Quantum Type Systems

Overview of Quantum Compution Technologies

Quantum Computing is a new and emerging computational paradigm whose main idea is to use quantum mechanical phenomena in order to perform computation. This has resulted in some very impressive algorithms which outperform the fastest known classical algorithms. A major breakthrough was recently achieved by Google which demonstrated quantum computational advantages on existing quantum computers. The development of quantum computing technologies is rapidly accelerating and has recently benefited from major investment from technological companies with dedicated quantum research teams, such as Google, Microsoft, IBM, and many other quantum startup firms.

Description and Objectives

This internship is concerned with the design of a new type system for quantum programming. The purpose of a type system is to serve as the core of a programming language and it is expected to be proven formally correct. Every quantum programming language has to manipulate both classical information (e.g. booleans, integers, etc.) but also quantum information (e.g. quantum bits). The classical part of the type system will be based on Quantitative Type Theory (QTT), which is a new type system that combines linearity and dependent types, both of which are important in quantum programming. The main goal of the internship is to design a suitable quantum extension to QTT by introducing quantum primitives in an effectful way to the system that allows the programmer to utilise quantum resources.

Idris is a very modern functional programming language, based on QTT, which introduces powerful and elegant programming constructions that look promising for the implementation of quantum programming primitives. The intern will also collaborate with another student who will be working on implementing the theoretical ideas discussed here in Idris.

By the end of the internship, the intern will acquire new skills and knowledge of quantum computation, logic, type systems and programming language design.

Skills and Abilities

- *Essential:* (Functional) programming skills. Knowledge of logic and/or type systems is a bonus.
- *Not required:* Knowledge of quantum computation is **_not_** required. We will explain the basics.

Research Lab

Lab: Inria/LORIA (Nancy, France)
Team: MOCQUA
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Feel free to email us if you are interested or if you have any questions regarding the internship.