Eesti Teaduste Akadeemia seminaride sari

TEADUSE UUED SUUNAD

KOMPLEKSSÜSTEEMID: ARENG JA ILMNEV KÄITUMINE

(seminar toimub inglise keeles)

COMPLEX SYSTEMS: GROWTH AND EMERGENT BEHAVIOUR

9. October 2009, 13:00 – 16:00

In the Academy House, 6 Kohtu str. Tallinn

This seminar discusses various aspects of complex systems (natural and artificial) related to the ways and possibilities of controlling their growth, and/or the resulting behaviour.

The authors, all involved in SAGECCO project, have suggested exploiting knowledge and properties of growing biological systems to engineer complex systems using similar growth processes, as the way to find vanishingly small regions of their phase space where they can exist and function as expected. Such growth to (dynamic analogue of) an attractor automatically provides repair (elimination of deviation from the desired growth trajectory) and homeostasis.

The following presentations demonstrate the scope and variety of problems and approaches that are to be dealt with in order to gain the ability to (partially) control the growth of complex systems.

Agenda

13:00 – 13:15 Opening, ***Jüri Engelbrecht***, Estonian Academy of Sciences, Vice-President

13:15 – 13:45 ***Susan Stepney***, Department of Computer Science, University of York, U.K.

COMPUTATION AND GROWTH

The ideas of computation are considered from the perspective of growth: growth and change of the space over which the computation progresses. Ideas of growth are inspired from the areas as diverse as the biological growth of an organism, to some Quantum Gravity notions of the growth of space-time itself. Growth concepts are discussed from a computational stance; required additions to computational theory to encompass such a growth perspective are also discussed.

13:45 – 14:15 ***Paul Valckenaers***, Department of Mechanical Engineering, Katholieke Universiteit Leuven, Belgium

INTEGRATE-ABILITY, MIRRORING THE REAL-WORLD AND CONTEXT-DRIVEN COORDINATION AND CONTROL

This presentation addresses the issues arising by integrating systems/solutions that are developed largely independently, but need to interact after integration. The presentation distinguishes which development steps and design decisions are respectively safe, or prone to cause integration problems. From this theoretical analysis, the elements that provide the proper context within a computer network and context-driven coordination mechanisms that regularly "re-grow" their solutions emerge as top candidates for scalable and integrate-able system components.

14:15 – 14:45 ***Farhad Arbab***, Centre for Mathematics and Computer Science, Centrum Wiskunde and Informatica, the Netherlands

GROWTH THROUGH DYNAMICALLY RECONFIGURABLE COORDINATION

Growth, as a special form of evolution/reconfiguration in a system, consists of two distinct, though intertwined, aspects: structure and behaviour. The effect of growth on the structure of a system is often most visible, as it is changed, e.g., to accommodate the addition of new entities. By modifying the way in which the existing entities in a system interact with one another or with the newly added entities, perhaps less visibly, growth invariably also changes the behaviour of a system. Thus, formal modelling and analysis of growth/evolution require formal models to concretely express not only the structure of a system, but also the interaction protocols among its constituents, in a form that makes those protocols amenable to direct manipulation by transformations that comprise a model of growth. The coordination language Reo offers a model of interaction/coordination where protocols are composed out of primitive interactions in a form that resembles the construction of electronic circuits from gates and elements. Reconfiguration of a protocol can then be expressed as algebraic graph transformation rules that manipulate a Reo circuit. In this talk we describe Reo, its tool support, and how it can be used to model evolution/growth of interaction/coordination in complex systems.

14:45 – 15:15 ***Julian Miller***, Department of Electronics, University of York, U.K

TRULY COMPLEX PROGRAMS CANNOT BE WRITTEN BY HUMANS…

The presentation discusses a visual programming environment that is inspired by the process of biological development. The idea is that programmers of the future will manipulate and develop visual software made from computational stem cells which differentiate into specialised computational sub-programs. They will manipulate the complex software through operations that are computational analogues of horticulture: planting, pruning, grafting, and genetic manipulation. They will interact with the software in a visual way rather than at the level of detailed computer code.

15:15 – 15:45 ***Leo Motus***, Research Lab for Proactive Technologies, Department of Computer Control, Tallinn University of Technology, Estonia

TOWARDS BEHAVIOUR VERIFICATION IN SELF-ORGANISING AND IN NETWORKED/INTEGRATED SYSTEMS

In order to control and improve the efficiency of growth processes in (artificial) complex systems they are to be monitored and assessed regularly. Conventional assessment methods (e.g. traditional formal verification and validation methods) are applicable to comparatively simple systems with static structure. This presentation departs from characteristic properties of complex systems – e.g. networked autonomous components with situation-dependent interactions pattern, increased share of proactive components, direct mediated interactions with the environment – and suggests an innovative approach to on-line behaviour verification. This approach is built around situation-aware interaction-centred model of computation and implants specific mediated interactions into the system's structure for control purposes.

15:45 - 16:30 General discussion