Training for Quantum Technologies @ TUIAȘI

16-20 December 2024

Lecture Contents

1. Introduction. The basics of quantum computing
   - Why Quantum Computing?
   - Quantum computation model (rules of QC)
   - Proprieties of QC
   - Quantum gates
   - Quantum algorithms - overview
   - Applications of QC
   - Physical realizations of quantum computers

2. Introductory Concepts
   - Bra-ket notation
   - Qubits
   - Qubit registers
   - Mathematical model of a quantum computer
   - Hilbert Space
   - Quantum state
   - Elements of a quantum computer

3. Quantum Gates
   - One-qubit Quantum Gates
   - Quantum Gates Acting on More Than One Qubit

4. Teleportation
   - Classical vs quantum information transmission
   - Quantum state entanglement
   - Using teleportation for quantum information transmission

5. Superdense coding

Laboratory Contents

1. Quantum Gates (lab work 2-3)
   - One-qubit Quantum Gates:
     - NOT gate
     - Z gate
     - Hadamard gate
   - Quantum Gates Acting on More Than One Qubit:
     - CNOT (controlled-NOT) gate
     - Swap gate
     - CCNOT (Controlled-Controlled-NOT or the Toffoli) gate
   - Simulation of quantum circuits
   - Simple applications such as:
     - writing the formal states for given circuits
     - designing the quantum circuits for certain states

2. Teleportation (lab work 4)
   - Teleportation circuit in QCAD
   - Teleportation circuit in IBM Quantum Learning (Composer)

3. Superdense coding (lab work 5)
   - Circuit implementation and analysis using Qiskit and IBM Learning (Composer)