Foundation of Software Technology (FaST)

by Marcello Bonsangue

Leiden Institute of Advanced Computer Science
Research & Education

Members

- Professors
  - F. Arbab, Head of Cluster
  - Joost Kok, Head of Cluster
  - Frank de Boer
- Associate Professors
  - Jetty Kleijn
  - Marcello Bonsangue
  - Luuk Groenewegen (retired)
- Assistant Professors
- PostDocs
  - Natallia Kokash
  - Michiel Helvenstein
  - Stijn de Gouw
- PhD Students
  - Bahamn Pourvatan
  - Jurriaan Rot
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  - Nikolaos Bezirgiannis
  - Kayvan Azadbakht
  - Kasper Dokter,
  - Sung Jongmans,
  - Natallia Kokash,
  - Chetan Nagarajagowda
  - Behrooz Nobakht
- Secretary
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Mission

- Development of formalisms, methods, techniques, and tools to design, analyze, and construct software systems out of components and services.

- Ingredients
  - Classes/Objects
  - Components
  - Services
- Construction
  - Composition
  - Correctness
- Issues
  - Concurrency
  - Coordination
  - Model
- Approach
  - Formal methods
  - Experimental systems
  - Empirical studies

Vision

- Mastering the complexity of modern software systems
  - Embedded systems
  - Systems of independent components
  - Service composition
  - Multi-core chips

- Characteristics
  - Concurrency
  - Distribution
  - Mobility
  - Dynamic reconfiguration / self-adaptation
  - Multiple, independent providers
  - Third-party black-box composition
  - Compositional end-to-end QoS

Areas

- Dynamically reconfigurable systems
- Testing, deductive verification, and model checking
- Formal models of concurrent, distributed, object oriented, and component-based systems.
- Formal semantics, process algebras and logics for reasoning about such systems
- Quality of service

Major challenge

Development of techniques for effectively establishing behavioral properties of dynamical systems

Activities – F. Arbab

- Coordination models and languages
  - Coordinated composition of software intensive systems
  - Coordination language Reo
  - Constraint automata

- Use of coordination
  - Compositional QoS
  - Code generation for multi-core systems
  - Service oriented computing
  - Testing

Activities – F.S. de Boer

- Software correctness
  - Programming logics
    - Deductive proof methods for the verification of programs
  - Object Orientation
    - Verification and Testing
  - Concurrency
    - Semantics
    - Multi-core programming
    - Cloud aware programming
  - Integrated Formal Methods
    - Testing
    - Model checking
    - Deductive verification
    - Abstraction

Activities – M. Bonsangue

- Formal Methods
  - Mathematically-based techniques for the specification, development and verification of software and hardware systems
    - Testing
    - Semantics and model checking of software connectors
    - Semantics and verification of dynamical evolving systems

- Algebra, Coalgebra and Logic
  - Mathematical frameworks for the specification of the reactive behaviour of systems
    - Process algebra, regular expressions
    - (Probabilistic, non-deterministic, …) automata
    - Modal logics

Activities – L. Groenewegen

- Coordination models
  - Paradigm language
    - PARallelism, its Analysis, Design and Implementation by a General Method
    - Modeling behaviors and constraints thereon
- Coordination patterns
  - Self-adaptation patterns
    - McPal
    - On-the-fly migration through coordination
    - Managing changing processes

Activities – J. Kleijn

- Concurrency
  - Using Petri nets, Team Automata, and other automata formalisms to model, analyze, and verify the behavior systems:
    - Computation
    - Biological systems
    - Hardware and software components

Interest in formal methods

- ***Maths for formal methods***

  Algebras, coalgebras and logics.

- ***Deductive verification***

  Study of logical formalism with the goal of proving formally that the software satisfies its specification.

- ***Model checking***

  Development of technique to automatically check that the software satisfies its specification.

- ***Testing***

  Executing a program with the intent of finding bugs.

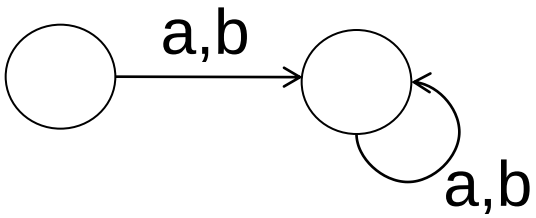
Few bachelor projects

- Equations and automata
- Parsing trees from derivatives
- Recursive guarded languages

- Monitoring and runtime verification
- Flow graph for a OO-language
- Resource aware programming
- Application specific scheduling

Equations and automata

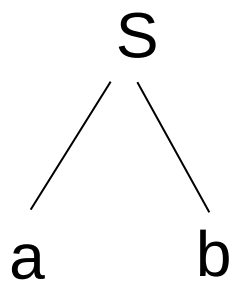
- Equation aab = ba



- Problem: Find a complete set of equations satisfied by an automaton.

Parsing trees from derivatives

- $S \rightarrow aSb \mid ab$
- $S_{ab} = (S_a)_b = (Sb \mid b)_b = S \mid \Lambda$



- Problem: Construct a parsing tree from the derivatives.

Recursive guarded language

- Regular guarded language
  - 0 — empty language
  - 1 — empty word language
  - b — Boolean actions
  - a — ordinary actions
  - r + r, r;r — choice, seq. composition
  - r* — recursion

- Problem: Extend it with full recursion.