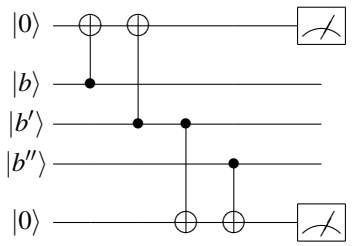
# Exercises in Quantum Computation VI

Wim van Dam
*Department of Computer Science, University of California at Santa Barbara, Santa Barbara, CA 93106-5110, USA*

**Question 1.** (Reading) Read "Physicists Triumph at Guess My Number", at URL
`http://www.qubit.org/library/intros/gmn/gmn.html`.

**Question 2.** (Classical Impossibilities) Consider the following distributed task that two parties $A$ and $B$ try to solve without mutual communication. Party $A$ receives a random bit $a \in \{0,1\}$ and $B$ receives a random bit $b \in \{0,1\}$. Given their respective inputs $a$ and $b$, the goal is for $A$ to produce a bit $x_a \in \{0,1\}$ and for $B$ to produce a bit $y_b \in \{0,1\}$ such that $x_a \oplus y_b = ab$ for all possible inputs $(a,b) \in \{0,1\}^2$. Prior to receiving the inputs $a$ and $b$, the parties are allowed to discuss a joint strategy to solve this problem. But after the input bits have been distributed, $A$ and $B$ are no longer allowed to communicate.
**(a)** Find a mathematical proof that shows that it will be impossible for $A$ and $B$ to solve this problem with a 100% success rate.
**(b)** Design an approach that has a success rate that is higher than 50%.
**(c)** Assuming that $A$ and $B$ are only using classical methods, what is the highest success rate that they can achieve?

**Question 3.** (Towards Quantum Error Correction) Consider the following 5 qubit circuit




**(a)** If the two measurements have output "1" and "1", what can you say about the input bits $(b,b',b'') \in \{0,1\}^3$?
**(b)** In general, what do the two bits of the measurement outputs tell about the 3 input bits $(b,b',b'') \in \{0,1\}^3$?
**(c)** Assume now that instead of the classical bits $b,b',b''$, the three qubits in the middle are in a general superposition

$$|\psi\rangle = \sum_{xyz \in \{0,1\}^3} \alpha_{xyz} |x,y,z\rangle.$$

For which amplitudes $\alpha$ is the quantum state such that the two measurements do not affect the superposition $|\psi\rangle$?