Quantum Hardware + Hype

Goals

- Be able to describe contenders for physical qubits + their advantages/disadvantages
- Be able to identify + discuss quantum computing hype.

Announcements

OH!! 12-1 today   10-11 Tomorrow

QC4 on web notes,   Survey PS10!,   2 notecards for Haymaker!!   exams

Exit Tickets

- Is Quantum Computing horribly space inefficient if need minimum 9 qubits per 1 logical qubit? It's worse...
- How does projective measurement not destroy superposition? (Does destroy entanglement) $a|000\rangle + b|111\rangle$
- Weight of correction   • Don't know initial input?

For Your company, answer questions:

- IBM ①
- IonQ ②
- PsiQuantum ③
- Microsoft ④
- QuEra ⑤
- Silicon Quantum Computing ⑥
- Google ⑦

- How do they construct a qubit
- What advantages does their qubit have ?
  - Error rate (gates/measurement)
  - Clock speed
  - Scalability
  - ?
- Disadvantages ?
- Hype ?

IBM → superconducting qubits
  + low error rate 1 in 7 million   Optimistic?
  + clock speed   180k klops
  + accurate   5000+ 2-qubit gates
  + modular infrastructure to scale   TBD
  − cryogenic → lots of wire

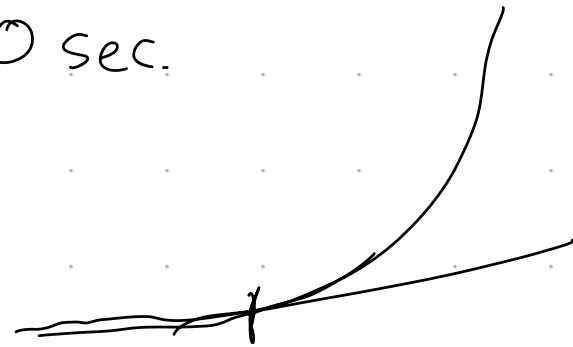IonQ → trapped Yt ion, held in place w/ mag fields
  + no physical conxn
  + stable (memory)   100 sec.
  − vaccuum
  − cryogenic
  − error rate is higher)

PsiQuantum → photons on a chip with interferometer
  + 99.999% fidelity
  + can use existing tech / manufacturing

+ noise resilience
+ better cooling
− need cooling
− need $
− switches hard to make

0 to 100
↑   ↑
here   plan

2029
error corrected

Microsoft → majorana particles
            (topological superconductor)

− exist?
+ scalable
+ protect from errors
+ precise measurement
− cooling

QuEra - neutral atoms, trapped with
          lasers
    + perfect qubit (?)
    + error resistence
    + demo error correction
    - environmental noise
    - scalability

Silicon Quantum Computing - phosph. doped silicon chips
                            e^- spin up or down
        - measuring
        - hard to manufacture (need super pure Si)
        - cryogenic
        - lithographic
      + simpler circuit design
      + good memory

Quantum value
in reach
Harvard, MIT
    Wow!

NVidia! Wow

Google → superconducting qubits

+ 105 qubits

± scalable error correction below threshold

↑

? true?

- cryogenic
- hardware not yet applications

- Pull in the reader
- You can do it!

9

Hype

- Personal experience with quantum hype? Effect on your taking this class? Changed perception?
- Who is creating hype? Benefit/Harm?
- Who is mitigating hype? Successfully?

https://x.com/DulwichQuantum/status/1816416163443716215