Quantum kernel learning Model constructed with small data

Takao Tomono[1), 2)] , Kazuya Tsujimura[3)]

1) Graduate school of Media and Governance, Keio University
2) Graduate school of Science and Technology, Keio University
3) Digital Innovation Div. Toppan holdings

ABSTRACT:
We are trying to solve the problem of image-based inspection with quantum machine learning. We are building a quantum machine learning model, assuming that the expressive power of the quantum kernel space may be superior to that of the classical kernel space. Through trials of the image inspection process, including not only factory products but all products (including agricultural products), we recognized the importance of trials with real data. Through these trials, we have confirmed the possibility of building a learning model with a small amount of data and have reported that the building process of the learning model is different from that of the classical model. In this study, we used various quantum kernels to train with a small image data set. After screening with a simulator, we confirmed the usefulness of the quantum kernel on an actual IBM machine. The learning model using a certain quantum kernel showed a significantly higher AUC, an evaluation index, compared to the learning model using the classical kernel. It has been reported that quantum kernel learning, like quantum circuit learning, exhibits a phenomenon similar to the Baren Plateau. One of the causes of this is quantum entanglement. Quantum entanglement is a fundamental quantum characteristic. However, there is a trade-off between its relationship with performance degradation in quantum kernel concentration. We will discuss about this relationship.