Homework 3: Regular Equivalences and Nonregularity

CSCI 161

Due 9pm, Thursday, October 8, 2020

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Overview. This is your second and final homework focusing on regular languages. The first question recalls the construction for converting an NFA to a DFA; the second has you construct a regular expression equivalent to an FA; the third and fourth have you design FAs equivalent to particular regular expressions, with the fourth requiring you to think beyond the general regex→NFA construction; the last involves proving nonregularity using the pumping lemma (Section 1.4), which will be discussed in class in Monday and Wednesday. *Questions 1-4 are graded on correctness only; full credit for Question 5 depends on logical soundness/clarity.*

Question 0. List any consultations/collaborations for this assignment and elaborate to the extent helpful.

Response. I consulted one of my classmates, Cole, for this assignment.

$N:$

Question 1. For the NFA $N = (Q, \{0, 1\}, \delta, q_0, F)$ depicted above and relabeling $Q = \{1, 2, 3\}$, consider the equivalent DFA $M = (Q', \{0, 1\}, \delta', q_0', F')$ constructed following the general procedure from class, i.e., with $Q' = \mathcal{P}(Q)$, $\delta'(R, a) = E(\bigcup_{r \in R} \delta(r, a))$ for all $R \in Q'$ and $a \in \Sigma$, $q_0' = E(\{q_0\})$, and $F' = \{R \in Q' \mid R \cap F \neq \emptyset\}$, where $E(R)$ denotes the set of states ϵ-reachable from some $r \in R$.

a) How many states are in Q' as defined above?

   8 states, since Q' = P(Q)

b) What is the start state?

   The start state is (1,2) since it is equal to E(1)

c) How many of these states are reachable from the start state?

   Only 2 since this is a DFA, each state only has 2 outputs since the length of our alphabet is 2.

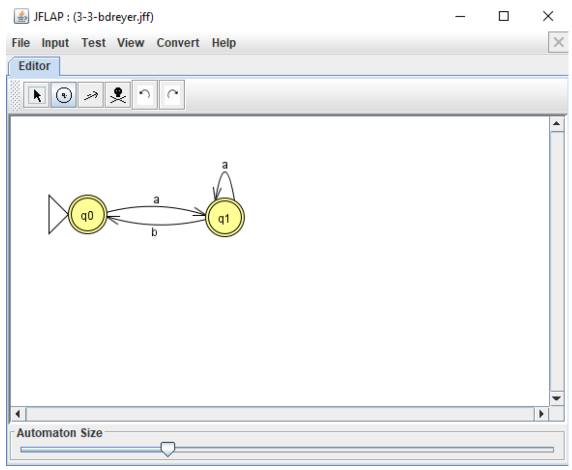
d) What is the label of the state the DFA is in after digesting the characters 10010?

   2

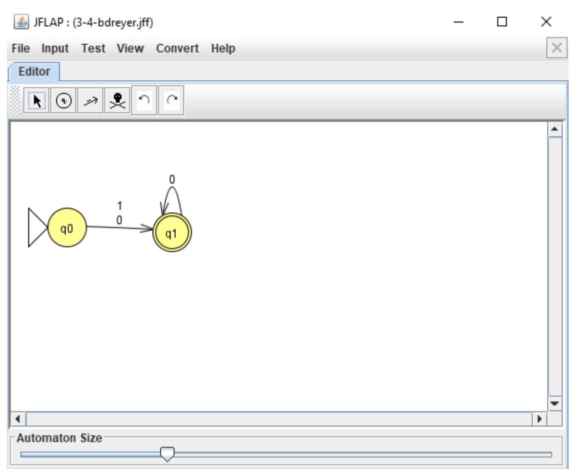
Question 2. Give a regular expression for the language recognized by the machines in Question 1.

Solution. 1*0*1

Question 3. Example 1.56 in the text illustrates the general conversion from a regular expression to an NFA for the regular expression $(ab \cup a)^*$. As with the general conversion from NFAs to DFAs, this general conversion may result in more states than necessary. Submit a JFLAP file containing a two-state NFA that recognizes the language described by $(ab \cup a)^*$, and include a diagram in your pdf.

N : 

Question 4. Submit a JFLAP finite automaton that recognizes the language of $(0 \cup 1) \circ 0^*$, and include a diagram of it in your pdf.

N : 

Question 5. The following language over $\Sigma = \{1, \#\}$ contains #-separated lists of distinct unary values:

$$A = \{x_1 \# x_2 \# \ldots \# x_k \mid k \geq 0, x_i = 1^* \text{ for all } i = 1 \ldots k, x_i \neq x_j \text{ for all } i \neq j\}$$

Use the pumping lemma to show A is not regular. In other words, give a string $s \in A$ and argue that no matter how you partition $s = xyz$ with $|y| > 0, |xy| \leq p$, there exists some $i = 0, 2, 3, \ldots$ such that $xy^i z \notin A$.

Solution. Didn't have enough time to finish this problem