Non-deterministic Finite Automata

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From: Elements of the Theory of Computation by Lewis and Papadimitriou

Nondeterministic Finite Automata (NFA)

- add the feature non-determinism to finite automata (ability to change states in a way that is only partially determined by the current state and input symbol)
- permit several possible next states or none at all

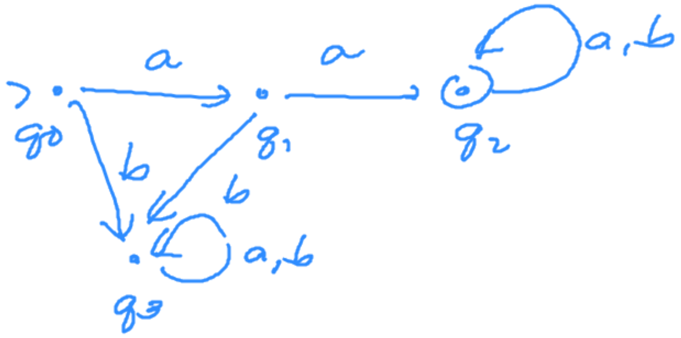
Formally, a nondeterministic finite automaton is a quintuple $M = (K, \Sigma, \Delta, s, F)$ where

- K is a finite set of states,
- Σ is an alphabet,
- $s \in K$ is the initial state,
- $F \in K$ is the set of final states, and
- Δ the transition relation is a finite subset of $K \times \Sigma^* \times K$

- $(q, u, p) \in \Delta$ iff an arrow q• →u •p appears in the state diagram
- each triple (q, u, p) is called a transition of M
- $(q, w) \vdash_M (q', w')$ iff there is a $u \in \Sigma^*$ such that $w = uw'$ and $(q, u, q') \in \Delta$
- $\vdash^*_M$ is the reflexive transitive closure of $\vdash_M$
- a string $w \in \Sigma^*$ is accepted by M iff there is a state $q \in F$ such that $(s, w) \vdash^*_M (q, e)$
- L(M), the language accepted by M is the set of all strings accepted by M.
- For as long as there is a sequence of moves which would result to a final state, and the string empty, then the string is accepted

$L = \{ w \in \{a,b\}^* \mid w \text{ starts with } aa \}$

DFA



NFA

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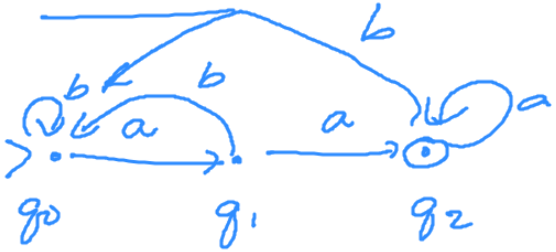
DFA



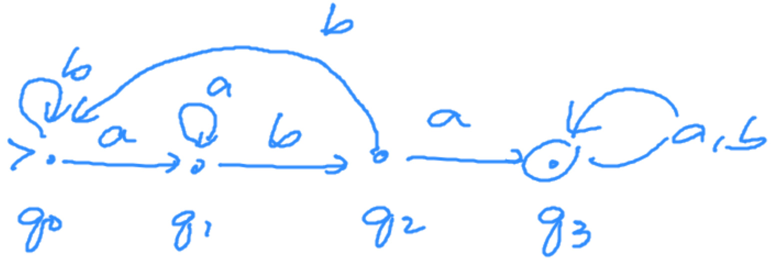
NFA

$(a+b)^* aa$

$L = \{ w \in \{a,b\}^* \mid w \text{ contains } aba \text{ as substring} \}$

$(a+b)^* aba (a+b)^*$

DFA



NFA

$L = \{ w \in \{a,b\}^* \mid w$ starts with aa or w ends with bb $\}$

R.E : $aa(a+b)^* + (a+b)^*bb$