Introduction to Quantum Programming and Semantics

Lecture 12: Measurement

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Overview

- Q#
- Measurement
- Mixed states
- Quantum channels
- Environment structures

Q#

Microsoft QDK

- Q# language
- Q# libraries with several standard operations and algorithms
- Dot.net integration with classical languages (Python, C#, F#, etc)
- Orchestration language to execute Q#:
  - Simulators
  - Resource estimators
  - Microsoft Azure quantum hardware

Q#

- Language itself is imperative …
- … but can be used in functional way through dot.net
- Not (necessarily) circuit description language:
  quantum instructions are dispatched in order
  and you can use measurement results in rest of program

  (cf measurement-based quantum computing, quantum error correction)

Measurement

Measurement

Mixed states

Mixed states

Quantum channels

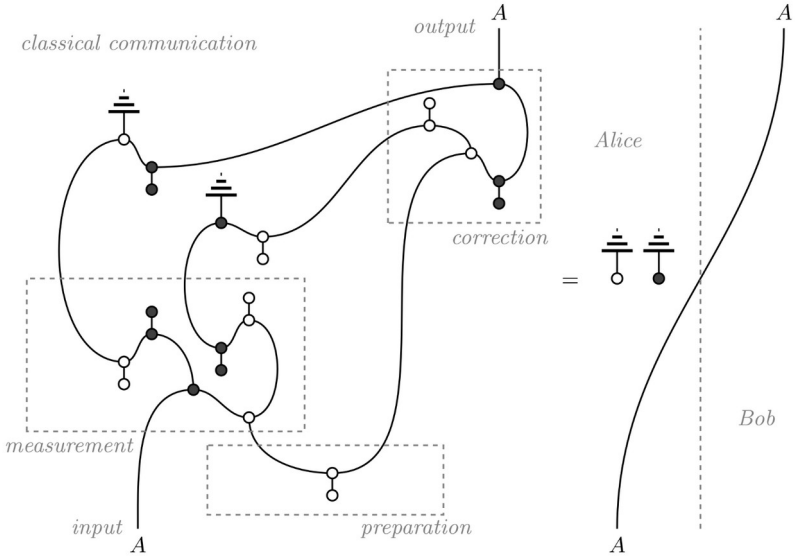
Completely positive maps

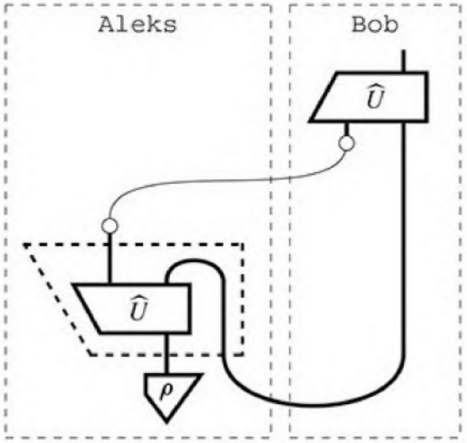
Kraus operators

Environment structures

Thick vs thin wires

Quantum teleportation





Summary:

- Q#: not necessarily circuit description, mid-circuit measurement
- Mixed states: partial knowledge
- Measurement: postselection, sums, graphically