Finite Automata Theory and Formal Languages

(Week 3, Lecture 2)

Nondeterministic Finite Automaton (NFA)

- An NFA is a TG with a unique start state and a property of having single letter as label of transitions.

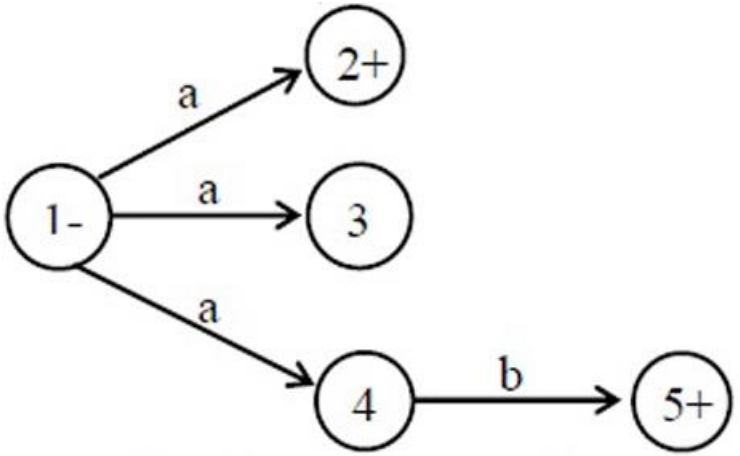
Nondeterministic Finite Automaton (NFA)

- An NFA is a collection of three things
  - Finite many states with one initial and some final states.
  - Finite set of input letters, say, $\Sigma=\{a,b,c\}$.
  - Finite set of transitions, showing where to move if a letter is input at certain state ($\wedge$ is not a valid transition), there may be more than one transition for certain letters and there may not be any transition for certain letters.

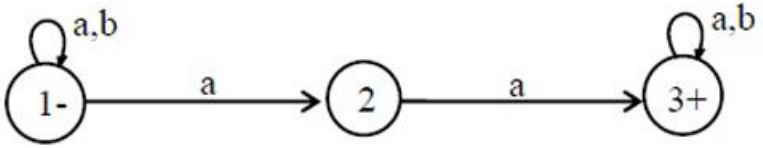
Nondeterministic Finite Automaton (NFA)

- Note:
  - It may be observed from the definition of NFA that the string is supposed to be accepted if there exists at least one successful path otherwise rejected. An NFA can be considered to be an intermediate structure between FA and TG.

Nondeterministic Finite Automaton (NFA)



It is to be noted that the above NFA accepts the language consisting of a and ab.



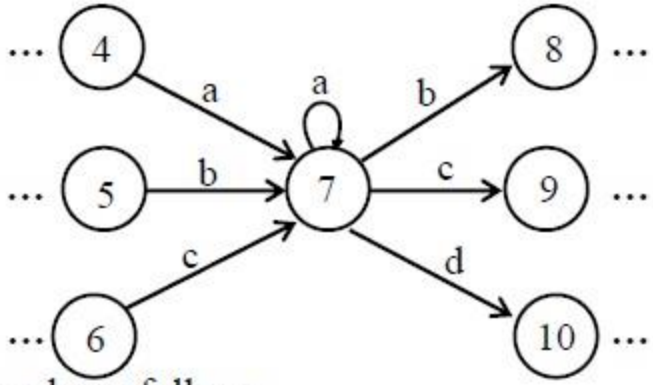
It is to be noted that the above NFA accepts the language of strings, defined over $\Sigma = \{a, b\}$, containing aa.

Nondeterministic Finite Automaton (NFA)

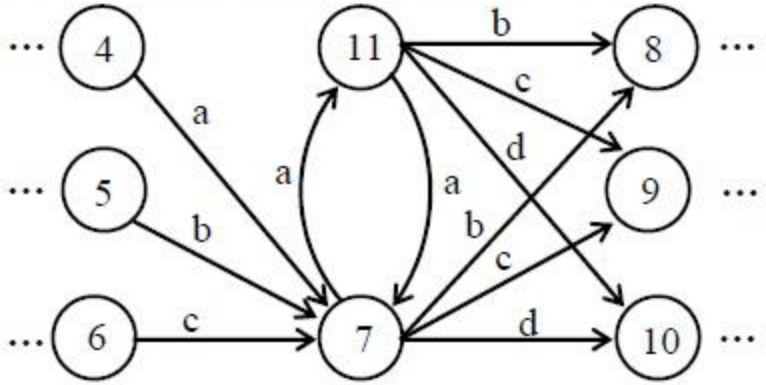
- Note:
  - NFA helps to eliminate a loop at certain state of an FA. This process is done converting the loop into a circuit but during this process the FA remains no longer FA and is converted to a corresponding NFA.

Nondeterministic Finite Automaton (NFA)

Consider a part of the following FA with an alphabet $\Sigma = \{a,b,c,d\}$



To eliminate the loop at state 7, the corresponding NFA may be as follows

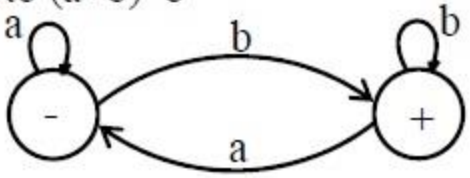


Nondeterministic Finite Automaton (NFA)

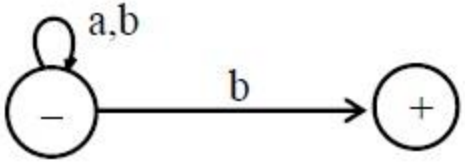
- Since an NFA is a TG as well, therefore there exists an NFA accepting the language accepted by the given FA. In this case these FA and NFA are said to be equivalent to each other.
- Note:
  - Every FA can be considered to be an NFA as well but the converse may not be true.
  - Every NFA can be considered to be a TG as well but the converse may not be true.

Nondeterministic Finite Automaton (NFA)

Consider the following FA corresponding to (a+b)*b

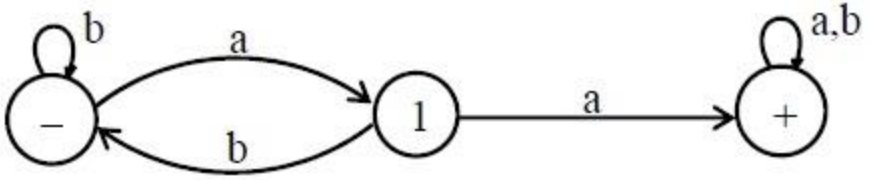


The above FA may be equivalent to the following NFA

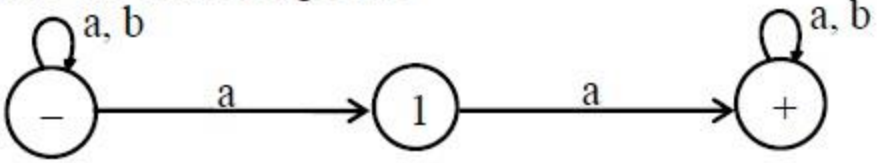


Nondeterministic Finite Automaton (NFA)

Consider the following FA



The above FA may be equivalent to the following NFA



NFA with a Null string

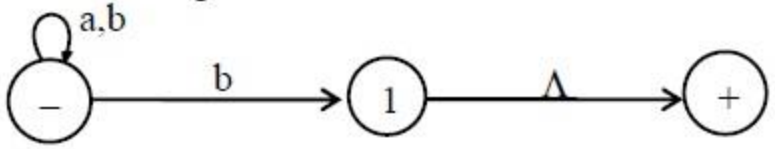
- If in an NFA, $\wedge$ is allowed to be a label of an edge then the NFA is called NFA with $\wedge$ (NFA-$\wedge$).

NFA with a Null string

- An NFA-$\wedge$ is a collection of three things
  - Finite many states with one initial and some final states.
  - Finite set of input letters, say, Σ={a,b,c}.
  - Finite set of transitions showing where to move if a letter is input at certain state. There may be more than one transitions for certain letter and there may not be any transition for a certain letter. The transition of $\wedge$ is also allowed at any state.

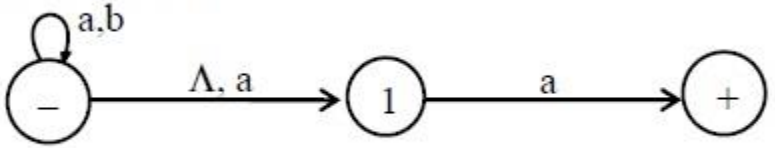
NFA with a Null string

Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in b**.

Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in a**.