cea list

3 years Postdoc position, CEA Paris-Saclay, France
Formal verification for quantum programming

Keywords: quantum programming, theory of programming languages, formal methods

The CEA LIST, Software Security Lab (LSL), has several open 3 years postdoc positions in the area of Formal verification for quantum programming, to begin *as soon as possible* at Paris-Saclay, France. It is articulated around the Qbricks tool, which aims at providing an automated solution for quantum programming formal verification.

Topic	Quantum programming and formal verification
Host	Commissariat à l'Énergie Atomique, Software Security Laboratory
Place	Paris-Saclay, France
Team	Qbricks
Advisor(s)	Christophe Chareton, Sébastien Bardin(`first.name@cea.fr`)

Context.
Quantum hardware has made tremendous progress, and useful quantum machines are expected to become available in a near future. Hence, the need to design and implement adequate software tooling for the quantum case, as available in the classical computing case. Our long term goal is to design and develop formal techniques and tools enabling productive and certified quantum programming. Especially, we develop Qbricks [1,2], a proof of concept environment for formally verified quantum programming language.

Current topic. We consider the standard quantum hybrid model, where a classical program builds a quantum circuit and sends it to a quantum co-processor. In these positions, we are interested in verification mechanisms aiming at ensuring that a quantum program implementation indeed satisfies its intended behaviour. We propose the following topics:

- high-level automatic verification of quantum programs for implicit program properties,
- design of verification oriented hybrid quantum programming languages
- high-level functional reasoning for quantum programs,
- circuit-level automatic verification of quantum programs,
- verification of circuit transformation and compilation

More details on these possibilities topics will be happily provided! The list is not exhaustive, ask us if you have some project in mind.

These positions include theoretical research as well as prototyping and experimental evaluation.The results will be implemented and evaluated on QBricks, our young development and verification environment for quantum programs.

Host Institution. CEA is a leading institute in research in France and Europe. We are part of List, its 700 persons institute dedicated to digital systems. Within List, the quantum verification group is a young and emerging six person team, developping quantum static analysis/verified programming and debugguing solutions. CEA List is located in Campus Paris Saclay.

Requirements. We welcome **curious and enthusiastic** candidates with a **solid background in Computer Science**, both theoretical and practical, and a **specialization in <u>either</u> formal methods or quantum computing** (it is assumed that candidates will dedicate some of their time upgrading their skills).

Application. Applicants should send an e-mail to Christophe Chareton (`christophe.chareton@cea.fr`) – including CV and motivation letter. **Deadline:** as soon as possible. Contact us for **more information**.

References

[1] Christophe Chareton, Sébastien Bardin, François Bobot, Valentin Perrelle, Benoît Valiron, **An Automated Deductive Verification Framework for Circuit-building Quantum Programs** Programming Languages and Systems - 30th European Symposium on Programming, ESOP 2021

[2] Christophe Chareton, Dongho Lee, Benoît Valiron, Renaud Vilmart, Sébastien Bardin, Zhaowei Xu. **Formal Methods for Quantum Algorithms.** Handb. Formal Anal. Verification Cryptogr. 2023: 319-422

[3] Matthew Amy **Towards Large-scale Functional Verification of Universal Quantum Circuits.** QPL 2018: 1-21

[4] Li Zhou, Gilles Barthe, Pierre-Yves Strub, Junyi Liu, Mingsheng Ying **CoqQ: Foundational Verification of Quantum Programs.** POPL 2023