Homework Assignment 7
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Nov. 13, 2002
Due on Nov. 20, 2002 by 1pm

1 Exercise 1
Take non-deterministic finite state automaton given below. Construct an equivalent
deterministic finite state automaton that accepts the same language, using the proof we learned in class
for Theorem 1.19. That is, apply the algorithm for converting any NFA to an equivalent DFA,
and provide the full-fledged description \((Q', \Sigma, \delta', q_0', F')\) and the (simplified) diagram of the resulting deterministic FSA. Specify which of the strings below are accepted by both automata
and which are rejected by both. Assume that the alphabet is \(\{0,1\}\).

\[
\begin{array}{ccc}
q_1 & \xrightarrow{1} & q_2 \\
& \xleftarrow{0} & \\
q_2 & \xleftarrow{0} & q_3 \\
& \xrightarrow{1} & \\
q_3 & \xrightarrow{1,0} & q_2 \\
\end{array}
\]

a. \(\epsilon\) \hspace{1cm} e. \(1\)
b. \(0\) \hspace{1cm} f. \(10\)
c. \(01\) \hspace{1cm} g. \(111\)
d. \(001\) \hspace{1cm} h. \(11000\)

2 Exercise 2
The following two languages are regular. For each of them, draw its corresponding FSA diagram
and show that its obeys the Pumping Lemma for the indicated strings.

a. \(\{w : w\text{ contains the sub-string }10\text{ exactly once}\}\).
   Pumping length = 4. Strings to be tested: 1110, 100000, 1100, 0010111.
b. \(\{w : w\text{ does not contain the sub-string }101\}\).
   Pumping length = 3. Strings to be tested: 1100, 1001, 100, 10.
3 Exercise 3

Show whether each of the following languages is regular or not. That is, if a language is regular, give a FSA that recognizes it; if a language is not regular, show it using the Pumping Lemma (reasoning abstractly about $p$).

a) $A = 1^n01^n0$, where $n \geq 0$.
b) $B = 1*01*0$.
c) $C = 0^n1^m$, where $n \geq 0$.
d) $D = 0^n1^m$, where $n > m + 4$.

4 Exercise 4 (Optional, extra points)

Show whether the following language is regular or not.

e) $E = 001^n01^m$, where $n \geq 0$, $m \geq 0$, and $m \neq n$.

5 Exercise 5

For each of the following languages, construct a FSA (deterministic or not) and its corresponding Right Linear Grammar:

i) $\{w : w \text{ is 10, 11, 01 or 00 followed by any number of 1s}\}$

ii) $10^*001^*$

iii) $\{w : w \text{ contains an even number of 1s}\}$

6 Exercise 6

The following English sentences illustrate a long distance dependency. Based on this dependency, construct a detailed proof showing that English is not a regular language (cf. Relative Clause proof in class). If the proof relies on the claim that some other language is regular or not regular, prove that claim too.

(1) a. John and Mary like to eat and sleep respectively.
b. John, Mary, and Sue like to eat, sleep and dance respectively.
c. John, Mary, Sue, and Bob like to eat, sleep, dance and cook respectively.
d. Etc.