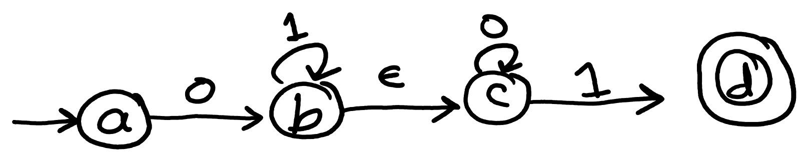
Nondeterministic Finite Automaton with Epsilon-Transitions

- Another extension of Finite Automaton.
- The new "feature": transition on ε (empty string) is allowed.
- In effect, an NFA is allowed to make a transition spontaneously, without receiving an input symbol.
- Note that, the new capability does not expand the class of languages that can be accepted by finite automata, but it does give some added "programming convenience".

Example:



Formal Definition:

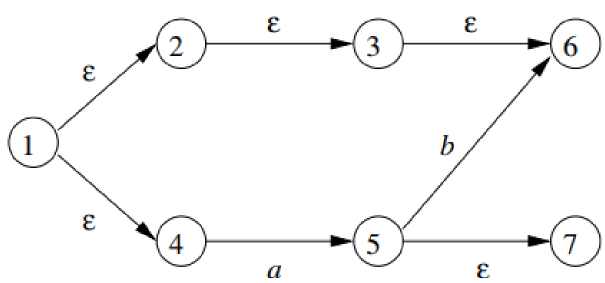
An ε-NFA is a quintuple (5-tuple), that is, a system which consists of 5 elements. We describe an ε-NFA, A as follows:

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

where
- Q - finite nonempty set of states;
- Σ - finite nonempty set of input symbols, input alphabet;
- δ - transition function, $\delta: Q \times (\Sigma \cup \{\varepsilon\}) \rightarrow 2^Q$;
- q_0 – initial state, $q_0 \in Q$;
- F - set of final or accepting states, $F \subseteq Q$.

Epsilon-Closures (ε*):

All the states that can be reached from a particular state only by seeing the ε symbol.



ECLOSE (3) = {3, 6}
ECLOSE (2) = {2, 3, 6}
ECLOSE (1) = {1, 2, 4, 3, 6}

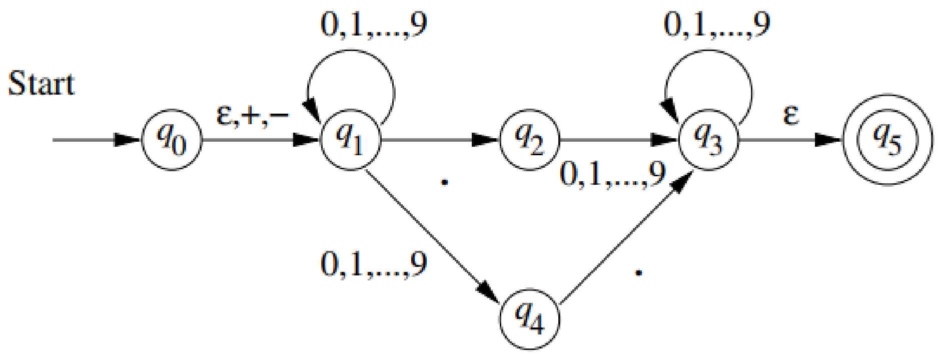
Eliminating ε-Transitions (ε-NFA to DFA):

Given any ε-NFA *E*, we can find a DFA *D* that accepts the same language as *E*.

Let $E = (Q_E, \Sigma, \delta_E, q_0, F_E)$, then the equivalent DFA can be found by defining

$$D = (Q_D, \Sigma, \delta_D, q_D, F_D).$$

Example:



The Equivalent DFA,