Middle East Technical University Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

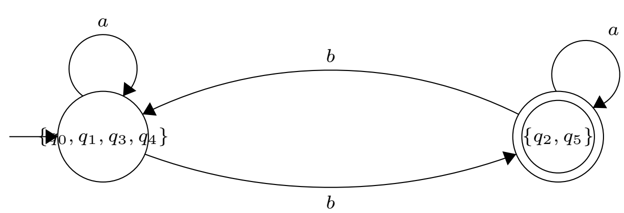
Spring 2022-2023

Homework 3

Name Surname: Yusuf Sami Lök
Student ID: 2521748

Answer for Q1

1. We have first two classes which are the sets that has final states and non-final states. After verifying that the states goes to the same equivalence classes with letters 'a' and 'b', we reached the end of the algorithm. We stopped since we were able to reach the same equivalence class in $\equiv_1$.
$\equiv_0 = \{q_2, q_5\}, \{q_0, q_1, q_3, q_4\}$
$\equiv_1 = \{q_2, q_5\}, \{q_0, q_1, q_3, q_4\}$



2. For $\{q_2, q_5\}$, the regular expression is L.
For $\{q_0, q_1, q_3, q_4\}$, the regular expression is $(Lba^* \cup a^*)$. We can loop with a or empty string or we can reach this state by passing through the $\{q_2, q_5\}$. L includes all strings accepts the language, then we can reach the $\{q_0, q_1, q_3, q_4\}$ with a "b" from $\{q_2, q_5\}$. Then we have a "a" loop. Therefore, it is $(Lba^* \cup a^*)$

3. In order to show that L' is not regular by using MyHill-Nerode theorem we need to prove that L' has infinite number of equivalence classes. For all distinct m+n values, there should be 1 distinct equivalence class because each distinct m+n value should have a distinct k+2u value. Therefore, there are infinite number of equivalence classes.
m+n = 0 → k+2u=0
m+n = 1 → k+2u=1
m+n = 2 → k+2u=2
m+n = 3 → k+2u=3
....
....
Therefore, for each m+n value there exist a unique distinct k+2u value. Since there are infinitely many equivalence classes, L' is not regular. To illustrate that:

$$[e] \not\approx [a] \not\approx [aa] \not\approx [aaa] \not\approx [aaaa]...$$

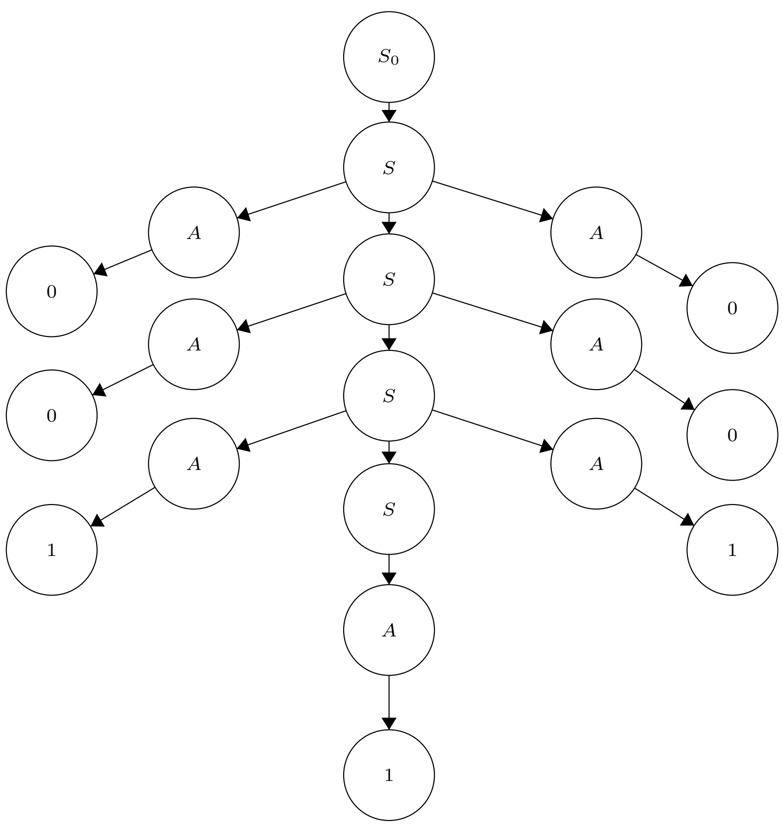
Answer for Q2

1. $G = (V_1, \Sigma, R_1, S_0)$ where $V_1 = \{S_0, B, D\} \cup \Sigma$
$\Sigma = \{a, b\}$ and
$R_1 = \{S_0 \to Bb|DS_0|S_0DB,$
$D \to bDa|aDb|DD|e,$
$B \to e|Bb\}$

2. $G = (V_1, \Sigma, R_1, S_0)$ where $V_1 = \{S_0, S_1, S_2\} \cup \Sigma$
$\Sigma = \{0, 1, 2\}$ and
$R_1 = \{S_0 \to S_1S_2,$
$S_1 \to 0S_11|e,$
$S_2 \to 1S_22|e\}$

3. $G = (V_1, \Sigma, R_1, S_0)$ where $V_1 = \{S_0, S, A\} \cup \Sigma$
$\Sigma = \{0, 1\}$ and
$R_1 = \{S \to A \mid ASA,$
$S_0 \to S$
$A \to 0|1\}$

Parse tree for string 0011100 is:



Answer for Q3

1. The (context-free) language is that accepts strings with the same first and last characters with at least two characters, as well as the empty string. $\{w|$the first and last characters of the w is the same with the length of w is at least 2 or w is empty, and w $\in \{0,1\}^*\}$

2. The (context-free) language is that accepts strings that contain at least two ones. $\{w|$w contains at least two ones, and w $\in \{0,1\}^*\}$