Computer Science Comprehensive Exam—Spring 2011
Compiler Construction

Instructions: Do *not* put your name on the exam, please answer all the questions directly on the exam itself. You may need scratch paper. Answer **all** the questions. You have 90 minutes. Explain answers as fully as possible, give examples or define terms, if appropriate.

1. Please compare the parser generators JavaCC and yacc (or Bison). What are the advantages and disadvantages of using both.

2. Convert the following NFA over the alphabet $\{a, b\}$ to a DFA using the subset construction. Note that some edges represent more than one transition. The start state of the NFA is 0; the final state, marked by double lines, is 3. Be sure to label the states of your DFA with *sets* of the NFA's state labels, so that the correspondence is clear. Do not simplify.

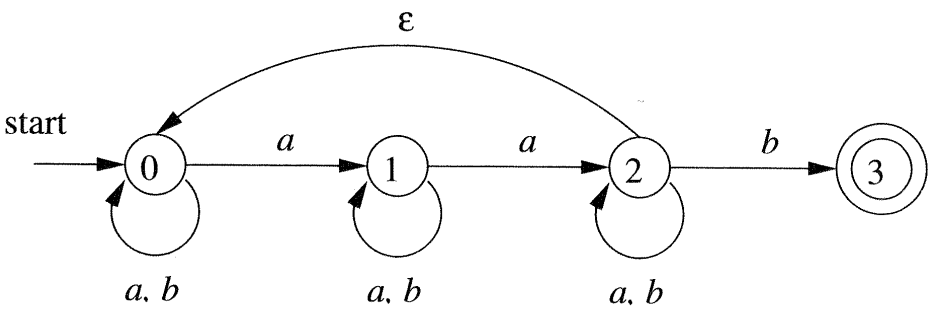

Figure 3.29: NFA for Exercise 3.6.3

3. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by SLR parsers? Circle the best response.

   (a) SLR is a subset of LR(1)

   (b) LR(1) is a subset of SLR

   (c) Their intersection is non-empty

   (d) Their intersection is empty

   (e) They are the same set

4. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by LL(1) parsers? Circle the best response.

   (a) LR(1) is a subset of LL(1)

   (b) LL(1) is a subset of LR(1)

   (c) Their intersection is non-empty

   (d) Their intersection is empty

   (e) They are the same set

5. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by LALR(1) parsers? Circle the best response.

   (a) LALR(1) is a proper subset of LR(1)

   (b) LR(1) is a subset of LALR(1)

   (c) Their intersection is non-empty

   (d) Their intersection is empty

   (e) They are the same set

6. What is the relationship between the set of languages recognized by LL(1) parsers and the set of languages recognized by LALR(1) parsers? Circle the best response.

   (a) LL(1) is a subset of LALR(1)

   (b) LALR(1) is a subset of LL(1)

   (c) Their intersection is non-empty

   (d) Their intersection is empty

   (e) They are the same set

7. Consider the following grammar (where uppercase letters are nonterminals):

0 $S' \to S\,\$$
1 $S \to$
2 $S \to X\,S$
3 $X \to B\,S\,E$
4 $X \to \mathbf{\{}\,S\,\mathbf{\}}$
5 $X \to \mathbf{w}$
6 $X \to \mathbf{b}$
7 $X \to \mathbf{e}$
8 $X \to \mathbf{/\,w}$
9 $B \to \mathbf{/\,b\{\,w\,\}}$
10 $E \to \mathbf{/\,e\{\,w\,\}}$

(a) Compute nullable, FIRST, and FOLLOW for the nonterminals of the grammar.

	nullable	FIRST	FOLLOW
S			
B			
E			
X			

(b) Create the LL(1) parse table.

(c) Is the grammar LL(1)?

8. For the following augmented grammar (upper case letters are nonterminals):

$$
\begin{array}{ll}
0 & S \to A\,\$ \\
1 & A \to E\,B\,L\,E \\
2 & A \to b\,e \\
3 & B \to b \\
4 & B \to o\,r \\
5 & E \to e \\
6 & E \to \epsilon \\
7 & L \to s\,L \\
8 & L \to s
\end{array}
$$

   (a) Give a diagram of the states and transitions of the LR(1) parsing automaton.

   (b) Give the LR(1) parsing tables.

   (c) Is the grammar LR(1)?

9. Use left factoring to transform the following grammar with terminals $\{i, t, e\}$:

$$
\begin{array}{ll}
0 & S \to iEtSeS\,\$ \\
1 & S \to iEtS\,\$
\end{array}
$$

10. (It may be more sensible to do this problem after doing problem 7.) Suppose we say a nonterminal N is *endable* if there is a γ such that the sentential form $\gamma N\$$ is derivable from a nonterminal. Which of the nonterminals in the grammar of problem 7 are *endable*?

	endable
S	
B	
E	
X	