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Quantum Electronics

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Section Editor-in-Chief:

Prof. Dr. Lucas Lamata
Universidad de Sevilla, Sevilla, Spain

About the section *Quantum Electronics*

This section publishes original and significant contributions to the theory and experimental implementations on the topic of quantum electronics. More specifically, articles will be considered on superconducting circuits, semiconductor qubits, NV centers, and electron qubits in general. Connections to atomic, molecular, and optical physics, as well as to mechatronic systems (i.e., robots and drones) when combined with quantum science, are also welcome. We will consider as well the relation to quantum artificial intelligence and quantum machine learning of electronic quantum systems. Reviews on these subjects as well as Special Issues dealing with specific topics are also published.

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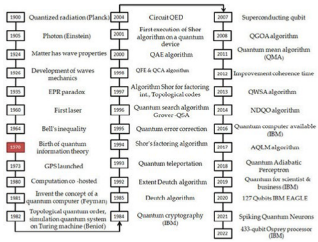
Section Quantum Electronics

Selected Papers

DOI:10.3390/electronics12112379

Quantum Machine Learning—An Overview

Authors: Kyriaki A. Tychola, Theofanis Kalampokas and George A. Papakostas

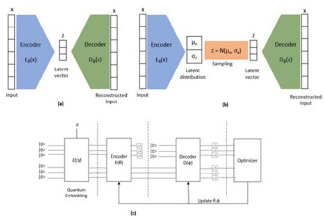


Abstract: Quantum computing has been proven to excel in factorization issues and unordered search problems due to its capability of quantum parallelism. This unique feature allows exponential speed-up in solving certain problems. However, this advantage does not apply universally, and challenges arise when combining classical and quantum computing to achieve acceleration in computation speed. This paper aims to address these challenges by exploring the current state of quantum machine learning and benchmarking the performance of quantum and classical algorithms in terms of accuracy. Specifically, we conducted experiments with three datasets for binary classification, implementing Support Vector Machine (SVM) and Quantum SVM (QSVM) algorithms. Our findings suggest that the QSVM algorithm outperforms classical SVM on complex datasets, and the performance gap between quantum and classical models increases with dataset complexity, as simple models tend to overfit with complex datasets. While there is still a long way to go in terms of developing quantum hardware with sufficient resources, quantum machine learning holds great potential in areas such as unsupervised learning and generative models. Moving forward, more efforts are needed to explore new quantum learning models that can leverage the power of quantum mechanics to overcome the limitations of classical machine learning.

DOI:10.3390/electronics12112402

Unlocking the Potential of Quantum Machine Learning to Advance Drug Discovery

Authors: Maria Avramouli, Ilias K. Savvas, Anna Vasilaki and Georgia Garani

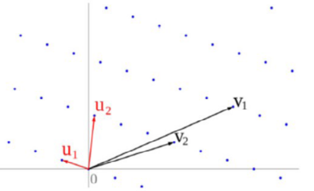


Abstract: The drug discovery process is a rigorous and time-consuming endeavor, typically requiring several years of extensive research and development. Although classical machine learning (ML) has proven successful in this field, its computational demands in terms of speed and resources are significant. In recent years, researchers have sought to explore the potential benefits of quantum computing (QC) in the context of machine learning (ML), leading to the emergence of quantum machine learning (QML) as a distinct research field. The objective of the current study is twofold: first, to present a review of the proposed QML algorithms for application in the drug discovery pipeline, and second, to compare QML algorithms with their classical and hybrid counterparts in terms of their efficiency. A query-based search of various databases took place, and five different categories of algorithms were identified in which QML was implemented. The majority of QML applications in drug discovery are primarily focused on the initial stages of the drug discovery pipeline, particularly with regard to the identification of novel drug-like molecules. Comparison results revealed that QML algorithms are strong rivals to the classical ones, and a hybrid solution is the recommended approach at present.

DOI:10.3390/electronics12122643

Evaluation and Comparison of Lattice-Based Cryptosystems for a Secure Quantum Computing Era

Authors: Maria E. Sabani, Ilias K. Savvas, Dimitrios Poulakis, Georgia Garani and Georgios C. Makris

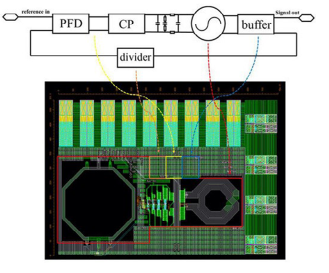


Abstract: The rapid development of quantum computing devices promises powerful machines with the potential to confront a variety of problems that conventional computers cannot. Therefore, quantum computers generate new threats at unprecedented speed and scale and specifically pose an enormous threat to encryption. Lattice-based cryptography is regarded as the rival to a quantum computer attack and the future of post-quantum cryptography. So, cryptographic protocols based on lattices have a variety of benefits, such as security, efficiency, lower energy consumption, and speed. In this work, we study the most well-known lattice-based cryptosystems while a systematic evaluation and comparison is also presented.

DOI:10.3390/electronics12153237

A Cryo-CMOS, Low-Power, Low-Noise, Phase-Locked Loop Design for Quantum Computers

Authors: Kewei Xin, Mingche Lai, Fangxu Lv, Kaile Guo, Zhengbin Pang, Chaolong Xu, Geng Zhang, Wenchen Wang and Meng Li



Abstract: This paper analyzes the performance requirements that need to be met by a clock generator applied to a low-temperature quantum computer and analyzes the negative effects on the clock generator circuit under low-temperature conditions. In order to meet the performance requirements proposed in this paper and suppress the negative effects brought about by the low temperature, a clock generator for ultra-low-temperature quantum computing is designed. This clock generator is designed by using F-CLASS Voltage Controlled Oscillator (VCO), power filter, tail resistor, differential charge pump, and other techniques. And the noise characteristics of the clock generator are analyzed by Impulse Sensitive Function (ISF) and simulation results. After simulation tests, the average power consumption of the clock generator designed in this paper is 7 mW, the phase noise is −121 dBc/Hz@1 MHz, and the jitter is 62 fs. The performance of the clock generator meets the performance requirements proposed in this paper, and the reduction in the corner frequency proves that the circuit will have better performance at low temperatures.

Invitation to Submit

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Guest Editors: Dr. He-Liang Huang, Dr. Chu Guo, Dr. Zu-En Su and Dr. Shi-Lei Su
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Quantum Computation and Its Applications
Guest Editors: Prof. Dr. Ilias K. Savvas and Dr. Apostolis Xenakis
Deadline: 15 December 2023

Quantum Computing System Design and Architecture
Guest Editor: Prof. Dr. Koen Bertels
Deadline: 31 December 2023

Advances in Silicon Quantum Electronics
Guest Editors: Prof. Dr. Xihua Wang and Dr. Lingju Meng
Deadline: 31 March 2024

Quantum and Optoelectronic Devices, Circuits and Systems, 2nd Edition
Guest Editor: Prof. Dr. Lucas Lamata
Deadline: 15 May 2024

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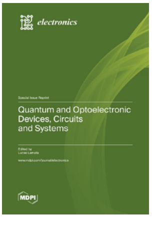

Quantum and Optoelectronic Devices, Circuits and Systems
Guest Editor: Lucas Lamata

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