Ph.D. in Information Technology
Thesis Defense

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Room Alpha – building 24

Gloria Turati – XXXVII Cycle

Assessing the Effectiveness of Ansatz Selection Methods in Variational Quantum Algorithms

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Abstract:

Variational quantum algorithms (VQAs) are hybrid quantum-classical methods that combine aparameterized quantum circuit, known as ansatz, with classical optimization. Their low-depth circuit design makes them particularly well-suited for current noisy intermediate-scale quantum (NISQ) devices. However, the effectiveness of VQAs is highly sensitive to the choice of the ansatz, and identifying an efficient circuit structure for a given problem remains a non-trivial and critical challenge.

This thesis tackles the ansatz selection problem by presenting methodologies for the construction and selection of effective ansatzes. It begins with a study of the Variational Quantum Linear Solver (VQLS), a variational algorithm for solving systems of linear equations, showing how an unsuitable ansatz can lead to sub-optimal results. This observation motivates a broader investigation into ansatz design strategies.

The work explores various approaches, including adaptive variational algorithms, reinforcement learning-based techniques, and the analysis of circuit Hamiltonian expressibility, a metric that quantifies an ansatz capability to explore the relevant energy landscape. This study provides insights into the strengths and limitations of these methods, contributing to the development of more robust and effective ansatz design strategies, and advancing the applicability of variational quantum algorithms on near-term quantum hardware.

PhD Committee

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