Technische Universität München **Summer Semester 2015**
I7
J. Esparza / A. Durand-Gasselin / D. Suwimonteerabuth **11.06.2015**

Model Checking – Exercise sheet 8

Exercise 8.1: What is syntactic sugar ?

CTL operators are defined as QT where Q is A or E and T is any LTL modality ($\mathbf{X}, \mathbf{F}, \mathbf{G}, \mathcal{U}, \mathcal{W}, \mathcal{R}$). So many operators means a lot of cases to handle for inductively proving results on CTL.

1. Show that any operator can be written by means of the three operators $E\mathbf{X}, E\mathbf{G}, E\mathcal{U}$ (and also with the boolean connectives).
2. Informally, why is $E\mathbf{G}$ necessary ?

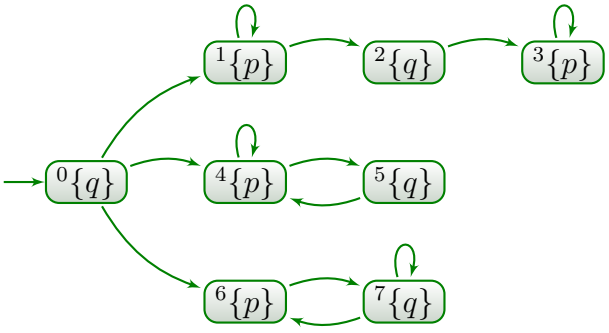
Exercise 8.2: Composition of unary operators

We are interested in combinations of CTL operators:

1. Draw an implication graph between $E\mathbf{F}E\mathbf{F}\varphi, E\mathbf{G}E\mathbf{G}\varphi, A\mathbf{F}A\mathbf{F}\varphi, A\mathbf{G}A\mathbf{G}\varphi$.
2. Add to the graph $A\mathbf{F}E\mathbf{F}\varphi$ and $E\mathbf{F}A\mathbf{F}\varphi$.
3. Give an example of a tree satisfying only the weaker constraint for each strict implication, when $\varphi = p$.
4. Complete that graph with $A\mathbf{G}A\mathbf{F}\varphi$, $A\mathbf{F}A\mathbf{G}\varphi$, $A\mathbf{G}E\mathbf{F}\varphi, E\mathbf{G}A\mathbf{F}\varphi$, $A\mathbf{F}E\mathbf{G}\varphi$, $E\mathbf{F}A\mathbf{G}\varphi$, $E\mathbf{F}E\mathbf{G}\varphi$ and $E\mathbf{G}E\mathbf{F}\varphi$.

Exercise 8.3: Fixpoint computations

We give the following Kripke structure:



1. Compute $[\![E\mathbf{G}q]\!]$ and $[\![E\mathbf{F}q]\!]$.
2. Compute $[\![A\mathbf{G}A\mathbf{F}p]\!]$ and $[\![A\mathbf{F}A\mathbf{G}p]\!]$.
3. Does $K \models \mathbf{FG}p$? Does $K \models \mathbf{GF}p$?