

Model Checking – Exercise sheet 8

Exercise 8.1

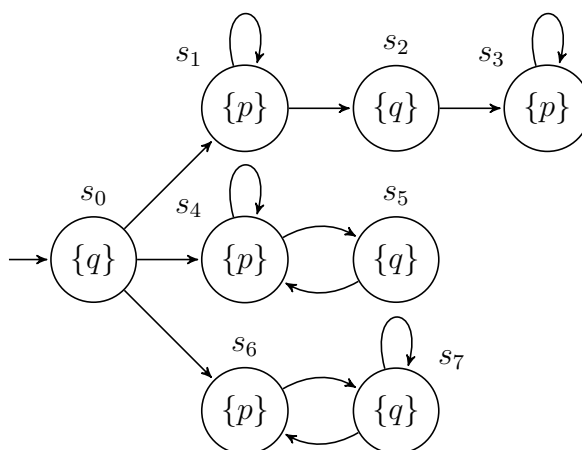
Given two CTL formulas ϕ_1 and ϕ_2 , we write $\phi_1 \Rightarrow \phi_2$ iff for every Kripke structure \mathcal{K} we have $(\mathcal{K} \models \phi_1) \Rightarrow (\mathcal{K} \models \phi_2)$. Furthermore, we define an implication graph as a directed graph in which nodes are CTL formulas and there is 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: **EF EF p**, **EG EG p**, **AF AF p**, **AG AG p**.
- (b) Add to the graph in (a) the following CTL formulas: **AF EF p**, **EF AF p**, **AG EG p**, **EG AG p**.
- (c) For each implication $\phi_1 \Rightarrow \phi_2$ in (b), give a Kripke structure \mathcal{K} that only satisfies ϕ_2 but not ϕ_1 , i.e. give a \mathcal{K} such that $\mathcal{K} \models \phi_2$ but $\mathcal{K} \not\models \phi_1$.
- (d) Complete the graph in (b) with the nodes: **AG AF p**, **AF AG p**, **AG EF p**, **EG AF p**, **AF EG p**, **EF AG p**, **EF EG p**, **EG EF p**.

Exercise 8.2

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



- a) Compute $\llbracket \mathbf{EG} q \rrbracket$ and $\llbracket \mathbf{EF} q \rrbracket$.
- b) Compute $\llbracket \mathbf{AG} \mathbf{AF} p \rrbracket$ and $\llbracket \mathbf{AF} \mathbf{AG} p \rrbracket$.