Machine learning on a quantum computer

Background
Quantum computing is expected to outperform classical computational capabilities for solving certain problems, e.g., factoring large numbers and simulating quantum systems. However, this performance requires much larger quantum processors than are currently available. Therefore, many researchers investigate whether some advantage could also be found in solving other types of problems, using less resources. A promising direction is variational quantum algorithms. This class of algorithms can be applied to numerous problems, including the task of classification, which otherwise is mainly the domain of classical machine learning. The quantum variational classification algorithms are an example of quantum machine learning.

Problem description
The project aims to investigate and compare classical kernel methods with quantum kernel methods. The focus is here to use currently available quantum devices (noisy intermediate-scale quantum [NISQ] devices) and use a variational approach for training. This allows us to reduce the resources needed on the quantum device and outsource some computations to a classical computer.

Workflow
We will first work on understanding the theoretical background for quantum kernels as well as classical kernel methods (the focus will be on classical support vector machines) and how these can be used for classification. We will then program a quantum computer or simulator to solve the classification problem while using a classical kernel as well as a quantum kernel.

Note: Supervision in English, Report in Swedish

Team size
3-6 students.

Student background
F, GU Fysik, TM, Kf, D.

Literature
[3] pennylane.ai/qml, Variational classifier

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