Topics in Quantum Information

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Prerequisiti: Standard linear algebra and probability theory.

Tipologia di esame: Homeworks and final project.

Aim: The Course aims to serve as an introduction to a selection of topics of interest in quantum information theory, with a focus on the role of uncertainty and noise. A mathematically consistent approach will be developed, in order to tackle problems of information encoding, communication and error-correction for finite-dimensional systems.

Topics:

1. **Quantum Theory as a Probability Theory:** Densities, observable quantities, measurements in a non-commutative setting. Unitary dynamics. Composite systems and entanglement. Partial trace and marginal densities.

2. **Quantum Information Distances, Uncertainty and Distinguishability:** Entropy, relative entropy, trace norm, their interpretation and basic properties. Fidelity and related quantities.


4. **Encoding Information in Quantum Systems:** The logical qubit. Encoding qubits in physical systems, operational requirements and "good codes". Quick overview of the network model.

5. **Classical and Quantum Information over Quantum Channels:** No-cloning theorem. Schumacher’s quantum noiseless coding theorem. The Holevo-Schumacher-Westmoreland theorem.


References: The main reference is M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum information (Cambridge, 2000). Other relevant references, on-line notes and research papers will be provided during the course.