Problem Statement

Quantum Computing promises to solve problems that are currently not solvable by classical algorithms by the means of quantum mechanical phenomena and quantum nature of the information. While machine learning promises to leverage classical computation to solve ever more complicated problems. More research has been made in the field of deep neural networks (deep learning) and big data. There are some algorithms that outperforms the deep learning algorithms. One of those is Kernel Methods, considered as cornerstone of classical machine learning.

The field of Machine learning stands to benefit from quantum algorithms, offering potential for the improved scalability and accuracy in solving complex tasks. [refereed from efficient subsampling (3, 22, 28, 30), embedding paper (8, 9, 10)]. The use of quantum fidelity kernels for classifications tasks is one of the emerging fields in the research. A few relevant and practical applications in quantum machine learning with kernel methods can be seen in [efficient paper (15, 17, 22, 23, 29, 12, 13, 24, 25, 36, 37). And another milestone was the introduction of concept kernel alignment. The method of kernel alignment for adjusting the kernel, specific for data can also be implemented in the field of quantum kernel alignment. QKA adapts classical kernel alignment to utilize quantum kernels, enhancing the model’s precision by aligning the more effectively with core data patterns [subsampling method (12, 14, 18)].

Despite the promise of quantum machine learning and quantum kernel methods as seen the methods used until now. Quantum Kernel Methods are skeptical about their practical applications of due to challenges associated with scalability. Kernel methods bring with them one main disadvantage, for generating the kernel matrix in one iteration entails quadratic computational complexity in the number of training samples. As mentioned in [efficient sampling] number of circuits at each training step scales quadratically with dataset size and in the presence of noise it has been shown to scale quartically [efficient sampling (13)]. These challenges of scalability and computational complexity underscore the need to develop methods that can reduce the computational demands of quantum kernel alignment.

[Figure that shows kernel executions for full kernel, sampling, quack methods]