Technische Universität München (I7) **Summer Semester 2020**
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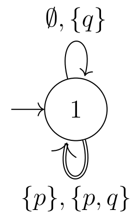
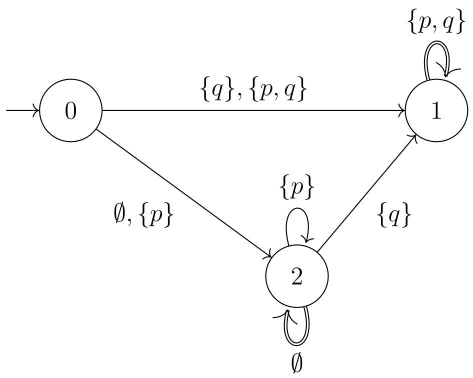
Model Checking – Exercise sheet 5

Exercise 5.1
Convert the following Büchi automata with transition-based acceptance condition ("doubled"-transitions have to be seen infinitely often) to equivalent Büchi automata with state-based acceptance conditions. Moreover, give a general procedure to perform this conversion.

(a)



(b)



Exercise 5.2
Extend the set of rules of the LTL to Büchi automata translation to directly deal with the **F** and **G** operators. Use it to construct a Büchi automaton for $\phi = \mathbf{GF}p$. Is it necessary to construct states which do not contain ϕ?

Exercise 5.3
Let $\phi = \mathbf{G}\left((\mathbf{X}(p\ \mathbf{U}\ q)) \rightarrow ((\neg p \wedge \mathbf{F}q) \vee (q\ \mathbf{U}\ \mathbf{X}q))\right)$ and $\mathcal{G}$ be a generalized Büchi automaton translated from ϕ using the construction presented in the lecture and the extended set of rules defined in the previous exercise.

(a) Write down the set of subformulae $Sub(\phi)$.

(b) What is the size of $CS(\phi)$?

(c) How many sets of accepting states does $\mathcal{G}$ have?

(d) Is $\{\phi\}$ an accepting state of $\mathcal{G}$?

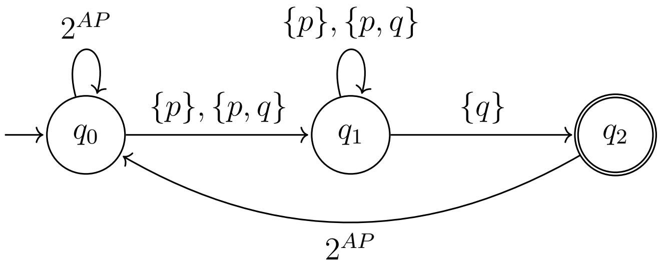
(e) Give a reachable state that has no successors.

(f) Give a successor state of the smallest consistent state containing $\{\phi, q, q \mathbf{U} \mathbf{X}q, \mathbf{F}q\}$.

(g) Give a predecessor state of the smallest consistent state containing $\{\phi, q, q \mathbf{U} \mathbf{X}q, \mathbf{F}q\}$.

Exercise 5.4

Consider the following Büchi automaton $\mathcal{B}$:



(a) Give an LTL formula ϕ such that $\mathcal{L}(\mathcal{B}) = [\![\phi]\!]$.

(b) By using the result from (a), propose a method to construct a Büchi automaton that accepts the complement of the language accepted by $\mathcal{B}$.

(c) Construct a Büchi automaton for the formula $\mathbf{G}(\neg p \vee (\neg p \mathbf{R} (p \vee \neg q)))$.

(d) By using the result from (c), construct a Büchi automaton that accepts the complement of the language accepted by $\mathcal{B}$.