CS138: Automata and Formal Languages
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UC Santa Barbara
Spring 2018

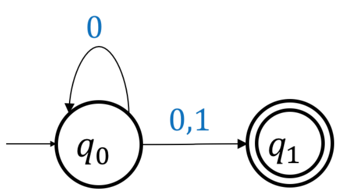
Homework 3

Posted: Monday, April 16, 2018 – 11:59pm
Due: Wednesday, April 25, 2018 – 2pm (Gradescope)

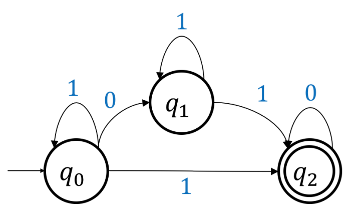
Task 1 – From NFAs to DFAs (12 points)

Transform the following three NFAs with alphabet $\Sigma = \{0, 1\}$ into equivalent DFAs. Use the general transformation method presented in class. Present and explain each individual step *explicitly*, in addition to giving the final transition graph.

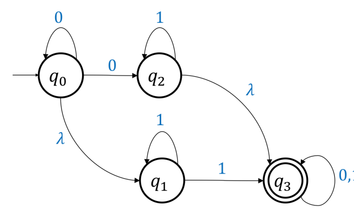
a)



b)



c)



Note: Do not minimize/modify the resulting DFA, except for removing unreachable states.

Task 2 – Regular Expressions (6 points)

Throughout this task, let us fix the alphabet $\Sigma = \{a, b, c\}$.

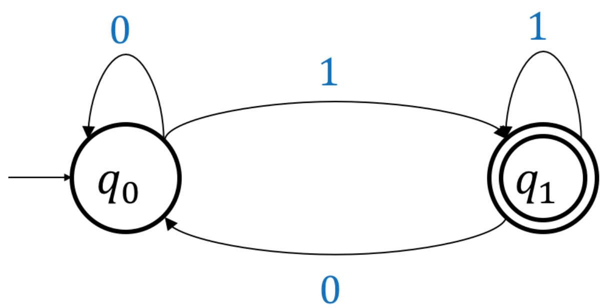
a) Use set notation to describe the languages $L(r_1), \ldots, L(r_6)$ defined by the following regular expressions. (We usually omit $\cdot$ for concatenation.)

- $r_1 = \lambda a a^*$
- $r_2 = (\emptyset + a)(\emptyset + b)(\emptyset + c)$
- $r_3 = (\lambda + a)(\lambda + b)(\lambda + c)$
- $r_4 = \emptyset + \lambda$
- $r_5 = (a + b + c + \emptyset)^*$
- $r_6 = \lambda^*$

b) Give a regular expression which defines the language of all strings in Σ^* containing the substring baa or the substring cba.

Task 3 – From NFAs to Regular Expressions (4 points)

Give a regular expression describing the language accepted by the following NFA.



Task 4 – Closure Properties (8 points)

Let L_1 and L_2 be regular languages. Show that the following languages are also regular.

a) The difference $L_1 \setminus L_2 = \{w \in L_1 : w \notin L_2\}$.

b) The symmetric difference $L_1 \oplus L_2 = (L_1 \setminus L_2) \cup (L_2 \setminus L_1)$.

c) The reversal $L_1^R = \{w^R : w \in L_1\}$.

Hint: You can use the closure properties presented in class for union, intersection, $\star$, concatenation, or the fact that every regular language has a DFA/NFA. Try to find the shortest answer.