CSEP 590tv In Class Problems, July 27, 2005

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1. Suppose we are working on the n bit Bernstein-Varizani problem and the hidden strings are $a = 01$ and $b = 0$. The two bit function is then $f(x_1, x_2) = (a \cdot x) \oplus b = (0 \cdot x_1 \oplus 1 \cdot x_2) \oplus 0 = x^2$. The unitary used to evaluate this function is

$$U = \sum_{x_1=0}^{1} \sum_{x_2=0}^{1} \sum_{y=0}^{1} |x_1, x_2, y \oplus f(x_1, x_2)\rangle\langle x_1, x_2, y|$$

Write this unitary as a sum of outer products of computational basis states for this choice of function.

Now apply this unitary to the three qubit wave function $\frac{1}{2}(|00\rangle + |01\rangle + |10\rangle + |11\rangle) \otimes \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)$. Express you answer as a sum over computational basis kets.

Finally, apply two Hadamards to the first two qubits of this resulting state. What is the resulting computational basis state for these first two qubits?

2. Suppose that we run Simon's algorithm for a 5 bit function. We obtain the four bitstrings, 01100, 11010, 00111, and 0001. Remember that these all satisfy $y \cdot s = 0$ mod 2. What is the hidden xor mask s?