"Introduction to Quantum Algorithms"

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Time and date: 2 hours every day June 26-30, 2023

Location: TBD

References:

Qiskit Textbook (https://qiskit.org/learn)
Learn quantum programming with PennyLane
TensorFlow Quantum
Quantum Computing: A Gentle Introduction by E. Rieffel and W. Polak
Qiskit YouTube channel
2020 Qiskit Global Summer School on Quantum Computing and Quantum Hardware
Playlist: Introduction to Quantum Computing and Quantum Hardware
Quantum Algorithm Implementations for Beginners
Introduction to Classical and Quantum Computing by T. Wong
Quantum Computation and Quantum Information by M. Nielsen and I. Chuang

- Lecture 1: single qubit

    1. Notation
    2. Quantum measurements
    3. Different computational bases
    4. Single qubit gates

- Lecture 2: system with two or more qubits

    1. Tensor product
    2. Two qubit gates: CNOT, SWAP, CPhase
    3. Three qubit gates
    4. No cloning theorem
    5. Superdense coding
    6. Teleportation

- Lecture 3: introduction to quantum algorithms

    1. A simple quantum algorithm with two qubits
    2. Deutsch algorithm
    3. Deutsch-Jozsa algorithm

- Lecture 4: more quantum algorithms

    1. Berstein-Vazirani algorithm
    2. Simon's problem

- Lecture 5: Quantum Fourier Transformation

  1. Discrete Fourier transformation
  2. Quantum Fourier transformation
  3. Quantium phase estimation and finding eigenvalues

- Lecture 6: Shor's algorithm

  1. Period finding to factor an integer
  2. RSA encryption
  3. Period finding / order finding
  4. Shor's algorithm
  5. Generalization

- Lecture 7: search algorithm

  1. Grover's search algorithm
  2. Extension to more than one special value
  3. Quantum counting

- Lecture 8: introduction to quantum machine learning

  1. Distance-based classifier
  2. Quantum optimization
  3. Quadratic Unconstrained Binary Optimization (QUBO) and Max-cut problem
  4. Adiabatic theorem and quantum annealer

- Lecture 9: Variational Quantum Algorithms (VQAs) and Quantum Neural Networks (QNN)

  1. Quantum Approximate Optimization Algorithm (QAOA)

- Lecture 10: Variational Quantum Algorithms (VQAs) and Quantum Neural Networks (QNN)

  1. FALQON and ADAPT-QAOA
  2. Data reuploadiing