COMS 3261 Handout 2B:
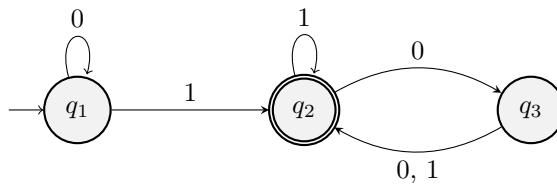# Finite Automata Practice Questions

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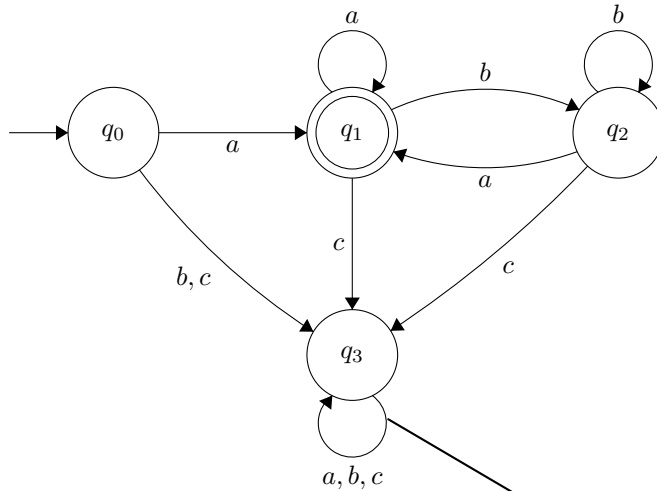Fall 2023

1   DFA Exercises

1. Determine which of ε, 11, 010, 10, 0101 is accepted by this DFA.

ε Not accepted

11   Accepted

010   Not accepted

10   Not accepted

0101   Accepted

2. The DFA state diagram below is defined on the alphabet $\Sigma = \{a, b, c\}$. Write out its formal definition (as a 5-tuple). When specifying the transition function δ, draw a table.

q_0

$D = (Q, \Sigma, \delta, q_0, F)$

$Q = \{q_0, q_1, q_2, q_3\}$

$\Sigma = \{a, b, c\}$

δ:

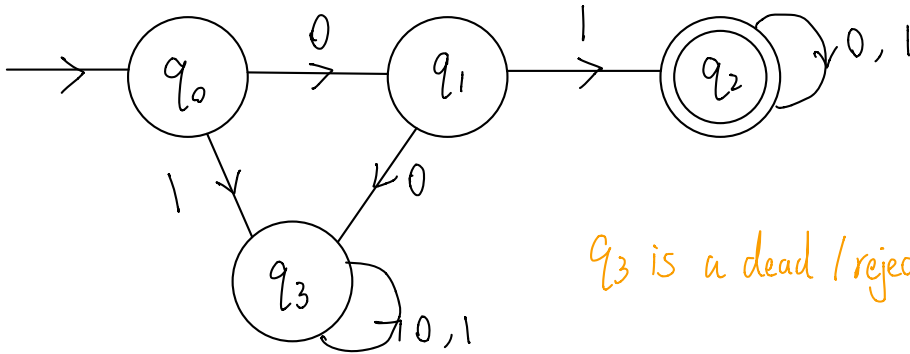|	a	b	c
q_0	q_1	q_3	q_3
q_1	q_1	q_2	q_3
q_2	q_1	q_2	q_3
q_3	q_3	q_3	q_3

$F = \{q_1\}$

dead / reject / bad state :

We could also not draw this because for DFAs we have a convention that when there are missing transitions, it means that they all go to the dead / reject / bad state.
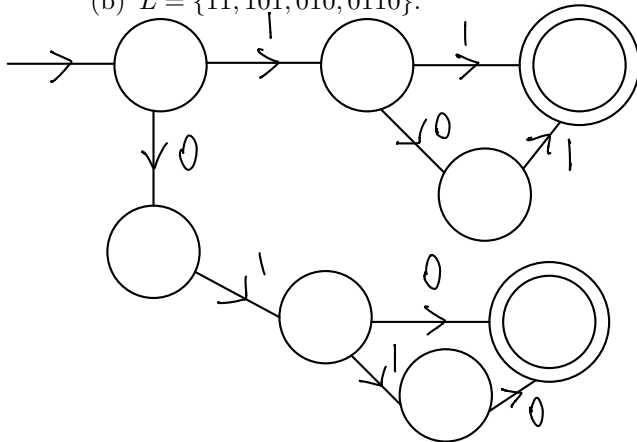
3. Draw a DFA that recognizes:

(a) All strings with the prefix 01.

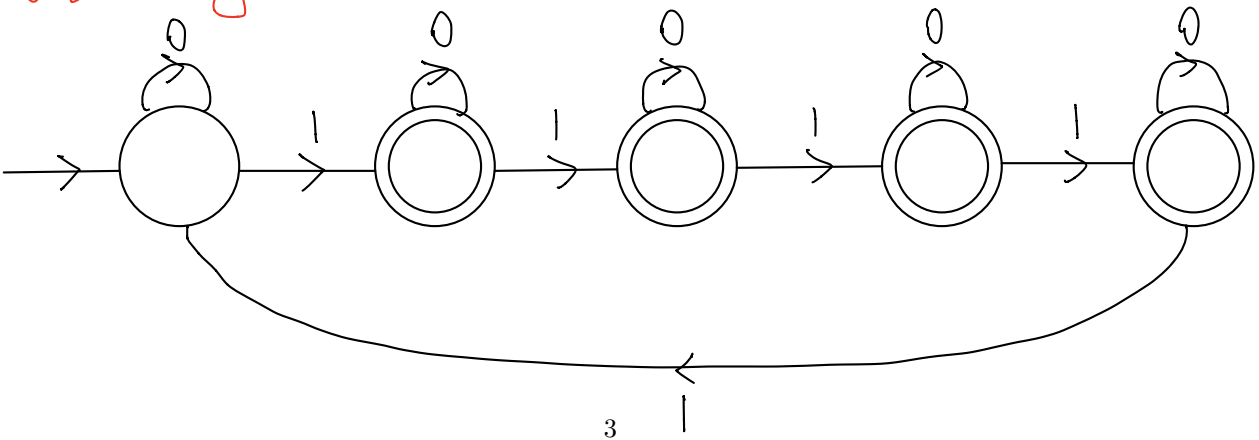q_3 is a dead / reject / bad state.

(b) $L = \{11, 101, 010, 0110\}$.

The dead / reject / bad state can be omitted. In this graph, we just omitted it to avoid making the graph messy.

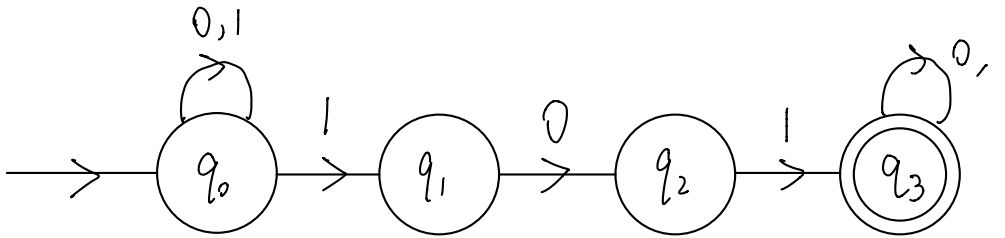(c) $L = \{w \in \{0,1\}^* \mid$ the number of 1's in w is not an integer multiple of 5$\}$.
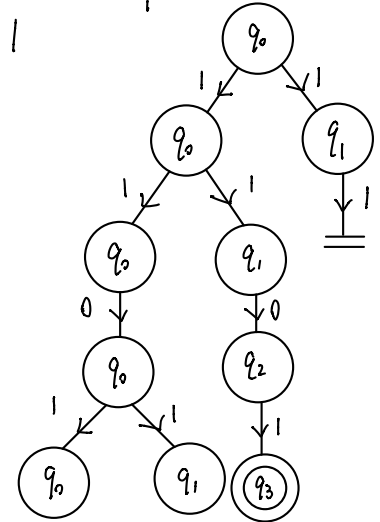
★ 0 is an integer multiple of 5!

2 NFA Exercises

1. Draw an NFA that recognizes:
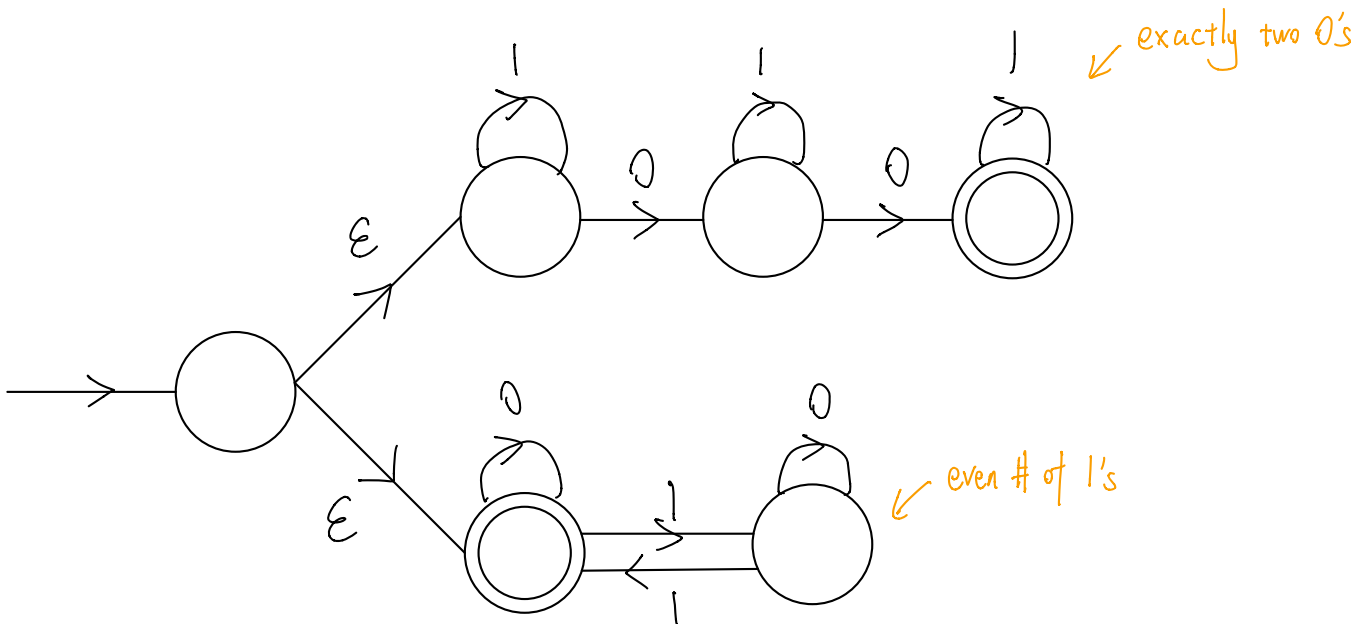
   (a) All strings that contain 101.

Computation tree on 1101

   (b) $L = \{w \in \{0, 1\}^* \mid w$ has exactly two 0's or an even number of 1's$\}$.

← exactly two 0's
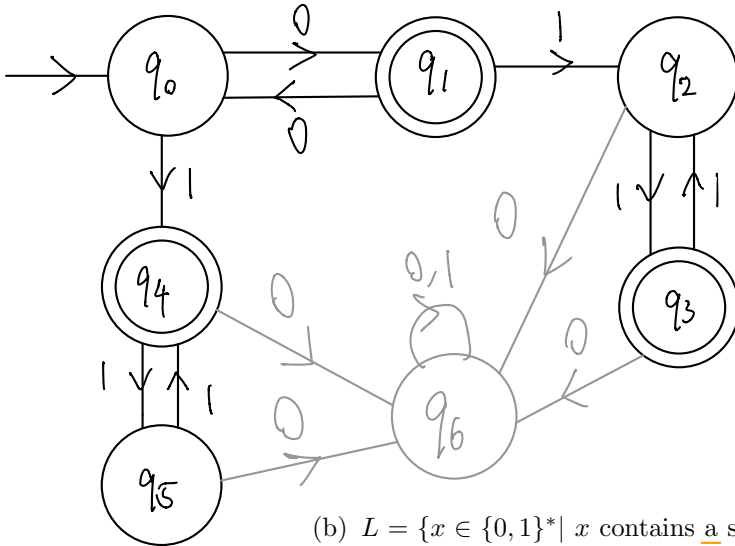

← even # of 1's

3   Miscellaneous Exercises

Draw either a DFA or an NFA.

1. Prove the following languages are regular:

   (a) $L = \{0^m 1^n \mid m, n \geq 0, \text{ and } m + n \text{ is odd}\}$

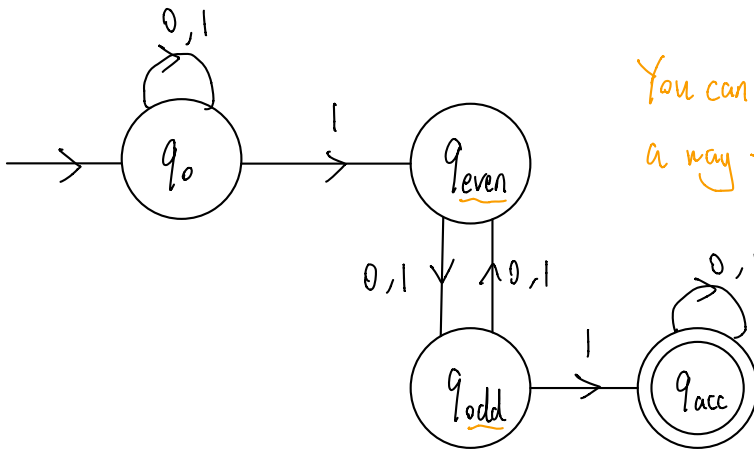   *Be careful about the order!*

   ex. $0^4 1^3 = 0^4 \cdot 1^3 = 0000111$

The grey part is the dead / reject / bad state.
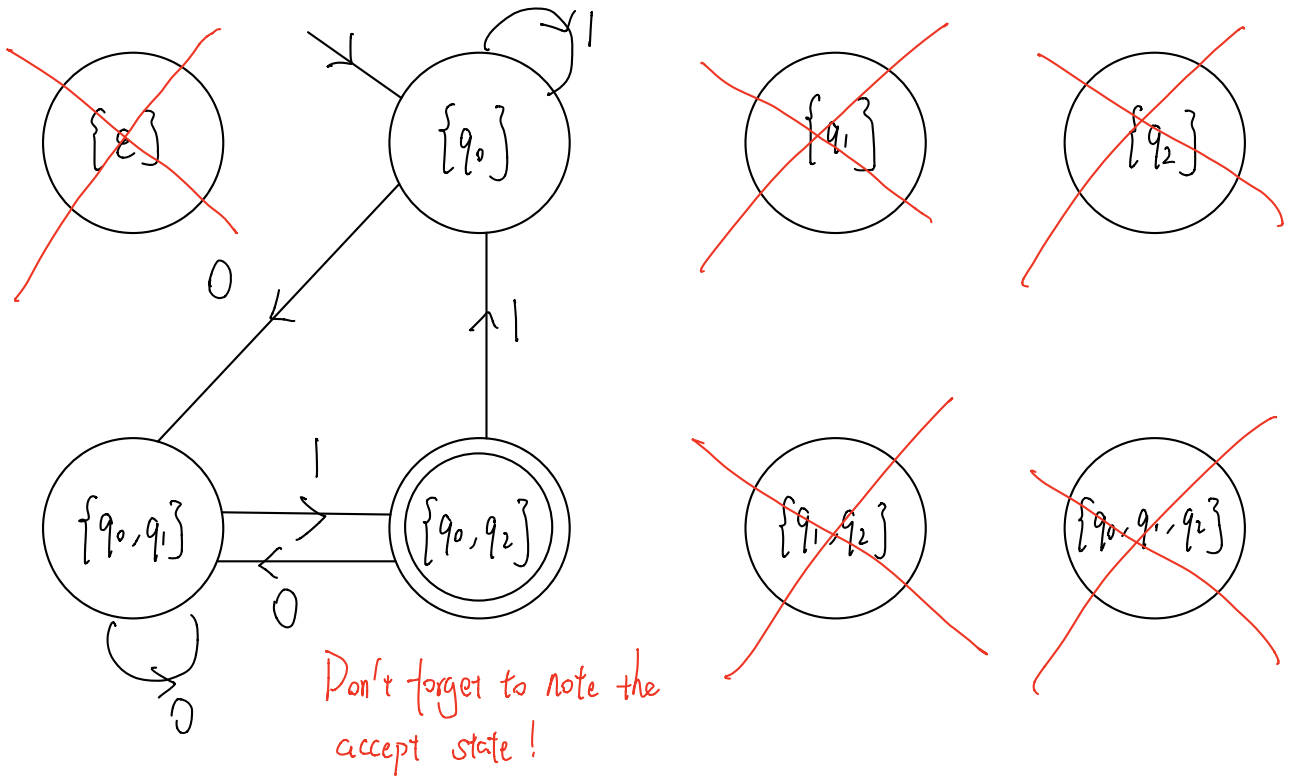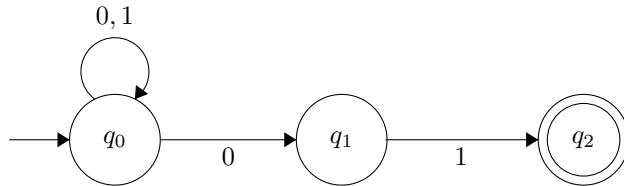In this case, we might want to just omit it.

   (b) $L = \{x \in \{0,1\}^* \mid x \text{ contains } \underline{a} \text{ substring of two 1's separated by an odd number of characters}\}$

Note that   111   is also accepted by L!

You can name the states in a way that can help make things clear!

5

2. Convert this NFA to a DFA using subset construction:

NFA δ:

	0	1	ε
q_0	$\{q_0, q_1\}$	q_0	
q_1		q_2	
q_2			

DFA δ:

	0	1
q_0	$\{q_0, q_1\}$	q_0
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_0, q_2\}$
$\{q_0, q_2\}$	$\{q_0, q_1\}$	q_0

Don't forget to note the accept state!

You could also draw the transition tables to help you understand:

6

3. (a) What is the language recognized by this NFA?

q_0

q_0 is not accepting : $\emptyset$

$\downarrow$

$\{\} \neq \{\varepsilon\}$

The complement of $\emptyset$ is Σ^*.
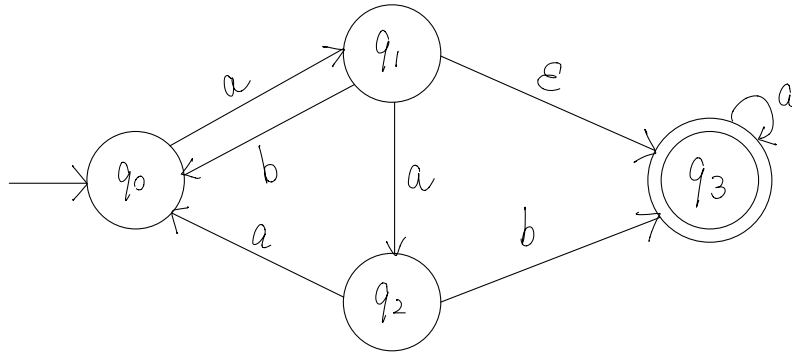
Note: They are not complement

(b) What is the language recognized by this NFA?   of each other.
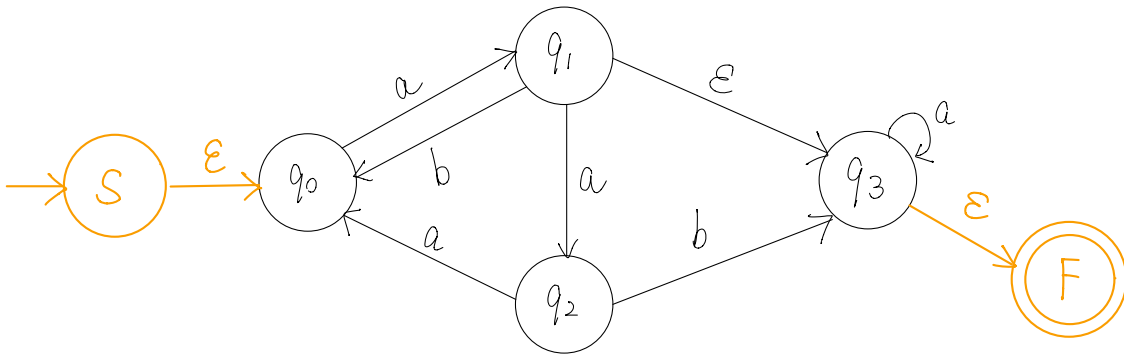
q_0

q_1 is accepting : $\{\varepsilon\}$

The complement of $\{\varepsilon\}$ is $\{w \in \Sigma^* \mid |w| \geq 1\}$.

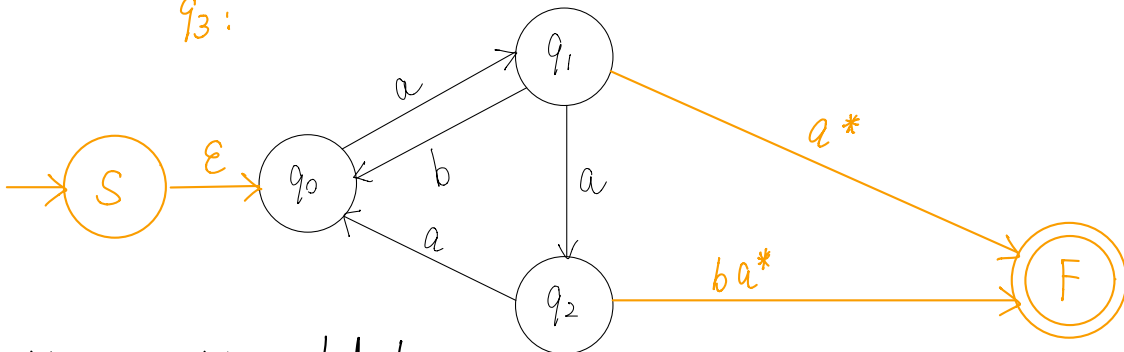4. Use state elimination method to convert this NFA into Regular Expression
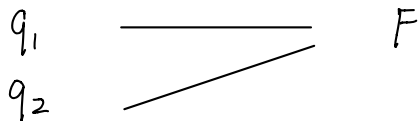

1. "Fix the NFA"

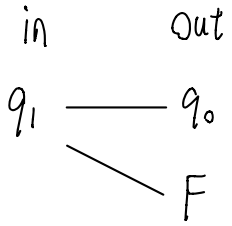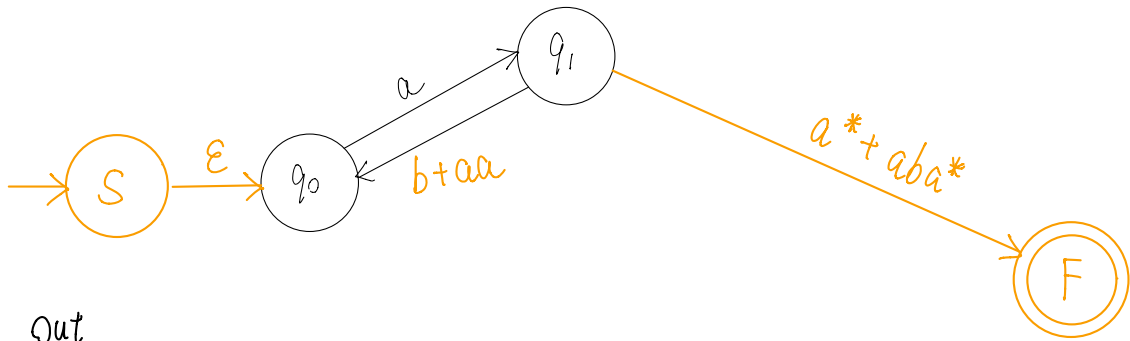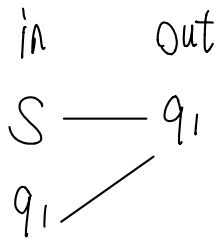2. Pick middle states (with fewer transitions)

q_3:

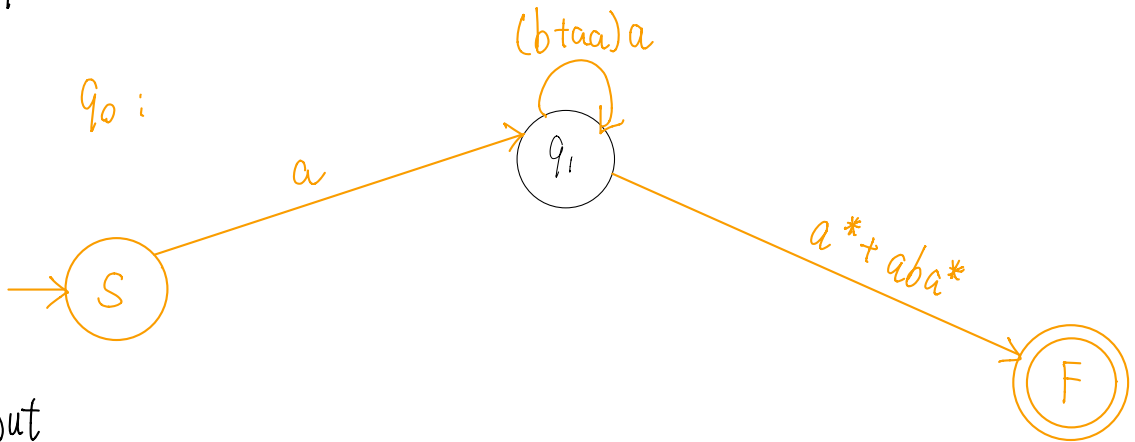
States that goes into q_3 States reached from q_3

q_1 _____   F

q_2 _____

q_2:

S $\xrightarrow{\varepsilon}$ q_0 $\xrightarrow{a}$ q_1 ... $q_0 \xrightarrow{b+aa}$ ... $q_1 \xrightarrow{a^*+aba^*}$ F

in   out

q_1 —— q_0

     F

q_0:

$(b+aa)a$

S $\xrightarrow{a}$ q_1 $\xrightarrow{a^*+aba^*}$ F

in   out

S —— q_1

q_1

q_1:

S $\xrightarrow{a\,((b+aa)a)^*\,(a^*+aba^*)}$ F

in   out

S —— F