T-79.148 **Spring 2002**
Introduction to Theoretical Computer Science
Tutorial 5, 26-28 February
Problems

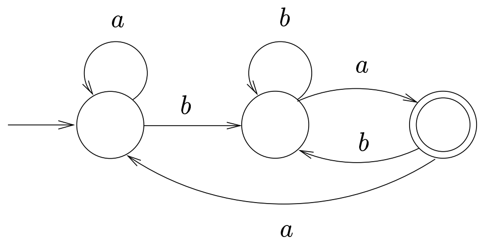
Homework problems:

1. Give regular expressions describing the following languages over the alphabet $\{a, b\}$:
   (a) $\{w \in \{a,b\}^* \mid w \text{ contains exactly two } a\text{'s}\}$
   (b) $\{w \in \{a,b\}^* \mid w \text{ contains at least two } a\text{'s}\}$
   (c) $\{w \in \{a,b\}^* \mid w \text{ contains an even number of } a\text{'s}\}$
   (d) $\{w \in \{a,b\}^* \mid w \text{ contains either } aa \text{ or } bb \text{ (or both) as a substring}\}$
   (e) $\{w \in \{a,b\}^* \mid w \text{ contains neither } aa \text{ nor } bb \text{ as a substring}\}$
   (f) $\{w \in \{a,b\}^* \mid w \text{ contains the substrings } ab \text{ and } ba \text{ (which may overlap)}\}$.

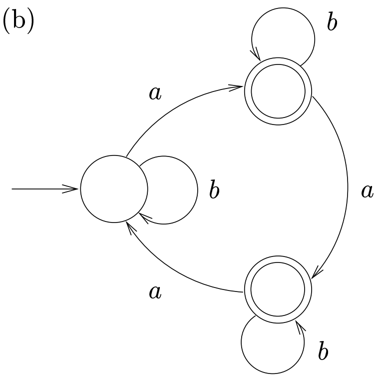
2. (a) Construct in a systematic way (as described in your textbook) a nondeterministic finite automaton corresponding to the regular expression $(ab \cup aab)^*$.
   (b) Make your automaton deterministic.

3. Construct in a systematic way (as described in your textbook) regular expressions corresponding to the following finite automata:

(a)



(b)



Demonstration problems:

4. Simplify the following regular expressions (i.e., design simpler expressions describing the same languages):
   (a) $(\emptyset^* \cup a)(a^*)^*(b \cup a)b^*$
   (b) $(a \cup b)^* \cup \emptyset \cup (a \cup b)b^*a^*$
   (c) $a(b^* \cup a^*)(a^*b^*)^*$

5. Determine whether the regular expressions $r_1 = b^*a(a^*b^*)^*$ and $r_2 = (a \cup b)^*a(a \cup b)^*$ describe the same language, by constructing the (minimal) finite state machines corresponding to them.

6. Prove that if L is a regular language, then so is $L' = \{xy \mid x \in L, y \notin L\}$.