UNIVERSITÄT ZU LÜBECK
INSTITUTE FOR SOFTWARE ENGINEERING
AND PROGRAMMING LANGUAGES

isp

Development of Safety Critical Systems(Sichere Software) winter term 18
Martin Leucker, Grigory Markin, Felix Lange November 29, 2018

Exercise Sheet 4

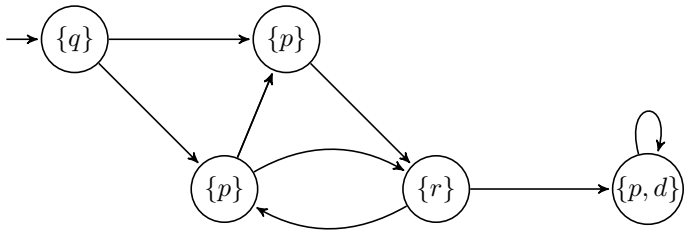
Task 4.1 Linear-time temporal logic

Specify the following properties of linear executions using LTL

- "p holds in the third position."
- "p never holds."
- "p holds before the third position or it never holds."
- "p holds from the beginning until q holds."
- "p holds from the beginning until q holds and q has to hold sometime."
- "p holds at most, as long as q holds."
- $\{w \in \Sigma^\omega \mid \forall_{i \in \mathbb{N}} \{p, q\} \subseteq w_i\}$
- $\{w \in \Sigma^\omega \mid \exists_{i \in \mathbb{N}} \{p, q\} \subseteq w_i\}$
- Σ^ω
- $\emptyset$

Task 4.2 Labeled Transition System

Consider the following labeled transition system.



Which of the following properties hold in *all* executions of the transition system ?

- p
- $\mathrm{F}\, d$
- $\neg\, \mathrm{F}\, d$
- $\mathrm{G}\, \mathrm{F}\, p$
- $\mathrm{F}\, \mathrm{G}(p\, \mathrm{U}\, q)$
- $q\, \mathrm{U} \neg (p\, \mathrm{U}\, d)$
- $\mathrm{G}(p \rightarrow \mathrm{X}\, \mathrm{F}\, p)$
- $\mathrm{X}\, \mathrm{X}\, \mathrm{X}\, p$

Task 4.3 Symbolic Encoding

Consider the labeled transition system from the previous Task.

- How many variables do we need to encode the transition system in propositional logic ?
- Define the set of propositional variables V and describe the set of initial states and the transition relation by propositional formulas I and T respectively.
- Consider LTL properties from the previous task that do not hold for the considered transition system. Find for every the properties the lowest bound k (if there exists one) that is enough to falsify the property using the Bounded Model Checking algorithm.