My thesis and other animals

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Outline

- Thesis Outline
- Contributions
- Future Directions
- Other Projects
- Summary

QML: A functional quantum programming language

Thesis Structure:

1. Introduction – history, motivation, and background

2. Reversible classical computing
3. Reversible quantum computing

} *physical models*
basis of computation
Haskell implementation

4. **FCC**: Reversible and irreversible classical computation
5. **FQC**: Reversible and irreversible quantum computation

derived from reversible computation, inspired by physical models
first formalisation of the Quantum Circuit Model, using Category Theory

Thesis structure

6. **QML**: A functional quantum programming language
   introduces syntax and typing rules + example programs
7. Operational semantics of **QML**
   with a denotational semantics using Superoperators
   all implemented in Haskell
8. Further research
   gives outline of completeness proof
   implementing infinite data structures and recursion
   dependent types, etc…
9. Summary and conclusions
   I passed!

Appendix: Shor's algorithm and the QFT

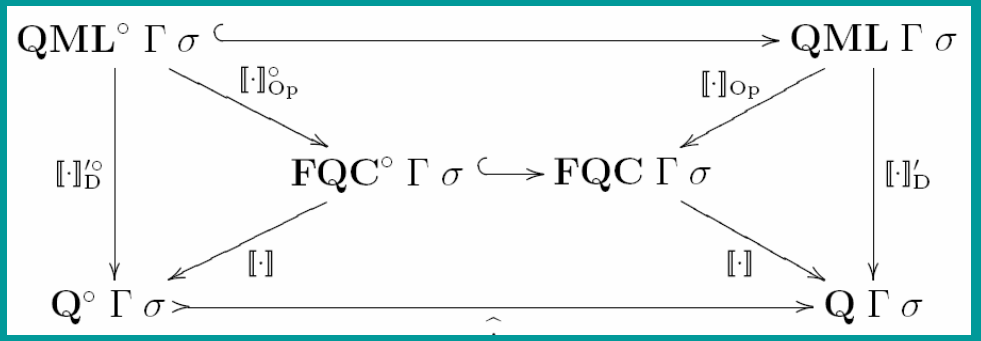
Contributions

QML

- functional language for quantum computations on finite types.
- quantum data *and* quantum control
- integrates *reversible* and *irreversible* quantum computation
- based on strict linear logic
  - *controlling measurement (weakening) rather than copying*
- Design guided by categorical semantics
  - *Programs are morphisms in **FQC**, giving quantum circuits*
  - *Gives first formal description of standard Quantum Circuit Model*
- Both operational and denotational semantics
  - *implemented in Haskell*

Future Directions

- Complete proof of *compositionality*
- Infinite data structures and recursion
- Full equational theory
- Dependent types and *views* for basis independence
- More research into **FxC** structure and *laws*
- Higher order programming (via Day's construction?)
- Reintroduction of coproducts, and classical data …



Other recent projects

The University of Nottingham

A thesis and beyond in 15 minutes (An overview)

Thanks for listening

Any questions?