CSE331	Automata and Computability
Lecture 8.1: NFA with ε Transitions	
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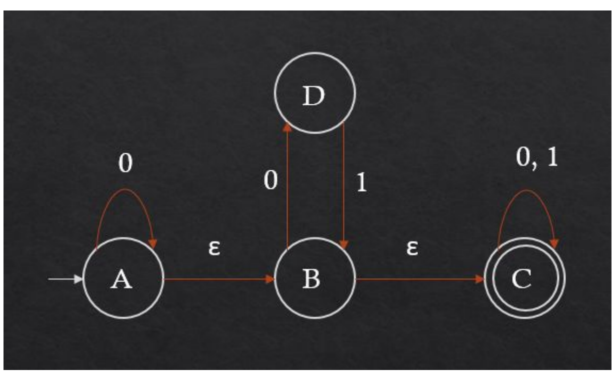
Epsilon NFA (*ε*-NFA)

The class of NFAs can be extended by allowing spontaneous transitions without reading any input symbols. In the diagram, such transitions are represented by an edge labeled by epsilon (***ε***). It is important to note that, ***ε*** is not considered as an input symbol. In fact, it is assumed that ***ε*** does not belong to any input alphabet. An NFA with **epsilon** transition(s) is called ***ε*-NFA.** Both NFAs and ***ε*-NFA**s recognize the same class of languages that are defined as **Regular Languages**. However, allowing transitions on epsilon adds certain programming conveniences.

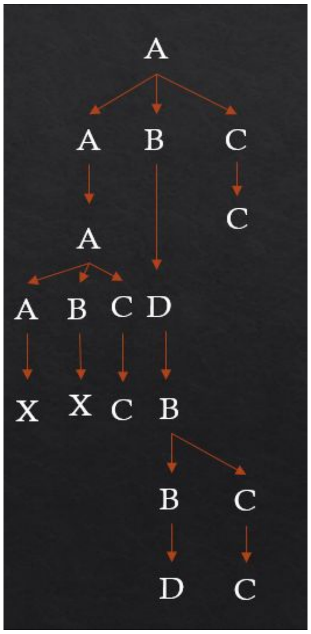
Example Simulation

Consider the following ***ε*-NFA**.



When the automaton is at state A, it "copies" itself. One of the copies remain at A and the other one goes to B following the **epsilon(*ε*)** transition from A to B. Again, when the automaton is at state B, it "copies" itself. One of the copies remain at B and the other one goes to C following the **epsilon(*ε*)** transition from B to C. Basically, When the automaton is at state A, after completing the epsilon transitions, the states that the automaton is at are: A, B, C. This is called the epsilon**(*ε*)** closure. ***ε*-Closure** of a state q is the set of states that can be reached from q by following the epsilon transitions and it includes the state q itself. According to the definition, **ε-Closure** of A is the set {A, B, C} and the **ε-Closure** of B is the set {B, C}.

If we process the string *010* can be represented by the following diagram:



Language of an NFA/ε-NFA

The language of an NFA/ε-NFA is the set of strings that it accepts. A string w is accepted by an NFA if δ(q0, w) contains a final/accepting state.

Comparison between DFA and NFA/ε-NFA

- A **DFA** cannot be in more than one state at any given point but an **NFA/ε-NFA** can.
- **DFA** does not allow moving to two or more different states, from the same state, on the same input symbol but an **NFA/ε-NFA** does.
- In **DFA**, the transition function is
  $\boldsymbol{\delta}:\boldsymbol{Q} \times \sum \rightarrow \boldsymbol{Q}$

  In **NFA/ε-NFA**, the transition function is
  $\boldsymbol{\delta}:\boldsymbol{Q} \times \sum \rightarrow \mathbf{P}(\boldsymbol{Q})$

  Here, **P(*Q*)** is the power set of Q.
- Determinism does not allow epsilon transitions but nondeterminism does.