Technische Universität München (I7) **Summer Semester 2018**
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Model Checking – Exercise sheet 8

Exercise 8.1

Given two CTL formulas ϕ_1 and ϕ_2, we write $\phi_1 \Rightarrow \phi_2$ iff for every Kripke structure $\mathcal{K}$ we have $(\mathcal{K} \models \phi_1) \Rightarrow (\mathcal{K} \models \phi_2)$. Furthermore, we define an *implication graph* as a directed graph whose nodes are CTL formulas, and that contains an edge from ϕ_1 to ϕ_2 iff $\phi_1 \Rightarrow \phi_2$. Let $AP = \{p\}$.

(a) Draw an implication graph with the nodes: $\mathbf{EFEF}p$, $\mathbf{EGEG}p$, $\mathbf{AFAF}p$, $\mathbf{AGAG}p$.

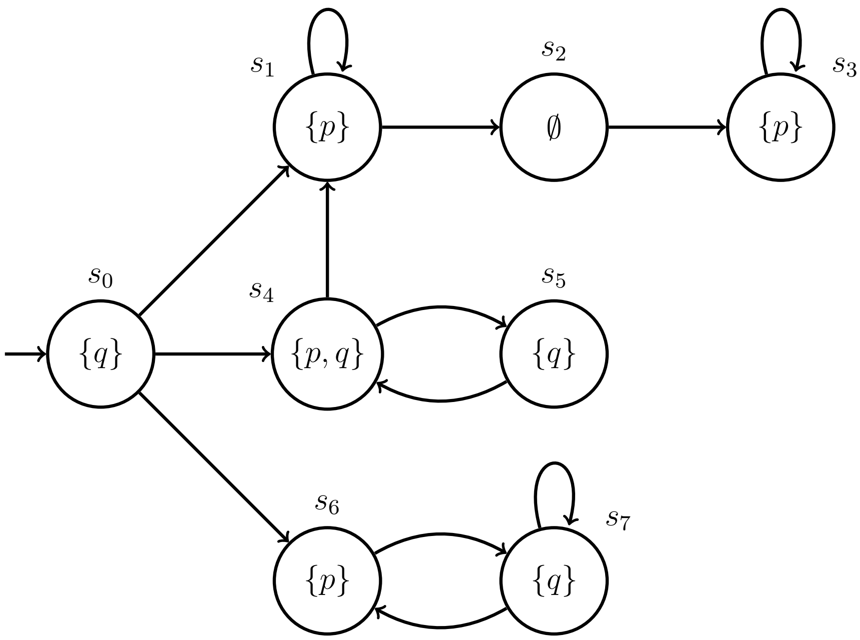
(b) For each implication $\phi_1 \Rightarrow \phi_2$ obtained in (a), give a Kripke structure $\mathcal{K}$ that satisfies ϕ_2 but not ϕ_1, i.e. give a $\mathcal{K}$ such that $\mathcal{K} \models \phi_2$ and $\mathcal{K} \not\models \phi_1$.

(c) Add the following CTL formulas to the implication graph obtained in (a): $\mathbf{AFEF}p$, $\mathbf{EFAF}p$, $\mathbf{AGEG}p$, $\mathbf{EGAG}p$.

(d) Complete the graph obtained in (c) with the nodes: $\mathbf{AGAF}p$, $\mathbf{AFAG}p$, $\mathbf{AGEF}p$, $\mathbf{EGAF}p$, $\mathbf{AFEG}p$, $\mathbf{EFAG}p$, $\mathbf{EFEG}p$, $\mathbf{EGEF}p$.

Exercise 8.2

Consider the following Kripke structure over $AP = \{p, q\}$:



(a) Compute $[\![\mathbf{EG}q]\!]$ and $[\![\mathbf{EF}q]\!]$.

(b) Compute $[\![\mathbf{AGAF}p]\!]$ and $[\![\mathbf{EFAG}\neg q]\!]$.