

Assignment 4

Exercise 1:

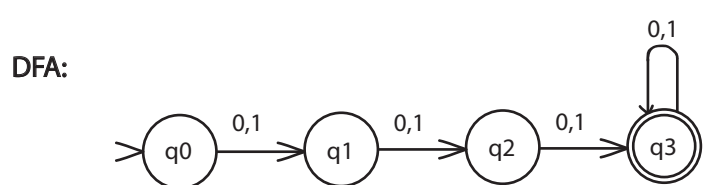
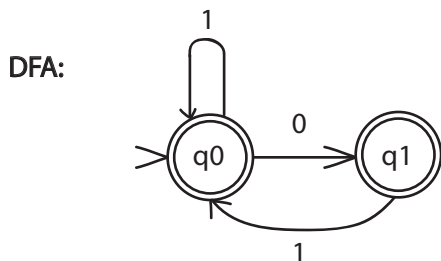
Construct both regular expression and deterministic automata that accept the following languages over $\{0, 1\}$.

a) Strings that do not contain 00.

b) Strings that contain at least three symbols.

RegEx: $r = (0?)(10?)*$

RegEx: $r = (0|1)(0|1)(0|1)(0|1)^*$

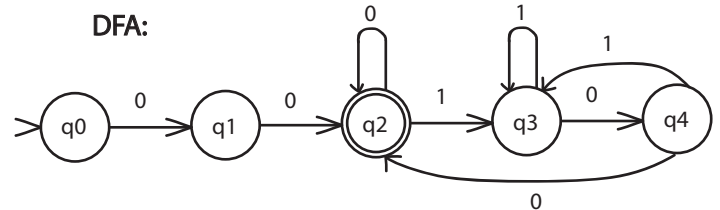
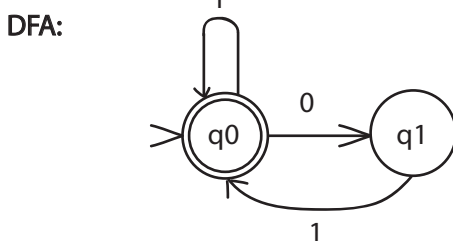


c) Strings where each 0 is directly followed by 1.

d) Strings that both start and end with 00.

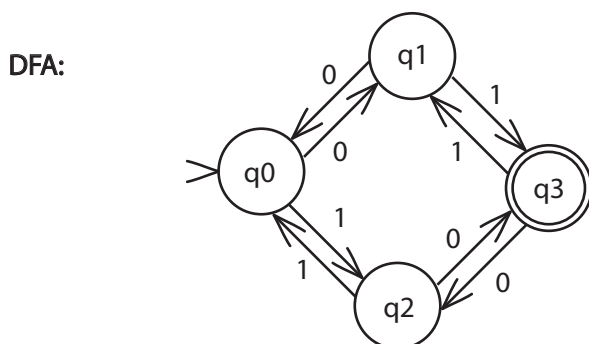
RegEx: $r = (01|1)^*$

RegEx: $r = (00)((0|1)^*(00))^*(0)^*$



e) Strings having an odd number of 0:s and an odd number of 1:s.

RegEx: $r = ((00|11)^*(01|10)(11|00)^*(10|01)(00|11)^*((11|00))^*(01|10)(00|11)^*$



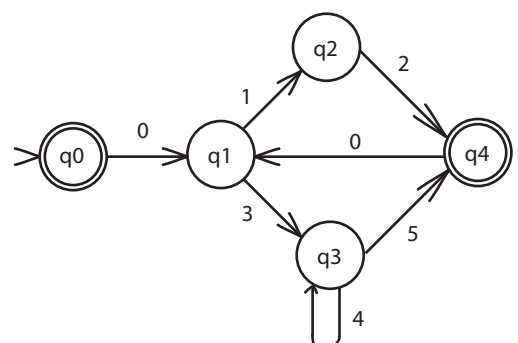
Exercise 2:

Present a deterministic finite automata and a regular expression for the language over $\{0, 1, 2, 3, 4, 5\}$ where each string satisfies all the following criteria:

- The string may either be empty or start with 0.
- Either 1 or 3 must follow after 0.
- 2 must follow after 1.
- 0 may follow after 2, otherwise the string must end.
- 5 must follow after 3, but there may be zero or more 4 between 3 and 5.
- 0 may follow after 5, otherwise the string must end.

RegEx: $r = (0?(12|34^*5))^*$

DFA:



Exercise 3:

Give context-free grammars for the following languages over $\{0, 1\}$.

a) Strings that both start and end with 00.

$A \rightarrow 00 \mid 000 \mid 00B00$
 $B \rightarrow \text{eps} \mid 0B \mid 1B$

b) Strings that do not contain 00.

$A \rightarrow B0B$
 $B \rightarrow \text{eps} \mid 1$

(c) Strings that contain at least three characters.

$A \rightarrow BBBC$
 $B \rightarrow 0 \mid 1$
 $C \rightarrow \text{eps} \mid 0C \mid 1C$

d) $L = \{0^n 1 2^n, n \geq 1\}$.

$A \rightarrow 0A11 \mid 011$

e) Palindroms. That is, non-empty strings having the same sequence of symbols when read backwards.

$A \rightarrow B$
 $B \rightarrow 0 \mid 1 \mid 00 \mid 11 \mid 0A0 \mid 1A1$

Exercise 4:

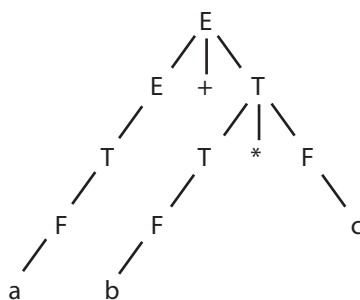
Consider the following grammar for arithmetic expressions:

$E \rightarrow E + T \mid T$
 $T \rightarrow T * F \mid F$
 $F \rightarrow a \mid b \mid c \mid (E)$

Give parse trees for the strings below:

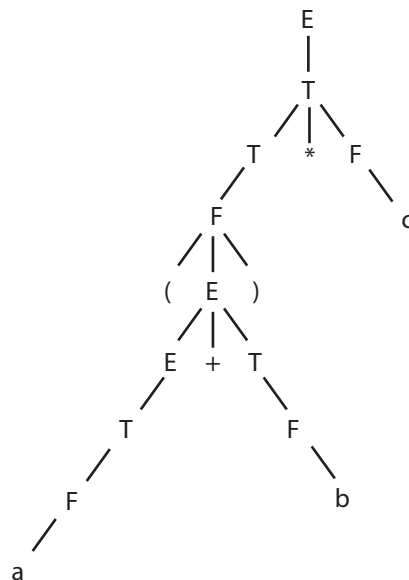
a) $a + b * c$

$E \rightarrow E + T \rightarrow E + T * F \rightarrow a + b * c$



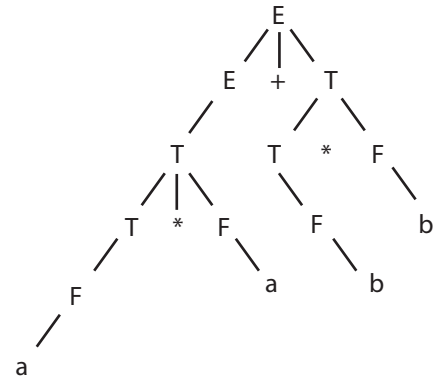
b) $(a + b) * c$

$T \rightarrow T * F \rightarrow (E) * F \rightarrow (E + T) * F \rightarrow (a + b) * c$



c) $a * a + b * b$

$T \rightarrow T * F \rightarrow$



Exercise 5:

Show that the grammar below is ambiguous:

$S \rightarrow bS \mid Sb \mid a$

Example: bab

