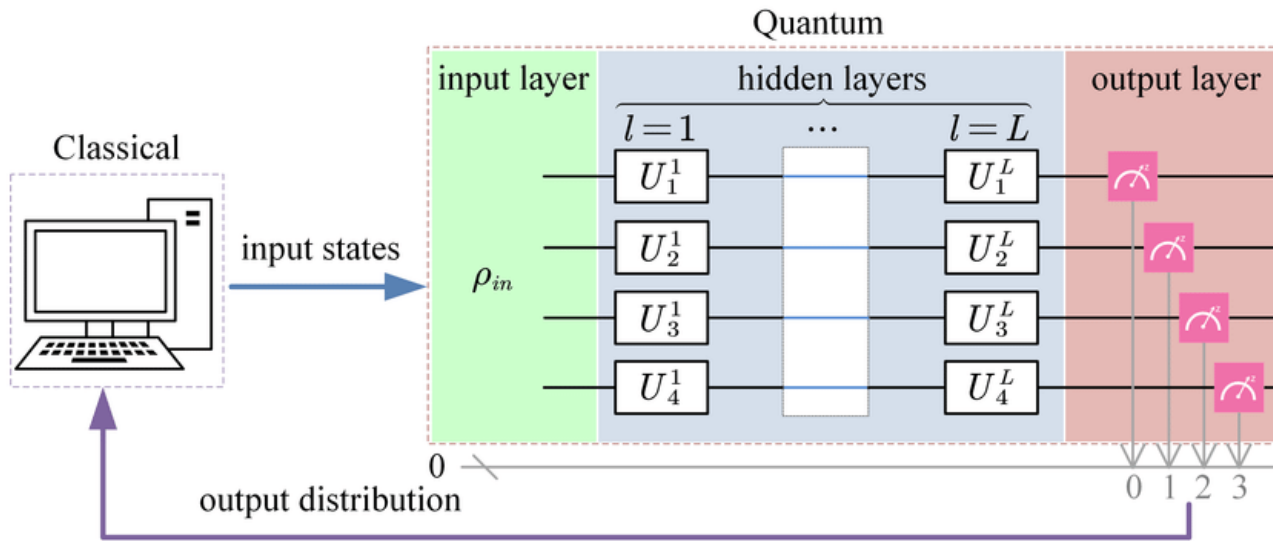


Quantum Computing: A New Frontier for Finance

Sofia Ma
2023 10

Why quantum computing?



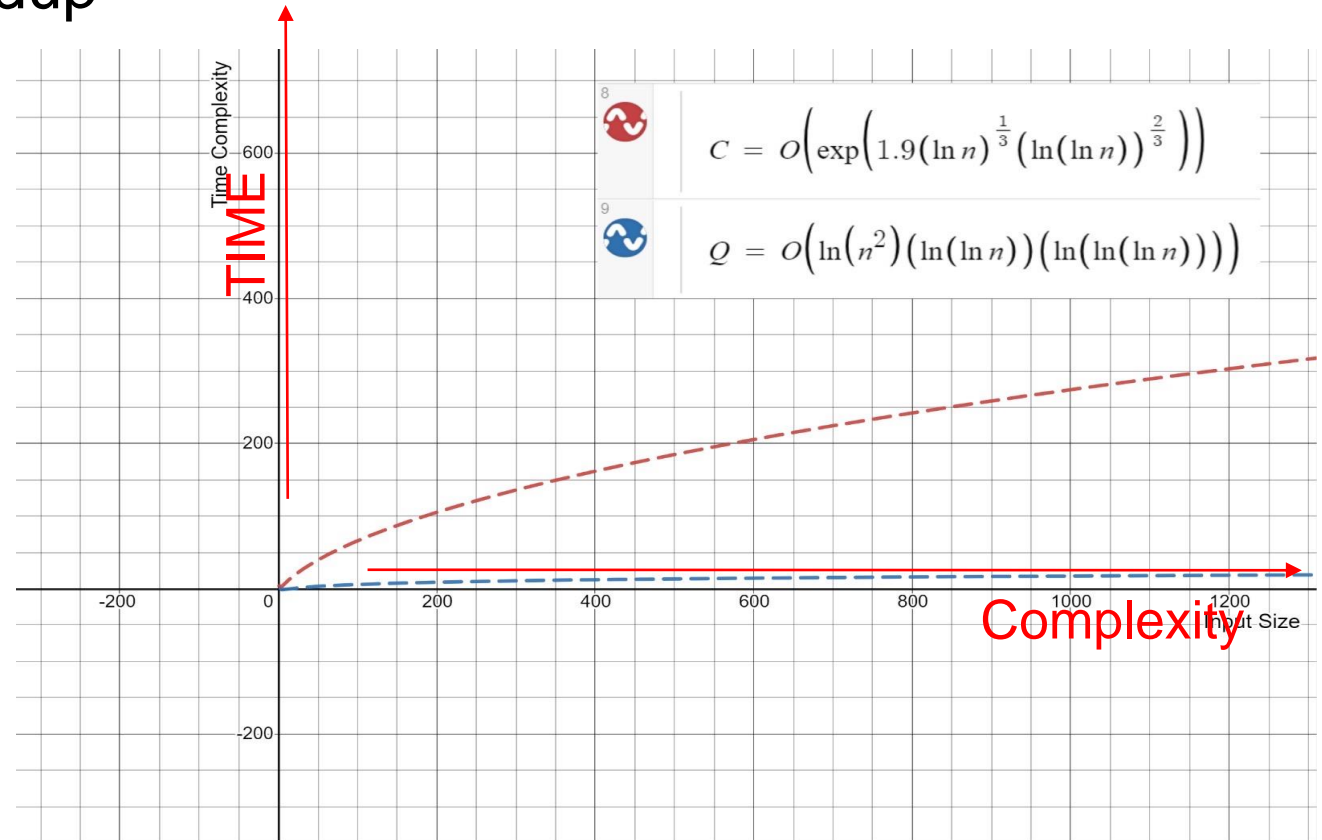
- 20+ years of Quantum Computing Growth since 1998.
- Areas:
 - Optimization
 - Quantum Simulation
 - Scenario Simulation
 - AI
 - Encryption

Why quantum computing?

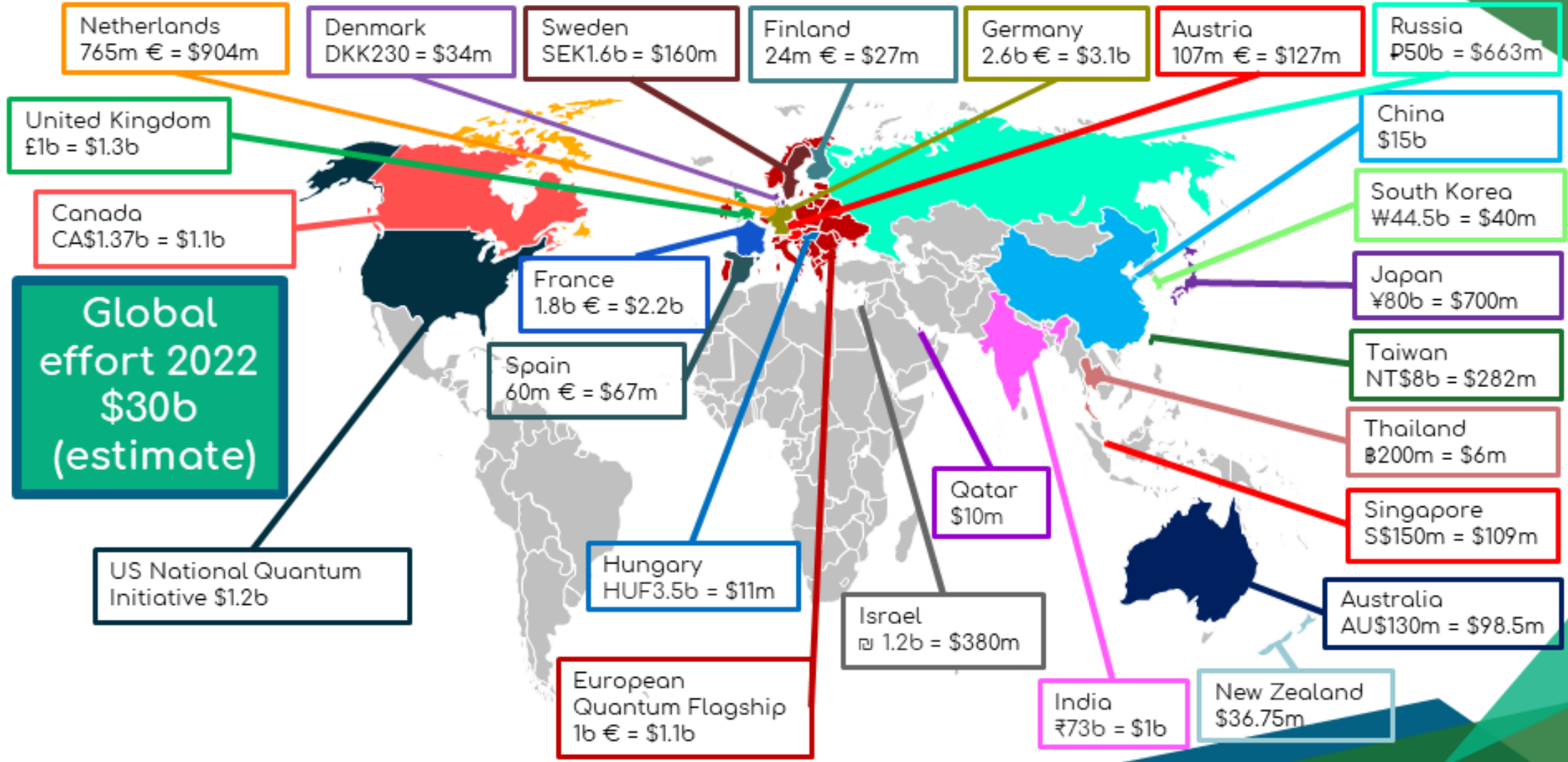
- Speed and efficiency
- Potential for complex problems

- Famous examples and its speedup
 - Shor's Factoring Algorithm

 - Grover's Search Algorithm



Quantum effort worldwide



Agenda



Background into Quantum Computing



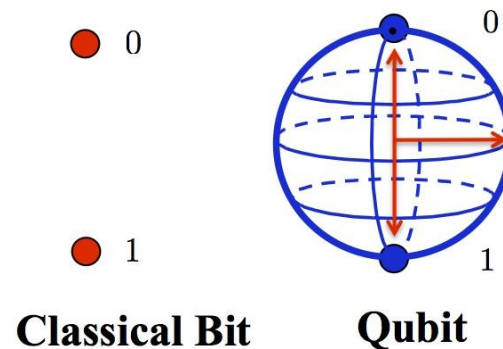
Example in Portfolio Optimization and Simulation



Links to further resources

What is quantum computing: Comparing Quantum to Traditional Computing

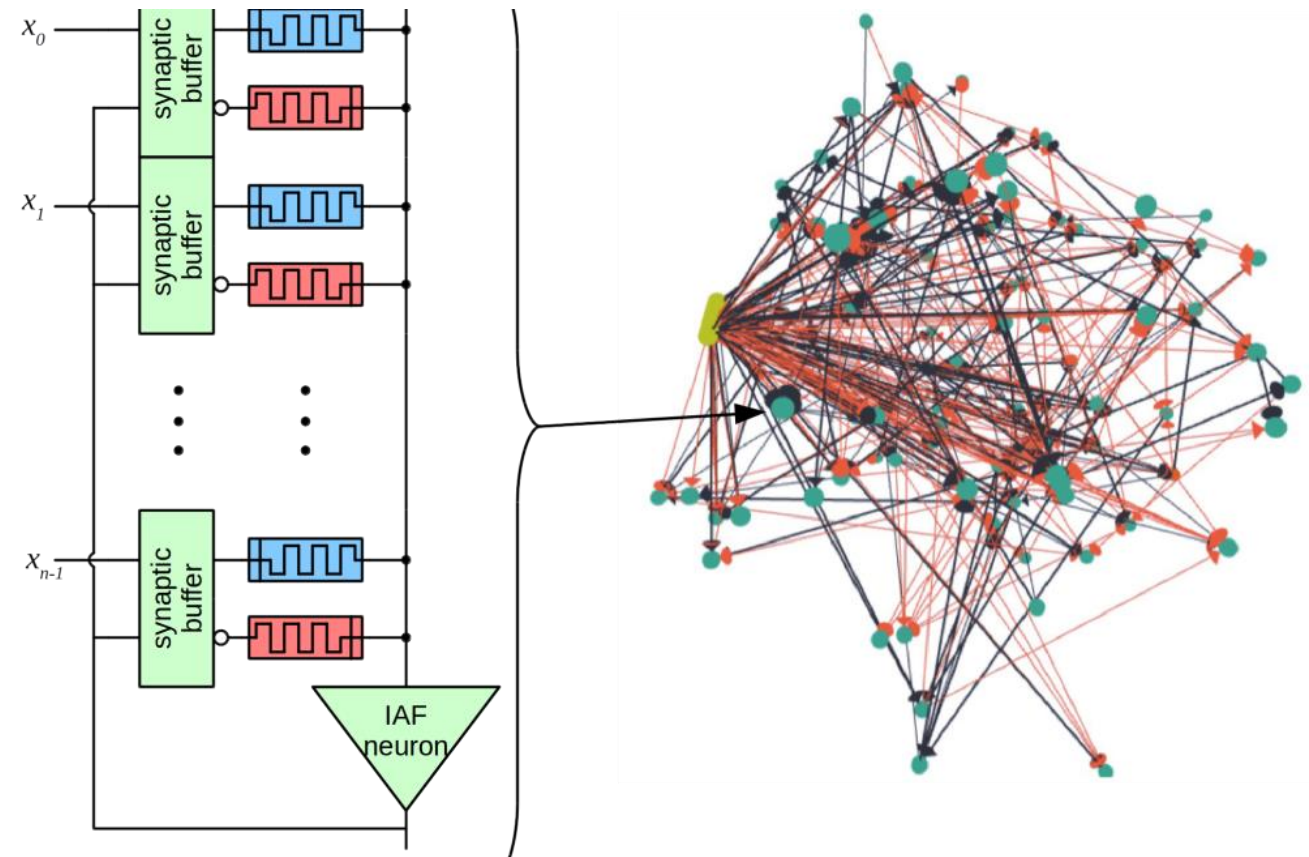
	Traditional	Quantum
Structure	Bits	Qubits
Dimensions	Binary	MultiDimensional
Power Increase	Linear	Exponential
Applications	everyday tasks that have low error rates	higher level of task, e.g., running simulations, analyzing data, creating energy-efficient batteries.



Quantum Compared to Deep Learning

A super-smart assistant

A portal to a parallel universe



Application in Finance



MATLAB Quantum Support Package

Build	Build Quantum Circuits
Simulate	Simulate Quantum Algorithms Locally
Execute	Execute Algorithms on Quantum Computers
Discover	Discover Quantum Computing Applications
Create and Solve	Create and Solve Quadratic Binary Unconstrained Optimization (QUBO) Problems

Applications in Portfolio Optimization



A. OVERVIEW OF
PORTFOLIO
OPTIMIZATION

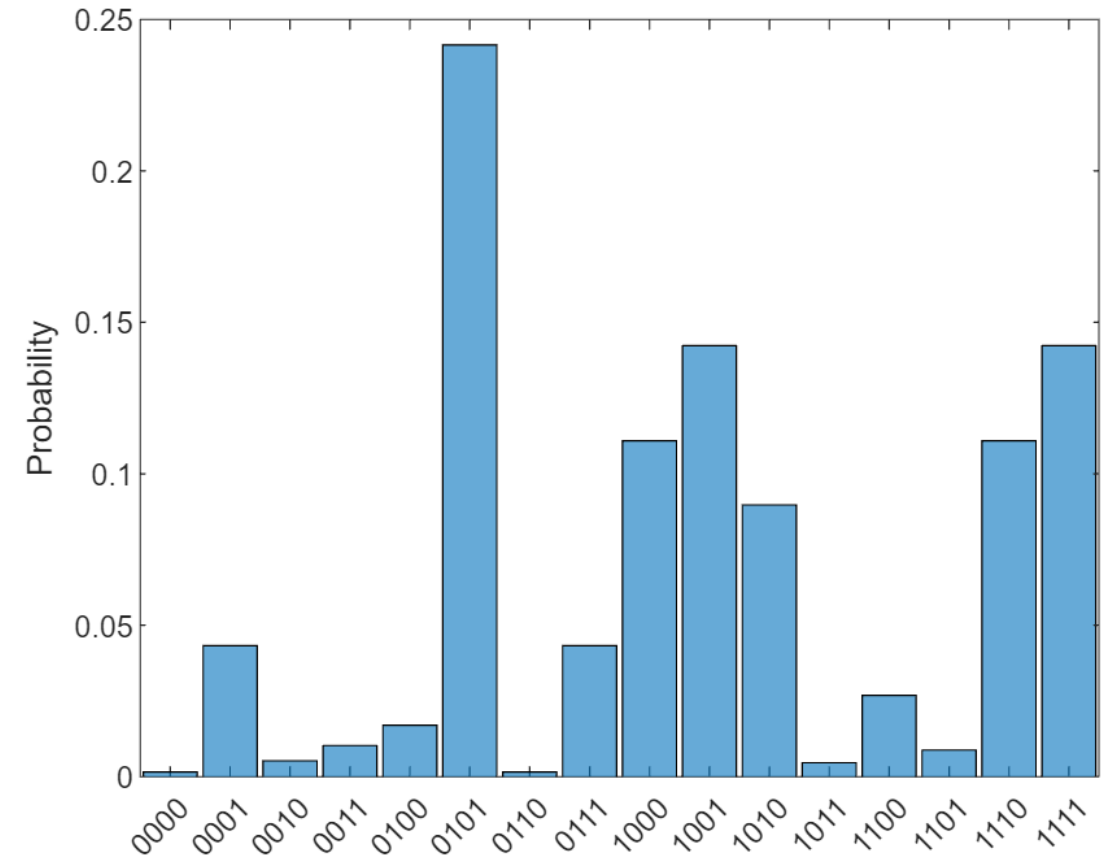
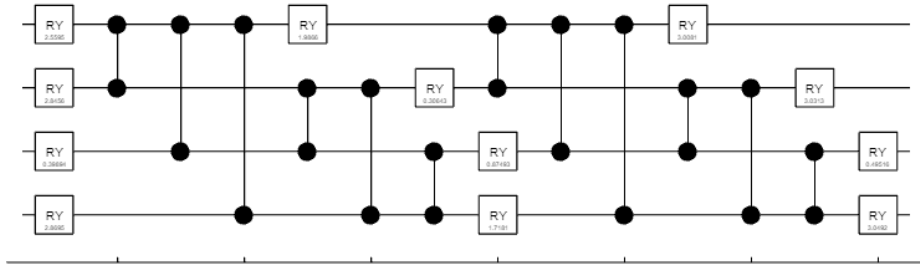


B. BENEFITS: FASTER;
MORE ACCURATE;
FLEXIBILITY

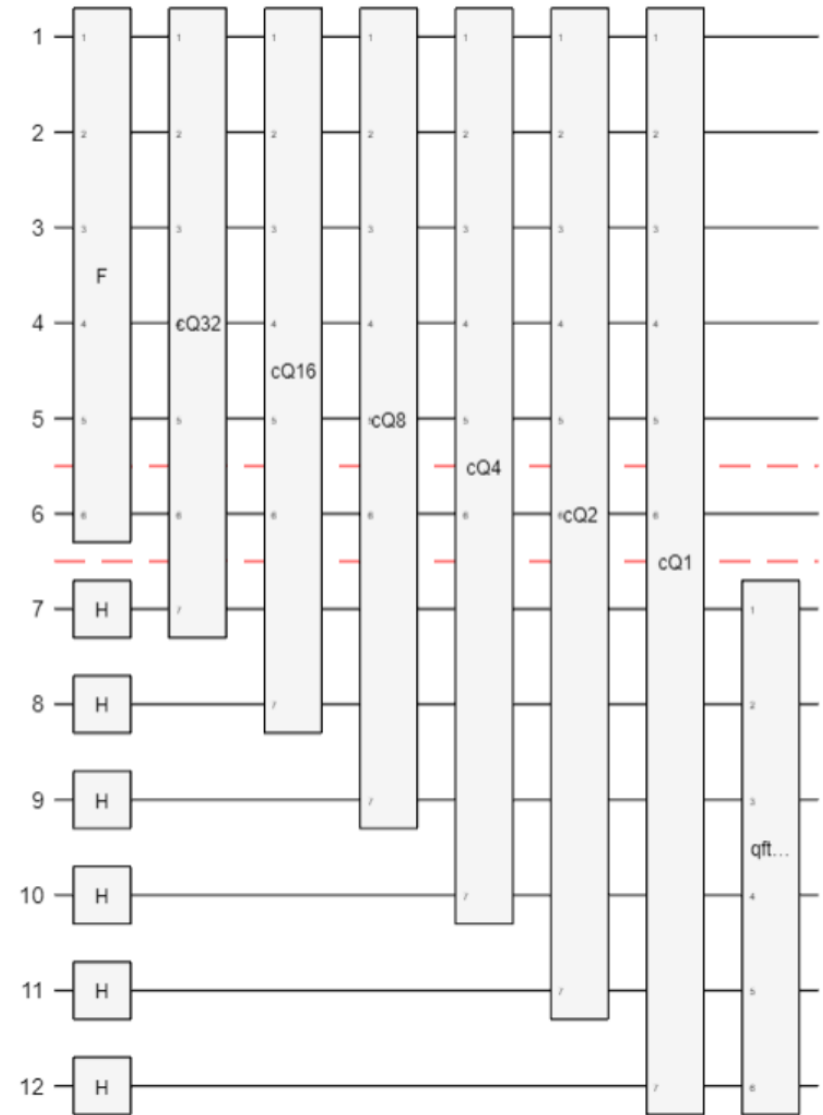
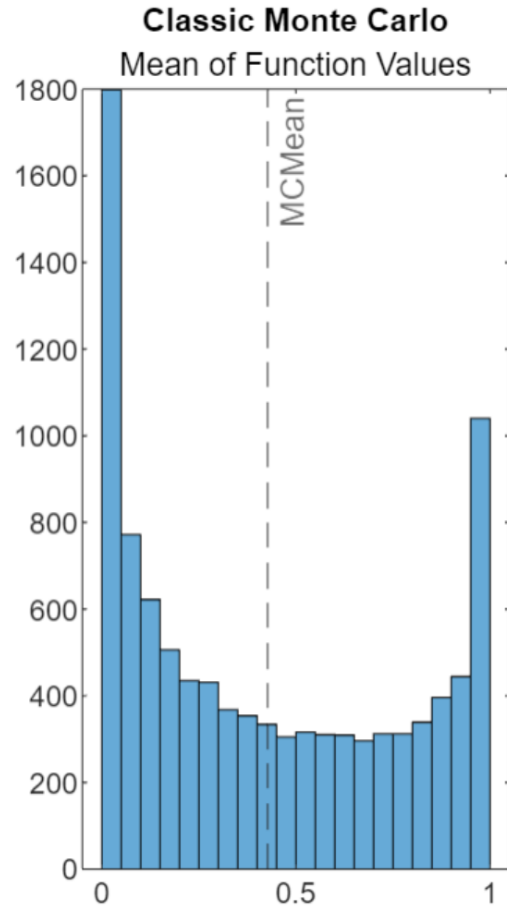
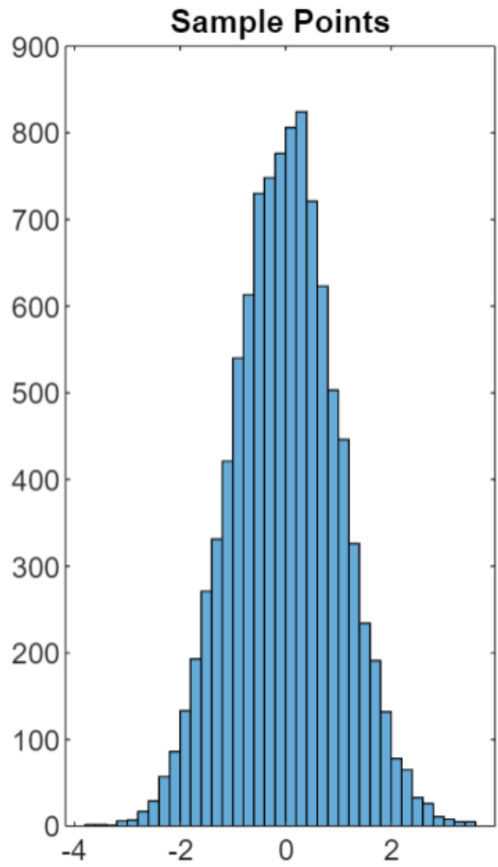
$$\begin{aligned}
 & \text{minimize : } \frac{1}{2} x^\top \Sigma x - x^\top \Sigma x_1 \\
 & \text{subject to : } \begin{cases} \sum_{i=1}^N x_i = 1 \\ x_i = x_{0,i} + x_i^+ - x_i^- \\ \sum_{i=1}^N x_i^+ + \sum_{i=1}^N x_i^- \leq \tau^+ \\ 0 \leq x_i, x_i^+, x_i^- \leq 1 \end{cases}
 \end{aligned}$$

Challenges: Computational Complexity;
Limited scalability;

MATLAB Quantum Portfolio Optimization

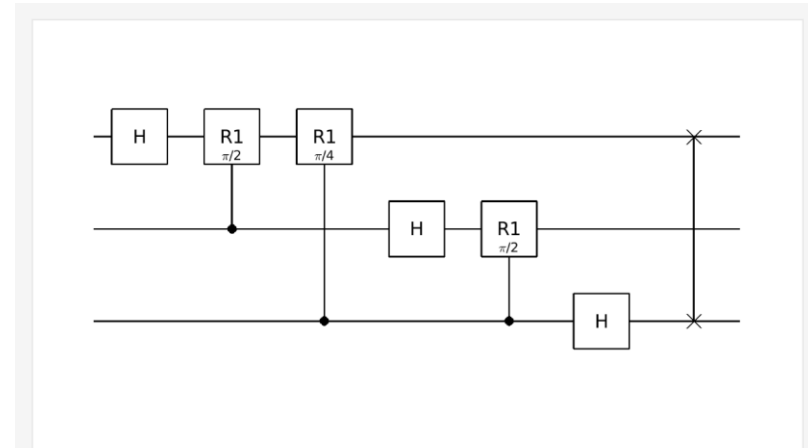


MATLAB Quantum Monte Carlo Simulation



Links to Quantum Resources

- Introduction
 - [Quantum Computing: Definition, How It's Used, and Example](#) *Investopedia*
- **On Mathworks.com**
 - [Quantum Computing with MATLAB Page](#)
 - [Quantum Computing Documentation](#)
- **MATLAB Examples**
 - [Quantum Computing MATLAB GitHub](#)
 - [Quantum Monte Carlo Simulation](#)



Build Quantum Circuits

Build quantum circuits using a sequence of quantum gates operating on one or more qubits. Use built-in, simple gates and create composite gates to capture complex operations and organize circuits.

- [Quantum Computing Circuit](#)
- [Types of Quantum Gates](#)

Recap – Quantum Computing is FAST, orders of magnitude FAST

Users can solve larger complex problems in shorter *timeframes*



Background into Quantum Computing



Example Portfolio Optimization and Simulation



Links to further resources

Thank you



Thank you for listening!
What are your user cases?



Sofia Ma



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