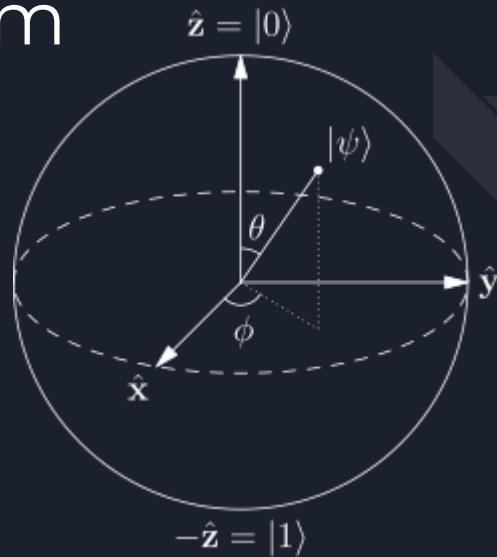




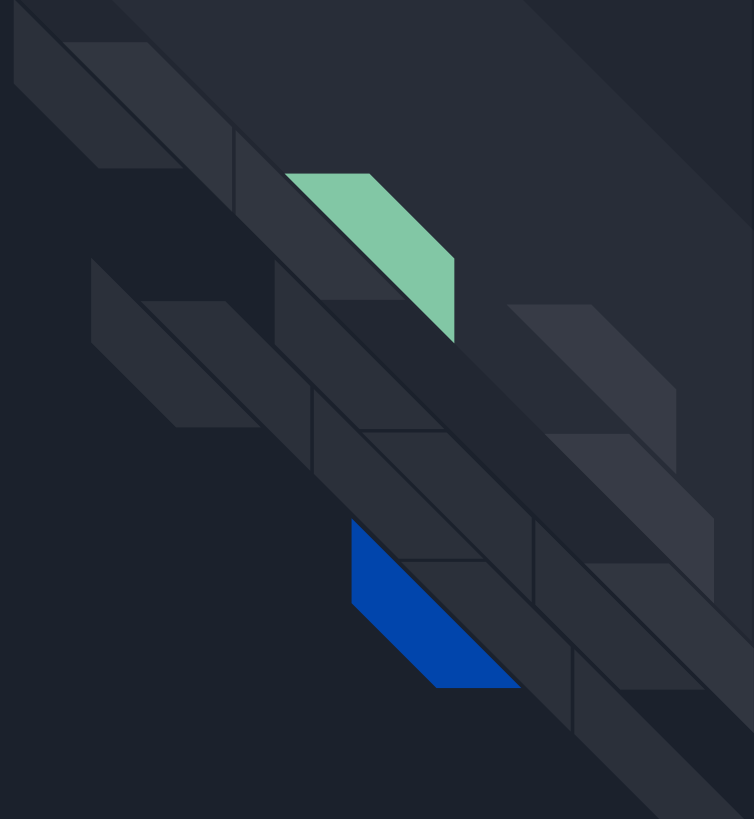
How will quantum computers be used in the future?

What is a quantum computer?



Future uses:

- Cryptography
- Simulation
- Optimization



Encryption





Breaking encryption

- One of the first things people think of - Shor's algorithm
- Public key encryption
- 20 years?
- Steal now decrypt later
- Quantum-resistant cryptography





Random number

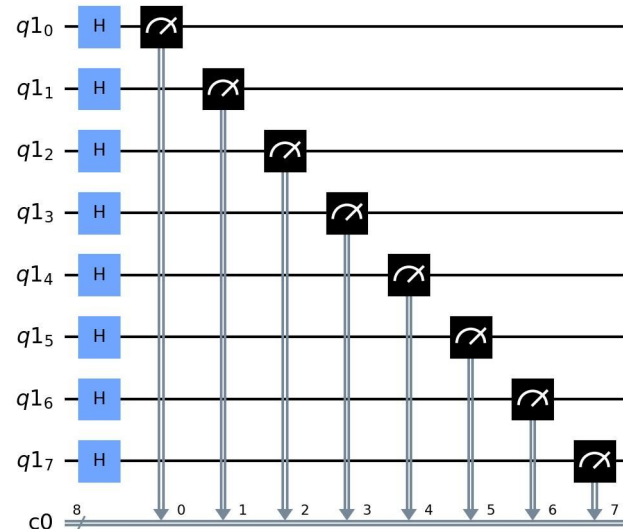
- Only source of completely random numbers - QRNG
- Pseudo-random is currently used



```

1 # circuit produces a random number from 0 to 2^bits and works even when more bits
are needed than qubits available
2 from qiskit import *
3 from qiskit.tools.visualization import *
4 from qiskit_ibm_runtime import QiskitRuntimeService
5 service = QiskitRuntimeService()
6 qcomputer = service.least_busy(simulator=False, operational=True)
7 simulator = Aer.get_backend('qasm_simulator')
8
9 backend = qcomputer
10 max_qubits = backend.num_qubits
11
12 def random_binary_circuit(length):
13     # create circuit
14     qr = QuantumRegister(length)
15     cr = ClassicalRegister(length)
16     circuit = QuantumCircuit(qr, cr)
17     circuit.h(qr)
18     circuit.measure(qr, cr)
19
20     # run circuit
21     result = execute(circuit, backend=backend, shots=1).result()
22     return list(result.get_counts(circuit).keys())[0]
23
24 def random_binary(length):
25     rand_bin = ""
26     full_circuits = length // max_qubits
27     partial_circuit_size = length % max_qubits
28     for i in range(0, full_circuits):
29         rand_bin += random_binary_circuit(max_qubits)
30     if(partial_circuit_size):
31         rand_bin += random_binary_circuit(partial_circuit_size)
32
33     return rand_bin
34
35 if __name__ == "__main__":
36     random = random_binary(8)
37     print(random)
38     print(int(random, 2))
39

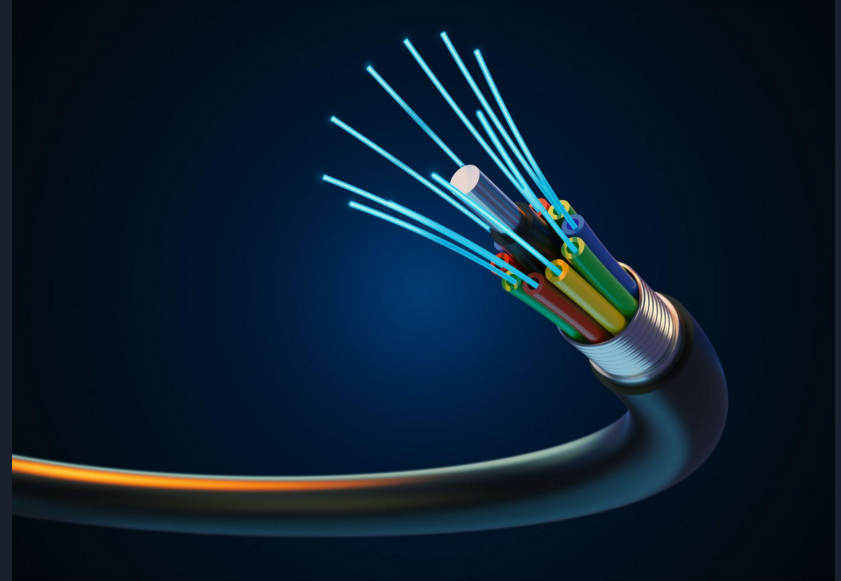
```



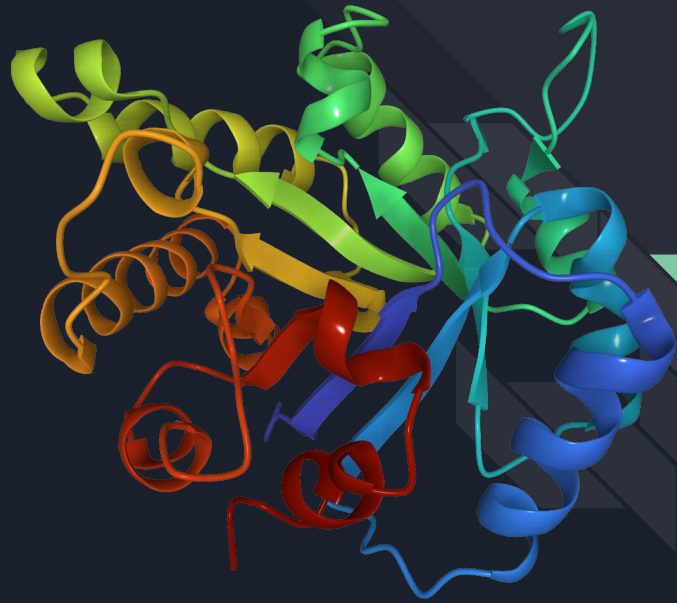
IBM Quantum

Secure message

- Key distribution
- Uncertainty principle
- Specialized optical fibre

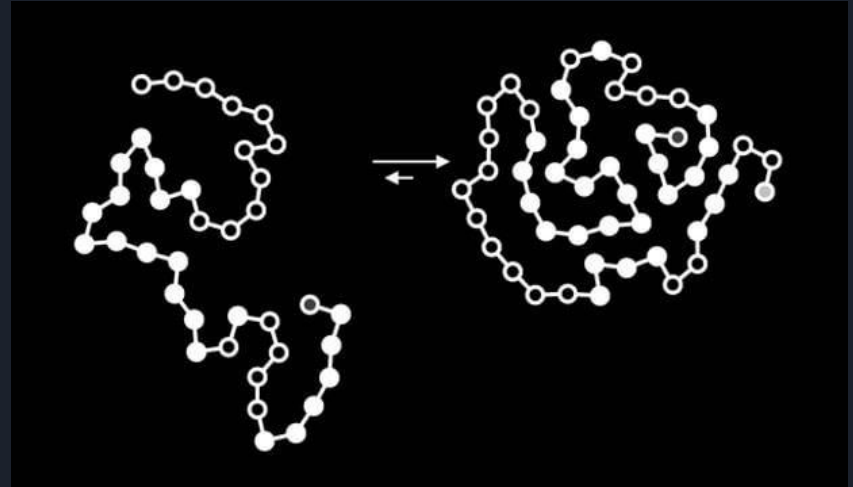
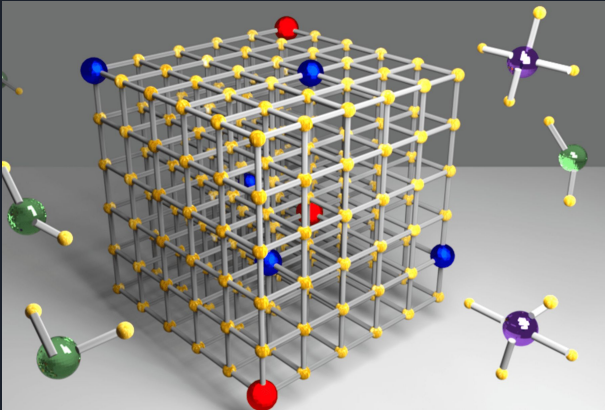


Simulation

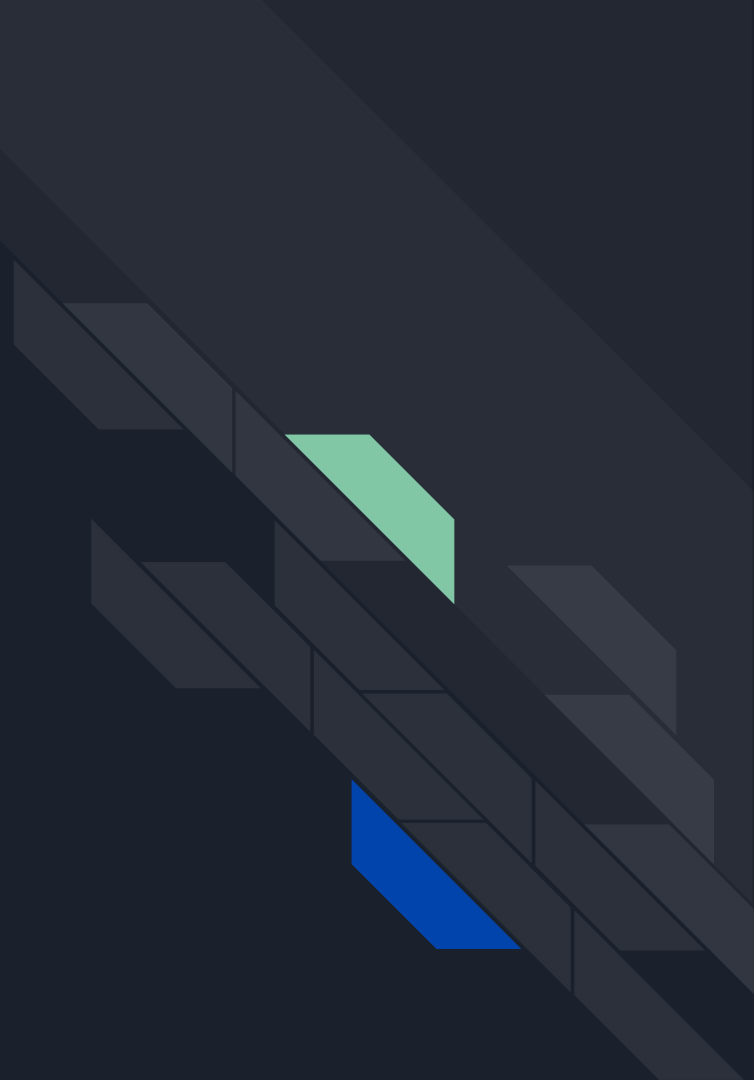


Quantum system simulation

- Better than conventional computers
- Many areas - sensing, communication, metrology, energy storage and pharmaceutical development

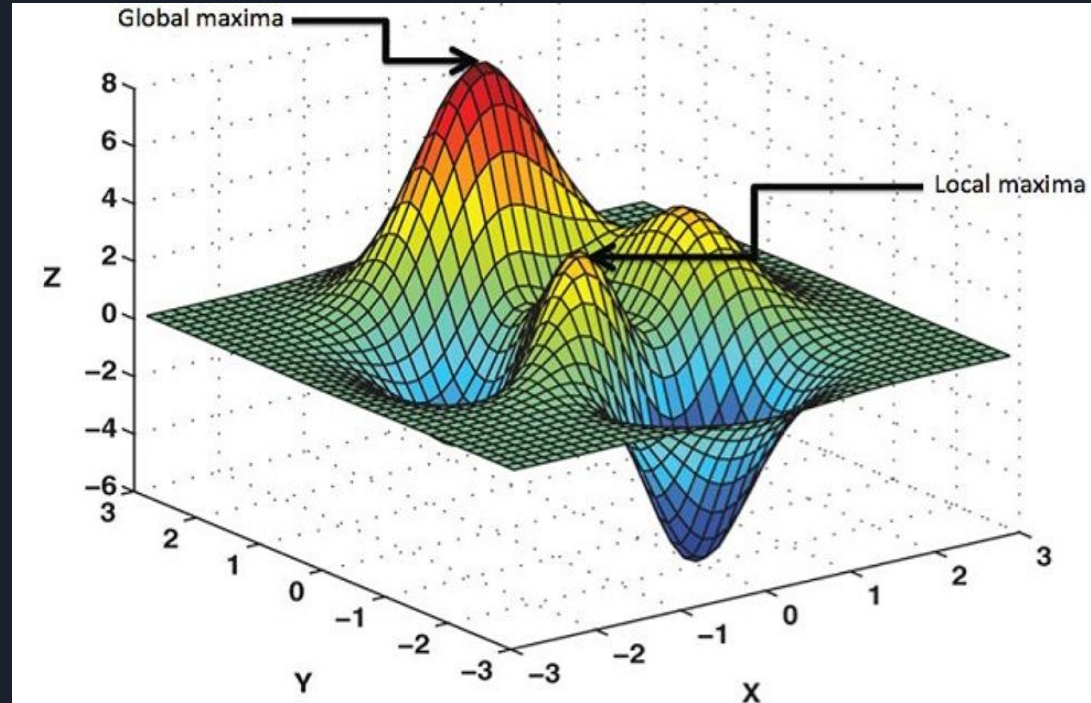


Optimisation problems

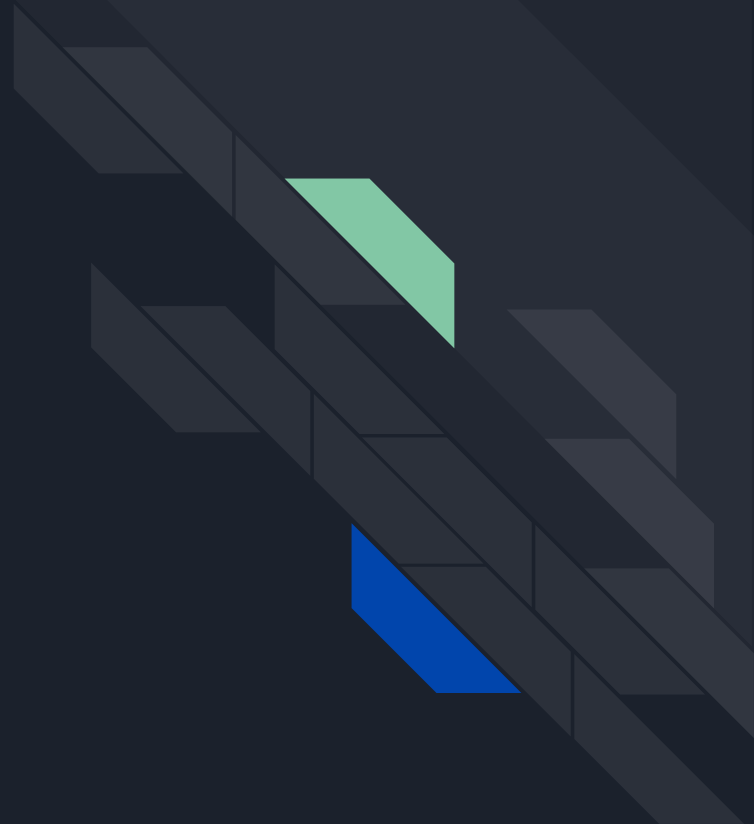


Quantum annealing

- Uses a different technology
- In current use



Conclusion



Any questions?

