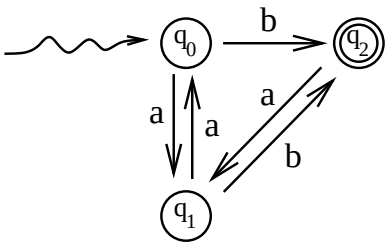
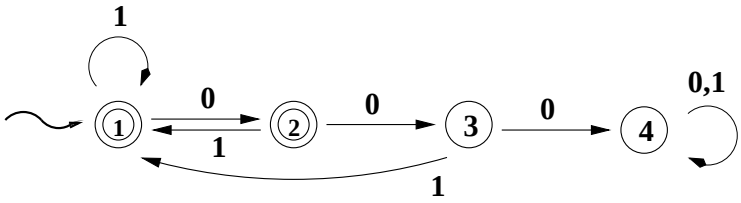
University of Nevada, Las Vegas Computer Science 456/656 Spring 2024

Answers to Assignment 1: Due Friday January 26, 2024

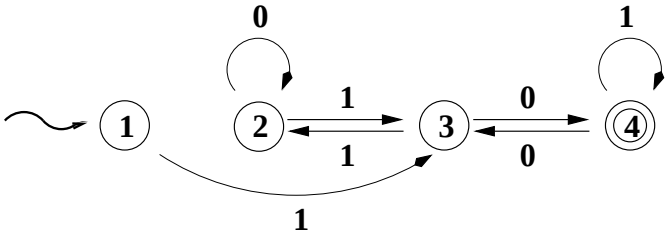
1. Let M_1 be the DFA shown below.



Let M_2 be the DFA shown below.



Let M_3 be the DFA shown below.



Which of the following languages is accepted by M_1? By M_2? By M_3?

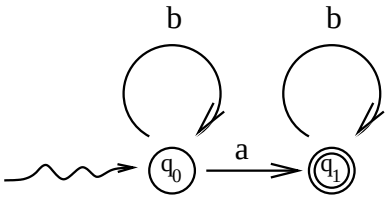
(a) I made a mistake drawing the state diagrem for M_2. State 3 is not supposed to be final The language of all binary strings in which every substring 00 is followed by 1 is not accepted by the original M_2, but is if we change state 3 to be non-final.

(b) The language of all strings over $\{a, b\}$ which end in b and which do not contain the substring bb is accepted by M_1.

(c) The language of all binary numerals for positive integers equivalent to 2 modulo 3 is accepted by M_3.

(d) The language of all strings over $\{a, b\}$ in which every b is followed by a is not accepted by any of the machines shown.

Construct a DFA which accepts the language $\{b^i a b^j : i, j \geq 0\}$, the language of all strings over $\{a, b\}$ which contain exactly one a. Your figure need not show the dead state.



2. Recall that $\emptyset$ is the empty language. If L is some language, what is the concatenation $\emptyset L$? Ans: $\emptyset$

3. Let $L_1 = \{\lambda\}$. the language consisting of only the empty string. If L_2 is some other language, what is the concatenation $L_1 L_2$? Ans: L_2

4. Is concatenation of languages commutative? That is, is the equation $L_1 L_2 = L_2 L_1$ always true? Ans: No.

5. Is it true that, for any language, $L^n L = L^{n+1}$? Ans: Yes.

6. Which of the following is true:

   (a) If L is any language, $L^0 = L$.

   (b) If L is any language, $L^0 = \emptyset$.

   (c) If L is any language, $L^0 = \{\lambda\}$.

   Hint: Think! Ans: False, False, True.

7. Does concatenation of languages distribute over union? That is, is $L_1(L_2 + L_3) = L_1 L_2 + L_1 L_3$ always true? Ans: Yes.

8. What is $\emptyset^*$, the Kleene closure of the empty language? Ans: $\{\lambda\}$.

9. What is L^{**}? Ans: L^*. Kleene closure is idempotent.

10. Is the union of two regular languages always regular? Ans: Yes.

11. Is the intersection of two regular languages always regular? Ans: Yes.

12. Is the complement of a regular language always regular? Ans: Yes.

13. Is the Kleene closure of a regular language always regular? Ans: Yes.

14. The DFA M_1 shown in Problem 1 is not minimal, that is, it's equivalent to a DFA with fewer states. Can you draw a state diagram of that DFA? Your figure need not show the dead state.