Adaptation is a Game

Roberto Bruni Andrea Corradini Fabio Gadducci
Dipartimento di Informatica, Università di Pisa, Italy

Alberto Lluch Lafuente Andrea Vandin
IMT Institute for Advanced Studies Lucca, Italy

ABSTRACT

Software systems operating in unpredictable environments must be *self-adaptive*. Unfortunately, there is no agreed foundational model for adaptation. Already in 1963 Lofti Zadeh claimed that *"it is very difficult—perhaps impossible—to find a way of characterizing in concrete terms the large variety of ways in which adaptive behavior can be realized"*. His pessimism was due to the inherent difficulty of subsuming both the *external* manifestations of adaptive systems (*black-box* adaptation) and the *internal* mechanisms that realize adaptation (*white-box* adaptation) in a coherent view.

Generally speaking, a program is considered to be adaptive if it modifies its own behavior in response to changes in its operating environment. According to the traditional view, a program is made of *control* (i.e. algorithms) and *data*. A change in the behavior implies a change in the data. The identification of suitable *control data* leads to an unambiguous definition of adaptation: the run-time modification of such data [1].

The above view can be elegantly formalized in variants of game models for open systems such as Interface Automata [3] enriched with formal counterparts of control data [2]. We argue that such formalization may help to reconcile black- and white-box approaches to adaptation, and may enable the use of Interface Automata both as a component-based design framework and as a verification framework for adaptive systems. For instance, model checking techniques for game models can be used to decide to which extent a system is able to adapt in order to satisfy its requirements despite of changes in the environment.

BODY

Control data variants of game models such as Interface Automata are suitable for the design and analysis of self-adaptive systems.

REFERENCES

[1] R. Bruni, A. Corradini, F. Gadducci, A. Lluch-Lafuente, and A. Vandin. A conceptual framework for adaptation. In *Procs. of 15th Intl. Conference on Fundamental Approaches to Software Engineering (FASE 2012)*, volume 7212 of *Lecture Notes in Computer Science*, pages 240–254. Springer, 2012.

[2] R. Bruni, A. Corradini, F. Gadducci, A. Lluch Lafuente, and A. Vandin. Adaptable transition systems. In *Procs. of 21st Intl. Workshop on Algebraic Development Techniques (WADT 2012)*, volume 7841 of *Lecture Notes in Computer Science*, pages 95–110. Springer, 2013.

[3] L. de Alfaro and T. A. Henzinger. Interface automata. In *Procs. of 8th European Software Engineering Conference/9th ACM SIGSOFT Intl. Symposium on Foundations of Software Engineering (ESEC/SIGSOFT FSE 2001)*, volume 26(5) of *ACM SIGSOFT Software Engineering Notes*, pages 109–120. ACM, 2001.

Volume 2 of Tiny Transactions on Computer Science