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A Review of Quantum Artificial Intelligence: Foundations and Recent Advances

Communication Info

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Abstract

The convergence of Quantum Computing and Artificial Intelligence (QAI) represents a paradigm shift in high-performance computing, promising to overcome the dimensionality limitations of classical machine learning [1]. This paper presents a rigorous survey of the QAI landscape as of 2025, moving beyond theoretical proofs to empirical industrial validation. In this paper we analyze the transition from noisy intermediate-scale quantum (NISQ) devices to early fault-tolerant systems [2], highlighting recent breakthroughs in error-corrected logical qubits (e.g., Google Willow [3]) and distributed modular architectures. Furthermore, we examine the emergence of hybrid frameworks for Generative AI, including Quantum Transformers and Physics-Informed Neural Networks (PINNs) [4]. Finally, we critically assess the barriers to deployment, specifically the "Barren Plateau" [5] phenomenon and data encoding overheads and propose a roadmap for Trustworthy QAI in safety-critical sectors such as healthcare and cybersecurity.

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