Qafny: A Quantum-Program Verifier (Artifact)

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Abstract

This artifact contains the Coq theory files for the Qafny proof system, including the formalism of the Qafny syntax, semantics, type system, and proof system, with the theorem proofs of type soundness, proof system soundness and completeness. It also contains a the compiled Dafny example programs generated from our Qafny-to-Dafny prototype compiler. These example programs serve as the validations of our Qafny-to-Dafny prototype compiler mechanism. The main work is introduced in the Qafny paper, which develops a separation logic style verification framework for quantum programs.

2012 ACM Subject Classification Theory of computation → Program verification; Theory of computation → Quantum information theory

Keywords and phrases Quantum Computing, Automated Verification, Separation Logic

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Evaluation Policy The artifact has been evaluated as described in the ECOOP 2024 Call for Artifacts and the ACM Artifact Review and Badging Policy.

1 Scope

There are two directories in the artifact. The proof directory contains theory files (Coq) for the Qafny proof system and many theorems. The dafny directory contains example compiled Dafny programs generated from our Qafny-to-Dafny prototype compiler, and they are executable in Dafny 3.1, meaning that Dafny is able to verify the generated quantum programs. It shows the feasibility and efficiency (running time in Figures 16 and 17) of using Dafny to verify quantum programs.

2 Content

The artifact comprises:

- (under artifact/dafny/) the Dafny programs, listed in the paper (Figure 16 and 17, running time only), generated by the Qafny prototype.
- (under artifact/proof/) the Coq proofs for the Qafny system, including the type soundness proof and the proof system soundness and completeness.

3 Getting the artifact

The artifact endorsed by the Artifact Evaluation Committee is available free of charge on the Dagstuhl Research Online Publication Server (DROPS). In addition, the Coq formalization within the artifact is also available at `https://github.com/plum-umd/QNP`.

4 Tested platforms

We provide two kinds of execution strategies. The easiest way for users is to use the docker image method in the README file. We require that the system be an X86-64 system and that the disk size be 2.8GB. If users have difficulty running the docker image, there is a way to build your own docker, described at the end of the README file. If it still has problems, users can access the artifact directory, and there are instructions in the README files in the two sub-directories on how to manually make the software, respectively. We tested the manual software building in an Ubuntu 22.04 machine with an Intel 64-bit CPU and 16GB memory and a Windows 11 machine with an Intel 64-bit CPU and 80GB memory.

5 MD5 sum of the artifact

e0d87be118b5024f66029dfe85695be5

6 Size of the artifact

1,013,544,424 Bytes