CS 410/510
Nonstandard Computation
Fall, 2005

Homework 1: Physics of Computation

Due Wednesday, October 5.

1. (a) Design a one-tape, non-reversible Turing machine with tape symbols are {0, 1, b } ("b" denotes a blank tape symbol), whose tape initially contains a binary integer, and which computes the "mod 2" value of that binary integer. In particular, if the input integer is even, the final tape should consist of a single 0 with the rest of the tape squares blank. If the input integer integer is odd, the final tape should consist of a single 1 with the rest of the tape squares blank. Your solution should consist of a set of quintuples

$$AT \rightarrow T'\sigma A',$$

in the same format as described in Bennett's paper, "Logical Reversibility of Computation". Add comments to your quintuples to explain what the purpose of each one is.

(b) Choose one of your quintuples from part (a) and give the pair of quadruples that would correspond to it in a reversible version of the Turing machine from part (a). In both parts (a) and (b), assume the input is "standard," as defined in the paper (i.e., it is on an otherwise blank tape and contains no embedded blanks, and the Turing machine tape head is initially on the square immediately to the left of the input).

Suppose your non-reversible Turing machine is given binary integer 100011. How many steps would be required by the corresponding reversible Turing machine to perform the mod-2 computation? How many tape squares would be required by the reversible Turing machine? Explain your answers.

2. Design a Fredkin gate (of the same format shown in Figures 4(b) and 6(a-c) in the paper "Conservative Logic") that realizes the Boolean function $\overline{a} \wedge b$.

3. Find a short paper or web site that describes some work on reversible computing that has taken place since the year 2000. In two or three paragraphs, summarize this recent work. Be sure to cite the paper or website in your writeup.