Quantum Processes and Computation

Assignment 6, Wednesday, March 6, 2019

Exercise teachers:
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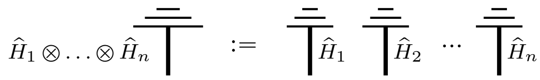
Handing in your answers: There are two options:

1. Deliver a hard copy to the mailbox of John van de Wetering. Mercator 1, 3rd floor.
2. E-mail a PDF to `wetering@cs.ru.nl`. Please include your name and the exercise number in the filename, e.g. `ACHTERNAAM-qpc-exercise1.pdf`.

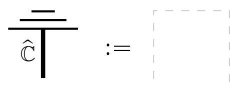
Deadline: Tuesday, March 12, 12:00

Goals: After completing these exercises you will know how to reason with non-pure quantum maps and discarding. The total number of points is 100, distributed over 4 exercises.
Material covered in book: sections 6.2 and 6.3.

Exercise 1 (6.32) (20 points): Show that:

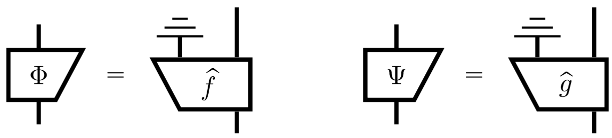


and that:



(noting that $\widehat{\mathbb{C}}$ is the 'no wire' system for **pure quantum maps**)
Hint: Check out the proof of Theorem 6.31.

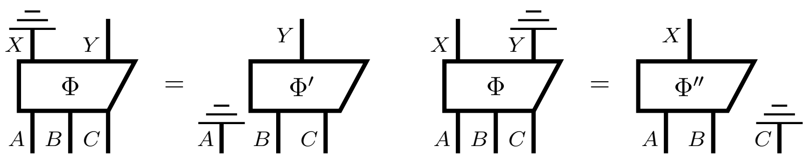
Exercise 2 (20 points): Let Φ and Ψ be quantum maps with purifications f, respectively g:



Give purifications of $\Phi \circ \Phi$ and $\Psi \circ \Phi$ in terms of f and g.

Exercise 3 (30 points): Prove that not every quantum map is pure, by showing that if this were the case, the identity wire would separate.

Exercise 4 (30 points): Construct a causal quantum map $\Phi : A \otimes B \otimes C \to X \otimes Y$ by making a connected circuit diagram involving exactly 3 causal quantum maps Φ_1, Φ_2, Φ_3 such that



Hint: Read Section 6.3.