Problem Set 3

CS172 Spring 2005

Out: February 9, 2005
Due: February 16, 2005 by 5 PM to 327 Soda

1. (*Sipser 3.9*) Let a k-PDA be a pushdown automaton that has k stacks. Thus a 0-PDA is an NFA and a 1-PDA is a conventional PDA. You already know that 1-PDAs are more powerful (recognize a larger class of languages) than 0-PDAs.

   (a) Show that 2-PDAs are more powerful than 1-PDAs.

   (b) Show that 3-PDAs are not more powerful than 2-PDAs.

   (Hint: Simulate a Turing machine tape with two stacks.)

2. (*Sipser 3.12*) A *Turing machine with left reset* is similar to an ordinary Turing machine except that the transition function has the form:

   $$\delta : Q \times \Gamma \to Q \times \Gamma \times \{R, RESET\}.$$

   If $\delta(q, a) = (r, b, RESET)$, when the machine is in state q reading an a, the machine's head jumps to the left-hand end of the tape after it writes b in the tape and enters state r. Note that these machines do not have the usual ability to move the head one symbol left. Show that Turing machines with left reset recognize the class of Turing-recognizable languages.

3. (*Sipser 3.13*) A *Turing machine with stay put instead of left* is similar to an ordinary Turing machine except that the transition function has the form:

   $$\delta : Q \times \Gamma \to Q \times \Gamma \times \{R, S\}.$$

   At each point the machine can move its head right or let it stay in the same position. Show that this Turing machine variant is *not* equivalent to the usual version. What class of languages do these machines recognize?

4. (*Sipser 3.16*) Show that a language is decidable iff some enumerator enumerates the language in lexicographic order.