Research internships as a grad (undergrad) student

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I'll talk about (physics) research internships...

There are internships on:

- Finance
- Data science
- Machine learning (maybe)

Physics research internships:

- Material science
- Quantum something
- Weather simulations
- Work on some lab
- Machine learning (maybe)

Advantages & disadvantages

Advantages:

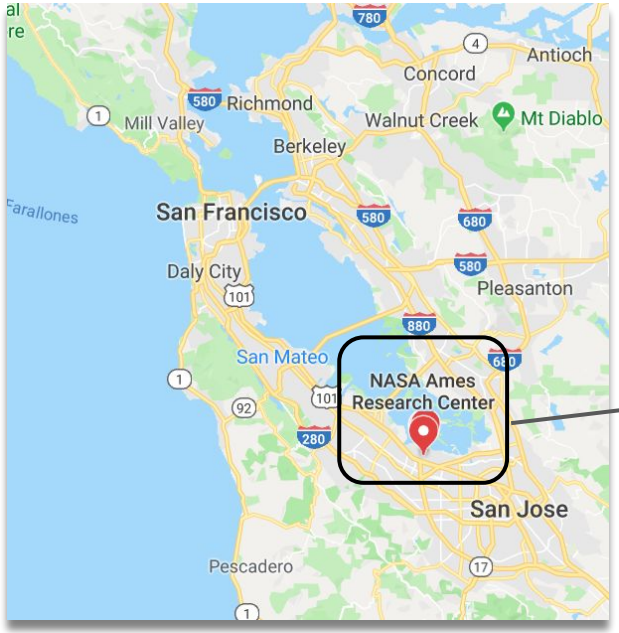
- Work on research where there is industry interest
- Pipeline for next hires: many people get offers afterwards
- Refreshing
- Do research with **lots** of resources
- Make some money
- See other ways of doing science

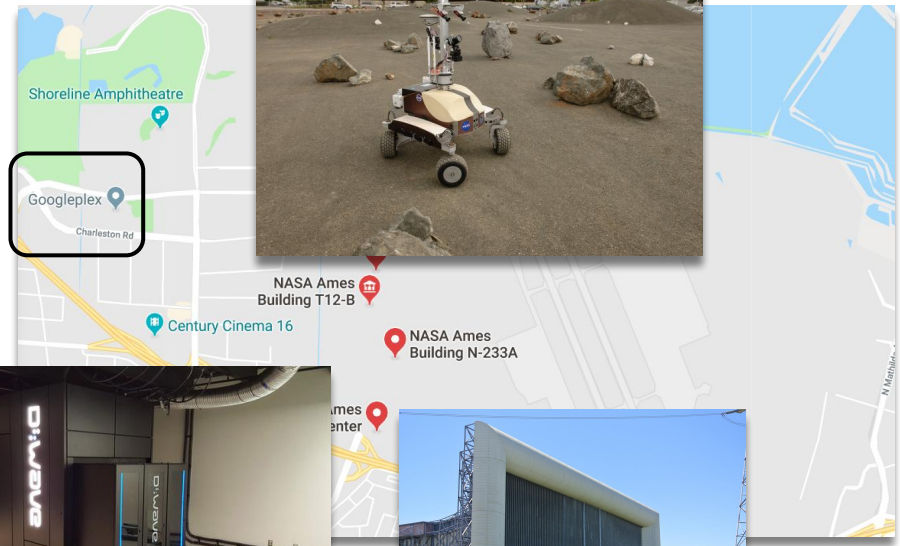
Disadvantages:

- Distracts from PhD and/or school work (if unrelated)
- It might need extra work after the internship

QuAIL @ NASA

Internship at QuAIL, NASA:
(Quantum Artificial Intelligence Lab)





Internship at QuAIL, NASA: (Quantum Artificial Intelligence Lab)

- About 10 researchers permanently working at QuAIL including:
  - 2 PhD students
  - 1 postdoc

- 6 interns

  Feynman Quantum Academy

Internship at QuAIL, NASA

Internships are typically 3 to 6 months long (not only in the summer):

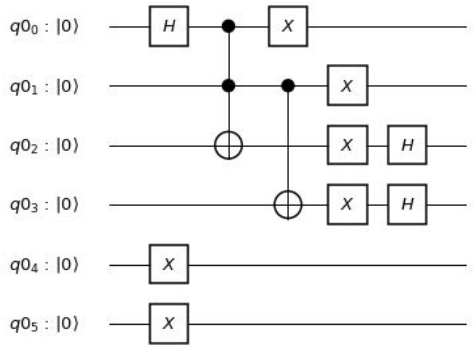
- Interview(s): conversation about your research and how it overlaps QC
- Offer to work on a particular project
- 2-3 weeks to learn about it
- 2-4 months to work full time on it
- Remaining time (maybe time after) to wrap up and ***write a paper***

Projects often pretty applied and in partnership with industry

Example: my project

Brief (not super accurate) history of quantum computing:

- **80s**: potential of quantum computing starts becoming clear
- **90s**: formalization through quantum circuits



Quantum algorithms:

- Good for *error-free* quantum computers
- In practice there is so much *noise*

Example: my project

Brief (not super accurate) history of quantum computing:

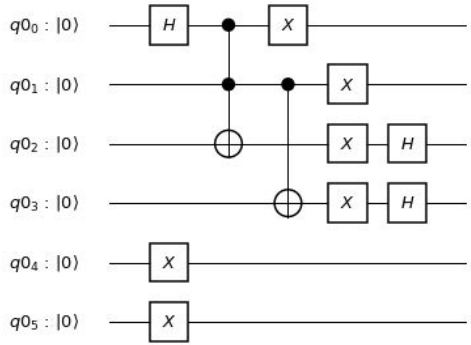
- **2000s**: error correction. Need 100s or 1000s of qubits to embed a single error-free logical qubits!
- **2010s**: focus on Noisy Intermediate-Scale Quantum (NISQ) computers. Are they useful?
- **Very soon**: Quantum supremacy or, in other words, show that a NISQ computer can solve a well-defined problem and the largest supercomputer on Earth “can’t”.

In 2017 Google proposes Random Quantum Circuits (RQC) to show supremacy

Example: my project

Sampling from RQCs:

Initialize



Measure

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01101000110
10010101001
01000100101
01010100110
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Simulating this process classically is VERY hard circuits for many qubits (>50) and/or large depth (>40). Need strong classical competitor.

Example: my project

- Studied existing simulators
- We came up with a new approach based on tensor networks
- Run on NASA supercomputers. Largest QC simulations ever run
- Open source code

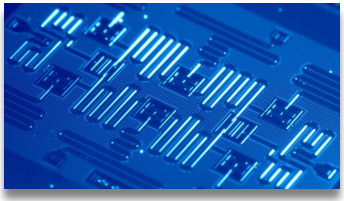
A flexible high-performance simulator for the verification and benchmarking of quantum circuits implemented on real hardware

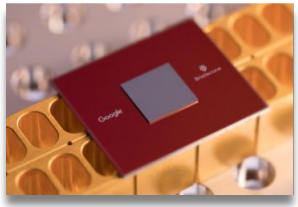
Benjamin Villalonga,[1,2,3,*] Sergio Boixo,[4,†] Bron Nelson,[2,5,‡] Christopher Henze,[2,§] Eleanor Rieffel,[2,¶] Rupak Biswas,[2,**] and Salvatore Mandrà[2,6,††]

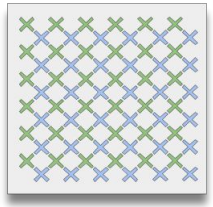
two HPC clusters combined reached a peak of 20 PFLOPS (single precision), that is 64% of their maximum achievable performance. To date, this numerical computation is the largest in terms of sustained PFLOPS and number of nodes utilized ever run on NASA HPC clusters.

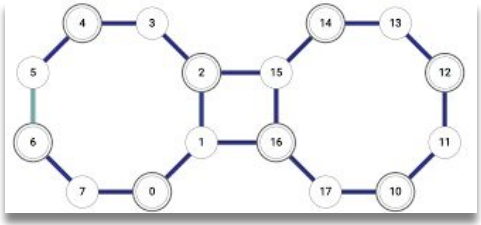
Example: other projects

- Used D-Wave
- Worked on quantum compilers for IBM, Rigetti, Google, …
- QAOA: near term heuristic algorithms for NISQ devices
- Overlap of Machine Learning with Quantum Computing
- Read-out of qubits









Quantum computing in general

Good time for quantum computing

There is budget:

- Large private investment in the last 5 years
- National Quantum Initiative ($1.2 billion)
- EU's Quantum Technologies Flagship (€1 billion)
- UIUC

QUANTUM FLAGSHIP

European Commission

Technology is entering an interesting NISQ era

Internships in Quantum Computing

- NASA
- Google
- Microsoft
- IBM
- Zapata computing
- German aerospace center (DLR)
- ...

General tips

How to get an internship

Application:

- General application forms
- Networking (conferences, advisor, reaching out, …)

Think hard about:

- Motivation
- Overlap / transferable knowledge
- Past work

This goes to your interview (and maybe motivation letter)

How to take advantage of an internship

Talk to your advisor (more on this later)

At the internship:

- Learn as much as you can
- Ask a lot of questions: they *know* you *don't know* (you already interviewed)
- Network (conferences, visits, meetings, …)
- Use the resources!

How to take advantage after an internship

Follow up might be very important:

- More projects / bigger projects
- Another internship
- A job offer
- Keep networking
- Get PhD funding
- …
- Don’t forget your thesis!

University advisor

- Probably understanding
- Work might relate to thesis
- Talk a lot to be on the same page (you might now have two advisors)
- Might create collaborations between them
- Might get funding for your group
- There is always Lance!

Questions & discussion