TDDD55

1 EXERCISES IN FORMAL LANGUAGES AND AUTOMATA THEORY

Exercises compiled by Jonas Wallgren 2007

Updated by John Tinnerholm in 2023

This material presents problems with partial solutions related to formal languages and automata theory for TDDB44 and TDDD55.

2 PROBLEMS

2.1 TRANSFORMING A LANGUAGE TO A DFA

Construct a DFA that accepts the language for each of the following languages:

A. $L_1 = \{x \in \{0,1\}^* \mid x \text{ should end with } 00\}$
B. $L_2 = \{x \in \{0,1\}^* \mid x = (01)^n, n \geq 0\}$
C. $L_3 = \{x \in \{0,1\}^* \mid \text{Every } 0 \text{ is immediately followed by } 1\}$

2.2 FROM NFA TO DFA

Given the NFA in Figure 1, see below, construct an equivalent DFA.

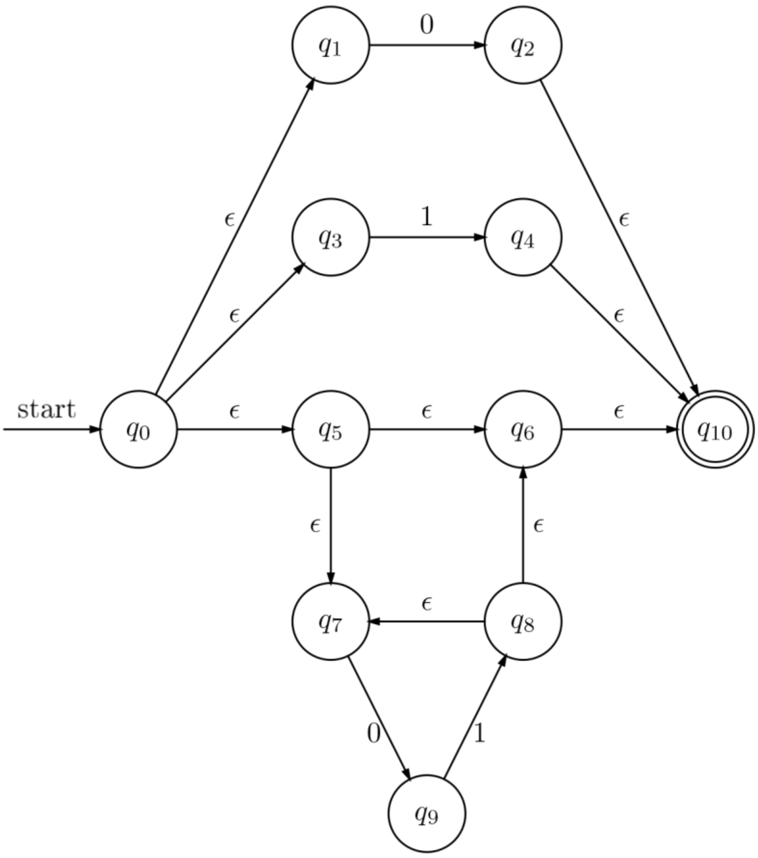


Figure 1: M_8

2.3 NFA Construction

Construct an NFA that accepts the language defined by the following regular expression:

A. $0+1$
B. $[0]^{+} + 1$
C. $[0\text{-}1]^{+} + 1$
D. $10 + (0 + 11)0^{*}1$

2.4 (Bonus) Describing Regular Expressions using Grammars

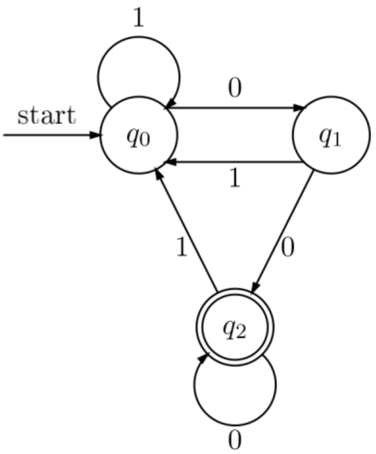
Provide Context-Free Grammar for the following regular expressions:

A. $00(1+0)^{*}1$
B. $101(101)^{*}010(010)^{*}$
C. $(11+010)^{*}11(00+11)^{*}$

PARTIAL SOLUTIONS

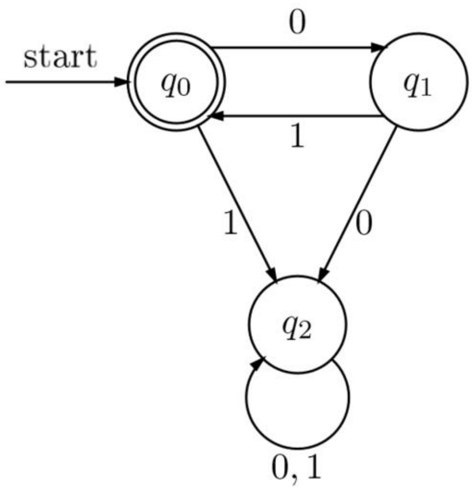
2.1 A)

An example of a DFA M15 such that **L(M$_{15}$) = L1** is given below



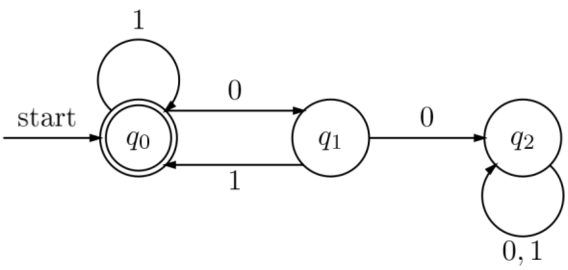
2.1 B)

An example of a DFA M_{16} such that $L(M_{16}) = L_2$ is below



2.1 C)

An example of a DFA M_{16} such that $L(M_{16}) = L_2$ is provided below



2.2

Hint: the subset construction results in a DFA with reachable states:

- {q0, q1, q3,q5, q6, q7, q10}
- {q2, q9, q10,}
- {q4, q10}
- {}
- {q9}

The initial state is {q0, q1, q3,q5, q6, q7, q10}. The final states are those containing q10.

2.3 (C)

By decomposing the regular expression syntactically according to the recursive definition of regular expressions, an NFA can be constructed systematically in a bottom-up fashion. By successively joining NFA: s corresponding to subexpressions according to the standard operators:

(*, +, $^+$)

The resulting NFA is depicted in Figure 5: M_{23}

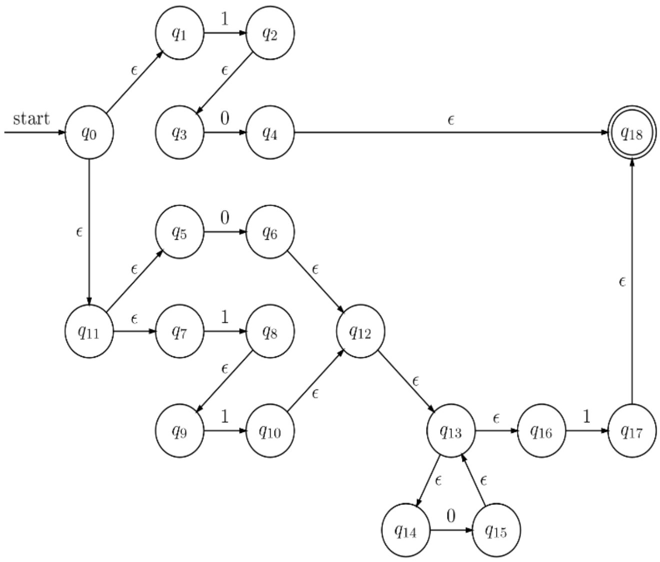


Figure 5: M_{23}

2.4

A)

$S \rightarrow 00A1$
$A \rightarrow \epsilon \mid 0A \mid 1A$

B)

$S \rightarrow 101A010B$
$A \rightarrow \epsilon \mid 101A$

$B \rightarrow \epsilon \mid 010B$

C)

$S \rightarrow A11B$
$A \rightarrow \epsilon \mid 11A \mid 010A$
$B \rightarrow \epsilon \mid 00B \mid 11B$