CS281 Spring 2010: Homework 1

Due Wednesday, April 14th – in class

1. **Exercise 8.2.2:** Design Turing machines for the following languages:

   (b) $\{a^n b^{n+1} c^n | \ n \geq 1\}$ (10pts)

   (c) $\{w \# w^R | \ w$ is any string of 0's and 1's$\}$ (10 pts)

2. **Exercise 8.2.3:** Design a Turing machine that takes as input a number N and adds 1 to it in binary. To be precise, the tape initially contains a \$ followed by N in binary. The tape head is initially scanning the \$ in state q_0. Your TM should halt with $N+1$, in binary, on its tape, scanning the leftmost symbol of $N+1$, in state q_f. You may destroy the \$ in creating $N+1$ if necessary. For instance, $q_0\$10011 \vdash^* \$q_f 10100$, and $q_0\$11111 \vdash^* q_f 100000$.

   (a) Give the transitions of your Turing machine, and explain the purpose of each state. (10 pts)

   (b) Show the sequence of ID's of your TM when given input \$111. (5 pts)

3. **Exercise 8.3.2:** A common operation in Turing-machine programs involves "shifting over". Ideally, we would like to create an extra cell at the current head position, in which we could store some character. However, we cannot edit the tape in this way. Rather, we need to move the contents of each of the cells to the right of the current head position one cell right, and then find our way back to the current head position. Show how to perform this operation. *Hint:* Leave a special symbol to mark the position to which the head must return. (10 pts)