Middle East Technical University Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

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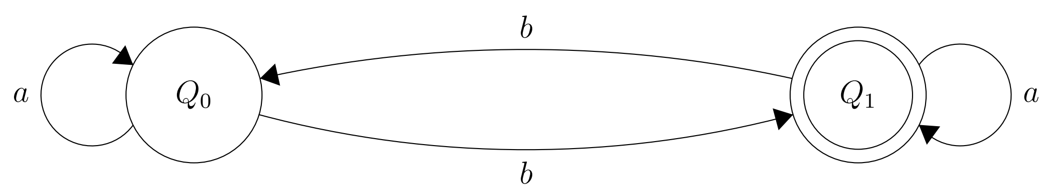
Homework 3

Name Surname: BAŞAR YILMAZ
Student ID: 2644409

Answer for Q1

1. First, we need to find first, second,... equivalence s.t.:
Basically, I created two sets from final and non-final states.
$\equiv_0$: $\{q_0, q_1, q_3, q_4\}$, $\{q_2, q_3\}$
$\equiv_1$: $\{q_0, q_1, q_3, q_4\}$, $\{q_2, q_3\}$
Since equivalences 0 and 1 are the same. We can infer that the final two sets are the two states we can use in our minimized DFA.
Let's say $\{q_0, q_1, q_3, q_4\} = Q_0$, and $\{q_2, q_3\} = Q_1$



$s = Q_0$ and $F = Q_1$

2. Since we have two states in our minimized DFA, we should have two equivalence classes. One of them is $[\epsilon]$, other one is $[b]$.

$[\epsilon] = Lba^* \cup e$

$[b] = L$

3. In order to prove that a language is not regular by MyHill-Nerode Theorem, we should show the language has infinitely many equivalence classes.

$a^n b^n d^n \in L'$, if we pick a^i where $i \neq n$ and $[a^i] \neq [a^n]$, and by the definition of the language $a^i b^n d^n \notin L'$

We can pick infinitely many n, i pairs. Thus, by MyHill-Nerode Theorem L' is not regular.

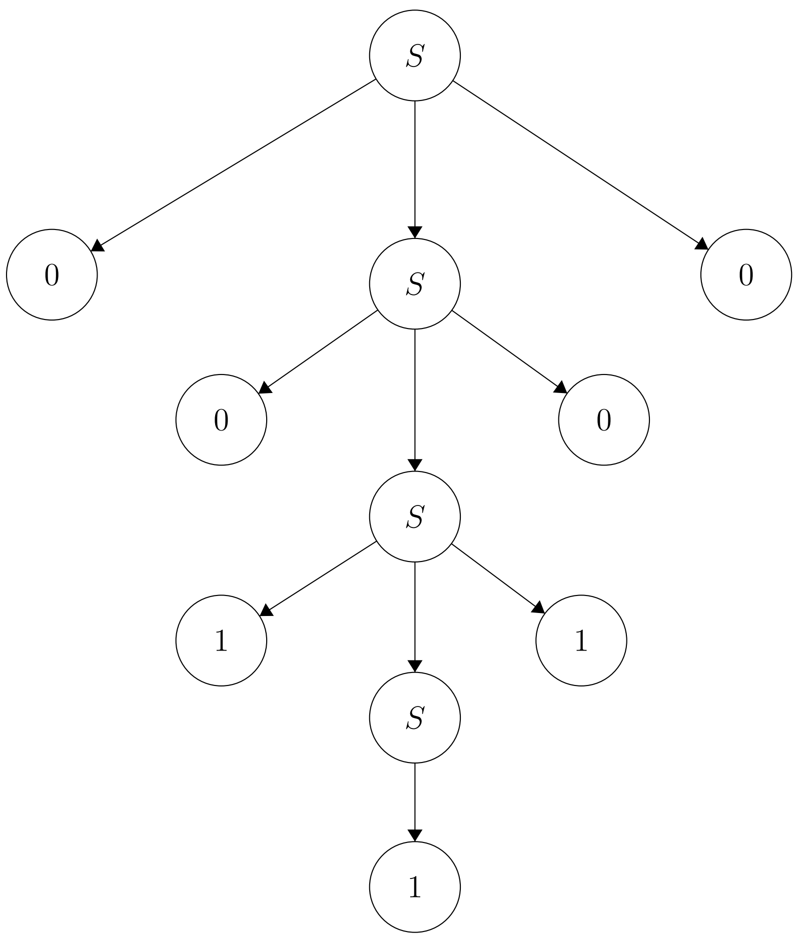
Answer for Q2

1. $G = (V_1, \Sigma_1, R_1, S_1)$ where $V_1 = \{S, X, Y\} \cup \Sigma_1$, $\Sigma_1 = \{a, b\}$ and
$R_1 = \{S \to Xb \mid YS \mid SYX$
$X \to Xb \mid e$
$Y \to YY \mid aYb \mid bYa \mid e\}$

2. $G = (V_2, \Sigma_2, R_1, S_1)$ where $V_2 = \{S, X, Y\} \cup \Sigma_2$, $\Sigma_2 = \{0, 1, 2\}$ and
$R_2 = \{S \to XY$
$X \to 0X1 \mid e$
$Y \to 1Y2 \mid e\}$

3. $G = (V_3, \Sigma_3, R_3, S_3)$ where $V_3 = \{S\} \cup \Sigma_3$, $\Sigma_3 = \{0, 1\}$ and $R_3 = \{S \to 1S0 \mid 0S1 \mid 0S0 \mid 1S1 \mid 1 \mid 0\}$

Parse tree for the string 0011100:



Answer for Q3

1. $L = \{w \mid w = vyv,\ |v| \geq 1\ :\ w, v, y \in \{0,1\}^*\} \cup\ \{\epsilon\}$

2. $L = \{w \mid w \text{ has at least two 1's} :\ w \in \{0,1\}^*\}$