Introduction to quantum machine learning - SGH

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1 Introduction

Until recently, technological development was based on reducing the size of transistors and increasing the computing power of processors. Due to the physical aspects of nature, this process must, from a certain point in, take into account the limitations of quantum physics. The future, however, may take advantage of other tools that go beyond classical computing power. Although the construction of quantum computers is still an engineering stage, it turns out that it is already possible to identify and use them to create algorithms that can be used in the field of machine learning. The use of quantum algorithms allows to reduce the processing time of large amounts of data, and thus extends the possibilities of data processing and modelling. The libraries presented during the classes - IBM qiskit or Pennylane (python) - allow for a simple and quick construction of any quantum algorithm. These algorithms, such as the Grover algorithm, can be used for many computational machine learning problems or for the construction of quantum neural networks.

2 Abstract

1. History of classical and quantum computers and their applications. Quantum effects used for acceleration of calculations.
2. Classic logic gates - Boola algebra, encryption
3. Vector spaces, quantum states, representation of classical and quantum bits
4. Quantum logic gates in simple algorithms and quantum circuits
5. Quantum Machine Learning in business - methods and implementations
6. Preparation of the python environment using the Docker tool *here will be nice have lectures about AWS Bracket*
7. Quantum bits using the IBM qiskit, cirq, and pennylane libraries
8. One-qubit logic gates - random bit generator

9. Multi-qubit logic gates
10. Shor's factorisation algorithm, Grover search. Python realisations.
11. Quantum Gradients and Quatnum-aware optimizers on pennylane.
12. HHL algorithm with implementation *need help with examples*
13. Quantum Approximate Optimisation Algorithm *need help with examples*
14. Community Detection with Hybrid Quantum Annealing *need help with examples*
15. Variational quantum classifier, Variational quantum eigensolver *need help with examples*

Old version:

1. Classical and quantum perceptron - implementation in the qiskit library
2. Variational quantum classifiers - data classification Iris
3. MNIST data classification using the PyTorch Quantum library
4. qPCA algorithm with the use of financial instrument price modelling
5. Realisations of quantum artificial neural networks - introduction