

Introduction to Quantum

Machine Learning & VQE

Quantum Software Development Journey: From Theory to Application with Classiq - Part 3

Program Overview

Quantum Software Development Journey: From Theory to Application with Classiq

- Week 1: Introduction to the Classiq Platform & High-Level Functional Design
- Week 2: Git & GitHub Software Development Skills
- Week 3: Introduction to Quantum Machine Learning and VQE
- Week 4: QNN and Advanced Applications

Session Overview

Introduction to Quantum Machine Learning and VQE

Introduction - 30 min

- What is it QML?
- What is it VQE?

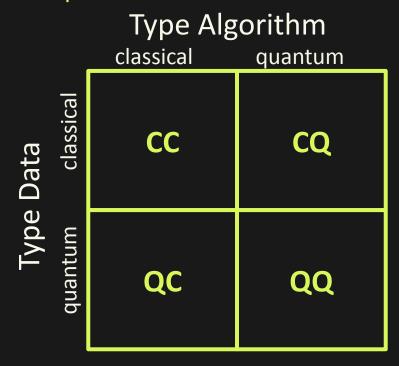
Hand-On Practice - 60 min

VQE Implementation with Classiq

Let's practice!

Quantum Machine Learning

- QML: The intersection between quantum computing and machine learning
- Mostly referred to ML algorithms for the analysis of classical data executed on/ assisted by a quantum computer



Machine Learning - Basic Concepts

- Learning from data to make predictions or decisions, rather than following a step-by-step instruction set (as in classical coding)
- Key Concepts:
 - Training Data
 - Features (predictors) and Labels (target variable), E.g. House pricing:
 - Features: Size of the house, number of bedrooms, location, age of the house, etc.
 - Labels: The actual price of the house (a continuous numerical value)
 - Training and Testing Phases
 - Model Evaluation



Training Machine Learning Model

- Initializing Model Parameters
 - Setting initial values for the parameters that the model will learn.
- Forward Propagation
 - Passing the input data through the model to get predictions
- Calculate Loss
 - Measuring the difference between the model's predictions and the actual target values using a loss function.
- Backpropagation and Optimization
 - Adjusting the model parameters to minimize the loss using optimization algorithms like gradient descent.

Parametric Quantum Circuits (PQC)

- Quantum circuits composed of parameterized gates
 - Such as: $R_{\nu}(\theta)$, $R_{\nu}(\theta)$, $R_{7}(\theta)$, controlled rotations and etc.
- Training these parameters: A circuit capable of learning!
- Ansatz: Specific form of a PQC tailored for a particular problem:
 - Represents a hypothesis about the structure of the quantum state or the solution space.
 - Designed to efficiently explore the solution space with a minimal number of parameters.



Variational Quantum Eigensolver (VQE)

- VQE is used to find the ground state energy of quantum systems.
 - Choose PQC which capture the Hamiltonian of a system
 - Calculate The expectation value
 - Classical optimizer

Encoding other information in the Hamiltonian and anzatz (QAOA)

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-CLASSIQ

THANK YOU

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