Compilation of Quantum Programs with Control Flow Primitives in Superposition

Master Thesis

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Outline

Introduction

test [Aaby, 2003]

Quantum Control Flow

- The idea of Quantum Control Flow was first used by [Altenkirch and Grattage, 2005] to define function quantum programming language.
- For example, it was used to define the Hadamard gate as the function *had*:

$$\begin{aligned} had &: Q \to Q \\ had &: x \mapsto \ \texttt{if}^{\circ} x \\ &\qquad\quad \texttt{then} \ \{false \mid -true\} \\ &\qquad\quad \texttt{else} \ \{false \mid true\} \end{aligned}$$

- Later, the concept was formally defined by [Ying et al., 2012].

Limitations

- Quantum control flow is mainly limited by two principles: *reversibility* and *synchronization*.

Quantum Control Machine

Quantum Control Machine (QCM) [Yuan et al., 2024]

Language Overview

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Syntax

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Translation

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Code Generation

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Optimization

. . .

Evaluation

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Conclusion

References

- Aaby, A. A. (2003).
  Compiler construction using flex and bison.
- Altenkirch, T. and Grattage, J. (2005).
  A functional quantum programming language.
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- Ying, M., Yu, N., and Feng, Y. (2012).
  Defining quantum control flow.
- Yuan, C., Villanyi, A., and Carbin, M. (2024).
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