# CONVERSION FROM NFA TO DFA

In NFA, when a specific input is given to the current state, the machine goes to multiple states. It can have zero, one or more than one move on a given input symbol. On the other hand, in DFA, when a specific input is given to the current state, the machine goes to only one state. DFA has only one move on a given input symbol.

Let, M = (Q, ∑, δ, q0, F) is an NFA which accepts the language L(M). There should be equivalent DFA denoted by M' = (Q', ∑', q0', δ', F') such that L(M) = L(M').

Steps for converting NFA to DFA:

**Step 1:** Initially Q' = ϕ

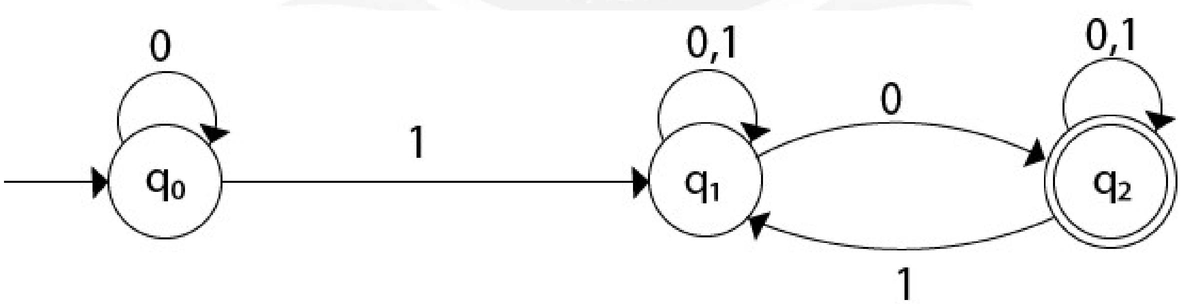
**Step 2:** Add q0 of NFA to Q'. Then find the transitions from this start state.

**Step 3:** In Q', find the possible set of states for each input symbol. If this set of states is not in Q', then add it to Q'.

**Step 4:** In DFA, the final state will be all the states which contain F(final states of NFA)

**Example 1:**

Convert the given NFA to DFA.




**Solution:** For the given transition diagram we will first construct the transition table.

| State | 0 | 1 |
|---|---|---|

| | | | |
|---|---|---|---|
| →q0 | | q0 | q1 |
| q1 | | {q1, q2} | q1 |
| *q2 | | q2 | {q1, q2} |

Now we will obtain δ' transition for state q0.

1. δ'([q0], 0) = [q0]
2. δ'([q0], 1) = [q1]

The δ' transition for state q1 is obtained as:

1. δ'([q1], 0) = [q1, q2] (**new** state generated)
2. δ'([q1], 1) = [q1]

The δ' transition for state q2 is obtained as:

1. δ'([q2], 0) = [q2]
2. δ'([q2], 1) = [q1, q2]

Now we will obtain δ' transition on [q1, q2].

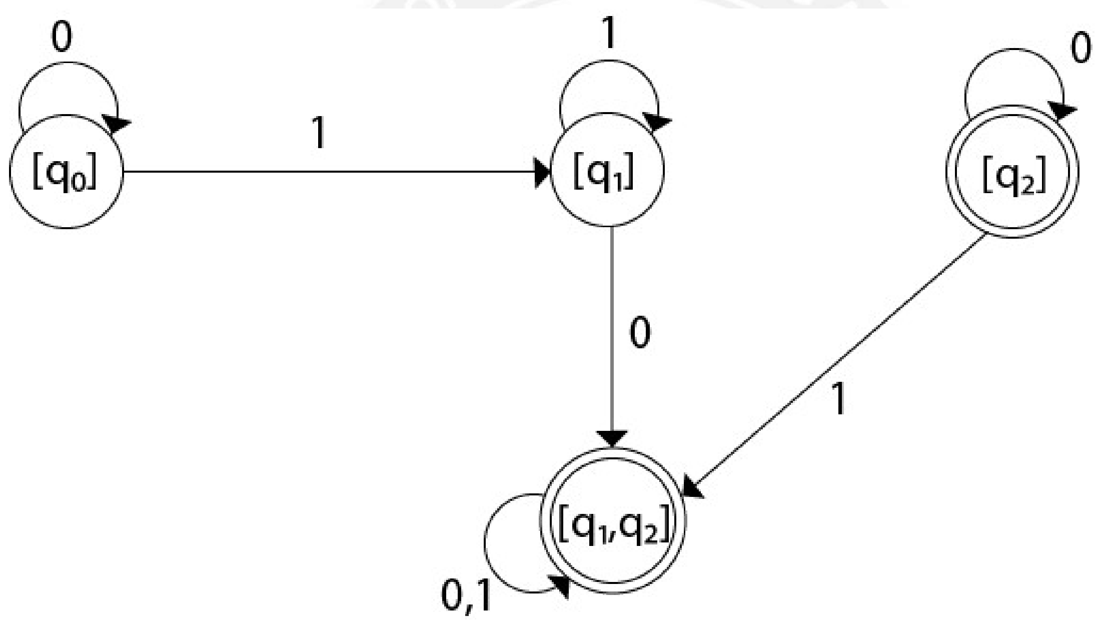
1. δ'([q1, q2], 0) = δ(q1, 0) ∪ δ(q2, 0)
2. = {q1, q2} ∪ {q2}
3. = [q1, q2]
4. δ'([q1, q2], 1) = δ(q1, 1) ∪ δ(q2, 1)
5. = {q1} ∪ {q1, q2}
6. = {q1, q2}
7. = [q1, q2]

The state [q1, q2] is the final state as well because it contains a final state q2. The transition table for the constructed DFA will be:

| **State** | **0** | **1** |
|---|---|---|

| | | |
|---|---|---|
| →[q0] | [q0] | [q1] |
| [q1] | [q1, q2] | [q1] |
| *[q2] | [q2] | [q1, q2] |
| *[q1, q2] | [q1, q2] | [q1, q2] |

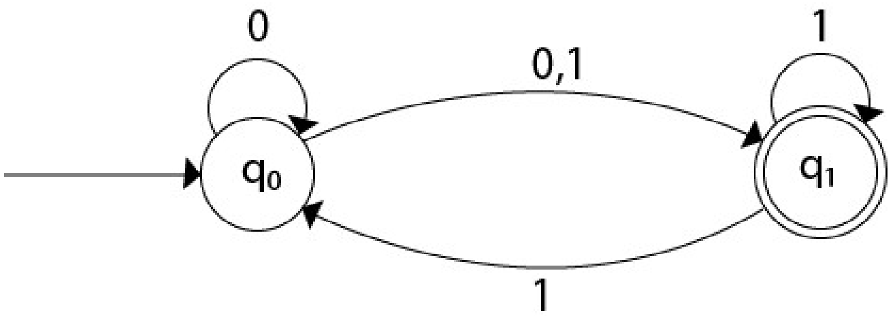
The Transition diagram will be:




The state q2 can be eliminated because q2 is an unreachable state.

**Example 2:**

Convert the given NFA to DFA.




**Solution:** For the given transition diagram we will first construct the transition table.

| State | 0 | 1 |
|---|---|---|
| →q0 | {q0, q1} | {q1} |
| *q1 | Φ | {q0, q1} |

Now we will obtain δ' transition for state q0.

1. δ'([q0], 0) = {q0, q1}
2. = [q0, q1] (**new** state generated)
3. δ'([q0], 1) = {q1} = [q1]

The δ' transition for state q1 is obtained as:

1. δ'([q1], 0) = ϕ
2. δ'([q1], 1) = [q0, q1]

Now we will obtain δ' transition on [q0, q1].

1. δ'([q0, q1], 0) = δ(q0, 0) ∪ δ(q1, 0)
2. = {q0, q1} ∪ ϕ
3. = {q0, q1}
4. = [q0, q1]

Similarly,

1. δ'([q0, q1], 1) = δ(q0, 1) ∪ δ(q1, 1)

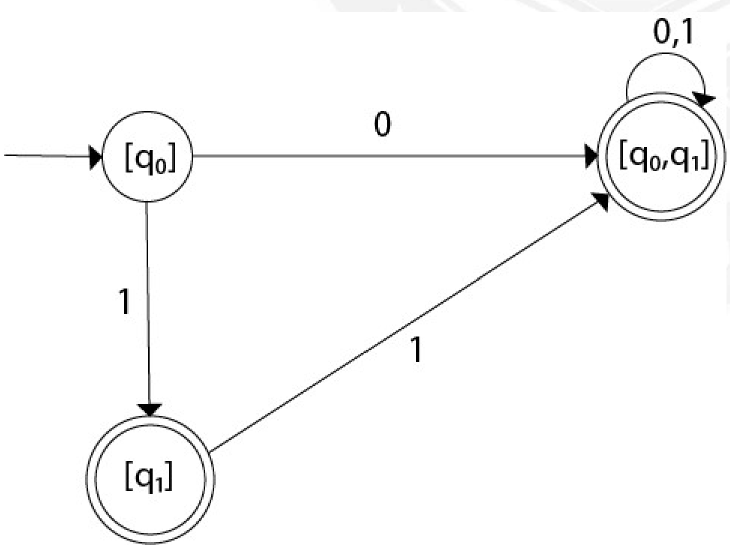
2. = {q1} ∪ {q0, q1}
3. = {q0, q1}
4. = [q0, q1]

As in the given NFA, q1 is a final state, then in DFA wherever, q1 exists that state becomes a final state. Hence in the DFA, final states are [q1] and [q0, q1]. Therefore set of final states F = {[q1], [q0, q1]}.

The transition table for the constructed DFA will be:

| State | 0 | 1 |
|---|---|---|
| →[q0] | [q0, q1] | [q1] |
| *[q1] | ϕ | [q0, q1] |
| *[q0, q1] | [q0, q1] | [q0, q1] |

The Transition diagram will be:




Even we can change the name of the states of DFA.

**Suppose**

1. A = [q0]
2. B = [q1]
3. C = [q0, q1]

With these new names the DFA will be as follows: