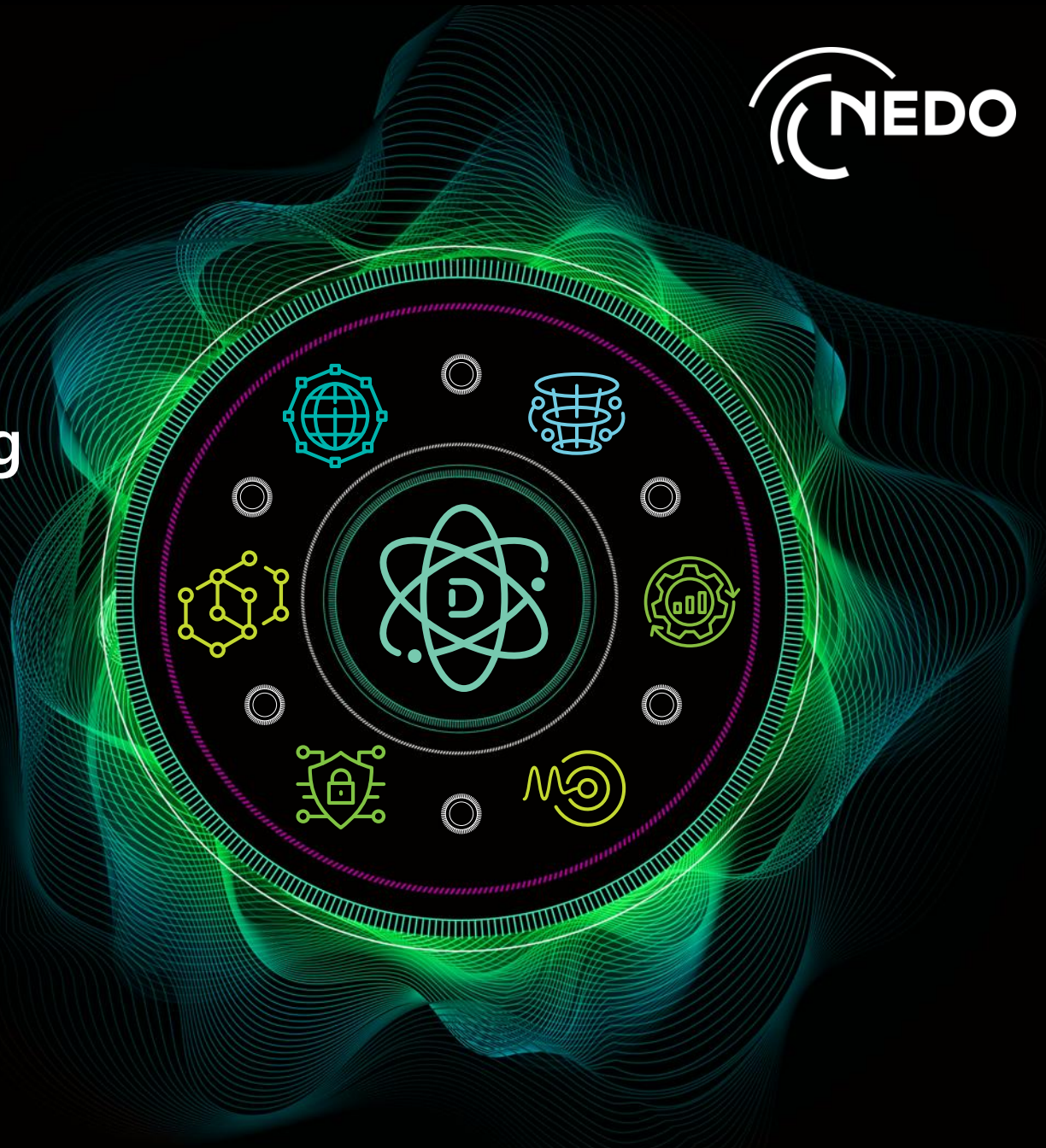
Quantum Computing Use Cases

Genome analysis technology using quantum AI

BlueMeme, Kyushu University



New Energy and Industrial Technology Development Organization (NEDO)

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Validation

Industry	Drug Discovery and Healthcare
Process	research and development
Method	AI
Category	Gate*

Background

- Transcription factors, which control the function of genes, are essential molecules for understanding life phenomena, disease research, and drug discovery.
- For many transcription factors, sufficient experimental data cannot be obtained, and high-precision analysis is difficult with conventional AI (deep learning). The decrease in prediction accuracy due to this "data shortage" is considered to be one of the factors hindering the progress of drug discovery and personalized medicine.
- BlueMeme and Kyushu University jointly develop QTFPred, a quantum AI model, as a new analysis method that uses quantum machine learning, a fusion of the principles of quantum computation and AI, to enable high-precision gene regulation prediction even with a small amount of data.

Issues and motivation to be solved

- For many transcription factors, the lack of experimental data makes it difficult to perform high-precision analysis with conventional AI.
- By utilizing quantum AI, we will attempt to improve the prediction accuracy, which hinders the progress of drug discovery and individual improvement, by predicting transcription factor binding patterns with high accuracy in a data-deficient environment.

Problem setting as a quantum computer

- QTFPred, a unique AI model equipped with a quantum computing mechanism, is designed to predict binding patterns with high accuracy even for transcription factors for which experimental data are limited.
- In tests using public human cell data, QTFPred achieved higher prediction accuracy than existing AI models on almost all tasks. Stable prediction performance was possible even under the condition of small amount of training data, and the performance was enough to be used in the research field.

Reference: BlueMeme Co., Ltd.: "BlueMeme and Kyushu University announce QTFPred, a quantum machine learning model that opens up new possibilities for drug discovery and medical research" (https://www.bluememe.jp/news/pressrelease/2025-12-02/), Kyushu University "BlueMeme, Kyushu University publish quantum AI genome analysis results in international journal" (https://www.kyushu-u.ac.jp/f/64123/25_1202_03.pdf)
*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.

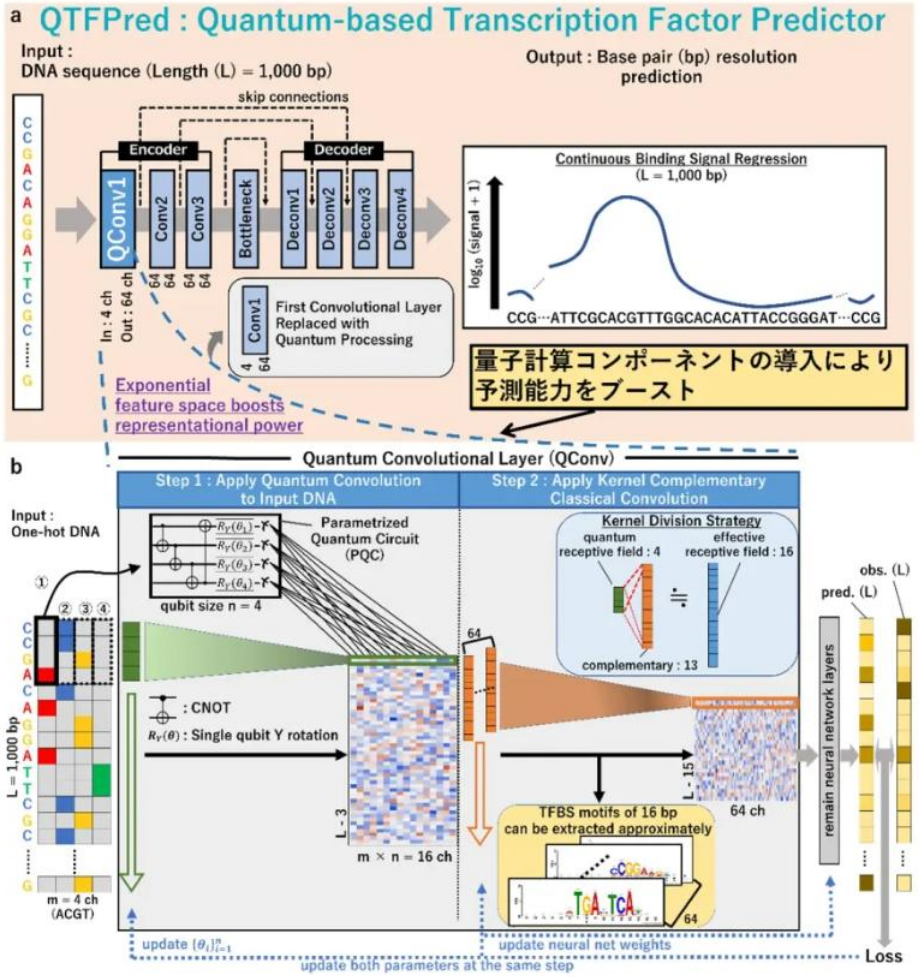
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Expected business benefits

- **Development of a new AI model that can accurately predict even small amounts of data: QTFPred, a unique AI model equipped with a quantum computing mechanism, was developed. Designed to predict binding patterns with high accuracy even for transcription factors with limited experimental data**
- **Demonstrated higher accuracy than conventional AI: QTFPred achieved higher prediction accuracy than existing AI models on almost all tasks tested using public human cell data. Stable prediction performance was possible even under the condition of small amount of training data, and the performance was enough to be used in the research field.**
- **Discovering patterns of cooperative binding of transcription factors: Analysis reveals how multiple transcription factors bind in concert. These results further deepen our understanding of life phenomena and offer new possibilities for drug discovery research.**
- **In the future, we will promote R & D in such directions as expansion of application areas** (application to chromatin analysis (ATAC-seq) and disease-related genomic regions), **verification with real quantum computers (development to large-scale analysis in the future), and development to drug discovery and personalized medicine** (application to disease risk prediction and target molecule search).



Overview of QTEPred

Reference: BlueMeme Co., Ltd.: "BlueMeme and Kyushu University announce QTFPred, a quantum machine learning model that opens up new possibilities for drug discovery and medical research" (https://www.bluememe.jp/news/pressrelease/2025-12-02/)
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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”.