Quantum Computing Use Cases

Monte Carlo Simulation for Derivative Pricing

Keio University, Mizuho, IBM,MUFG



New Energy and Industrial Technology Development Organization (NEDO)

Keio University, Mizuho, IBMMUFG: Monte Carlo Simulation for Derivative Pricing [2019/04]

Concept

Industry	Finance
Process	securities
Method	Simulation
Category	Gate*

Background

- The financial industry runs **a large number of high-performance computers (classical computers) and performs various calculations.**
  - ✓ For example, for a financial product, **the price is calculated by computer over several hours at night to determine the price of the product the next day.**
- "Options trading," one type of derivatives, involves trading the "right" to buy and sell financial instruments such as stocks and bonds at a predetermined price, but **this price is calculated in large quantities every day by high-performance computers.**

Issues and motivation to be solved

- **One spends more than a few hours at night doing calculations on the computer, and the challenge is to speed up those calculations.**
- **Monte Carlo calculation** are used to calculate prices and since this is one of the calculations that are said to have advantages by using quantum computers, **financial institutions around the world are conducting research**
- **Keio, Mizuho, IBM-MUFG collaborated in joint research** to speed up Monte Carlo calculations.

Expected business benefits

- By eliminating the quantum Fourier transform, the number of qubits did not increase, and **the number of quantum gates was reduced by nearly 90%.**

Problem setting as a quantum computer

- The challenge is to calculate the price of an option trade, **one of derivatives, at high speed.**
- use an **amplitude estimation algorithm** to perform Monte Carlo calculations
  - ✓ To compute the amplitude estimation algorithm, an operation called quantum Fourier transform was necessary, but **a statistical method of post-processing on a classical computer eliminates the need for quantum Fourier transform and shortens the circuitry of the quantum computer.**

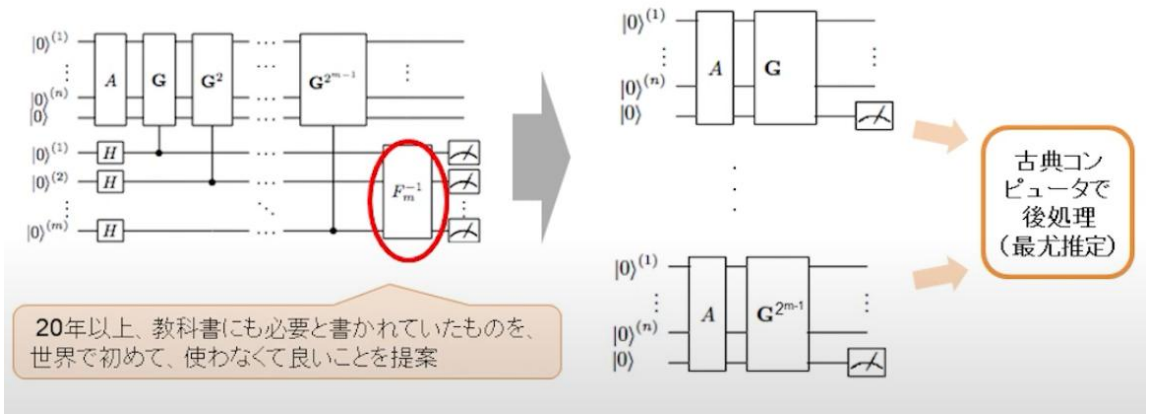


Image of the amplitude estimation algorithm

Reference: Tokyo Stock Exchange Management Department "Why finance firm MUFG is studying quantum computers", (https://money-bu-jpx.com/news/article028387/), FINOLAB CHANNEL"Why finance firm MUFG is studying quantum computers" (https://www.youtube.com/watch?v=MOkSZ-cWCG0)

*Gate（gate-based）: A computing approach in which operations are applied sequentially to qubits to perform calculations. Similar in concept to logic circuits in classical computers, it can address a wide range of problems.

More use cases are available on our website. We invite you to explore them.
https://www.quantum-computing-use-cases.nedo.go.jp/english/

More Use Cases

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This collection of use cases was obtained as a result of the work commissioned by the New Energy and Industrial Technology Development Organization (NEDO) "Cyber-Physical Development Business of Quantum/Classical Hybrid Technology/Study of Use Case of Quantum Technology" and the “Post-5G Information and Communications System Infrastructure Reinforcement R & D Project (Quantum Industrialization)/Comprehensive Study for Promoting the Industrialization of Quantum Computers”.