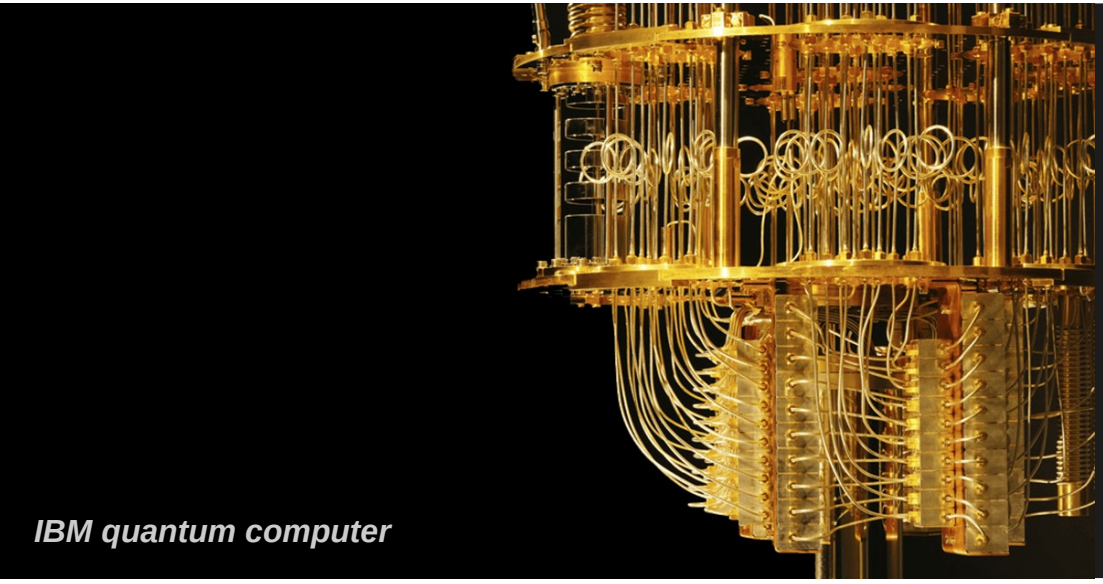


IBM quantum computer

Quantum technology turns ordinary reality upside down.
(Michael Crichton)

IBM has created the largest quantum lab in the world
Qiskit is the key to open its doors

of learning with and

Experiences in the Quantum Community

IBM Quantum and Qiskit Perspective

Jacob L. Cybulski

School of IT, SEBE, Deakin University

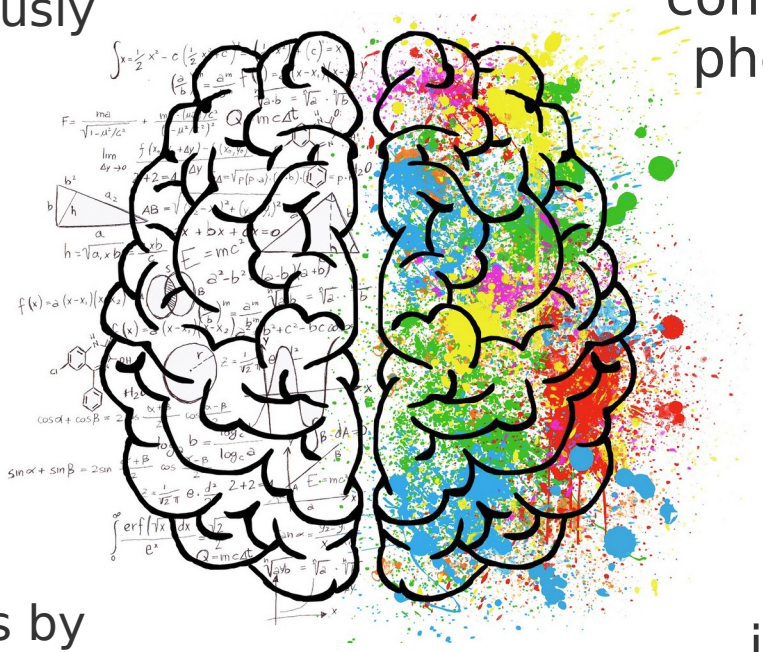
Quantum Computing
Needs diverse talents

Benefits of Quantum Computing engagement with its application areas flows both ways

Quantum Computing offers novel solutions to previously unsolved problems in many different areas

For example: Physics, Chemistry, Pharma Science, Bio-Tech, Medicine, Finance, Logistics, Comp Sci, Games, Music, Art ...

Quantum Computing rapidly expands its ranks by drawing in scientists from outside its traditional Physics background



Quantum Computing community responds to this phenomenon and supports the newcomers with opportunities to learn its methods, tools and knowledge

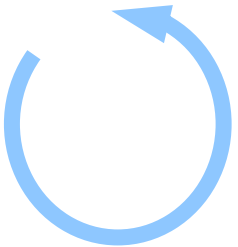
The “outsiders” in turn enrich the quantum domain with new perspectives, new insights, new application opportunities, and much more

Do not believe what you are told...

- The majority of quantum *(learning)* events tell their participants that no prior knowledge is necessary
- **Do not believe it!**
- You always need to do some extra reading and there are great many texts, which are highly recommended by the quantum community
- The majority of these books however are written for physics graduates ☹
- Nevertheless, there are some great readings for people outside Physics, such as computer scientists, so get them and start reading! 😀

First Steps in Quantum Computing
What do you need to learn?

Step 1. QC tools
- IBM Quantum Lab
- Python + Jupyter
- Git / GitHub



Step 2. QC foundations
- Complex numbers
- Linear algebra
- Probability theory
- Statistics
- QC algorithms

Step 3. Learn QML
- Calculus
- Optimisation techniques
- Machine learning
- QML algorithms

Step 4. Extend and apply
- Error mitigation
- Hardware calibration
- QC and QML applications

Engage with Quantum Community
IBM, Qiskit and Others

IBM Quantum Training

- Qiskit Camp
- Qiskit Global Summer School
- IBM Quantum Internships
  Development, Engineering, Research
- IBM Qiskit Developer
  Exam and Certification

IBM Quantum Challenges

- Qiskit Challenges
  2019 Sept, 2020 May, Nov, 2021 May, Sept - Africa
- Qiskit Hackathons
  Korean – 24 hours, European R&D – 2 months

IBM Quantum Badges

- Quantum Advocate
- Quantum Ambassador
- Quantum Challenge
  Participation, Foundation, Advanced
- Quantum Practitioner

IBM Quantum Learning

- Qiskit Textbook
- Qiskit Tutorials
- Qiskit Quantum Clubs
- Qiskit YouTube, Medium and Slack
- Qiskit Seminars, Meetups and Unconferences

Others

- Qubit by Qubit
- QWorld
- QOSF
- SheQuantum
- PennyLane / QHack
- MIT iQuHACK
- LinkedIn / Twitter

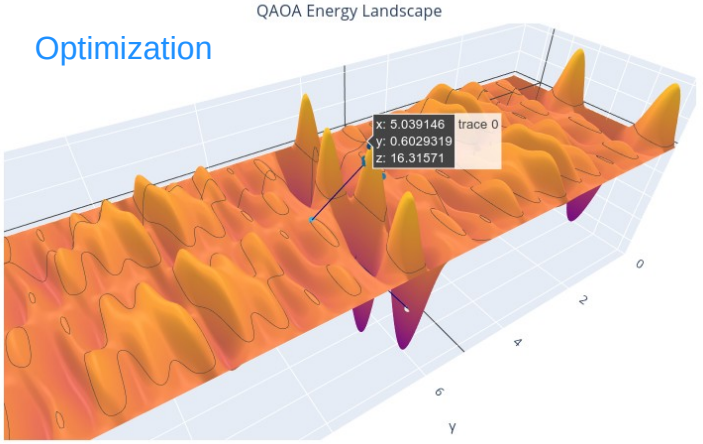
QGSS'2021 (QC+QML)

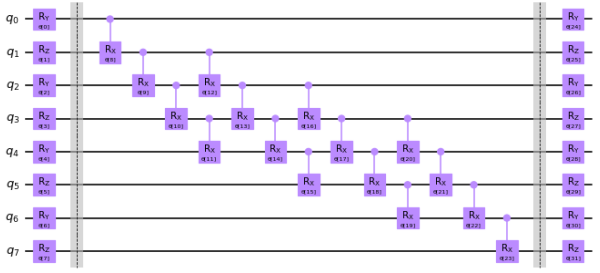
5,000 participants

Day	Topics Week 1	Format
Monday	Vector Spaces, Tensor Products, and Qubits	Lecture
	Introduction to Quantum Circuits	Lecture
Tuesday	Simple Quantum Algorithms I	Lecture
	Simple Quantum Algorithms II	Lecture
Wednesday	Noise in Quantum Computers	Lecture
	Introduction to Quantum Computing Algorithms and Operations	Lab
Thursday	Introduction to Classical Machine Learning (ML)	Lecture
	Advanced Classical Machine Learning (ML)	Lecture
Friday	Intro to the Quantum Approximate Optimization and Applications	Lecture
	Building a Quantum Classifier	Lecture
	Introduction to Variational Algorithms	Lab

Day	Topic Week 2	Format
Monday	From Variational Classifiers to Linear Classifiers	Lecture
	Quantum Feature Spaces and Kernels	Lecture
Tuesday	Quantum Kernels in Practice	Lecture
	Introduction to Quantum Kernels and SVMs	Lab
Wednesday	Introduction and Applications of Quantum Models	Lecture
	Barren Plateaus, Trainability Issues, and How to Avoid Them	Lecture
	Introduction to Training Quantum Circuits	Lab
Thursday	Introduction to Quantum Hardware	Lecture
	Hardware Efficient Ansatze for Quantum Machine Learning	Lecture
	Introduction to Hardware Efficient Ansatze for QML	Lab
Friday	Advanced QML Algorithms: Quantum Boltzmann Machines QGANs	Lecture
	The Capacity and Power of QML & the Future of QML	Lecture

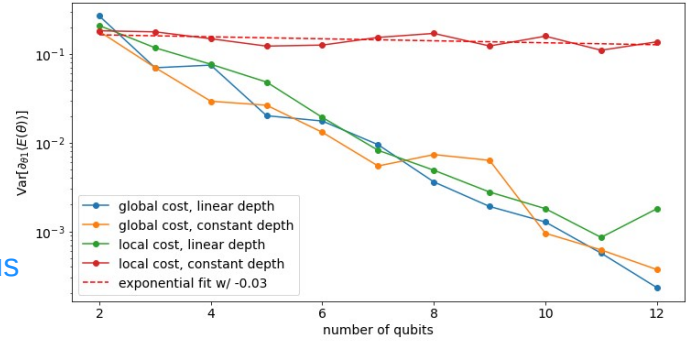
Optimization



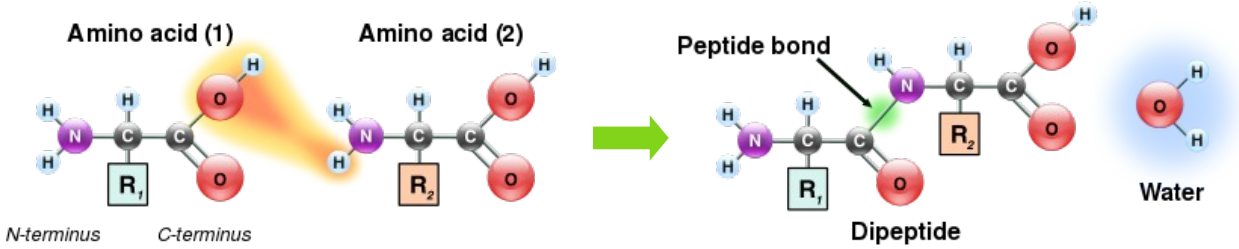


Ansatze

Barren Plateaus



Challenges



IQC 2020 Nov (3 weeks)

2,000 participants

- Create simple quantum circuits
- Use Grover and qRAM to solve complex quantum games

IQC 2021 May (1 week)

2,200 participants

Main breakthroughs in 40 years of quantum computing

- Construct a Toffoli gate using a specific set of basis gates
- Use Shor's algorithm to factorise a "large" number (35)
- Create circuits to detect and correct errors on qubits
- Calibrate the pulse amplitude of a transmon qubit using Rabi oscillation and then find its transition frequency
- Use Variational Quantum Eigensolver (VQE) to determine the ground state (lowest energy) of the LiH molecule

IQC 2021 Africa (11 days)

- Use Quantum Approximate Optimization Algorithm (QAOA) and VQE to maximise crop yield
- Create a quantum share distribution and then apply Quantum Amplitude Estimation to predict future price of options
- Use VQE to explore whether a (toy) anti-retroviral molecule binds with a (toy) virus protease (by finding their ground state)

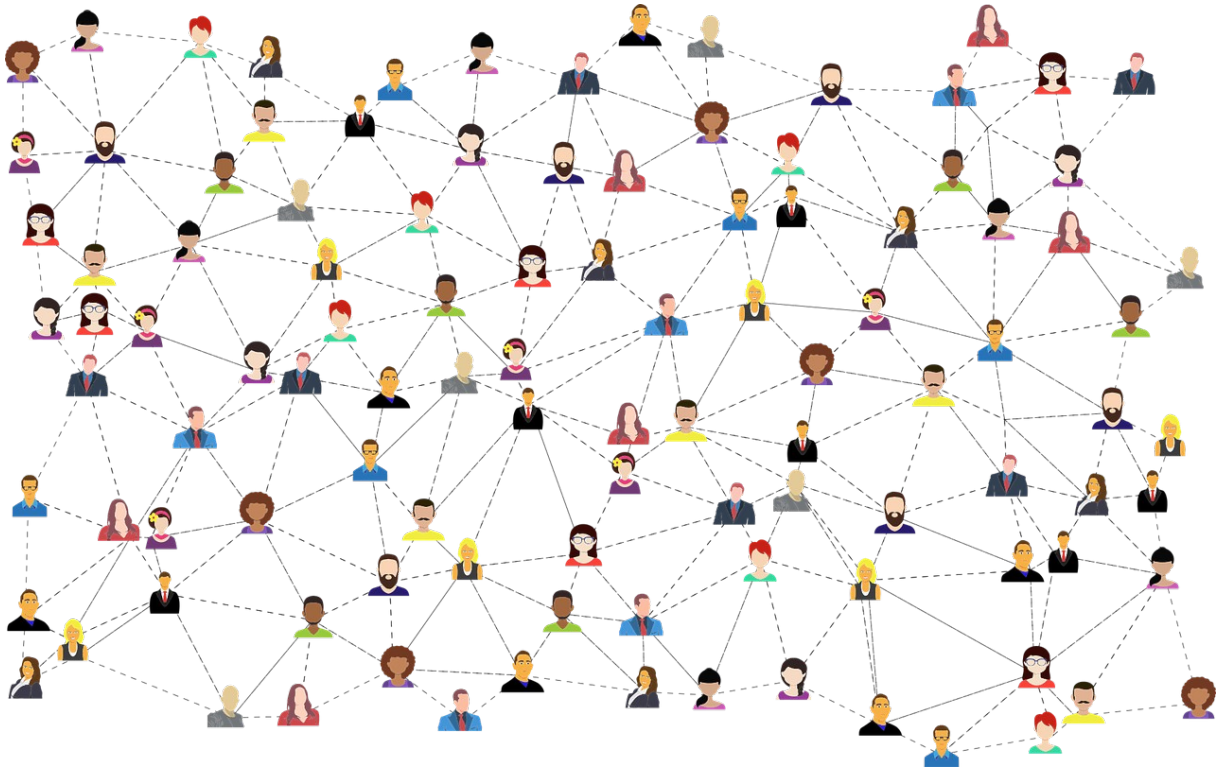
So far 700 participants

Learning with the Quantum Community

Questions?

Connect with
open quantum communities

Quantum
community
supports
diverse
audience



Enrol in quantum
summer school

Learn in
quantum
competitions

Undertake
quantum
training
and quantum
learning

Become quantum advocate