

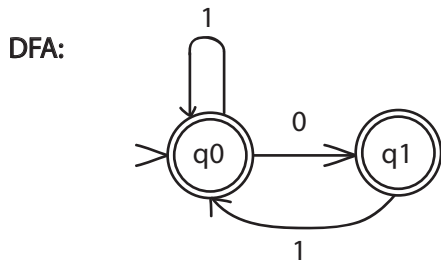
Assignment 4

Exercise 1:

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

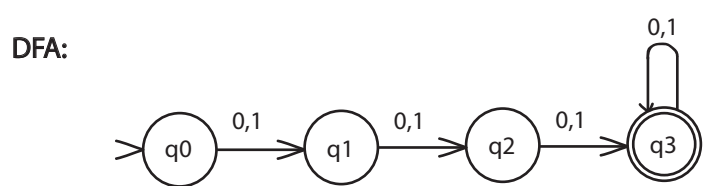
a) Strings that do not contain 00.

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



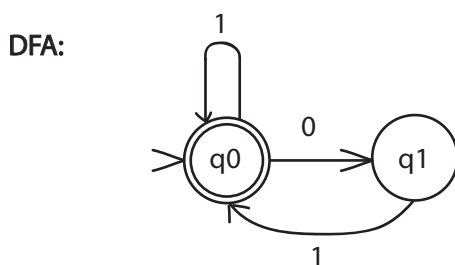
b) Strings that contain at least three symbols.

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



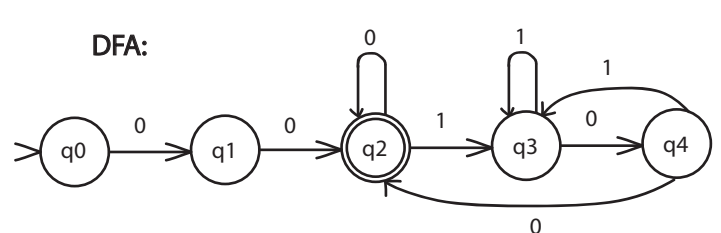
c) Strings where each 0 is directly followed by 1.

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



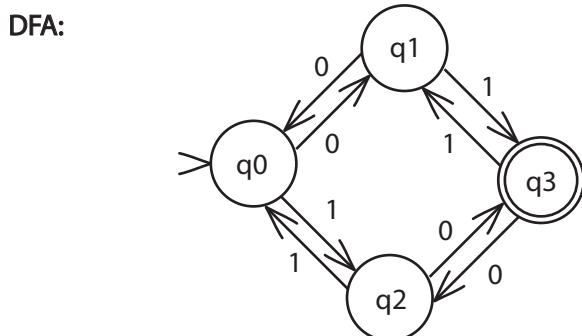
d) Strings that both start and end with 00.

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:

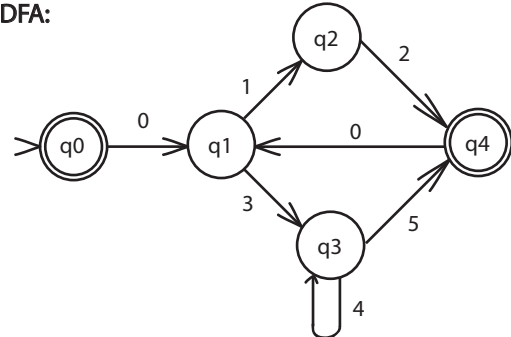
Present a deterministic finite automata and a regular expression for the language over $\{0, 1, 2, 3, 4, 5\}$ where each string satisfies all the following criteria:

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

$A \rightarrow 0A11 \mid 011 \mid \text{eps}$

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

$A \rightarrow 0A0 \mid 1A1 \mid 0 \mid 1 \mid \text{eps}$

Exercise 4:

Consider the following grammar for arithmetic expressions:

$E \rightarrow E + T \mid T$

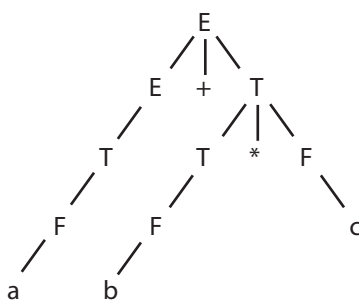
$T \rightarrow T * F \mid F$

$F \rightarrow a \mid b \mid c \mid (E)$

Give parse trees for the strings below:

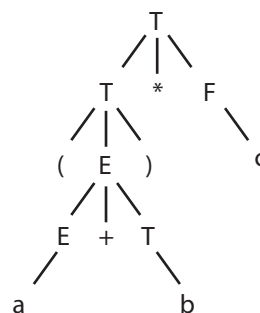
a) $a+b*c$

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



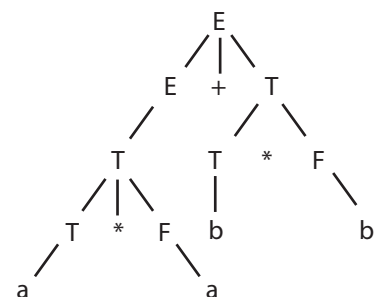
b) $(a+b)*c$

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



c) $a*a+b*b$

$T \rightarrow T*F \rightarrow$



Exercise 5:

Show that the grammar below is ambiguous:

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