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Hand in until 16:00 on July 22, 2020
Discussion: July 22, 2020

Tutorial for Program Verification
Exercise Sheet 19

In this exercise sheet we work with nondeterministic finite automata.

Submit your solution by uploading it as PDF in ILIAS.

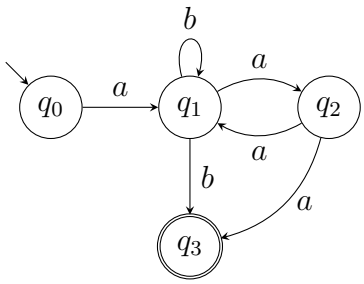
A *nondeterministic finite automaton* (NFA) is a tuple $\mathcal{A} = (Q, \Sigma, \Delta, Q_0, F)$ where Q is a finite set of states, Σ is a finite alphabet, $\Delta \subseteq (Q \times \Sigma) \times Q$ is a transition relation, $Q_0 \subseteq Q$ is a set of initial states, and $F \subseteq Q$ is a set of final (or accepting) states.

A *run* for a finite word $w = a_1 \dots a_n \in \Sigma^*$ in an NFA $\mathcal{A}$ is a finite sequence of states $q_0 q_1 \dots q_n$ such that $q_0 \in Q_0$, and $(q_i, a_{i+1}, q_{i+1}) \in \Delta$ for all $i \in \{0, \dots, n-1\}$. A run is *accepting*, if it ends in a final state $q \in F$.

A word $w \in \Sigma^*$ is *accepted* by an NFA $\mathcal{A}$ if there exists an accepting run in $\mathcal{A}$.

Exercise 1: Nondeterministic Finite Automata 2 Points

Let $\Sigma = \{a, b\}$. Consider the following NFA $\mathcal{A}$ given by its graphical representation, where we mark initial states by ingoing edges, and final states by double circles.



For each of the following words, state whether they are accepted by the NFA $\mathcal{A}$ or not. If a word is accepted by $\mathcal{A}$, give an accepting run.

(a) $w_1 = aaab$

(b) $w_2 = abaaba$

(c) $w_3 = abaabaa$

(d) $w_4 = abba$