Title:

Adaptive virtual organisms: A compositional model for hardware-software binding in the IoT era

Abstract:

This talk focuses on extensions of regular languages/expressions in 2 and 3 dimensions, with applications to interactive, distributed, adaptive systems. We start with a new model of adaptive systems, called ``virtual organisms''; then we briefly present Agapia, a structured HPC programming environment, here used for getting quick implementations for virtual organisms simulations.

The relation between a structure and the function(s) running on that structure is of central interest in many fields. Our presentation addresses this question with reference to computer science recent hardware/software advances, particularly in areas as IoT, CPS, robotics, self-systems, etc.

At the modeling, conceptual level, the key ingredient is the introduction of the concept of ``virtual organism'', to populate the intermediary level between rigid, slightly reconfigurable, hardware agents and abstract, intelligent, adaptive software agents. A virtual organism has a structure, resembling the hardware capabilities, and it runs low-level functions, implementing the software requirements. Roughly speaking, it is an adaptive, reconfigurable, distributed, interactive, open system, consisting of a network of heterogeneous computing nodes, with a constrained structural shape, and running a bunch of overlapping functions. The model is compositional, both in space (allowing the virtual organisms to aggregate into larger organisms) and in time (allowing the virtual organisms to get composed functionalities).

Technically, the virtual organisms presented here are in two dimensions (2D) and their structures are described by regular 2D pattens (including also the time dimension, we get a model using 3D regular patterns). By reconfiguration, an organism may change its structure to another structure belonging to the same 2D pattern. We illustrate the approach briefly describing three simple organisms: (1) a tree collector organism; (2) a feeding cell organism, consisting of a membrane, with collecting/releasing trees attached on its external/internal side; and (3) an organism consisting of a collection of connected feeding cell organisms.

The second part is a brief survey of work on register-voice structured interactive systems (rv-IS model) and on Agapia programming. The rv-IS model is based on space-time duality and is used for modeling, programming and reasoning about structured, open, interactive systems. Agapia, introduced ten years ago, is a structured programming language where dataflow and control flow structures can be freely mixed. Currently, its compiler produces HPC executions, within either MPI or OpenMP environments.

Bio:

Gheorghe Stefanescu is a Professor of Computer Science at the University of Bucharest, where he was the first head of the newly established Department of Computer Science (2009-2016). He has extensive experience in the formal methods research area, with a focus on programming languages and distributed systems. Before joining University of Bucharest in 1995, he spent 15 years as a researcher at the Mathematical Institute of the Romanian Academy. He obtained his PhD at University of Bucharest in 1992. He held several visiting positions at National University of Singapore (3 years), University of Illinois at Urbana-Champaign (1 year), Kyushu University (1 semester). He was awarded the “Grigore Moisil” award of the Romanian Academy in 2002 (for year 2000 publications).