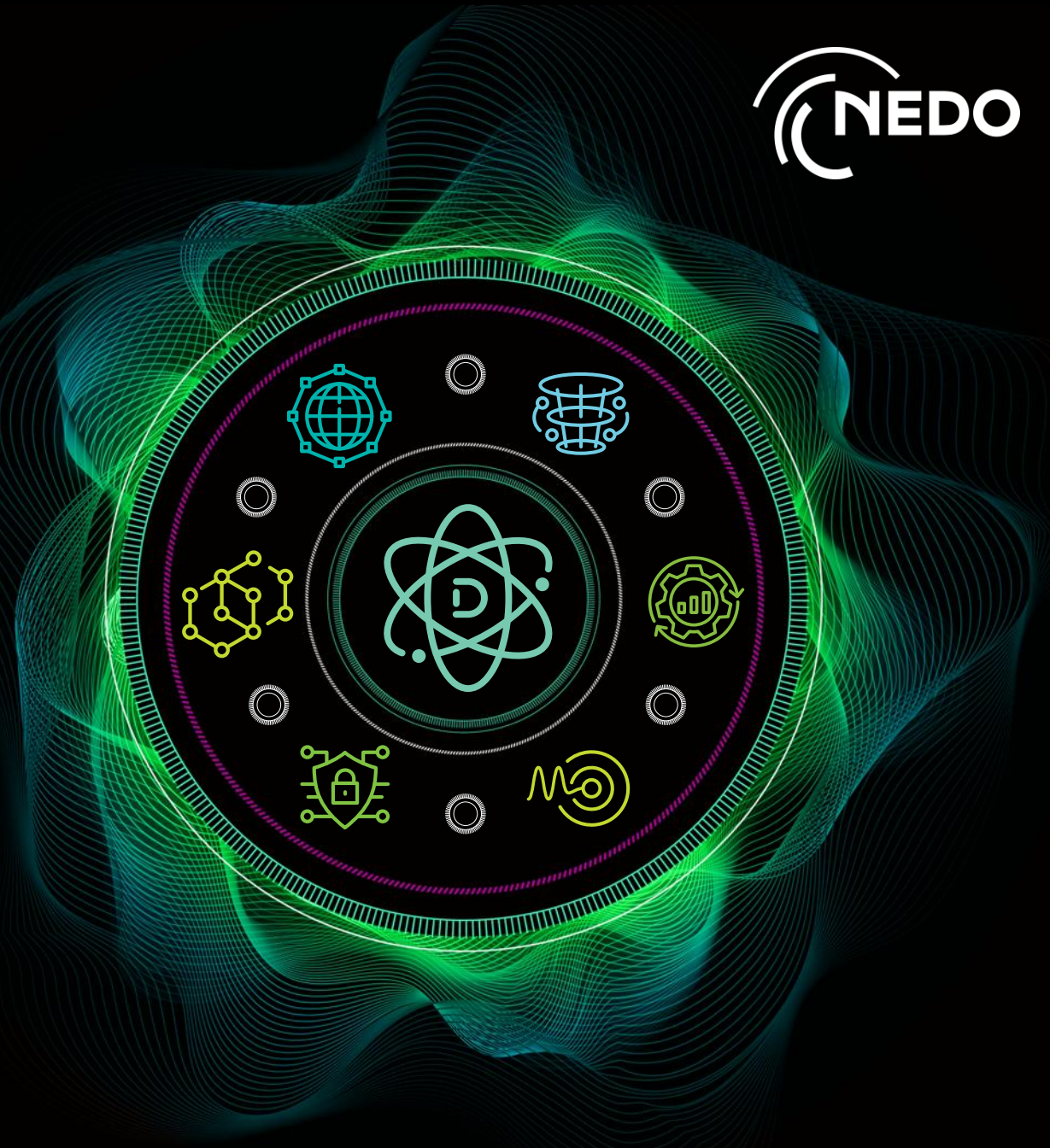
Quantum Computing Use Cases

Lowering the Cost of LLM in Biomedical Information Analysis

BlueMeme



New Energy and Industrial Technology Development Organization (NEDO)

BlueMeme: Lowering the Cost of LLM in Biomedical Information Analysis [2023/6] 1/2

Concept

Industry	Other
Method	AI
Process	inference
Category	Gate*

Background

- **In recent years, biomedical information analysis *, which analyzes biological data such as genome data and clinical information such as medical records of patients by computational science techniques such as machine learning and statistics, has attracted attention.**
  - ✓ Biomedical information analysis refers to the use of information technology to analyze and process biological data in the fields of biology, medicine, and life sciences.
- Moreover, **LLMs (large-scale language models), which are being developed and popularized, have begun to be used in biomedical information analysis,** but the economic burden of large computational resources and high costs has made it virtually **difficult for SMEs, local governments, and research institutes to develop and operate LLMs.**

Issues and motivation to be solved

- **Dramatically reduce LLM operating costs with quantum AI**
  - ✓ learn and infer LLMs on quantum computers that were learned on classical computers
- By significantly reducing the number of LLM parameters, **significantly reduce the cost of running the model**
- **More research institutions and companies can contribute to clinical applications** by developing and operating biomedical language models inexpensively.

Expected business benefits

- **The inference cost exceeds the learning cost when deploying the trained model through APIs, and** ChatGPT is estimated to cost more than $700,000 (approximately ¥100 million) per day to operate, and supporting customer service using GPT -4 **is estimated to cost SMEs more than $21000 (approximately ¥3 million) per month**
- The latest research in the field of quantum AI **demonstrates the quantum advantage of implementing LLMs on a quantum computer to train and reason with less memory than would be required on a classical computer**.
- By developing and operating biomedical language models cheaply, **we aim to enable more research institutions and companies to contribute LLM to clinical applications.**

Reference: DS100"BlueMeme and Kyushu University collaborate on quantum AI language models" (https://ds100.jp/news/2023/06/21/bluememe%E3%81%A8%E4%B9%9D%E5%B7%9E%E5%A4%A7%E5%AD%A6%E3%80%81%E9%87%8F%E5%AD%90ai%E3%82%92%E7%94%A8%E3%81%84%E3%81%9F%E5%A4%A7%E8%A6%8F%E6%A8%A1%E8%A8%80%E8%AA%9E%E3%83%A2%E3%83%87%E3%83%AB%E6%A7%8B/), bluememe “Initiatives in the field of biomedical information analysis using quantum computing ” (https://www.bluememe.jp/research-and-development/)
*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.

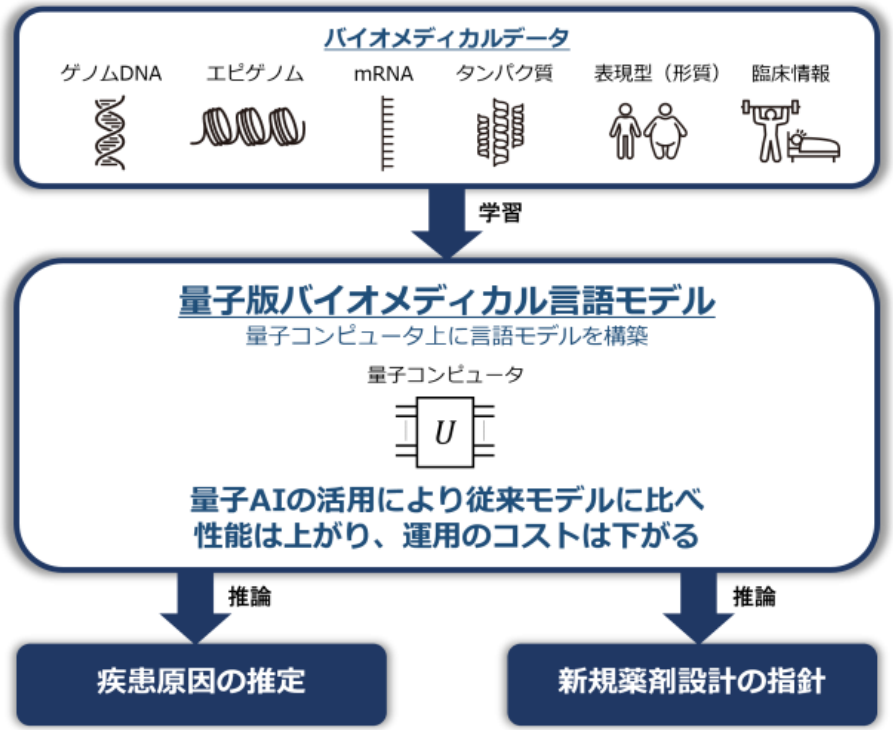
BlueMeme: Lowering the Cost of LLM in Biomedical Information Analysis [2023/6] 2/2

Concept

Industry	Other
Method	AI
Process	inference
Category	Gate*

Problem setting as a quantum computer

- **The latest omics data with high precision and high resolution is used as a learning basis of omics language model using quantum AI technology.**
  - ✓ Omics language models are artificial intelligence models that train and develop vast amounts of omics data (information about a comprehensive set of biomolecules) to specialize in biological data analysis.
- Quantum AI reduces the number of parameters in LLMs to **reduce the computing costs of learning and inference**
- We will conduct performance verification using computational infrastructure such as simulations on GPU supercomputers and real quantum computers.



Omics language model using quantum AI technology

Reference: bluemememe "Initiatives in the field of biomedical information analysis using quantum computing" (https://www.bluememe.jp/research-and-development/)
*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)
AI and Robotics Department (e-mail: quantum_ai@ml.nedo.go.jp)

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”.