Verification, Performance Analysis and Controller Synthesis for Real-Time Systems

Kim G. Larsen

CISS, Aalborg University, Denmark

The lectures will provide a thorough tutorial of the tool UPPAAL and the newly emerged branches UPPAAL Cora, UPPAAL Tron and UPPAAL Tiga (see `www.uppaal.com`) and their applications to the modeling, simulation, verification, optimal scheduling and planning synthesis, and testing.

Particular attention will be given to the theory of the underlying formalisms of the UPPAAL tool suite, including: timed automata, priced timed automata, and (priced) timed games addressing a number of associated decision problems related to model-checking and optimal scheduling and strategies. The lectures will highlight the by now classical region-construction underlying the decidability of several of these problems. Also, the frontier of decidability will be drawn including pointing out a number of open problems.

Though indispensable for showing decidability, the notion of region does not provide the means for efficient, practical tool implementations. The lectures will provide a thorough description of the algorithms and data structures used in the UPPAAL tool suite and their impact on performance on practical examples. This will include detailed accounts of so-called zones, unions of zones, and priced zones and their efficient representation using symbolic datastructures such as difference bounded matrices and clock difference diagrams. Also, the on-the-fly algorithmic principle underlying all branches will be detailed.

During the lectures the demonstration and application of the UPPAAL tool suite will be given on a number of practical and industrial cases.

UPPAAL is a tool for modelling, simulating and verifying real-time and hybrid systems, developed collaboratively by BRICS at Aalborg University and Department of Computer Systems at Uppsala University since the beginning of 1995 (see `www.uppaal.com`).

It will be usefull to have consulted the following references to some degree. Downloads of these as well as several other papers may be obtained from `www.cs.aau.dk/∼kgl/Marktoberdorf08/`.

References

1. G. Behrmann, A. David, and K. G. Larsen. em A Tutorial on Uppaal. In "Formal Methods for the Design of Real-Time Systems"; International School on Formal Methods for the Design of Computer, Communication and Software Systems; LNCS 3185; 2004.

2. J. Bengtsson and Wang Yi. *Timed Automata: Semantics, Algorithms and Tools.* In Concurrency and Petri Nets 2004; LNCS 3098; 2004.

3. G. Behrmann, K. G. Larsen, and J. I. Rasmussen: *Optimal Scheduling Using Priced Timed Automata.* In ACM SIGMETRICS Performance Evaluation Review, Vol. 32 (4); pp 34–40; ACM Press; 2005.

4. P. Bouyer and F. Chevalier. *On the Control of Timed and Hybrid Systems.* EATCS Bulletin 89; pp 79–96; 2006.

5. P. Bouyer, F. Cassez, E. Fleury, and K. G. Larsen. *Synthesis of Optimal Strategies Using HyTech.* In Proc of the Workshop on Games in Design and Verification (GDV'04); Boston, USA; ENTCS 119(1), pp 11–31; 2004.