Quantum Approximate Optimization Algorithm

Enhancing stock portfolio management using quantum machine learning

FYS5419 – Quantum Computing and Quantum Machine Learning

Project 2

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Abstract

Financial markets exhibit pronounced non-stationarities driven by structural breaks, macroeconomic shocks, and evolving investor behavior. This project investigates the use of machine learning methods for identifying and modeling regime changes in financial time series. We consider supervised and unsupervised approaches to regime detection, including clustering-based methods and probabilistic state models, and evaluate their ability to capture shifts in volatility, return dynamics, and cross-asset dependencies. Model performance is assessed using historical market data under realistic out-of-sample settings. The results highlight both the potential and limitations of machine-learning-based regime modeling in quantitative finance, with implications for risk management, portfolio allocation, and adaptive trading strategies.

1 Introduction

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Quantum computing combines ideas from linear algebra, probability theory, and computer science to enable new computational paradigms beyond classical algorithms. Introductory expositions such as Rieffel and Polak (1998) and Olivares (2020) explain how qubits, superposition, and entanglement form the foundation of quantum information processing, while more mathematically oriented treatments emphasize operator theory and Hilbert space methods (Scherer 2019). From a programming perspective, practical workflows and software abstractions are discussed in Hundt (2022) and Hidary (2019).

One important application area is quantum machine learning, where hybrid classical–quantum models and variational circuits are increasingly studied (Schuld and Petruccione 2018; Conti 2023; Pattanayak 2021). These methods often rely on variational optimization frameworks similar to those used in near-term quantum algorithms.

A prominent example is the Quantum Approximate Optimization Algorithm (QAOA), which provides a variational approach to solving combinatorial optimization problems on noisy intermediate-scale quantum (NISQ) devices. The theoretical structure and implementation considerations of QAOA are described in Zhou et al. (2018), while introductory and experimental perspectives can be found in (Giovagnoli 2020; Irfan 2023). Together, these works illustrate how hybrid optimization loops between classical and quantum processors form a central paradigm in modern quantum algorithm design.

More broadly, quantum computation and quantum information theory provide the conceptual framework linking these developments, including complexity-theoretic motivation and algorithmic primitives such as amplitude amplification and phase estimation (Michaelson and Isaac 2010).

The QAOA workflow can also be implemented using modern quantum SDKs such as Qiskit, which provide end-to-end tutorials covering circuit construction, parameter optimization, and execution on simulators or hardware (IBM Quantum 2024).

2 Methods

This is the methods section, lorem ipsum

3 Results

These are the results

4 Conclusion

References

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5 Appendix