DFA/NFA

Prepared by Asst. Prof. Dr. Mohamed KURDI

DFA – Exercise #1

$\Sigma = \{0,1\}$, L = {w | w starts with 1 and ends with 0} Give the state diagram of a DFA that recognizes L.

DFA – Exercise #1

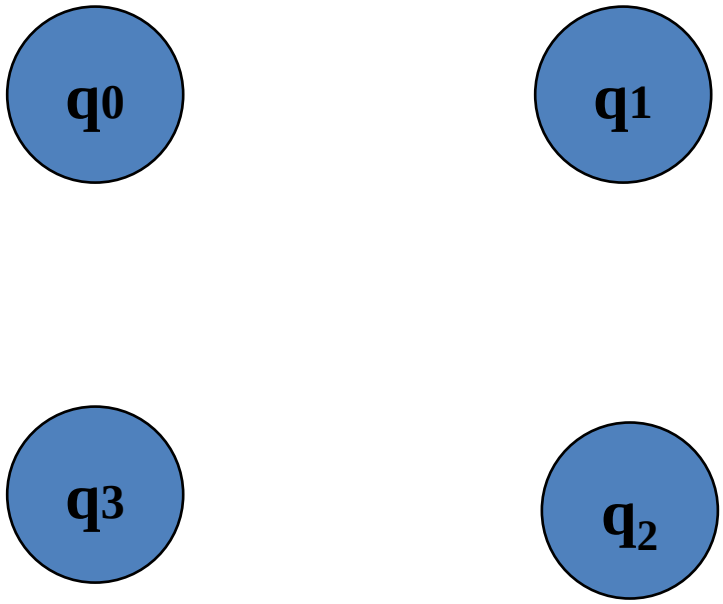
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #1

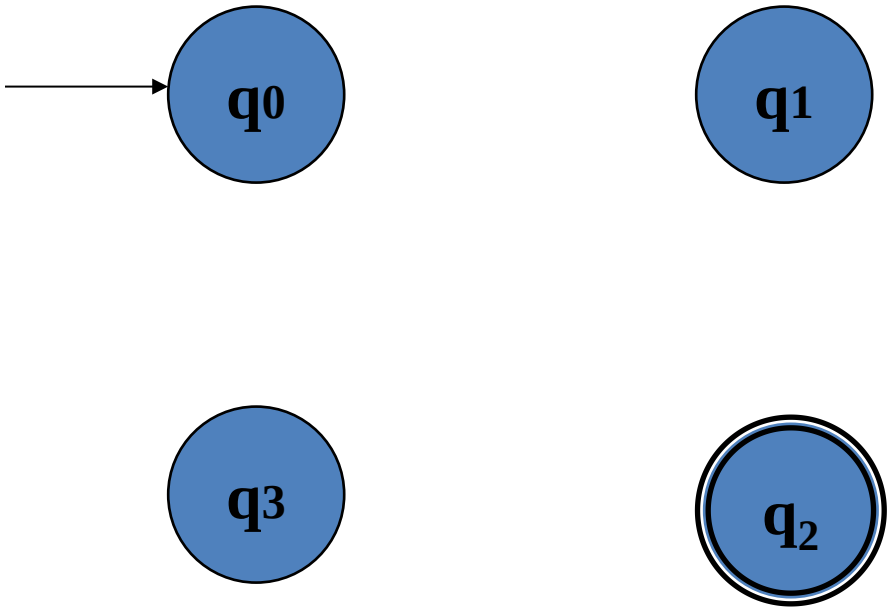
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #1

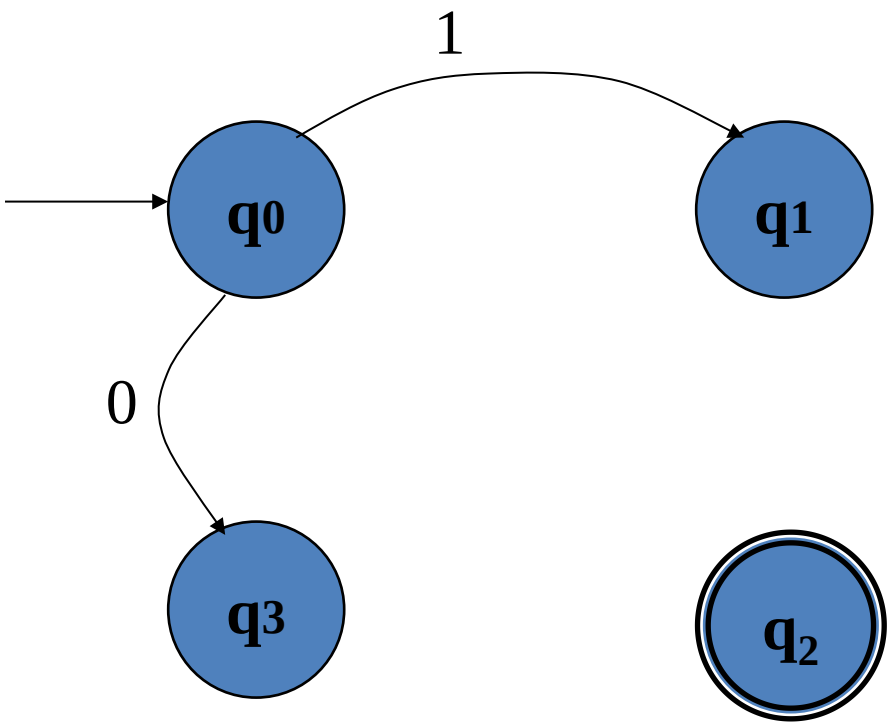
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #1

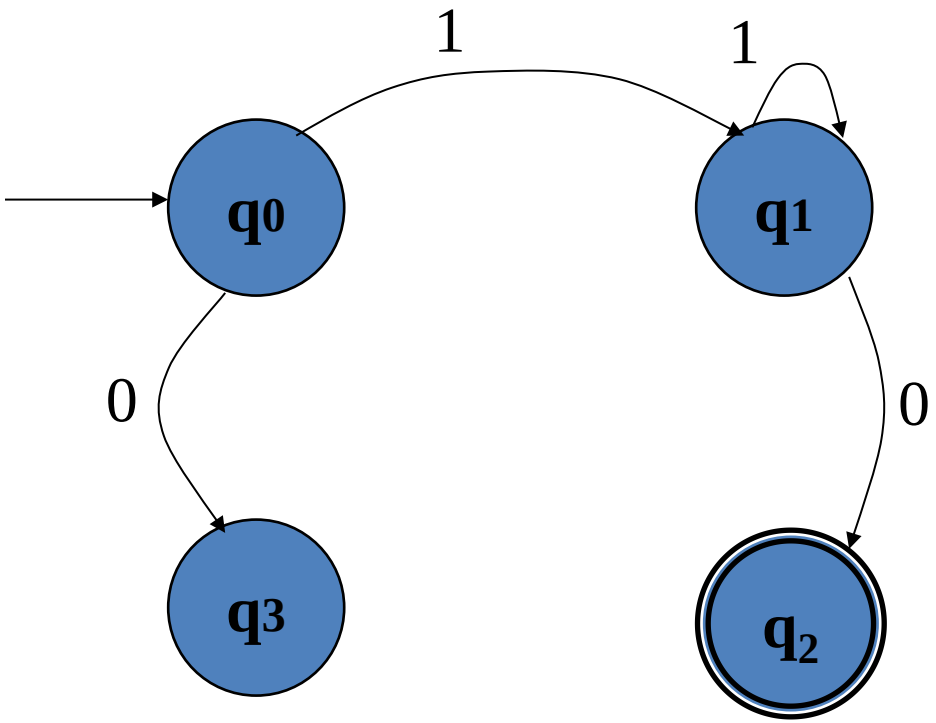
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #1

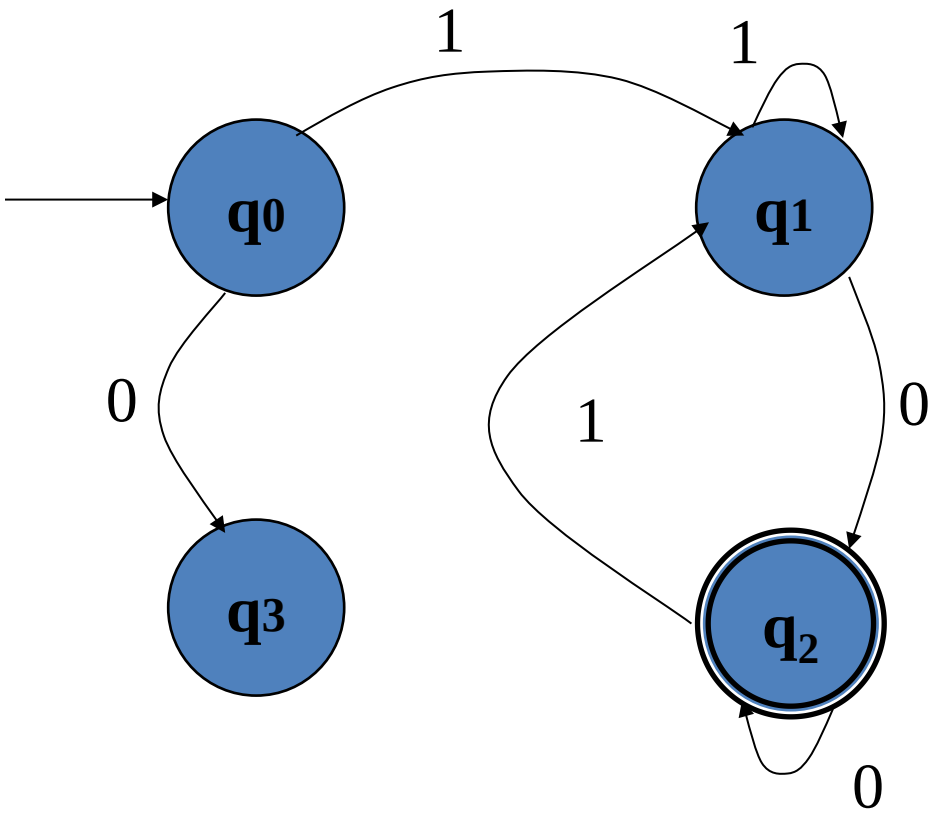
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #1

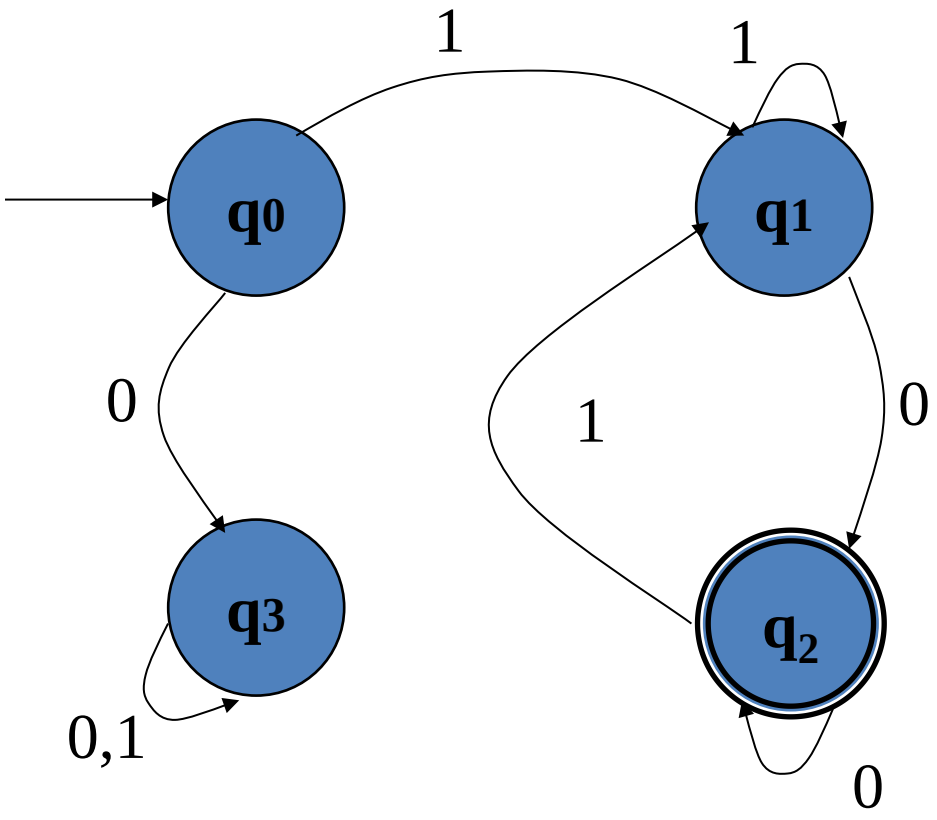
w starts with 1 and ends with 0

q_0: no symbols are read yet.

q_1: the string read so far starts with 1 and ends with 1.

q_2: the string read so far starts with 1 and ends with 0.

q_3: the string read so far starts with 0, and it also ends with 0 or 1 (the trap state).



DFA – Exercise #2

$\Sigma = \{0,1\}$, L = {w | w contains at least three 1s} Give the state diagram of a DFA that recognizes L.

DFA – Exercise #2

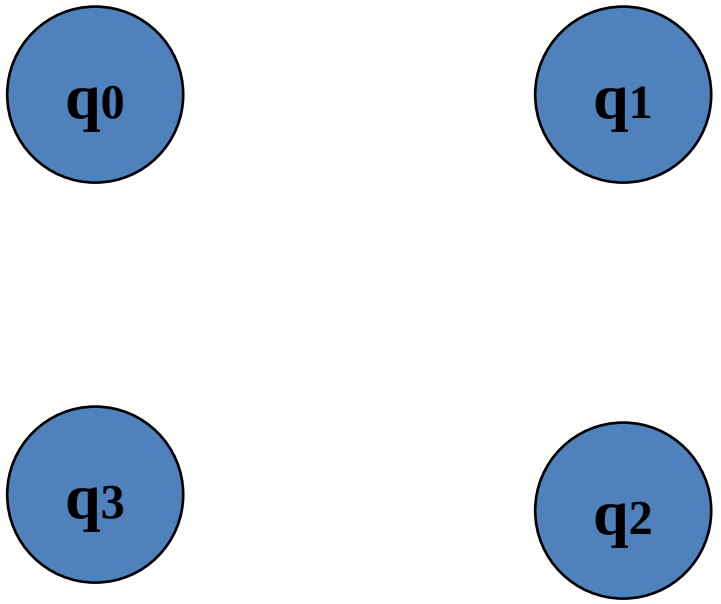
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #2

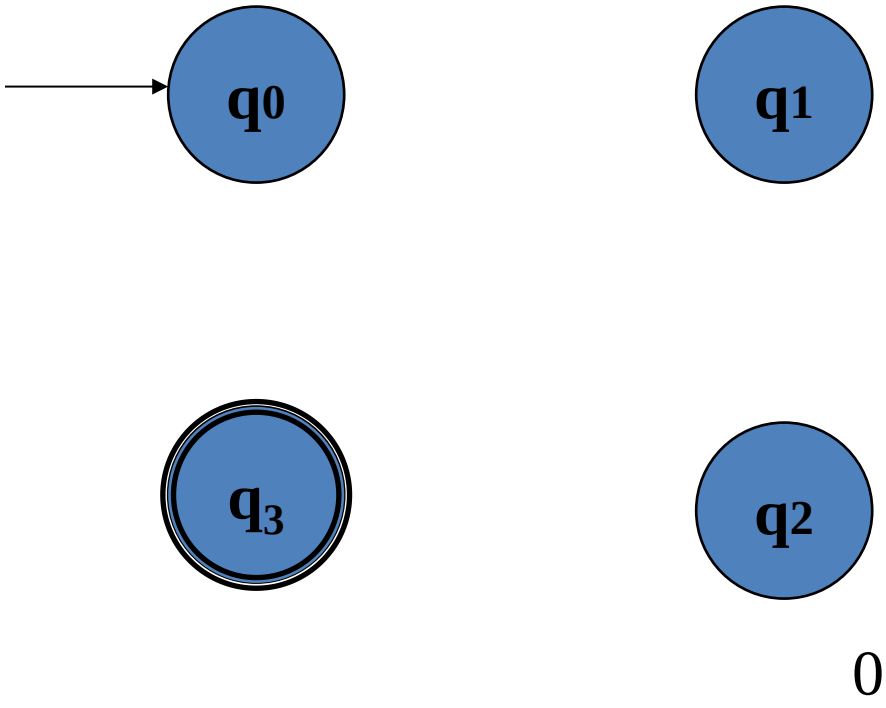
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #2

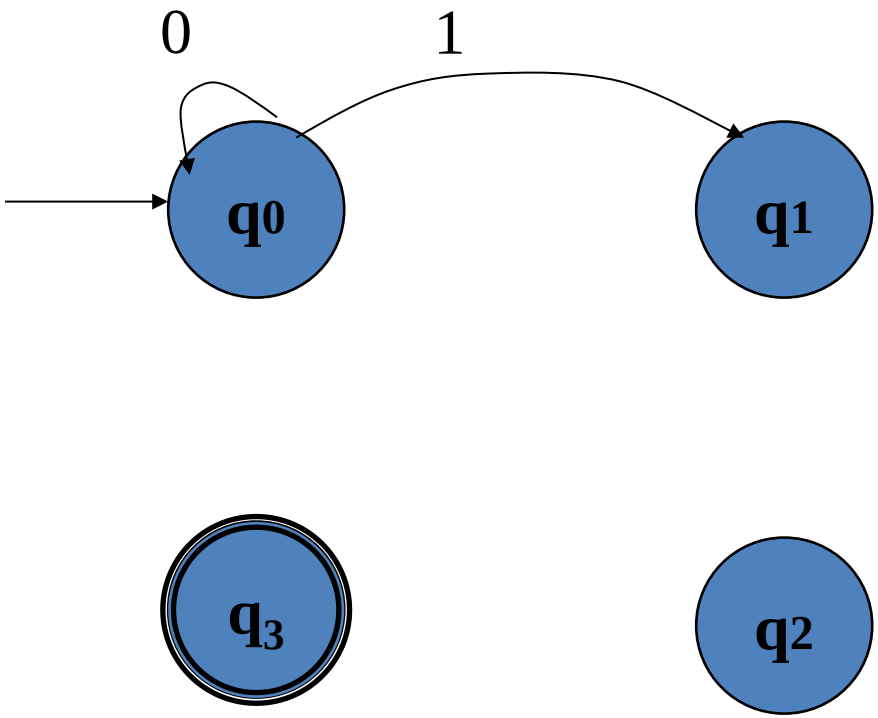
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #2

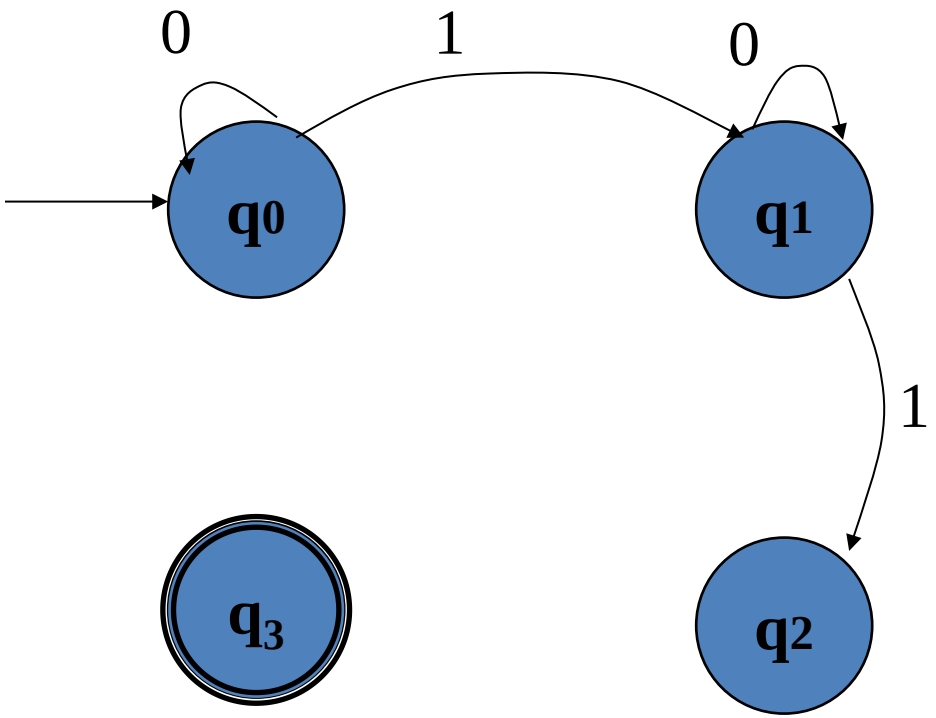
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #2

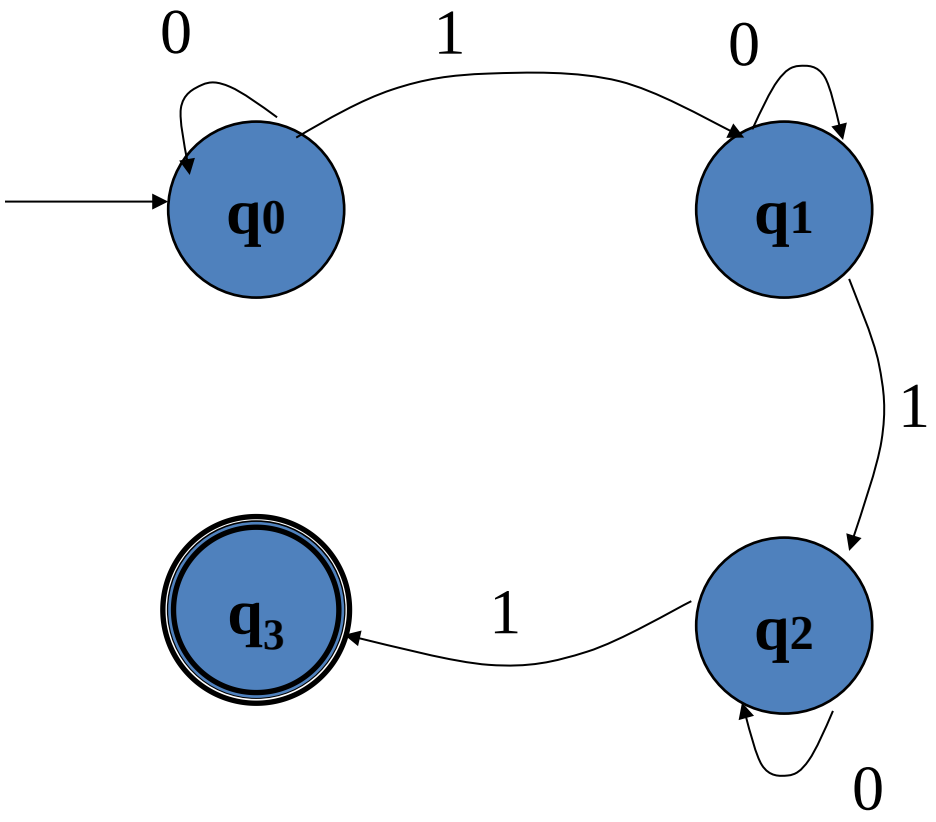
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #2

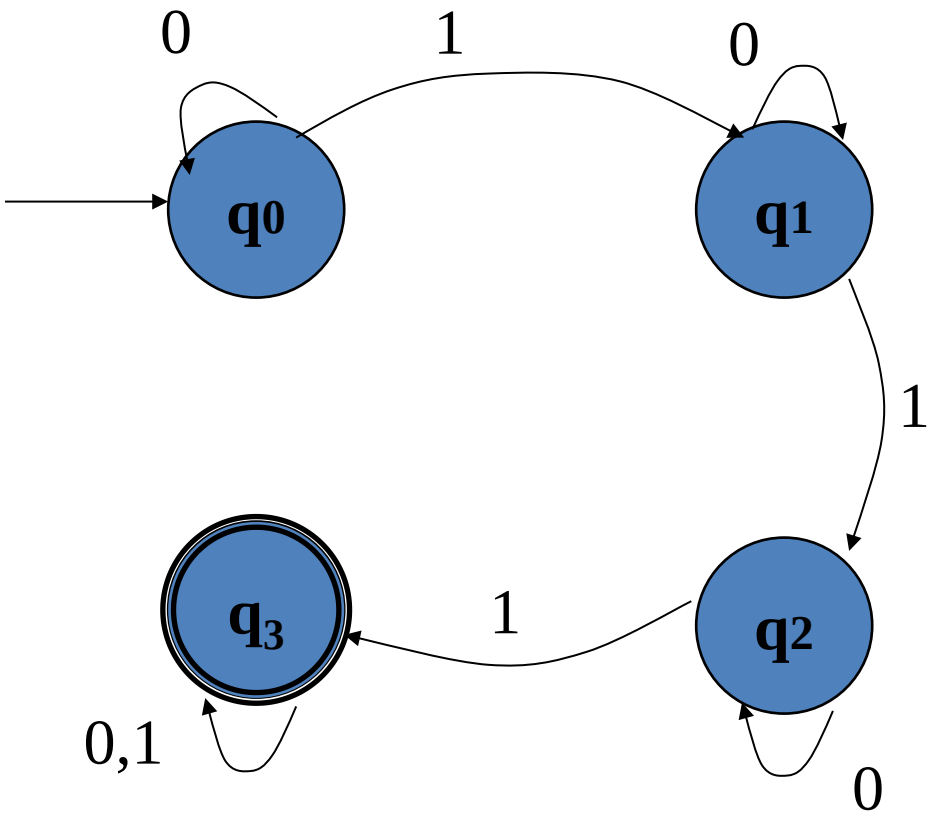
w contains at least three 1s

q_0: no symbols are read yet or the string read so far does not contain any 1.

q_1: the string read so far contains one 1.

q_2: the string read so far contains two 1s.

q_3: the string read so far contains three 1s or more.



DFA – Exercise #3

$\Sigma = \{0,1\}$, L = $\{w \mid w$ contains the substring 0101, i.e., $w = x0101y$ for some x and $y\}$ Give the state diagram of a DFA that recognizes L.

DFA – Exercise #3

w contains the substring 0101

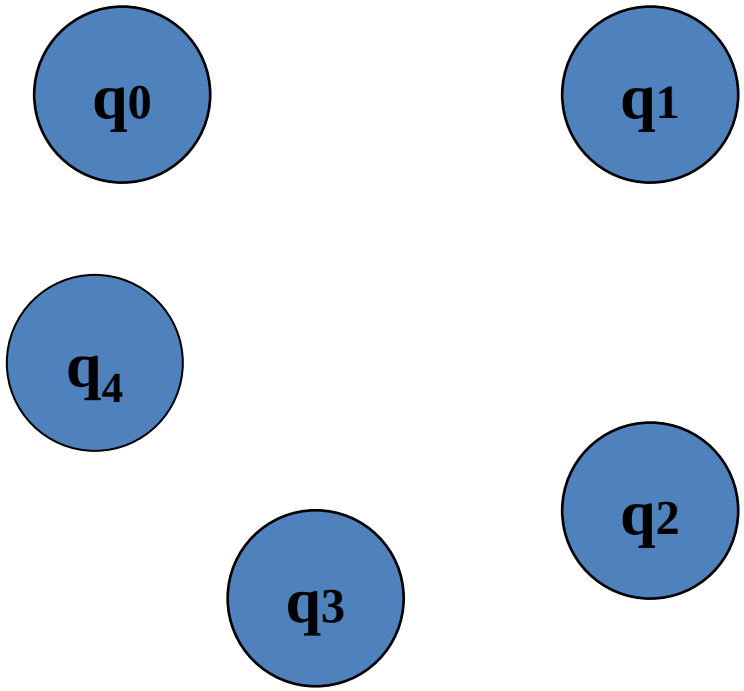
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

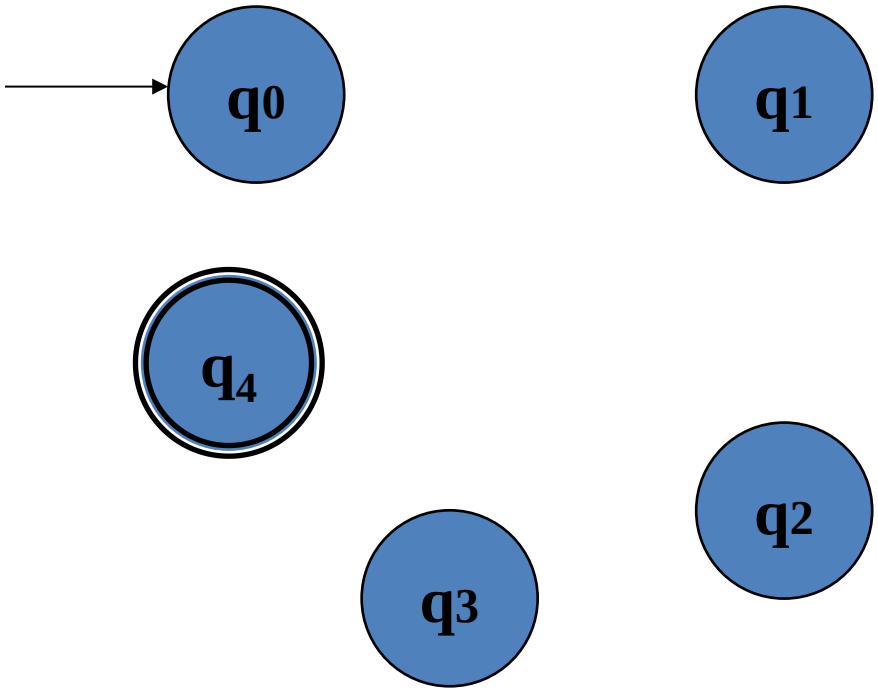
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

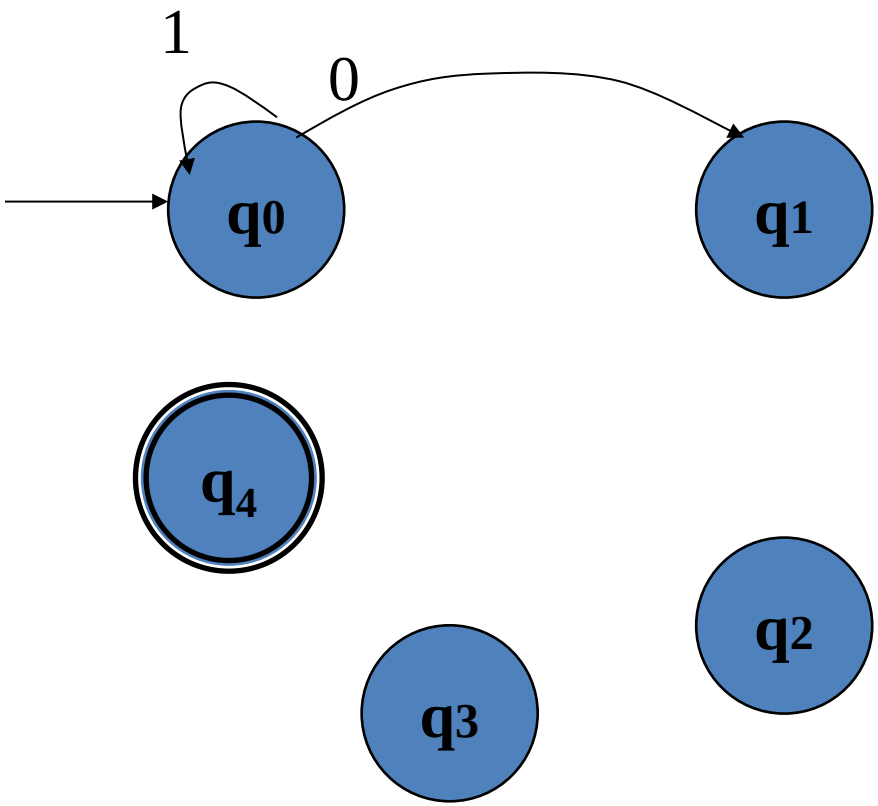
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

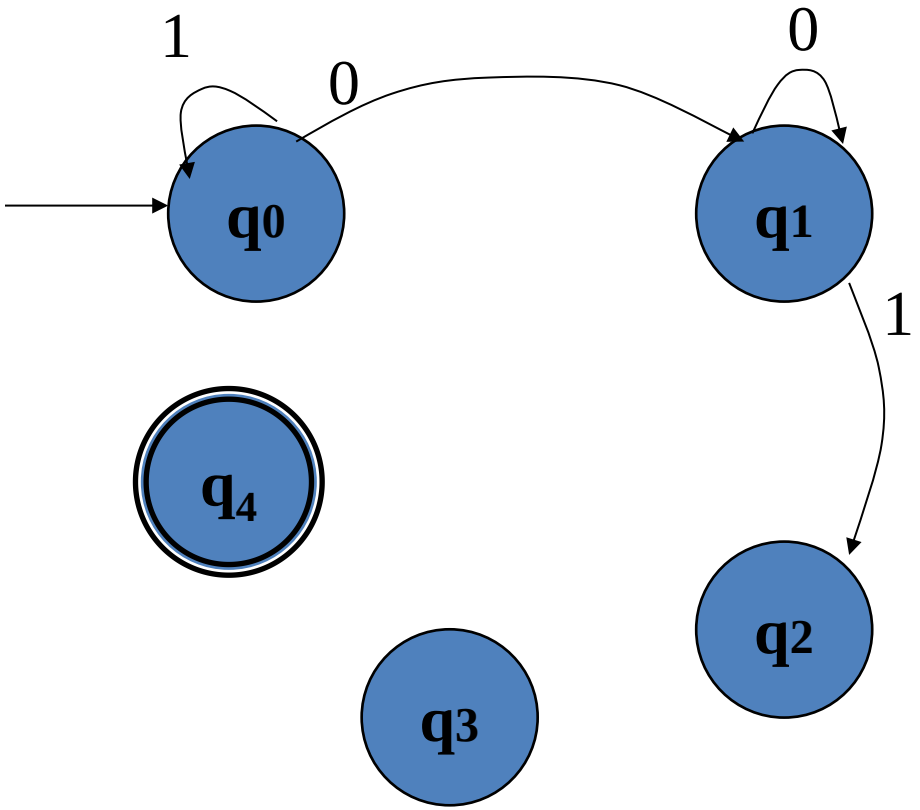
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

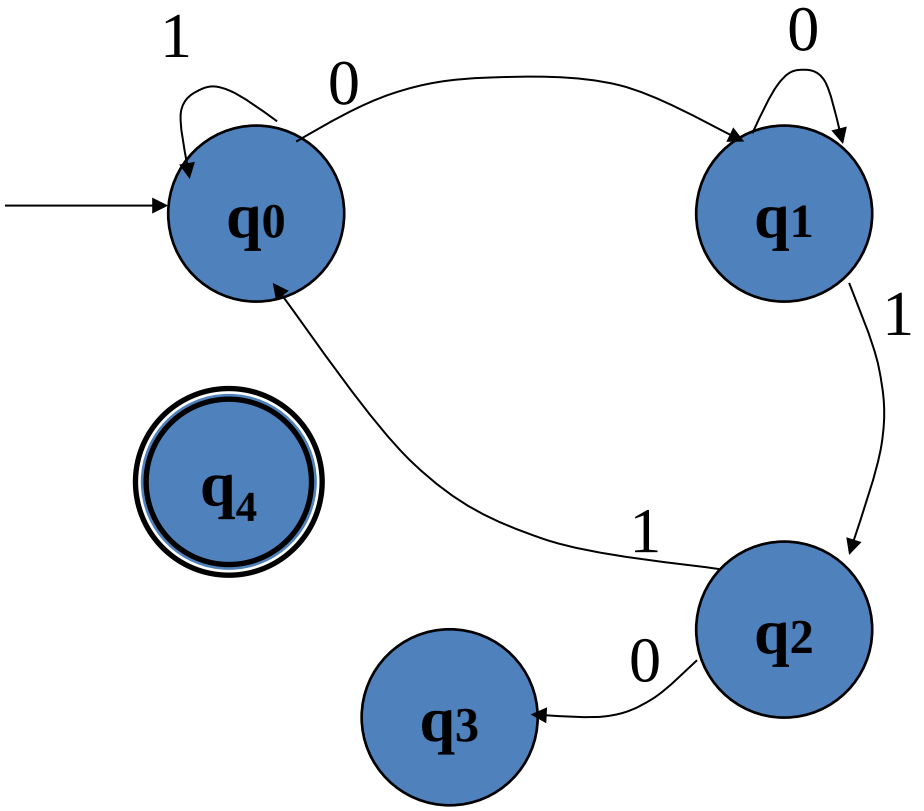
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

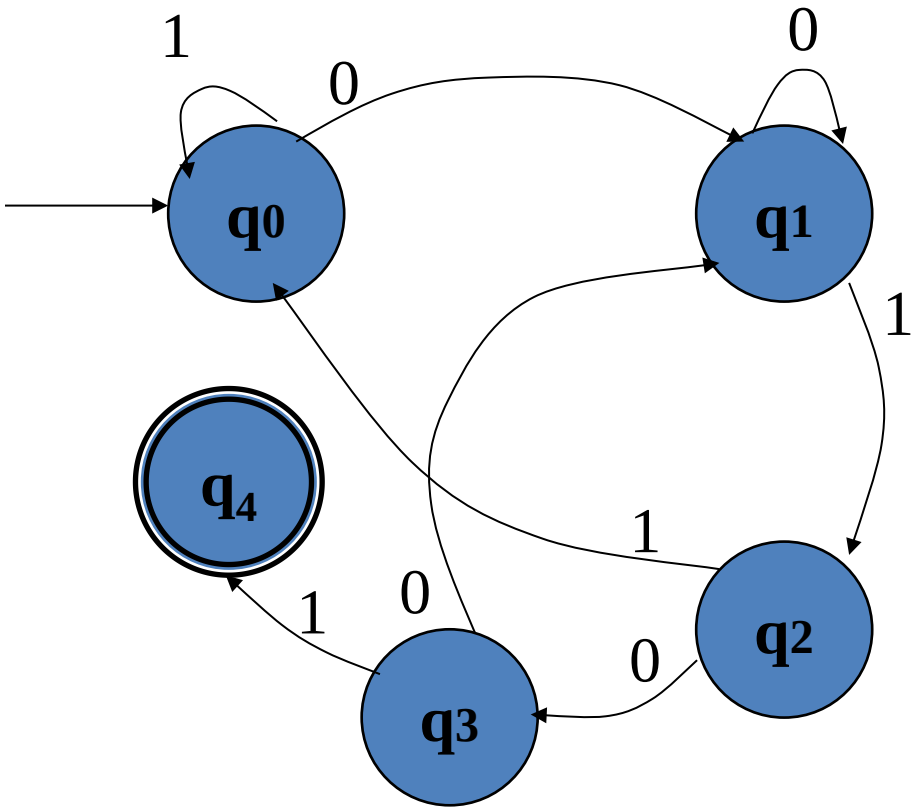
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #3

w contains the substring 0101

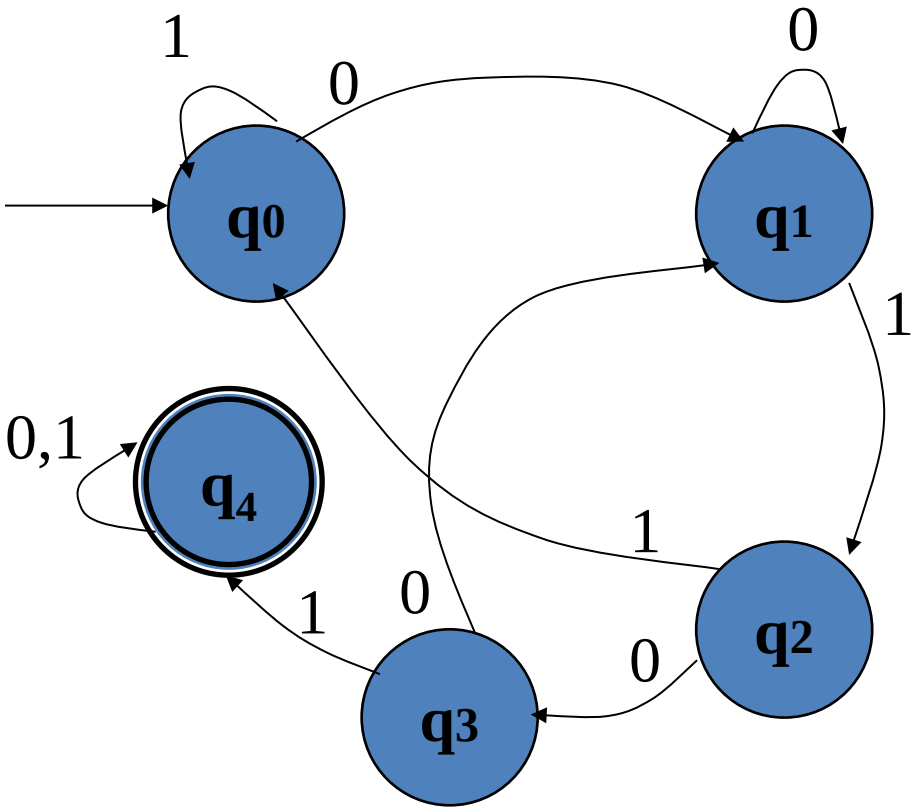
q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 01.

q_3: the string read so far contains 010.

q_4: the string read so far contains 0101.



DFA – Exercise #4

$\Sigma = \{0,1\}$, L = $\{w \mid w$ has length at least 3 and its third symbol is a 0$\}$ Give the state diagram of a DFA that recognizes L.

DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

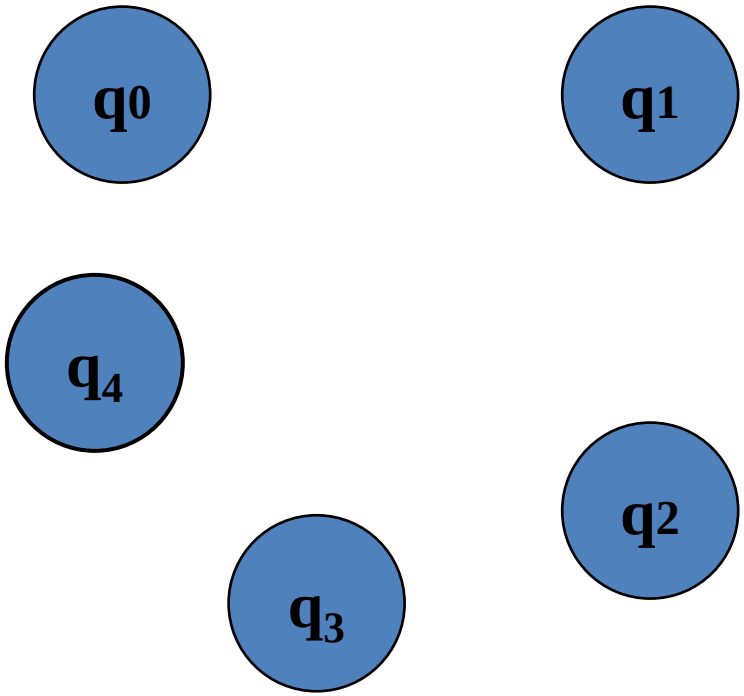
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

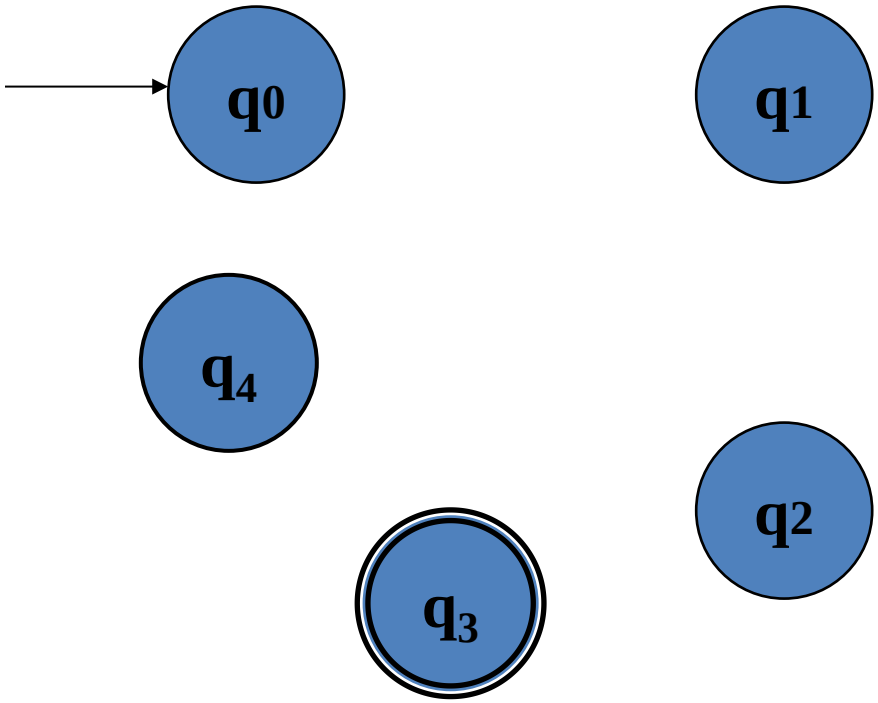
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

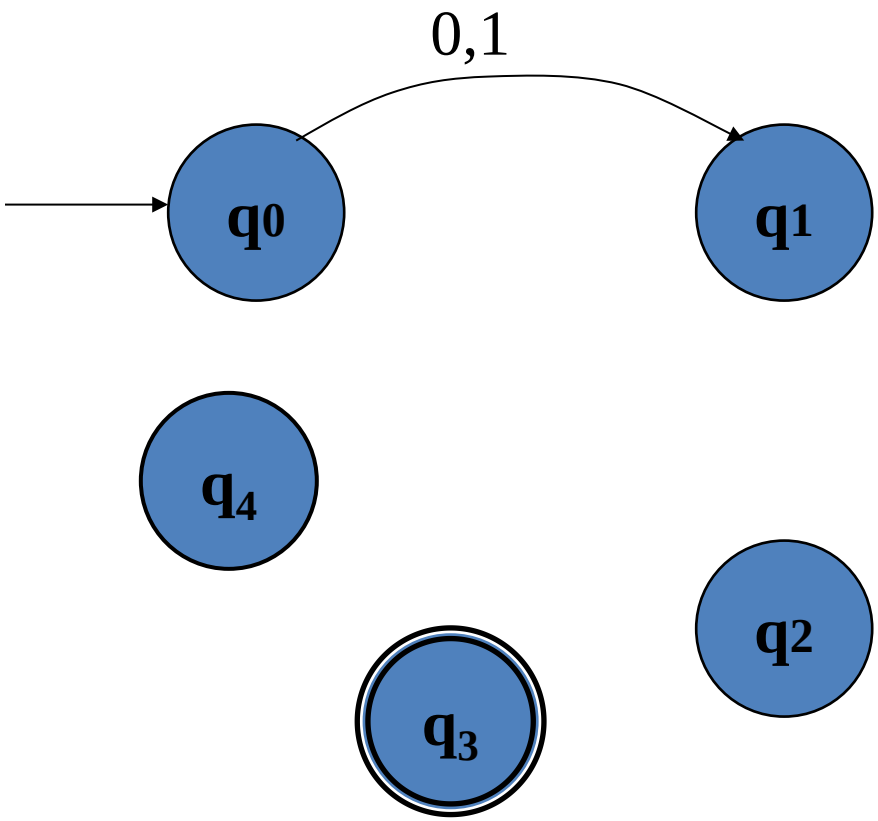
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

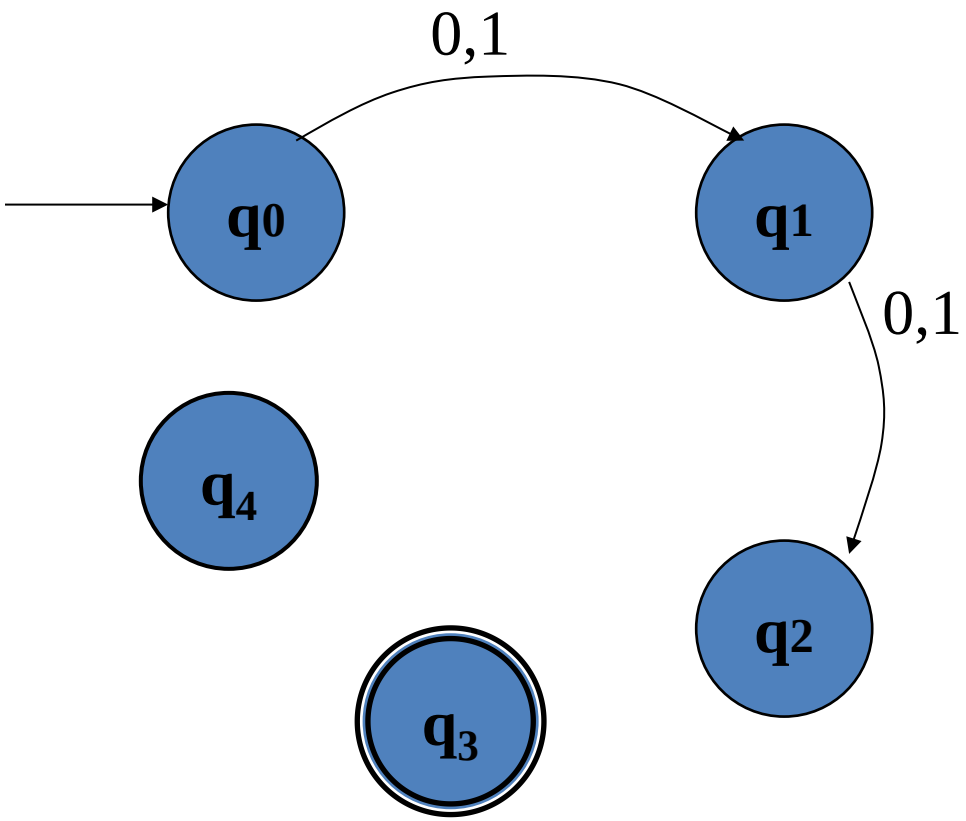
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

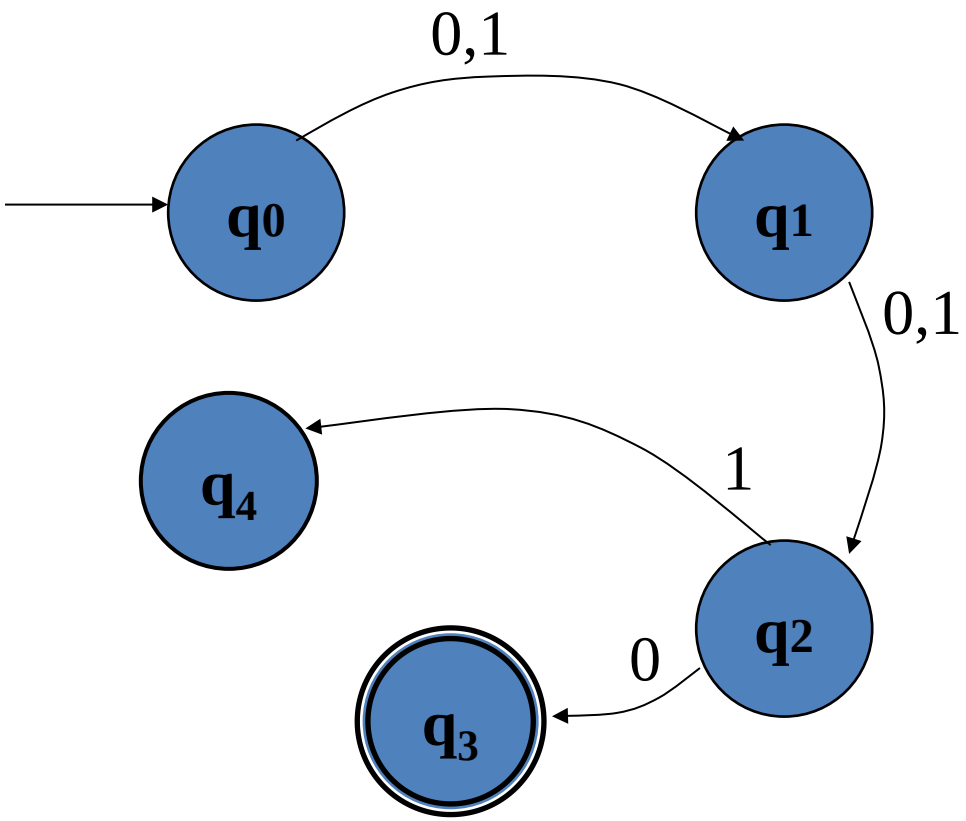
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

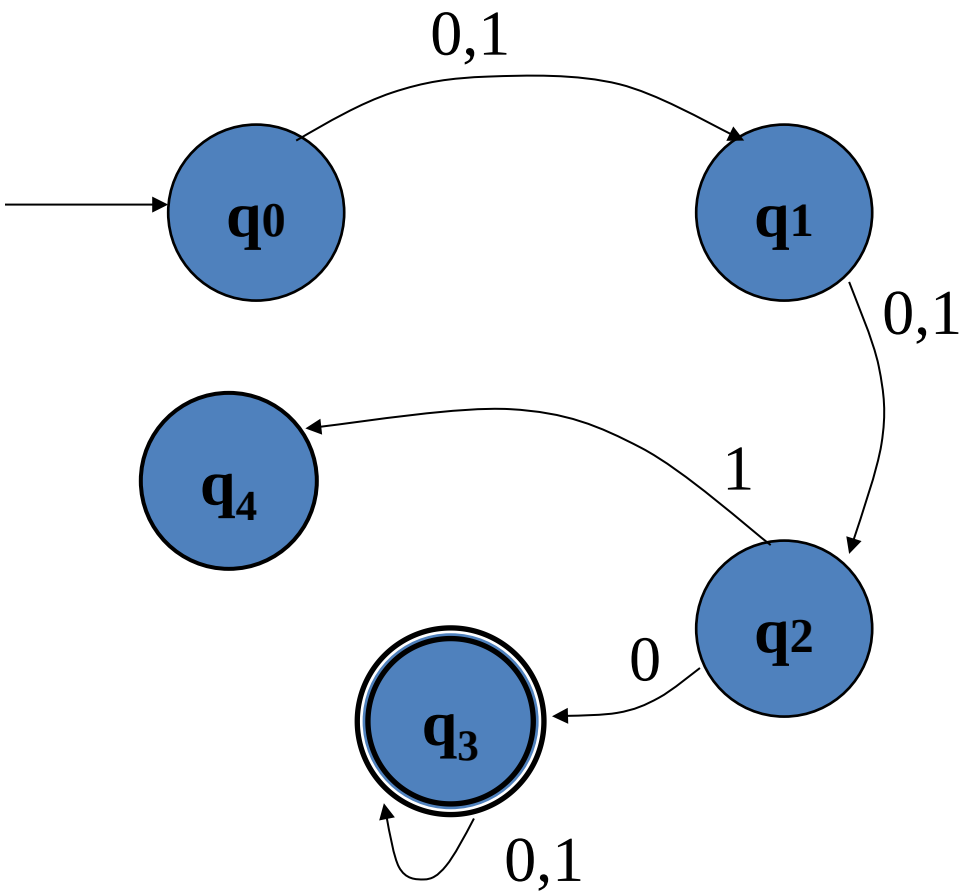
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #4

w has length at least 3 and its third symbol is a 0

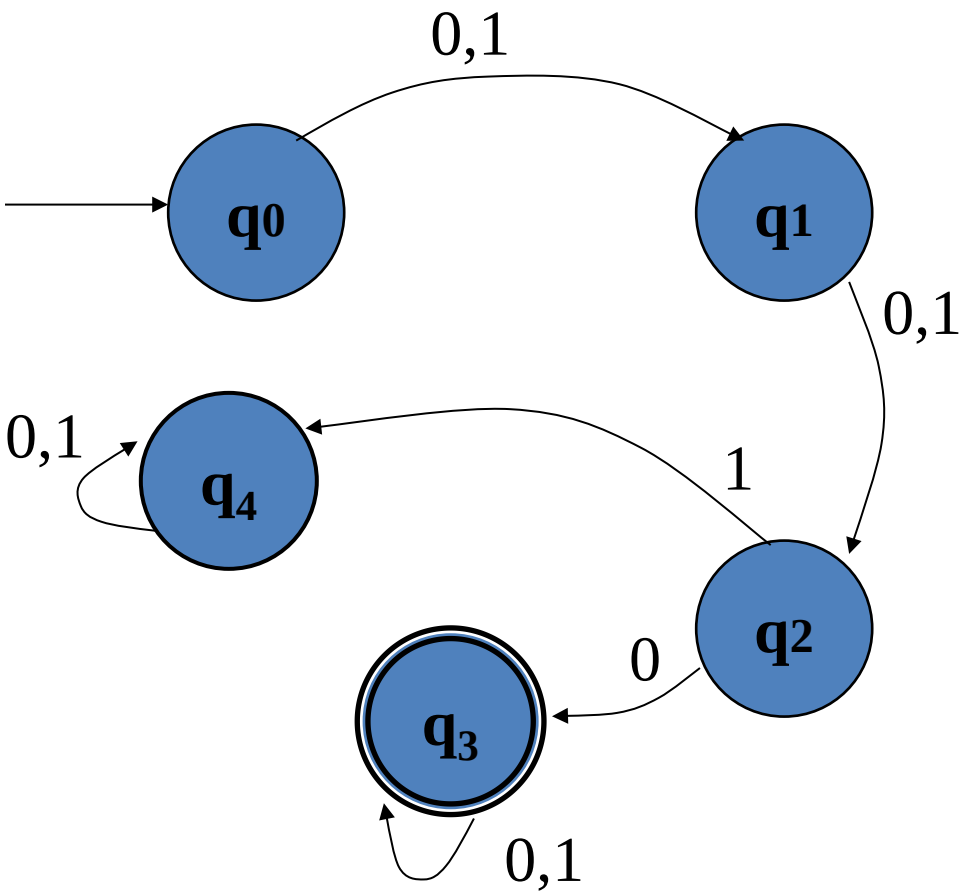
q_0: no symbols are read yet (the length is zero).

q_1: the length of the string read so far is 1

q_2: the length of the string read so far is 2

q_3: the length of the string read so far is 3 or more, and its third symbol is 0

q_4 the length of the string read so far is 3 or more, and its third symbol is 1.



DFA – Exercise #5

$\Sigma = \{0,1\}$, L = {w | w starts with 0 and has odd length, or starts with 1 and has even length} Give the state diagram of a DFA that recognizes L.

DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

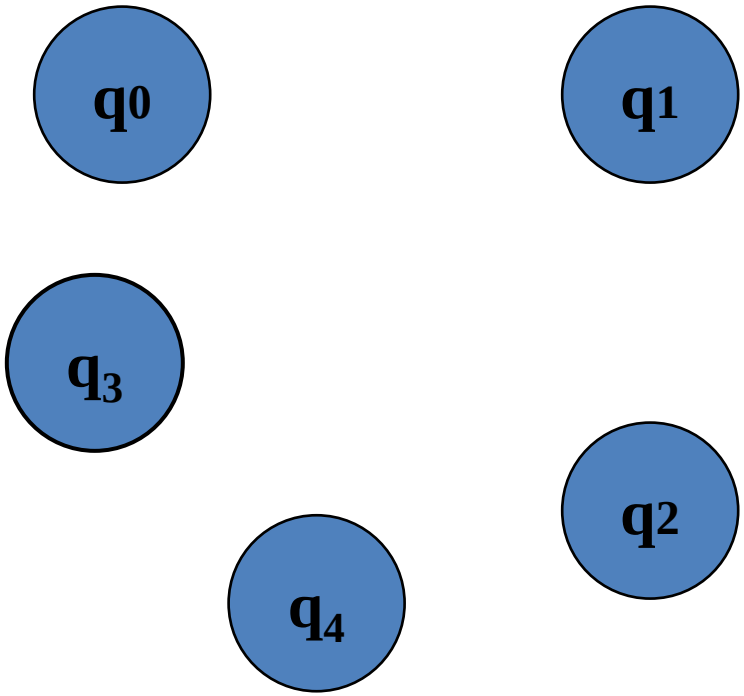
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

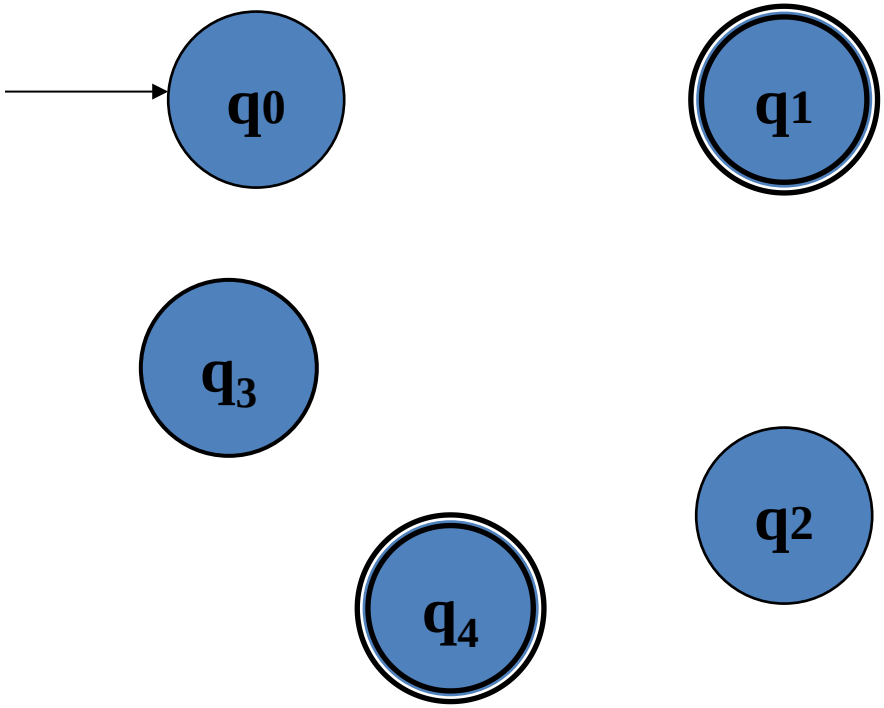
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

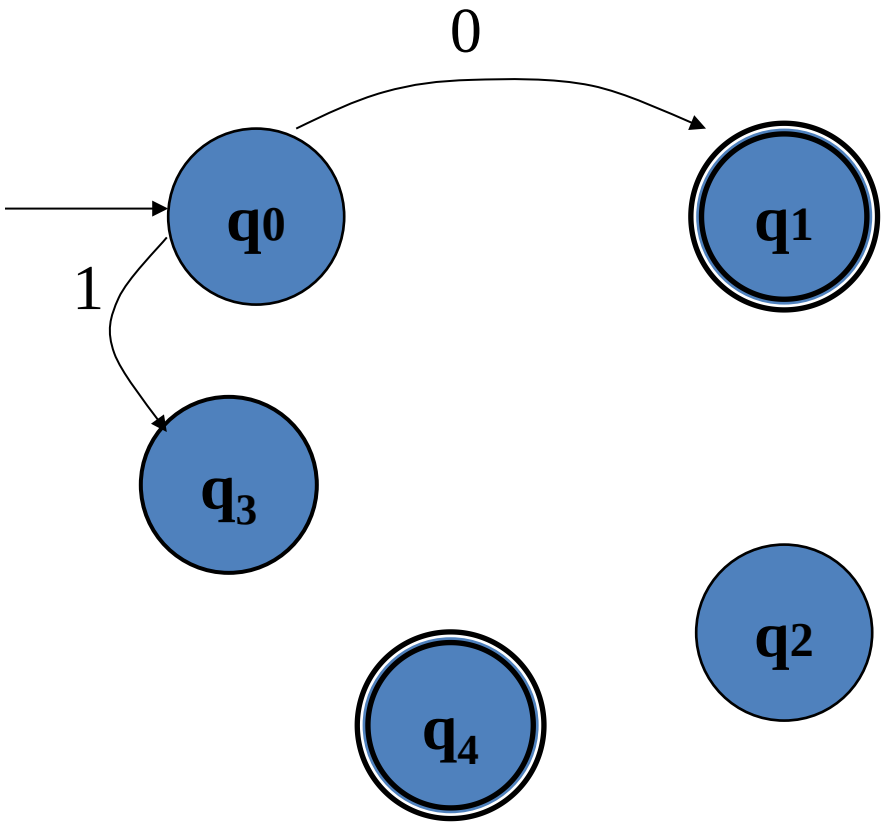
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

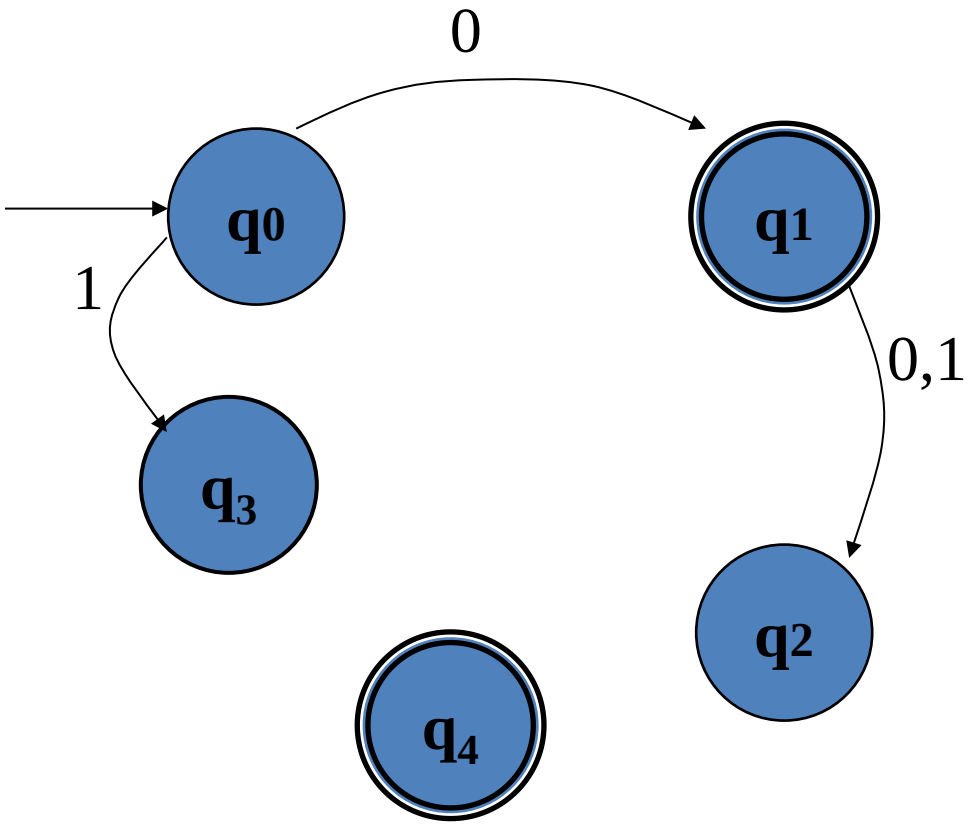
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

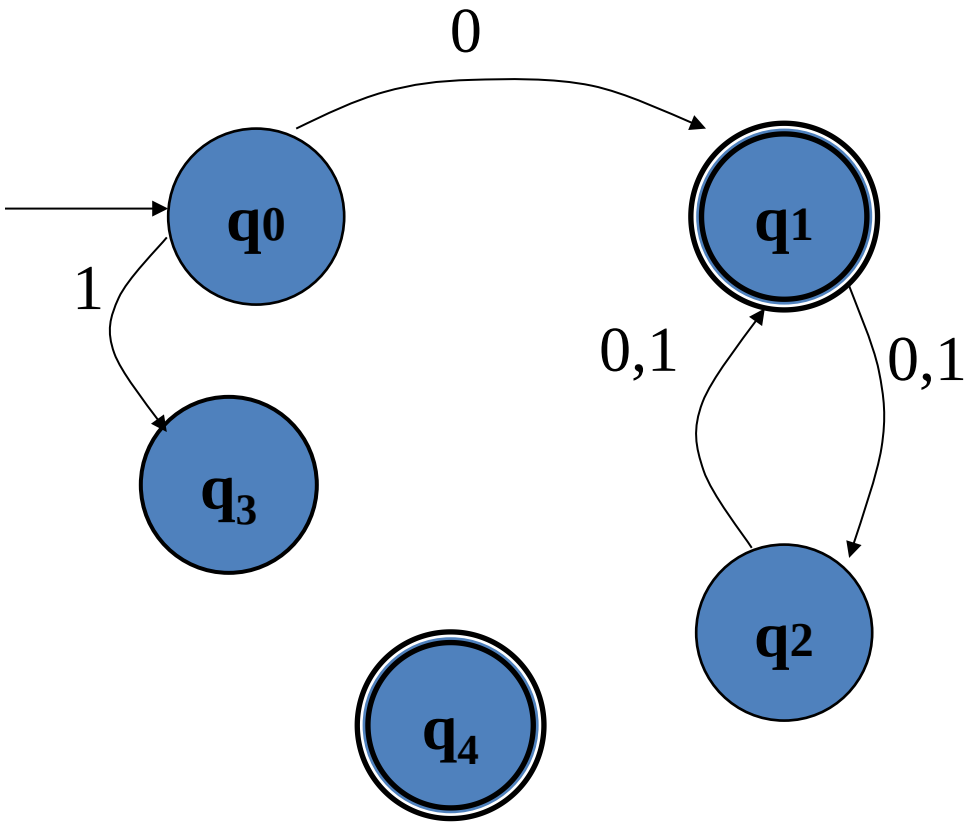
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

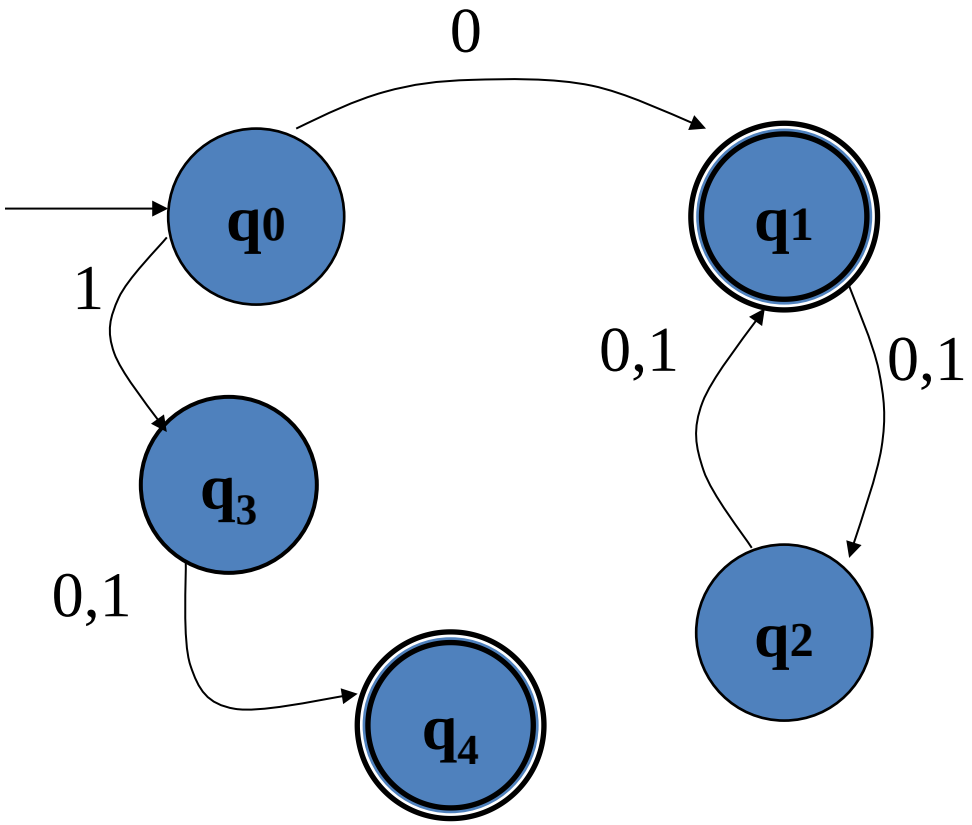
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #5

w starts with 0 and has odd length, or starts with 1 and has even length

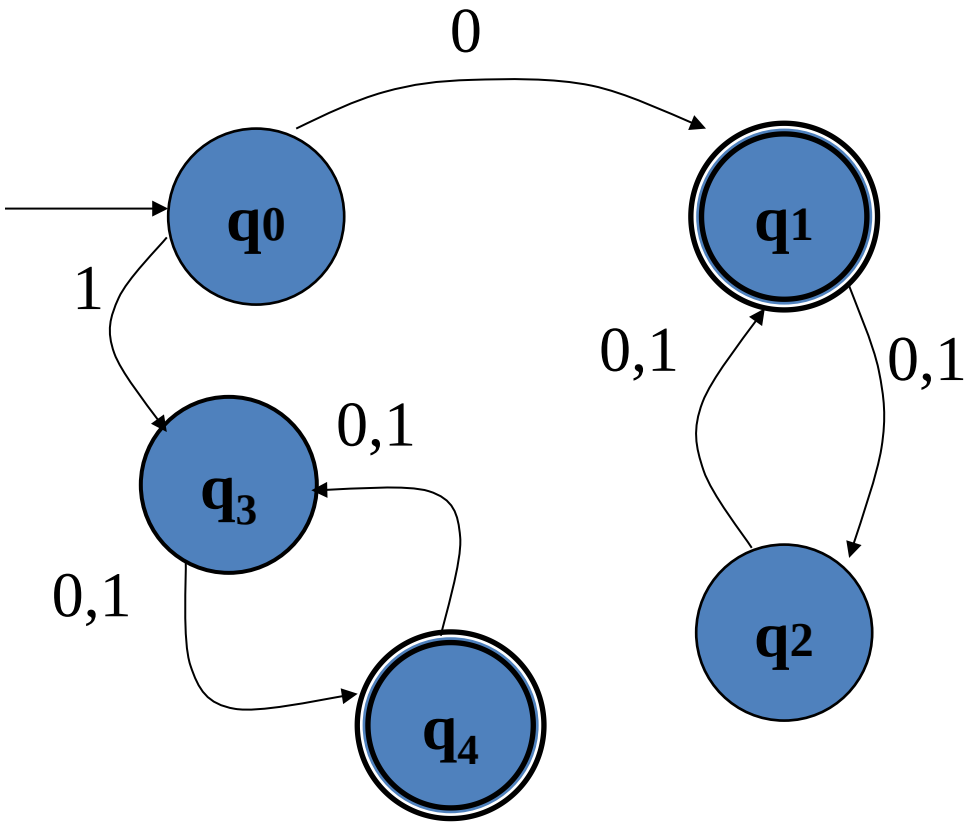
q_0: no symbols are read yet (the length is zero).

q_1: the string read so far starts with 0 and length is odd

q_2: the string read so far starts with 0 and length is even

q_3: the string read so far starts with 1 and length is odd

q_4: the string read so far starts with 1 and length is even



DFA – Exercise #6

$\Sigma = \{0,1\}$, L = $\{w \mid w$ does not contain the substring 110$\}$

Give the state diagram of a DFA that recognizes L.

DFA – Exercise #6

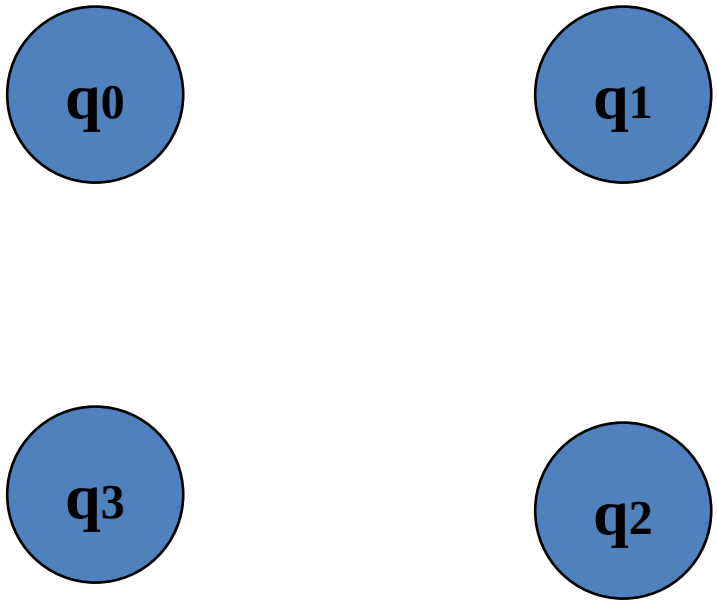
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

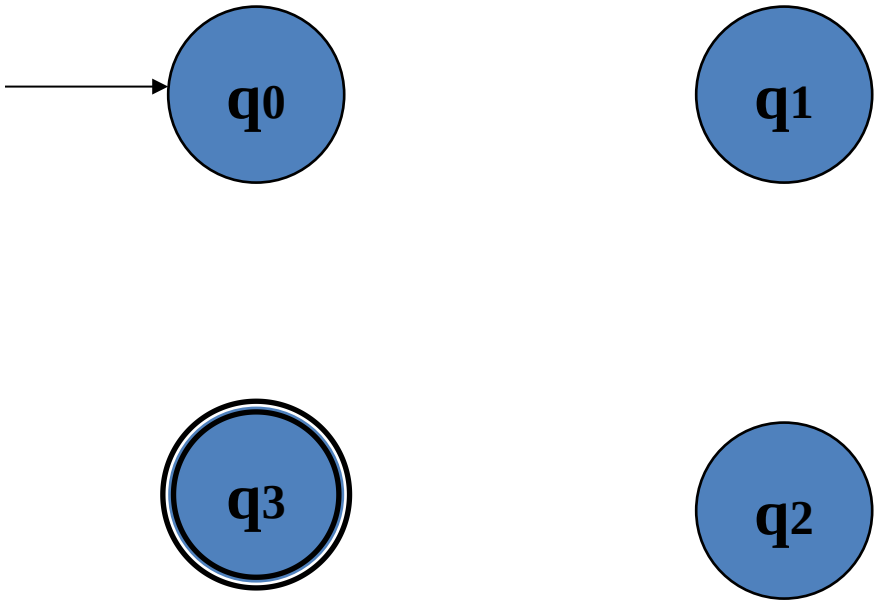
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

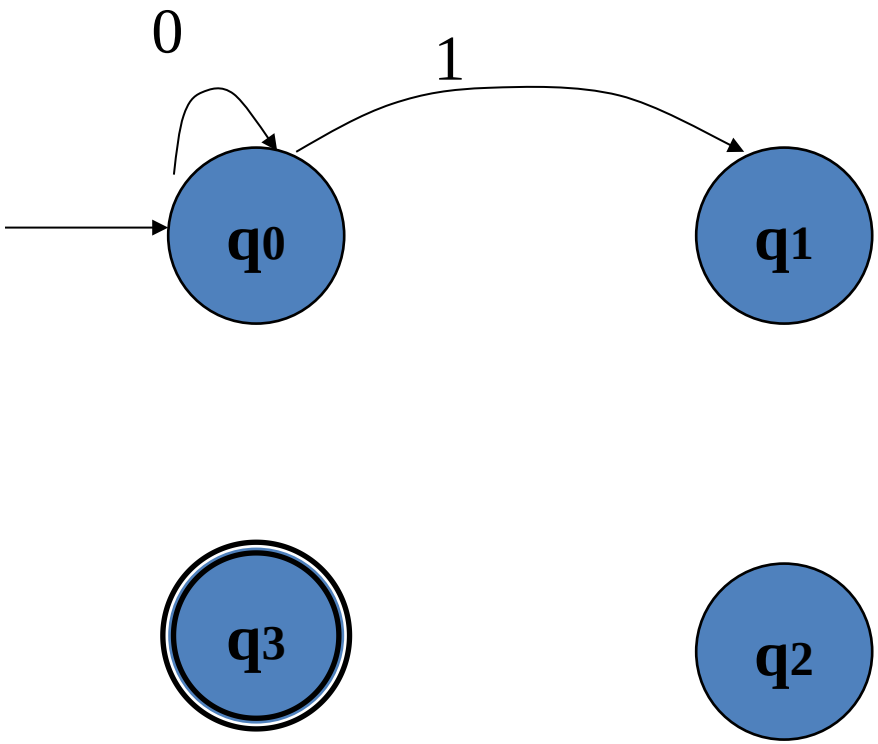
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

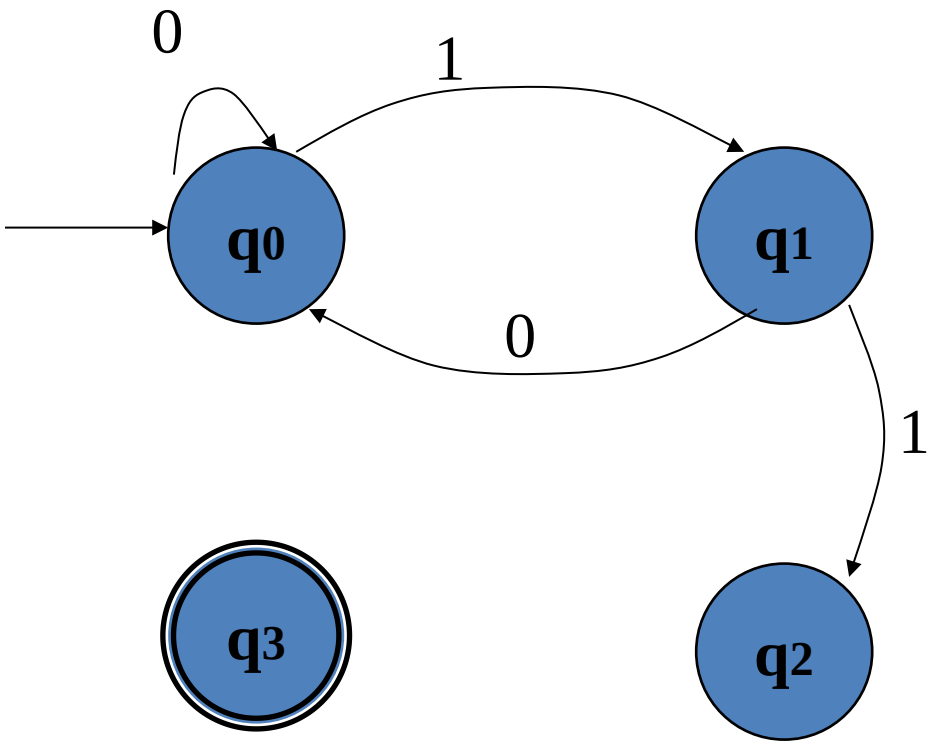
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

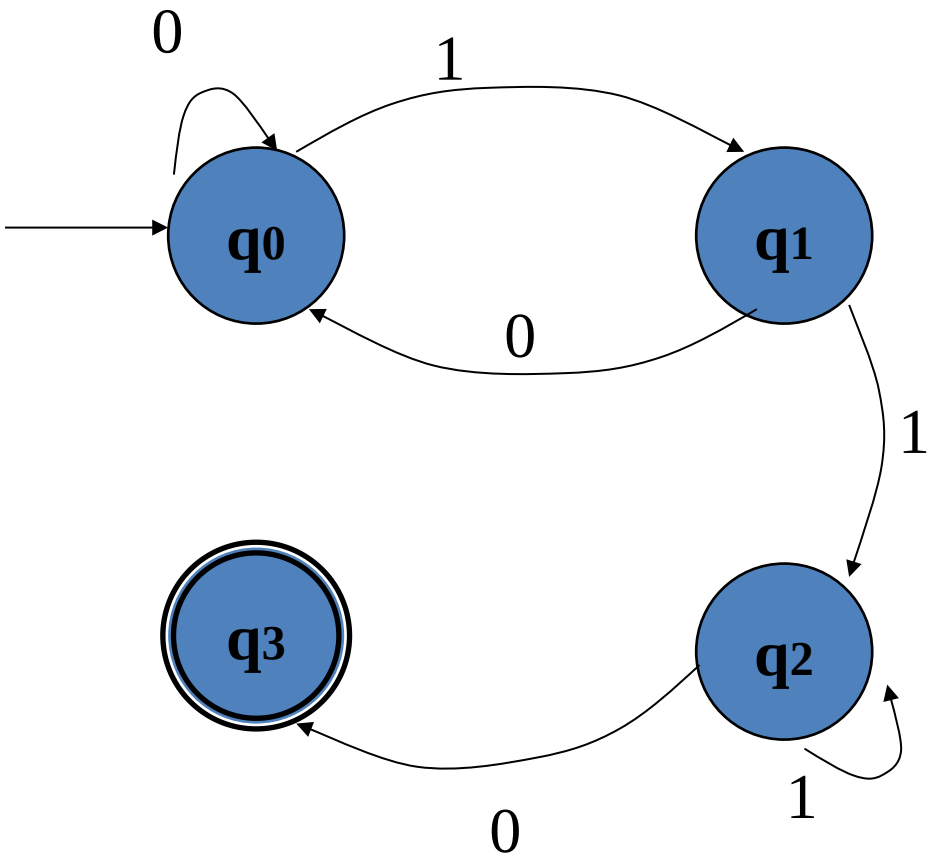
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

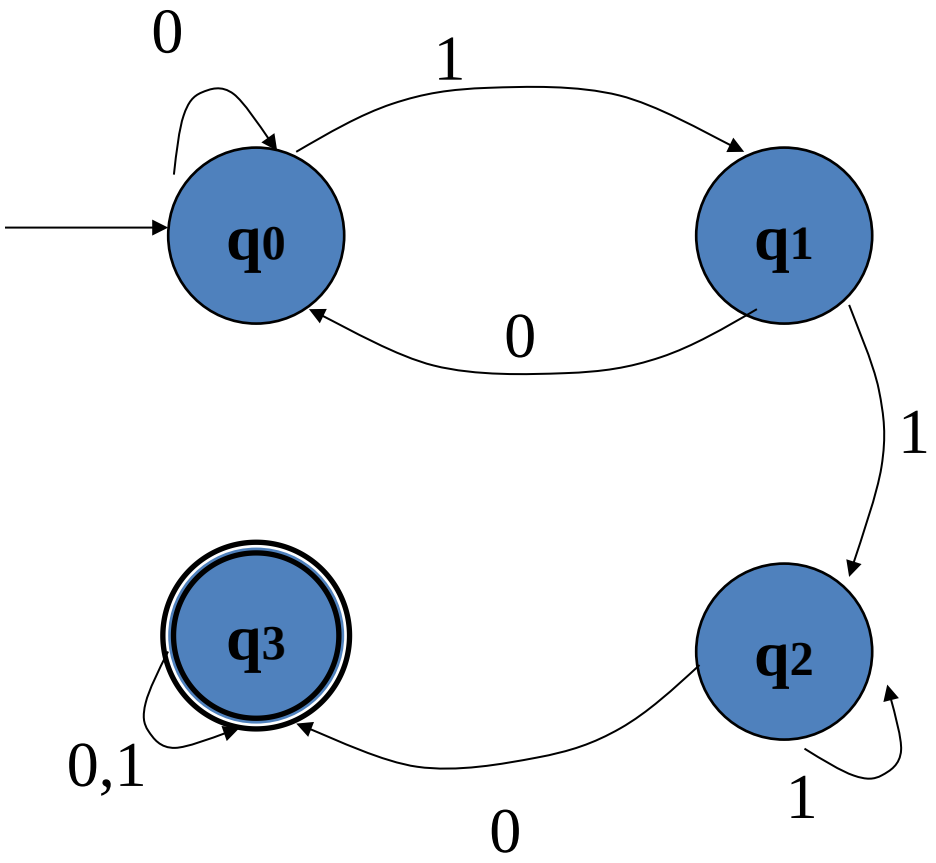
w does contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



DFA – Exercise #6

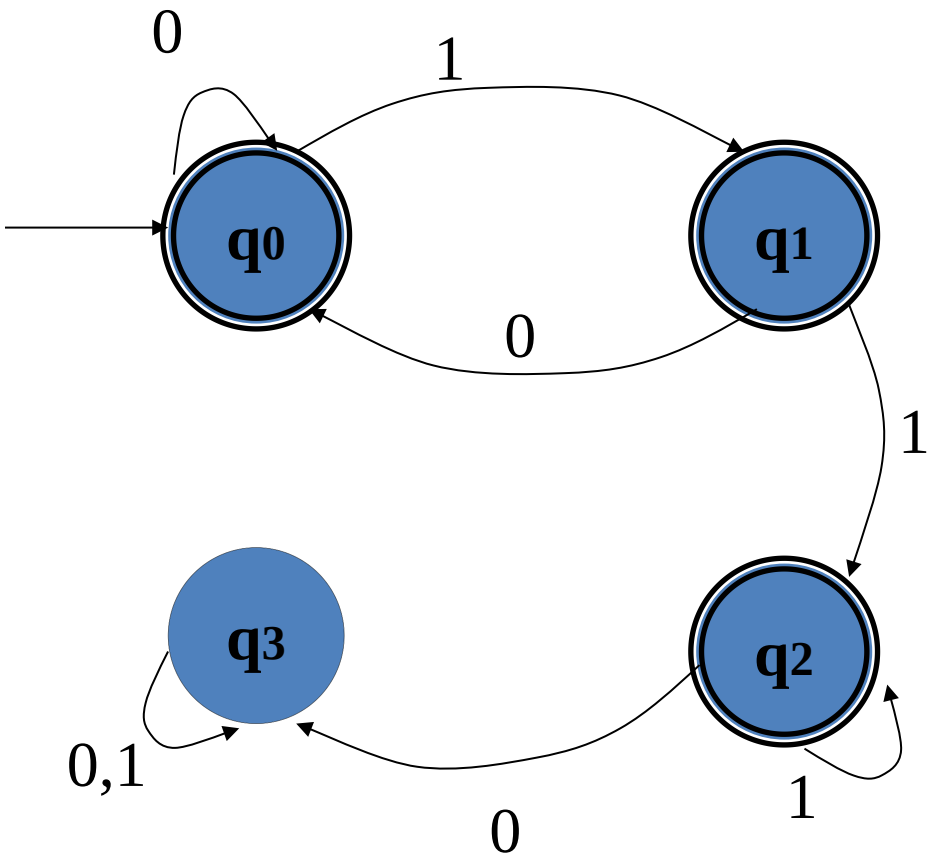
w does not contain the substring 110

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 1.

q_2: the string read so far contains 11.

q_3: the string read so far contains 110.



NFA – Exercise #1

$\Sigma = \{0,1\}$, L = $\{w \mid w$ begins with 0 and ends with 1$\}$

Give the state diagram of an NFA that recognizes L.

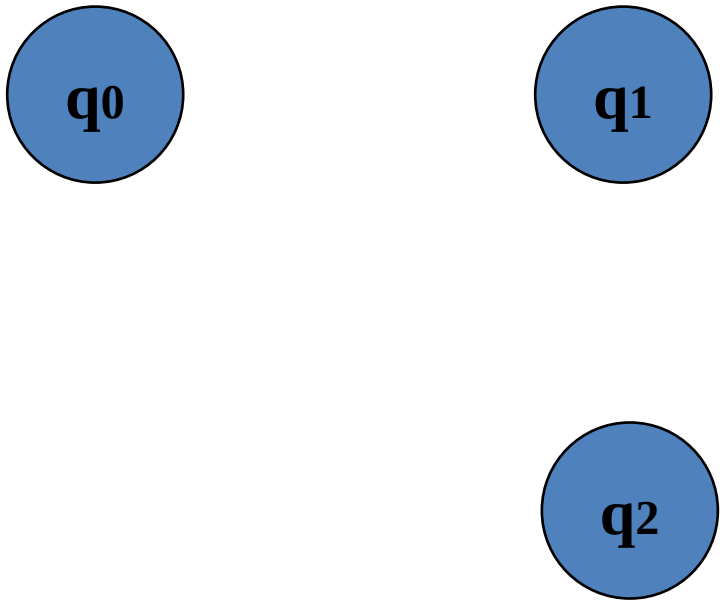
NFA – Exercise #1

w begins with 0 and ends with 1

q_0: no symbols are read yet.

q_1: the string read so far starts with 0 and ends with 0.

q_2: the string read so far starts with 0 and ends with 1.



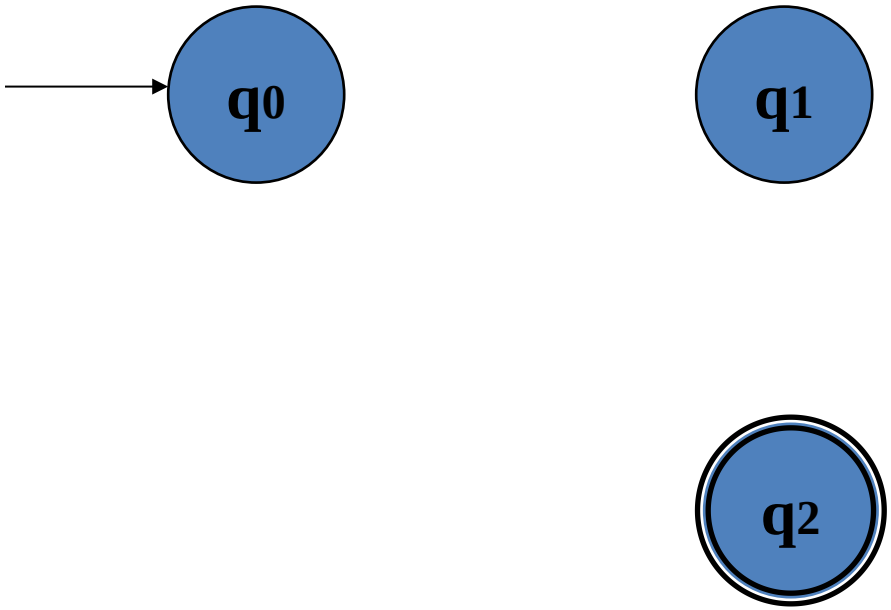
NFA – Exercise #1

w begins with 0 and ends with 1

q_0: no symbols are read yet.

q_1: the string read so far starts with 0 and ends with 0.

q_2: the string read so far starts with 0 and ends with 1.



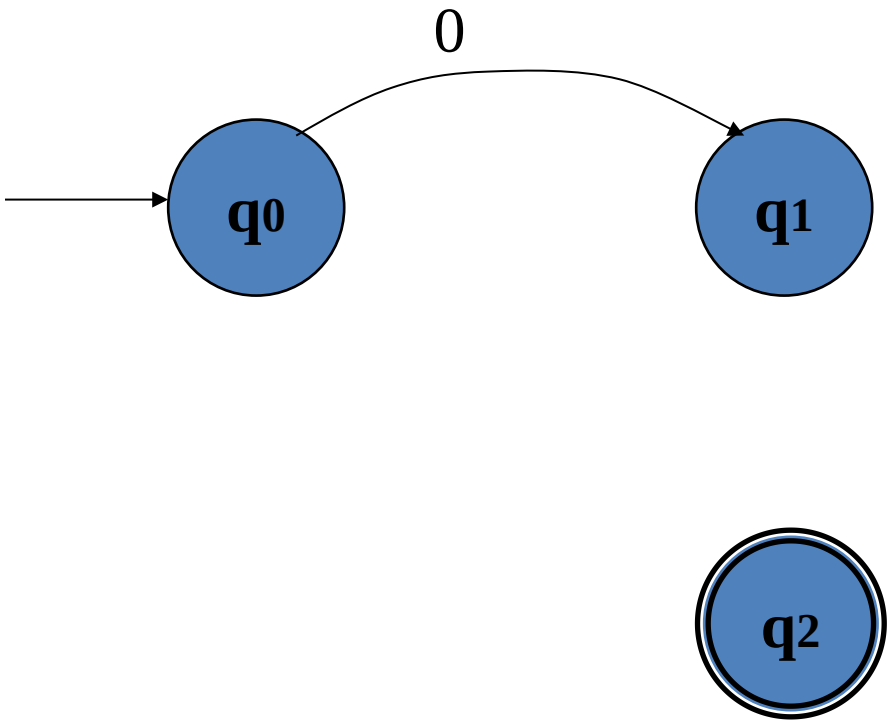
NFA – Exercise #1

w begins with 0 and ends with 1

q_0: no symbols are read yet.

q_1: the string read so far starts with 0 and ends with 0.

q_2: the string read so far starts with 0 and ends with 1.



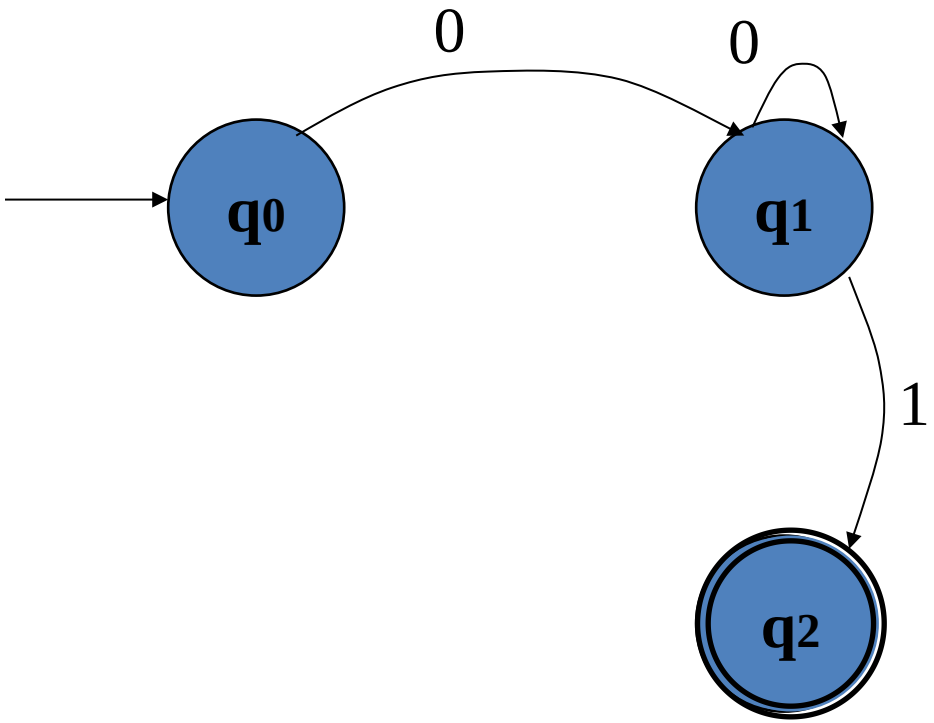
NFA – Exercise #1

w begins with 0 and ends with 1

q_0: no symbols are read yet.

q_1: the string read so far starts with 0 and ends with 0.

q_2: the string read so far starts with 0 and ends with 1.



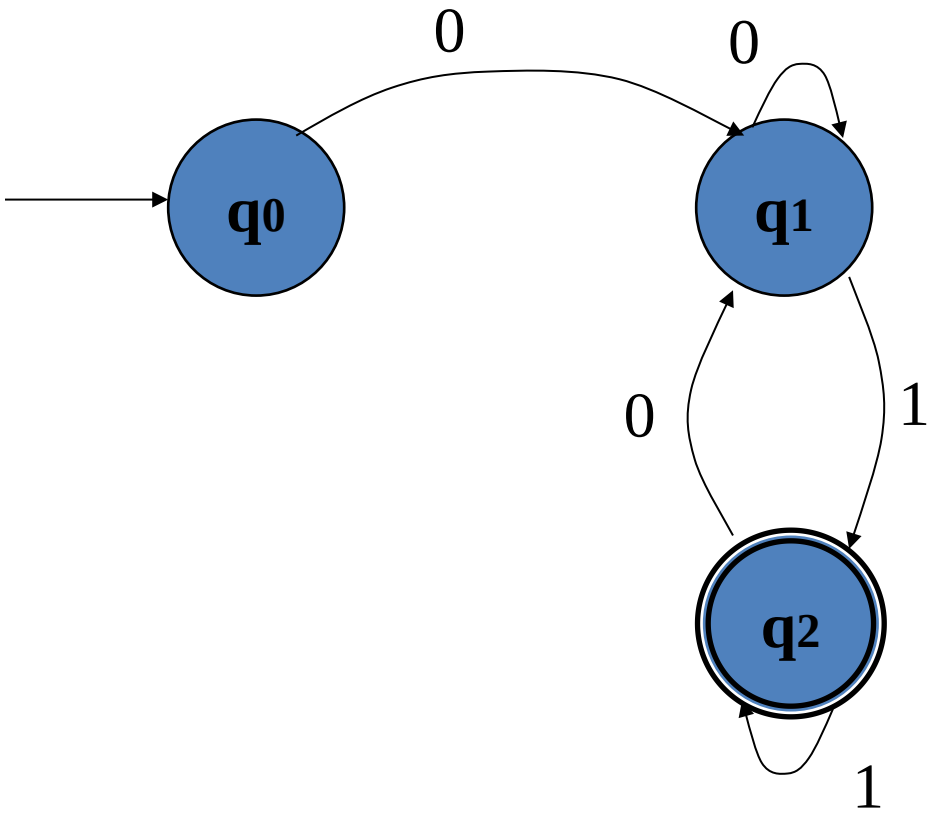
NFA – Exercise #1

w begins with 0 and ends with 1

q_0: no symbols are read yet.

q_1: the string read so far starts with 0 and ends with 0.

q_2: the string read so far starts with 0 and ends with 1.



NFA – Exercise #2

$\Sigma = \{0,1\}$, L = {w | w contains the substring 001}

Give the state diagram of an NFA that recognizes L.

NFA – Exercise #2

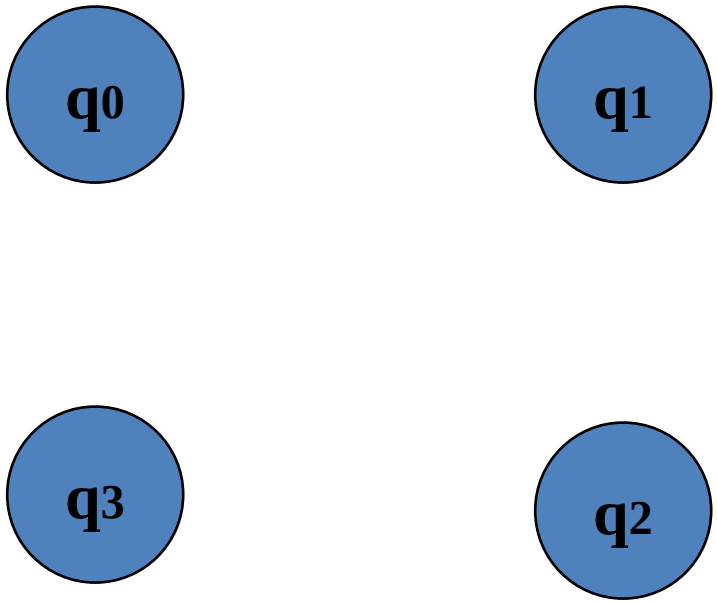
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.



NFA – Exercise #2

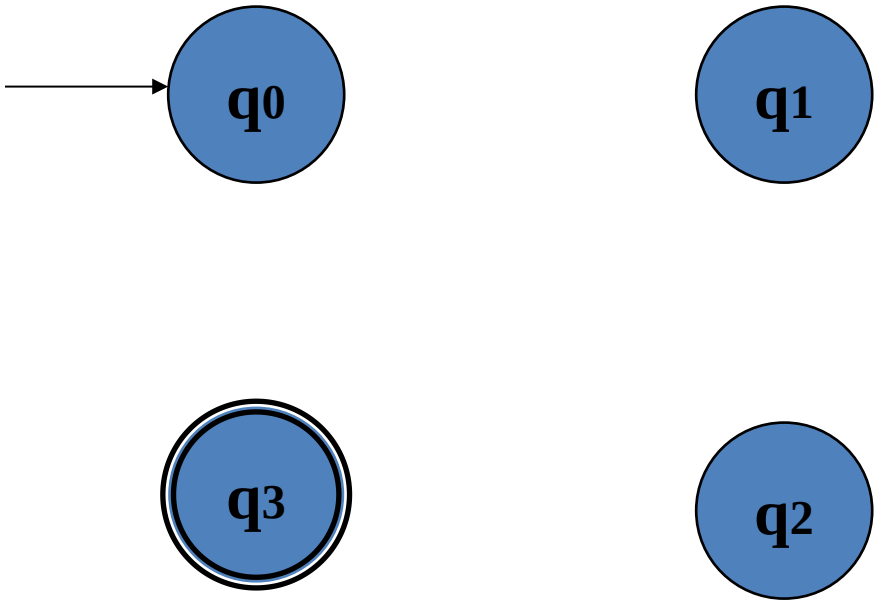
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.



NFA – Exercise #2

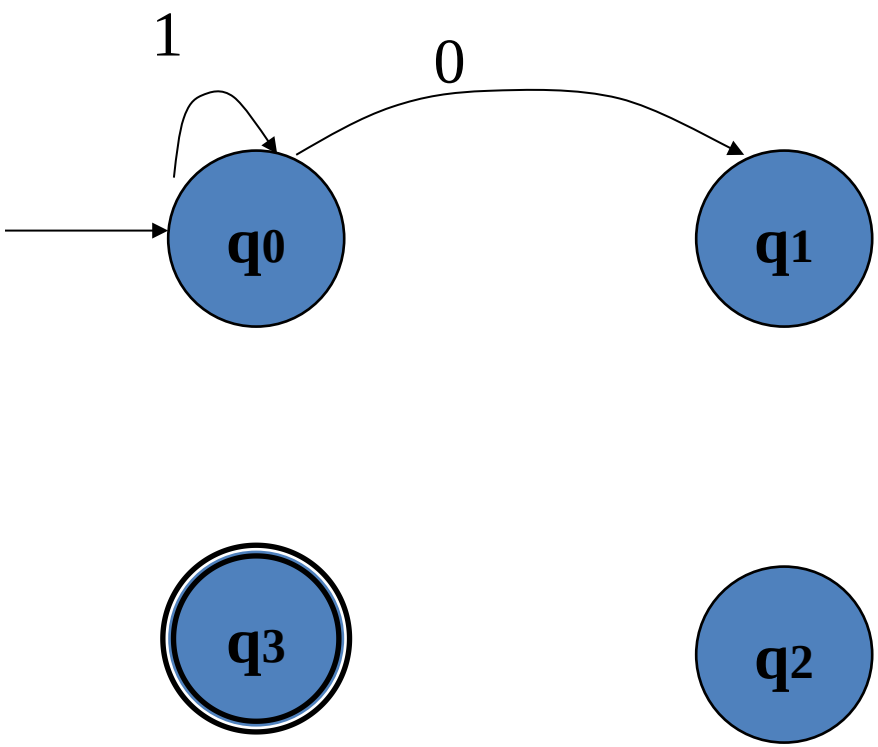
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.



NFA – Exercise #2

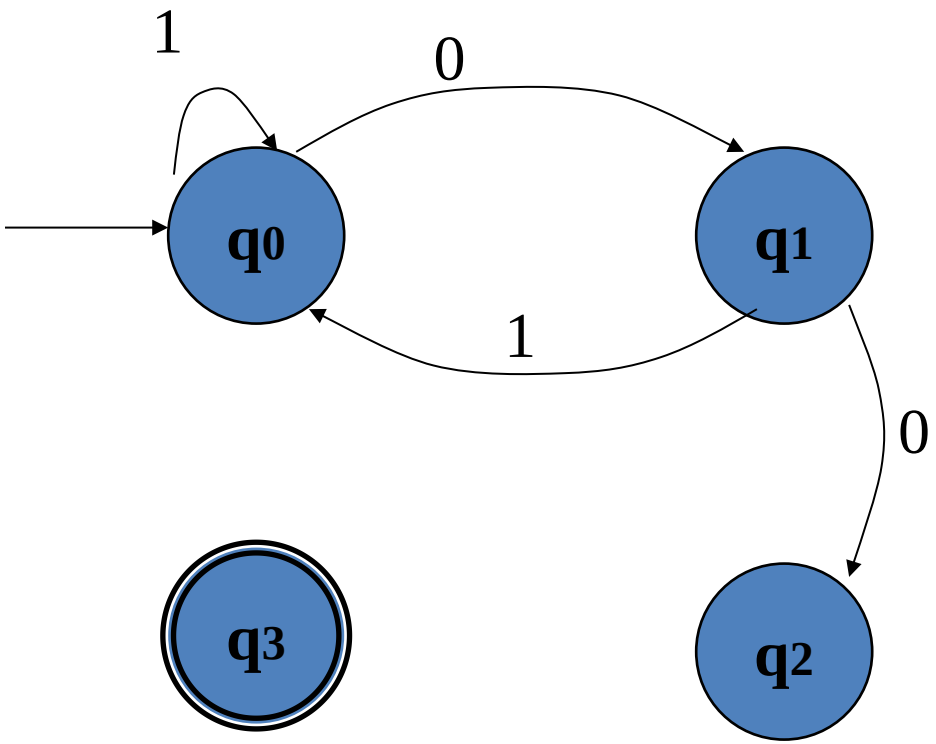
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.



NFA – Exercise #2

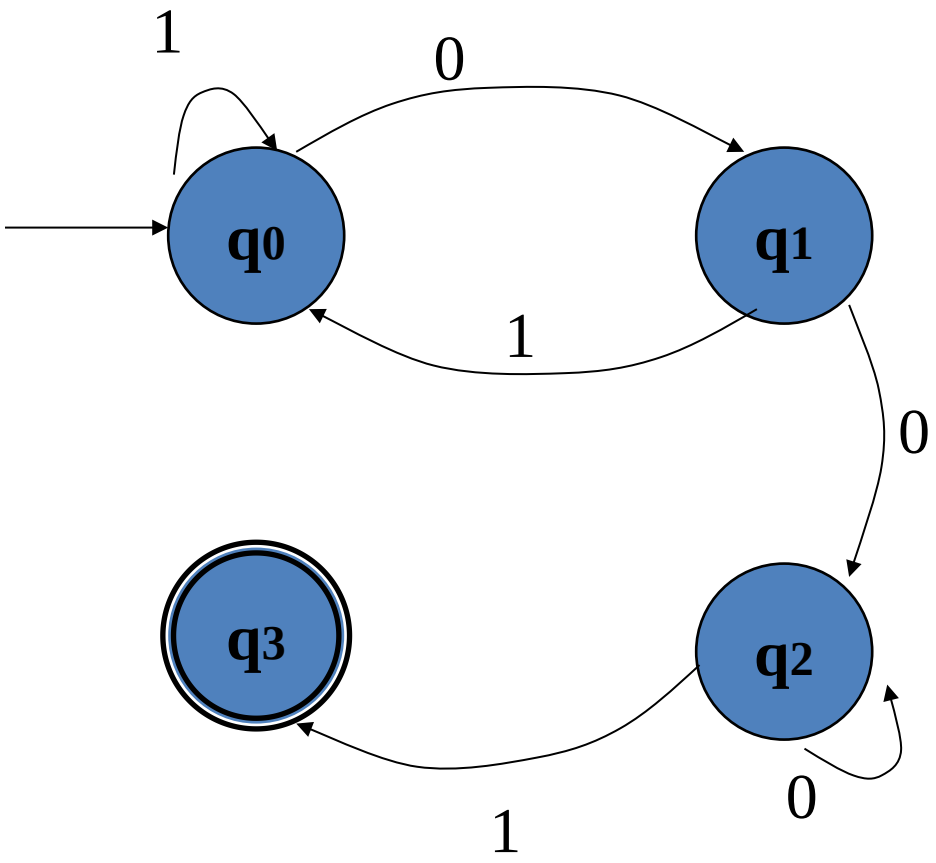
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.



NFA – Exercise #2

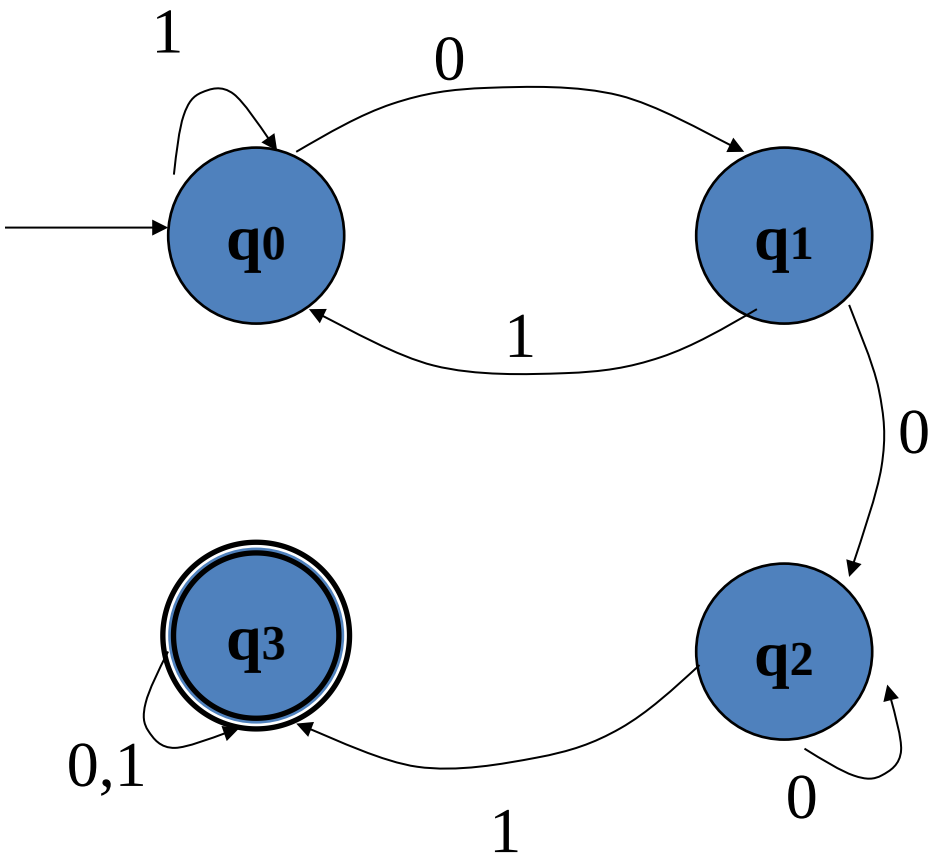
w contains the substring 001

q_0: no symbols are read yet or the string read so far does not contain any symbol of the substring.

q_1: the string read so far contains 0.

q_2: the string read so far contains 00.

q_3: the string read so far contains 001.

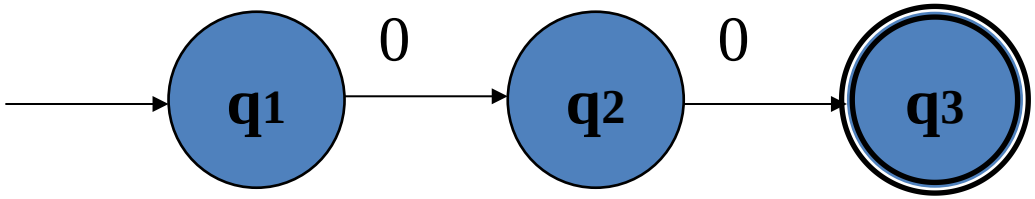


NFA – Exercise #3

$\Sigma = \{0,1\}$, L = {*w* | w contains at least two 0's, or exactly two 1's }
Give the state diagram of an NFA that recognizes L.

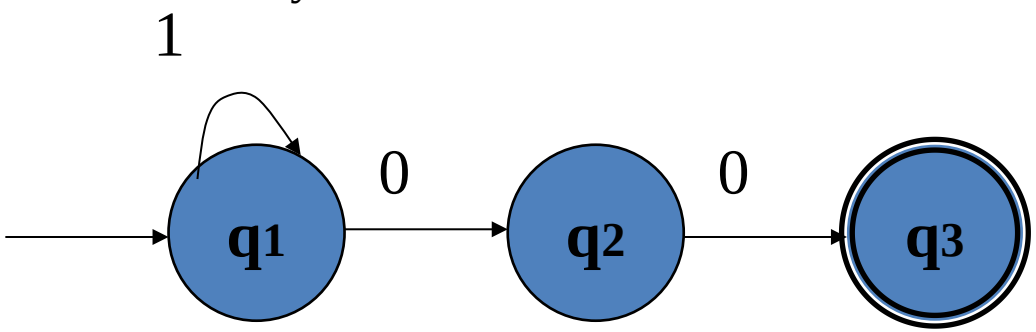
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



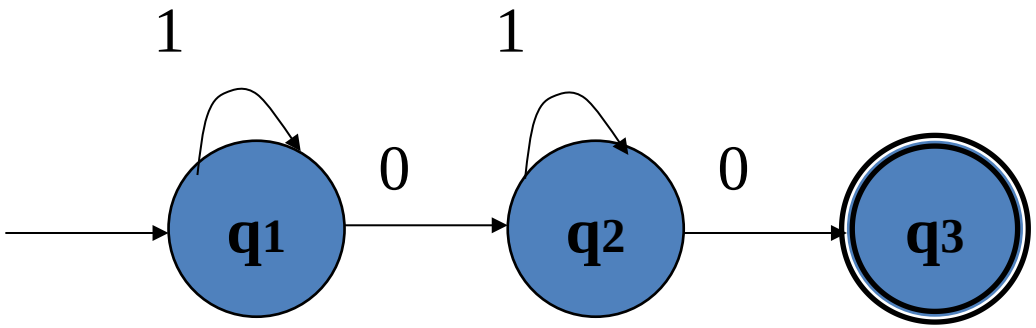
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



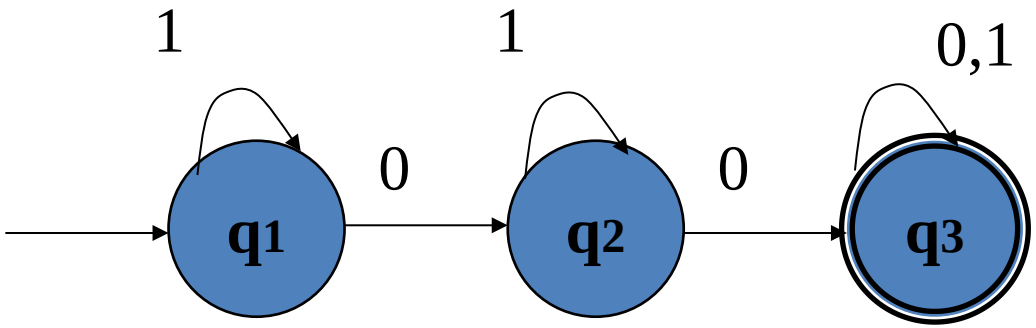
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



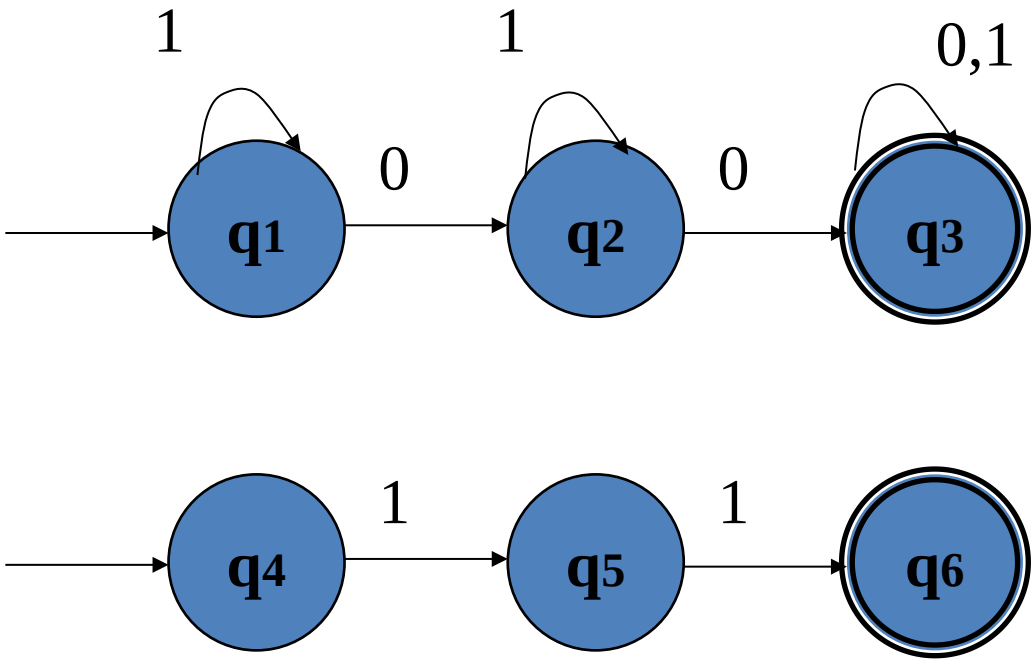
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



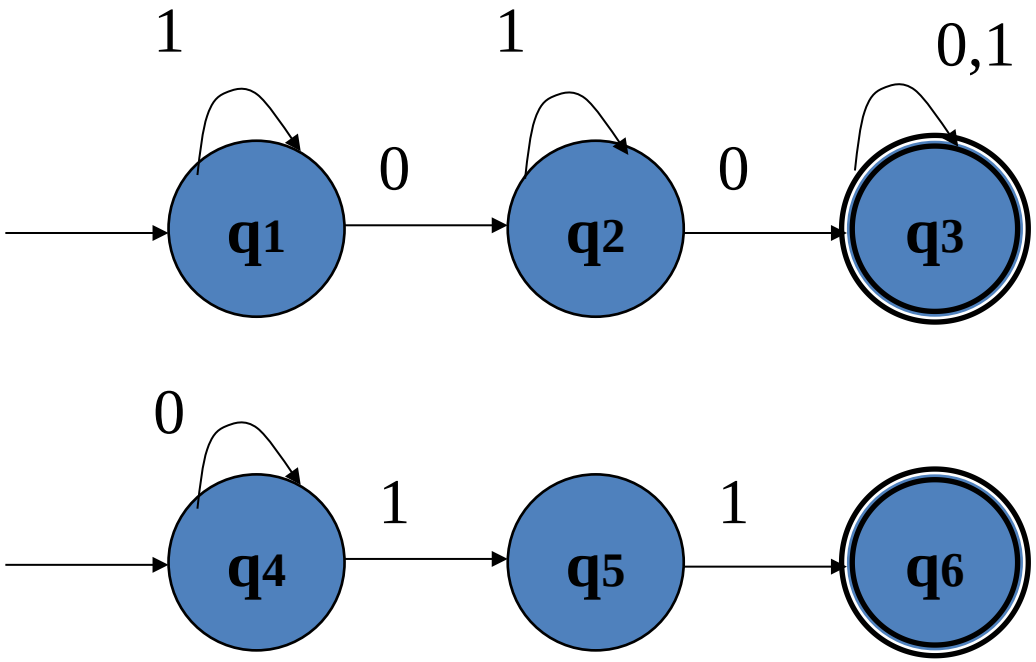
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



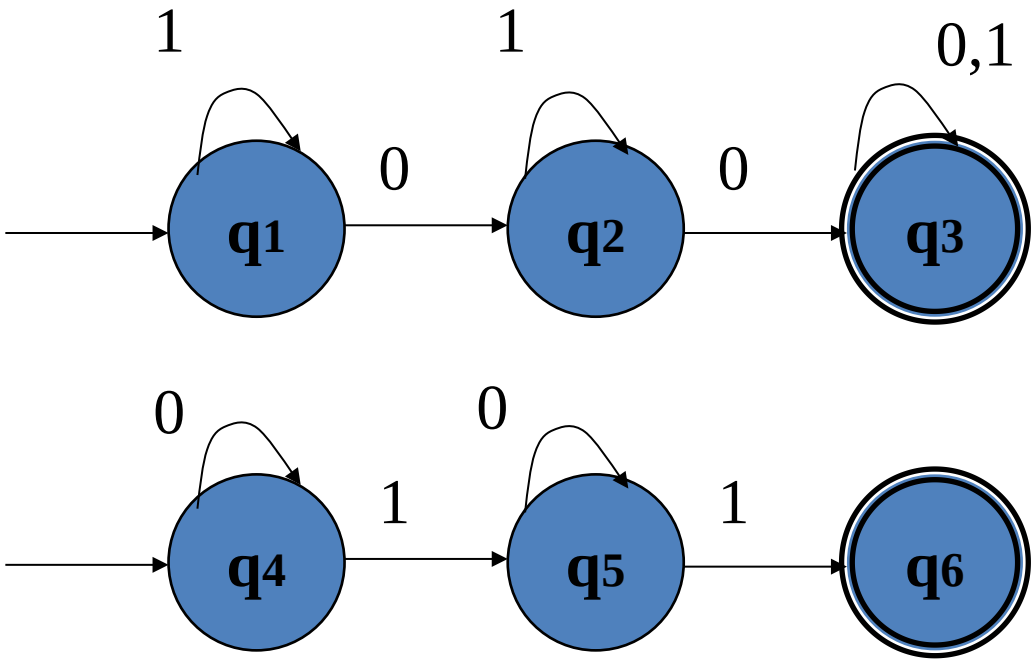
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



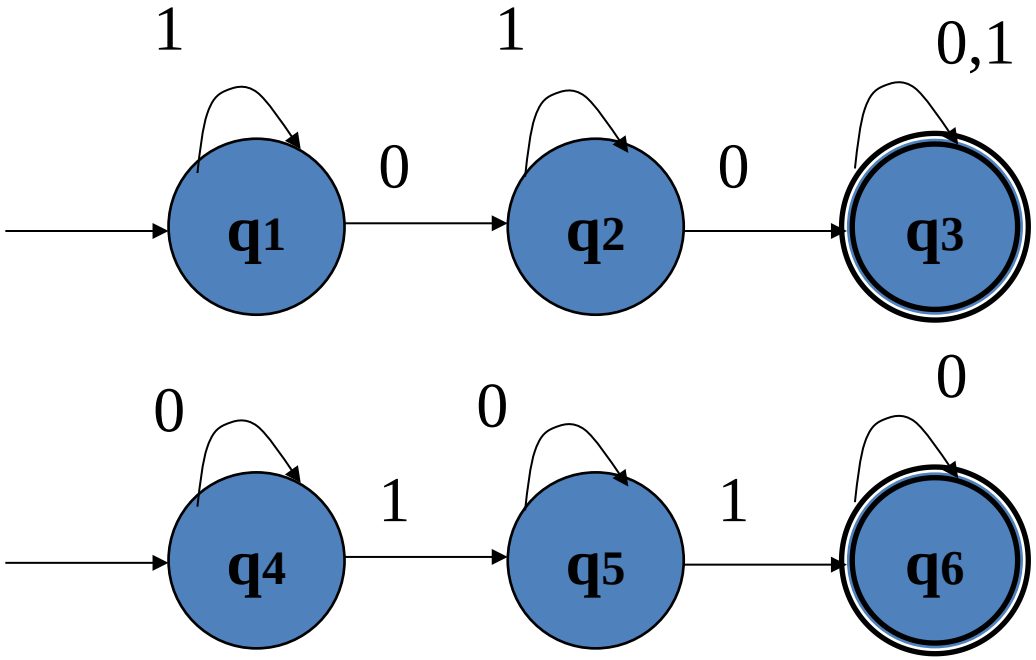
NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



NFA – Exercise #3

w contains at least two 0's, or exactly two 1's



NFA – Exercise #3

w contains at least two 0's, or exactly two 1's