Tutorial 9

COMP 5361: Discrete Structures and Formal Languages

Mohammad Reza Davari

Concordia University

Outline

Contents of the section

Nondeterministic Finite Automata (NFA)

Definition

NFA is exactly like DFA but with a different definition for the transition function δ.

- **DFA Transition Function**: A function that takes a state and input symbol as arguments and returns **exactly one state**.
- **NFA Transition Function**: A function that takes a state and input symbol as arguments and returns **set of zero, one, or more states**.

Nondeterministic Finite Automata (NFA)

Example

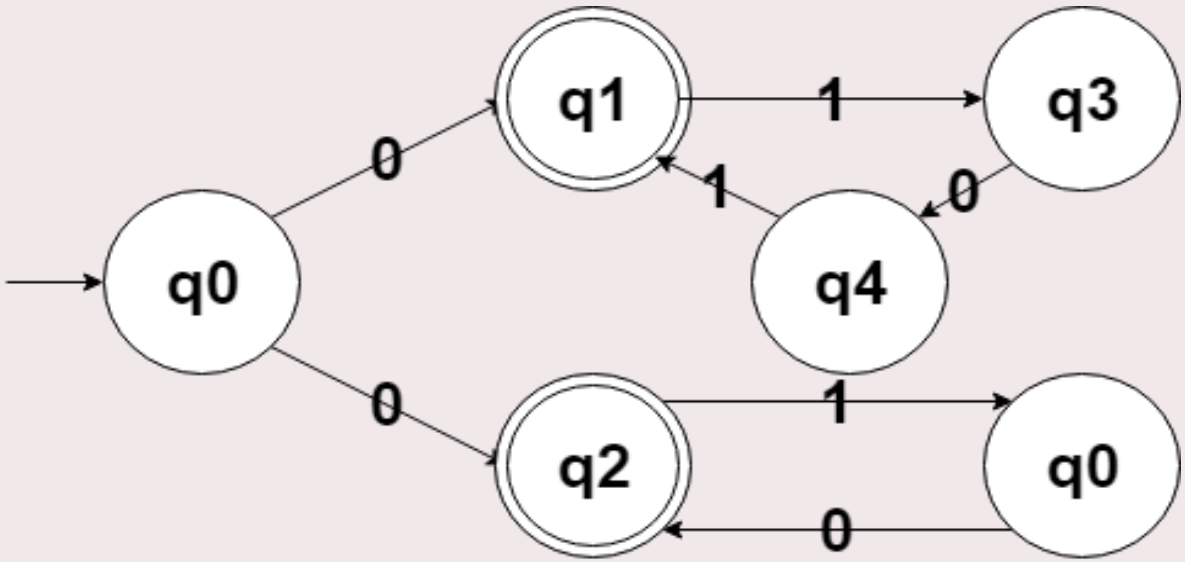

Figure: An example of NFA.

Nondeterministic Finite Automata (NFA)

Formal Definition

An NFA is a 5-tuple:

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

Where,

- Q is a finite set of states.
- Σ is a finite set of input symbols.
- $q_0 \in Q$ is the start state.
- $F \subset Q$ is the set of final or accepting states.
- δ the transition function is a function that takes a state in Q and an input symbol in Σ as arguments and returns a **subset** of Q.

Nondeterministic Finite Automata (NFA)

Definition

- **The Extended Transition Function**: The extended transition function of δ is denoted by $\hat{\delta}$. It takes a state q and a string of input symbols w and returns the **set of states** that the NFA is in if it starts in state q and processes the string w.

Nondeterministic Finite Automata (NFA)

Example

Find the following values for the NFA defined in slide 5.

1. $\hat{\delta}(q_0, 0)$

Nondeterministic Finite Automata (NFA)

Example

Find the following values for the NFA defined in slide 5.

1. $\hat{\delta}(q_0, 0)$
2. $\hat{\delta}(q_2, 0)$

Nondeterministic Finite Automata (NFA)

Example

Find the following values for the NFA defined in slide 5.

1. $\hat{\delta}(q_0, 0)$
2. $\hat{\delta}(q_2, 0)$
3. $\hat{\delta}(q_0, 010)$

Nondeterministic Finite Automata (NFA)

Definition

- **The Language of an NFA**: The Language of an NFA is the set of strings w in Σ^* such that $\hat{\delta}(q_0, w)$ contains at least one accepting state.

$$L(N) = \{w | \hat{\delta}(q_0, w) \cap F \neq \emptyset\}$$

Contents of the section

Examples

Example 1

Build a DFA for the NFA seen in slide 5.

Examples

Example 2

Build a DFA for the following NFA.

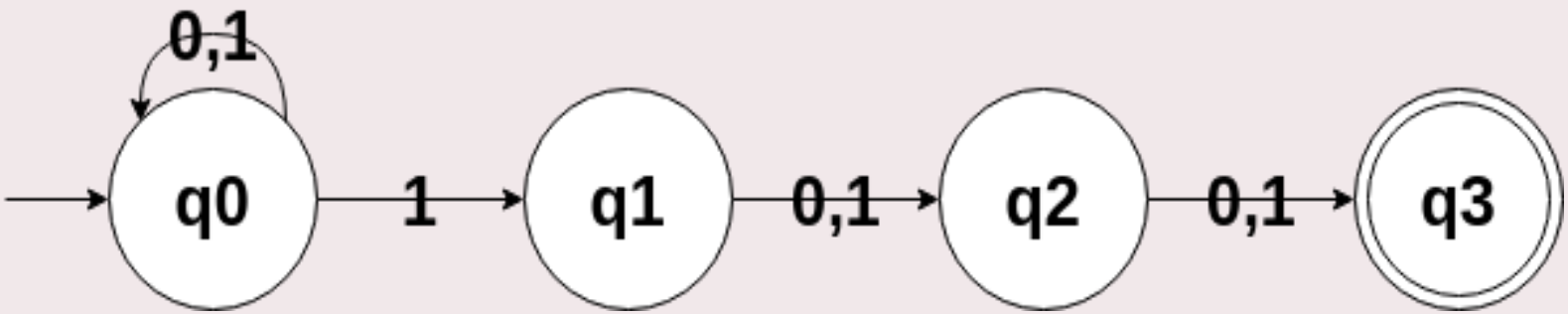

Figure: NFA to DFA example.

Example 3

Build a DFA for the following NFA.

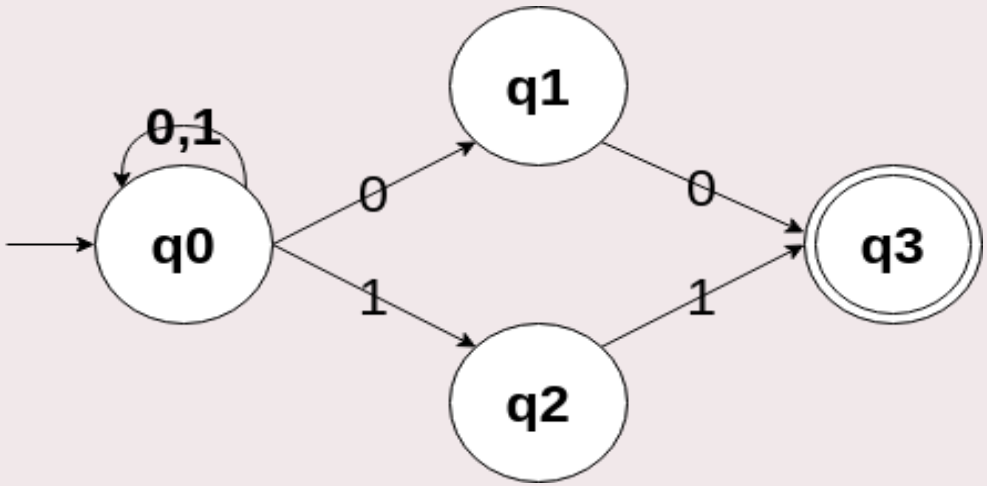

Figure: NFA to DFA example.