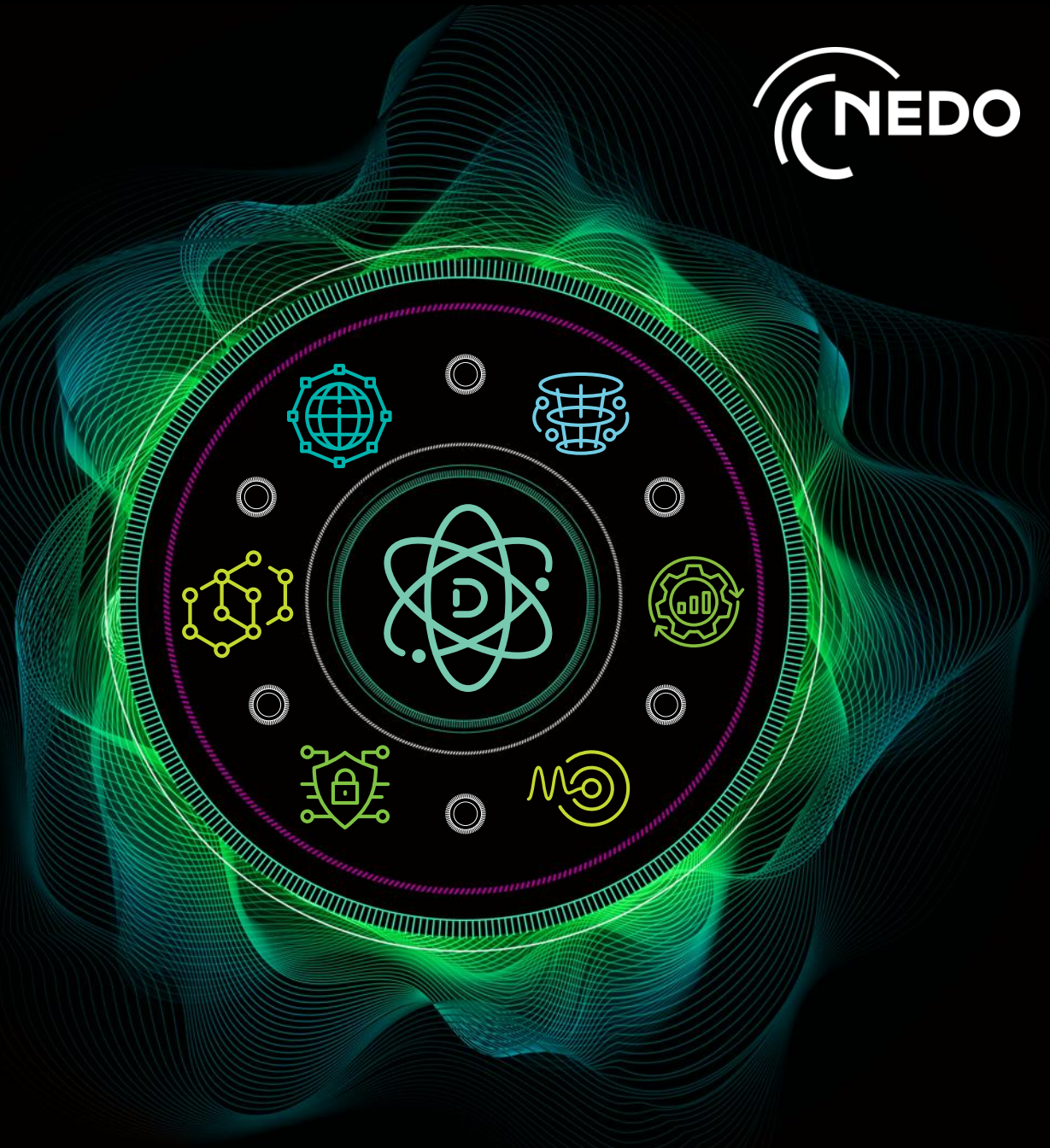
Quantum Computing Use Cases

Estimated Resources Required for Portfolio Optimization

Goldman Sachs, AWS



New Energy and Industrial Technology Development Organization (NEDO)

Goldman Sachs AWS:
Estimated Resources Required for Portfolio Optimization [2023/11]

Concept

Industry	Finance
Process	securities
Method	combinatorial optimization
Category	Gate*

Background

- One commonly studied use case in the quantitative finance space is portfolio optimization
- A quantum algorithm for solving portfolio optimization has been proposed, **which is expected to provide theoretical speedups compared to classical algorithms.**

Issues and motivation to be solved

- As quantum technology is expected to be used to solve portfolio optimization problems, **it is difficult to evaluate whether quantum computers can be used to theoretically achieve higher speeds, but it is important to estimate the number of qubits and other factors required to achieve such speeds.**
- Despite the difficulty, Goldman Sachs and AWS worked together to **estimate the quantum computer resources needed to solve portfolio optimization.**

Problem setting as a quantum computer

- **Build a portfolio that maximizes expected returns while minimizing the likelihood of risk deviating from expected values**
- The classical method widely used to solve portfolio optimization, the **Interior Point Method** * **(IPM), is replaced with the quantum interior point method (QIPM) using quantum technology and speed up is achieved.**
- **Estimate QIPM Quantum Resources** Based on the Number of stocks

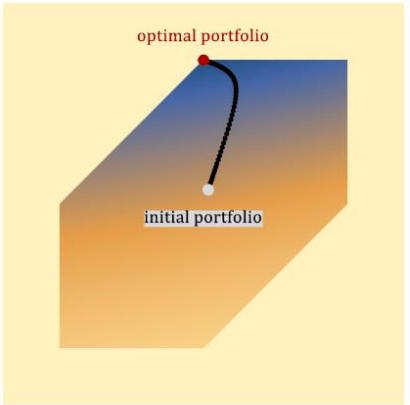


Diagram of Interior Point Method Solving Portfolio Optimization

Expected business benefits

- Based on an estimate of quantum computer resources with the number of stocks set at 100, it was shown that **8 million logical qubits are needed**
- **Quantum algorithms are still running in millions of years,** according to the estimates
- In the case of QIPM, they show that **it is not useful unless there is a significant improvement in the underlying algorithm,** and it has become clear that there are still significant challenges to its practical use.

*: An algorithm for optimization problems, characterized by convergence to optimization through feasible regions.

Reference: AWS"A detailed, end-to-end assessment of a quantum algorithm for portfolio optimization, released by Goldman Sachs and AWS" (https://aws.amazon.com/jp/blogs/quantum-computing/a-detailed-end-to-end-assessment-of-a-quantum-algorithm-for-portfolio-optimization-released-by-goldman-sachs-and-aws/)

*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

New Energy and Industrial Technology Development Organization (NEDO)
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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".