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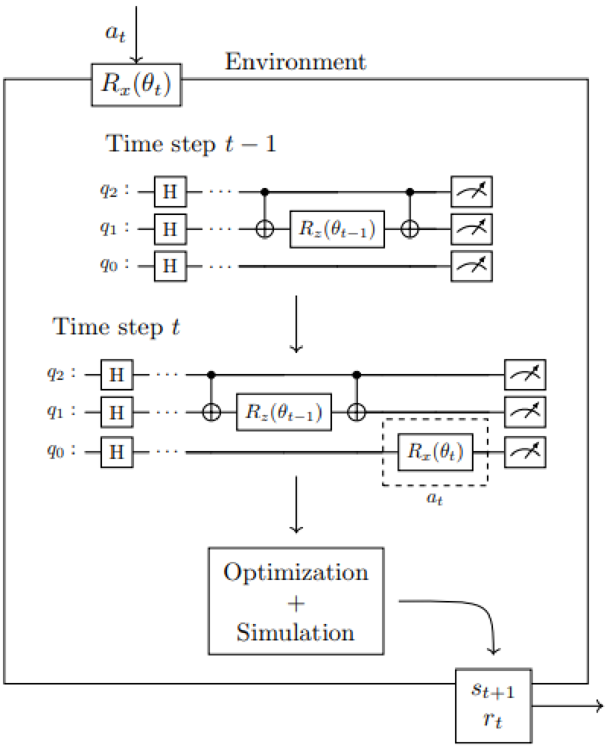
# HIGHLIGHTING NEWS

## AUTOMATED DESIGN OF STRUCTURED VARIATIONAL QUANTUM CIRCUITS WITH REINFORCEMENT LEARNING

This paper presents two reinforcement learning–based methods, RLVQC Global and RLVQC Block, for designing variational quantum circuits tailored to combinatorial optimization problems in QUBO form. Both approaches model circuit synthesis as a sequential decision process where gates are added iteratively, guided by the Proximal Policy Optimization algorithm and measurement-based observations. RLVQC Block learns a modular two-qubit gate block applied across all interacting qubit pairs, extending QAOA's structure, while RLVQC Global freely places gates without structural constraints.



The environment is represented by the parameterized quantum circuit, and the initial state is a single layer of Hadamard gates applied to all qubits. The observation space is the same for both methods, and it is defined as a $2^n$-dimensional vector containing empirical measurement probabilities for all computational basis states of the quantum circuit. The reward function was designed to minimize the Hamiltonian's expectation value and circuit depth. The action space for RLVQC Block inserts a gate into a 2-qubit block, while in RLVQC Global, it inserts a one- or two-qubit gate. The two-qubit rotation gates correspond to XX(t), YY(t), and ZZ(t). Both actor and critic networks are fully connected, multi-layer, feed-forward neural networks that only differ in the output layer. Gate parameters are optimized using the Cobyla algorithm in a noise-free environment.

The work reports that both methods can outperform QAOA for experiments on QUBO instances derived from Maximum Cut, Maximum Clique, and Minimum Vertex Cover over various graph topologies. Additionally, RLVQC Block is reported to achieve the best approximation ratios and generate circuits with fewer CNOT gates, while maintaining comparable depth and gate count to QAOA.

READMORE (Paper)

## FINE-TUNING LARGE LANGUAGE MODELS ON QUANTUM OPTIMIZATION PROBLEMS FOR CIRCUIT GENERATION

This paper presents a fine-tuned Qwen 2.5 Instruct model capable of generating parametrized quantum circuits for 12 graph-based optimization problems. The authors constructed a dataset of 14,000 OpenQASM 3.0 circuits with optimized parameters, obtained via QAOA, VQE, and adaptive VQE algorithm solutions.

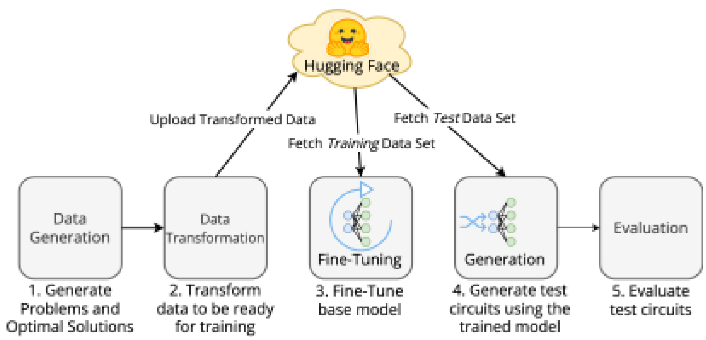



Fig. 5. Overview of complete pipeline.

The work reports that its fine-tuned model produces syntactically correct circuits with initial parameters closer to optimal than random initialization, and achieves expectation values and probability distributions more closely aligned with optimal solutions.

The work highlights its application in bootstrapping parameter initialization for quantum optimization routines. However, scalability to larger circuits and generalization to unseen quantum optimization problems remain open challenges.

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