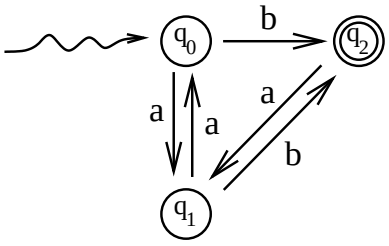
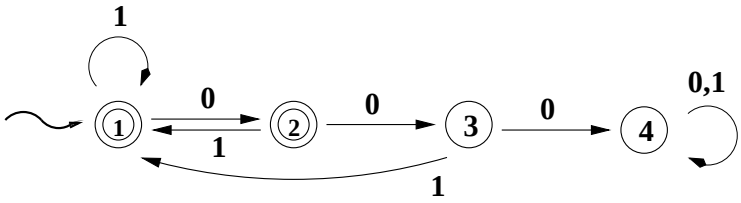
University of Nevada, Las Vegas Computer Science 456/656 Spring 2025

Answers to Assignment 2: Due Saturday February 1, 2025

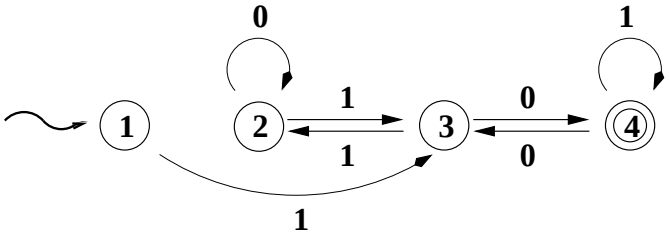
1. Let M_1 be the DFA shown below.



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?

M_1 accepts (b).

M_2 accepts (a).

M_3 accepts (c).

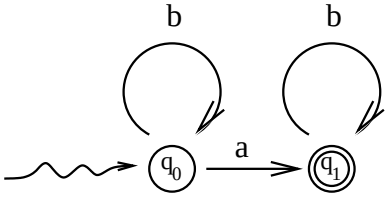
(a) The language of all binary strings in which every substring 00 is followed by 1.

(b) All strings over $\{a, b\}$ which end in b and which do not contain the substring bb.

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

(d) The language of all strings over $\{a, b\}$ in which every b is followed by a.

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 $\emptyset L$?

   $\emptyset$

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_1L_2?

   L_2

4. Is concatenation of languages commutative? That is, is the equation $L_1L_2 = L_2L_1$ always true?

   No. For example, if $L_1 = \{a\}$ and $L_2 = \{b\}$, then $L_1L_2 = \{ab\}$ and $L_2L_1 = \{ba\}$.

5. 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, $L^0 = \{\lambda\}$.

   $L^0 = \{\lambda\}$

6. Does concatenation of languages distribute over union? That is, is $L_1(L_2 + L_3) = L_1L_2 + L_1L_3$ always true?

   Yes. To convince yourself, work out a few tiny examples.

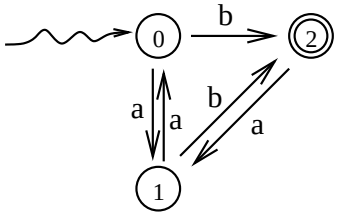
7. What is $\emptyset^*$, the Kleene closure of the empty language?

   $\{\lambda\}$. See problem 5 above.

8. True(T) or False(F).

   i **F** Concatenation is commutative. That is, $L_1L_2 = L_2L_1$ for any languages L_1 and L_2.
   ii **T** Concatenation is associative. That is, $(L_1L_2)L_3 = L_1(L_2L_3)$ for any languages L_1, L_2, and L_3.
   iii **T** The intersection of any two regular languages is regular.
   iv **T** The complement of any regular languages is regular.
   v **T** The Kleene closure of any regular languages is regular.

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



	0	1	2
0	O	O	X
1	O	O	X
2	X	X	O