Qeios

Peer Review

Review of: "A Review of Formal Methods in Quantum Circuit Verification"

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While there aren't many details (especially technical details) and a fair bit of the article reads like popular science (especially the introduction), the author provides a nice collection of references on the verification of quantum circuits, and the narrative surrounding these references is clearly written even if it is short. I'm not overly familiar with the literature on verification methods and so cannot make any claims with regards to comprehensiveness and/or appropriateness of the review, other than that it is useful to me as a portal into the literature.

With regards to the following statement motivating the difficulty of quantum circuit verification and thus the importance of developing methods:

“Verification of quantum circuits is challenging because the state space grows exponentially with the number of qubits. An n-qubit system occupies a Hilbert space of dimension 2^n, making classical simulation not feasible for large circuits.”

While this is true, there are many classes of “large” circuits that are efficiently classically simulable, for example, weakly entangled circuits and Clifford circuits. So, I'm left wondering what verification methods have been done/could be done in this arena, or if this is the best motivation. It seems like overkill to require efficient classical simulation for verification in many cases. (For example, this is covered a bit in Sec. 5.3: Runtime Verification.) Later claims under Sec. 7.1: Scalability do not address this, but should.

Although it could also use more detail, the section on future directions is a nice addition to the review of prior work.

There's at least one typo/display error (assolini2025formal).

doi.org/10.32388/77UERC

Declarations

Potential competing interests: No potential competing interests to declare.