Learning Goals for IN5110

Tobias John

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After the lecture, the students are able to...

1 Introduction

- explain what we mean by "correctness" and how formal methods and model checking can be used to asses it.
- explain advantages and restrictions of model checking compared to testing and argue, when to use model checking.

2 Logic

- define propositional and first-order logic and explain differences.
- explain the difference between syntax and semantic.
- use these logics to express properties of systems and describe their limitations.

3 Transition Systems and Temporal Logic

- provide the definition of labeled transition systems.
- build transition systems as models for provided systems.
- build the transition system for a provided program.
- use the asynchronous product to build a model for systems running in parallel.
- define CTL* formulas.
- use temporal logic to describe provided, informal properties.
- decide if a system is a model for a (simple) temporal property.

4 LTL Model Checking

- define LTL formulas.
- explain the concept of "linear time" and compare it to the concept of "branching time".
- name the temporal operators and explain their semantics.
- explain the concept of dual connectives and complete sets of operators.
- know different classes of LTL formulas and identify them for provided formulas.
- provide the general approach of LTL model checking.
- define and explain the concept of a (generalized) Büchi automaton.
- transform a provided transition system into an equivalent Büchi automaton.
- explain in which cases one wants to use "stutturing".
- provide an equivalent Büchi automaton for a provided LTL formula.
- define maximal consistent sets and build them for a provided LTL formula.
- explain the algorithm to construct a generalized Büchi automaton for a LTL formula.
- explain the construction to turn generalized Büchi automata into Büchi automata and show it on provided examples.
- construct an automaton for the intersection of the languages of two Büchi automata.
- explain the general algorithm to check emptiness of a Büchi automaton.
- define SCCs and identify them in a provided Büchi automaton.
- explain how SCCs can be used to check for emptiness of Büchi automata.
- name the complexity of LTL model checking and explain why it is such.

5 CTL Model Checking

- explain the concept of "branching time" and compare it to the concept of "linear time".
- provide the computation tree for a given transition system.
- define CTL formulas.

- explain the semantic of CTL formulas.
- name examples of formulas that are not expressible in CTL / LTL.
- explain the general CTL model checking algorithm.
- decide (using the algorithm) if a system models a CTL formula.
- execute the shown fixpoint algorithms on provided examples.
- explain the concept of "symbolic state model checking".
- define switching functions.
- encode provided sets of states and transition relations as transition functions.
- explain why switching functions are a useful model for symbolic state model checking.
- define (reduced) (O)BDDs
- construct a reduced OBDD for a provided switching function.
- name the complexity of CTL model checking and explain why it is such.
- argue, when to use CTL model checking and when to use LTL model checking.

6 CTL* Model Checking

- explain the relation between CTL*, LTL and CTL.
- name the general approach for CTL* model checking.
- name the complexity of CTL* model checking and relate it with the complexity of LTL and CTL model checking.