Formal Methods (VIMIMA07)

Topics for the Final Exam

Materials: https://inf.mit.bme.hu/en/edu/courses/formal-methods/materials

Formalization of requirements using temporal logics:

1. Basic formalisms: Kripke Structure, Labelled Transition System, Kripke Transition System, Timed Automata.

2. Linear time temporal logics: The operators of PLTL, its formal syntax and semantics.

3. Branching time temporal logics: The operators of CTL and CTL*, their formal syntax and semantics. Comparison of the expressiveness of PLTL, CTL and CTL*.

Model checking:

4. Model checking using the tableau method: The tableau construction rules. Application of the tableau method for model checking PLTL properties.

5. Model checking based on the semantics: Model checking with iterative labelling in case of CTL properties.

6. Binary decision diagrams: The definition and construction of ROBDD. Representing a Boolean function using ROBDD. Applying logic operations on the ROBDD representation.

7. The basic idea of symbolic model checking: The role of characteristic functions. Implementing model checking with the help of ROBDD representations.

8. Bounded model checking: The basic idea of bounded model checking. The algorithm for bounded model checking. Typical problems in case of software model checking.

Statecharts:

9. Model elements in statecharts: States and hierarchical state refinement, history states, state configurations. The types and labels of state transitions.

10. Informal semantics of statecharts: The basic concepts of event processing, the „run-to-completion" principle. Conditions for enabled transitions, the resolution of conflicts, the rules of firing, the ordering of actions.

Petri nets:

11. Basic concepts of Petri nets: Formal definition of Petri nets. The rules for enabled transitions and firing of transitions. Extensions: inhibitor arcs, priorities, places with finite capacity. The comparison of the expressiveness of simple and extended Petri nets.

12. Simulation of Petri nets: Simulation algorithms for simple Petri nets and Petri nets extended with priorities. Modelling activities and resources in Petri nets.

13. Dynamic properties of Petri nets: The notion of reachability. The definition of boundedness, liveness, reversibility, home state, coverability, persistence, and fairness. Typical application of dynamic properties in practical modelling.

14. Reachability analysis of Petri nets: The construction of reachability and coverability graphs (the related algorithms.

15. Structural properties of Petri nets: Place and transition invariants. The basic idea for checking and computing invariants. Structural boundedness and liveness. Typical application of structural properties in practical modelling.

Colored and Stochastic Petri nets

16. Basic concepts of colored Petri nets: Model elements in colored Petri nets. Application of color sets for the specification of place types. Specification of initial markings, arc expressions, and guard conditions.

17. Semantics of colored Petri nets: The conditions for enabled transitions, bindings, and firing of transitions. Mapping colored Petri nets to simple Petri nets.

18. Stochastic Petri nets: Firing rule in stochastic Petri nets. Various types (classes) of stochastic Petri nets.