quantum computing & annealing?
- How to control a current-day quantum computer?
- What is it good for?

+ few introductory lectures + individual/group projects and talks

↳ incl. programming your own quantum computing + annealing codes
↳ grade by evaluated term project + talk + individual short oral exam on own contribution

Info about participants:

- Which study program?
- Who has finally decided to take written term project / talk?
- Are there fixed groups of people for a project / students with their own suggestions for projects?

[used to adjust lectures

Initial knowledge poll

How well do you know the following terms

terms:

quantum computing	classical computing
quantum annealing	Copenhagen interpretation
quantum theory	qubit
quantum theory of spins	quantum gates
density matrix	adiabatic & topological quantum computing
superconducting qubit	
quantum error correction	adiabatic theorem of quantum mechanics
toric code	
nonabelian anyons	Majorana zero mode
optimization problems	Qiskit
! python	Ocean SDK
cloud computing	! programming

! -> If you do not know this, consider another course

Schedule

April 4 : today, Introduction

April 11 Lecture I

April 18 Eastern

April 25 Lecture II

Vote for dates for talks

May 2

May 9

May 16

May 23 Pentecost (vacation)

May 30

June 6

June 13

June 20

June 27 Deadline

July 4

July 11/12 ? talks

July 18/19 ? → vote on April 25

25 · 20 mins = 8h 20 mins
⇒ 2 blocks ≈ 5h

you work here
~ 11 weeks
~ 8h per week

Scenario I

Scenario II

Deadline

talks

Project list

View full list at Stine

areas

- Scientific application & algorithms
- Experimental aspects
- Industrial/economical applications
- General aspects

- Group projects encouraged
- own suggestions encouraged

Expectations:

will get best grade, including:
- ↳ Short introduction to topic
- ↳ Detailed explanation of project
- ↳ working code & simulation data

- 20 mins focused & interesting talk [group projects + 10 mins per additional students]
- Active communication and taking supervisors seriously

+ short oral exam for group projects

Motivation

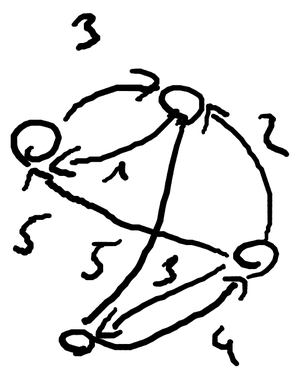
- state-of-the-art research in novel technology
- excellent hiring chances with practical quantum computing experience
- fast growing industrial development

This is how you get best grades

- projects are open to some extent
- contribute with own ideas, leave your mark on the project
  - ↳ what do you wish to calculate/optimise with quantum hardware?
  - ↳ Which aspect do you want to understand & work out particularly?

→ example:

Traveling Salesman problem



- shortest path?
- Implementation already exists.

⇒ be creative & document it =
- Create interesting application: Eg. Visit all major sights of UK fastest with public traffic & test it
- Create Wiki entry
- Focus on various ways to solve the problem
- Extend the problem
- Improve documention
- Create a "cheat sheet" on solving Trav. salesm. problem step by step for people without knowledge

when existing solutions exist, go beyond them, change them, ask your own questions

process of assigning projects:

① Assign to list of projects online

or

↳ ② send own project & group

→ Until Wednesday! [changes possible upon reasonable request]

Common element: Quantum computer:
↳ program code with Qiskit

Hands on
{ Quantum annealer
↳ program code with Leap/Ocean SDK

→ can be run as simulation or on real quantum computing hardware

→ present list of projects

Final presentations: block talks 2 days
in lecture free time?
→ Doodle to find dates

What are your questions & expectations?