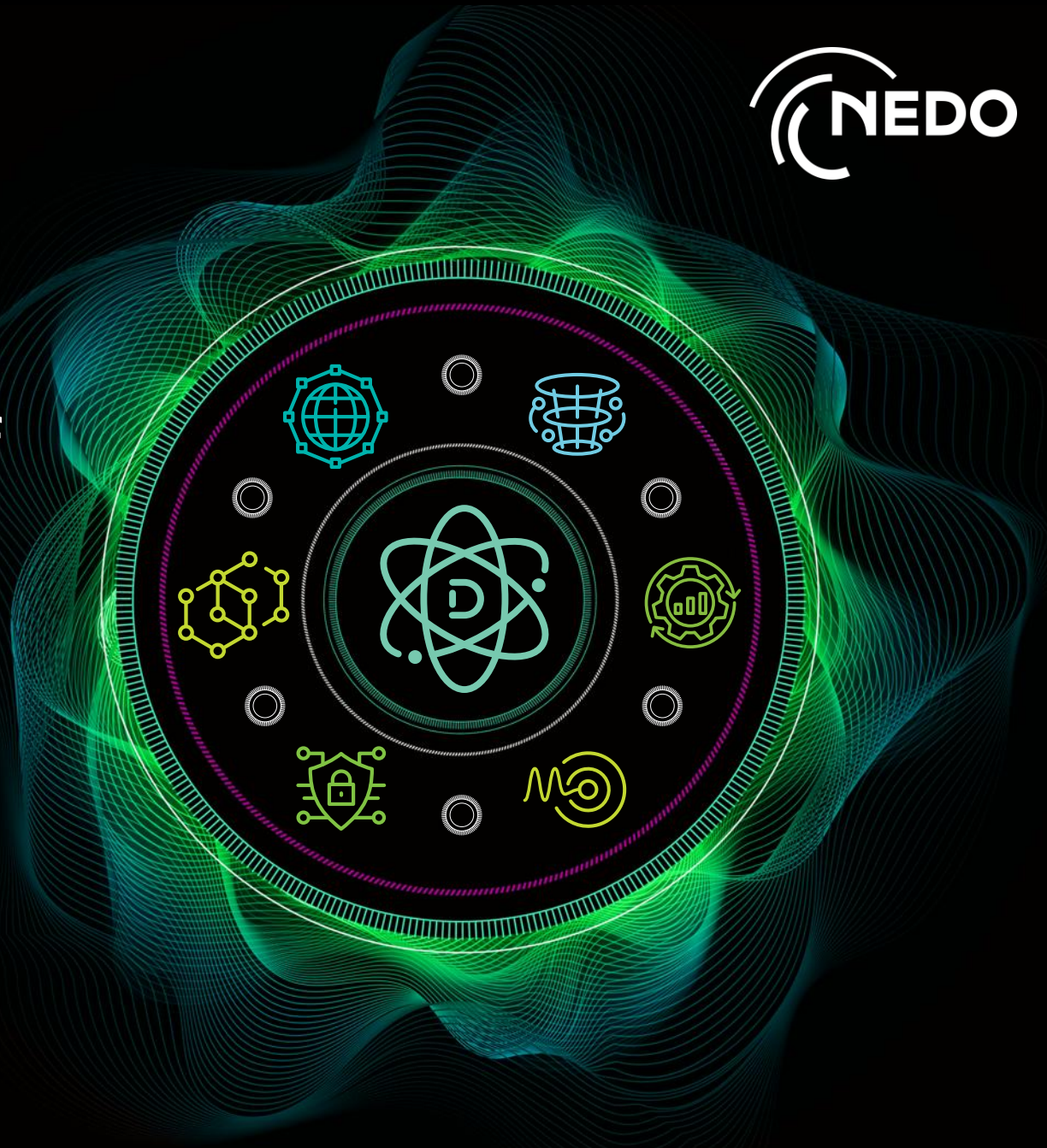
Quantum Computing Use Cases

Demonstration of effectiveness of quantum machine learning for quality inspection of agricultural products

Keio University, TOPPAN Holdings



New Energy and Industrial Technology Development Organization (NEDO)

Keio University, TOPPAN Holdings:Demonstration of effectiveness of quantum machine learning for quality inspection of agricultural products [2025/3] 1/2

Validation

Industry	Other
Process	Other
Method	AI
Category	Gate*

Background

- In the field of image inspection in manufacturing and inspection processes, there is a need for a technology for discriminating between normal and abnormal products with high accuracy. Agricultural products in particular have large variations in shape and internal structure, making it difficult to collect and label sufficient training data.
- In quantum machine learning, the "quantum kernel method" is drawing attention as an approach that can improve separation capability even for small data by mapping data to a high-dimensional quantum feature space.
- Keio University and TOPPAN Holdings verified the effectiveness of SVM using quantum kernel for internal vine cracking of apple

Issues and motivation to be solved

- In agricultural and product quality inspection, it is necessary to detect various abnormal patterns by learning from small amounts of data, which is a difficult problem with conventional machine learning.
- Utilizing the classification capability of quantum kernels in a high-dimensional space, we will explore the applicability of quantum kernels to non-destructive testing of agricultural products.

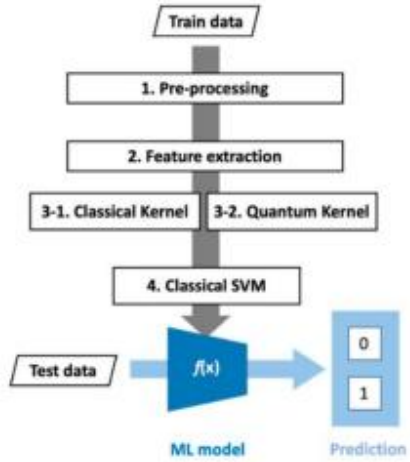


Image of the inspection process using classical and quantum kernel methods

Reference: Keio University: "Realization of High-precision Abnormality Detection Technology Using Quantum Kernel — Demonstration of the Effectiveness of Quantum Machine Learning with Small Data and Promotion of Manufacturing DX —" (https://www.keio.ac.jp/ja/press-releases/files/2025/3/24/250324-1.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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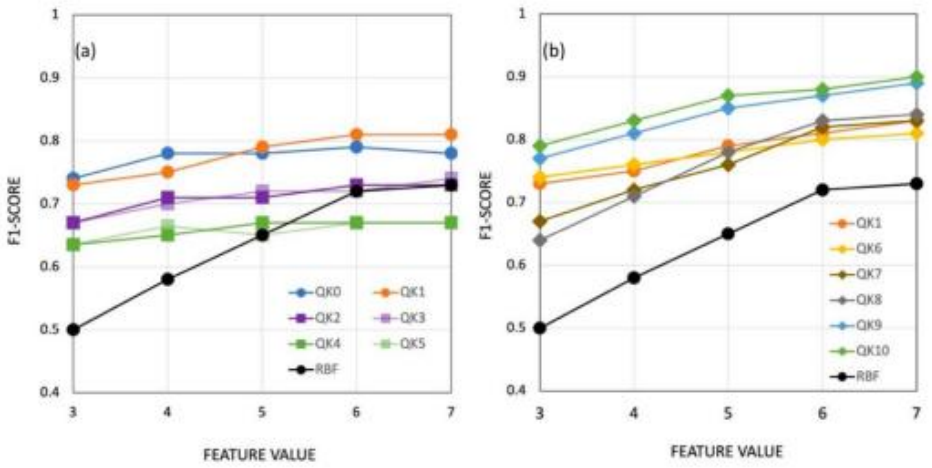
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Problem setting as a quantum computer

- Using a dataset of light transmissive images to detect internal cracks in apples that cannot be seen visually
- Preprocessing and feature extraction are performed on the data, and machine learning is performed using a Support Vector Machine (SVM) embedded with a quantum kernel.

Expected business benefits

- Application not only to agricultural products but also to quality inspection in the manufacturing industry, technology deployment to fields requiring abnormality detection with small amounts of data, and promotion of manufacturing DX (digital transformation)



Relationship between feature number and F1 score based on quantum simulator calculation result
It is shown that the quantum kernel (QK9, QK10) outperforms the classical kernel (RBF).

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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

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