Approximating Hybrid System Dynamics for Analysis and Control

Bruce H. Krogh

Department of Electrical and Computer Engineering, Carnegie Mellon University
Pittsburgh, PA 15213-3890 USA
krogh@ece.cmu.edu

Abstract. The objective of this lecture is to survey and assess the state of the research on methods for approximating hybrid system dynamics. For all but the most trivial dynamic systems, approximations are necessary to make analysis and controller synthesis tractable. This is true for both continuous-state systems and discrete-state systems, and theories have been developed in both domains to justify and guide model simplification and approximation (although ad hoc engineering judgment remains the method of choice in most applications). For hybrid systems, decidability results indicate that approximations will always be necessary to solve analysis and controller synthesis problems for even the simplest systems. These results will be reviewed briefly as a motivation for the work on approximation methods.

We will then consider two principal types of approximations that have been explored in the literature. The first set of methods approximates general hybrid system dynamics with simpler hybrid models for which some computational tools exist, such as linear or timed automata. The second set of methods generates finite-state discretizations of the continuous dynamics in a hybrid system so that tools for discrete-state systems can be applied. In both cases, the literature will be reviewed and success with applications will be assessed. Strengths and limitations of each approach will be summarized, and the types of problems that can be solved using each approach will be identified. Some software packages for building and approximating hybrid system models will also be reviewed and examples will be presented.

The final part of the lecture will discuss prospects for the future, both in terms of a theory for approximating hybrid systems dynamics and tools for computer-aided analysis and controller synthesis. Open problems and directions for future work will be identified.

F.W. Vaandrager and J.H. van Schuppen (Eds.): HSCC'99, LNCS 1569, pp. 2–2, 1999.