Lecture 13: Finite Automata – What is it and what are its types?

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Automata is a Plural of Automaton (i.e. Automatic)

self-controlled machine

- ✓ **It's an other method for defining languages**
- ✓ **It's a <u>Graphical Method</u>**
- ✓ **Finite Automata (FA) is also called <u>Finite Automata Machine (FAM)</u>**

Token changes Position on the input of certain number by Dice

<u>State</u>

<u>Letters in alphabet</u>

Tokens

<u>Transition</u>

Direction

Initial State

Final State

Normal State

Lecture 13: Finite Automata – What is it and what are its types?

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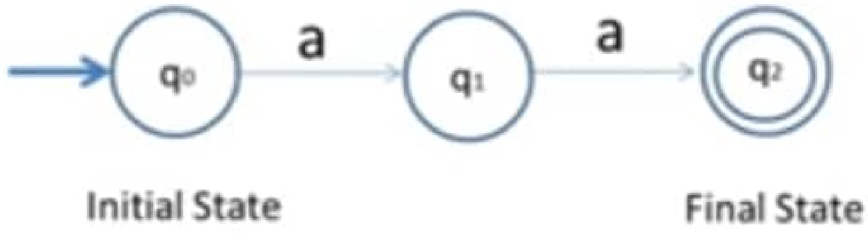
Limited

محدود

(Jis chez ki koi had ho)

Q: Number of States
Q_0: Initial State
F: Final State
Σ: Letters in Alphabet
∂: Transitions / Movements

L1 = {aa}



L2 = {aba}

Lecture 13: Finite Automata – What is it and what are its types?

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- ✓ Finite Automata is a method for defining languages.
- ✓ It is kind of Graphical Method that consists of following 5 parts;

FA: {Q, Q_0, F, ∑, ∂}

Q: Number of States
Q_0: Initial State
F: Final State
∑: Letters in Alphabet
∂: Transitions / Movements

- ✓ Finite Automata is also named as Finite Automata Machine (FAM)

What is it named as Finite Automata?

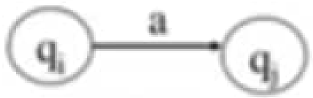
Automata: Plural of Automaton (i.e. automatic, self controlled machine)
Finite: Finite number of states / letters/ transitions

What are types?

FA / FAM

Deterministic Finite Automata (DFA)

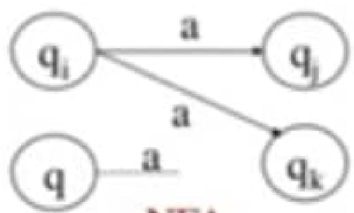
Only one output



DFA

Non-Deterministic Finite Automata (NFA)

Can be any output
/ Output is not determined



NFA

Lecture 14: Deterministic Finite Automata - What is DFA and how to draw DFA?

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Next state is known (Has only one next state)

Plural of Automaton (i.e. automatic, self controlled machine)

Finite number of states, letters and transitions

Q: Number of States

Q_0: Initial State

F: Final State

∑: Letters in Alphabet

∂: Transitions / Movements

L1 = {aa}

Initial State

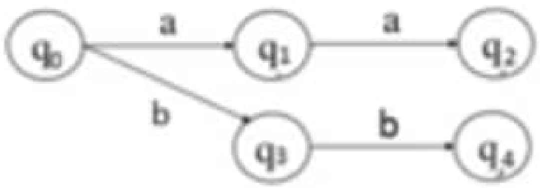
Final State

Symbols:

Initial State

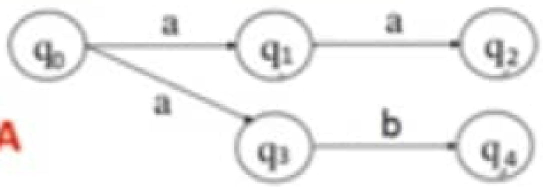
Final State

DFA



Initial State

Final State



NFA

Lecture 14: Deterministic Finite Automata - What is DFA and how to draw DFA?

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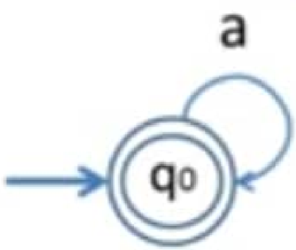
L2 = {aba}

loop

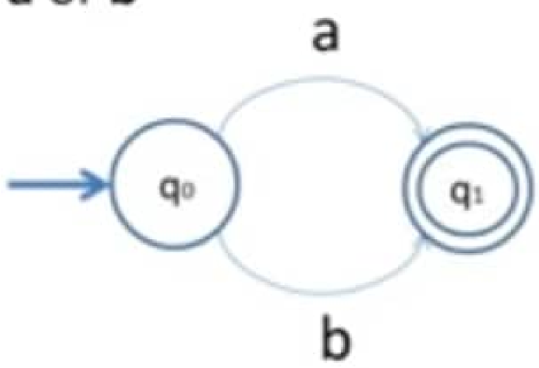
a*



Contains any no of a's

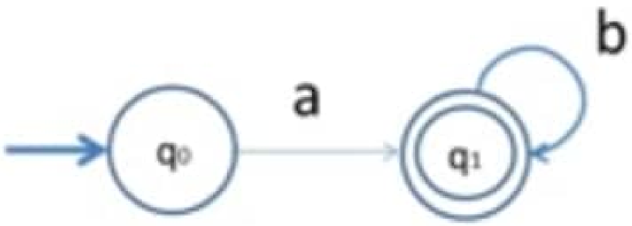
Contains **a** or **b**

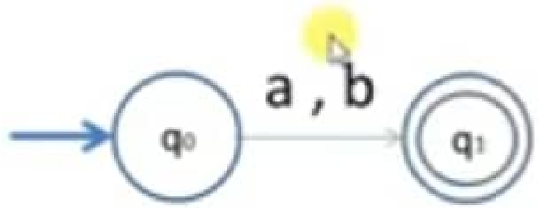
a+b



Starts with a and contains any number of b's in end

ab*





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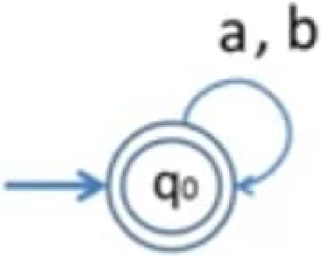
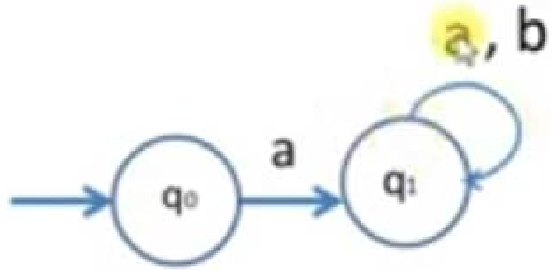
Contains any number of **a's** or **b's**

$(a+b)^*$



Stars with **a**

$R = a(a+b)^*$



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Definition:

- ✓ It's a type of Finite Automata that used to define languages in which next state is already known
- ✓ It consists of following 5 Parts;

FA: {Q, Q_0, F, ∑, ∂}

Q: Number of States
Q_0: Initial State
F: Final State
∑: Letters in Alphabet
∂: Transitions / Movements

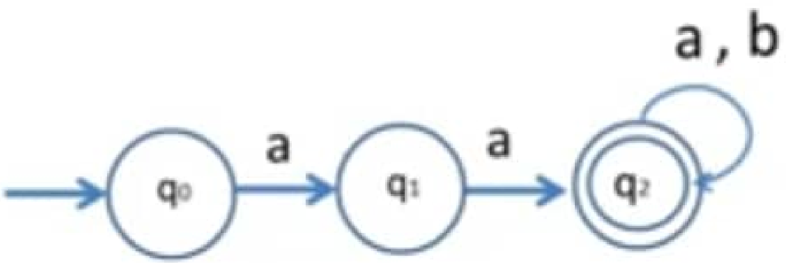
What is it named as Deterministic Finite Automata?

Automata: Plural of Automaton (i.e. automatic, self controlled machine)
Finite: Finite number of states / letters/ transitions
Deterministic: Output is already known (has only one next state)

How to draw Deterministic finite automata

DFA for a language that starts with **aa**

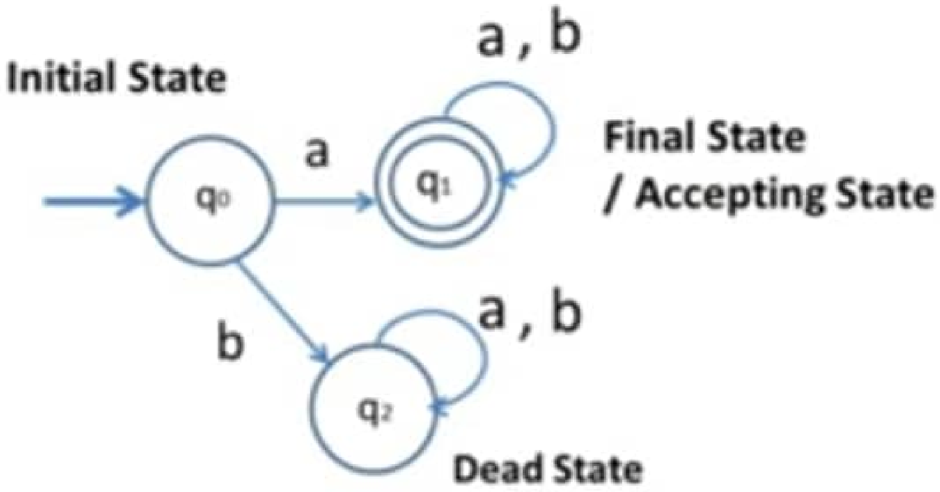
R = aa(a+b)*



- Circle/Ovals for Initial State, Normal State and Final State
- Arrow for Transition with letters above
- Loop and OR
- Only one output; single letter can not go to multiple state from one state

Starts with **a**

$R = a(a+b)^*$



q_0: Initial State

q_1: final State

q_2: Dead State (Dead End State)

Initial State

It is the state that the machine naturally starts in before it reads any input. It is called as **Entry Point**.

Final State

It is the state where the machine halts when it has no input left. It is also called **Accepting State**

Dead State / Dead End State

It is also called as **Rejecting State** and **Trap State**. Once the machine enters a dead state, there is no way for it to reach an accepting state

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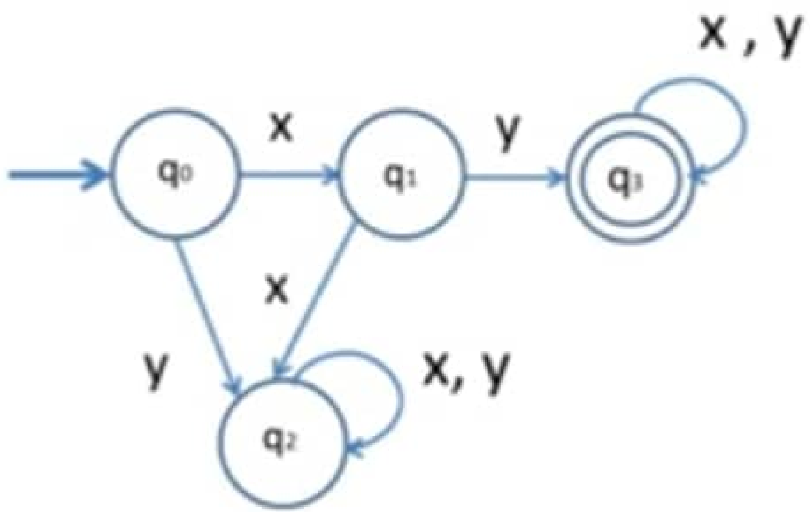
Construct an FA which recognizes the set of all strings defined over S = {x, y} starting with the prefix 'xy'.

R = xy(x+y)*



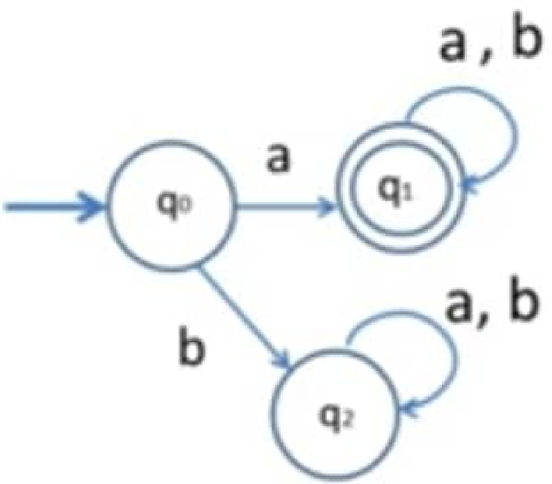
xyxx
xyyyy
xyxxyy

yx
xx

q_0: Initial State
q_3: Final State (Accepting State)
q_2: Dead State (Dead End State/Trap State/Rejecting State)

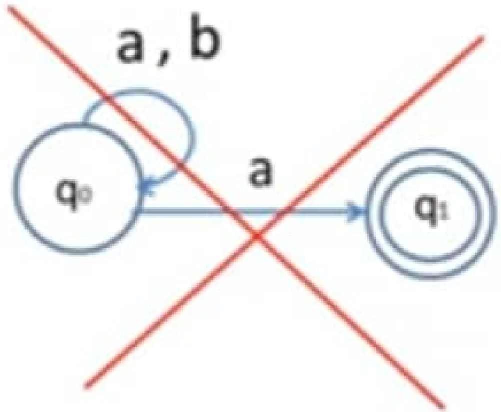
Starts with **a**

R = a(a+b)*



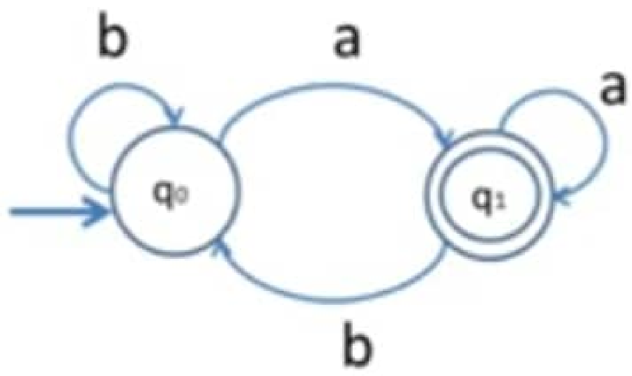
Ends with **a**

R = (a+b)*a



a
aa
aaa
ba
baa
bbaa
aba
abba
babbaa

DFA:
One letter can not go to many state from one state.
(i.e., Only one output)



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EVEN-EVEN

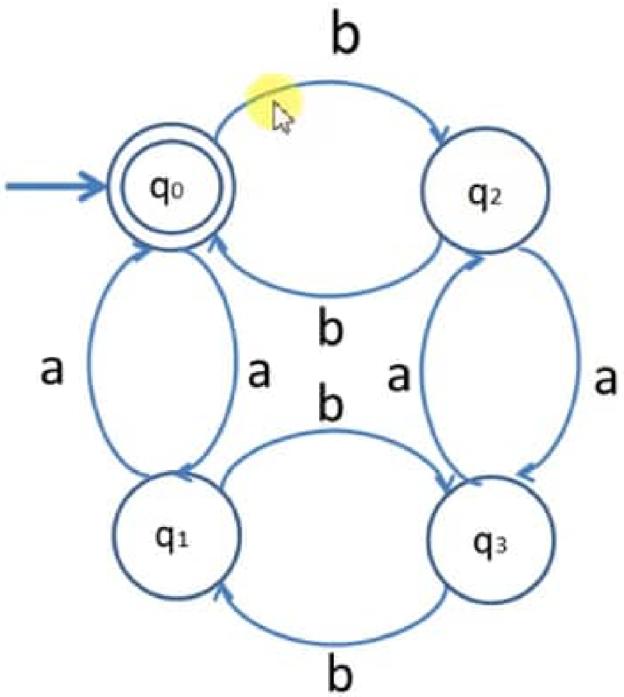
$\Sigma=\{a,b\}$

Even number of a's and Even number of b's

R = [aa + bb + (ab+ba)(aa+bb)*(ab+ba)]*
E =
RE =

aabb
bbaa
abab
baba
aa
bb

ab**aa**ab
ab**bb**ab



Even Numbers

0 , 2 , 4 , 6 , 8, ..

Odd Numbers

1 , 3 , 5 , 7 , 9 ,...

RE : Regular Expression
DFA : Deterministic Finite Automata

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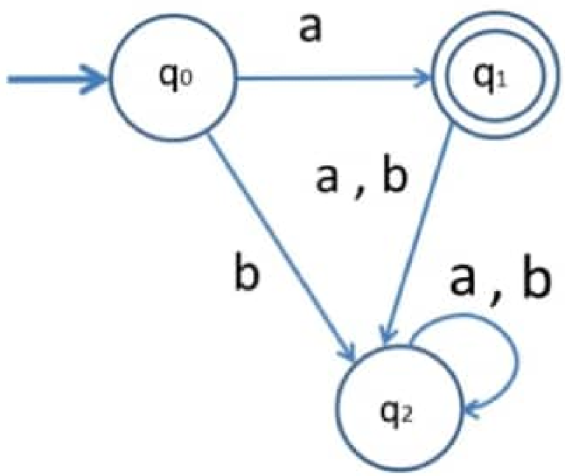
Q: Draw fa that accept exactly a

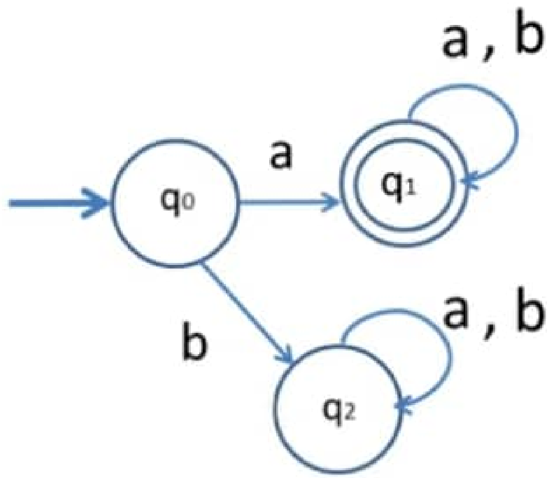
R = a



q_0: Initial State
q_1: final State
q_2: Dead State (Dead End State)

Q: Draw fa that accepts all words starting with a

R = a(a+b)*



q_0: Initial State
q_1: final State
q_2: Dead State (Dead End State)

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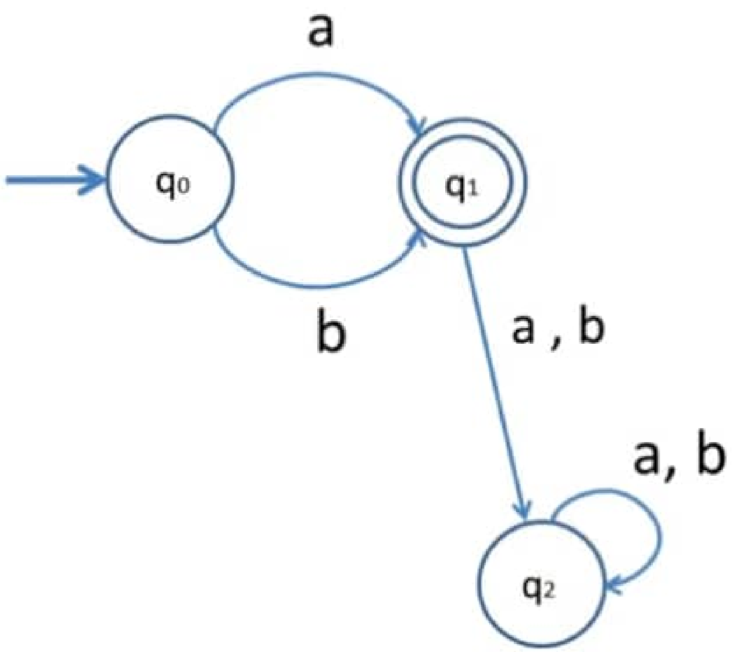
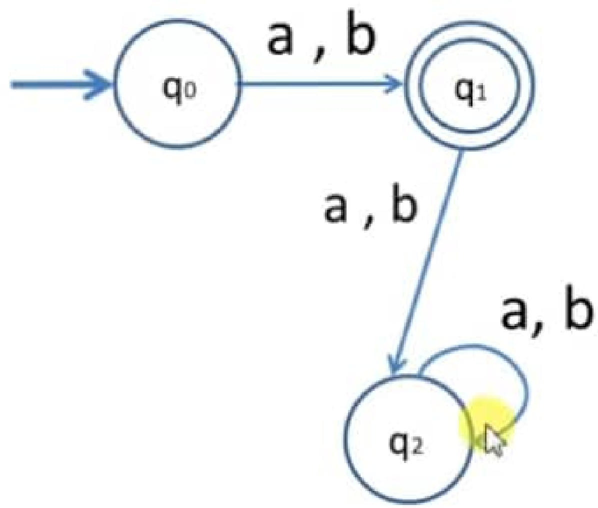
Q: Draw fa that accepts exactly a or b

Comma , = OR

R = a+b





q_0: Initial State
q_1: final State (accepting state)
q_2: Dead State (Dead End State / trap / rejecting)

q_0: Initial State

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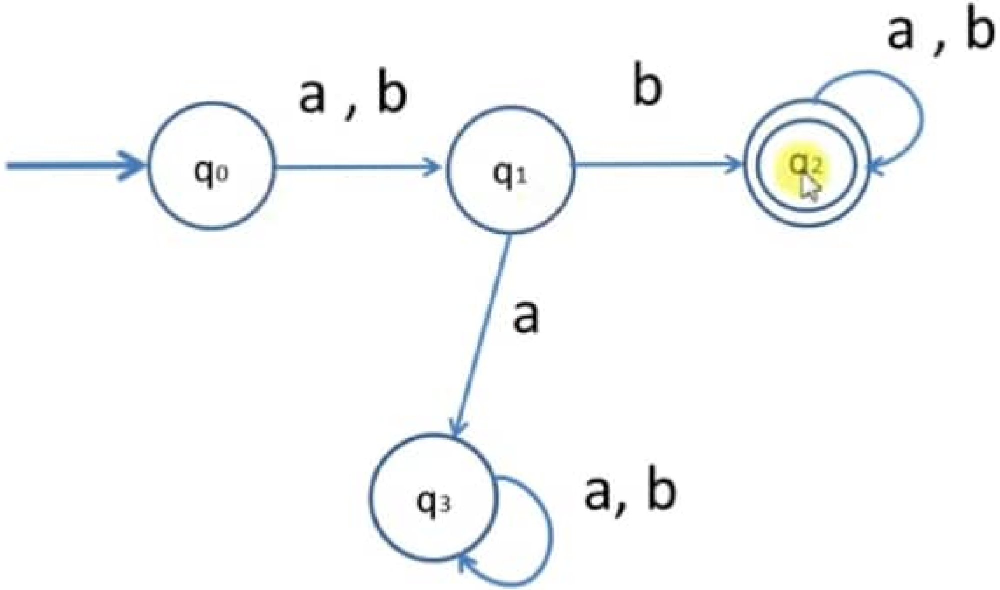
Q: Draw fa for the language that have b as a second letter over $\Sigma = \{ a , b \}$

$R = (a+b)b(a+b)^*$

a**b**
b**b**
a**b**aa
b**b**aa
a**b**aababa



q_0: Initial State
q_2: final State (accepting state)

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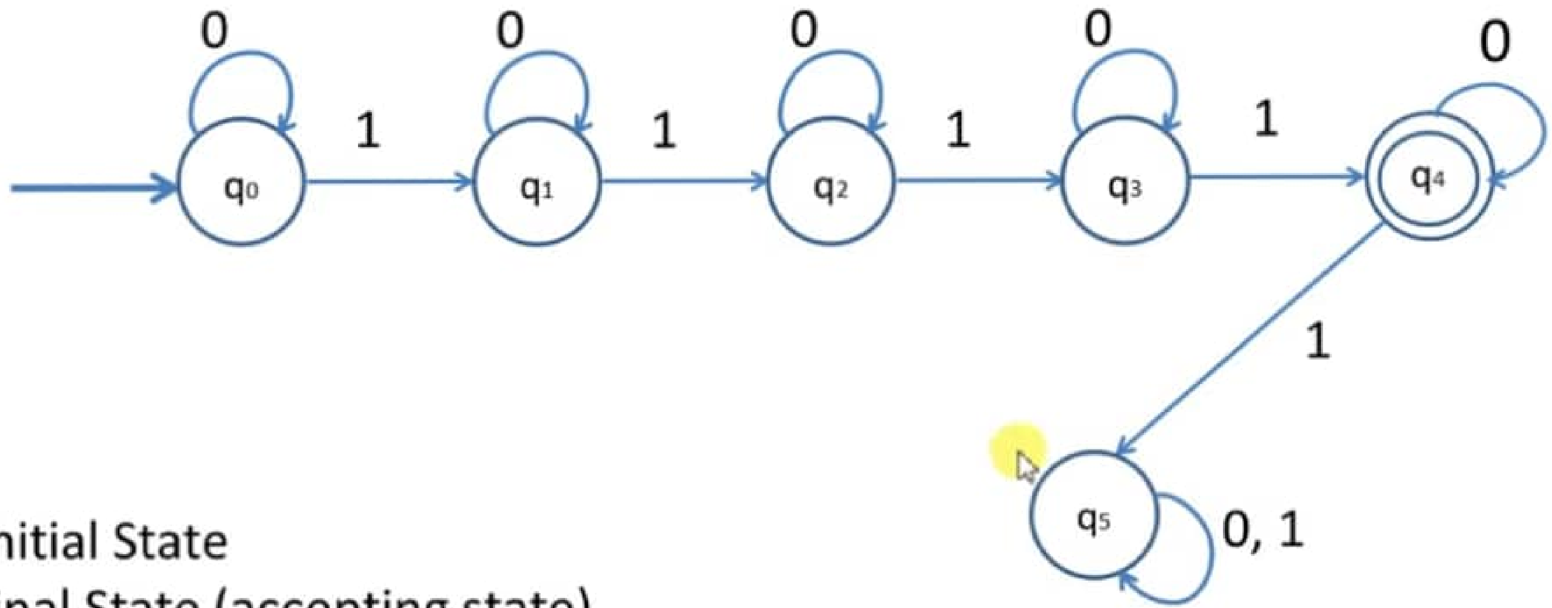
Q: Draw fa for the language that have exactly 4 ones in every string over $\Sigma = \{0, 1\}$

$R = 0^*1\ 0^*1\ 0^*1\ 0^*1\ 0^*$



1111
01111
011110
010101010

q_0: Initial State
q_4: final State (accepting state)

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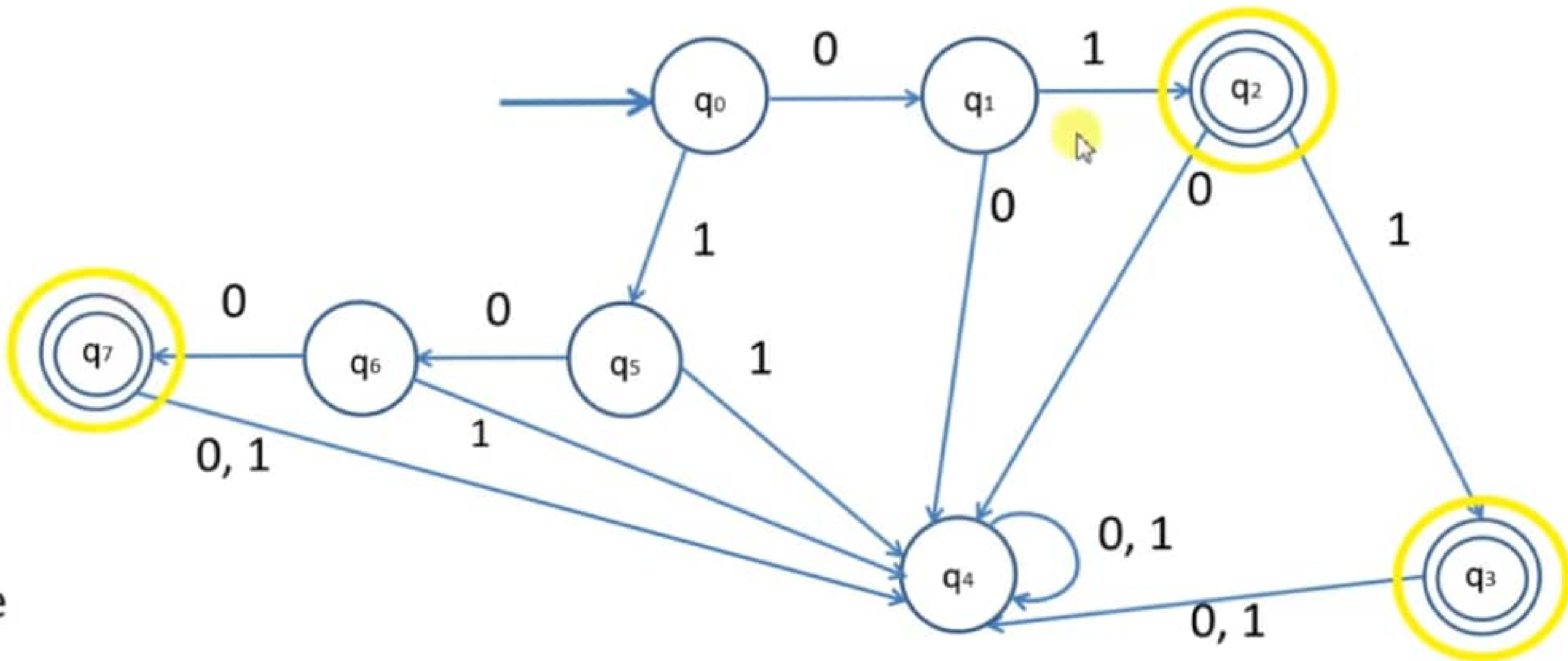
Q: Draw fa for the language that only accept L = {01, 011 , 100} over ∑ = { 0 , 1 }

R = 01 + 011 + 100



q_0: Initial State

q_2, q_3, q_7: final State

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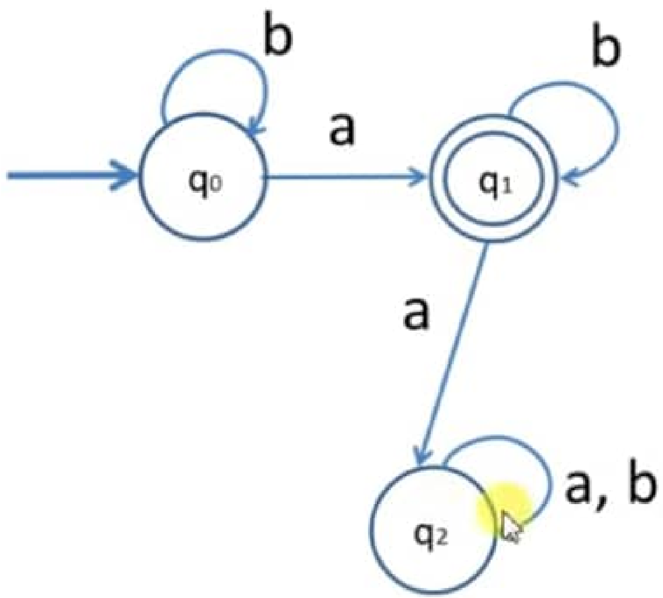
Draw fa for the language L = { $w.n_a = 1$ w Ɛ (a,b)* }

R= b* a b*

a
ab
ba
bab
bbbabbb



q_0: Initial State
q_1: final State
q_2: Dead State (Dead End State)

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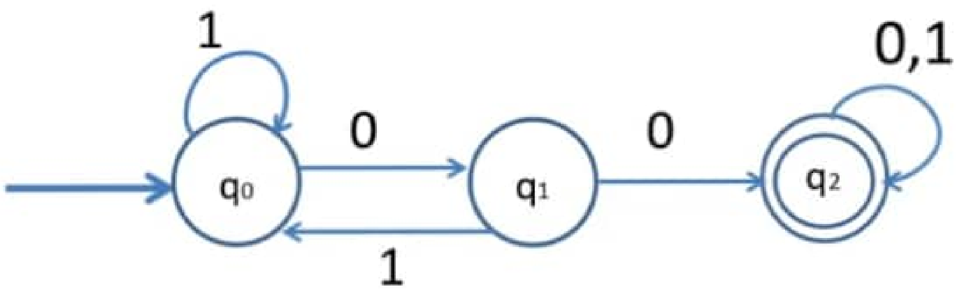
Q: $L = \{ w \in \{0, 1\}^* \mid w \text{ contains } 00 \text{ as a substring} \}$

$R = (0+1)^* \, 00 \, (0+1)^*$

00
1**00**
1**00**1
101**00**1
010**00**1
111**00**111
1**00**01



q_0: Initial State
q_2: final State (Accepting State)

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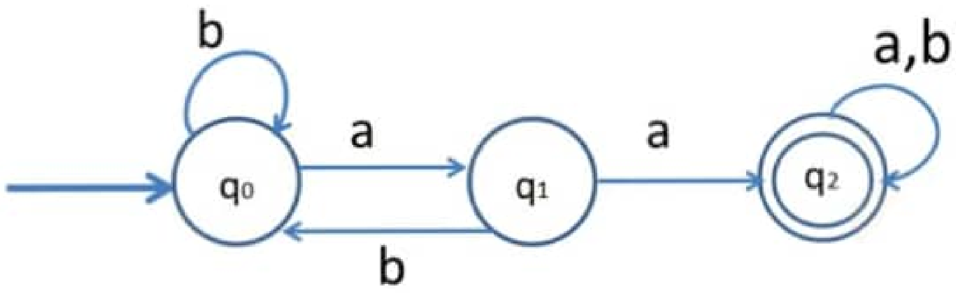
Q: Draw fa that accept all strings with double aa in somewhere over $\Sigma = \{a, b\}$

$R = (a+b)^* \, aa \, (a+b)^*$

$R = (0+1)^* \, 00 \, (0+1)^*$

aa
b**aa**
b**aa**b
bab**aa**b
ab**aa**ab
bbb**aa**bbb
b**aa**ab



q_0: Initial State
q_2: final State (Accepting State)

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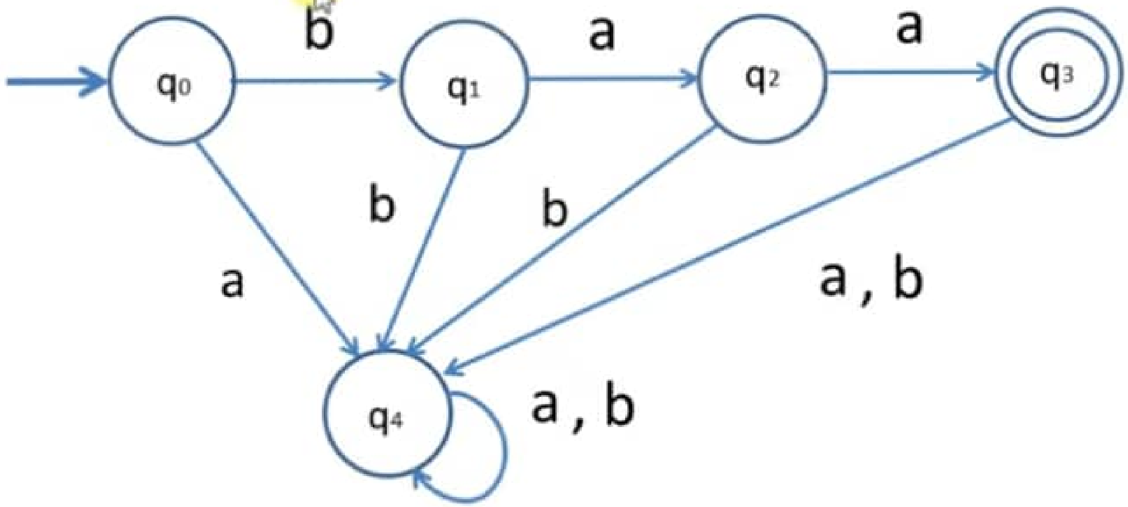
Q: Draw fa that contains exactly baa

R = baa



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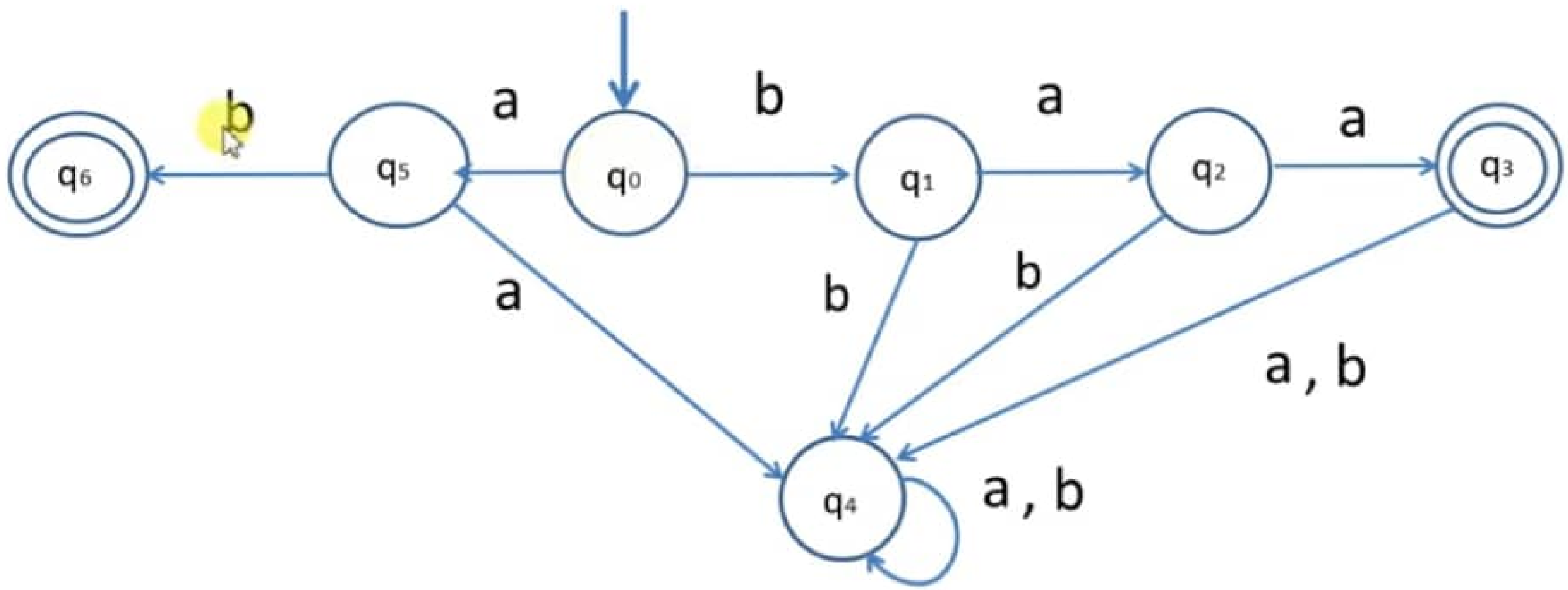
Q: Draw fa that accept exactly baa and ab

R = baa + ab



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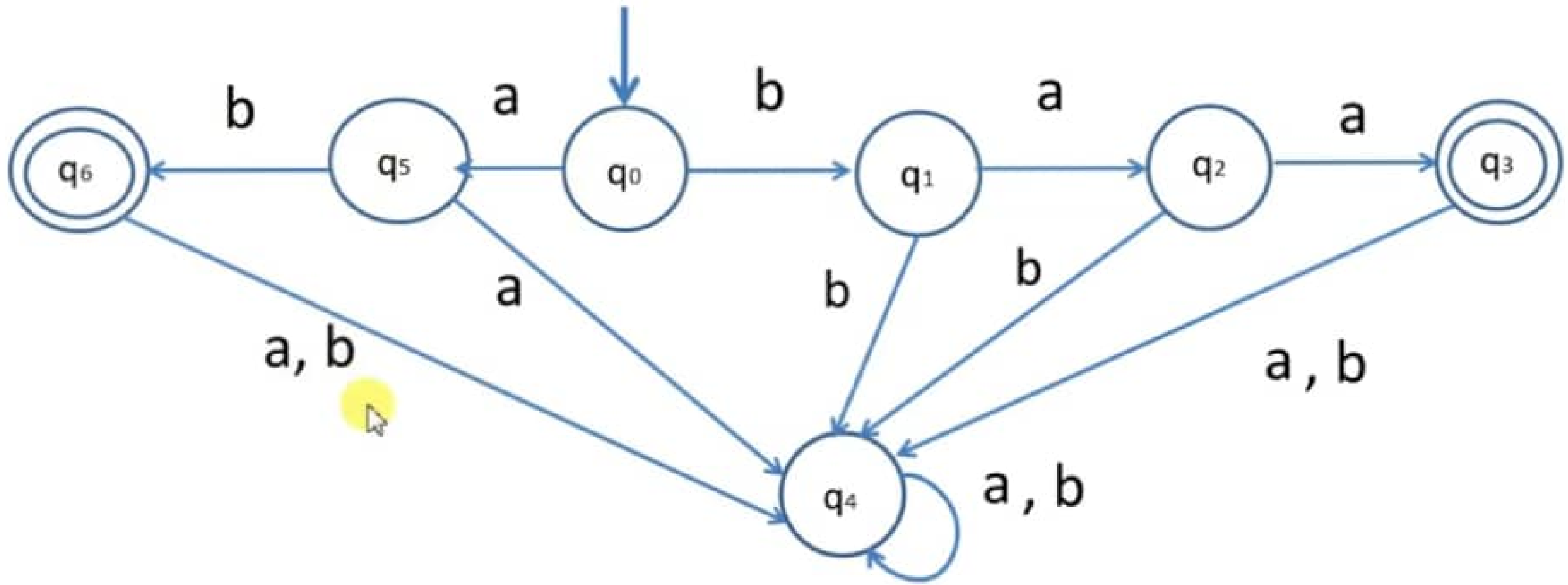
Q: Draw fa that accept exactly baa and ab

R = baa + ab



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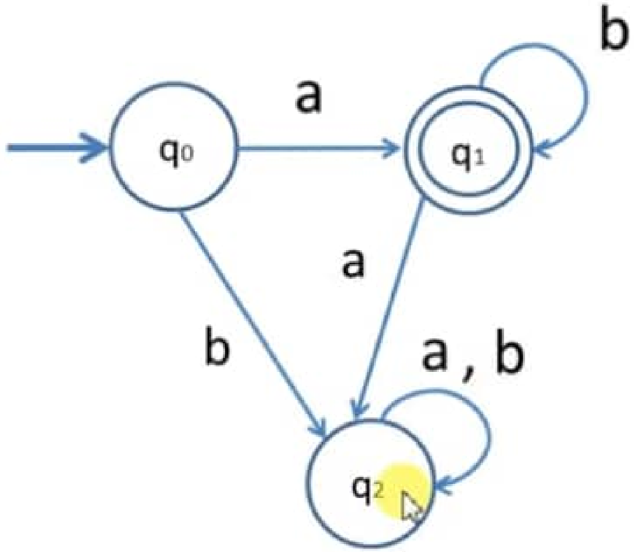
Q: Draw fa starting with a and contains any number of b's in end

R = ab*



q_0: Initial State
q_1: final State (Accepting State)
q_2: Dead State (Dead End State/Trap/Rejecting)

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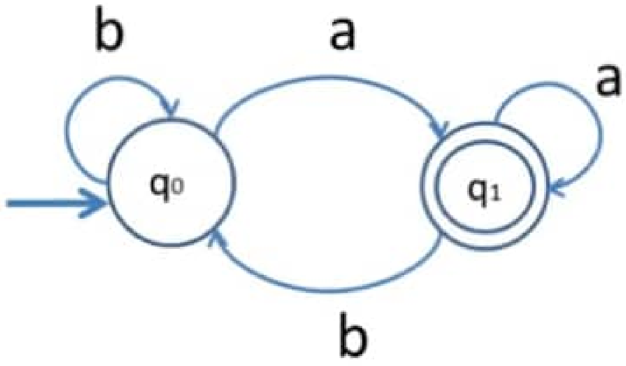
Q: Draw fa accept all words ending with a

R = (a+b)*a



a
aa
aaa
ba
baa
bbaa
aba
abba
babbaa

q_0: Initial State
q_1: final State (Accepting State)

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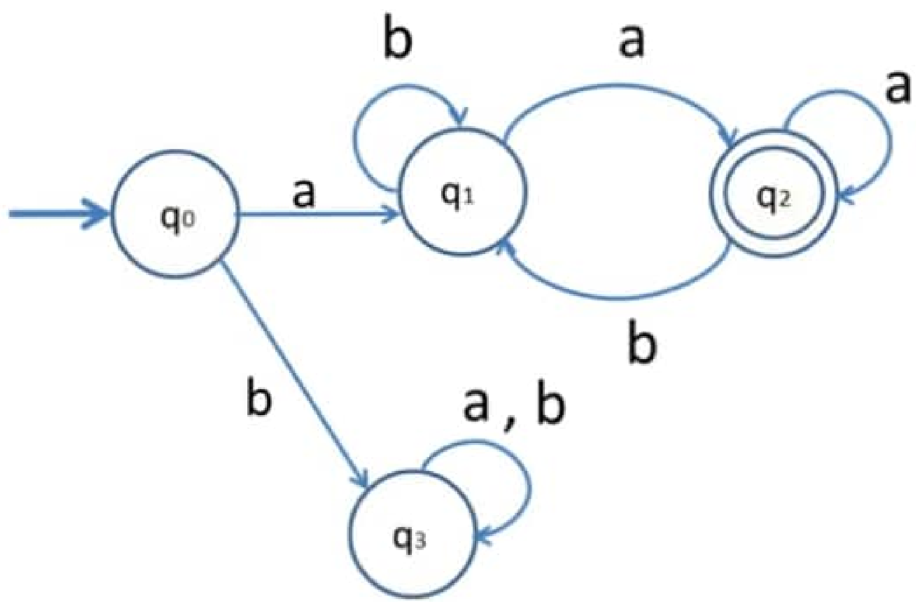
Q: Draw fa that accept all words starting and ending with a over $\Sigma = \{a , b\}$

$R = a(a+b)^*a$



q_0: Initial State
q_2: final State
q_3: Dead End State

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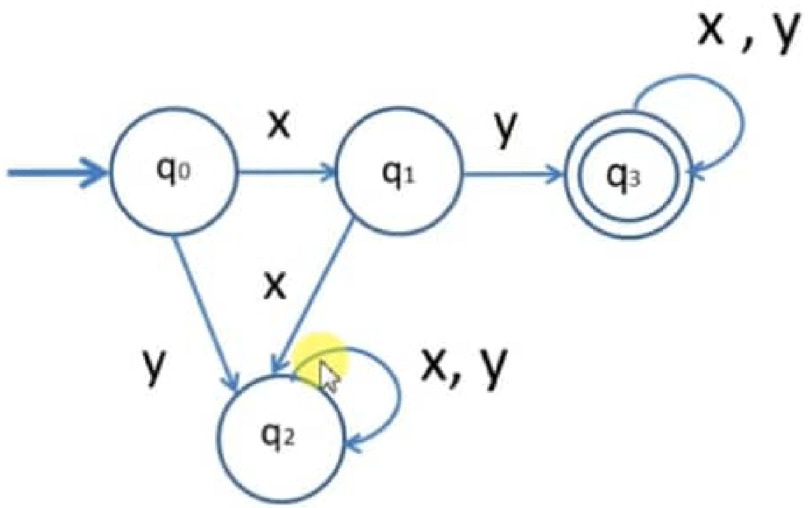
Q: Construct an FA which recognizes the set of all strings defined over S = {x, y} starting with the prefix 'xy'.

$R = xy(x+y)^*$



xyxx
xyyyy
xyxxyy

yx
xx

q_0: Initial State
q_3: Final State (Accepting State)
q_2: Dead State (Dead End State/Trap State/Rejecting State)

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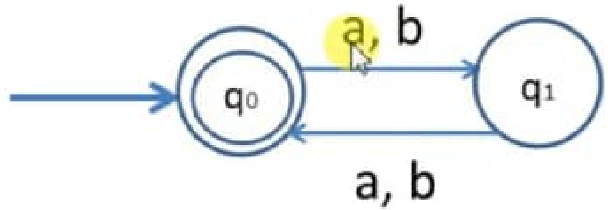
Q: Draw fa that accept all strings with even length over $\Sigma = \{ a , b \}$

$R = (aa + ab + ba + bb)^*$



q_0: Initial State

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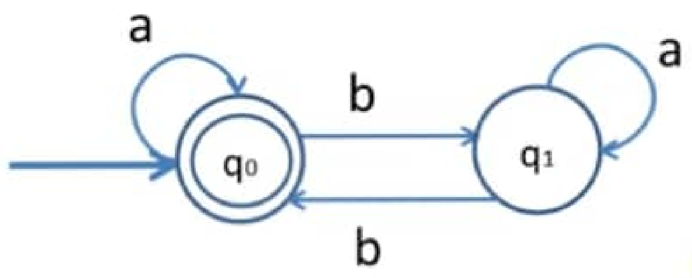
Q: Draw fa that accept all strings with even no of b's over $\Sigma = \{ a , b \}$

$R = a^* + (a^* ba^* ba^*)^*$



bb
aaaa
baba
bbaa

q_0: Initial State
q_1: Final State (Accepting State)

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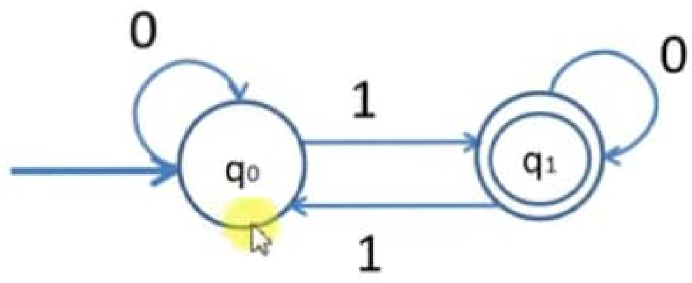
Q: Draw fa that accept all strings with odd no of 1's over $\Sigma = \{ 0 , 1 \}$

$R = 0^*10^* \ (10^*10^*)^*$



q_0: Initial State

q_1: Final State (Accepting State)